Environment, Technology, and Development

Yearbook for the History of Global Development

Environment, Technology, and Development

Volume 5

Environment, Technology, and Development

Edited by
Ismay Milford, Corinna R. Unger, and Iris Borowy

DE GRUYTER
OLDENBOURG

This publication was financed in part by the Open Access Fund for Books of Freie Universität Berlin.

ISBN 978-3-11-161004-7
e-ISBN (PDF) 978-3-11-161135-8
e-ISBN (EPUB) 978-3-11-161168-6
ISSN 2702-1327
DOI https://doi.org/10.1515/9783111611358

Library of Congress Control Number: 2025944850

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.dnb.de.

This book is published open access at www.degruyterbrill.com.

Cover image: Gettyimages / ipopba
Printing and binding: CPI books GmbH, Leck

www.degruyterbrill.com
Questions about General Product Safety Regulation:
productsafety@degruyterbrill.com

Contents

Ismay Milford, Corinna R. Unger, and Iris Borowy

Environment, technology, and development: History of a contentious relationship

Introduction

At the first *All-African Seminar on the Human Environment*, held in Addis Ababa in August 1971, Ghanaian diplomat and UN official Fred Arkhurst assured delegates that there was "no conflict, at this stage, between environment and development."[1] He argued that both "underdevelopment" and "uncontrolled development," but not development per se, caused environmental problems. During the discussion that followed, however, some insisted that "any kind of physical development did have an impact on ecosystems," and others pointed out that "technological prosperity [had] often been achieved at a high price."[2] The meeting had been organised in anticipation of the famous *United Nations Conference on the Human Environment*, scheduled to take place in Stockholm in 1972, in view of the conflicting interests of what were referred to as "developed" and "developing" states. Many representatives of African states at Addis Ababa were apprehensive that the growing emphasis on the environment in international organizations would stall national economic development plans and provide a pretext for industrialized countries to move their "pollutive industries" to countries on the African continent. In response, one resolution passed in Addis Ababa promoted "intermediate technology" – small-scale, people-centered, and in line with "traditional forms of education."[3]

The dilemma about whether technology could produce measurable socio-economic development without environmental degradation was characteristic of debates in international fora in the 1970s and 1980s. These debates were punctuated by concerns over global power asymmetries, and by attempts to pin down the meaning of and relationship between development, environment, and technology.

1 "Summary of statements by Fred Arkhurst and Enrique Iglesias of the Secretariat of the UN Conference on the Human Environment," in United Nations, *Report of the First All-African Seminar on the Human Environment* (UN Economic Commission for Africa, 1971), 6.

2 "Summary of discussion following the statements," in United Nations, *Report of the First All-African Seminar*, 9.

3 United Nations, *Report of the First All-African Seminar*, 10, 15.

https://doi.org/10.1515/9783111611358-001

Coming in the wake of the first UN Development Decade, political independence for states in much of Africa and Asia, the emerging environmental movement, and a widespread fascination with high-profile technological feats such as the landing of humans on the moon, considering technology, environment, and development as a combined element of the global agenda was not far-fetched.

Several events bore this out. In 1963, the UN held a conference dedicated to the *Application of Science and Technology for the Benefit of the Less Developed Areas.* Participants consisted almost entirely of people from the global North. The conference produced an eight-volume report dedicated, among other topics, to natural resources, agriculture, industry, urbanization, education, and science. The dominant view of technology at the conference was overwhelmingly positive, and the environment tended to be regarded as a place whose limitations science and technology could overcome. Professor Bernardo A. Houssay from Argentina expressed a characteristic attitude when he declared science and technology to be "the key to progress of any nation, for on them depend its health, agricultural and industrial production, well-being and wealth, cultural development, rank and prestige, power and even independence." He suggested that "under-developed countries" faced a simple choice between science or poverty.[4]

The *United Nations Conference on the Human Environment*, for which the meeting in Addis Ababa had prepared, did discuss possible negative outcomes of technological activities, such as toxic waste or pollution, but its members clearly did not see fit to break with the overall positive view of science and technology. Principle 18 of the conference declaration framed them as part of the solution rather than the problem, stating that "[s]cience and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind."[5] Seven years later, in 1979, the UN held another large-scale event in Vienna, the *United Nations Conference on Science and Technology for Development.* This time, the global South was strongly represented. Vehement, at times acerbic debates took place before and during that meeting, pitting demands formulated by the Group-77 (consisting of non-aligned countries from Africa, Asia, and Latin America) for North-South transfers of funding and know-how against a rejection of this idea by the tradi-

4 United Nations, *Science and Technology for Development. Report on the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas* (New York: United Nations, 1963), 26–27.

5 United Nations, "Declaration of the Conference on the Human Environment," 5–16 June 1972, accessed July 21, 2025, https://documents.un.org/doc/undoc/gen/nl7/300/05/pdf/nl730005.pdf.

tionally industrialized countries, which were experiencing emerging neoliberal tendencies.[6]

Similar tensions characterized debates in the Brundtland Commission in the mid-1980s. Its report, published in 1987, expressed more clearly than earlier documents the inextricable but volatile relationship between technology, environment, and development. The report characterized technology as "the mainspring of economic growth" that contained both the "potential for slowing the dangerously rapid consumption of finite resources" and "high risks [of] new forms of pollution."[7] Gro Harlem Brundtland coined a tantalizingly simple definition of the two other terms: "the 'environment' is where we all live; and 'development' is what we all do in attempting to improve our lot within that abode."[8] If much of what people did to improve their lot, ranging from the wheel to windmills to mobile phones, involved some form of technology, then the three elements were bound together by a relationship somewhere between symbiosis and mutual destruction.

This volume, like delegates in Addis Ababa and members of the Brundtland Commission, is interested in this relationship. The international meetings, working groups, and publications of the 1970s and 1980s proved highly influential in shaping perceptions of and responses to the challenges provided by unequal development, technological interventions, and environmental degradation. They certainly brought many of the underlying tensions into the open. But the contributions in this volume show that those debates were merely episodes in a much longer, more dispersed history of thinking about and enacting this three-way relationship. This history extended far beyond international fora and into other sections of society, from theologians in late-nineteenth-century Spain to farmers in 1960s Zimbabwe. *Unlike* those we quote above, this volume does not seek to pin down a formula, nor to offer solutions to a supposedly universal and intractable dilemma. Instead, we are interested in how environment, technology, and development manifested and interacted in specific historical settings, across the world, from the mid-nineteenth to the late-twentieth centuries. Actors in these settings did not always use the terms we are employing, nor their equivalents in other languages. In some cases, they did not articulate a relationship with words at all, but

6 United Nations, Press Release, 15 August 1979, TEC/274, S-0913–0019–06, United Nations Archive, New York City, 6.
7 World Commission on Environment and Development, *Our Common Future* (Oxford: Oxford University Press 1987; repr., 2009), 4–5.
8 Gro Harlem Brundtland, "Foreword to World Commission on Environment and Development," *Our Common Future* (Oxford: Oxford University Press 1987; repr., 2009), xi.

rather enacted it, contested it, or witnessed it playing out. But they all, in their own ways and contexts, negotiated the intricacies of this three-way relationship.

In this introduction, we aim to position this volume in relation to existing research. After charting recent shifts in scholarship on the relationship between environment and technology, we will suggest why it is useful to bring development explicitly into the conversation, before setting out the insights to be gained from presenting such a broad range of rooted, historical cases together, around three themes. By bringing these cases into conversation, through practices and discourses of development, this volume takes a further step towards a more integrated approach to studying the environment-technology nexus in its complexity.

Historiographical developments

Historians have been studying the relationship between the environment and technology for a long time, but the past three decades have witnessed a distinct shift in this direction. In 1994, historians of technology Jeffrey K. Stine and Joel A. Tarr called on historians to "accelerate their in-depth exploration of the technology/nature dynamic," arguing that the relationship between environment and technology presented an understudied "interpretive challenge" for the discipline. It was illustrative of the scholarly discussion of the moment, however, that the special issue they introduced focused on the environmental ramifications of industrial activities in Europe and the USA. Describing technology as a "force used to manipulate nature for humankind's ends," the authors did not grapple with the historicity and cultural specificity of the categories of technology and environment, nor did they question where cause and consequence lay in the relationship between them.[9]

Roughly thirty years later, a roundtable on "Global Histories of Technology in Worlds of Environmental Change" suggests that the field has changed substantially.[10] For one, the Western nation state is no longer the key unit of analysis, and global phenomena and scales of investigation have taken center stage. Relatedly, critiques of Eurocentrism as well as deconstructivist approaches have left their mark on the field, challenging scholars to write global histories that do not merely reproduce elite perspectives or rely too heavily on general categories like "the West and the rest" or "global South and global North." There is much greater ap-

9 Jeffrey K. Stine and Joel A. Tarr, "Technology and the Environment: The Historians' Challenge," *Environmental History Review* 18, no.1 (March 1994): 1–7.
10 Erik van der Vleuten et al., "Roundtable: Global Histories of Technology in Worlds of Environmental Change," *Technology and Culture* 66, no.1 (2025): 11–37.

preciation for the co-production of environment and technology, for vernacular and indigenous forms of knowledge, for the importance of local sites and spaces, for material conditions and bodily experiences, and for the complexity of interactions between a variety of actors.[11]

This shift paralleled those happening in environmental history and the history of technology. If the environment was once treated as the static background to human activities, environmental historians have pointed out the degree to which the natural world around us has been the product of human intervention.[12] It has become increasingly accepted that humans have shaped their surroundings in profound, often destructive ways. Overuse of resources, notably salinization of irrigated agricultural soils and deforestation, has been a frequent feature of history.[13] In all contexts, how people have shaped their environments and have used natural resources has reflected, and often intensified, existing power relations.[14]

European colonialism has formed a major focus of environmental history as a research field. Historians have pointed out how central notions like the "mastery of nature" were to the imperial project.[15] Identifying plants, animals, minerals, and other matter that could be of economic interest became a central occupation of imperial administrations as well as private actors benefitting from political conditions. In the late nineteenth and early twentieth centuries, when many scientific and technical fields were consolidated and professionalized, colonial powers invested in the establishment of research centers in the colonies as well as at home.[16] Botanists and zoologists sought to identify the most productive species in

---

11 Peter Robb, "Bihar, the Colonial State and Agricultural Development, 1880 – 1920," *The Indian Economic and Social History Review* 25, no.2 (1988): 205 – 235; Monica M. van Beusekom, "Colonisation Indigène: French Rural Development Ideology at the Office du Niger, 1920 – 1940," *The International Journal of African Historical Studies* 30, no.2 (1997): 299 – 323; Helen Tilley, *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870 – 1950* (Chicago: University of Chicago Press, 2011).

12 Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 1979); Alfred Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900 – 1900* (Cambridge: Cambridge University Press, 1986); Ted Steinberg, *Nature Incorporated: Industrialization and the Waters of New England* (Cambridge: Cambridge University Press, 1991).

13 Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed*, revised edition (London: Penguin Books, 2011); Clive Ponting, *A New Green History of the World: The Environment and the Collapse of Great Civilizations* (London: Penguin Books, 2007).

14 Joachim Radkau, *Nature and Power: A Global History of the Environment* (New York: Cambridge University Press and German Historical Institute Washington, DC, 2008).

15 Crosby, *Ecological Imperialism*; Corey Ross, *Ecology and Power in the Age of Empire: Europe and the Transformation of the Tropical World* (Oxford: Oxford University Press, 2017).

16 See Benedikt Stuchtey, ed., *Science across the European Empires, 1800 – 1950* (Oxford: Oxford University Press, 2005); Brett M. Bennett and Joseph M. Hodge, eds., *Science and Empire: Know-*

the world and "acclimatize" them to other areas in order to optimize agricultural and livestock production.[17] As imported micro-organisms pushed back or replaced indigenous ones, categories of "foreign" and "native" were (re)constructed.[18] Different concepts of property and of valuable environments fundamentally transformed landscapes, as did intensified forms of making nature profitable through the introduction of new production methods based on mineral extraction and plantation agriculture.[19] Using coercion and sometimes outright violence, colonial administrations, in collaboration with private companies, drew on local labor in very similar ways as they drew on natural matter: as seemingly infinite resources waiting to be exploited.[20] Colonial calls for conservation and environmental protection were a part of this dynamic, rather than a divergence from it.[21] Often concealing economic interests, they allowed Europeans to present themselves as enlightened thinkers, based on misreadings of local ecologies and the simplistic and

ledge and Networks of Science across the British Empire, 1800–1970 (Basingstoke: Palgrave Macmillan, 2011).

17 M. A. Osborne, "Acclimatizing the World: A History of the Paradigmatic Colonial Science,' *Osiris* 15 (2000): 135–151; Iris Borowy, "The Other Side of Bio-Invasion: The Acclimatisation Movement in Germany," in *Invasive and Introduced Plants and Animals: Human Perceptions, Attitudes and Approaches to Management*, ed. Ian D. Rotherham and Rob Lambert (London: Earthscan 2011), 153–166.

18 Matt K. Chew and Andres H. Hamilton, "The Rise and Fall of Biotic Nativeness: A Historical Perspective," in *Fifty Years of Invasion Ecology: The Legacy of Charles Elton*, ed. David Richardson (Oxford: Wiley-Blackwell, 2011), 35–47; Matt K. Chew, "Anekeitaxonomy: Botany, Place and Belonging," in *Invasive and Introduced Plants and Animals*, ed. Rotherham and Lambert, 137–152.

19 William Cronon, *Changes in the Land: Indians, Colonists, and the Ecology of New England* (New York: Hill & Wang, 1983); John M. Mackenzie, ed., *Imperialism and the Natural World* (Manchester: Manchester University Press, 1990); Tom Griffiths and Libby Robin, eds., *Ecology and Empire: Environmental History of Settler Societies* (Edinburgh: Keele University Press, 1997); William Beinart, *The Rise of Conservation in South Africa: Settlers, Livestock, and the Environment 1770–1950* (Oxford: Oxford University Press, 2003); Jane Carruthers, *The Kruger National Park: A Social and Political History* (Pietermaritzburg: University of Natal Press, 1995); Claudio Garavaglia and Juan Carlos Garavaglia, eds., *La naturaleza colonizada: Ecología y medio ambiente en la historia de América Latina* (Mexico City: Universidad Autónoma Metropolitana, 2003).

20 J. P. Daughton, *In the Forest of No Joy: The Congo-Océan Railroad and the Tragedy of French Colonialism* (New York: W. W. Norton, 2021); Armel Campagne, "French Colonizers and Coal Mining in Colonial Vietnam, 1873–1939" (PhD diss., European University Institute Florence, 2024).

21 Gufu Oba, *African Environmental Crisis: A History of Science for Development* (New York: Routledge, 2020); James Fairhead and Melissa Leach, *Misreading the African Landscape: Society and Ecology in a Forest-Savannah Mosaic* (Cambridge: Cambridge University Press, 1996); Giovanni Tonolo, "Oil-Palm Development in Dahomey/Bénin: A socio-environmental history, 1894–1978" (PhD diss., European University Institute Florence, 2024).

racist assumption that observations from European contexts could be transferred to allegedly less civilized places.

For all the attention colonial history has received, it is not the only field in which the interplay between technology and environment can be studied. Also, the types of technologies involved were not limited to colonial settings and changed over time. Specifically, the twentieth century saw a proliferation and intensification of technologies that came to set it apart from earlier periods and the conditions of colonial rule. For example, hydroelectric power in combination with the engineering capacity necessary to build large dams reshaped major rivers and river valleys around the world. The invention of the electric chainsaw and the mechanization of forestry more generally accelerated the speed of deforestation dramatically. Farming machinery incentivized the creation of huge monoculture fields and privileged the economic development of countries whose landscapes favored such agricultural formats, notably the United States, Canada, Australia, and the USSR.[22] The availability of cheap energy proved transformative to the relationship between technology and the environment. Much of this transformation, aptly called the Great Acceleration, took place on a global scale after the Second World War, leading historian Christian Pfister to coin the expression of the "1950s Syndrome."[23] Bringing the nineteenth and twentieth centuries together, as this volume does, at times affirms these turning points, at other times challenges them.

The question of where, how profoundly, and for how long humans (and technologies) have shaped the environment received new impetus with the notion of the Anthropocene, a term to designate a geological era defined by the impact of the human species, proposed by atmospheric physicist Paul Crutzen and biologist Eugene F. Stoermer in 2000 and taken up across the disciplines since. While some historians embrace the potential usefulness of the term, others argue that the narrative of a shared, planetary condition obscures the systems that some humans have created and benefited from historically, namely capitalism and colonialism, and even that it serves those same interests today.[24]

22 David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W.W. Norton, 1997); John R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (New York: W.W. Norton, 2000).

23 Christian Pfister, "The '1950s Syndrome' and the Transition from a Slow-Going to a Rapid Loss of Global Sustainability," in *The Turning Points of Environmental History*, ed. Frank Uekoetter (Pittsburgh: Pittsburgh University Press, 2010), 90–118; John R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge, Mass.: Harvard University Press, 2016).

24 Timothy Makori et al., eds., "Anthropo*scenes* in Africa. Lived experiences of planetary transformation," special issue of *Journal of Political Ecology* (forthcoming, 2025); Manuel Arias-Maldonado, "Towards a Good Anthropocene?" in *Rethinking the Environment for the Anthro-*

The discussion about how we narrate the planet has led historians to place new emphasis on the production of the *idea* of the environment in the past, how far this idea shaped how people interacted with their surroundings, and which consequences those interactions had. The concept of a connected, planetary environment stretches at least into the nineteenth century – a pre-history of sorts to Earth Systems Science and the term Anthropocene. In the early twentieth century, for example, the notion of the Noosphere gained brief currency, proposing that technology facilitates rapidly intensifying cultural and scientific exchanges between people around the globe, creating a shared intellectual dimension that leads to an increasingly unified and responsible stewardship of planet Earth.[25] These concepts have never existed in an ideational vacuum but have been decisively shaped by structures of international governance, scientific standardization, and technologies developed for warfare.[26]

In parallel to these trends in environmental history, in histories of technology the growing influence of Science and Technology Studies (STS) has allowed for a greater emphasis on the co-constitution of society and technology and the importance of environmental materiality. This perspective effectively challenges an older, diffusionist view on technology that tended to reproduce Eurocentric narratives anchored in colonial and imperial logics. Studies of how European colonial powers used technologies as "tools of empire" risked uncritically reproducing a trust in technology.[27] In recent years, however, this top-down narrative has been challenged by scholars who argue that the concept follows the self-de-

pocene, ed. Manuel Arias-Maldonado and Zev Trachtenberg (London: Routledge, 2019), chapter 9; Christophe Bonneuil and Jean-Baptiste Fressoz, *The Shock of the Anthropocene: The Earth, History and Us* (London: Verso Books, 2016); Kathryn Yusoff, *A Billion Black Anthropocenes or None* (Minneapolis: University of Minnesota Press, 2018).

25 Etienne Benson, *Surroundings: A History of Environments and Environmentalisms* (Chicago: University of Chicago Press, 2020); Deborah R. Coen, *Climate in Motion: Science, Empire, and the Problem of Scale* (Chicago: University of Chicago Press, 2020); Helmuth Trischler, "The Anthropocene: A Challenge for the History of Science, Technology, and the Environment," *Naturwissenschaften, Technik und Medizin* 24, no.3 (2016): 309–335; Boris Shoshitaishvili, "From Anthropocene to Noosphere: The Great Acceleration," *Earth's Future* 9, no.2 (2020): 1–11.

26 Perrin Selcer, *The Postwar Origins of the Global Environment: How the United Nations Built Spaceship Earth* (New York: Columbia University Press, 2018); Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, Mass. MIT Press, 2010); Andra Chastain and Timothy Lorek, *Itineraries of Expertise: Science, Technology, and the Environment in Latin America's Long Cold War* (Pittsburgh: University of Pittsburgh Press, 2020).

27 Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981); Clarence B. Davis, Kenneth E. Wilburn, and Ronald Robinson, *Railway Imperialism* (New York: Greenwood Press, 1991).

scription of the colonial actors too closely.[28] In the framework of a research group on global histories of technology, Michael Hård has shown, for instance, that Europeans traveling to Indonesia or India in the nineteenth century acknowledged and admired local construction and agricultural practices. Rather than dismissing them as "primitive," they understood how well-adapted those tools and techniques were to local conditions and used them for their own purposes. Drawing on a variety of case studies along these lines, Hård and his group demonstrate that the once-dominant notion of technology "transfer" is inaccurate. People interact, produce, and are produced by technologies in myriad ways. In grounded historical settings, there is no clear forward march where a "new" technology replaces an "old" one.[29] Instead of moving merely from North to South, technological materials and know-how moved in all conceivable directions.[30]

In sum, scholars working in both environmental history and the history of technology are now more inclined to recognize that environment and technology are both produced and reproduced *in interaction with* society. These parallel moves in the scholarship provide further encouragement to bring environment and technology into a shared frame of analysis, and many have taken up this challenge in recent years.[31] Notably, research focusing on the African continent has decisively eschewed binaries such as artisanal-industrial, urban-rural, and sustainable-harmful that previously hampered an integrated approach.[32] This empir-

28 Aparajita Mukhopadhyay, *Imperial Technology and "Native" Agency: A Social History of Railways in Colonial India, 1850–1920* (London: Routledge, 2018); Norman Aselmeyer, "The Shadow Line: Railway and Society in Colonial East Africa, c. 1890–1914" (PhD diss., European University Institute, Florence, 2022); Friedrich Ammermann, "After the Romance, Rails Remain: The Cape to Cairo Railway as Imperial Infrastructure in Southern Africa, 1889–1967" (PhD diss., European University Institute, Florence, 2024).

29 Mikael Hård, *Microhistories of Technology: Making the World* (Cham: Springer International Publishing, 2023). On other work of the research group, see "The Project Global-HoT", accessed July 21, 2025, https://www.tu-darmstadt.de/global-hot/the_project_global_hot/index.en.jsp.

30 Clapperton Chakanetsa Mavhunga, *What Do Science, Technology, and Innovation Mean from Africa?* (Cambridge, Mass.: MIT Press, 2017).

31 See the volumes in the book series *Studies in Modern Science, Technology, and the Environment* (Rutgers University Press) and *Intersections: Histories of Environment, Science, and Technology in the Anthropocene* (University of Pittsburgh Press), as well as the bibliography at Envirotech, "Bibliography", accessed July 21, 2025, https://www.envirotechhistory.org/envirotech-resources/bibliography.

32 Robyn d'Avignon, *A Ritual Geology: Gold and Subterranean Knowledge in Savanna West Africa* (Durham, NC: Duke University Press, 2022); Joshua Grace, *African Motors: Technology, Gender, and the History of Development* (Durham, NC: Duke University Press, 2021); Emily Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar Es Salaam* (Pittsburgh: University of Pittsburgh Press, 2020); Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* ical work has been accompanied by attempts to develop a conceptual apparatus for thinking about the relationship. Sara Pritchard and Carl Zimring, for example, have proposed the idea of "envirotechnical systems" to capture the feedback loops in the relationship.[33] Sverker Sörlin and Nina Wormbs have coined the term "environing technologies" to suggest how technologies make environments legible for humans, allowing them to "appear as historical products," both materially and as a knowledge-based system.[34] Joining this vibrant body of scholarship, this volume adds another dimension to the conversation: development.

Bridging the gap by including development

While the last decades have seen very dynamic and productive developments in the history of environment and technology, we observe a mismatch between the conceptual and methodological discussion and the empirical work that accompanies it. The conceptual debate focuses mostly on issues related to North-South inequality, often taking colonialism, racial capitalism, and extractivism as the most important lenses to understand change. In contrast, recent empirical research complicates our understanding of these structures, showing the extent of contingency across time and space. And yet, counterintuitively, there is little empirical work that explicitly brings together cases from different socio-political-economic contexts since the nineteenth century. Without such work, drawing connections between specificity and larger historical patterns remains challenging.

Against this background, we argue that introducing the notion of development allows us to examine the relationship between environment and technology in new ways, embracing a wide range of actors, settings, and driving forces. In line with the *Yearbook* itself, we define development broadly, not merely as a top-down project by colonial and post-colonial elites in the twentieth century, but rather as "the entire spectrum of concepts, discourses and policies related to ways in which countries or regions could and should evolve."[35] In contrast to

(Cambridge, Mass.: MIT Press, 2012); Pamela Khanakwa, "Environmental Risk Management from below: Living with Landslides in Bududa, Eastern Uganda," *Journal of Eastern African Studies* 17, no.3 (2023): 384–403.

33 Sara B. Pritchard and Carl A. Zimring, *Technology and the Environment in History* (Baltimore: Johns Hopkins University Press, 2020), 9–10.

34 Sverker Sörlin and Nina Wormbs, "Environing Technologies: A Theory of Making Environment," *History and Technology* 34, no.2 (2018): 101–125.

35 "Yearbook for the History of Global Development," accessed July 16, 2025, https://www.degruyterbrill.com/serial/yhgd-b/html.

older interpretations of development that critiqued the alleged diffusion of European or Western knowledge to other parts of the world, we emphasize its multidirectional nature. This does not mean negating the power inequalities that characterize much of the history of development, but acknowledging the non-linearity and complexity of development projects geared at changing existing socio-economic, cultural, and political structures and establishing new, "better" societies. Many of these plans and expectations relied heavily on the use of technologies of various kinds, and they tended to see the environment as a resource that could be drawn upon and manipulated according to development needs and interests, but there was no uniformity on either front.[36] It is in such situations that the environment-technology-development nexus becomes most visible.

Historians of development have been relatively late in incorporating the role of technology and the environment into their research.[37] For a long time, the history of development was written as one of ideas, policies, and approaches: these were deemed to be the driving forces of development initiatives, while material dimensions remained in the background. Particular research topics in the history of development have sometimes pushed technological and environmental aspects into the foreground, notably large infrastructure projects such as hydro-electric dams.[38] The assumptions behind these projects – that humans could wield technology in order to extract value from their environment indefinitely – were typical of high-modernist visions of development. Historical accounts of these projects have shown that the reality was more complex and contingent, but have rarely made the interaction between environment and technology their main concern.[39] Meanwhile, if development is often a backdrop or theme in the histories of environment and technology cited above, it is rarely used as a central analytical

---

36 Thomas Robertson and Jenny Leigh Smith, eds., *Transplanting Modernity? New Histories of Poverty, Development, and Environment* (Pittsburgh: Pittsburgh University Press, 2023); Corinna R. Unger, "Nature, Resources, and Development: Historical Perspectives on the Global Environment," *Comparativ* 32, no.6 (2022): 675–690.

37 For an overview of the emergence of the field, see Iris Borowy, Corinna A. Pernet, and Corinna R. Unger, "The history of development: A critical overview," in *The Routledge Handbook on the History of Development*, ed. Corinna R. Unger, Iris Borowy and Corinne A. Pernet (London: Routledge, 2022), 3–16.

38 See, for example, Vincent Lagendijk and Frederik Schulze, eds., *Dam Internationalism: Rethinking Power, Expertise and Technology in the Twentieth Century* (London: Bloomsbury Academic, 2024).

39 See, for example, Julia Tischler, *Light and Power for a Multiracial Nation: The Kariba Dam Scheme in the Central African Federation* (Basingstoke: Palgrave Macmillan, 2013); Allen F. Isaacman and Barbara Isaacman, *Dams, Displacement, and the Delusion of Development: Cahora Bassa and Its Legacies in Mozambique, 1965–2007* (Athens: Ohio University Press, 2013).

lens.[40] Histories of development, we argue, offer a productive way to bring environment and technology into dialogue. When we look to the practices and discourses that accompanied development initiatives, and see how they played out on the ground, it is hard to maintain a separation between environment and technology.

The cases presented in this volume show how environment and technology constitute each other. The Marshall Island stick charts examined by Robert Batchelor, for example, were a technology (and an infrastructural object, as he frames them) premised upon constant adaptation to changes in sea currents, legible only through embodied practice and oral traditions. This challenge to the coherence of either technology or environment as spheres of human history is very much in line with recent calls for more attention to be given to the co-production of environment, technology, and society.[41]

Generally, the volume starts out from the observation that the categories of environment and technology have been built on shaky ground, and that they themselves have histories. In many specific settings, the distinction between environment and technology, or between developed and developing, looks artificial. This becomes clear through historical case studies, especially when bringing together those relating to periods before the mid-twentieth century – when neither the North-South conception nor the idea of "developing" countries were common currency – with those from contemporary history. As the contributions to this volume show, often the tensions arising from competing demands on a productive technology and an intact environment played out in similar ways in different social and political settings, across time and space. The postwar seed distribution projects of United Nations Relief and Rehabilitation Administration (UNRRA) in the chapter by Amalia Ribi-Forclaz targeted war-torn Europe, and established norms that would inform international development programs in the following decades. The responses of Italian farmers, deviating from UNRRA's intentions, were notably similar to those of farmers in late colonial Zimbabwe that Bryan Kauma documents – despite the very different racial politics of agricultural reform in that setting.

This volume takes note of theoretical and conceptual insights, which have animated recent debates on technology and the environment, and brings the discussion back to empirical, historical cases. This means adopting expansive definitions

40 There are exceptions, for example, Antoine Acker, *Volkswagen in the Amazon: The Tragedy of Global Development in Modern Brazil* (Cambridge: Cambridge University Press, 2017).

41 Ute Hasenöhrl, "Histories of Technology and the Environment in Post/Colonial Africa: Reflections on the Field," *Histories* 1, no.3 (2021): 122–144, 123; Iva Peša, "A Planetary Anthropocene? Views From Africa," *Isis* 113, no.2 (2022): 386–395.

of technology, environment, and development, without demanding that authors agree on concepts or terminology. A range of technologies emerge, from oil mills to thatch roofs, from lithography to waste disposal. The environment appears not as a pre-existing canvas for human activity but as one that comes into view precisely through human attempts to map, fertilize, measure, and extract. The contributions move away from the "capital D" development used to describe Cold War-era projects executed to "develop" countries in Africa, Asia and Latin America, and towards a more expansive temporal and geographical scope. The development of roofs on residential houses in North-West Cameroon since the 1940s, for example, is analyzed by Evelyne Tegomoh not as a colonial initiative to introduce "modernity" or "order" but rather in terms of dynamics in which the Papiakum palace is looked to for the most desirable building practices, while mobile architect-builders adopt techniques used in nearby cities. If international organizations have featured prominently in the history of development, this volume brings an unusual cast of actors to the fore, from missionaries to computer programmers, from zootechnicians to rural laborers. Where possible, we have highlighted instances in which actors assumed to be marginal to development projects can be seen to influence them, such as harvesters of gutta-percha on the Malay peninsula or women homemakers responsible for negotiating architectural norms in Cameroon.

Across the contributions, the making of development, technology, and the environment comes into focus through practices, discourses, and the interaction between them. The production of knowledge and expertise is a theme that resurfaces in many of the contributions, and serves as a particularly useful way to understand how discourse and practice inform one another. While some contributions, such as Elena Kochetkova's exploration of Soviet "rationality," offer rich conceptual histories derived from scientific publications, others bring out the materiality of practices, such as Giovanni Tonolo's chapter on palm oil mills. By focusing on the practices and discourses of different actors involved in development projects, this volume brings scholarly insights on environment and technology – many of them theory-driven – into conversation, and back into concrete historical settings. The gendered and racialized nature of expertise comes to the surface (respectively) in accounts of agronomist Ely Pattison in the 1940s, and of the marginalization of rainmaking rituals by missionaries in German colonial East Africa. True to the thrust of the *Yearbook* as a whole, the contributions laid out here belie a narrow view of the sites and drivers of development, broadening our scope beyond the late colonial and postcolonial state and their backers in international organizations.

Structure

The contributions are organized around three key interventions that this volume intends to make. Rather than structure the volume around chronology or geography (and we make no claim to representativeness on either score), we hope to draw lines between episodes and actors far removed in space or time, in order to bring to the surface insights that might not be visible in a more concentrated study. Many of the contributions speak to two or more of these themes, and there are several cross-cutting topics that we have not explicitly highlighted but are of potential interest to readers – religion, finance, rural-urban dynamics, non-human species, and water management, to name a few.

(I) Competing visions of progress

Where certain visions about the nature of societal "progress" have become dominant, it can be difficult to see the alternatives that always accompanied them. The four chapters in this section recover competing paradigms about what sort of environment-technology nexus was desirable in a particular setting and ask what political, economic, and religious agendas were at play.

Julia Mariko Jacoby's chapter on river management in Japan, from the mid-nineteenth to the mid-twentieth century, shows that even as Japanese "engineering bureaucrats" embraced Western technologies of water management, they drew on "premodern" Japanese river control, alert to the specificities of Japanese climate and topography. Conflicts around "tradition" manifest quite differently in Daniel Pérez Zapico's chapter, in which Catholic thinkers in late-nineteenth-century Spain made a case for "white coal" – hydroelectricity – as a moral energy source and an alternative to industrial coal production that they saw as a challenge to rural family structures. Alternatives to capitalist industrialization reappear in Elena Kochetkova's chapter. In the late Soviet Union, scientists, industrialists, and politicians engaged in a discourse of "rationality" to consciously reframe human-nature relations, advocating non-depleting growth and waste-free consumption. The final chapter in this section, authored by Odinn Melsted, Cyrus C. M. Mody, George Roberts, and Candida F. Sánchez Burmester, recovers a surprising thread in the history of the famous *Limits to Growth* report, in which a lobby of powerful voices, from Rio de Janeiro to Dakar, spoke in favor of accelerated growth in developing countries, backed by industrial investment and private capital. Collectively, the chapters in this section suggest that no model for societal development went unchallenged and attest to the ambiguities of the discursive field around environment and technology.

(II) Expertise produced and challenged

The figure of the expert has long since come under attack in critical histories of development, but contributions in this section show how expertise relating to environment and technology was robustly challenged in the very moment it was produced. These challenges came not only from human opposition to the policies of experts-in-the-making, but also from technologies incapable of yielding intended results, and environments that did not conform to scientific paradigms.

Veronika Eszik follows debates around piped water and water meters in a rapidly expanding Budapest, when the culture of expertise was in ascendancy in the late nineteenth century. The city's bureaucrats, looking to engineering methods from cities in Germany, were shocked when residents contested their credibility. Expertise was challenged, too, in late colonial Zimbabwe, as Bryan Kauma's chapter shows. The intention to roll out agrotechnologies with the help of demonstrators was greeted by scepticism among Black farmers, who were alienated from fertile land, alert to white settler hegemony, and frequently misused chemical fertilizers. In Karoline Wetjen's chapter, we see the production of expertise among another group in a colonial context: missionaries. German missionaries in African countries were unexpectedly significant in the development of Western climatology, using meteorological instruments to amass data while they simultaneously studied and marginalised indigenous knowledge about the weather. Meanwhile, the very basis of expertise is challenged in Eleanor Choo's chapter on the harvesting of gutta-percha (used to insulate telegraph cables) in maritime Southeast Asia. She shows how Dutch and British traders adopted (sometimes untrue) knowledge about tree distribution and conservation that was produced by local harvesters, who had their own business interests in mind. This section shows that there was nothing natural about the location of expertise or the division between expert and vernacular knowledge about the environment.

(III) Techniques and experimentation

Given the volume's intention to complicate a linear story of technological advance and environmental degradation, experimentation emerges in this section as a fruitful motif. While it might appear self-evident that accepted scientific knowledge rests on processes of experimentation, the contributions here show how this unfolded in particular settings, challenging chronologies about experiments preceding knowledge, and the static nature of a dominant paradigm. Departing from the attention to discourse in the first section, here we uncover technical tools and practices that may have evaded formal understanding among some contemporaries but served similar purposes as their counterparts in other times and places.

The first case is that of the stick charts produced by Marshall Islanders, introduced in Robert Batchelor's chapter. Rather than attempting to pin down the origins and uses of stick charts, as Western anthropologists have for more than a century, Batchelor frames the charts as infrastructural objects that confounded external viewers and allowed their users to resist colonial logics of development. In Evelyne Tegomoh's chapter, the dynamic materials and techniques of roof construction among the Papiakum people of Cameroon in the mid-twentieth century offer a complementary view on the "socialness of things," as connotations about social status embedded in roofs were shaped by both environments and architects. Techniques for the extraction of palm oil in colonial Dahomey are at the centre of Giovanni Tonolo's chapter. Mechanization of extraction might seem the obvious trajectory, as colonial officials sought high yields and looked to palm oil production elsewhere in the world, but Tonolo uncovers impediments to the introduction of oil mills, from colonial fears about political resistance to environmental specificities. The notion of experimentation is developed further in Corentin Gruffat's chapter, which takes us back to the late-nineteenth-century Habsburg Empire, introducing zootechnicians who sought to "improve" cattle. Albums of breeds, increasingly produced with the use of photography and chromolithography, did more than simply represent an animal, but were part of the process of "improvement." Finally, the chapter by Amalia Ribi Forclaz analyzes experiments in the introduction of hybrid seeds in postwar Italy by UNRRA, from the planning of the program all the way to the unpredictable reception (sometimes through the black market) of seeds by farmers. The material co-production of environments and technologies is brought to the fore in this section, making clear how differently this could manifest in distinct historical settings.

We hope that this volume will stimulate further discussions about the contentious but highly important relationship between environment, technology, and development among historians. We would like to take the opportunity to thank all those who have made this volume possible: the authors, who were wonderfully cooperative and impressively fast in writing and revising their chapters; the two reviewers, who provided invaluable comments and suggestions that helped us to see many issues more clearly and make them clearer; the staff at the European University Institute who organized the January 2024 workshop from which this volume emerged; Rebecca Orr, who carefully edited the chapters; and Rabea

Rittgerodt-Burke, who steered this volume through the production process. Freie Universität Berlin provided funding for Open Access publication, and Ismay Milford's Marie Skłodowska-Curie Actions grant (101059465) for image printing. We are grateful for all of this.

Part 1: **Competing Visions of Progress**

Julia Mariko Jacoby

“Governing the mountains, governing the water” (*chisan chisui*): Developing rivers in modern Japan

1 Introduction: Development and river construction in Japan

When the Second World War ended for Japan, onslaught by nature did not. Shortly after Japan embraced defeat in September 1945, a strong typhoon crossed the city of Hiroshima, which had just been hit by the first of two atomic bombs. This typhoon, dubbed the Makurazaki typhoon, left 2,473 people dead, 1,283 missing, and 2,452 injured, most of them in Hiroshima.[1] This was only the first of several severe typhoon disasters to hit the island almost annually until 1953. Exacerbated by the destruction caused by the war, each of these typhoons killed and injured hundreds of people, amounting to thousands of casualties and tens of thousands of destroyed homes in total (see Table 1). The mounting toll of these typhoon floods was publicly debated, since their damage was perceived as excessive compared to the regular annual typhoons the Japanese were used to.[2] One key reason identified was the ‘devastation of national soil’ (*kokudo kōhai*). The Japanese forests, which had been planted and protected since the early modern period to retain excess water from heavy rainfalls and thus prevent floods, had been cut down recklessly, first to fuel the war effort and later to account for postwar re-

1 For the Makurazaki Typhoon disaster, see Kunio Yanagida, *Kūhaku no tenkizu* [The empty weather chart] (Tokyo: Shinchōsha, 1975).

2 Japan lies within the influence of the Northwestern Pacific Basin, which is responsible for most of the tropical cyclones in the world, an average of twenty-five per year. From May to October each year, Japan has a typhoon season, during which approximately ten of them approach the islands in an average year. They cause high wind speeds and storm surges. The most damage is caused by the heavy rainfall a typhoon brings, which in turn can trigger floods and landslides. For an overview on the Japanese Climate see Japan Meteorological Agency, “Overview of Japan’s Climate,” accessed July 22, 2025, https://www.data.jma.go.jp/cpd/longfcst/en/tourist_japan.html. For tropical cyclones in the Pacific see James P. Terry, *Tropical Cyclones: Climatology and Impacts in the South Pacific* (New York: Springer, 2007).

https://doi.org/10.1515/9783111611358-002

source scarcity.[3] The ensuing clear cuts left the bare hills both unable to retain runoff water and vulnerable to landslides. In addition, river engineering had been neglected during the war, and thus, the weakened flood protection was easily overwhelmed by strong typhoon floods. The conclusion was that the badly maintained "national soil" fell easily victim to flooding.[4]

Table 1: Deadliest typhoon disasters during the postwar period (1945 – 1953). Data from the Japan Meteorological Agency, "Saigai o motarashita kishō jirei (Shōwa 20 – 63 nen)," [Examples of meteorological phenomena that caused disasters (1934 – 1984)], accessed July 15, 2025, https://www.data.jma.go.jp/stats/data/bosai/report/index_1945.html.

Year	Name	Dead	Missing	Injured	Houses destroyed[5]	Houses partly destroyed
1945	Makurazaki	2,473	1,283	2,452	89,839	
1945	Akune (Louise)	377	74	202	6,181	
1947	Kathleen	1,077	853	1,547	9,298	
1948	Ione	512	326	1,956	5,889	12,127
1949	Della	252	216	367	1,410	4,005
1949	Judith	154	25	213	569	1,966
1949	Kitty	135	25	479	3,733	13,470
1950	Jane	398	141	26,062	19,131	101,792
1951	Ruth	572	371	2,644	24,716	47,948
1952	Dinah	65	70	28	73	89
1953	No. 13	393	85	2,559	8,604	17,467
Total		**6,408**	**3,469**	**38,509**	**169,443**	**198,864**

To remedy the situation, the "national soil" had to be reconstructed. In the aftermath of the war, Japan had lost its colonies and was troubled by food shortages. The US, which occupied Japan from 1945 to 1952, directed the Japanese adminis-

3 For the introduction of afforestation and protection forests in Japan, see Conrad D. Totman, *The Green Archipelago: Forestry in Preindustrial Japan* (Berkeley, CA: University of California Press, 1989), 93 – 97.

4 The argument is discussed in detail, for example, in Kōichi Aki, *Nihon no suigai* [Floods of Japan] (Tokyo: Iwanami Shoten, 1952).

5 Until 1947, only 'damage to housings' (*jūka sonkai*) per housing unit is given. From 1948 onwards, the numbers are divided in housings 'fully destroyed' (*zenkai*) and 'half destroyed' (*hankai*).

tration to develop its own "national soil" and make use of its resources.[6] US experts suggested the model of the Tennessee Valley Authority (TVA) as a solution. The TVA was a New Deal project intended to ease the effects of the Great Depression in the "underdeveloped" American South by comprehensively developing the Tennessee River Valley with a series of hydroelectric dams that powered agriculture production and industries, and also by promoting afforestation and social programs.[7] The vision of turning surplus water in rivers, which could potentially cause flooding, into usable resources was enthusiastically embraced by Japanese bureaucrats. By comprehensively engineering the rivers and forests upstream, they could not only address the problem of typhoon floods but also solve postwar energy scarcity, killing two birds with one stone.

Another reason why Japanese bureaucrats welcomed the TVA solution was that they had already studied and adopted it as a model for river development in the 1930s.[8] The Japanese Empire had run river-based redevelopment programs domestically and in its colonies.[9] In the 1950s, after the TVA briefly gained traction as a buzzword, its vision was reshaped (or reduced) into laws and programs to systematically engineer Japan's rivers: levees in the downstream sections, the construction of multipurpose dams upstream, as well as afforestation and erosion control construction projects for the mountains. These programs marked the completion of river engineering policies that had been pursued since the early twentieth century and again in the interwar period. As a result, Japan became the country with the fourth largest number of high dams after China, the US, and India, with over 3,000 dams, and a key technological player in promoting river development in Southeast Asia.[10]

6 Jin Satō, *"Motazaru kuni" no shigenron: Jizoku kanō na kokudo o meguru mō hitotsu no chi* [The resource theory of a "have-not country": The other knowledge surrounding a sustainable country] (Tokyo: Tōkyō Daigaku Shuppankai, 2011), 77.

7 For the history of the TVA, see for example Aelred J. Gray and David A. Johnson, *The TVA Regional Planning and Development Program: The Transformation of an Institution and its Mission* (Aldershot: Ashgate, 2005); Daniel Klingensmith, *One Valley and a Thousand: Dams, Nationalism, and Development* (Oxford: Oxford University Press, 2007).

8 Eric Dinmore, "Concrete Results? The TVA and the Appeal of Large Dams in Occupation-Era Japan," *The Journal of Japanese Studies* 39, no.1 (2013): 1–38.

9 Aaron S. Moore, *Constructing East Asia: Technology, Ideology, and Empire in Japan's Wartime Era, 1931–1945* (Stanford, CA: Stanford University Press, 2013).

10 International Commission on Large Dams, "Number of Dams by Country," accessed March 24, 2025, https://www.icold-cigb.org/article/GB/world_register/general_synthesis/number-of-dams-by-country; Aaron S. Moore, "From 'Constructing' to 'Developing' Asia: Japanese Engineers and the Formation of the Postcolonial, Cold War Discourse of Development in Asia," in *Engineering Asia: Technology, Colonial Development, and the Cold War Order*, ed. Hiromi Mizuno, Aaron S. Moore and John DiMoia (London: Bloomsbury Academic, 2020): 85–112.

This chapter examines the complex entanglements between the environment, global knowledge circulation concerning flood control, and development policies in mid-twentieth-century Japan. Disasters were seen as a sign that the environment was not properly maintained and became an incentive to implement a development vision, which led to the redesign of river regimes all over Japan. As an intermediate nation – not fully recognized as a “civilized” peer by the Western powers, but wielding local imperial power in Asia – Japan had gained knowledge and modeled policies after the West, while it also circulated knowledge in its own colonial and later neo-colonial settings. ‘Engineering bureaucrats’ (*gijutsu kanryō*), who had professional training in engineering and dominated Japanese river development, combined globally circulating knowledge with local engineering traditions.[11] They adapted development visions learned from the US to fit river engineering policy already well-established since the nineteenth century: ‘water governance’ (*chisui*), which involved building dams, straightening and deepening river channels and fortifying them with levees, and ‘mountain governance’ (*chisan*), which focused on afforestation and erosion control works upstream.

This chapter analyzes the role of bureaucratic experts as drivers in developing and shaping the environment in Japan, and looks at the part played by “domestic” and “foreign” knowledge and technology, thereby exploring the intricacies of global development in local contexts and traditions. While adopting science and technology developed in other places, it was crucial for engineering bureaucrats to contemplate the specificities of the given environment, adapting or rejecting knowledge to fit “Japanese” needs. This challenges the simplistic narrative that development was globally spread by the “West” and imposed on other parts of the world. Local actors did not only embrace development on their terms. They also adapted it to their own environment by drawing upon various sources of knowledge: Western “scientific” knowledge, “domestically” developed “scientific” knowledge, and local water control “traditions.” While doing so, they were perfectly aware of the situatedness of knowledge in the environment and kept reflecting on it.

This chapter therefore not only sheds light on Japanese visions of development but also explores the role of science and technology in transforming the environment, or as Sverker Sörlin and Nina Wormbs have termed it, the “environing technologies” that were negotiated in Japan.[12] This chapter asks the following

11 Shōichi Ōyodo, *Gijutsu kanryō no seiji sankaku: Nihon no kagaku gijutsu gyōsei no makuaki* [The political participation of engineering bureaucrats: The beginning of Japan’s technocratic administration] (Tokyo: Chūō Kōronsha, 1997).

12 Sverker Sörlin and Nina Wormbs, “Environing Technologies: A Theory of Making Environment,” *History and Technology* 34, no.2 (2018): 101–25. See also the introduction to this volume.

questions: What was the perception of the Japanese environment and what were the expectations placed on development and technology? What knowledge was perceived as modern, foreign, or domestic? What kind of knowledge was deemed suitable for domestic needs? How was "foreign" knowledge adapted, and under what circumstances was vernacular knowledge incorporated? Section 2 of this chapter (following this introduction, section 1) discusses the background and specifics of Japanese development, highlighting the dominance of engineering bureaucrats, and is complemented by a literature review.

The next two sections (3 and 4) discuss debates fought over water control from a long-term perspective, spanning from the late nineteenth century to the postwar period, and situate these discussions in the context of contemporary global developments. In those debates, rivers and mountains were always viewed in conjunction with each other. This was seen as necessary given environmental conditions in Japan, which has a steep topography and a high erosion rate due to abundant rainfall.[13] As a result, it became established in modern Japan that both water control and erosion control were essential for controlling floods, and therefore, rivers had to be developed comprehensively. This entailed water control downstream to protect the lowlands and quickly discharge the water, and erosion control upstream to prevent sediments from filling up reservoirs and rivers, with forests planted to retain excess water and stabilize erosion.

The third section addresses a debate which took place towards the end of the nineteenth century, when the environmental effects of modernizing the economy and introducing Western knowledge to Japan first became visible. In the process, local stakeholders demanded federal funding, centralized water control, and the introduction of erosion control measures against flooding, which were both implemented at the turn of the twentieth century. The section contrasts the adaptation of Western knowledge in Japan by Dutch experts with the recurring reference to older traditions.

The fourth section focuses on the postwar debate introduced at the beginning, where the TVA was enthusiastically discussed as a model for comprehensively developing rivers and turning surplus water into resources. The section both traces continuities from the interwar efforts of imperial Japan to systematize water control through development projects, as well as bureaucratic implementation in the

13 The rainfall is approximately double the amount of central Europe, which was the point of reference for many Japanese engineers around 1900. Responsible for the most floods are heavy rains during the monsoon season and the annual typhoon season. For an overview to the Japanese climate, see Japan Meteorological Agency, "Overview of Japan's Climate," accessed July 22, 2025, https://www.data.jma.go.jp/cpd/longfcst/en/tourist_japan.html; Conrad D. Totman, *Japan: An Environmental History* (London: I.B. Tauris, 2014), 7–22.

postwar period, which involved the systematic construction of multipurpose dams and comprehensive river engineering. The chapter concludes with general observations about the formation and characteristics of the Japanese bureaucracy-dominated form of development.

2 Engineering bureaucrats, development, and rivers in Japan

This chapter seeks to elucidate the distinctive features of development in the Japanese case, which is characterized by practices of adapting Western science and technology, and the central role of engineering bureaucrats in shaping Japanese development and the relationship with the country's environment. These features can be traced back to the establishment of the modern Japanese state in the Meiji period (1868–1912), which adopted the strategy of introducing Western science and technology to compete in a world order dominated by Western imperialism. After a 250-year-long period of relative isolation from international relations in the Edo period (1603–1868), Japan was forced by Commodore Perry and his gunboat diplomacy into signing unequal treaties with the US in 1854. As a result, Japan entered into global trade and diplomatic relations, facing an economic and military imbalance with the Western powers. After a short civil war, a new government came into power in 1868, which mainly consisted of well-educated lower samurai, the warrior class that had occupied administrative positions in the former feudal government.

Out of fear of suffering the fate of its neighboring countries and ending up in colonial subjugation, the new Meiji government conducted a thorough reform program to "enrich the nation and strengthen the army." The reform aimed to thoroughly reshape the country according to Western models with the aim of being recognized as a "civilized" country by the West and accepted as an equal negotiating partner. The self-imposed development program encompassed government institutions, the military, the economy, society and culture, and lasted around thirty years, relying heavily on importing and adapting knowledge from the "West."[14] For the Japanese during the Meiji period, "civilization" signified the achievements of Western knowledge. Successfully incorporating Western knowledge was seen to

14 For an overview on the Meiji Restoration, see Andrew Gordon, *The Modern History of Japan: From Tokugawa Times to the Present* (New York, Oxford: Oxford University Press, 2003), 61–137.

lend Japan superiority in a Western-led civilizational world order, and to distinguish it from other Asian nations deemed "less civilized" or "barbaric".[15]

The Meiji reform program was orchestrated by the government and relied heavily on foreign experts and government bureaucrats acquiring Western knowledge. As river engineering had been part of the Japanese bureaucracy since the early modern period, the ministries employed trained engineers, who played a crucial role in adapting and disseminating foreign knowledge, which will be discussed in more detail in the following section. While policymaking was first dominated by members of the bureaucracy trained in law, engineering bureaucrats gained growing competence in shaping development policies since the late nineteenth century.[16] As such, it became established that engineering bureaucrats were both the group responsible for adapting knowledge and technology from abroad, and for molding that knowledge into policies.

Although the modern concept of development – the transformation of the environment with the goal of gaining economic benefits according to a comprehensive vision – was thus introduced to Japan via knowledge circulation processes involving engineering bureaucrats in the twentieth century, Japanese society was already no stranger to the idea of engineering the environment. As the premodern Japanese economy was based on rice, water control and river engineering had been important concerns for the Japanese state since ancient times. Being part of the Sinosphere, Japan initially learned river engineering technology from China in the ancient period, which was further adapted in local contexts and fully localized by the early modern period.[17] During a civil war, which lasted

15 The thought to "leave Asia" and become part of "Western civilization" propagated by thinker Fukuzawa Yukichi (1835–1901) was especially influential during the Meiji period. Yukichi Fukuzawa, "Good-bye Asia (1885)," in *Japan: A Documentary History: The Late Tokugawa Period to the Present*, ed. David J. Lu (Armonk, NY: M.E. Sharpe, 1997): 351–53. For an overview on Japanese cultural identity and nationalism since the Meiji period see Eika Tai, "Rethinking Culture, National Culture, and Japanese Culture," *Japanese Language and Literature* 37, no.1 (2003): 1–26.

16 Janis Mimura, *Planning for Empire: Reform Bureaucrats and the Japanese Wartime State* (Ithaca, NY: Cornell University Press, 2011); Tsuyoshi Wakatsuki, *Senzen Nihon no seitō naikaku to kanryōsei* [The changing structure of bureaucracy under the party cabinet system in prewar Japan] (Tokyo: Tōkyō Daigaku Shuppankai, 2014).

17 The Sinosphere is a term introduced by Joshua A. Fogel to denominate a cultural region in Asia that was shaped by Sinocentrism and deeply influenced by culture, thought, and technology from Ancient China. Joshua A. Fogel, *Articulating the Sinosphere: Sino-Japanese Relations in Space and Time* (Cambridge, MA: Harvard University Press, 2009). Reading Ancient Chinese scriptures were a fixture of intellectual learning (with a similar status to Latin in Europe) in the Sinosphere and only got contested with the arrival of Western knowledge in the nineteenth century, see Michael Facius, *China übersetzen: Globalisierung und chinesisches Wissen in Japan im 19. Jahrhundert* (Frankfurt am Main: Campus, 2017); Douglas Howland, *Translating the West:*

from the mid-fifteenth to the late sixteenth century, and the subsequent establishment of the feudal government of the Tokugawa in the early seventeenth century, river engineering gained importance, and technologies evolved. The Tokugawa shōgunate (1603 – 1868) and local domains established specialized bureaucratic positions for river engineering, as large-scale development projects were undertaken around 1700 to redirect major rivers to protect cities and gain new fields for mainly rice cultivation.[18] This early modern land reclamation project followed policy trends established in Ming-Qing China.[19]

This background is also reflected in the Japanese word for 'development,' *kaihatsu.* It derives from classical Chinese and has been in use since the seventeenth century to describe the process of clearing land for new rice fields, which usually implied constructing infrastructure for irrigation as well.[20] From the Meiji period onwards, *kaihatsu* became equivalent to the English word 'development.'[21] *Kaihatsu* then also became used in the context of "developing" colonies, first during the incorporation and agricultural colonization of Hokkaidō, which began in the

Language and Political Reason in Nineteenth-Century Japan (Honolulu: University of Hawai'i Press, 2002).

River engineering technologies such as, for example, bamboo nets filled with stones (similar to gabions) used to construct levees or to weigh down wooden devices for regulating river flow, can be traced to ancient Chinese ancestors but were locally adapted, which can be seen local variants with their own names. See Masakazu Ishizaki, "Jakago ni kansuru rekishiteki kōsatsu," [A Historical Study on Gabion] *Nihon Dobokushikenkyū Happyōkai Ronbunshū* 7 (1987): 253 – 58; Tadashi Miyamura, *Suigai: Chisui to suibō no chie* (Tokyo: Chūō Kōronsha, 1985), 60 – 64. For an overview on premodern Japanese river engineering, see for example Conrad Totman, "Preindustrial River Conservancy: Causes and Consequences," *Monumenta Nipponica* 47, no.1 (1992): 59 – 76; Kōchi Yamamoto, *Kasen teibō no gijutsushi* [The history of river embankment technology] (Tokyo: Gihōdō Shuppan, 2017), 5 – 93.

18 For an overview on early modern river control see Roderick I. Wilson, *Turbulent Streams: An Environmental History of Japan's Rivers, 1600 – 1920* (Leiden, Boston: Brill, 2021), 91 – 122; Yamamoto, *Kasen teibō no gijutsushi*, 33 – 43. For the ecological consequences of developing new rice fields see Kōichi Takei, *Edo Nihon no tenkanten: Suiden no gekizō wa nani o motarashita ka* [The turning point of Edo Japan: What did the dramatic increase of paddy fields cause] (Tōkyō: NHK shuppan, 2015).

19 For an overview on agricultural policies and development in Ming-Qing China see Shaohua Zhan, *The Land Question in China: Agrarian Capitalism, Industrious Revolution, and East Asian Development* (London, New York: Routledge, 2019), 19 – 35.

20 Zen'ichi Itō, "Kaihatsu," in *Nihon hyakka zensho (Nipponica)*, vol. 4, ed. Shōgakukan (Tokyo: Shōgakukan, 1984): 683 – 84.

21 F. Brinkley and Nanjō, F., Iwasaki, Y., eds., *An Unabridged Japanese-English Dictionary* (Tōkyō: Sanseidō, 1896), 532.

1870s.[22] As Japan established its colonial empire between the late nineteenth and early twentieth centuries, *kaihatsu* was also used to refer to imperial colonization in Taiwan, Korea, and Manchuria.[23] In the postwar period, the term gained a new layer of meaning as the concept of development, which was adapted from the US. *Kaihatsu* began to denominate a policy program driven by a comprehensive vision. This shift occurred when comprehensive regional development became integral to Japanese national policy planning. Since 1962, Japan has issued a national planning program approximately every ten years called the 'National Comprehensive Development Plan' (*zenkoku sōgō kaihatsu keikaku*), which outlines a future vision of the country's development, comprising infrastructure, regional economic planning, and environmental considerations.[24]

As is evident from the evolving meaning of *kaihatsu*, economic development and policy are closely entangled with the transformation of the environment in Japan, which in turn is strongly connected to technology. On the one hand, despite the romanticized and often nationalist notions and self-descriptions of "living in harmony with nature", Japan's relationship with nature has been characterized by historians of Japan as interventionist. Tessa Morris-Suzuki, for example, has argued that precisely because Japanese thinkers identified humans as the "crowning glory of a rich and benign natural order," it was the duty of humans to keep nature in order and unlock its riches. Natural beauty is thus strongly correlated with cultivation and management.[25] River engineering technology was a central means through which the Japanese interacted with their environment, mainly to obtain agricultural riches, especially since the early modern period, when the reclama-

22 Itō, "Kaihatsu," 4; Yoshinori Hisamatsu, *Hokkaidō shinsaku* [New strategies for Hokkaidō] (Sapporo: Maeno Chōhatsu, 1892), 67; Tetsuo Enami, *Hokkaidō kaitakuron gairyaku* [Summary of the theory of colonizing Hokkaidō] (Tokyo: Enami Tetsuo, 1882), 7.

23 For example, Katsutami Kobayashi, *Taiwan keieiron* [Theory on managing Taiwan] (Tokyo: Hori Usaburō, 1902), 34–42; Anonymous, "Chōsen kaihatsu no daiippo," [The first step of developing Korea] *Tōyō jihō*, no. 150 (1911); Noboru Harada, *Manshū kaihatsu 15 nenshi* [15 year account of developing Manchuria] (Tokyo: Kaigai Keizai Tsūshinsha Henshūbu, 1921).

24 Ministry of Land, Infrastructure, Transport and Tourism, "Zenkoku sōgō kaihatsu keikaku (gaiyō) no hikaku," [The comparison between the national comprehensive development plans (summary)], accessed April 3, 2025, https://www.mlit.go.jp/common/001116820.pdf. Japanese regional planning originally derived from the German *Landesplanung* during World War II, but it got adapted through the influence of the American TVA program, as will be discussed in more detail below. See also Yoshihito Honma, *Kokudo keikaku o kangaeru: Kaihatsu rosen no yukue* [Thinking of the national plan: The future route of development] (Tokyo: Chūō Kōron Shinsha), 1–8.

25 Tessa Morris–Suzuki, "The Environment in Japanese Economic History," *Asian Studies Review* 14, no.1 (1990): 80–87; Tessa Morris-Suzuki, "Concepts of Nature and Technology in Pre-Industrial Japan," *East Asian History* 1, no.1 (1991): 81–97.

tion of new rice fields required the construction and maintenance of many irrigation channels.

Conrad Totman argues that beginning around 1700, the cutting of forests and expansion of agriculture by land reclamation upstream significantly increased sediment intake into the rivers, forcing villagers into a constant fight against floods by maintaining and dredging rivers and canals.[26] In addition, in traditional water control, organic materials such as wood, bamboo, and reed were used to construct weirs, groins, and other technologies for controlling river flow. These were prone to decay and destruction by floods.[27] Thus, constant maintenance and care were necessary to keep early modern cultivated landscapes functioning. The introduction of modern Western technology, as Philip C. Brown has shown in his case study of the construction of a large-scale irrigation channel in Niigata, promised a level of river control not possible in earlier periods. Despite this, the vision of how to alter the river system remained the same: constructing a diversion channel to drain the lowland of the Shinano River. However, it was only with the advent of Western technology that the drilling of the Ōkozu Diversion Channel through a small mountain range and the distribution of the mighty Shinano River using large-scale weirs was realized. When it finally became operational in the 1930s, it turned the Niigata Plain into one of the most productive rice baskets in Japan.[28] Therefore, there is a continuity in thought that water control technology and its constant care are needed for agricultural gains.

On the other hand, the Japanese experienced numerous extreme natural phenomena, such as earthquakes, tsunamis, typhoons, floods, and landslides, which instilled a sense of fear and veneration of nature as an unpredictable force. This has also led to a strong preoccupation with how to avoid disasters, which in the modern period mainly involved enlisting the help of science and technology.[29] The "disastrous" nature of Japan was seen as exceptional compared to West-

26 Totman, "Preindustrial River Conservancy." Takei Kōichi also makes a similar argument. Takei, *Edo Nihon no tenkanten*, 226 – 62. Ōkuma Takashi argues that Edo period people closely monitored the river's flows and frequently adapted river engineering works accordingly (for example, they punctually destroyed levees to ease flood energy), Takashi Ōkuma, *Kōzui to chisui no kasenshi: Suigai no seiatsu kara juyō e* [The river history of floods and water governance: From the suppression of floods to acceptance] (Tokyo: Heibonsha, 2007), 103 – 14.

27 Takei, *Edo Nihon no tenkanten*, 247– 254.

28 Philip C. Brown, "Floods, Drainage, and River Projects in Early Modern Japan: Civil Engineering and the Foundations of Resilience," in *Environment and Society in the Japanese Islands: From Prehistory to the Present*, ed. Bruce L. Batten and Philip C. Brown (Corvallis: Oregon State University Press, 2015): 96 – 113.

29 Julia Mariko Jacoby, "Disaster Prevention in Japan 1885 – 1978: Natural Disasters, Scientific Expertise, and Global Transfers of Knowledge," (unpublished manuscript, 2021); Itoko Kitahara, ern countries. Knowledge and technology produced in contexts of disasters were thus seen as a niche where Japan, as a scientific nation, could compete.[30] New voices in the history of environment and technology, like Sara B. Pritchard and Carl A. Zimring, have emphasized the importance of attending to the close entanglement between environment and technology and treating them as an "envirotechnical" entity, instead of viewing technology as something that can be universalized and separated from its environmental context.[31] But in the case of analyzing development, the entanglement goes beyond environment and technology and includes questions about how policies are decided and implemented, as well as the role played by international economic and political trends. Following the ideas laid out in the writings of new materialism, especially in Jane Bennet's *Vibrant Matter*, I look at entanglements and assemblages of both material and immaterial things, including the environment, technology, bureaucracy, the generation of political decisions, and practices of knowledge production and adaptation.[32]

This chapter, therefore, brings together literature that has only recently started to intersect due to its disparate nature. The close relationship between engineering bureaucrats and the state, and their strong influence on policies, has drawn the attention of political historians. For example, describing Japan as a "construction state," Gavan McCormack unfolds the postwar connection between politics, bureaucracy and the construction industry, highlighting how this closeness has fueled the subsidizing of infrastructure projects, including those involving rivers.[33] Meanwhile, Patricia Sippel diagnoses the establishment of *chisui* as a "sacred domain" of the Japanese state since the early modern period, emphasizing its endurance and the seeming impossibility to challenge policies that heavily rely

ed., *Nihon saigaishi* [Disaster history of Japan] (Tokyo: Yoshikawa Kōbunkan, 2006); Tekunoba Saigai Kenkyū Project, *Kindai Nihon no saigai: Meiji, Taishō, Shōwa no shizen saigai* [Disasters of modern Japan: Natural disasters of the Meiji, Taishō, and Shōwa periods] (Tokyo: Tekunoba, 1993).

30 Julia Mariko Jacoby, "Learning from the Earthquake Nation: Japanese Science Diplomacy in the 20th Century," *Journal of Contemporary History* 56, no.3 (2021): 485–501; Kenji Itō, "The Question of Research in Prewar Japanese Physics," in *Science, Technology, and Medicine in the Modern Japanese Empire*, ed. David G. Wittner and Philip C. Brown (London: Taylor and Francis, 2016): 193–210.

31 Sara B. Pritchard and Carl A. Zimring, *Technology and the Environment in History*, Historical Perspectives on Technology, Society, and Culture (Baltimore: Johns Hopkins University Press, 2020).

32 Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, London: Duke University Press, 2010).

33 Gavan McCormack, "Growth, Construction, and the Environment: Japan's Construction State," *Japanese Studies* 15, no.1 (2008): 26–35.

on engineering, while also pointing to their exploitative nature and neglect of local interests.[34] Most literature, however, is limited to the realm of policy making and explores how water control shaped governance and bureaucracy.[35] There is also a body of literature on the fight of engineers for political influence in the interwar period, which has recently been contextualized within the global rise of technocrats and their contribution to World War II.[36] These studies usually do not engage with the specific technologies that the engineering bureaucrats used in policy designs. Instead, such discussions are mostly found in histories of technology written by engineers themselves or science journalists with engineering backgrounds. In Japan, these works are meticulously researched but are often written to support a political agenda or display an uncritical attitude towards technologies and their protagonists.[37] Only recently has river engineering in Japan been studied at the intersection of political history, the history of technology, and the environment, in works by Roderick I. Wilson, Eric Dinmore, and Aaron S. Moore, and in Japanese, Kajiwara Kenji and Nakamura Shin'ichirō.[38] However, their research has largely concentrated on the history of rivers and dams and mostly neglected the integral role of erosion control in river engineering in Japan.

---

34 Patricia Sippel, "Chisui: Creating a Sacred Domain in Early Modern and Modern Japan," in *Public spheres, private lives in modern Japan, 1600–1950: Essays in honor of Albert M. Craig*, ed. Albert M. Craig et al. (Cambridge, MA: Harvard University Asia Center, 2005): 153–184.

35 Ryōsuke Maeda, *Zenkoku seiji no shidō: Teikoku Gikai kaisetsugo no Meiji kokka* [The beginnings of national politics in modern Japan: The Meiji state reform under the parliamentary system, 1890–1898] (Tokyo: Tōkyō Daigaku Shuppankai, 2016); Takashi Mikuriya, *Seisaku no sōgō to kenryoku: Nihon seiji no senzen to sengo* [Comprehensiveness and power in policies: Prewar and postwar in Japanese politics] (Tokyo: Tōkyō Daigaku Shuppankai, 1996).

36 Ōyodo, *Gijutsu kanryō no seiji sankaku*; Wakatsuki, *Senzen Nihon no seitō naikaku to kanryōsei*; Mimura, *Planning for Empire*; Erich Pauer, "Die Mobilisierung der Ingenieure in der Zwischenkriegszeit: Von der Technokratie zum ‚wissenschaftsgeleiteten Industrialismus' (kagakushugi kôgyô)," *Nachrichten der Gesellschaft für Natur- und Völkerkunde Ostasiens* 175–176 (2004): 93–128.

37 Some well-written examples are Ōkuma, *Kōzui to chisui no kasenshi*; Shigeki Matsuura, *Senzen no kokudo seibi seisaku* (Tokyo: Nihon Keizai Hyōronsha, 2000).

38 Japanese names are given in their original order in this chapter, with the family name first, but kept in the "Western" order in the footnotes for uniformity. Moore, *Constructing East Asia*; Dinmore, "Concrete Results?"; Wilson, *Turbulent Streams*; Kenji Kajiwara, *Sengo kasen gyōsei to damu kaihatsu: Tonegawa suikei ni okeru chisui, risui no kōzōtenkan* [Postwar river governance and dams: The structural changes in the flood control and water use in the Tone River system] (Kyoto: Mineruva Shobō, 2014); Shin'ichiro Nakamura, *Floods and Probability: A Technological and Social History of Design Flood* (Tokyo: Tōkyō Daigaku Shuppankai, 2021).

3 Between knowledge adaptation and inventing tradition: Establishing water control in modern Japan

When the new modern Japanese state implemented its fundamental reform program in the late nineteenth century to "enrich the nation and strengthen the army," river engineering also played an important part, mainly because of its role in transportation and trade. As a consequence, the early Meiji state heavily invested in river engineering with the goal of facilitating navigation.[39] In these projects, the government relied on Western expertise, which was expensive at that time, highlighting the importance of river engineering.[40] In contrast, river engineering for flood control and agricultural purposes was, in continuation of early modern practices, at first left to local governments and village communities.[41] Importing knowledge from the West was achieved in two ways: Hiring foreign experts (*oyatoi*) or sending Japanese students abroad, which was both sponsored mainly by the government because of the high cost. The government hired foreign experts from various Western countries to build up projects and to teach Japanese on the spot. The selection process was carefully conducted: the criteria used were a blend of identifying the most prolific nation in a given field, ensuring compatibility with Japanese needs, and balancing the influence exerted by the Western powers.[42] The Home Ministry, which oversaw river engineering, hired mainly Bri-

39 Fumi Ashina, "Meijiki no kasen seisaku to gijutsu mondai: 'Teisui kōji kara kōsui kōji e' zushiki o megutte," [The river engineering policy and technology problem of the Meiji period: On the schema "from low water construction to high water construction"] *Shigaku zasshi* 115, no.11 (2006): 1831–1863.

40 Construction in Western style in the 1870s and 80s did not only require experts in Western knowledge but also the use of modern materials, which were acquired via the networks of the Western experts and provided profit to their home countries. See for example Kazumasa Iwamoto, "Orandajin dobokugishi Mulder no sekkei rinen: Oranda de hakken shita shinshiryō o chūshin to shite," [The design philosophy of Dutch engineer Mulder: Concentrating on new sources discovered in the Netherlands] *Dobokushi kenkyū kōenshū* (2019): 173–78; Kristin Meißner, "Responsivity within the Context of Informal Imperialism: Oyatoi in Meiji Japan," *Journal of Modern European History* 14, no.2 (2016): 268–289.

41 Maeda, *Zenkoku seiji no shidō*, 102; Takumi Yamashita, "Tenryū gawa karyū chi'iki ni okeru suibō kumiai katsudō to sono keizaiteki kiban: Meiji kara Shōwa senzenki o chūshin to shite," [The activities and the economic base of the water defense associations: With emphasis from the Meiji to the prewar part of the Shōwa period] *Rekishi chirigaku* 42, no.1 (2000): 64–83.

42 Ardath W. Burks, ed., *The Modernizers: Overseas Students, Foreign Employees, and Meiji Japan* (Boulder: Westview Press, 1985); Edward R. Beauchamp and Akira Iriye, *Foreign Employees in* tish engineers because of their expertise in railroad construction. River engineering, however, was dominated by Dutch engineers.[43] The choice to hire Dutch has been debated in the literature. During a government expedition in the 1870s, the Japanese chronicler Kume Kunitake (1839–1931) remarked on the flat Dutch topography and considered it unsuitable as a model for Japan, characterized by steep mountains. However, it is understandable that the Meiji government turned to the Dutch, as they at first prioritized building harbors and engineering rivers for transportation.[44] The Dutch, long renowned for their expertise in civil engineering and water control, had a solid education system in place for water engineers and were internationally sought-after experts in the field.[45] In addition, the Netherlands was a minor imperial power compared to Britain, which enabled the Japanese administration to exert control over the direction and budget of infrastructure projects.[46]

Nevertheless, it was a priority for the Japanese government to quickly replace foreign hires with domestic experts. Thus, an education system was introduced. Foreign experts taught higher engineering education first at the Kobu Daigakko, which in 1886 became part of the Imperial University of Tokyo. Tokyo University became the elite institution for teaching Japanese bureaucrats, and later, the tight-knit community of Tokyo University graduate engineers came to dominate water control policies.[47] When engineers entered the Home Ministry, they could gain the opportunity to be sent abroad for studies. Later influential engineering bureaucrats in river engineering, such as Okino Tadao (1854–1921) and Furuichi Kōi (1854–1934), studied in France.[48]

Nineteenth Century Japan (Boulder: Westview Press, 1990); Meißner, "Responsivity within the Context of Informal Imperialism."

43 Kiyoko Toda, "Kōbushō ni okeru oyatoi gaikokujin: Meiji zenki Nihon no gijyutsu dōnyū o megutte," [The foreign experts at the Ministry of Public Works: On the import of technology in early Meiji Japan] *Nara Kenritsu Daigaku Kenkyū Kihō* 13, no.4 (2003): 27–36.

44 Kunitake Kume, *Tokumei zenken taishi beiō kairan jikki* [A true account of the ambassador extraordinary and plenipotentiary's journey of observation through the United States of America and Europe] (Tokyo: Hakubunsha, 1878), 235–290.

45 Karel Davids, ed., *The Rise and Decline of Dutch Technological Leadership: Technology, Economy and Culture in the Netherlands, 1350–1800,* History of Science and Medicine Library, Knowledge Infrastructure and Knowledge Economy 7, vol. 1 (Leiden: Brill, 2008).

46 Iwamoto, "Orandajin dobokugishi Mulder no sekkei rinen"; Shigeki Matsuura and Yoshiyuki Kamibayashi, "Orandajin gijutsusha to igirisujin gijuchusha no kakushitsu: De Rēke (Johannis de Rijke) to Pāmā (Henry Spencer Palmer) o chūshin ni," [The feud between Dutch engineers and British engineers: Concentrating on de Rijke (Johannis de Rijke) and Palmer (Henry Spencer Palmer)] *Suiri Kagaku* 37, no.4 (1993): 25–51.

47 Ōyodo, *Gijutsu kanryō no seiji sankaku*, 22–27.

48 Wilson, *Turbulent Streams*, 150–55.

The decisions on infrastructure projects, however, lay with the bureaucrats of the Home Ministry who were graduates of law, and not engineering. Japanese historian Ōyodo Shōichi argues that this served to keep the decisions on water infrastructure in the hands of the government and limit foreign influence.[49] Dutch expert Johannis de Rijke (1842–1913), who worked in Japan from 1873 to 1903, staying longer than his compatriots, often complained in his letters about the difficulties of dealing with the Japanese bureaucrats.[50] In the 1870s and 1880s, trade ports and transport channels were built all over Japan. The most popular technology learned from the Dutch were 'groins' (in Dutch *kribben*, and in Japanese *kereppu*), structures built into the riverbed to stabilize the flow and deepen the channels for navigation. Similar structures had already existed in the Edo period, albeit made with less durable organic materials. *Kereppu* were built all over Japan, including in unsuitable places, which might have contributed to later attacks of local stakeholders on the government's prioritization of 'low water' (*teisui*) construction downstream.[51] To manage flood control, diversion channels were built to eliminate the excess water. This was in continuation of Edo-period practices, as historian Philip C. Brown describes in the case of the aforementioned Ōkozu Diversion Channel, which was initially planned in the Edo period but was only realized with modern technology, against warnings by Dutch engineers.[52]

This does not mean that the Dutch engineers only concentrated on "low" construction downstream. Johannis de Rijke also lobbied for erosion control for his river projects and acquired knowledge from Dutch books that he asked friends to obtain, thus learning from knowledge generated in the Dutch Indies.[53] As he spent most of his professional career in Japan, he also gained and generated new knowledge on-site. Often facing budgetary constraints, he incorporated existing knowledge and practices, creating pidgin knowledge.[54] For example, he worked with Ichikawa Yoshikata, who had served as an engineer for erosion control for Kyoto prefecture and later authored a treatise on water control.[55] They

49 Ōyodo, *Gijutsu kanryō no seiji sankaku*, 26–27.

50 A collection of de Rijke's letters can be found in Louis van Gasteren, *In een Japanse stroomversnelling: Berichten van Nederlandse watermannen rijswerkers, ingenieurs, werkbazen 1872–1903* (Amsterdam, Zutphen: Euro Book; Walburg Pers, 2000), 473–516.

51 Ashina, "Meijiki no kasen seisaku to gijutsu mondai."

52 Brown, "Floods, Drainage, and River Projects in Early Modern Japan."

53 van Gasteren, *In een Japanse stroomversnelling*, 344–345.

54 Pidgin knowledge denominates knowledge amalgamated from various sources. The term was coined by historian Harald Fischer-Tiné for colonial contexts, see Harald Fischer-Tiné, *Pidgin-Knowledge: Wissen und Kolonialismus* (Zurich: Diaphanes, 2013).

55 Yoshikata Ichikawa, *Suiri shinpō* [The real treasure of hydrology] (Tokyo: Suirikan, 1896). In this treatise, Ichikawa criticizes Dutch erosion control dams as not stable enough.

collaborated to build erosion control dams, structures meant to retain sediment and prevent it from blocking the rivers, which were already common in the Edo period.[56] In de Rijke's works conducted at the Jōganji River, the river with the steepest gradient in Japan, he incorporated existing open levees, so-called *kasumitei*, into his reconstruction plans after a devastating flood in 1891. *Kasumitei* were discontinuous levees that allowed overflowing water in regular intervals to flow backwards, thereby reducing its destructive energy and utilizing the deposits brought by flooding.[57] De Rijke also published a Dutch treatise on this river project, where he described the incorporation of traditional woven baskets made from bamboo or willow branches, filled with stones, into the design of his levees.[58] These *jakago*, which derived from Chinese flood control technology, were widely used in early modern water control.[59] De Rijke likely created these pidgin designs through conversations with local officials and workers from the rural prefecture of Toyama.

Paradoxically, this incorporation of vernacular knowledge did not quell the rhetoric that, because of the Netherlands' flat topography, Dutch engineers were ill-equipped to deal with Japan's steep and fast rivers. This opinion was also echoed by leading engineering bureaucrats, who had gained influence over water control policies by the 1880s and 1890s.[60] Rather, the situation further fueled the Japanese engineers' argument that Dutch engineers were not skilled enough in modern technology.[61] In the first large-scale river construction endeavor undertaken by the government as a response to a devastating flood in 1885, de Rijke's design was discarded in favor of Okino Tadao's. Okino's design was similar to de Rijke's in many ways, with one notable exception. Whereas de Rijke had proposed to use an existing wetland lake as an overflow reservoir, Okino proposed to construct a large weir on the Biwa Lake, which was the main source of the Yodo

56 Wilson, *Turbulent Streams*, 146–148. In local administrations, practices from the Edo period were carried over to the Meiji period. In the Edo period, there were already bureaucrats tasked with erosion control, who oversaw afforestation and the construction of erosion control dams. Kunihiko Mizumoto, *Doshadome bugyō: Kasen saigai kara chiiki o mamoru* [The gravel stopping magistrates: Protecting the countryside from river disasters] (Tokyo: Yoshikawa Kōbunkan, 2022).
57 Norikazu Ichikawa, "De Rijke no Jōganjigawa kaishū kōji ni okeru gijutsu," [De Rijke's technologies used at the Jōganji River improvement construction] *Dobokushi kenkyū*, no.20 (2000): 117–128.
58 Johannis de Rijke, "Banjirs en vloeden in Japan," *De Ingenieur* 15, no.36 (1900): 544–548.
59 Ishizaki, "Jakago ni kansuru rekishiteki kōsatsu."
60 Yasuo Itō, "Ranjin yōkōshi to sono chisui shisō," [The hired Dutch engineers and their water control thought] *Kyōto rekishi saigai kenkyū*, no.2 (2004): 1–5, here 4.
61 Iwamoto, "Orandajin dobokugishi Mulder no sekkei rinen."

River.[62] Okino’s choice not only demonstrated that his design relied more heavily on modern technology, but also indicated that Japanese engineers were beginning to address the growing demand for solutions that would not only stabilize canals downstream, but also retain water upstream to prevent it from overflowing downstream.

Despite de Rijke’s efforts to promote erosion control, Dutch technology became a popular target of criticism during a debate advocating for flood control measures upstream through afforestation and erosion control instead of through fortifying channels downstream. This debate unfolded as a result of floods in the 1880s and was part of the larger struggle of the local educated elite seeking political participation.[63] As there was no national system of water control regulation and funding in place, and the responsibility for water control construction was shouldered by local governments and communities, the debate about water control became an important vehicle to bring local concerns into the political arena.[64] This included requests for central government funding for larger flood works and criticism of the water construction policies of the government, which concentrated on building navigable channels and constructing levees.[65] This critique was partly focused on the reliance on foreign technologies. For example, Nishi Moromoto, a local journalist in Toyama prefecture, reacting to the aforementioned Jōganji River construction, criticized officials for using the technology of de Rijke despite the fact that his levees were not sufficiently strong. [66] According to him, foreigners’ inexperience with Japanese nature led them to overlook the real problem of sediment overload. This problem had been exacerbated by deforestation in the nearby mountains in recent years, which occurred as forestry regulations

62 Wilson, *Turbulent Streams*, 172 – 183; Shigeki Matsuura, “Meiji no Yodogawa kaishū keikaku: De Rijke kara Okino Tadao e,” [Yodo River improvement project for flood prevention in the Meiji era: From de Rijke to Okino Tadao] *Doboku gakkai ronbunshū*, no.425 (1991): 213 – 220.

63 Ashina, “Meijiki no kasen seisaku to gijutsu mondai”; Michael Lewis, *Becoming Apart: National Power and Local Politics in Toyama, 1868 – 1954* (Cambridge, MA: Harvard University Press, 2000), 74 – 117. For the Freedom and People’s Rights Movement, see Gordon, *The Modern History of Japan*, 80 – 85; Yūsaku Matsuzawa, *Jiyū minken undō: Demokurashī no yume to zasetsu* [The Freedom and People’s Rights Movement: A dream of “democracy” and its failure] (Tokyo: Iwanami Shoten, 2016).

64 Maeda, *Zenkoku seiji no shidō*, 100 – 114; Lewis, *Becoming Apart*, 75 – 76.

65 Ashina, “Meijiki no kasen seisaku to gijutsu mondai.”

66 Ichirō Kaibara, “Chisan chisui – suiri no koten kaisetsu: Nishi Moromoto cho ‘Chisuiron’ ni tsuite,” [Commentary on classic literature on mountain and water governance – water use: On the ‘Treatise on water governance’ by Nishi Moromoto] *Suiri Kagaku* 1, no. 2 (1957): 76 – 86.

were disrupted when the regime changed. Pointing to forestry regulations in Europe, Nishi demanded their reform in Japan.[67]

As in the case of the Toyama journalist, local intellectuals and stakeholders involved in water construction joined the debate to advocate for prioritizing flood control at the national level. The Imperial Diet, the Japanese parliament introduced in 1890 to appease the demands for political participation, became the main forum for these discussions. While figuring out how to navigate the parliamentary system, local delegates from flood-stricken regions formed a political alliance during the 1890s. They submitted petitions to the government and established an association with a magazine that aimed to promote knowledge about water control. Leading engineering bureaucrats also supported the group.[68] The knowledge promoted in the magazine included information on recently conducted water construction works and treatises by Dutch experts, but also reprinted Edo-period knowledge about water control and erosion control.[69] The group's lobbying led to the implementation of river engineering projects for the six major rivers under the central government's control. Following a major flood in 1910, this was later expanded to include fifty-six rivers, although not all of these projects were carried out.[70] The importance of controlling floods upstream in the mountains was acknowledged in the passing of the so-called "three water control laws," which consisted not only of the Water Control Law (1896) but also the Forest Law and the Erosion Control Law (both 1897).

The construction on the major rivers included building continuous levees and creating a distinction between the riverbanks, which were designated public land, and settlements.[71] Only a few critics spoke out against levees as potentially harmful. Odaka Atsutada (1830–1901), an entrepreneur without engineering training, criticized the reliance on levees. He argued that building levees would only lead to a race to build even taller ones and eventually render the river more dangerous by increasing the river's velocity. Quoting a classic Chinese text from the Western Han Dynasty (202 BCE- CE 9), the *Three methods of Jia Rang*, he stated that rivers needed space to meander.[72] In this context, Odaka presented an Eastern tradition

67 Moromoto Nishi, *Chisuiron* [Treatise on water governance] (Toyama: Seimeidō, 1891).
68 Wilson, *Turbulent Streams*, 206–212; Maeda, *Zenkoku seiji no shidō*, 104.
69 A full reprint of the magazine can be found in Tadashi Miyamura and Masakazu Ishizaki, eds., *Nōgyō doboku koten senshū Meiji – Taishōki 8 kan: Chisuiron* [Selected classics of irrigation engineering Meiji – Taishō period vol. 8: Treatises on water governance] (Tokyo: Nihon Keizai Hyōronsha, 1989–1991).
70 Wilson, *Turbulent Streams*, 212–216, 225.
71 Wilson, *Turbulent Streams*, 225–38.
72 Atsutada Odaka, *Chisui shinsaku* [New policy in water governance] (Tokyo: Odaka Jirō, 1891).

of river engineering, although he does not refer to water engineering during the Edo period, which already made heavy use of levees. His analysis, however, points to a growing trend in the 1880s to reappraise "traditional" knowledge based on Chinese learning as the core of Japanese identity.[73]

In the case of erosion control and forestry, continuities from the Edo period were explicitly drawn. Towards the end of the seventeenth century, silviculture had developed in Japan, after heavy extraction during the civil war period, and the development of new fields, which had both taken a heavy toll on forests.[74] Deforestation, sediment input into the rivers and flooding were recognized as interconnected issues early on in Japan, in the middle of the seventeenth century, especially in the heavily logged mountains around the Seto Inland Sea, where the rivers are short and the granite bedrock is prone to erosion.[75] In response, the shōgunate and local domains enacted logging bans, initiated afforestation and built erosion control dams.[76] Kumazawa Banzan, a neo-Confucian thinker who also advised on the policies of the Okayama domain at the Seto Inland Sea, wrote treatises about the necessity to protect the forests for water control. These treatises were rediscovered and promoted by Okayama Prefecture erosion control specialist Uno Enzaburō (1834–1911). Uno petitioned and worked to reintroduce erosion control in Okayama in 1882, which had been neglected in the early Meiji period, and thus became an influential figure for erosion control in Japan.[77] As a consequence, erosion control became established and seen as a Japanese tradition.

Forestry was learned in Japan from German *oyatoi.* However, they were invited in the mid-1880s, later than the river engineers, presumably because agricul-

73 Especially in education, Confucian moral education was deemed as providing necessary values which could not be replaced by Western education. Western individualism was constantly criticized as harmful to Japanese society. See Howland, *Translating the West*, 55–60; Harry D. Harootunian, *Overcome by Modernity: History, Culture, and Community in Interwar Japan* (Princeton, N.J.: Princeton University Press, 2002), 53–54.

74 Totman, *The Green Archipelago.*

75 Tokuji Chiba, *Hageyama no kenkyū* [The research on denuded mountains] (Tokyo: Soshiete, 1991), 41–55.

76 Totman, *The Green Archipelago*, 81–115, 130–148; Mizumoto, *Doshadome bugyō.*

77 Okayamaken Nōrin Suisanbu Chisanka, "Okayama ken chisanjigyō no ayumi: Hageyama taisaku," [The development of the mountain governance project in Okayama Prefecture: Measures against mountain denudation] *Sabō gakkaishi* 53, no. 2 (2000): 66–69. Uno republished Kumazawa's writings on mountain governance by erosion control: Banzan Kumazawa, *Chisui shokurin hongenron* [Water control afforestation: The treatise on fountains], ed. Enzaburō Uno (Okayama: Nozaki Mataroku, 1904).

ture was less prioritized by the Meiji state.[78] The interest in forestry for erosion control clearly guided the adaptation of knowledge afterwards. Most notably, the German forester Karl Hefele (1863–1904) was dismissed due to his lack of knowledge of erosion control, and Austrian Amerigo Hofmann (1875–1945) was invited instead between 1904 and 1909. He conducted experiments on afforestation and erosion control, and later, applied the knowledge he acquired to Italy. The reasoning was that Germany did not have enough high mountains prone to erosion. Thus, the Japanese turned to experts from the Austro-Hungarian Empire instead.[79] Notable pioneers of erosion control technology (*sabō*) who studied in Vienna included, for example, Akagi Masao (1887–1972), who lobbied for erosion control in the interwar and postwar periods.[80] Although knowledge was adapted from Europe, erosion control was perceived as a technology with a strong national tradition that was acknowledged by their European peers. “Mountain governance” was built into the overall idea to manage river systems in a comprehensive manner. The Forestry Law stipulated the establishment of flood protection forests. From the early twentieth century, the government promoted science-backed afforestation campaigns.[81] Erosion control became an increasingly important aspect of flood control during the twentieth century because of the constant lobbying by engineering bureaucrats, especially Akagi Masao.[82]

78 The Meiji state had mostly invested in infrastructure and a few key industries such as heavy industry or silk and cotton production, but failed to address local demand for research in agriculture and manufacture. This only shifted in the 1880s with the growing demand for political participation from rural intellectuals. See Gordon, *The Modern History of Japan*, 71–72, 83 and Tessa Morris-Suzuki, *The Technological Transformation of Japan: From the Seventeenth to the Twenty-First Century* (Cambridge: Cambridge University Press, 1994), 98–103. For the development of forestry in Japan, see Jun’ichi Iwamoto, “The Development of Forestry in Japan,” in *Forestry and the Forest Industry in Japan*, ed. Yoshiya Iwai (Vancouver B.C.: UBC Press, 2002): 3–9.

79 Haruo Nishimoto, “Tokyō teikoku daigaku sabō kōya gaikokujin kyōshi, Amerigo Hofmann no gyōseki ni tsuiteno ichi kōsatsu,” [A consideration on footprint of Amerigo HOFMANN, foreign professor of SABO laboratory, the Imperial University of Tokyo] *Sabō gakkaishi* 70, no. 5 (2018): 24–33; Hiroshi Koide, Takeo Satō and Ichirō Kaibara, *Nihon no suigai: Tensai ka jinsai ka* [Flood disasters in Japan: Heaven-sent or man-made disasters?] (Tokyo: Tōyō Keizai Shinpōsha, 1954), 187–190, 197–198.

80 Masao Akagi, *Sabō ichiro* [One way to erosion control] (Tokyo: Zenkoku Chisui Sabō Kyōkai, 1963), 32–33.

81 Tarō Takemoto, “A History of Tree Planting in Modern Japan: Resource Utilization and Environment Conservation,” in *Handbook of Environmental History in Japan*, ed. Tatsushi Fujihara (Amsterdam: Amsterdam University Press, 2023): 233–251, here 242–244.

82 Akagi, *Sabō ichiro.*

4 Adapting developmental visions to Japan in the prewar and postwar periods

As a result of the campaigning for river engineering for flood control, the major rivers were subjected to significant readjustments and construction projects, which Wilson refers to as the introduction of the "modern river regime."[83] The river construction works, however, did not proceed as swiftly as the authorities wanted. Historian Mikuriya Takashi blames the dysfunctions of the early twentieth-century water control regime on administrative "sectionalism," which resulted in competing responsibilities and a lack of coordination. For example, while river construction and water control were mainly under the control of the Home Ministry, irrigation ponds and channels were the responsibility of the Ministry of Agriculture. According to Mikuriya, the comprehensive vision of development planning facilitated the coordination of administrative tasks and a pacification of rivalries.[84] These centrally coordinated grand development visions also empowered technically skilled bureaucrats to shape policies.[85] As such, the Japanese engineering bureaucrats also joined the technocratic visions of engineers around the world during that period, who presented large-scale technological projects as solutions for social problems.[86] During the interwar period, Japanese engineering bureaucrats were repeatedly sent abroad by the government to study such projects, especially dam construction.[87] This overseas experience not only shaped ideas about water control policies in Japan, but also especially influenced efforts to build dams to develop the Japanese colonies of Taiwan, Korea, Manchuria, as well as in occupied Chinese territories during World War II after 1937.[88]

The most influential advocate for policies coordinating dam construction projects was the engineering bureaucrat Mononobe Nagaho, who was sent to the US and Europe to study concrete dams in the 1920s.[89] In 1926, he put forward a plan to

83 Wilson, *Turbulent Streams*, 225.

84 Mikuriya, *Seisaku no sōgō to kenryoku*, 97–158.

85 Hiromi Mizuno, *Science for the Empire: Scientific Nationalism in Modern Japan* (Stanford, CA: Stanford University Press, 2009), 43–52.

86 For a global context of large-scale development visions of the 1930s, see David Ekbladh, *The Great American Mission: Modernization and the Construction of an American World Order* (Princeton, NJ: Princeton University Press, 2011), 40–76.

87 Matsuura, *Senzen no kokudo seibi seisaku*, 73, 274.

88 For dam construction of Japan in its colonies, see Moore, *Constructing East Asia.*

89 For a biography of Mononobe, see Kōichi Kawamura, *Mononobe Nagaho: Doboku kōgakkai no kyosei* [Mononobe Nagaho: The great star of the civil engineering world] (Akita: Mumyō Shuppan, 1996).

systematically dam Japanese rivers for flood control, hydroelectricity, water supply, and irrigation.[90] Japan was subjected to much greater rainfall than the Western countries he visited, and had much narrower river valleys. As a result, according to Mononobe, plans for using concrete dams had to be modified from what he had observed in the West. He suggested building several smaller reservoirs on the rivers in a row.[91] Mononobe's vision for development involving concrete high dams was not realized in the interwar period, although dams gained popularity for development in both the colonies and domestically. After a large typhoon in 1934, another river construction program was launched that was expanded to all Japanese rivers. In this context, the TVA, established in 1933, was already a subject of study. The Home Ministry praised the comprehensive river development approach, which consisted of building dams, implementing erosion control and promoting agricultural development, viewing it as a model for Japan. As a result, a development program was implemented in Northeast Japan, which was poor and had recently suffered major crop failures.[92] Many of the plans, including development plans for occupied China after 1937, were not finished or put into practice because of wartime shortages. However, the continuities of the personnel in the administration during the postwar period meant engineering bureaucrats were already experienced with comprehensive river development designs and the use of high dams when they were proposed as a solution to address energy shortages after 1945.[93]

In order to rebuild Japan after the war, the US occupation authorities sent a group of experts, many of them New Dealers, including Edward A. Ackerman (1911–1973), who later served as vice director of the TVA. They cooperated with engineering bureaucrats from Japanese ministries to design development schemes. Ackerman founded the Resources Council, an advisory organ for the Japanese government, which included representatives of engineering bureaucrats from various fields. The council enabled free discussions between US and Japanese experts and fostered knowledge exchange. The TVA was among one the

90 Matsuura, *Senzen no kokudo seibi seisaku.*

91 Nagaho Mononobe, "Chosuiyō jūryoku entei no tokusei narabini sono gōriteki sekkeihō," [The special properties of gravity dams for water control and its technological construction method] *Doboku gakkai zasshi* 11, no. 5 (1925): 995–1157.

92 Naimushō Dobokukyoku, *Kasui tōsei no teishō* [Advocacy for the comprehensive river and water control project] (Tokyo: Naimushō Dobokukyoku, 1935); Tomohiro Okada, "Saigai to kaihatsu kara mita Tōhokushi," in *"Seizon" no Tōhokushi: Rekishi kara tou 3.11*, ed. Masakatsu Okado et al. (Tokyo: Ōtsuki Shoten, 2013): 2–52.

93 Dinmore, "Concrete Results?"

most popular subjects of discussion.[94] Water was one of the few resources that mainland Japan had in abundance.[95] Using dams, the surplus water of the typhoon floods that plagued postwar Japan could be turned into "useful" water that provided a valuable resource. Another reason why the TVA aligned with the Japanese agenda was that it incorporated forestry practices upstream, which aided in flood control and provided wood resources.[96] In 1950, the National Planning Law was enacted, and since then, Japan has issued national planning visions roughly every ten years.[97] In the meantime, ten-year construction programs for "water governance" and "mountain governance" were issued in the ministries to manage the actual work of water control.[98]

The comprehensive vision of the TVA was divided according to the ministries' competencies. Accordingly, the water control visions provided by the TVA were translated into the existing patterns of water control and erosion control that had been established since the Meiji period. They were divided and fragmented according to the engineering bureaucrats' education and ministerial affiliation. Water control and river engineering were primarily the responsibility of civil engineers, while "mountain governance" and erosion control were taught at the faculty of agriculture, creating separate personal networks for "water governance" and "mountain governance." River construction had fallen under the administration of the Home Ministry in the prewar period and the Ministry of Construction in the postwar period. "Mountain governance" through afforestation was under the administration of foresters at the Ministry of Agriculture. Erosion control responsibilities were divided between the Ministry of Construction, which mainly took care of check dams (small dams designed to slow down rivers upstream and catch sediment), and the Ministry of Agriculture, which oversaw hillside works to prevent mountain slides.[99] The administrative "sectionalism" of the prewar period thus continued into the postwar period, meaning in practice that the comprehensive development vision was translated into a multitude of construction projects alongside river systems and afforestation campaigns, allocated across different administrative sections. The construction of dams, the most cru-

94 Satō, *"Motazaru kuni" no shigenron*, 77–93.

95 Robert Y. Grant, *Report of the Natural Resources Section no. 149: River Control and Utilization in Japan* (Tokyo: General Headquarters, Supreme Commander for the Allied Powers, Natural Resources Section, 1951).

96 Aki, *Nihon no suigai*, 124–127, 140–141.

97 Honma, *Kokudo keikaku o kangaeru.*

98 Nakamura, *Floods and Probability*, 81–82.

99 Masao Akagi, Ushimaro Hayao, and Hirotada Gotō, "Zadankai: Sabō to chisan (ge)," [Roundtable: Erosion control and mountain governance 2] *Suiri Kagaku* 4, no. 1 (1960): 121–136, here 125.

cial element of the TVA vision, experienced a boom in the 1960s and 1970s and came under central regulation by the Multipurpose Dam Law in 1957.[100]

The most prominent proponent of the multipurpose dam was Aki Kōichi (1902–1985), who served as vice president of the Resources Council. He was a student of Mononobe Nagaho's and had served as a civil engineer in the Home Ministry. During the war, he had been sent to occupied China and later played an important role in propagating dams for regional development in Southeast Asia.[101] In popular science books, he promoted the idea that postwar floods were caused by overlogging and a lack of investment in river construction.[102] As a solution, he argued that repairing and building levees downstream was necessary for flood prevention, but they could not be built high enough to entirely block out floods. Water also had to be retained upstream in dam reservoirs.[103] The stored water could be used for hydroelectricity, industrial production and irrigation, as Japan was desperate for energy and resources after losing its colonies.[104] Japan had difficulties in the past in building dams because its soil was prone to erosion and as a consequence, the reservoirs would fill up too quickly. To prevent erosion, he assigned afforestation and erosion control an important role.[105] Ultimately, Aki acknowledged the TVA as a model for the comprehensive development of river systems.[106]

Not all engineering bureaucrats supported the vision of engineering rivers from the mountains to their outlets, a topic that was also discussed in public. Geologist Koide Hiroshi (1907–1990), who also served as a member of the Resources Council representing the Ministry of Agriculture, criticized many of the water control measures implemented by the Ministry of Construction. He especially opposed the use of continuous levees and dams, pointing to Japanese traditions of living with river overflow. In a book on *Floods in Japan*, which he co-wrote with Marxist economist Satō Takeo and forest scientist Kai Gen'ichirō, he claimed that blaming deforestation for the floods masked the failures of modern engineering.[107] According to him, Japanese river engineers wrongly adapted Western

100 Kajiwara, *Sengo kasen gyōsei to damu kaihatsu*, 30–48.

101 For a rather uncritical biography of Aki, see Tetsurō Takasaki, *Gekkō wa taiga ni haete: Gekidō no shōwa o ikita mizu no kagakusha Aki Kōichi* [The moonlight is reflecting on the great river: Aki Kōichi, the water scientist who lived through the turbulent Shōwa period] (Tokyo: Kajima Shuppankai, 2005).

102 Aki, *Nihon no suigai*; Kōichi Aki, *Kōzui no hanashi* (Tokyo: Iwanami Shoten, 1952).

103 Aki, *Nihon no suigai*, 133–137.

104 Aki, *Nihon no suigai*, 117–126.

105 Aki, *Nihon no suigai*, 129.

106 Aki, *Nihon no suigai*, 155–160.

107 Koide, Satō and Kaibara, *Nihon no suigai*, 45–50.

knowledge. Continuous levees would lead to fast-flowing rivers with a lot of sediment accumulation in riverbeds and “ceiling rivers” that were more elevated than the surrounding land. These would make breaches and flooding more devastating, because of their high speed and the difficulty in draining the floods afterwards.[108] Adding more dams would only increase the risk of “man-made” disasters, as the results of breached dams were devastating.[109] Vernacular water control strategies, according to Koide, were better equipped to reduce floods and deal with sedimentation. Protection forests at riverbanks protected levees and reduced flood speed. *Kasumitei*, the discontinuous levees that allowed an overflow backwards, which Johannis de Rijke also used, also slowed down flooding and made the water retreat again faster.[110] When a certain amount of overflow was allowed, the fertile sediment could also be used in agriculture. Afforestation was not a universal solution, since the afforestation favored conifer monocultures because of commercial reasons, but these were not ideal for retaining floods.[111] Finally, Koide also argued against the construction of dams, since the fast sedimentation in Japan would quickly render dams useless.[112] Koide concluded that Japan should not treat floods as a problem only to be solved by engineering, but should also address the social and economic problems caused by flooding.[113]

Although some river engineers, especially Ōkuma Takashi (*1942), continued to argue for allowing a certain amount of overflow and living with floods, drawing on traditional flood management practices, the reality was different.[114] Postwar growth and urbanization meant that space in the plains was needed for settlement. It became desirable to keep river channels narrow and to allow less overflow. Engineering historian Nakamura Shin’ichirō has pointed out that the flood protection standards were tied to the national budget in the postwar period to save on levee costs, but the subsequent economic miracle enabled flood protection standards – and levees – to become higher.[115] The problem of sedimentation in dam reservoirs was engineered away, by installing sediment discharge gates, dredging, and especially by promoting “mountain governance” and erosion con-

108 Koide, Satō and Kaibara, *Nihon no suigai*, 71–74, 220–222.
109 Koide, Satō and Kaibara, *Nihon no suigai*, 52–56.
110 Koide, Satō and Kaibara, *Nihon no suigai*, 167–170.
111 Koide, Satō and Kaibara, *Nihon no suigai*, 213–217.
112 Koide, Satō and Kaibara, *Nihon no suigai*, 268–269.
113 Koide, Satō and Kaibara, *Nihon no suigai*, 276–277.
114 Ōkuma, *Kōzui to chisui no kasenshi.*
115 Nakamura, *Floods and Probability*, 173–180.

trol.[116] These were introduced based on Aki Kōichi's and erosion control pioneer Akagi Masao's claims that the problem of sedimentation in dams would be solved by the systematic implementation of afforestation and erosion controls, which were both energetically pursued in the 1950s and 1960s.[117] Erosion control also became an international export for Japan. In 1951, while still under US occupation, soil conservationist Walter C. Lowdermilk (1888–1974) came to observe Japanese erosion control and suggested the use of the Japanese term, *sabō* as an internationalism. It has been employed internationally as a technical term since then.[118]

5 Conclusion

Examining water control in Japan reveals not only complex entanglements between environment, society, and development, but also between globally circulating knowledge on development and vernacular environmental understanding. Contrary to their image of living "in harmony with nature," the Japanese of the modern era have persistently argued for the engineering and control of nature, attributing natural disasters to the neglect of river engineering or the "devastation" of mountain forests. Care of the environment was strongly tied to technology, which had to be adapted to the Japanese environment. Engineering bureaucrats in Japan never tired of emphasizing how different (and more difficult) the Japanese environment was compared to Western environments – steeper topography, and more rain and erosion – meaning that technology had to be tailored to the Japanese environment. What was considered "suitable for the Japanese environment" was complex and varied according to the arguments being presented. For example, in the case of nineteenth-century civil engineers, water control technology had to be even more modern and engineered than suggested by the Dutch advisor de Rijke, who was more open to integrating Japanese vernacular knowledge. Erosion control was perceived as a neglected Japanese tradition overlooked by Western technology that was crucial for flood control, while many practices were also learned from Austria. Finally, the argument that Japanese vernacular practices were more suitable for dealing with floods gained traction in light of

116 Damu kōgakukai Kinki-Chūbu wākingu gurūpu, *Damu no kagaku: Shirarezaru chōkyodai kenzōbutsu no himitsu ni semaru* [The science of dams: Close in on the secrets of unknown megastructures] (Tokyo: Sofutobanku Kurieitibu, 2012), 186–197; Ministry of Land, Infrastructure, Transport and Tourism, "Omo na taisha taisaku," [The main strategies to get rid of sedimentation], accessed April 4, 2025, https://www.mlit.go.jp/river/dam/taisa/taisa3.pdf.

117 Aki, *Nihon no suigai*, 141; Akagi, Hayao and Gotō, "Zadankai," 129.

118 Akagi, *Sabō ichiro*, 2–3.

a comprehensive development scheme that subjected entire rivers to development, inspired by the TVA, an American development program.

In this way, Japan actively participated in the global movement towards comprehensive development in the nineteenth and twentieth centuries while continually connecting it back to its own traditions and structures. This resulted in a process of development dominated by engineering bureaucrats who, since the reforms of the Meiji period, had overseen the search for and adaptation of knowledge from abroad. In the case of comprehensive river development, the dualism in the perception of the Japanese environment, between plains and steep mountains, became a defining and structuring element. Starting with the debate over "low" and "high" water construction in the late nineteenth century, which brought the necessity of erosion control onto the political agenda, the dualism was present in the education of engineering bureaucrats and the division of responsibilities between the ministries. The adaptation of technological and developmental visions from abroad was tailored to fit the existing dualism in river development. The bureaucratic approach to development led to the standardization of water control practices, narrowing them down to a few universally applied measures, and resulted in straightened rivers fortified by levees and controlled by thousands of dams. As a key power in Asia, Japan also played a role in propagating technologies like dams and erosion control in the second half of the twentieth century. Although vernacular flood control practices have been repeatedly revisited as environmentally friendly alternatives to "standard" flood control measures, it must be noted that these are limited to a few methods that do not require much overflowing space and can easily be integrated into modern bureaucratic catalogs of river engineering. Examples include the planting of protection forests and the use of discontinuous levees like *kasumitei.*

The case of Japan is a reminder that the development and engineering of the environment is not necessarily something brought to the world by the "West," but also something embraced by a culture such as Japan's, which tied technology to the belief in the necessity of constantly cultivating the environment. Since the nineteenth century, the adaptation of Western technology has enabled the engineering of the Japanese environment on an unprecedented scale. The embedding of development into bureaucratic structures was spearheaded by a small group of engineers educated at the University of Tokyo, resulting in a narrow understanding of what development should entail. The bureaucratic structures have led to a central national coordination of development on the one hand and a fragmented approach to execution on the other hand. This has facilitated the establishment of routines and path dependencies in river development that seem almost impossible to challenge, that Patricia Sippel has referred to as a “sacred domain.”[119] Even if the necessity of river engineering measures like dams have been questioned more in recent decades with the rise of environmentalism, the Japanese state has continued to double down on its established practices of river development.[120]

119 Sippel, “Chisui.”
120 A good example for this is the “National Resilience” program of the Japanese government, which is Japan’s response to the UN’s Sustainable Development Goals, including climate action. This program continues the traditional river development programs aimed at flood prevention. Cabinet Secretariat, “Building National Resilience,” accessed April 2, 2025, https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/index_en.html.

Daniel Pérez-Zapico

Coal anxieties and the search for a "moral" energy resource in early twentieth-century Catholic Spain

Introduction

In 1923, Salvador Grech Abellán, an assistant professor of electrical engineering at the *Instituto Católico de Artes e Industrias* (Catholic Institute for Arts and Industry – henceforth ICAI), delivered the following statement during a field trip by fourth-year electrical engineering students to the Bolarque dam. Inaugurated in 1910 with the objective of supplying Madrid, this infrastructure marked the transition to large-scale hydroelectric power production aimed at providing urban centers with high-voltage electric transmissions:

> Upon observing the tranquil waters as they meander into the canal, one cannot help but admire Man's hand, who stops the water, directs it where he pleases, and use machines built by him to transform its energy into electricity; this electricity in turn illuminates our dwellings and streets, and it powers our trams and subways … Indeed, Man stands as the pinnacle of Creation.[1]

This chapter will explore several of the topics found in the kind of Catholic "technological sublime" articulated by Abellan: the theological significance of specific natural assets, the role of religious imaginations in aestheticizing particular energy resources and technologies, and the intersection of these elements with extractivist narratives used to promote industrial and capitalist development during a period of national crisis.

In my previous work, I have examined the controversies surrounding the electrification of Spain during the Restoration era (1874–1931), particularly following the loss of Spain's last overseas colonies in 1898 – a process that shocked public opinion as it underscored the nation's declining status as a second-rank European power. These debates saw the coexistence of diverse modernizing agendas, which connected varying conceptions of development with different notions of nationhood. This chapter delves further into these issues by examining the intersection

1 Salvador Grech Abellán, "Excursiones científicas," *I.C.A.I.: revista ilustrada del Instituto Católico de Artes e Industrias*, year VII, no.28, July 1923, 116; all translations of quotations from Spanish are by the author unless otherwise noted.

https://doi.org/10.1515/9783111611358-003

of energy and Catholicism in early twentieth-century Spain. It does so by exploring the ideas and values embedded in the exploitation and use of natural energy resources – particularly coal and electricity.[2] While the harnessing of nature and the mobilization of its energy assets were central to all developmental schemes of the period, Spanish Catholicism adopted a more cautious stance toward industrial modernization. In this context, not all natural resources carried the same ethical connotations. Catholic thinkers often viewed coal-fueled industrial modernization as undermining domestic values, rural life, and the balance between cities and the countryside to the detriment of the latter. Accordingly, this chapter explores how hydroelectricity was expected to shape particular techno-environmental trajectories and configurations, reflecting Catholics' visions of how the long-desired national development should be achieved.

The opening section of this chapter introduces a set of ideas concerning the technology–environment–development nexus in late nineteenth-century Spain, which foreshadow the debates that followed. As such, this section highlights the diversity of voices and cultural frameworks used to interpret and represent nature and its resources within a Spanish Catholicism that was far from ideologically homogeneous. Accordingly, it will juxtapose two opposing perspectives. On the one side are anti-industrial, traditionalist visions informed by theological traditions which sought to preserve a pristine nature wisely ordained by the Creator, and unspoiled by a potentially destructive industrialization. Conversely, on the other side, these views coexisted with religious discourses in which extractivist narratives and capitalist developmental needs converged. This section situates these positions within a geopolitical context of developmental ideas that positioned Spain as backward. Since industrial modernization was generating a new global economic geography polarized between dynamic and stagnant regions – including fading empires such as Spain – access to and control of specific natural resources – particularly coal reserves – played a pivotal role in facilitating development within an emerging worldwide energy economy with a broad mineral base. Consequently, the second section of the chapter introduces and examines the concept of "coal anxieties" to describe a transnational phenomenon during the formation of global coal capitalism, marked by concerns in certain countries about the potential of their domestic coals to support national development. This section will follow the endeavors of a group of Catholic engineers affiliated with the ICAI in their pursuit of alternatives to coal. During the period

2 This chapter elaborates on certain ideas previously mentioned in Daniel Pérez-Zapico, "A Way Out of Darkness: Thinking About the Future of Spain Through the Promises of Electricity and Energy Abundance, 1898–1931," *Journal of Energy History* 8, no.1 (2022): 12–17.

under consideration, the prospect of coal shortages was a persistent source of concern; however, this section also addresses the social and moral challenges posed by specific industrial configurations dependent on coal. This topic will be further developed in the final section, which focuses on hydroelectricity as a "moral" natural resource. In grappling with the need to overcome the limitations of domestic coal, Catholic thinkers also explored the social and political possibilities enabled by the subdivision and decentralized distribution of energy – made feasible by the material properties of hydropower and emerging electrical infrastructures.

A growing body of literature has explored the connections between religion and the environment.[3] Energy historians have also examined the cultural forces shaping both past (and present) energy transitions.[4] This chapter contributes to that conversation by analyzing the moral economy underpinning specific models of industrial development reliant on hydraulic power. In doing so, it engages with the moral dimensions embedded in different energy regimes and the possibilities of transitioning between them.[5] It also highlights the role of religious and political imaginaries in shaping discourses on development, visions for natural resource exploitation, and the adoption of specific technologies. In this context, the prevalence of Catholicism as a cultural and ideological force in nineteenth and early twentieth-century Spain reveals the intriguing ambivalence surrounding notions of development and progress, as well as toward nature itself as a source of future possibilities. As will be shown, innovation was not necessarily aligned with progressive visions – it could also be mobilized in the service of conservative agendas.[6]

---

3 See, for example, Bronislaw Szerszynski, *Nature Technology and the Sacred* (Hoboken: Wiley, 2008); Celia Deane-Drummond, Sigurd Bergmann, and Markus Vogt, eds., *Religion in the Anthropocene* (Cambridge: The Lutterworth Press, 2017); Evan Berry, *Devoted to Nature: The Religious Roots of American Environmentalism* (Oakland: University of California Press, 2015).

4 See, Stephanie LeMenager, *Living Oil: Petroleum Culture in the American Century* (New York: Oxford University Press, 2014); more generally, Imre Szeman and Dominic Boyer, eds., *Energy Humanities: An Anthology* (Baltimore: Johns Hopkins University Press, 2017).

5 See, Leo Coleman, *A Moral Technology: Electrification as Political Ritual in New Delhi* (Ithaca: Cornell University Press, 2017); Rebecca K. Wright, *Moral Energy in America* (Baltimore: John Hopkins UP, 2025).

6 See, also, Sorcha O'Brien, "Electricity, Modernity and Tradition During Irish Rural Electrification 1940–70," *Journal of Energy History* 8, no.1 (2022): 1–18.

Religious imaginations and the technology-environment nexus in late-nineteenth-century Spain: between anti-industrialism and extractive capitalism

In 1884, *La Ilustración Católica* (The Catholic Enlightenment), a widely read Catholic weekly, documented the installation of the first electric lights on the streets of Madrid. The author of the article articulated his skepticism regarding the novel lighting system, citing concerns over its potential impact on public health, as electricity was considered too harsh for the eyes. This criticism, particularly prevalent among those with interests in the gas industry, reflected a broader disapproval of modern technologies, which echoed the views of some Spanish Catholics. According to this analysis, industrial technologies – and, by extension, industrial modernity – had a questionable moral standing:

> To be honest, the [electric] light is shiny but too bright. During the day, we enjoy the bright sunlight, and at night, we enjoy the vivid light of electric bulbs. This means that our eyes are always under persistent strain. God gave us eyes with eyelids to show that we should protect them and rest. Anything that disrupts the natural order of things, meticulously crafted by the Almighty, seems to cause disasters for humankind, … It is not possible for either day to be night, or for night to be day, or for the Earth to be an Eden without humankind suffering the consequences of such a sudden change.[7]

At the start of the Restoration era (1874–1931), certain sectors of the ultra-Catholic traditionalist faction expressed reactionary views regarding the changes wrought by industrial modernization in prominent, widespread publications. These views evidenced vehement opposition within a militant anti-modern framework that was shared across European Catholicism. In Spain, however, this perspective was influenced by the traumatic legacy of the previous regime, the so-called "Six Democratic/Revolutionary Years" (1868–1874) (*Sexenio Democrático/Revolucionario*), which, for the first time in Spain, sanctioned the separation of church and state and the freedom of worship. With the restoration of Alfonso XII in 1874, the Church regained its strength and once again became one of the state's central institutions, as Catholicism was reestablished as the official religion. However, internal divisions emerged between liberal Catholics, more willing to accept political

7 "Revista," *La Ilustración Católica. Seminario religioso científico-artístico-literario*, no.26, September 15 1884, 302.

modernity, and fundamentalist and traditionalist movements that wanted an even more confessional and Catholic society. Moreover, social changes, new political movements, and the advance of secular ideologies became a constant source of tension.

At any rate, fundamentalist Catholic critiques of the modern industrial world often responded to the Promethean challenge of technology, which was seen as threatening a pristine environment and a natural order deemed perfect by divine creation. By adhering to the fundamental principles of patristics – a field of theological study dedicated to examining the teachings of the Church Fathers from the early centuries – certain Catholics concluded that any modification to the natural order was inherently sinful. While craftsmanship was viewed favorably – after all, Jesus himself had been a carpenter – modern industrial technologies represented a qualitative leap forward. Consequently, the transformative impact of modern technologies and industry appeared to be associated with a novel form of materialism that was denaturalizing Creation. This, in turn, resulted in the erosion of the cultural and, hence, political authority of the Church.[8]

However, despite the anti-industrial connotations of such narratives, the defeat of 1898 emphasized the pressing need for industrial modernization, with several developmental schemes framed in the public debate in terms of national "regeneration."[9] In an international context in which economic performance was associated with industrial prowess, numerous voices within national Catholicism espoused the view that industrial development was imperative. Consequently, positions favoring industry as a catalyst for economic prosperity and national pride coexisted with those opposed to the excessive ascendancy of techno-scientific initiatives. For instance, around the 1898 crisis, the main journal associated with the emerging Catholic social doctrine movement was aware of the underdeveloped state of Spanish industry when compared with that of other European nations:

> We will speak out if we have to, because we cannot be satisfied with our country's remaining behind in the contemporary industrial movement. We also cannot be content with our nation, so glorious in many respects, being behind other countries. We want that our nation

8 Numerous examples demonstrated how these tropes concerning a pervasive, artificial modern technology circulated: "The Sun must be jealous of the advancements in physics, for, at this rate, it will be completely overshadowed. Its absolute sovereignty risks being overruled by the proliferation of multiple electric suns that will provide us with light, heat and movement in accordance with our desires." "Revista," *La Ilustración Católica. Seminario religioso científico-artístico-literario*, December 21 1881, no.23, 177.

9 "Regenerationism" was an intellectual and political movement, primarily active in the late nineteenth and early twentieth centuries, that sought to diagnose and address Spain's perceived decline.

> occupies the first place in religious matters and in matters of honor, but also in the order of material wealth.[10]

How were the fundamental differences between those Catholic sectors that viewed industry as a threat to a natural environment wisely ordained by God, and those that promoted industrial entrepreneurship reconciled? The neo-Thomistic revival of the late nineteenth century arguably provided the intellectual basis for revalorizing industrial labor and integrating machinery into broader developmental paradigms. According to Aquinas' system, God had chosen humanity as his preferred creation. As such, humankind was entrusted with the responsibility of contributing to God's creative endeavors, thereby transforming nature into a kind of second creation. This narrative proved instrumental in countering the anti-industrial intransigence of virulent anti-modern reactionaries since, contrary to the patristic tradition, humans were legitimized to dominate and enhance the natural order, even if that dominion should prioritize spirit over matter.[11]

It is evident that a number of "regenerationist" intellectuals concurred with the notion that Spain possessed a wealth of natural resources which were perceived as practically inexhaustible, but in a state of neglect and underdevelopment.[12] Therefore, a legitimate research question may explore the role of Catholicism as a cultural and ideological driver behind broader attitudes and visions of nature, including the promotion of specific extractivist narratives. It is evident that certain religious imaginaries that aligned with the Christian conception of nature as a second creation proved instrumental to the needs of Spanish capitalism, as they were responsible for promoting the harnessing of those natural resources through a rhetoric of abundance and limitlessness. In 1884, for instance, an article in *La Ilustración Católica* (The Catholic Enlightenment) discussed the application of Faure's electric accumulator to Parisian trams, envisioning a brave new world

10 "La crisis obrera," *Boletín del Consejo Nacional de las Corporaciones Católico-Obreras de España*, February 1897, no.2, 3.

11 The Neo-Thomistic revival, which emerged in the late nineteenth century, was a philosophical and theological movement aimed at revitalizing the ideas of Thomas Aquinas. Gaining momentum after Pope Leo XIII's 1879 encyclical *Aeterni Patris*, the movement sought to apply Thomistic principles to contemporary debates and challenges. It aimed not only to counter the influence of Enlightenment thought and the decline of traditional Thomism, but also to reconcile modern scientific discoveries with the foundational teachings of the Church. A comprehensive view of the interactions between Catholicism and science in Don O'Leary, *Roman Catholicism and Modern Science: A History* (New York: Continuum, 2006).

12 On the pivotal role that nature and natural resources played within "Regenerationism" see, for example Santos Casado de Otaola, *Naturaleza patria. Ciencia y sentimiento de la naturaleza en la España del regeneracionismo* (Madrid: Marcial Pons, 2010).

of inexhaustible energy resources made possible by "God's providence." This narrative, however, was entirely blind to the potential ecological consequences of "mankind's insatiable thirst":

> Mankind, characterized by insatiable pleasures and needs, tends to consume and devour everything, disregarding what will happen in the future and thereby destroying the might vitality and lifeblood of the world … but then, luckily, Providence intervenes to rectify these ravages and provides new resources for human activity.
>
> That the global supply of olive trees is insufficient to meet human demand, and petroleum comes to help with its great deposits, which are abundant in the Earth's crust; that oil production declines or its consumption increases significantly, and gas comes to help with its light; coal becomes expensive and its luminosity proves inadequate to meet the demands of contemporary industry, and so electric light jumps in to open new horizons, which seem limitless to the desires and ambitions of mankind. God's kind and watchful Providence, what would men do without your loving care?[13]

At the turn of the twentieth century the dominant moral imperatives arising from the necessary extraction and mobilization of the country's natural resources for industrial and capitalist modernization may have further reinforced this narrative. In this sense, these discourses were convenient as the Church was eager to demonstrate its industrial capacity and initiative, especially in the face of those secularists who considered that Catholicism was at odds with any serious development project. A key question, however, remained about the role of the nation's energy resources in this broader context: what raw materials could be then mobilized for national development?

Questioning coal

Economic historians have generally regarded the presence of energy resources as a pivotal factor in the historical process of industrialization and economic modernization.[14] Recent scholarship in industrial and energy history, however, increasingly challenges the "coal-centric" narratives that have long dominated canonical interpretations of the nineteenth-century "industrial revolution."[15]

13 Nulema, "Revista," *La Ilustración Católica. Seminario religioso científico-artístico-literario*, no.5, February 15 1884, 50.

14 See Edward A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge: Cambridge University Press, 2010).

15 The presence of natural resources – particularly coal – was a necessary but not exclusive precondition for the initial industrial take-off, as evidenced by Robert C. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009). More-

Jean-Baptiste Fressoz, for example, argues against the modernist ideologies implicit in defining epochal changes in human history, relying on the dominance of a single energy source. Fressoz proposes an alternative to the teleological language of the "energy transitions" metaphor, suggesting instead a consideration of the multiple and dynamic "energy additions" throughout history based on the incorporation of concurrent fuels and energy technologies.[16] Notwithstanding this, and even if the shift from a traditional, pre-industrial energy regime to another one reliant on fossil fuels did not happen overnight, at the beginning of the twentieth century, coal became the cornerstone of an emerging global fossil economy and a cultural force that defined the power and capacity of nations.[17] Indeed, between 1850 and 1914, coal extraction increased 16-fold worldwide, with the United Kingdom producing 65% of coal globally at the beginning of the period, falling to 25% by 1914. This was second only to the United States' 43%, and followed by Germany with a further 25%.[18] The extraction and consumption of coal thus established a geopolitics of development. As such, the world appeared to be divided between a minority of countries that had access to fossil fuels and had developed robust infrastructures for their use, and a majority of nations that depended on traditional

over, in the mid-nineteenth century coal provided only a limited amount of the global energy consumption; see, Jürgen Osterhammel, "Energy and Industry: Who Unbound Prometheus, When, and Where?" in *The Transformation of the World: A Global History of the Nineteenth Century*, by J. Osterhammel (Princeton/Oxford: Princeton University Press, 2014), 637–672. Other energy sources, in particular water, were essential as a primary source of energy in the initial processes of industrialization, whether in the United Kingdom, the United States, Canada or, in the case of Spain, Catalonia; see Louis C. Hunter, *A History of Industrial Power in the United States, 1780–1930, vol. 1: Waterpower in the Century of the Steam Engine* (Charlottesville: University Press of Virginia, 1980); Ruth W. Sandwell, ed., *Powering Up Canada: A History of Power, Fuel, and Energy from 1600* (Montreal: McGill-Queen's University Press, 2016); Jordi Maluquer de Motes, "La despatrimonialización del agua: movilización de un recurso natural fundamental," *Revista de historia económica* 1, no.2 (1983): 79–96. An interesting case is Japan, where limited domestic coal resources had to be "crafted" as to suit foreign technological imports. See, Aleksandra Kobiljski. "Energy Workarounds: Designing Coals for the Japanese Steel Industry, 18951911," *Technology and Culture* 63, no.2 (2022): 326–348.

16 See Jean-Baptiste Fressoz, *More and More and More: An All-Consuming History of Energy* (London: Penguin Books, 2024); another suggestive notion is that of "reorganized energy regimes." See, David E. Nye, "A Model for Heterogeneous Energy Transitions," in *Electrical Conquest. New Approaches to the History of Electrification*, ed. W. Bernard Carlson and Erik M. Conway (Cham: Springer, 2023), 21–50.

17 See Cara N. Daggett, *The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work* (Durham: Duke University Press, 2019).

18 Osterhammel, "Energy and Industry," 655.

energy resources and were compelled to import coal from other regions, including the United Kingdom, the Ruhr area, and other far corners of the world.[19]

In the case of Spain, its early industrialization – very localized and uneven, yet with noteworthy developments since the early nineteenth century or even the late eighteenth century – was heavily reliant on the abundance or scarcity of natural resources at the local level (water or coal, but also iron ore), the degree of institutional and social maturity of the respective regions (including the level of technical training), as well as the presence of foreign capital and expertise. The dynamic interplay between these factors resulted in diverse patterns that gave rise to intense processes of regional industrial modernization in areas of Andalusia, but above all in Catalonia, the Basque Country, and Asturias throughout the nineteenth century. However, Spain was among the group of countries where the problems derived from the location and poor conditions of coal extraction negatively affected the national economy, although a good transport infrastructure could have alleviated these initial deficiencies. It is evident that other factors mattered, such as the political instability that characterized the entire nineteenth century, the fiscal hardships faced by the state, and the competing interests of the agrarian elites who wielded near-hegemonic power and were reluctant to prioritize industrial entrepreneurship in the development of the country.[20]

As already mentioned, at the turn of the twentieth century, Spanish coals – and by extension the country’s natural resources – became subject to public scrutiny within the context of “regenerationist” debates. Opinions on this matter varied widely. Some were overly optimistic, assuming that abundant domestic coal reserves could be readily extracted if only national infrastructure were improved. In contrast, more pragmatic assessments recognized the challenges posed by Spain’s coal resources. In the face of mounting imports from foreign nations (particularly the United Kingdom) to compensate domestic shortages, prominent experts and business leaders advocated for the protection of national coal resources via tariffs and taxation. Other recommendations included intensifying coal extraction through more efficient methods – including the installation of large thermoelectric power plants near coal pits that were expected to utilize low-quality coal – and enhancing transport infrastructure. As a matter of fact, coal shortages worsened during the early years of the twentieth century. For example, the 1912 mining strikes in the United Kingdom had deleterious effects on Spanish industries as international coal prices rose. Paradoxically, coal extraction

19 Osterhammel, “Energy and Industry.”

20 An overview in Gabriel Tortella-Casares, *The Development of Modern Spain: An Economic History of the Nineteenth and Twentieth centuries* (Cambridge and London: Harvard University Press, 2000).

in Spain increased during the Great War, although production primarily served the needs of the European combatants. This surge was driven by entrepreneurs who promoted small-scale mining ventures to capitalize on foreign demand. However, after the war boom, these small coal pits proved economically unviable and highly inefficient due to their limited size. In the northern regions, the presence of low-quality coals that accumulated without viable usage, exacerbated the so-called "coal question." Additionally, Spain's mining sector lacked the necessary technological upgrades and mechanization. In any case, the Great War aggravated domestic shortages, and the resulting rise in energy prices and inflation worsened the social situation – families lacked coal for cooking and heating – and pushed the already weakened Restoration political system to the brink of collapse. The efforts of the Minister of Development, Viscount of Eza, during the Dato government (June-November 1917) were unsuccessful in ameliorating the economic and industrial crisis. This culminated in the nation's first general strike in August 1917, orchestrated by railroad workers. It was preceded in July by the so-called Assembly of Parliamentarians, which sought a radical democratization of the oligarchic Restoration regime.[21]

I have previously examined the expectations associated with the potential transition to hydroelectricity in Spain, as discussed by some Spanish engineers at the beginning of the twentieth century from a techno-nationalist perspective.[22] Here I will focus on a group of Catholic engineers affiliated with the *Instituto Católico de Artes e Industrias* (ICAI), an institution established in Madrid in 1908 with an initial focus on providing night-time education for workers. This institution subsequently evolved to train mechanical assemblers and other qualified intermediate personnel for industry, in addition to electrical engineers.[23] The institution embodied the Jesuit commitment to technical education by providing an alternative educational system to the state. This system included other scientific institutions such as the Chemical Institute of Sarriá (1905) and the Ebro Observa-

21 An overview of Spain's mining sector in Miguel Ángel Pérez de Perceval, Miguel A. López-Morell, and Alejandro Sánchez Rodríguez, eds., *Minería y desarrollo económico en España* (Madrid: Instituto Geológico Minero de España, 2006); Isabel Bartolomé Rodríguez and Carles Sudrià, "Un recorrido poco exitoso: de la Primera a la Segunda Revolución Industrial, 1814–1939: la era del carbón," in *Atlas de la industrialización de España1750–2000*, ed. Jordi Nadal Oller (Barcelona: Crítica, 2003), 61–100.

22 See Daniel Pérez-Zapico, "Electrical Futures for a Regenerated Spain: Electricity, Engineering and National Reconstruction after the 1898 'Disaster,'" *History and Technology* 39, no.1 (2023): 91–125.

23 The ICAI awarded a diploma that was never officially recognized by the state, due to opposition from industrial engineers, leading to ongoing friction between ICAI's electrical engineers and the broader engineering community.

tory (1908). Notably, however, the industrial sector that they prioritized matched the ICAI’s focus on the energy sector, particularly electricity, as a pivotal driver for national revitalization. Besides its role in supplying a significant number of specialized, highly skilled workers and engineers who received hands-on, practical training oriented towards the private sector, the ICAI was an agenda-setting institution. Accordingly, it played an active role in the technical discussions of the period. Notable figures – including military officers, politicians, the King and Queen, as well as students and engineers from other prestigious technical schools in Madrid, such as the School of Civil Engineering and the Central School of Industrial Engineers – frequently attended ICAI’s halls for regularly held outreach talks. In these sessions, ICAI’s experts discussed both the technical requirements for Spain’s electrification and the moral foundations of the endeavor, in particular, the social challenges arising from coal extraction.

Indeed, José Agustín Pérez del Pulgar (1875–1939), a Jesuit priest, scientist, and founding member of ICAI, played a central role in shaping the debates around national electrification, especially in response to the issues associated with coal dependency. Pérez del Pulgar proposed the establishment of a large national high-voltage electricity network, under the protection of the state, that would cover the entire national territory, and traverse the main centers of energy production and consumption.[24] The grid’s primary function was to facilitate the connection of power stations within the coal basins – mainly in the north of the peninsula – with the abundant waterfalls, which were to be systematically exploited through the construction of a series of large dams to produce hydroelectricity. Most importantly, Pulgar viewed the energy issue as a matter of political economy. In essence, energy was regarded as a crucial element in ensuring stability and social justice during a period of significant unrest. In this way, Pulgar defined energy as “the most powerful tool for lifting people out of economic ruin and sustain them so that they do not descend into the abyss of social revolt into which the high cost of living and the decrease in production threaten to plunge them.”[25] Indeed, Pulgar could not help but refer to the “social question,” i.e. the rise of “the masses who lived by their manual labor” and who sought to improve their living conditions, demanded better wages, and, as Pulgar noted “consumed greater amounts of energy.” As a result, meeting the “needs and aspirations of the weakest” –

24 Pulgar’s first articles on the grid were published in 1915 in the Jesuit scientific magazine *Ibérica.* In 1917, his proposal for electrification was referred to the Permanent Electricity Commission, which issued a report in 1919 confirming the viability of the grid; however, the project was never realized.

25 José A. Pérez del Pulgar, “Producción y distribución nacional de energía eléctrica,” *La Energía Eléctrica*, no.1, January 10 1921, 2.

which Pulgar defined in terms of energy provision – was framed as falling within "the norms of what is legitimate and just." Achieving this goal, in Pulgar's view, required a fundamentally interventionist state.[26] During the critical moment of autumn 1917, as the priest intensified the dissemination of his writings, he strategically advocated for energy policy that emphasized the necessity of a state-led approach to organizing and systematizing national energy resources.[27]

Pulgar undertook numerous international trips to study the energy sectors and electrification efforts of various European countries, often at the request of companies or influential figures in the international electricity industry. In 1923, Pulgar visited Berlin at the invitation of the Siemens company to examine the Siemensstadt installations, before moving on to Stockholm at the invitation of the Allmänna Swenska company. He documented his observations of coal shortages in Germany during the Franco-Belgian occupation of the Ruhr with the assistance of Walter Reichel, director of Siemens-Dynamowerk, and professor at the Technical University of Berlin.[28] Pulgar shared his observations regarding "the enormous logistical endeavors underway in Germany to compensate for the reduction of coal reserves from the Ruhr and other coalfields." Pulgar's account underscored the significance of charcoal as a viable alternative energy source. While he noted the poor quality of this coal – "so waterlogged that it requires drying before use in large cookers resembling very wide chimneys that emit substantial steam clouds" – he underscored its utilization in areas facing shortages. The scarcity of coal also led to the electrification of the Silesian railway network, with the power station constructed at Mittelsteine serving as a key asset. This station utilized lower-quality coals that were deemed "to be of an even lower quality than the coal commonly referred to in Spain as absolutely useless."[29]

It is evident that Pulgar focused on subjects pertinent to solving the "coal question" in Spain. This focus appeared to align with efforts observed in Germany, where the objective was not only to implement technologies for the utilization of lower-quality coals in proximity to pitheads, but also to identify alternative sour-

26 Pulgar, "Producción."

27 "The organization of these elements [energy and other natural assets] should be regulated in normal times, in such a way that, in necessary cases, it would be possible to make them independent of the will of private individuals, employers or workers, but much more independent of direct or indirect foreign intervention." José A. Pérez del Pulgar, "La nacionalización de la energía eléctrica," *La Energía Eléctrica*, November 25 1917, no.22, 257.

28 His observations paint a picture of a devastated Freiburg, characterized by its "gloomy and poor" population, and a nation dispossessed "of all its coal mines, light and railways have had to be restricted to the indispensable." José A. Pérez del Pulgar, "Desde Berlín," *I.C.A.I.: revista ilustrada del Instituto Católico de Artes e Industrias*, October 1923, no.29, 8–10.

29 Pulgar, "Desde Berlín."

ces of power. In this way, Pulgar wanted to stimulate Spanish ingenuity and inventiveness.[30] However, the reference to the electrification of the Silesian railway was particularly telling for other reasons. Pulgar identified two primary issues concerning the transportation of coal in Spain. Firstly, the country lacked the necessary railway infrastructure to effectively transport this fuel due to an outdated infrastructure in urgent need of renovation. This led to his advocacy for the electrification of Spain’s railroads. Secondly, and more importantly, coal transport resulted in the concentration of such an important resource in the hands of a highly unionized branch of workers, as evidenced by the events of 1917. In this vein, an outreach talk held in April 1921 by ICAI professors, titled “The railway problem in Spain,” addressed the issue primarily as a “social problem,” due to the numerous “social conflicts” derived from the organization of transport infrastructure, which was keeping the country “in constant state of alarm.” ICAI’s professor Pedro M. de Artiñano advanced the argument that electric traction was the most economical system, given “our hydraulic resources … immensely superior to what our railways would need.”[31] For Pulgar, Artiñano, and their colleagues at ICAI, the case for shifting to hydroelectricity and implementing a national grid was closely tied to concerns over the social organization of coal extraction and distribution. This viewpoint was reiterated by Pulgar, who insisted that labor costs in the coal sector would persistently rise as the workers became more skilled, hence demanding higher wages. And, while Pulgar stressed the need to rationalize coal consumption, the broader trend pointed toward a growing shift to hydroelectric power:

> In addition to the substantial increase in coal prices, we must not lose sight of the fact that the aforementioned calculations do not account for the labor involved in loading and unloading coal, nor the myriad of eventualities associated with transport, particularly those of a social nature. It is important to note that labor requirements are considerably less pronounced in the context of electric supply compared to those associated with coal and steam.[32]

30 “To put it simply, if we could emulate the Germans, we could get all the railways of our Northern line up and running by utilizing the waste from the now almost totally ruined poorest coal basins of Spain, such as those in Palencia, for which our mines are insufficient to meet our needs, having to import more than half of the coal they consume from England.” Pulgar, “Desde Berlín.”

31 Manuel Hernández, “El problema ferroviario en España. Conferencias de carácter industrial y financiero, organizadas por el ICAI,” *I.C.A.I.: revista ilustrada del Instituto Católico de Artes e Industrias*, April 1921, 69.

32 José A. Pérez del Pulgar, “Producción y distribución nacional de energía eléctrica,” *La Energía Eléctrica*, no.4, February 25 1921, 39.

The social and political concerns surrounding coal extraction and transport extended beyond the circle of ICAI's engineers. Nevertheless, I argue that Pulgar's particular framing of these issues as matters of social order reflects the influence of the Church's social doctrine on his understanding of technology's role in society. In fact, several of these professionals contributed to widely circulated Catholic periodicals, aiming to engage both clergy and lay audiences. Within these forums, technical discussions on the feasibility of transitioning from coal to hydroelectric power in early twentieth-century Spain became deeply intertwined with the broader social concerns of Spanish Catholicism, as demonstrated in the following section.

"White coal" and its moral underpinnings

In 1917 and 1918, two articles appeared in the ultraconservative Catholic newspaper *La Hormiga de Oro* (The Golden Ant) barely six months apart and with the same title, "Hulla negra y hulla blanca" (Black Coal and White Coal). Both pieces addressed the energy assets available in Spain and reiterated some of the same concerns surrounding national coals. The author of the first piece was Antonio Fernández de Navarrete, IX Marquis of Legarda (1859–1936), an aristocrat and civil engineer who occupied a prominent position in the management of public works and was associated with the electricity sector in La Rioja and Aragon; the second author was Leocadio Lorenzo, a member of the Claretian order. Navarrete defined coal as a relevant, albeit "discredited" energy source. In order to confront the ongoing challenges posed by the coal crisis, Navarrete proposed a strategy that centered on the protection and increase of coal extraction, although he acknowledged the inherent limitations of that approach, including its slowness. Lorenzo, on the other hand, remained skeptical about the potential for enhancing transport infrastructures and extraction techniques, despite efforts underway by national engineers. While Navarrete contemplated other fuels, including gas and petrol, both agreed that hydropower was the optimal choice.[33] As in Pulgar's writings, Lorenzo was aware of the superior qualities of "white" coal over mineral fuels, which had to be taken from the earth and necessitated substantial manpower for its transportation and distribution: "[Hydroelectricity] does not travel stored in slow, ponderous carriages; rather, it moves rapidly, akin to lightning, riding

33 Marqués de Legarda, "Hulla negra y hulla blanca," *La Hormiga de Oro*, no.31, August 4 1917, 170–171.

lightly and smoothly on thin copper wire, as if on Zephyr’s wings.”[34] According to the priest, calculations by Spain’s experts placed available hydraulic energy at five million horsepower. This could be used to save the eight million tons of hard coal needed by the national economy, according to his calculations. Therefore, hydroelectricity was described as an apparently “inexhaustible mine”:

> Given the favorable circumstances of Spain regarding its hydraulic endowment, we can hold great hopes for the industrial revitalization of Spain, provided that the abundant resources with which God has endowed us are not mismanaged … Does the reader understand what it means for Spain to have an energy reserve of five million horsepower annually, which are exempt from taxation, thereby eliminating the financial burden of coal, and providing a safeguard against fluctuations in fuel and motor machine costs?[35]

Given his confessional background, Lorenzo further highlighted the theological valences of electricity produced through water, which contributed to the aestheticization of hydropower: “White coal, the hydraulic energy signified by that white foam that bubbles at the base of waterfalls and emanates from the inside of the turbines with a dull rumble… this is our treasure, our great national wealth.”[36] As mentioned in the first section, the neo-Thomistic revival of the late nineteenth century favored the promotion of metaphysical conceptions of the cosmos, matter, and nature. The Catholic Church invested significant efforts in promoting a particular interpretation of natural history through science popularization campaigns, which suggested that the natural world was imbued with divine forces as opposed to strictly naturalistic and materialistic conceptions of nature. In this regard, steam, electricity and other natural forces were posited as creations which had been “bred” by God and intended to showcase His might.[37] The physical properties of electricity in its natural state played a pivotal role in this regard, as they facilitated the preservation of a significant degree of mystery within nature, thus facilitating the endorsement of a dualistic perspective, both on a cosmic and on a human scale. The existence of electricity thus demonstrated the presence of a divine or spiritual dimension in the natural world, as humans were entrusted with the responsibility of harnessing and subduing this force as part of the divine

34 Leocadio Lorenzo, “Científica. Hulla Negra y Hulla Blanca,” *La Hormiga de Oro*, no.7, February 16 1918, 38–39.

35 Lorenzo, “Científica.”

36 Lorenzo, “Científica.”

37 An example from 1906: “Who gives power to steam and its expansion to gas, / and makes the fleeting electric fluid sparkle?” J. de Mena, “Dios… ¿dónde está?,” *La Hormiga de Oro*, no.44, November 3 1906, 708.

plan.[38] Furthermore, a crucial component of the celebration of hydroelectricity pertained to the moral implications of this new energy regime. In his 1917 article, the Marquis of Legarda highlighted the moral advantages of electricity over coal, noting "its divisibility and ease of household distribution," which "has achieved the ideal (so much praised by sociologists and moralists) of domestic industry."[39]

Indeed, the material properties of electricity, particularly the subdivision of energy, enabled Spanish Catholics to address two key issues in the country's political economy. Firstly, the promotion of hydroelectricity would stimulate national development. Secondly, and most importantly, this energy resource would contain the social ills linked to industrialization, as observed in more developed industrial countries. Catholic intellectuals, particularly those associated with the clergy, identified an inextricable bond between the economic and industrial challenges faced by the nation and its imperative "religious and social regeneration," particularly after the events of 1898. These ideas were emphasized during the First Social Catholic Week held in Madrid in 1907, an event designed to promote the principles of Catholic social doctrine in the country.[40] While industrialization was indeed recognized as an imperative, Julián de Diego y García Alcolea (1859–1927), Bishop of Astorga and future Archbishop of Santiago de Compostela, highlighted the profound transformations in the socio-economic order brought by the modern industrial world. He associated these changes with the emergence of large-scale industrial settlements, which he viewed as a key factor in the decline of small workshops. In his view, this shift was a primary cause for widespread social unrest.[41] In light of the challenges posed by large-scale industrialization, the Church's social program advocated for the restoration of Christian civil society,

38 A series of articles aimed at disseminating electrical technologies published in 1916 in *La Hormiga de Oro* included the following statement: "the myriad applications of this force that fills the Universe are so vast and important, I believe we must focus our understanding on comprehend this phenomenon so that we can fully control and draw from it all the good that the Creator, the only infinite and truly wise, wants us to make of this force, for it is common sense that God has not made anything useless." "De Polo a Polo. La electricidad en la Edad antigua. Origen de la ciencia eléctrica," *La Hormiga de Oro*, no.1, January 1 1916, 4–5.

39 Marqués de Legarda, "Hulla negra y hulla blanca," 170–171.

40 *Crónica del curso breve de cuestiones sociales celebrado en Madrid durante el mes de mayo de 1906* (Madrid: [s.n.], 1907).

41 "Industrial freedom was a powerful stimulus for individual initiative, which, driven by competition, led to the development of large-scale industry with its powerful machinery, manufacturing concentrations and extensive trade; but these triumphs were not without consequence. Each triumph of big industry invariably entailed the demise of numerous small industrialists, who were compelled to either become unskilled workers or to migrate." *Crónica del curso breve*, 22–23.

conceptualized as a unified body of families operating on the basis of home-based economics.[42]

In the year preceding the inaugural celebration of the First Social Catholic Week in Madrid, Álvaro López Núñez (1865–1936), an esteemed member of the Royal Academy of Moral and Political Sciences and a vocal proponent of Catholic social doctrine, engaged in a discussion on the significance of energy resources and technologies in the development of "domestic industries." His article, published in the Catholic newspaper *La lectura dominical* (The Sunday Reading), signaled how "a reaction in favor of [home-based work]" was happening elsewhere, and that this shift was influenced by "the decentralization of motive power, whether gas, oil or electricity." López was cognizant of the numerous problems associated with domestic work, including long working hours and the lack of sanitation conditions in some home-based workshops. However, this industrial organization model would free workers "from the tyrannical rule of the manager or foreman" as the "head of the workshop is also the head of the family." Consequently, domestic work was suggested to "reconstitute families, now separated and demoralized by large-scale industrial work."[43] The *Revista católica de las cuestiones sociales* (The Catholic Journal of Social Issues) had also published several articles since the beginning of the new century on the possibilities of reversing the concentration of machines and workers in large factories, thanks to electricity. This journal was the longest-running publication of a confessional and doctrinal nature dedicated to the Catholic workers' movement, serving as a forum for the most conservative and fundamentalist writers. Its primary goal was the dissemination of the Church's social doctrine guided by Leo XIII's encyclicals *Arcanum Divinae sapientiae* (1880) and *Rerum Novarum* (1891). These documents defined the family as the central pillar of society and aimed to combat its erosion and the ensuing loss of traditional values. In 1904, the Catholic propagandist Jimenez Tejeda published the article "The modern workshop and the evolution of economy" indicating: "We just have to keep up with the current pace of scientific progress with the hope that, just as the discovery of steam lead to industrial production in big factories, electricity delivered to the households will catalyze the decentralization of industry and the return of the family workshop."[44] A further salient concern was ensuring that woman remained within the domestic

42 T. van Osselaer and P. Pasture, eds., *Christian Homes. Religion, Family and Domesticity in the 19th and 20th centuries* (Leuven: Leuven University Press, 2014).

43 F. León, "Movimiento social. La industria doméstica," *La lectura dominical*, no.629, January 20 1906, 42.

44 T. Jimenez Tejeda, "El taller moderno y la evolución económica," *Revista católica de las cuestiones sociales*, no.113, May 1904, 304–305.

sphere, a goal facilitated by a decentralized power supply. The introduction of electricity was therefore proposed to facilitate a way "for women to work at home, thereby reducing their presence in factories and thus mitigating the promiscuity within workplaces." Conversely, the "improvement of communication infrastructures, which are becoming easier and cheaper," was poised to facilitate the mobility of workers, enabling them to commute to factories on a daily basis. This enhancement promised the relocation of individuals to the countryside.[45]

Indeed, the promotion of the home-based economy through hydroelectricity was to be also instrumental in the development of the Spanish countryside, another vector of the Catholics' developmental agenda in a nation where the bulk of its economy was based on agriculture.[46] As the lawyer Jesús R. Coloma noted in his 1916 article titled "Life in the countryside," published in the *Revista católica de las cuestiones sociales:* "The fields produce more than just wheat but a complete civilization as well … It is therefore imperative that the worker loves the land that cultivates, the soil to which his life belongs and where human labor becomes intertwined with eternal creative activity."[47] Agriculture and the countryside were central to the dissemination of Gospel values, serving as a form of national spiritual reserve against the corruption of the "modern world."[48] However, Coloma, in alignment with other "regenerationist" intellectuals, was aware of the countryside's state of neglect. As such, he argued for the need to reform and transform agriculture through technology. Consequently, public authorities must intervene to provide essential services to rural communities, including infrastructures such as railroad lines, highways, postal services, telegraphs and telephones, lighting, and public hygiene. More crucially, he signaled the necessary industrial transformation of agricultural products through the application of "scientific-industrial progress" via locomotives, internal combustion engines and, above all, hydroelectricity supply.

In the face of the state's limited initiative, Catholics endeavored to promote the technification of agriculture through the unionization of consumers and producers in rural cooperatives. It is accurate to state that initiatives in Spain were comparatively less prominent than in other countries, particularly France and

45 Tejeda, "El taller moderno."

46 Around 1905, 70% of the population lived in the countryside.

47 Jesús R. Coloma, "La vida en el campo," *Revista católica de las cuestiones sociales*, no.253, January 1916, 15.

48 National-ruralism emerged as a conservative ideology in Spanish Catholicism in early twentieth-century. See, Teresa María Ortega López and Francisco Cobo Romero, "'Guardianas de la raza'. El discurso 'nacional-agrarista' y la movilización política conservadora de la mujer rural española (1880–1939)," *Historia y Política*, no.37 (2017): 57–90.

Belgium. In these countries, the Catholic cooperative movement had put forward several national commissions for the improvement of rural life, with the support of local and national administrations. In Spain, the National Catholic-Agrarian Confederation (established in 1917) comprised 57 federations and 2.5 million members as of 1929, according to its internal records. A total of approximately 4,000 trade unions had established some 1,700 rural savings banks with the capacity to invest 300 million pesetas in loans. However, these loans had only financed eleven flour mills, twenty oil mills, fifteen cooperative wineries and seven power stations throughout the country.[49]

In reality, electricity cooperativism in Spain during the first three decades of the twentieth century exhibited a marked weakness and did not originate from a deliberate strategy to promote rural electrification from the state, as was the case in other countries.[50] Despite the notable expansion of Spanish electrification thanks to the transition from coal to hydroelectric production from the 1910s onwards, the distribution of energy remained predominantly in the hands of large enterprises that assumed the role of holding companies. The absence of effective regulatory oversight over distribution networks during the early decades of the twentieth century resulted in the reliance on private sector initiatives. These endeavors focused on major urban and industrial consumption areas, including Madrid, Catalonia, the Levante and Andalusia regions, as well as select industrial and urban centers in the north, notably in the Basque Country. Rural electrification was not a priority.[51] The development of cooperatives was thus driven by a local response to the lack of interest demonstrated by larger companies, highlighting the fundamentally decentralized nature of electricity production in Spain, and accounts for the great variety of its regional electricity markets. As a result, solutions tailored to meet territorial needs for the supply of rural electricity were regionally implemented. In northern areas such as Navarre, Gipuzkoa, Cantabria, Galicia, and Asturias, the dense network of family relations and the abundance of small rural or agricultural landowners facilitated a diffuse industrialization model using local capital in small and medium-sized companies and workshops. This occurred regardless of the concurrent emergence of large hydroelectricity

49 Manuel S. Cuesta, "La defensa de la organización agraria católica en la asamblea," *Revista católica de las cuestiones sociales*, no.415, July 1919, 9–11.

50 In fact, the first National Rural Electrification Plan in Spain was not issued until 1973.

51 At least until the 1960s-1980s, rural electrification played a modest role in agricultural change in Spain and was the consequence, rather than the cause, of the modernization of the sector. An overview in Joseán Garrués-Irurzun and Iñaki Iriarte-Goni, "Rural Electrification in Spain: Territorial Expansion and Effects on the Agricultural Sector (c. 1900–c. 2000)," *Rural History* 34, no.2 (2023): 201–219.

companies. In 1915, for example, the Asturian priest Graciano Martínez (1869–1925) articulated his hopes for the mechanization of the "workshops and factories of these regions (Asturias, Vizcaya, Catalonia)" thanks to the abundant availability of hydroelectricity – defined in this context as "green coal" – to transform old mills into small power stations, with the objective of mechanizing rural communities:

> Nature endowed [these regions] with those rivers and torrents for a reason, which here and there give rise to magnificent waterfalls producing thousands and thousands of HP. … I do not lose hope of seeing these northern regions, which are renowned for their enterprising and progressive spirit, bestowed with waterfalls abundant in electric power, so that even local kitchens would be powered only by electricity.[52]

Consequently, despite the limited success of the early Catholic cooperative movement, it contributed to the diversification of capital mobilized in early electrification processes in Spain, including off-grid developments. However, while Graciano celebrated this new energy and industrial landscape tied to a peasantry of small landowners, the ideological implications of decentralized, community-based energy provision were even more significant. Firstly, it offered an economic alternative to the dominant model of industrial and urban modernization, aiming to reorganize the nation's productive forces while balancing urban and rural development. Furthermore, the implementation of rural electrification was presented as a strategic response to the accelerating rural exodus, which reached its zenith around the 1920s, coinciding with a decline in emigration to America. Rural electrification was also intended to alleviate workers' urban unemployment by enhancing rural life and productivity. Secondly, this cooperative movement, spearheaded by agrarian Catholic unions, signaled a return to a "corporate regime" within an organic conceptualization of society, a tenet that characterized Catholic social doctrine. Consequently, Catholic unions and credit cooperatives were not to depend on town councils or the state but on the "Christian guilds of farmers," overseen by diocesan councils and protected by the National Council of Catholic Workers' Corporations.[53] In this regard, the development of Catholic cooperatives was concomitant with the strengthening of provincial and municipal rural autonomy. These initiatives sought to modernize the traditional craft and guild institutions of the Middle Ages by adopting corporate ownership. This challenged both economic liberalism – represented by large monopolistic companies –

52 Graciano Martínez, "Por entre la psicología nacional," *España y América*, no.13, July 1 1915, 7–8.

53 *Boletín del Consejo Nacional de las Corporaciones Católico-Obreras de España*, July 1898, 50.

but also *caciques*, or local chiefs, upon whom the Restoration’s fraudulent political system relied. Most relevantly, Catholic agrarian unions sought to curtail the rise of class tensions and socialist unions in the Spanish countryside. Indeed, despite its idealization, the countryside was undergoing significant transformations, marked by rising social tensions stemming from the emergence of capitalist production relations. In this regard, Catholic agrarian unions – and indeed the countryside as a whole – became a kind of lightning rod against the spread of socialism. Consequently, cooperatives symbolized “the same for production, … as for the maintenance of peace in rural villages” and “the barrier that contains the onslaught of the Revolution, which will be kept at bay as long as the countryside contains it.”[54]

Conclusions

As evidenced in the pages of this chapter, a diverse group of propagandists and authors associated with Spanish Catholicism – ranging from laypeople to clerks and engineers – participated in the development debates that followed the events of 1898. It is important to note that Spanish Catholics were not the only political or social actors who discussed what notion of progress was necessary for Spain after the loss of its overseas empire. However, the specific case of Spanish Catholics offers a unique perspective on the moral dimensions embedded within various concurrent schemes of industrial modernization, while also highlighting the techno-environmental configurations that may arise from these exchanges. Accordingly, the present chapter provides a framework for analyzing how specific nature-related conceptions, influenced by religious imaginaries and theological traditions, can be combined with capitalist and extractivist imperatives in a context of national crisis. This process unfolded within an international context characterized by imperialist and nationalist competition, within the broader framework of an emerging global fossil fuel economy reliant on coal. In these circumstances, when attempting to delineate the relationship between technology, development, and the environment, some Catholics acknowledged that God had been especially generous to the Spanish nation, thus aligning with the most overtly confident “regenerationist” thinkers. However, not all natural resources carried the same moral weight. The ethical considerations surrounding certain natural assets – or the absence thereof – were determined, at least in part, by their physical characteristics

54 Manuel S. Cuesta, “La defensa de la organización agraria católica en la asamblea,” *Revista católica de las cuestiones sociales*, July 1929, no.415, 9–11.

or their availability. The predominant factor in this determination, however, was their social organization and the potential political economy that might result from it. In this context, "white coal" was regarded as both a moral energy and technological resource – as well as a national and superabundant asset – as opposed to coal. As such, hydropower emerged as a proposed solution to address widespread social issues and as a means to embed Catholic principles into industrial modernization. Religious thinkers promoted a vision of nature that retained metaphysical elements as opposed to purely modern materialistic views in an approach that sought to balance industrial and agricultural efforts, thereby protecting domestic life and promoting rural progress. This chapter aims to show how religious agendas may have shaped developmental trajectories, ideas about the mobilization and use of energies, and the role of technologies – from large scale infrastructures to off-grid developments.[55]

55 For an analysis of the ideological dimensions of the nineteenth-century transition from water to coal and steam, see Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (London: Verso, 2016); also, Daniel Macfarlane and Andrew Watson, "Hydro Democracy: Water Power and Political Power in Ontario," *Scientia Canadensis* 40, no.1 (2018): 1–18. This chapter challenges the idea that decentralized, community-based hydroelectricity is inherently "progressive"; see Jim Cooper, "Electric Co-operatives: From New Deal to Bad Deal?," *Harvard Journal on Legislation* 45 (2008): 335–75.

Elena Kochetkova

The ideals of rationality and development in the political economy of the late Soviet Union

Introduction

The official narrative of conquering nature persisted from the earliest years of the Soviet project, reflecting a strong desire to promote the ideals of technocracy and industrialization – even though the outcomes often fell short of these ambitions. Notable initiatives that showcased this agenda included the exploration of the Arctic, beginning in the early twentieth century, through to the building of cellulose-producing factories on Lake Baikal during the 1950s and 1960s, and the construction of hydropower facilities by Soviet engineers in Angola in the 1970s onward. Efforts to harness the economic capacities of nature in the name of industrialization contributed to the onset of the Anthropocene but also faced insurmountable obstacles. As some scholarship shows, nature resisted, undermining Soviet economic plans and diminishing the results of technological efforts. Over the course of the Soviet century, this occurred in regions such as the Arctic and Siberia, where harsh climates and inaccessible terrain posed persistent challenges, and in Africa due to unanticipated environmental damage caused by floods, to name just a few examples.[1] At the same time, nature – exploited as an economic resource during the Anthropocene – imposed a specific limit on human activity: it could be devastated, thereby posing critical threats to the extractive economy.

Recent scholarly works emphasize that it was through a better understanding of this axiom that the Soviet Union and other socialist countries sought to develop improved models of human-nature relations. Over the twentieth century, they sought to harmonize the relations between nature and their regimes in a holistic manner.[2] The Soviet industrial mindset was underpinned by less visible yet com-

1 Andy Bruno, *The Nature of Soviet Power: An Arctic Environmental History* (Cambridge: Cambridge University Press, 2016); Elena Kochetkova, David Damtar, Polina Slyusarchuk, and Julia Lajus, "Soviet Technological Aid and the Technopolitics of Hydropower in Africa during the Cold War," in *Transplanting Modernity*, ed. Jenny Leigh Smith and Thomas Robinson (Pittsburgh: University of Pittsburgh Press, 2023), 146 – 164, among others.

2 Andy Bruno and Viktor Pál. "Socialist Environmental Holism in the Soviet Arctic and the Plains of Hungary," *Ab Imperio* 2024, no.2, (2024): 119 – 146.

https://doi.org/10.1515/9783111611358-004

plex forms of engagement with nature, which resulted in attempts to rationally organize human-nature relations. The notion of 'rationality' (*ratsional'nost'*) was frequently invoked both in the professional vocabulary of engineers and economists, and in the rhetoric of politicians, to denote a desire to structure life according to principles of rational planning and material logic. It was often paired with the concept of rationalization (*ratsionalizatsiia*), which emphasized the process of organizing social, economic, and industrial development according to technocratic principles. By the mid-century, rationality had become a dominant Soviet framework for interpreting human–nature relations, contributing to efforts to quantify environmental processes and rationalize the relationship between nature and society. Rationality implied a variety of ideas and processes, which would ostensibly enable economic growth and broader human control over natural processes and domestic use of material resources.[3] In this work, I discuss rationality as a framework for approaching natural resource use.

This chapter focuses on key transformations in the meaning of rationality as applied to the use of natural resources and notions of development in the political agenda and industrial production in the Soviet Union. The relations between the Soviet project and nature were laced with environmentalist strands, which, though initially fragile, became increasingly visible in the later decades of Soviet history. Although lacking a universally accepted definition, scientists, industrialists, and politicians frequently invoked the concept of rationality to articulate visions of economic and social development.[4] This chapter examines the meanings

3 Elena Kochetkova, *The Green Power of Socialism: Wood, Forest, and the Making of Soviet Industrially Embedded Ecology* (Cambridge, Mass.: The MIT Press, 2024); Roman Gilmintinov, "Socialist Valuation of Nature: Political Economy, Environmental Regulation, and Coal Mining in the Soviet Union" (PhD diss., Duke University, 2024).

4 See, among others, various approaches towards environmental history of Russia and the Soviet Union in Paul Josephson et al., eds., *An Environmental History of Russia* (Cambridge: Cambridge University Press, 2013); Laurent Coumel, "A Failed Environmental Turn? Khrushchev's Thaw and Nature Protection in Soviet Russia," *The Soviet and Post-Soviet Review* 40, no.2 (2013): 167–189; Jonathan Oldfield, Julia Lajus, Denis J. B. Shaw, "Conceptualizing and Utilizing the Natural Environment: Critical Reflections from Imperial and Soviet Russia," *Slavonic and East European Review* 93, no.1 (2015): 1–15; Nicholas Breyfogle, *Eurasian Environments: Nature and Ecology in Imperial Russian and Soviet History* (Pittsburgh: University of Pittsburg Press, 2018); Andy Bruno, "Climate History of Russia and the Soviet Union," *WIREs Climate Change* 9, no.5 (2018), e534; Evgeny Gololobov, "Antropogennoe vozdeistvie cheloveka na prirodu i ee okhrana na severe Zapadnoi Sibiri," *Tomsk State University. Journal of History* 61 (2019): 12–20; Julia Lajus, "Soviet Official Critiques of the Resource Scarcity Prediction by Limits to Growth Report: The Case of Evgenii Fedorov's Ecological Crisis Rhetoric," *European Review of History: Revue europŭenne d'histoire* 27, no.3 (2020): 321–341; Catherine Evtukhov, Julia Lajus, and David Moon, eds., *Thinking Russia's History Environmentally* (New York: Berghahn, 2023).

of rationality between ideas and actions to better understand its roles in changing attitudes towards natural resources in Soviet industry and the political language that described industrial development. My analysis is built upon professional publications in scientific journals, *Priroda* (Nature) and *Lesanaia promyshlennost'* (Forestry Industry), and published volumes and archival reports of industrial and research institutes, discussing rationality and natural resources. While offering insights into earlier decades, I am particularly interested in the period between the early 1950s and early 1980s, which were years of substantial transformation in both industrial technologies and industrial views on nature.

This chapter argues that, as it was applied to industrial development, rationality was a powerful discursive instrument that penetrated political and expert languages to characterize the Soviet approach to nature. Rationality was a more complex category than just reconciliation between nature and industry because it did not deny and even emphasized exploitative relations – as Soviet society, industry, and the state were to benefit from the industrial potential of nature in the name of development and technologically-led progress. Rationality, however, described an ideal balance envisioned by the Soviet regime, based on the rational coordination of production and natural resource use, which would not recklessly deplete nature. Even though this compromise was not always reflected in concrete practices or outcomes, it contributed to the foundation of professional and political mindsets of late state socialism in the Soviet Union. As much as nature continued to be viewed as a reservoir of materials for industrialization, emergent notions of efficiency and non-depleting growth came to be emphasized in its exploitation, comprising a range of approaches from no-waste production to the sourcing of alternative resources. This built on the idea that consumption of resources should be controlled and rational, even as it was not to be subjected to outright limitation. The explicit drive to exploit nature was increasingly accompanied by emerging concerns for sustainability as a reaction to the unconventional route through which the Soviet state aimed for economic progress. Rationality that thus set limits on *wasteful consumption* while not denying – and even facilitating – an agenda of growth and development, provided both justifications and instruments for a *soft dominance* over nature. This line coexisted in the political language and industrial development with real Soviet practices that caused pollution and environmental degradation.

Politicizing rationality

The roots of rationality extend far beyond its Soviet-era usage, reaching back to antiquity. Yet, it was in the seventeenth century that metaphysical and scientific notions of rationality were profoundly transformed, placing *ratio* at the center of emerging conceptions of objective knowledge and power. Over the following centuries, rationality evolved into a plurality of forms, ranging from the linguistic and ideological to the economic, political, and cultural domains.

In Soviet Russia, the Bolshevik Revolution of 1917 brought rationality to the heart of political governance, deployed to craft a controlled, calculated, and comprehensive mechanism for labor operations, continuous industrial production, and numerous other practices of economic and social life. The concept's wide usage was thus not necessarily connected to the exploitation of nature and economic production. In the 1920s, for example, the subject of the rationalization of the Russian language was a popular point of discussion in post-revolutionary academic and political circles, along with efforts to adopt Taylorism and Fordism, both regarded as leading Western industrial models.[5] Rationality was at the core of the rationalization and invention movement, which aimed to stimulate factory workers and engineers to engage in creative activities and develop ideas that could improve production and save costs.[6] Rationality was also widely applied to discussions around the secularization of the Soviet citizen and church-state relations. As in Britain and other European countries, the Soviet concept of rationality was actively promoted in the 1920s and 1930s to support the rise of applied science and technical progress as tools for socialist construction.[7] It was also used by Soviet scientists to emphasize the dominance of ratio in building a new world, to reshape every element of social organization and its supplements, such as nutrition and physical activities.[8]

The notion of rationality as it came to be employed regarding the use of natural resources in Russia is also rooted in the pre-1917 period and further devel-

5 See on some early Soviet developments and experiments in Nikolai Krementsov, "Big Revolution, Little Revolution: Science and Politics in Bolshevik Russia," *Social Research: An International Quarterly* 73, no.4 (2006): 1173–1204; Michael David-Fox, *Revolution of the Mind: Higher Learning among the Bolsheviks, 1918–1929* (Ithaca: Cornell University Press, 2016); David Greenstein, "Assembling Fordizm: The Production of Automobiles, Americans, and Bolsheviks in Detroit and Early Soviet Russia," *Comparative Studies in Society and History* 56, no.2 (2014): 259–289; Sebastien Moret, "From Technicians to Classics: On the Rationalization of the Russian Language in the USSR (1917–1953)," *Russ Linguist* 34 (2010): 173–186, and others.

6 Elena Kochetkova, "Performing Inventiveness: Industrial and Technical Creativity in the USSR, 1950s–1980s," *The Soviet and Post-Soviet Review 49, no.*3 (2022): 249–273.

7 Robert Bad, *Applied Science: Knowledge, Modernity, and Britain's Public Realm* (Cambridge: Cambridge University Press, 2024).

8 Here I refer to the cases when the political power aimed to regulate physical activities of workers. See, for example, David Hoffmann, *Bodies of Knowledge: Physical Culture and the New Soviet Man* (London: Routledge, 2002).

oped during the first decades of the Soviet project. In 1915, the Commission for the Study of the Natural Productive Forces (KEPS) was established as an economic reaction to the demands of the First World War. The Commission's purpose was to scientifically investigate "the natural productive forces," which included natural resources. It found new relevance in a transformed form with the onset of the Soviet era as it came to focus on the integrated use of natural resources, long-term planning, reforestation, and other measures seen as important for preventing the depletion of nature.[9] The word was further employed in the period of rapid industrialization during the 1920s and 1930s, to suggest how the new political and social order would deal with the materiality of the natural world.[10]

Despite the many destructive aspects of Soviet industrialization and technological modernization, the appeal to rationality reflected a strong commitment to technological and economic development aimed at maximizing efficiency. Nature was supposed to facilitate industrial and social successes, and a major political line reiterated that nature was to provide society with material resources and fuel for development. Many specialists, however, stressed that resources should be used with minimal waste loss because of economic rationale, and insisted on the integrated use of natural resources through which every single waste item would be turned into reusable material. These views circulated in industry, even though they often did not translate into widespread action in Soviet industrial development. As early as the 1930s, legislation used rationality, such as central decrees which reorganized a special committee on the development and protection of natural resources of the Russian Republic. It declared the rational use and even augmentation of natural wealth (*umnozhenie prirodnykh bogatstv*) as the prioritized approach in the industrial dealing with nature. For example, in 1930, the All-Russian Central Executive Committee and the Council of People's Commissars of the Russian Socialist Republic issued the resolution "On the Protection and Development of the Natural Resources of the RSFSR". A year later, the Central Committee of the Party and the Council of People's Commissars of the USSR issued a decree titled "On Measures to Improve Forest Protection and the Organization of Reforestation Efforts," which emphasized the need to increase the amount of forest resources.[11] This drive for maximizing the use of nature was not unique, and was

9 "Problemy ispol'zovaniia prirodnykh resursov" [Problems of the Use of Natural Resources], *Priroda*, no.9 (1967): 115.

10 See Laurent Coumel, ""The Green Power of Socialism," Review," *The Russian Review* 83, no.3 (2024): 479 – 480.

11 *Ob okhrane i razvitii prirodnykh bogatstv RSFSR*, 1930 [On the Protection and Development of the Natural Resources of the RSFSR], accessed 10 July 2025, https://docs.historyrussia.org/ru/nodes/389088-ob-ohrane-i-razvitii-prirodnyh-bogatstv-rsfsr-post-vtsik-i-snk-ot-20-iyunya-1930-g.

also evident in other countries, such as the efforts seen in the United States during the 1920s to industrialize agriculture.[12] Rationality was also adopted in other capitalist economies to entail the acquisition of more efficient equipment, planning, and the distribution of resources.[13] Yet, the Soviet project typically explained rationality as a natural feature of state socialism and denied its broader use.

In the late 1930s, there was a continued political push for industrial development, which led to the establishment of several industrial sites. For example, large cellulose manufacturers were established in the north of Russia to satisfy the demand for pulp and cellulose needed for military and civilian production. By the 1950s, the concept of rationality in the use of material resources had already formed part and parcel of official political language justifying industrial enlargement. The rational use of natural resources arose during a period of intensive exploitation of resources in the Soviet political context and came to be incorporated into the highest level of political documents. Thus, the new program of the Communist Party, endorsed at the 22nd Party Congress in 1961, invoked the concept of rationality dozens of times to frame a wide range of issues – from the selection of sites for industrial construction to broader questions of economic development. It was also used to emphasize the forms through which resources extracted from nature would be used. The political declaration around the new round of exploitation of natural resources in Eastern Siberia and the Far East – forests, oil, and gas in particular – placed rationality at the core. Political rhetoric exploited rationality as a principle that could help reconcile the drive towards modernization with both the possibilities and limits of nature. Recognizing that natural resources were exhaustible, official documents emphasized the need to find a better balance between resource protection and exploitation. As the program of the Party stated, "Significant attention will be paid to the protection and the rational use of forest, water, and other natural resources," implying that nature would serve an important mission for future economic development.[14] The Khrushchev administration's political line emphasized modernization, further mechanization of industrial operations for natural resource excavation and processing, and economic growth as the core of the political agenda.

The increasing politicization of rationality in the use of natural resources resulted from escalating concerns about natural resources at a time filled with expectations of growth and technological progress. The real growth of the Soviet

12 Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (Yale: Yale University Press, 2010), 11.

13 Lennart Schön, *An Economic History of Modern Sweden*, (New York: Routledge, 2012), 8.

14 *Programma KPSS*, 1961 [The Program of CPSU, 1961], accessed July 9, 2025, https://leftinmsu.narod.ru/polit_files/books/III_program_KPSS_files/066.htm.

economy in the 1950s, along with substantial technological achievements in space engineering, chemistry, ongoing industrial construction, and general technological enthusiasm, led many to believe in the notion of continuous progress.[15] The well-known Soviet formula of communism, as explained in the 1961 Program of the Communist Party, implied the integration of progress, science, production, and rationality. According to the official narrative, these elements would bring Soviet society to a state of ubiquitous prosperity and satisfy people‘s needs at levels exceeding developed capitalist countries.[16] This political interpretation of communism employed numerous Soviet ideological clichés, appealing to the promise of modern development in which science and technology were to further advance economic and social life.

Beyond the Party Program, however, the language of Soviet regime absorbed rhetoric about the rational use of material resources as a crucial principle to build the economy of the new society. As one commentator put it, "now, when the Soviet people are successfully building communism – the bright future of the whole humankind – the rational and careful use of natural resources that make up the most important basis of the productive forces of the country is our primary all-nation task."[17] Saving nature and ensuring environmental protection were declared important conditions for the ends of social well-being, which were more frequently put at the core of the Soviet interpretation of socio-economic development. Economization and rationality were to provide more abundant materials for consumer production because "the preservation and rational, careful use of natural resources is the essential economic and social problem of all the countries of the world. *Nature protection* serves to increase material riches, *to increase the prosperity* [italics are mine, E.K.] of the nations, the improvement of people‘s health, [and] the satisfaction of their cultural and aesthetic needs."[18] Over time, this concept expanded to encompass a range of priorities, such as access to consumer products and health-related services, that when combined would lead to higher living standards and deliver Soviet society to the communist stage of development.

15 See more on Soviet economic development in Philip Hanson, *The Rise and Fall of the Soviet Economy: An Economic History of the USSR from 1945* (New York: Routledge, 2003); Ekaterina *Zhuravskaya, Sergei Guriev and Andrei Markevich,* "New Russian Economic History," *Journal of Economic Literature* 62, no.1 (2024): 47–114.

16 *Programma KPSS*, 1961.

17 "Sokhranim i umnozhim bogatstva rodnoi zemli" [Let's Preserve and Multiply the Riches of Our Native Land], *Priroda*, no.12 (1960): 4.

18 A.G. Bannikov, "Luidi dolzhny berech‘ i liubit‘ prirodu" [People Must Protect and Love Nature] *Priroda*, no.12 (1960): 26.

The later decades brought about a more environmentalist approach to rationality in Soviet economic policies and prevailing beliefs in progress, even amid economic slowdown. If not used synonymously, rationality was evoked as a prerequisite for nature conservation, even though it was often used formally rather than as a driver of real policy change. Legislation from the 1960s onward developed aspects of the protection of separate natural objects, which at times appear explicitly environmentalist, and emphasized rationality as a crucial measure to avoid the wastage of natural resources. For example, between 1957 and 1963, the Supreme Councils of all national republics of the Soviet Union approved laws on nature protection, including the rational use of water resources.[19] The year 1968 further saw a series of laws issued by the Central Committee of the Party and the Council of Ministers of the USSR on the elimination of contamination in the Caspian Sea and the introduction of "measures on preservation and the rational use of natural resources of Lake Baikal." In 1972, the government issued further laws on "measures for the elimination of contamination of the basins of rivers Volga and Ural by non-refined waste waters," "measures on further nature protection and the rational use of natural resources," and policies aimed at "the increase of nature protection and the improvement of the use of natural resources" – in addition to regional legal acts aimed to protect smaller rivers and lakes, along with their bioresources. In the early 1970s, planning for economic development included political attempts to decrease the consumption of fresh water by industrial enterprises and improve the cleaning of waste, all embedded in the discourse of rationality.[20]

Late Soviet legislation emphasized rationality as "a measure of improvement" for the use of natural resources.[21] This type of improvement, however, was distinct from the notorious Soviet projects of transforming nature, even though its fundamental drive remained economic. Improving the use of nature by means of rationality manifested in ideas around the protection of nature as a source of riches, in which the rational use and conservation of nature co-existed. This form of improvement emphasized it has no sense behavioral shifts. For example, human behavior, which had to be guided towards rationality and, overall, inte-

19 I. Shishkin, "Energiia termal'nykh vod" [Energy of Thermal Waters], *Priroda*, no.5 (1969): 103.
20 Plan meropriiatii po sokrashcheniiu raskhoda svezhei vody, uluchsheniiu ochistki promstokov i sokrashcheniiu sbrosa zagriaznenii v vodoemy Liaskel'skogo TsBK na 1976 god [Plan of Measures for Reducing Fresh Water Consumption, Improving Industrial Wastewater Treatment, and Reducing Pollutant Discharge into the Liaskelskii TsBK Reservoir for the Year 1976], The National Archive of the Republic of Karelia. F. R-3091. Op. 1. D. 925. L. 10.
21 Here I refer to James Scott, *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale: Yale University Press, 1999).

grated into more balanced relations with nature. Such practices were intended to avoid the depletion of nature, even as it continued to be exploited in ways that would enable the most efficient exploitation of resources.

The explanation of rationality was not solely associated with economic goals behind increasing consumption, but also appealed to long-term social dynamics. Typically for the late Soviet regime, this referred to morality as a debt and responsibility of the Soviet people. The political narratives of late Soviet legislation focused on future generations who depended on present-day politics. This demand explained that "the necessity for transmitting the environment in a better condition to the future generations derives from the essence of the very communist formation." [22] The political language appealed to rationality, or more correctly, the lack of rationality explaining the economic loss accrued from illegal practices, such as smuggling, illegal fisheries, and the hidden release of unprocessed waste from enterprises. The propaganda against smugglers denoted illegal behavior as irrational, and the state additionally designed other instruments, such as the Committee of People's Control, which monitored illegal acts of behavior by both producers and consumers.[23] Already present in early Soviet discourse, rationality continued from the mid-1960s onward to remain – and even intensify – as a firmly established and widespread element. Rationality developed as a crucial tool for increasing the efficiency of nature – not by directly destroying it, but by harnessing its greatest economic potential.

Rationality as economizing the production

Economizing was a central element of rationality and an inherent component of the late Soviet political economy, being a term heavily used during the final decades of the regime. While evident in the earlier period, it became especially

22 G.S. Gudozhnik, *Nauchno-tekhnicheskaia revoluitsiia i ekologicheskii krizis* [Scientific and Technical Revolution and Ecological Crisis] (Moskva: Mezhdunarodnye otnosheniia, 1975), accessed July 9, 2024, http://ecologylib.ru/books/item/f00/s00/z0000013/st007.shtml

23 Viktor Chernyi, *Narodnyi kontrol' na predpriiatiiakh neftegazovogo kompleksa Zapadnoi Sibiri v 1971–1980 gg.: Opyt kriticheskogo analiza partiinogo i gosudarstvennogo rukovodstva* [People's Control at Enterprises of the Oil and Gas Complex of Western Siberia in 1971–1980: Experience of Critical Analysis of Party and State Leadership] (PhD diss., Tomsk State University, 2002); Valentina Roxo, "'You Ought to Love Nature!' People's Control Committees – Environmental Whistleblowers and Western Siberia Oil in the 1970s," in *Thinking Russia's History Environmentally*, Catherine Evtukhov, Julia Lajus, and David Moon, eds., (New York: Routledge, 2023), 224–249; Elena Kochetkova, "People's Control and the Morality Quest of the Late Soviet Economy," *Journal of Social History*, (2025).

prominent in late Soviet discourse and was often combined with rationality. Economizing came to refer to the rationalization of decision-making around resource use, emphasizing the importance of economic calculation. Economizing supplanted the view of nature as a potentially endless source of abundant resources. It defined the need for a thorough calculation of costs and the advancement of technological possibilities with the goal of promoting future economic growth. In Jurgen Habermas' terminology, it denoted the "scientization of politics," which signifies the rationalization of political decision making.[24] In the Soviet Union, political and economic decisions were strongly shaped by technocratic influence. In Soviet discourse, rationality did not simply mean planning, but *rationalized* planning underpinned by cost and effect calculations that were supported by professional expertise.

Scientists and engineers were active participants in Soviet industrial development, exploring and explaining the possibilities of nature. Some commentators claimed that Soviet scientists were always concerned with the growth of productive forces, based on the principle of the rational use of natural riches. They stressed that the expeditions and research of the Academy of Sciences, for example, had a major "economic effect" on the country by offering better knowledge about coal and metallurgic spots, water basins and other resources – especially in the economic regions of great political interest, such as Siberia and the Far East.[25] At the same time, knowing more about nature, they explained, made it clear that natural resources were limited, and this reality created obstacles for large-scale economic goals.

Another dimension of economizing was the ongoing criticism of widespread Soviet industrial practices of overexploitation of techniques and equipment; instead of repairing and modernizing, critics decried, workers used the mechanisms at "their ultimate capacity." This happened because many enterprises exploited old equipment and lacked the means for technological modernization. At the same time, conversely, others pointed out that in some cases, machinery was underexploited. In some instances, for example, new equipment was kept in storage rather than installed in production chains. The use of natural resources was increasingly framed in similar terms, with critics leveling the charge that Soviet industry was either overusing or underusing resources, depending on the sector. Both were to be economized to balance the use of nature for economic purposes.

24 Robyn Eckersley, "Habermas and Green Political Thought: Two Roads Diverging," *Theory and Society* 19, no.6 (1990): 739 – 776. See also Jon Mulberg, "Economics as the Scientization of Politics," *Journal of Philosophical Economics* 14, no.1 – 2 (2021), 227 – 238.

25 *Priroda i obshchestvo: Geograficheskii sbornik* [Nature and Society: Geographic Collection] (Saratov: Privolzhskoe knizhnoe izdatel'stvo, 1968).

Unlike what was seen as the Western tendency toward wastefulness – often criticized as an inherent feature of capitalism – the Soviet economy was not described as inherently wasteful, but rather as merely lacking rationality. In other words, this paradigm implied that the Soviet society had high rational potential for the most efficient and economical organization but had not properly employed it *yet.* For this reason, forest workers left large quantities of wood unused after logging operations, for instance, while employees of grocery stores allowed spoiled goods to be sold and failed to monitor the quality of food properly.[26] The lack of proactive rationality led to material loss and waste, and an emphasis on economizing thus emerged as an equally important principle of the planned economy. This emphasis emerged after a long history of Soviet ideological explanations for the economic process, dating back to the 1930s. As one early Soviet commentator put it, the society "suffers from the loss due to the insufficient technical base and production conditions, poor organization of the production, and … the low level of utilization of our huge economic potential." [27] The underlying reason hid in the aims that consecutive regimes set: socialism was inherently aimed at "the achieving of prosperity in the country."[28] In other words, productivity was inevitable and fully inherent to the Soviet society, but it needed to be stimulated and encouraged.[29]

The increased value placed on the rational use of natural resources in order to economize production was part of the bigger context of the late Soviet "scientization of politics." One of the manifestations of this trend was the adoption of mathematical methods in the economy, as part of automated systems of control and production.[30] The label of irrational was understood to denote, *a priori,* the sinister and degraded, while rationality and control were seen to lead to progressive development.[31] Rationality, however, was not to be understood as a means for appeasing economic desires and dreams about strong industry in the planned economy; it found ways to satisfy (sometimes enormous) appetites while not de-

26 Kochetkova, *The Green Power of Socialism.*
27 Iosif Burdiansky, *Osnovy ratsionalizatsii proizvodstva* [Fundamentals of Production Rationalization] (Moskva, Leningrad: OGIZ, 1934), 32.
28 F.N. Petrov, "Dlia blaga cheloveka" [For the Benefit of Man], *Priroda*, no.12 (1961): 5.
29 D.G. Zuliaev, *Upravlenie ratsionalizatorskoi deiatel'nost'iu na promyshlennom predpriaiatii* [Management of Rationalization Activities at an Industrial Enterprise] (Izhevsk: Izd-vo "Shelest," 2022).
30 See, for example, Sergei Prokhorov, "Computers in Russia: Science, Education, and Industry," *IEEE Annals of the History of Computing* 21, no.3 (1999): 4–15.
31 Ekonomist Elena Veduta ob otechestvennoi modeli tsifrovoi ekonomiki [Economist Elena Veduta on the Domestic Model of the Digital Economy], Nomad, 2018, accessed 9 July, 2025, https://nomad.su/?a=15-201808270015.

stroying nature in recognition of her economic service. In any case, rationality meant active intervention in human-nature relations in order to account for both social benefits and the improvement of the material possibilities of nature. As a 1968 article in *Priroda* put it, "In order to actively interfere in the development of nature and to use her resources rationally as well as to achieve 'enrichment' [*obogashcheniia*] of her resources, it is necessary to penetrate into the essence of most sophisticated connections."[32]

The Soviet interpretation of future development, embedded in the terms of communism at the time, included the reconciliation of nature and production. Yet they both were to work in the name of a joint aim: economic growth. Economist N. Gladkov in the 1960s pointed to a widely circulated view that nature protection was in contradiction with the realities of using natural resources. Not challenging economic growth as a desired development as such, he nevertheless emphasized that "the use of natural resources [*prirodopol'zovanie*] is a deep and often ambiguous notion which implies not only the economically effective involvement of territorial complexes of the geographical environment in the process of production, but [its] protection and, in a number of cases, the restoration and transformation [*preobrazovanie*]."[33] Many engineers involved in production dependent on natural resources, such as the forestry industry, shared the belief that future economic growth would create demands for more natural resources. This view was also shared by some economists, planners, and scientists who had always had a stake in progress, a firm category of the Soviet vision of development, understood as the primary goal for the future. Thus, in 1968, the economic geographer Aleksey Minz began his book by stating that "the volume of natural resources which are involved in economic use is steadily growing."[34] Enthusiasm for future economic growth was also instigated by experiments with new synthetic materials, such as wood plastics, which facilitated the production of new consumer goods while also demanding hugely increased quantities of material resources.

32 K. Otorbaev, S. Umyrzukov, "Vysoko v gorakh" [High in the Mountains], *Priroda*, no.12 (1968): 80.
33 Konstantin Pashkov, *Okhrana prirody v Baikal'skom regione: Problemy organizatsii i osnovnye napravleniia deiatel'nosti (1917–1991)* [Protection of Nature in the Baikal Region: Problems of Organization and Main Directions of Activity (1917–1991)] (PhD diss., Baikal'skii gosudarstvennyi universitet ekonomiki i prava, 2012).
34 Aleksey Minz, "Geograficheskie voprosy khoziaistvennogo ispol'zovaniia prirodnykh resursov SSSR" [Geographical Issues of Economic Use of Natural Resources of the USSR], *Voprosy geografii* 75 (1968): 19–37.

This was well reflected in other science publications such as a 1968 volume titled *Nature and Society* that discussed the rational use of natural resources and presented conclusions of a scientific conference. Combining science and rhetoric, the volume emphasized that nature must be protected. The rational use of natural resources meant that the Soviet citizen was to act as a planner who stood above industry and nature to devise better modes for organizing economic production.[35] The scientific foundation for building communism was conventional, and the rational use of natural resources emerged as an alternative to the electrification phase of the early Soviet decades and the chemicalization phase of the post-war period. Both phases were considered technological means towards achieving communism.[36] As one commentator put it, achieving communism was only possible by using the country's natural resources. Therefore, they continued, "We will increasingly consume natural riches, but at the same time, we will have to eliminate the wasteful use of natural resources."[37] They connected this issue not only to the economic meaning, but also explained that it had huge social importance, and rationality in the use of natural resources was only possible on "the scientific basis." This technocratic perspective was part of a broader explanation for economic and social mechanisms that described communism as a pathway to material abundance and prosperity.

Over the course of the last decades of state socialism, the rhetoric about communism and the interpretation of its stages, such as developed socialism (*razvitoi sotsializm*), were increasingly formalized. The rational use of natural and material resources in general also held a consistent place in this ideological context. Balancing ideological narratives, courses of action, and professional explanations, rationality thus served as a stable political and ideological pillar in understanding natural resources and their use in late state socialism within the Soviet Union.

Economizing implied finding an approach to nature that would not cross the threshold beyond which lay the complete depletion of the natural environment. Rationality insisted on the importance of calculating the "non-depleting potential" of the natural object and establishing "red lines" to identify the limits of potentially unlimited exploitation. Discussing thermal waters, for example, one article stated in 1969:

---

35 *Priroda i obshchestvo.*

36 Here I mean "communism is the power of the Soviets plus electrification of the whole country" and "communism is the power of the Soviets plus chemicalization" as two slogans used in the Soviet Russia/Union over the Soviets decades.

37 "Nauka v novoi piatiletke" [Science in the New Five-Year Plan], *Priroda*, no.5 (1971): 3.

> We will discuss the most important issue now, namely the rational use and protection of the thermal waters. But before we can speak about it, we must decide if it is acceptable at all to drill hot groundwater. Will it lead to the cooling of our planet? It is too early to be concerned about it now because we take away only a small part of the warmth of ground resources which also replenish due to radioactive decay.

This is why, they explained, it was too early to speak about the limitation of the use of the Earth's warmth. Yet, they warned, "do not kill the golden goose, especially a goose capable of delivering golden eggs over the course of thousands of years." However, they insisted that it was not possible to exploit any ground water without knowing the speed at which it replenished, and it was equally important to calculate the cost of drilling, "how much water to extract, how to rationally use it, what benefits it will give, and, finally, where to release the waste water."[38] The improvement in the use of natural resources was possible due to the rational calculations intended to quantify the limits of nature.[39] The scientific service of industrialization and modernization aimed to use rational knowledge for the improved exploitation of nature and resources for stable economic growth.[40] As many believed, science was to provide the basics for the rational use of natural resources, "which defines the economic and industrial potential of the country."[41] The limits of the available natural resources, on the one hand, and the push for increased production and full-scale modernization, on the other hand, made economizing a crucial instrument of Soviet politics. Economizing, like rationality, was an ambiguous concept that combined the growth rhetoric that proliferated across various official documents and speeches with scientific dimensions. They both promised a harmonization between the demands and limits of natural resources.

Rationality as an industrial experiment

The notion of rationality also provided the intellectual infrastructure and justification for industrial and scientific experimentation with waste materials that re-

38 Shishkin, "Energiia termal'nykh vod," 103.
39 Mikhail Guzev, *Ekonomicheskie interesy i stimulirovanie ratsional'nogo prirodopol'zovaniia v razvitom sotsialisticheskom obshchestve* [Economic Interests and Incentivizing Rational Use of Natural Resources in a Developed Socialist Society] (PhD. diss., Rostovskii gosudarstvennyi universitet, 1984).
40 S.G. Sinitsyn, *Ratsional'noe lesopol'zovanie* [Rational Forest Use] (Moskva: Agropromizdat, 1987).
41 N.V. Mel'nikov, "Problemy ispol'zovaniia prirodnykh resursov" [Problems of Natural Resource Use], *Priroda*, no.9 (1967), 115.

mained after industrial operations. One of the most celebrated examples of this was the use of wood waste to rationalize the exploitation of forest resources. The idea of no-waste production became a guiding vision for those foresters, who believed that rationality could be implemented across industrial operations in forests and at wood processing enterprises to preserve forest wealth. The rational use of resources also gained traction in the food industry, justifying a shift toward more "rational and economically effective use of the main industrial funds" during the economic reforms of the 1960s.[42]

The growing emphasis on rationality partly stemmed from large-scale debates surrounding nationally and internationally significant natural sites, such as water basins. The infamous fight over the construction of cellulose factories on the shores of Lake Baikal in the 1960s – traditionally viewed as a national treasure and unique natural gift – provoked a political reaction. Scientists and engineers who insisted on protecting Baikal from pollution to ensure water purity for cellulose production were influential enough to prompt the development of a specific water treatment model, even though they did not halt factory construction. The Baikal conflict produced a new, though limited, model of nature-human relations, despite the ongoing contamination of the lake. The Baikal complex encouraged the development of so-called bioeconomic systems – economic models designed to account for broader relationships with the natural environment.[43] Technologically, the debates led engineers in Leningrad to experiment with solutions for the "Baikal scheme" of water treatment. The public reaction and technological responses reinforced the dominance of rationality in official political discourse. Rather than focusing on the wastewater produced by strategic industries, however, the state increasingly emphasized the ecological behavior of citizens, which it claimed caused economic losses.

Specialists often noted that, beyond better management, it was also possible to process food waste and agricultural products more efficiently. Inspiration came from advances in chemistry and its growing role in food science and production, which made it possible to substitute natural materials with more economical syn-

42 O perevode predpriiatii pishchevoi promyshlennosti na novye usloviia planirovaniia i ekonomicheskogo stimulirovaniia promyshlennogo proizvodstva, 1967 [On the Transition of Food Industry Enterprises to New Conditions of Planning and Economic Incentives for Industrial Production, 1967], Central State Archive of Saint-Petersburg. F. R-2225. Op. 4. D. 1575. L. 193.

43 Pavel Oldak, "Novoe mesto prirody v ekonomicheskikh issledovaniiakh [The New Place of Nature in Economic Research]," *Priroda*, no.2 (1973): 34. See also on working out the Baikal scheme and its environmental and political implications in Elena Kochetkova, "An Ecological Controversy: Soviet Engineers and the Biological Treatment Method for Industrial Wastewater in the 1950s and 1960s," *Ab Imperio* 1 (2019): 153–180.

thetic alternatives. Rationality provided a framework for finding alternative materials to address resource depletion. A key example was experimentation with perennial plants like reeds, proposed as substitutes for wood in producing inexpensive mass-consumption goods.[44]

Food science similarly offered broad possibilities for experimentation, such as replacing natural foods with synthetic substances – for example, by ceasing the extraction of ethyl alcohol from grain, potatoes, or beets. Synthetic materials came to symbolize progress and shaped visions of a scientifically guided future. Scientists believed these materials could help rationalize production by reducing the consumption of natural resources.[45] One method for producing ethyl alcohol involved hydrolyzing wood processing waste, which yielded technical alcohol from forestry by-products. Many pulp and paper enterprises built specialized facilities to use waste materials in producing ethyl alcohol for chemical industries, including agriculture, cosmetics, and food production.

The language of rationality supported these technological transformations and explained the ascendancy of synthetic materials as a rational response to economic needs. Science not only protected nature, it released its most valuable resources for other economic uses, minimizing waste by replacing natural inputs with synthetic ones. Producing ethyl alcohol from edible potatoes was considered wasteful; producing it from wood by-products was deemed rational and inherently progressive. Cost was a major motivator, as synthetic materials promised cheaper production. Scientific advances made it possible to transform previously uneconomic materials into food products. Thus, the issue of food waste – including the discarding of milk whey or cattle feed – drew sharp criticism and was seen as a sign of economic negligence.[46] In typical Soviet fashion, the irrational use of material and natural resources became grounds for criticizing managers and directors. Party organizations often blamed them for failing to utilize all materials involved in production and for wasting energy, fuel, and other resources.[47]

44 Elena Kochetkova, "Industry and Forests: Alternative Raw Materials in the Soviet Forestry Industry from the mid-1950s to the 1960s," *Environment and History* 24, no.3 (2018): 323–347. See also on the use of waste and waste regime in Zsuzsa Gille, *From the Cult of Waste to the Trash Heap of History: The Politics of Waste in Socialist and Post-Socialist Hungary* (Bloomington: Indiana University Press, 2007).

45 Anatoly Averbukh, *Zamena pishchevogo syr'ia v promyshlennosti* [Substitution of Food Raw Materials in Industry] (Leningrad: Lenizdat, 1959), 37.

46 P. Groizman, "Porogi na molochnoi reke" [Rapids on the Milky River], *Vyborg*, April 5, 1991, s. 4.

47 Protokoly zasedanii Komiteta narodnogo kontrolia, 1966 [Minutes of the Meetings of the Committee of People's Control, 1966], The National Archive of Estonia. F. R-2158. Nim. 12. L. 19.

When experimenting with synthetic materials, scientists often invoked rationality as a means to address modern social challenges. One prominent academic debate in the mid-1960s to 1970s focused on global overpopulation. Scientists treated this as a critical future issue and proposed chemistry as a solution to food shortages. As academician Nikolai Zhavoronkov wrote in his article titled "*Will the Human Have Enough Food Resources? What Chemistry Will Be Asked For To Provide the Globe with Food?*" agricultural soil was limited. He added that "the best way to quickly increase the amounts of food resources is to conduct chemicalization [*khimizatsiia*, or intensification of chemical use.– E.K.] of agriculture and farming and enlarge the use of chemical fertilizers in the first place."[48] Others, like academician and head of the Academy of Sciences Alexander Nesmeyanov, went further, conducting experiments to synthesize food from oil and other non-agricultural materials. Less radical were the calculations for producing fodder yeast to increase outputs of pork, chicken, eggs, and milk. As Zhavoronkov put it, "the human has such [a powerful] knowledge and technique which, if not used in the name of crime and military aims, open grandiose perspectives to us. One of the most generous tasks of today and tomorrow is to provide every person with full-valued nutrition."[49] Calculating the benefits that science and technology could bring to society resulted from the rational approach to the natural and social order. If used rationally, for the benefit of the economy and society, science and technology could both prove valuable for modern development.

However, this scheme encountered obstacles in the reality of the planned economy – a setting poorly aligned with the ideas promoted by optimistic scientists and engineers. Soviet economic realities, including shortages and irrational logistics, often diverged from professional aspirations, leading to criticism of existing practices. The gap between projected progress and actual practice led to increasing dissatisfaction among specialists with the Soviet Union's economic and environmental performance.

A lack of rationality in particular, was often blamed for damage to fish populations, contamination of water, and the wastage of food that could have been redirected to animal husbandry. Soviet individuals were also blamed: some scientists warned of the negative effects of human activity on the Earth. As academician and geologist Evgeny Sergeev stated in 1977, "man is becoming the biggest ge-

48 Nikolai Zhavoronkov, "Khvatit li cheloveku prodovol'stvennykh resursov? Chto potrebuetsia ot khimii dlia obespecheniia Zemli prodovol'stviem?" [*Will the Human Have Enough Food Resources? What Chemistry Will Be Asked For To Provide the Globe with Food?*"], *Nauka i zhizn'* 5 (1965): 7.

49 Ibid., 9.

ological force."[50] Advocating the limits to growth, he warned that irrationality and *short-sightedness* were key contributors to environmental destruction: "We must remember the negative consequences of technical activities."[51]

The challenge of scaling laboratory experiments using natural materials to the level of the national economy proved significant. Scientists stressed the need for sustained rationality in the audacious political campaigns undertaken by the Soviet regime in the Eastern parts of the country. Western Siberia became one of the playgrounds for post-war large-scale modernization and the active excavation of natural resources, and this enormous portion of the earth was the target of substantial transformation.[52] In scientific criticism, nature was a gift giver to be treated carefully, and thorough calculation of economic effects was thus needed, along with measures to define the sensitivity of exploitation and the rational distribution of resources. Science was useful as long as it could provide alternative materials to natural resources. As economists S.G. Strumilin and E.E. Pisarenko wrote in 1977, the rational approach to the interplay between the economy and nature created the basis for social benefit. Rationality implied the possibility of engineering nature: "It is time to stop exploring nature as such and move to projecting the new, human-desired environment and the rational human control of the evolution of biosphere."[53] The increase of the productivity of nature was therefore crucial, and its outcomes quite successful in forestry, for example, through greater, more rational planning of cutting, reforestation, and the use of wood waste and industrial waste left after harvesting and processing operations.[54] As one specialist put it, "the rational use of forests... is only possible when one forest organism binds together all the elements of forestry which connect forest exploitation and reforestation with other economic activities."[55]

The international context – particularly Western discussions of growth limits – also influenced Soviet notions of rationality. Growing concern about environmental degradation in Europe left its mark on Soviet discourse. Commentators ref-

50 E.M. Sergeev, "Ratsional'noe ispol'zovanie geologicheskoi sredy" [Rational Use of the Geological Environment], *Priroda*, no.1 (1977): 85.

51 Sergeev, "Ratsional'noe ispol'zovanie geologicheskoi sredy," 87.

52 Sergeev, "Ratsional'noe ispol'zovanie geologicheskoi sredy," 91.

53 G. Strumilin, E. Pisarenko, "Ekonomika i statistika 'darovykh' blag prirody" [Economy and Statistics of Nature's 'Free' Gifts], *Priroda*, no.1 (1977): 3. See also I.P. Gerasimov, "Unikal'naia priroda Tsentral'nogo Predkavkaz'ia" [Unique Nature of Central Predkavkaz], *Priroda*, no.12 (1979): 3.

54 Mako Dakov, "Budushchee bolgarskikh lesozagotovok" [Future of Bulgarian Timber Harvesting], *Lesnaia promyshlennost'* 12 (1971): 28.

55 "Polveka nazad v nashem zhurnale" [Half a Century Ago in Our Magazine], *Lesnaia promyshlennost'* , no.12 (1972): 14.

erenced international agreements and legal frameworks. In 1975, *Pravda* reported on the Meeting on Security and Cooperation in Europe held in Helsinki, stating: "the protection and the improvement of the environment, as well as nature protection and the rational use of her resources in the interests of todays and future generations, are among the tasks which have a huge meaning for the prosperity of people and economic development of all countries." It further argued that "many problems of the environment… can be effectively solved only by close international cooperation."[56] Citing the international context, Soviet commentators supported economic growth but stressed the need to balance production with environmental care. In 1979, the Central Committee and the Council of Ministers issued a joint decree "On Additional Measures for Increasing Nature Protection and Improving the Use of Natural Resources," which emphasized both "the protection of nature" and "the rational use of natural resources." As one commentator put it, "nature protection in the Soviet Union implies the complex of measures on the rational use and replenishing (*vosproizvodstvo*) of natural riches."[57] A 1981 decree of the Central Committee reinforced this position, calling for intensified economic development while reducing input costs and resource consumption.[58]

By the late Soviet period, nature was increasingly understood as an agent – more than a store of materials, it came to be seen as a complex actor deserving of scientific attention. The idea of rationality thus began to include this new agency of nature in regulating human-nature relations. While the prevailing scientific view remained grounded in industrial logic, it was now more nuanced and favored softer forms of control. Science assumed a more paternalistic role, aiming to improve nature's economic value through closer integration with society. This line of thinking continued into the Perestroika period, when officials increasingly

56 "Soveshchanie po bezopasnosti i sotrudnichestvu uspeshno zaversheno" [Meeting on Security and Cooperation Successfully Concluded], *Pravda*, August 2, 1975, 1.

57 A.N. Lavrishchev, Ekonomicheskaia geografiia SSSR [Economic Geography of the USSR]. Moskva, 1986, accessed July 9, 2025, https://economics.studio/ekonomicheskaya-geografiya/ohrana-prirodyi-sssr-ratsionalnoe-ispolzovanie-32088.html. See also Evgeny Gololobov, Daria Ashikhina, "Ekonomicheskie aspekty ekologicheskogo regulirovaniia v SSSR v 1970-e-80-e gg." [Economic Aspects of Environmental Regulation in the USSR in the 1970s–1980s], *Vestnik Tomskogo gosudarstvennogo universiteta. Istoriia* 84 (2023): 5–10.

58 Postanovlenie TsK KPSS i SM SSSR "Ob usilenii raboty po ekonomii i ratsional'nomu ispol'zovaniiu syr'evykh, toplivno-energeticheskikh i drugikh material'nykh resursov," 1981 [Resolution of the CPSU Central Committee and the USSR Council of Ministers "On Strengthening Work on the Economy and Rational Use of Raw Materials, Fuel-Energy, and Other Material Resources," 1981], accessed July 9, 2025, https://tehnorma.ru/doc_ussrperiod/textussr/usr_10812.htm.

criticized the shortcomings of the Soviet system, even though resource waste and environmental crime had long been subjects of internal critique.

Conclusion: soft dominance over nature

The term *rationality* served as an instrument in shaping human–nature relationships in the Soviet Union, used to justify less environmentally destructive modes of resource extraction, even as the primary value of nature remained economic. It reconciled nature protection and economic efficiency stemming from the material shortages and economic constraints of the Soviet economy, which demanded that natural resources be more carefully distributed and efficiently used. Increased productivity was not to come from nature itself, but from transforming industrial practices and economic habits. Science and technology were viewed as the tools for enacting this transformation, and professionals increasingly invoked rationality to address environmental and resource-related challenges. Rationality, in this sense, did not merely imply the subordination of nature to human will or political power; it called for a calculated and optimized engagement with nature to derive the greatest possible benefit without complete exhausting its reserves.

Engineers and scientists largely remained committed to the industrial discourse that positioned nature as a resource base. However, they gradually changed their perspective on how they imagined the interaction between society and nature. They expressed growing concern regarding the environmental and economic consequences of wasteful practices – such as those seen in the Baikal conflict or widespread deforestation. Fears about resource scarcity maintained the influence of scientific and technical professionals in policy discussions, even if their ability to affect real change was limited. These actors emphasized the need for a rational approach to nature – one informed by the technological capacities of modern industry. The dream of waste-free production, the development of substitutes for traditional materials, and innovations in resource processing inspired many to envision transformed human–nature relations.

Because Soviet politics was deeply intertwined with scientific discourse, *rationality* became a politicized term, used to articulate how the state envisioned its relationship with nature under communism. Ideological portrayals of abundance and fertility rarely aligned with reality, and the persistent criticism of irrational resource use became part of the broader Soviet narrative about how to build a prosperous communist society. Rationality bridged the gap between political aspiration and material conditions, acquiring varied meanings and functions. By the mid-1960s, the rational use of natural resources therefore became a central topic in both official and professional discussions about how to structure the political economy of nature in the Soviet Union and beyond. Rationality was expected to reconcile progressive scientific visions with the stagnation and inefficiencies that marked Soviet economic development.

This chapter has argued that rationality evolved into a distinct discourse which, when applied in industry, fostered a vision of *soft dominance* over nature within the late Soviet political economy. This was not a move toward ecological parity, but an attempt to forge more efficient relations between nature and industry – where nature was assigned a primarily economic role. Rationalization did not entail transforming nature itself, but rather intensifying its output through calculated planning and waste reduction. While it reflected concern for the future economic potential of natural resources, Soviet rationality did not seem to strive for ecological balance in the modernized society. Instead, it remained a veiled form of dominance over nature – less destructive than outright exploitation, but still deeply rooted in control.

One of the most enduring questions raised by this analysis concerns the interplay between *ideas* and reality. As historian Marija Drėmaitė insightfully asks, was the rational socialist society "imaginary or real?"[59] Political visions of communism overlapped with professional debates about rationality in the industrial reality, which came to represent both an aspiration and a critique. Rationality served as a justification for better resource use in the name of building communism, but was also a response to the persistent failure to achieve that goal. The contradiction at the heart of Soviet society – between ideological declarations and material realities – was embedded in the concept of rationality itself. Many experiments were only partially implemented, falling short of the ambitions of the era, including in the areas of automation and waste-free production. Rationality became a flexible, often ambiguous category: a way to interpret failure and to convey hopes for a future development that remained just out of reach.

Despite its contradictions, rationality remained a foundational concept in Soviet political and industrial development, serving to justify the directions of industrialization, modernization, and restructuring (*perestroika*). In this context, rationality continued to shape Soviet actions and the vision of progress well into the final decades of the regime.

---

59 Marija Drėmaitė, "Planning the Rational Soviet Baltic Society: Industry and Built Environment in Lithuania in the 1960s," in Modernism and Rationalization, ed. Caspar Jørgensen and Morten Pedersen (Aalborg: Gandrup Bogtrykkeri, 2006), 72.

Odinn Melsted, Cyrus C. M. Mody, George Roberts, Candida F. Sánchez Burmester

The limits to growth and development? Computer modeling, planetary limits, and the question of industrial development in the Global South, 1960s–1970s

List of abbreviations

ADELA	Atlantic Community Development Group for Latin America
CoR	Club of Rome
DRC	Development and Resources Corporation
IDRC	International Development Research Centre
LAAD	Latin American Agribusiness Development Corporation
LAWM	Latin American World Model or *Modelo Mundial Latinoamericano*
MIT	Massachusetts Institute of Technology
OECD	Organization for Economic Cooperation and Development
OECEI	*Oficina de Estudio para la Colaboración Económica International* or Bureau for Research on International Economic Collaboration
PICA	Private Investment Company for Asia
SIFIDA	*Société Internationale Financière pour les Investissements et le Développement en Afrique* or International Financial Group for Investment and Development in Africa
STS	Science and Technology Studies
TVA	Tennessee Valley Authority
US(A)	United States (of America)
USSR	Union of Soviet Socialist Republics

Acknowledgement

The research and writing for this article was supported in part by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (Dutch Research Council) under grant VI.C.191.067 “Managing Scarcity and Sustainability.”

Introduction

In 1972, the MIT computer modeling study, *The Limits to Growth*, commissioned by the Club of Rome (CoR), projected humanity heading for collapse if the growth in

https://doi.org/10.1515/9783111611358-005

population, resource consumption and environmental pollution continued to push planetary boundaries.[1] In the ensuing debate, actors in the Global South fiercely criticized the CoR and *Limits* for linking the notion of ecological limits to limitations on population and economic growth in the developing world. As Argentinian researcher Gilberto Gallopin put it in retrospect, while such models were "concerned with a crisis looming in the future, already the majority of humankind was living in a state of poverty and misery." For this reason, the "policies oriented towards getting a state of global equilibrium as recognized in Limits to Growth would tend to ensure that the present injustices in the global systems are maintained."[2]

Yet the ideas behind the CoR's project on the predicament of mankind grew out of the often-overlooked roots of the Club in Latin American industrial development. Starting in the 1950s, the CoR's founder and leader, Aurelio Peccei, promoted industrial development in the region, particularly through the multinational investment corporation Atlantic Community Development Group for Latin America (ADELA), which aided the transfer of technologies, skills and capital to counter the growing imbalance between North and South. This development model was challenged by concerns about population growth, environmental problems, and resource scarcity that were reflected in the *Limits* debate. Perhaps because of Peccei's deep involvement in Latin America, he and the CoR engaged with critiques of *Limits* originating in the Global South. In Argentina, the CoR sponsored the Fundación Bariloche in developing an alternative computer modeling study of 1976, the *Modelo Mundial Latinoamericano* or Latin American World Model (LAWM), which envisioned a future where the developing world could progress within limits that were sociopolitical, rather than physical. In Africa, the Club de Dakar – taking its cue from the CoR – was created in 1974 to promote industrial development with private capital and rejected the notion of physical limits to development.

Our chapter ties together several strands of history that have largely – if at all – been studied separately. While there is a substantial literature on the CoR and *Limits*, the main focus has been on the influence on societal debates about resources and the environment, on the disciplines of systems analysis and future

1 Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III., *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (New York: Potomac, 1972).

2 Gilberto C. Gallopin, "The Latin American World Model (a.k.a. the Bariloche Model): Three Decades Ago," *Futures* 33, no.1 (2001): 77–88, here 81.

studies, and on the MIT group's use of computer modeling.[3] Matthias Schmelzer has argued that the CoR built primarily on personnel and studies of the Organization for Economic Cooperation and Development (OECD) in the 1960s.[4] While the link to OECD is evident, it should not overshadow the equally important influence of Peccei's efforts in Latin America with ADELA.[5] The critique of *Limits* from the Global South, above all the 1976 LAWM, has likewise often only been mentioned in passing in studies of the *Limits* debate.[6] In contrast to the CoR, the history of the Club de Dakar has largely been forgotten after the organization's sudden end following the downfall and imprisonment of its founder, Mohamed Tiékoura Diawara, and has only recently been rediscovered.[7] To the rich literature on the history of development, we contribute a view on the business-led development model promoted by Peccei, ADELA, and the Club de Dakar, which was considered a private sector alternative to international agencies.

In this chapter, we examine the relationships between computer modeling, industrial development, and the debates about environmental pollution and planetary limits. In doing so, we point out two ways in which technologies and environmentalism interacted with ideas about development. On the one hand, technology transfers were an essential part of the business-led industrial development model promoted by Peccei and his allies, but were also challenged by the environmental

3 Kevin T. Baker, "World Processors: Computer Simulation, The Limits to Growth, and The Birth of Sustainable Development" (PhD diss., Northwestern University, 2019); Peter Moll, *From Scarcity to Sustainability: Futures Studies and the Environment: The Role of the Club of Rome* (Bern: Peter Lang, 1991); Fernando Elichirigoity, *Planet Management: Limits to Growth, Computer Simulation, and the Emergence of Global Spaces* (Evanston, IL: Northwestern University Press, 1999); Patrick Kupper and Elke Seefried, "A Computer's Vision of Doomsday: On the History of the 1972 Study The Limits of Growth," in *Exploring Apocalyptica: Coming to Terms with Environmental Alarmism*, ed. Frank Uekötter (Pittsburgh: Pittsburgh University Press, 2019), 49–74; Elke Seefried, *Zukünfte. Aufstieg und Krise der Zukunftsforschung, 1945–1980* (Berlin: De Gruyter, 2015); Thomas Turnbull, "Simulating the Global Environment: The British Government's Response to *Limits to Growth*," in *Histories of Technology, the Environment, and Modern Britain*, ed. Jon Agar and Jacob Ward (London: UCL Press, 2018), 271–299.

4 Matthias Schmelzer, "'Born in the Corridors of the OECD': The Forgotten Origins of the Club of Rome, Transnational Networks, and the 1970s in Global History," *Journal of Global History* 12, no.1 (2017): 26–48.

5 As has been proposed by Piccioni and Sánchez Burmester: Luigi Piccioni, *Forty Years Later: The Reception of the Limits to Growth in Italy, 1971–1974* (Brescia: Fondazione Luigi Micheletti, 2012); Candida F. Sánchez Burmester, "From Development to Sustainable Development: Latin America and the Limits to Growth Debate, 1961–1987" (MA Thesis, Maastricht University, 2021).

6 Though see Ana Grondona, "Latin American World Model: A Third-World Voice to Face Limits to Growth," *Journal of Imperial and Commonwealth History* 52, no.6 (2024): 1003–1031.

7 See George Roberts' forthcoming work on the Club de Dakar.

and scarcity debates of the 1970s. On the other hand, the technology of computer modeling decisively shaped the era's imaginaries of development and specifically the question of whether planetary limits would ultimately constrain development. Technology therefore played many roles: it was a *problem* that had created an imbalance between humans and the natural environment as well as between the developed and developing world; it was a research *instrument* that allowed the simulation of the future through computer models; and it was seen as a *solution* to bridge imbalances in development through technology transfers from North to South, redress environmental problems, and overcome resource constraints. To that end, we build on concepts and studies from history of technology and Science and Technology Studies (STS), particularly studies of computer modeling, the concept of technology transfers, and Eden Medina and colleagues' problematization of the widespread notion of North-South technology transfers as simply being "imported magic." That view, we agree, ignores the local shaping of those technologies as well as local knowledge and innovation, as was the case with Fundación Bariloche's computer modeling study.[8]

Based on publications and archival materials of actors involved with the organizations under examination, our chapter explores this history in three, largely chronological sections. It first looks at the roots of the Club of Rome in Aurelio Peccei's Latin American initiatives in the 1950s and 1960s and how Peccei and the CoR instead ended up promoting *Limits* by 1972. The second part focuses on the development implications of *Limits*, how the CoR dealt with criticisms from the Global South, and how it supported the alternative Latin American World Model. The final section zooms in on the case of the Club de Dakar and relates its fate to the overall demise of all three organizations – ADELA, the Club of Rome and the Club de Dakar – and with them their development plans and imaginaries during the 1980s.

1 Development by investment: Peccei in Latin America, 1950 – 1968

With the publication of *The Limits to Growth* in March 1972, the Club of Rome was catapulted onto the world's front pages and acclaimed as a leading exponent of neo-Malthusianism – and of computer modeling – in the ensuing debate about

8 Eden Medina, Ivan de Costa Marques, and Christina Holmes, introduction to *Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America*, ed. Eden Medina, Ivan de Costa Marques, and Christina Holmes (Cambridge, MA: The MIT Press, 2014), 1 – 23.

population, pollution, and resource scarcity. Histories in which the CoR figures therefore start from the foreknowledge that *Limits* would be its best-known achievement.[9] Yet the CoR wandered into commissioning *Limits* somewhat accidentally, and many of its members were taken aback both by its findings and its acclaim.[10] Certainly, no one in the CoR saw it as the final say. Many of the CoR's activities for the rest of the 1970s – such as commissioning the Latin American World Model – were intended to critically reassess *Limits.*

When the Club was founded in 1968, its early membership regarded it as a nexus where elites from government, industry, and academia could forge solutions to *all* of the world's problems, not just problems relating to population growth, pollution, or resource scarcity.[11] That's apparent, for instance, in Club member Arne Tiselius' invitation to the Club's founders (Aurelio Peccei and Alexander King) to use the Nobel Symposia in the early 1970s as a platform for addressing issues such as "global inequality, the dangers of new technology, the alienation of youth," and rapprochement between East and West.[12] Moreover, contrary to Matthias Schmelzer's claim that the Club was "born in the corridors of the OECD," the Club's various preoccupations mainly reflected Aurelio Peccei's experience with industry-led development in the decade prior to its founding and his visions and concerns for the world's future.[13]

Those visions began to coalesce in the 1950s, when Peccei, originally from Italy, was Fiat's (very successful) man in Latin America. On that basis, in 1956–1957, he convinced the leadership of Fiat to back two new ventures. The first was the *Oficina de Estudio para la Colaboración Económica International* (OECEI, or Bureau for Research on International Economic Collaboration) at Fiat in Buenos Aires. Unusual for an automobile manufacturer at the time, Fiat's research center mainly produced Latin American economic and development reports

9 E. g., Jenny Andersson, *The Future of the World: Futurology, Futurists, and the Struggle for the Post-Cold War Imagination* (Oxford: Oxford University Press, 2018); Elke Seefried, "Rethinking Progress: On the Origin of the Modern Sustainability Discourse, 1970–2000," *Journal of Modern European History* 13, no.3 (2015): 377–400. Elodie Vielle Blanchard, "Modelling the Future: An Overview of the 'Limits to Growth' Debate," *Centaurus* 52, no.2 (2010): 91–116. Bretton Fosbrook, "How Scenarios became Corporate Strategies: Alternative Futures and Uncertainty in Strategic Management" (PhD diss., York University, 2017).

10 On the somewhat accidental commissioning, see Baker, "World Processors," 18–19.

11 On the Club's founding ideals, see, Aurelio Peccei, "The Club of Rome: Ten Years On," *Futures* 10, no.2 (1978): 171–174.

12 The quote, and background on Tiselius' invitation to Peccei and King, is from Sven Widmalm, "'Super Bowl of the World Conference Circuit'? A Network Approach to High-Level Science and Policy Conferencing," *British Journal for the History of Science* 56, no.4 (2023): 535–551, here 540.

13 Schmelzer, "'Born in the Corridors,'" 26–48.

and built up a permanent staff of over fifty researchers.[14] Second, in 1957, Peccei convinced Fiat leadership and other major Italian firms to back Italconsult, a new engineering consultancy seeking contracts for development projects in the Global South.[15] An important model for Italconsult was David Lilienthal's Development and Resources Corporation (DRC), founded in 1955 to apply the "TVA model" of large engineering works for rural uplift to various erstwhile allies of the United States, such as Iran, Colombia, and South Vietnam.[16] By 1958, Peccei was personally lobbying Lilienthal to explore possible collaborations between DRC and Italconsult in countries including Egypt, Somalia, and Yugoslavia.[17]

In 1964, Peccei also became involved in founding the Atlantic Community Development Group for Latin America (ADELA). The seeds of ADELA lay in plans hatched by the US Senator Jacob Javits, which were subsequently taken up by a group of industrialists, including Gianni Agnelli of Fiat. This group assembled a four-man team which drew up plans for ADELA. Peccei served as its head. They devised a plan for companies in Europe, North America, and Japan to invest up to USD 500,000 each in the company, in return for a seat on ADELA's board. This money would then flow through ADELA's regional offices ("Adelitas") into relatively small projects around Latin America and the Caribbean.[18] ADELA was created as an investment fund "to foster socio-economic progress in Latin America by stimulating private enterprises through providing development services, technology and financing, including equity as a minority investor."[19]

14 Gunter A. Pauli, *Crusader for the Future: A Portrait of Aurelio Peccei, Founder of the Club of Rome* (Oxford: Pergamon Press, 1987), 65.
15 Pauli, *Crusader for the Future*, 65.
16 David Ekbladh, "Profits of Development: The Development and Resources Corporation and Cold War Modernization," *Princeton University Library Chronicle* 69, no.3 (2008): 487–506. Gregory Brew, *Petroleum and Progress in Iran: Oil, Development, and the Cold War* (Cambridge: Cambridge University Press, 2022).
17 Letter from Aurelio Peccei to David Lilienthal, 2 December 1958, Box 410, Folder Peccei, A. 1958, David E. Lilienthal Papers, Mudd Manuscript Library, Princeton University; Letter from Aurelio Peccei to David Lilienthal, 6 December 1958, Box 410, Folder Peccei, A. 1958, Lilienthal Papers; Letter from Aurelio Peccei to David Lilienthal, 7 January 1959, Box 415, Folder Peccei, A. 1959, Lilienthal Papers; Letter from from Aurelio Peccei to Raul D. Turdera, 4 November 1960, Box 421, folder Peccei, A. 1960, Lilienthal Papers.
18 For background, see *ADELA 10* (Adela, 1974), Box 1, unfoldered material, Robert Ross Papers on Development and Investment in Latin America and Africa, Mudd Manuscript Library, Princeton University. See also Richard Boyle and Robert Ross, *Mission Abandoned: How Multinational Corporations Abandoned Their First Attempt to Eliminate Poverty, Why They Should Try Again* (Princeton: Robert L. Ross, 2009) and Joseph James Borgatti, *ADELA: The Noble Birth and Costly Death of Early Venture Capitalism in Latin America* (New York: Chapin Publishing, 2018).
19 Quoted from *ADELA 10.*

Backed with the capital provided by the corporate shareholders, ADELA started operations in 1965. It prioritized capital investments in a wide range of promising private enterprises, but without acquiring majority shareholding in those companies. Its core agency became ADELATEC, which in many ways resembled Peccei's Italconsult and provided technical and management assistance to Latin American companies as well as economic and feasibility studies for ADELA management.[20] The investments were often in agribusiness and related animal and forest/plant products, but also in the mining, tourism, textiles and chemical industries.[21] Initially, the company had a total of 124 corporate shareholders from 15 countries. By 1975, that number had ballooned to 233 shareholders and some 105 directors.[22] Given the low cap on investments and large number of directors, few board members gave ADELA much thought. Nor did the board's chair, a rotating position with a roughly two-year term. Real oversight was therefore entrusted to the board's four vice chairmen, one of whom was Peccei for the first decade of ADELA's existence.[23]

To understand the link between ADELA and the founding of the CoR, we turn to a keynote speech Peccei gave at ADELA's official opening in 1965. Critically, Peccei's audience extended far beyond the investors and other dignitaries present in Buenos Aires to hear him speak about "The Challenge of the 1970s for the World of Today."[24] Over the following years, Peccei distributed copies of his speech widely, one of which found its way to Alexander King, the director-general for scientific affairs at the OECD. King subsequently approached Peccei, with whom he was previously unacquainted. Together, they made plans for a "club" of elites to implement the vision Peccei outlined in his speech, thus setting in motion the development of the CoR.[25]

Yet in his Buenos Aires speech, Peccei hardly mentioned the topics for which the CoR would later become famous, like overpopulation, resource scarcity, and

20 ADELA Investment Company S.A., Annual Report (1966), Box 1, unfoldered material, Ross Papers.

21 ADELA Investment Company S.A., Annual Report (1970 and 1973), Box 1, unfoldered material, Ross Papers.

22 That figure is from *ADELA 10.* A slightly different (though mostly overlapping) list is presented in *Mission Abandoned*, but with no date given. An overview of investments by sector can be found in the 1973 Annual Report, 8.

23 Criticism of the rotating chair system and the inattentiveness of directors comes from Borgatti, *ADELA*.

24 The copy of the speech that we quote from is accessible in: Aurelio Peccei, The challenge of the 1970s for the world of today: A basis for discussion, Lecture given at the National Military College, Buenos Aires, 27 September 1965, Box 463, Folder "Peccei, A. 1966," Lilienthal Papers.

25 Moll, *From Scarcity to Sustainability*, 60 – 61.

environmental pollution. Instead, he dwelt on nuclear holocaust, computer-aided pedagogy, the technology gap between the US and Europe, over-abundance of leisure thanks to automation, European unification, disarmament, and rapprochement with the Soviet Union. Those themes were also present in Peccei's book *The Chasm Ahead* (1969), yet they were largely washed away by the *Limits* controversy.[26] However, the 1965 speech *did* signal two aims that were later amplified by *Limits* and which thus (accidentally) became the CoR's signature themes: the need for new forecasting tools and the need for more equitable international development. For Peccei, these two objectives were mutually reinforcing cornerstones of world peace. The developed nations must "generat[e] an analogous transformation of underdeveloped economies," otherwise "the gap between them instead of narrowing is growing wider, so much as to give cause to fear that discontent will end in a cataclysmic explosion." Crucial to preventing such an explosion was "to understand where we are and where we are going. The question that must be set is that already indicated: are we capable of controlling our future, of parrying the threat that the world, even though becoming very small, literally falls to pieces?"

Yet Peccei didn't think that confronting the world's problems required *global* action – at least not initially: "the areas to be interested in development and in co-prosperity in the next decade are necessarily and only two: the Soviet area, comprising the USSR and Eastern Europe, and the Latin American area." Regarding the Soviets, Peccei imagined "reciprocal cooperation" among equals, with Western Europe taking the first steps and the US following behind to draw the USSR into "a ten-year program of cooperation … permitting, among other things, the gradual conversion of industries for war into industries for peace."

For the rest of the world, Peccei thought "that the wealthy nations must in the future help much more than in the past those people more derelict than any other," but only if "total foreign aid added to domestic savings [can] reach a certain 'critical volume' over a self-sufficient period." Thus, aid had to flow initially only to regions that could immediately make use of it; all other regions would have to focus first on accumulating sufficient domestic savings before they would be ready to follow the initial aid recipients' lead. In his view, only Latin America was already at the "critical volume" point, while "there are various allied factors which favor Latin America, not met at present in other as yet undeveloped regions," especially "a cultural base homogeneous with the West; about 150 years of independence" and "broad *de facto* experience of economic activities based on private initiative." Thus, "Latin America – and no other undeveloped region

26 Aurelio Peccei, *The Chasm Ahead* (New York: Macmillan, 1969).

– can and must therefore be the test-bench for the practicability of bringing a whole continent within the area of well-being."

Curiously, Peccei claimed that North Africa and the Middle East would develop along with Latin America but would not serve as a development test-bench because "the Mediterranean cannot be considered extraneous [to Europe] and hence the people around its shores must be called upon to share in its development." Development plans for sub-Saharan Africa and the rest of Asia, however, were "clearly an objective for a second period. The prerequisite … will be the consolidation of a large area of prosperity from Siberia to Patagonia and from the Nile delta to Alaska." Once that had been achieved then the ADELA model could be applied to other regions.

This was, indeed, what ADELA's supporters later attempted to do. In 1970, an overlapping group of investors, in cooperation with the African Development Bank, established the *Société Internationale Financière pour les Investissements et le Développement en Afrique* (International Financial Group for Investment and Development in Africa, SIFIDA), which they explicitly modeled on ADELA. SIFIDA's advocates argued that Africa was not just suffering from a lack of capital investment, but also the accompanying technological expertise, which could only be brought about from a closer relationship between venture capital and industry.[27] Its shareholders represented some of the most powerful names in global industry and finance: IBM, Barclays, Mitsubishi, Deutsche Bank, and Fiat – all shareholders of ADELA as well.[28] The company's USD fifty million capital was designed to support private investment all over Africa, but in practice was used almost entirely by foreign capital in states receptive to external investment, such as Kenya, Zaire, Ivory Coast, and Senegal, where SIFIDA invested primarily in textiles, tourism and forestry, but also other sectors like metallurgy.[29]

Similar ADELA-type models emerged elsewhere, too. In 1969, several early ADELA promoters – joined by David Rockefeller and others – organized the Pri-

27 Henry Phillips, "Venture Capital: Its New Role in Developing Africa," *African Affairs* 70, no.281 (1971): 395–403.

28 Tim Anderson, "Adela: The Violation of the Bond Market," *Euromoney*, September 1981.

29 On SIFIDA, see Mathieu Kaluma, "Une Société Internationale Financière pour les Investissements et le Développement en Afrique: la SIFIDA," *Congo-Afrique: économie, culture, vie sociale* 10, no.49 (1970): 477–484; André Badibanga, "Les fonds africains de développement: annexes du système mondial ou instruments de la croissance auto-entretenue?," *Revue Tiers Monde* 22, no.87 (1981): 655–666. For an overview of investments, see for example SIFIDA Annual Report (1973 and 1982), Box 1, unfoldered material, Ross Papers.

vate Investment Company for Asia (PICA).[30] That year also saw ADELA spin off the Latin American Agribusiness Development Corporation (LAAD; ADELA continued to own a 20 % share).[31] Then in 1974, Adnan Khashoggi spearheaded a Middle East Private Investment Company – "the scope of activities would essentially be identical with that of ADELA" – with the help of ADELA's upper management plus Saudi oil money.[32] Finally, in 1977, LAAD's principals outlined plans for similar capitalist-led development in Egypt, Morocco, Sudan, and Tunisia; while much later – immediately after the end of the Cold War – LAAD was again offered as a model for investment-development for post-socialist Baltic, Balkan, Eastern European, and Central Asian economies.[33] In other words, ADELA's creators (including Peccei) and admirers saw Latin America as the developing region most ripe for productive investment in the 1960s and, consequently, the region that could serve as a testbed for an industry-led development model that could be exported throughout the Global South.

Latin America also figured prominently in early recruitment for the Club of Rome. By 1971, there were five members based in Latin America, some of whom would be instrumental in Club activities focused on that region, including (as we will see) its patronage of a Latin American World Model.[34] Compare that with what Peccei called the "Soviet area," which had only one member as late as early 1974. The Latin American cohort was also larger than those for sub-Saharan Africa or Asia, if Japan is excepted.[35] Overall, then, we can infer that throughout his time with Italconsult, ADELA, *and* the Club of Rome – from the 1950s until

---

30 Senator Jacob Javits of New York, "The Private Investment Company for Asia," 10 January 1969, remarks on the floor of the Senate, 91st Congress – 1st Session, *Congressional Record*, 115, pt. 1: 1255.

31 Borgatti, *ADELA*, 44 and 77.

32 Ernst Keller (president of ADELA), prospectus for Middle East Private Investment Corporation, December 1974, Box 3, unfoldered material, Ross Papers.

33 Robert Ross (president of LAAD), report on "Agribusiness in Central Asia: Opportunities and Constraints," August 1998, Box 1, unfoldered material, Ross Papers; "Central European Agribusiness Development Corporation (CEAD): A Concept Paper," August 1991, Box 1, unfoldered material, Ross Papers; and Ross and Elsayed G. Shoreibah, "Report on North Africa: Preliminary Report on Creating a Regional Agribusiness Development Corporation," 1977, Box 1, unfoldered material, Ross Papers.

34 Membership as of 24 June 1970, Box 17, Folder 684, Gordon S. Brown Papers, Massachusetts Institute of Technology, Department of Distinctive Collections, Cambridge, Massachusetts.; membership as of 18 March 1971, Box 42, Folder "Club of Rome, Membership, 1984," Jay W. Forrester Papers, Massachusetts Institute of Technology, Department of Distinctive Collections, Cambridge, Massachusetts.

35 Compare Membership as of 25 January 1973 with Membership as of 31 July 1974, both in Box 29, Folder 6, Elizabeth Mann Borgese Fonds, Dalhousie University Libraries.

his death in 1984 – Latin America was Peccei's "test-bench" for refining methods of applying Global North investment, technology, and expertise to the development of the Global South.

2 Modeling the future of development: The limits to growth debate and the Latin American World Model, 1968 – 1973

When *The Limits to Growth* was released in 1972, the German magazine *Der Spiegel* spoke for many in labelling the Club of Rome and MIT's modeling study "A Computer's Vision Of Doomsday."[36] Almost overnight, the CoR and the MIT team became famous for fueling a debate about physical limits to economic and population growth, even though the Club's core members, above all Peccei and King, had rather argued in favor of economic growth in the past. Working with its World3 computer model, the MIT team had in fact simulated different scenarios for the future of the world system, but the diagram that stood out was the "standard run," which projected that if current growth trends (or "business-as-usual") in population, industrialization, pollution, food production and resource exhaustion continued to push the planetary boundaries, society would be heading for collapse. The authors questioned technological optimist claims of human ingenuity overcoming those ultimate limits to the availability and affordability of food, minerals, and clean air and water.[37] The CoR thereby made the research method of systems analysis with the aid of computer modeling both famous *and* relevant to debates about development.

By questioning growth and technological optimism, and showing a new sensibility for environmental and resource issues, *Limits* was very different from Peccei's earlier thinking. Even though both looked at a series of interconnected problems and uncertainties that confronted mankind – termed the world *problématique* – the assumptions and arguments were fundamentally different. The reasons for this change lie partly in shifts in the thinking of Peccei, who in 1965 anticipated neither the rise of popular environmental movements in the following years nor the pessimistic turn in the outlook for resource availability, especially given the uncertain outlook for world oil supply as OPEC gained in confi-

36 Kupper and Seefried, "A Computer's Vision of Doomsday," 61.
37 Meadows et al., *The Limits to Growth.*

dence.[38] Published in 1968, Paul and Anne Ehrlich's book *The Population Bomb* fueled a debate between resource optimists (the "cornucopians") and pessimists (the "cassandras").[39] Already by 1970, Peccei adapted his *problématique* thinking and included population growth and "growing environmental pollution" in his list of critical problems.[40]

But the making of *Limits* was also shaped by contingencies in the CoR's broader activities, rather than the vision of Peccei alone. In the early years, the CoR set out to study a set of interconnected world problems, which became the first phase of the "Predicament of Mankind" project. To that end, the Club searched for a method of analyzing and raising awareness of the *problématique*, whereas later phases would focus on providing solutions to those problems. At a meeting in Bern, Switzerland, in June 1970, the search for a methodology led to a competition between two approaches. On one side, economist and early CoR member Hasan Özbekhan pushed for a cybernetic study of world problems. The other approach, presented by MIT professor, computing pioneer and systems dynamics researcher Jay Forrester, entailed a computer-aided analysis of world system dynamics. Forrester attended the meeting on the invitation of his MIT colleague Carroll L. Wilson, an early member of the CoR. Apparently, because Özbekhan's funding proposal had been rejected by the German Volkswagen Foundation, the CoR chose Forrester's approach instead.[41] Forrester soon wrote the first two models (World 1 and World2), but then delegated the task to Dennis and Donella (Dana) Meadows and their team to refine the World3 model and write *Limits*, which became an instant bestseller upon release in March 1972.[42]

While the *Limits* study was embraced by many people – ranging from scientists to environmentalists – it also stirred up a controversial debate. Critics brought up methodological critiques of the computer model as well as technological optimist and resource cornucopian rejections of its core arguments.[43] But the most politically forceful dissent came from the Global South, where there was

38 Seefried, *Zukünfte*, 263 – 267; Giuliano Garavini, *The Rise and Fall of OPEC in the Twentieth Century* (Oxford: Oxford University Press, 2019); Christopher R. W. Dietrich, *Oil Revolution: Anticolonial Elites, Sovereign Rights, and the Economic Culture of Decolonization* (Cambridge: Cambridge University Press, 2017).

39 Paul R. [later also credited to Anne H.] Ehrlich, *The Population Bomb* (New York: Sierra Club, 1968).

40 The Club of Rome, The Predicament of Mankind: Quest for Structured Responses to Growing World-wide Complexities and Uncertainties: A Proposal, 1970, Box 12, Folder 12, Forrester Papers.

41 Seefried, *Zukünfte*, 252 – 253.

42 Baker, "World Processors," 20 – 21.

43 For overviews, see Seefried, *Zukünfte*, 270 – 292; Walter E. Hecox, "Limits to Growth Revisited: Has the World Modeling Debate Made Any Progress?' *Environmental Affairs* 5, no.1 (1976): 65 – 96.

deep concern for the implications of the findings of *Limits* for the future of development. These emerged even prior to the publication of *Limits.* In April 1971, the CoR discussed the preliminary findings of the MIT study – then still entitled "Dynamics of Global Equilibrium" – at a meeting near Montréal.[44] Latin American members raised concerns about the study's fundamental assumptions and suggested holding a special meeting in the region to address its flaws.

In mid-1971, the CoR and the Instituto Universitario de Pesquisas sponsored a meeting of around twenty Latin American scientists in Rio de Janeiro.[45] When Dennis Meadows presented the World3 model, the audience reacted very critically. Instead of making predictions based on current trends, they felt it was necessary to examine the potential for fundamental changes in institutions and values. For them, the predicted problems in the future were outlined from the perspective of the developed world, which neglected that two-thirds of the population were already struggling with crises similar to those anticipated by the MIT study. There were also concerns that policies aimed at a "state of global equilibrium" would, in reality, perpetuate existing global inequalities. The study's proposed no-growth economics to prevent a planetary catastrophe would therefore deny the developing world its chance to develop and, in many ways, "colonize" its future.[46]

In light of this feedback, the CoR's leadership grew more critical of the *Limits* report's implications for development in their internal discussions. Shortly before the release of the report in 1972, Carroll Wilson wrote to Peccei that the study's implications for developing countries were a serious concern, as the hostile reception in Brazil had revealed:

> I might also add my own view that the implications of 'The Limits to Growth' for the less developed countries are very disturbing and generate great hostility. Those who are perceptive can see through the arithmetic and understand just what it means in terms of their as-

---

44 Dennis L. Meadows, The Club of Rome Project on the Predicament of Mankind. Preliminary Draft: Phase One: Dynamics of Global Equilibrium, Material prepared for the Club of Rome Meeting, Montebello, Canada, 4 – 6 April 1971, Box 55, Folder 2106, Carroll L. Wilson Papers, Massachusetts Institute of Technology, Department of Distinctive Collections, Cambridge, Massachusetts.

45 See an interview with Jorge A. Sabato: Willem L. Oltmans, *On Growth* II (New York: Capricorn, 1975), 38 – 39. The date for the Rio meeting is sometimes given as 1970 but can only have occurred in 1971.

46 Donella H. Meadows, John Richardson, and Gerhart Bruckmann, *Groping in the Dark: The First Decade of Global Modelling* (Chichester: John Wiley, 1982), 45. See also: Seefried, *Zukünfte*, 276.

pirations for material standards of living comparable with those of the highly developed countries. Nothing we say in our rhetoric is going to make any impact on these people.[47]

Club leaders expressed their sensitivity to these concerns by adding a disclaimer at the back of the *Limits* study, which noted that the report's conclusion applied to all peoples, no matter their level of development, but that the "major responsibility must rest with the more developed nations, not because they have more vision or humanity, but because having propagated the growth syndrome, they are still at the fountainhead of the progress that sustains it." That way, the developed countries would need to create a world of stability and work towards creating a "more equitable distribution of wealth and income worldwide."[48] Still, the awareness of critiques, blind spots, and the admitted need to differentiate the developed and developing world, were not implemented in the MIT team's World3 computer model.

The initiative for taking a different approach to *Limits* came instead via Latin America. After the Rio meeting, a group of nineteen interdisciplinary researchers, mostly from Argentina, Brazil and Chile, some of whom had standing relationships with Peccei and the CoR, decided to conduct the study on an alternative world model. They did so under the auspices of the Fundación Bariloche, an Argentine research foundation established in 1963.[49] The Fundación's computer – the first in the city of Bariloche – was crucial to the committee's proposal for a study that would examine the *problématique* from a different perspective than *Limits*, but with a comparable systems and modeling approach.[50] That was much closer to Peccei's original vision as laid out in the 1965 speech than the path the CoR had followed in the early 1970s. Thus, initially the Bariloche group received funding from the CoR to conduct a feasibility study,[51] and later asked

47 Carroll L. Wilson to Aurelio Peccei, 2 February 1972, Box 38, Folder 1574, Wilson Papers.
48 Meadows et al., *The Limits to Growth*, 185–197, quote on 194.
49 See Grondona, "Latin American World Model," who helpfully situates the Fundación Bariloche's history within the context of Argentina, but not the active role the CoR played in the development of the LAWM.
50 Aurelio Peccei, Note for Hulio Jaguaribe, Jorge Sabato, Victor Urquidi: Latin American Project for Phase Two, 13 April 1971, Box 38, Folder 1574, Wilson Papers.
51 Herrera, Amílcar O., Hugo D. Scolnik, Graciela Chichilnisky, Gilberto C. Gallopin, Jorge E. Hardoy, Diana Mosovich, Enrique Oteiza, Gilda L. de Romero Brest, Carlos E. Suárez, and Luis Talavera, *Catastrophe or New Society? A Latin American World Model* (Ottawa: International Development Research Centre, 1976), 4.

the Canadian International Development Research Centre (IDRC) for a grant that would cover the costs of the LAWM study, estimated at USD 81,000.[52]

From the outset, the LAWM study was proposed as one that would start out with a "critical analysis" of the MIT model, followed by a "disaggregation" of the model.[53] The CoR, therefore, presented LAWM as part of a second wave of studies on the global *problématique* that would take into account the "specific problem complex of the less developed countries and their plea for planetary socio-economic justice."[54] Yet the Bariloche group's approach was very different from the MIT system dynamics group in that they started from the assumption that the main problem was not physical limits but social and political inequalities, both at an international and national level.[55] Moreover, rather than offer an ostensibly value-neutral exploration of what might happen if present trends continued, the LAWM model was explicitly normative. That is, the group first defined what kind of future was desirable and then used the computer model to calculate how that vision could be achieved. By separating those two steps, the Bariloche team made two models: a conceptual model that sketched out a desirable future for all people, especially the Global South; and a mathematical model to demonstrate the feasibility of the conceptual model.[56]

The conceptual model further challenged World3's global view by dividing the world into four regions, not dissimilar to Peccei's regional differentiation in the 1965 speech: the Global North and three regions with significantly different development status in the Global South (Latin America and the Caribbean, Asia and Africa).[57] In each of those regions, the primary aim of economic activity was to satisfy basic needs for all, such as nutrition, housing, health and education. The LAWM sketched a future non-consumerist society, where production would be determined by social needs rather than profit. In such a society, irrational and wasteful consumption would be reduced, and thus the "limits to growth" would

---

52 Aurelio Peccei to Club of Rome Executive Committee members, 7 July 1972, Box 38, Folder 1574, Wilson Papers.

53 Amílcar O. Herrera to Aurelio Peccei, 4 August 1972, Box 55, Folder 1207, Wilson Papers. Quotes in Spanish: "Análisis crítico del modelo MIT," "desagregación del modelo MIT."

54 Club of Rome: Technical Symposium, Tokyo, Japan, 24–25 October 1973, Box 55, Folder 2109, Wilson Papers.

55 Amílcar O. Herrera, "Introduction and Basic Assumptions of the Model," in *Latin American World Model: Proceedings of the Second IIASA Symposium on Global Modelling*, ed. Gerhart Bruckmann (Laxenburg: IIASA, 1974), 3–8, here 5.

56 Herrera et al., *Catastrophe or New Society?*, 44–46.

57 Graciela Chichilnisky, "Latin American World Model: Theoretical Structure and Economic Sector," in *Latin American World Model: Proceedings of the Second IIASA Symposium on Global Modelling*, ed. G. Bruckmann (Laxenburg: IIASA, 1974), 115–133, here 124.

never be reached. The Bariloche group also envisioned each regional unit as nearly self-sufficient in education and housing but allowed for a degree of international trade in food, other commodities and capital goods.[58]

Yet despite rejecting the consumer society, the Bariloche group did not problematize environmental pollution as a potential side-effect of population growth and economic growth in the LAWM. Rather, it suggested that the basic-needs society without excessive growth could be assumed to be "intrinsically compatible with its environment."[59] More fundamentally, their model also rejected the notion of fixed physical limits for resources. Instead, it approached resource availability as a question of demand and technological exploitability, rather than pure availability of resource stocks.[60] The Bariloche group also saw technology generally as a liberating tool for humanity. In contrast to *Limits*, "the danger" was "not in the continuation of technological progress but rather in its social use."[61] Their model outlined different technological progress rates specific to the four regions. However, the modeled technological progress rates were lower than the ones the group observed in empirical historical data.[62]

With the corresponding mathematical model, the Bariloche team ran computer simulations on its own world model with the four regions as sub-models to evaluate under what conditions it would be feasible "to achieve the proper satisfaction of the basic needs."[63] Their simulations found that if the suggested policies were implemented in 1980, Latin America would be able to reach the stage of satisfactory basic needs in the early 1990s, Africa by 2010, and while the computer model initially did not see the goal as feasible in Asia due to population growth and increased cost of food production, the problem could be fixed by allowing food imports to Asia from in-principle self-sufficient regions, which enabled Asia to reach the basic-needs rate by 2020 – i.e., much the same sequence of development that Peccei had outlined in 1965.[64] In the future, as their calculations suggested, economic growth should persist but eventually slow down.

As expressed in the title of its report, *Catastrophe or New Society?,* the Bariloche group did not project a future "catastrophe" if current trends continued, but instead envisioned a "new society" that facilitated development. Based on their fundamentally different imaginary, the Bariloche group has been called

58 Herrera et al., *Catastrophe or New Society?*, 43.
59 Herrera et al., *Catastrophe or New Society?*, 24.
60 Oltmans, *On Growth* II, 37–43.
61 Herrera, "Introduction and Basic Assumptions of the Model," 5.
62 Herrera et al., *Catastrophe or New Society?*, 41–42.
63 Herrera et al., *Catastrophe or New Society?*, 42.
64 Herrera et al., *Catastrophe or New Society?*, 83–93.

the “anti-club of Rome.”[65] Yet the whole project of an alternative Latin American World Model was actively encouraged and supported by the CoR during, and even prior to, the *Limits to Growth* debate. The CoR and, particularly, Peccei were informed about the progress of the study and commented on early drafts.[66] In the end, though, the CoR did not publish the report in its name but left publication to the study’s main funder, IDRC.[67]

The publication of *Catastrophe or New Society?*, however, became overshadowed by the 1976 military coup in Argentina, which meant that the debate over the LAWM was far more muted than that over *Limits*. The coup brought major difficulties for the Fundación Bariloche, which had mainly relied on government funding, but could not expect the military government to continue supporting its research activities with 220 full-time employees. Mobilizing its international network, the Fundación’s leaders reached out to international organizations and supporters, among them Peccei, in the hope of securing further foreign funding.[68] Despite those difficulties, the core idea of LAWM, that “basic needs” had to be met, was adopted by several sub-organizations of the UN, such as the ILO, UNESCO, and CEPAL, while “basic needs” also found its way into the continued debate about the *Limits* study, as Dana Meadows and colleagues acknowledged.[69]

3 Beyond the limits to growth: The Club de Dakar, 1974–1980

While Latin Americans took the lead in developing a response to *Limits*, they were not its sole critics in the Third World. As we have seen, even before the publication of *Limits*, leading CoR members had acknowledged the need to address its implications for the Global South. An internal report for members from 1973 lamented that the study had serious limitations:

---

65 Pauli, *Crusader for the Future*, 79.
66 Aurelio Peccei to Carlos A. Mallmann, 10 January 1975, Box 55, Folder 2098, Wilson Papers.
67 The Fundación Bariloche had hoped to receive an official resolution or approval of the CoR, but following the CoR’s Berlin meeting in October 1974, Fundación representatives gained the impression that the CoR did not fully endorse its approach and declined to include an official commentary of the CoR leaders. See Jorge. A. Sabato to Carlos A. Mallmann, 11 December 1974, Box 55, Folder 2098, Wilson Papers.
68 Carlos A. Mallmann to Maurice Strong, 23 September 1976, Box 69, Folder 668. Maurice F. Strong Papers. Environmental Science and Public Policy Archives, Harvard College Library.
69 Jacques Havet, “UNESCO Secretariat,” in *Models, Planning and Basic Needs*, ed. Sam Cole and Henry Lucas (Oxford: Pergamon, 1979), xv–xvi. Here xv.; Meadows et al., *Groping in the Dark*, 46.

> One of the defects of the Limits to Growth model is that it can say little about the differences in the behaviors of various regions of the world because the model is essentially global. Gaps between developed and developing countries and even within the same country, however, are so wide that the existence of such gaps may be considered in itself one of the most serious worldwide problems.[70]

These gaps only widened further in the context of the first oil crisis, which broke out in late 1973. In February 1974, Peccei organized an informal meeting to discuss the "world *problématique*" and North-South issues in Salzburg, which brought together half a dozen CoR members with six heads of state. The latter, whom Peccei had personally approached, were deliberately chosen from smaller countries, such as Mexico and Senegal, plus representatives from Algeria and Pakistan.[71]

Conversations in Salzburg informed the CoR's largely overlooked follow-up report to *Limits.* CoR members Mihaljo Mesarovic and Eduard Pestel attended the meeting, having just completed a draft of a report entitled *Mankind at the Turning Point*, which was subsequently revised in light of proceedings at Salzburg.[72] Unlike the generalized predictions of *Limits*, this "Second Report to the Club of Rome" again used computer modeling, but did so to provide an aid for policymakers to evaluate their future strategies. The World Integrated Model, as it became known, reflected Pestel's and Mesarovic's concerns with the monolithic World3 model and the techno-pessimist arguments of *Limits.* Rather than treat the planet in its totality, *Mankind at the Turning Point* disaggregated the world into seven interdependent sub-regions, thus allowing growth in underdeveloped areas to be offset by no-growth in more developed areas. While still concerned with collapse, they did not argue against growth but introduced the concept of healthier "organic growth" within the bounds of the global system. Together, these features were designed to allay concerns about "zero growth" in the Third World. To avoid "world-shattering catastrophes," they argued, the gaps "at the heart of mankind's present crises: the gap between "North and South," rich and poor" needed to be bridged.[73] The revised *Mankind at the Turning Point* report was then presented at the CoR's general assembly in Berlin in October 1974, along with three other computer modeling studies that had been supported by the Club in the second phase of

---

70 Club of Rome: Technical Symposium, Tokyo, Japan, 24 – 25 October 1973, Box 55, Folder 2109, Wilson Papers.

71 Alexander King, "The Club of Rome: A Case Study of Institutional Innovation," *Interdisciplinary Science Reviews* 4, no.1 (1979): 54 – 64.

72 Eduard Pestel, "Modellers and Politicians," *Futures* 14, no.2 (1982): 122 – 128.

73 Mihajlo D. Mesarović and Eduard Pestel, *Mankind at the Turning Point: The Second Report to the Club of Rome* (New York: Dutton, 1974), ix.

its *Predicament of Mankind* project: North-South Economic Relationships and Industrial Transfer by a Japanese team, the World Food Model of Hans Linnemann, and the Latin American World Model.[74] More generally, the CoR made a pronounced effort to diversify participation at its Berlin meeting the following October by inviting more attendees from the Third World, including Africa.

Even before these overtures, African leaders had engaged with the implications of *Limits.* At a colloquium on Third World industrialization in Dakar in 1972, Senegal's president, Léopold Senghor, challenged the implications of the CoR's report. Reframing its essential *problématique*, Senghor argued that the issue was not growth itself, but rather "a certain *type* of growth, which generates waste and tensions." Those problems would not be resolved until the West recognizes that the Third World was "entitled to develop."[75] The conclusions *of Limits*, he told an interviewer, were a problem for the West. "Western man stuffs himself with fat and sugar: we have not yet reached that stage," Senghor said. "We need a minimum of growth."[76] Once again reflecting the interpersonal connections between the CoR and dissenters to its landmark, Senghor became drawn into Peccei's circles and attended the Salzburg meeting of heads of state.

Where, though, was this renewed growth to come from? Whereas other African states had sought to build socialist economies around principles of self-reliance after independence, Ivory Coast, like Senghor's Senegal, had welcomed foreign investment, especially from France. Its minister of planning, Mohamed Tiékoura Diawara, believed that Africa needed to cooperate with European industry, rather than challenge it, to facilitate the transfer of technological capital and restructure African economies around export-led growth. At the Dakar colloquium in 1972, he proposed that an international group of experts be drawn from the public and private sectors to reflect on these challenges.[77] Against the backdrop of a worsening global economic situation over the next two years, Diawara recruited members into his venture, with Senghor's blessing.

Launched in the Senegalese capital in December 1974, the Club de Dakar was clearly inspired in form and name by the CoR. Indeed, Diawara cited the impact of

---

74 Roberto Vacca, Some Operational Considerations Prompted by the Club of Rome Symposium Held in Berlin, 24 November 1974, Box 55, Folder 2112, Wilson Papers.

75 Léopold Sédar Senghor, "Statement by the President of the Republic of Senegal," in Republic of Senegal and CEDIMOM [European Centre for Overseas Industrial Progress and Development], *Colloque international sur le développement industriel africain, Dakar, 20–25 novembre 1972* (Dakar: Nouvelles Editions Africaines, 1973), 279–280.

76 Oltmans, *On Growth* II, 107.

77 Diawara, Mohamed T. "Étude des voies et moyens pratiques de l'industrialisation en Afrique," in *Colloque international*, 131–39.

the CoR on European public opinion as evidence for the importance of "kindling ideas capable of stimulating minds [*frapper les esprits*]."[78] Like the CoR, it was unabashedly elitist, assembling prominent politicians, businessmen, scientists, economists, and technocrats from mostly Western Europe and Western Africa. They touted the "club" model as a fresh form of internationalist thinking which could transcend the deadlocked, confrontational politics of the North-South debate that dominated the 1970s. There was significant overlap between the European membership of the two groups. Peccei himself was invited to become a member of the Club de Dakar (though his actual contribution appears to have been nominal). Members took their cue from the Fundación Bariloche, too. The Burkinabé historian Joseph Ki-Zerbo had attended the CoR general assembly in Berlin two months earlier. He told the audience in Dakar that he had been impressed by representatives of the Fundación, whose work he said aimed "to define a new type of social and civilizational development in Latin America."[79]

Yet Club de Dakar members were also keen to differentiate themselves from their Roman counterpart. The Club de Dakar's principal members emphasized their distinctive mission. "The Club de Dakar is not the African twin of the Club of Rome," stressed the French futurologist and dual club member Pierre Piganiol.[80] Rather than diagnose the causes of global inequalities and particularly underdevelopment in Africa, the Club de Dakar set out to develop solutions to address them. Following Diawara's own vision, members concentrated on how the expatriation of European capital investment to Africa would regenerate growth on both continents that had broken down amid the economic turmoil of the 1970s. Whereas *Limits* had rung alarm bells about global demographic growth, Diawara argued that the African continent's young population represented an untapped pool of labor which could be harnessed by capitalists from the developed world through investment in industries based in Africa. Over time, this would enable the transfer of technology and expertise to African economies, providing them with a stronger basis for export-led growth. This would alleviate racial tensions in Europe created, as Diawara saw it, by the influx of migrant workers from the former colonies.[81] This emphasis on externally financed industrialization sat

78 Siradiou Diallo, "Mohamed Diawara: l'imagination au service du développement," *Jeune Afrique*, 28 December 1974, 65.
79 Club de Dakar, Réunions constitutives: compte rendus des débats', Dakar, 2–3 December 1974, mimeograph, 86, 93.
80 Pierre Piganiol, "Le 'Club de Dakar' veut favoriser un développement harmonieux de la production africaine," *Le Figaro*, 14–15 December 1974.
81 This general argument can be found throughout press coverage of the Club de Dakar and its own publications. See for example Diallo, "Mohamed Diawara."

alongside a more general blueprint for global economic redistribution, which shared much ground with the principles of the New International Economic Order. Technology, in this sense, was conceived much more in terms of the transfer of industrial machinery for manufacturing, rather than computer-driven modeling.

Drawing on the distinctive trajectories of Senegal and Ivory Coast since independence, the Club de Dakar linked national development to an openness to foreign investment. The French economist Maurice Guernier, another dual Rome/Dakar member, had previously argued that the Third World must abandon its "outdated socialist anticapitalist complex," since industrial progress was impossible "without a massive appeal to foreign industries [...] for they alone have the necessary dynamism, technical expertise, and sense of organization."[82] In putting this logic into practice, the Club de Dakar explored mechanisms for channeling private industrial investment into Africa. ADELA represented a potential model. Guernier, who had himself been involved in ADELA, suggested that a similar institution "could constitute an interesting solution for African countries if it is shaped by African conditions."[83] The Club's general assembly in Luxembourg in 1977 meeting concluded that SIFIDA (the investment fund set up in 1970) represented a promising institution for achieving the goals of the Club de Dakar, which concluded that "[t]o refuse for ideology's sake investment in one country amounts to giv[ing] up a developmental potential which, impulsed by the search for profit, continually imagines new solutions for existing problems."[84]

The Club de Dakar also took up Peccei's original vision that technology could alleviate the world's problems so long as no region outraced the others in technological development – a vision set aside in *Limits*, which was oft-criticized for neglecting innovation's contribution to overcoming scarcity. Thus, although the Club de Dakar continued to argue the case for global economic redistribution, it also began to explore new avenues opened by technological developments in the North. In 1980, the Club stated that "[t]he new technological revolution, notably computing [*micro-information*] and biotechnology, opens to all the countries of the world the possibility of a new leap forward which can only be collective."[85]

82 Josué de Castro and Maurice Guernier, "Manifesto for the Third World," *CrossCurrents*, 18, no.1 (1968): 1–10, here 5.
83 Ernst H. Plesser, Activation of Financing for Industrial Development in Africa, report to the Club of Dakar Annual General Assembly, 27–29 November 1978, Libreville, PP MS 53/1/1, William Black-Campbell Papers, Special Collections of the School of Oriental and African Studies, London.
84 Ibid.
85 Club de Dakar, "Une coopération internationale pour sortir de la crise," (1980), PP MS 53/1/1, Black-Campbell Papers.

The Club's general assembly in Vienna in 1981 featured presentations on computing, biotechnology, and information systems, including from IBM. The Club de Dakar did not see the import of such new technologies as a panacea, however. Diawara stressed new technologies needed to be grounded and developed in the specific cultural contexts of Third World countries, to promote not just economic progress, but allowing peoples to develop their "cultural personalities." Following the Vienna meeting, the Club de Dakar identified collaborative research projects on biotechnology, data processing, and new systems of education in the Third World.[86]

The Club's leadership sensed that this engagement with technology offered it new purpose in the rapidly changing international business environment of the early 1980s. Diawara developed a close association with the international technological park at Sophia Antipolis in the Côte d'Azur, which hosted several Club de Dakar seminars that brought together European businesses and African clients. Sophia Antipolis had opened its doors in 1974 as "a utopian vision of a rural *Quartier Latin*, a City of Science of Wisdom" inspired by Silicon Valley.[87] Much like the Club de Dakar, it brought together networks drawn from academic research, industrial capital, and civil service policymakers, with a focus on high-technology activities. The Club also began planning a world fair of technologies for development – Technodev – which would facilitate dialogue between producers and users and provide developing states with a full choice of technological options, which, the Club argued, "in the modern world, is the first condition of any true autonomy." The inaugural Technodev was slated for Paris in 1986.[88]

However, as plans for Technodev were being drawn up, Diawara – the founder, president, and chief animator of the Club de Dakar – was sensationally arrested in 1984 for embezzling regional development funds in West Africa. In truth, the Club had been struggling for a role since the collapse of the North-South debate. But Diawara's conviction and the fifteen-year prison sentence he received from a Burkina Faso court prompted the Club's swift dissolution.[89]

At roughly the same time, the other initiatives surveyed here suffered from the effects of global economic transformation and were marginalized by right-

86 "The Club's work programme 1982," n.d., PP MS 53/1/1, Black-Campbell Papers.
87 Christian Longhi, "Networks, Collective Learning and Technology Development in Innovative High Technology Regions: The Case of Sophia-Antipolis," *Regional Studies* 33, no.4 (1999): 333–342, here 334.
88 "Technodev," 23 September 1983, enclosed in Guillon to Black-Campbell, 23 December 1983, PP MS 53/1/2, Black-Campbell Papers.
89 See Philippe Gaillard, "Les bons placements de Mohamed Diawara," in G*rands procès de l'Afrique contemporaine* (Paris: Jalivres, 1990), 113–137.

ward political turns. Having expanded rapidly with the founding of dozens of "Adelitas," when the post-1973 economy turned, ADELA suddenly found itself on the verge of bankruptcy. No new investments were made after 1980, although the company did not formally close until the 1990s. More dramatically, under the junta that came to power in Argentina in 1976, the Fundación Bariloche was reduced to just fifteen staff members, and its output closely monitored. Many of the LAWM team's members spent years in exile from the right-wing military regimes in Chile and Brazil, as well as Argentina. Although the Fundación Bariloche revived with the fall of the dictatorship in 1983, it did not regain its earlier prominence.

Similarly, the Club of Rome never again attained anything like the notoriety it enjoyed following the publication of *Limits* in 1972. Though Peccei individually remained prominent on the world scene, collectively the focus shifted from the central Club to various national Clubs of Rome, especially those in the US, Canada, the Netherlands, and Japan. Those, in turn, suffered from their countries' rightward political shift around 1980. The USA CoR was closely associated with the Global 2000 report commissioned by the Carter administration, which Ronald Reagan's campaign fiercely criticized. With Reagan's election, USA CoR gradually became moribund, and the other national Clubs declined as well. With Peccei's death in 1984, King attempted to formalize the central Club's operations. However, the transition from charismatic to bureaucratic authority faltered and the Club steadily dwindled.

Conclusions

As the wind came out of the sails of these overlapping organizations, the obscurity into which they meandered might explain the limited interest which historians have shown in them. But recovering their histories shows how, between the 1960s and 1980s, ideas and debates about the role of technology in facilitating development saw both notable continuities and fundamental transformations. The Club of Rome and MIT's landmark study *The Limits to Growth* implied that there had to be limits to economic and population growth in the developing world. But situating this report in a longer historical arc allows us to demonstrate how the ideas and initiatives of the Club of Rome and Aurelio Peccei were rooted in earlier development research and corporate ventures in Latin America in the 1960s. ADELA propagated foreign direct investment and technology transfers as a development model, which Peccei also addressed in his influential 1965 Buenos Aires speech about the impending challenges facing the world. In these early interventions, Peccei and his allies initially argued for economic growth and industrial development but then re-evaluated their arguments about growth in light of the resource scarcity and environmental debates of the 1970s, which were incorporated into the computer modeling of *Limits.*

Facing the critique of *Limits* from the Global South, the Club of Rome supported the critical re-evaluation presented by the Argentine Fundación Bariloche, which in 1976 produced an alternative, regionally nuanced, and explicitly normative computer modeling study that rejected resource limitations, was aimed at fulfilling basic needs, and envisioned the developing world to develop. The Eurafrican initiative of the Club de Dakar, while taking its cue from the Club of Rome, similarly questioned the notion of *Limits* and propagated foreign direct investment and technology-aided industrial development in a conscious echo of ADELA. Even though all of these organizations and their development imaginaries were sidelined in the course of the 1980s, they exemplified the links between technology, environment and development in the 1970s and important influences on the debates that emerged from this nexus. They demonstrate how the belief that technology transfers would (continue to) enable economic growth was challenged by the notion of "limits to growth," but also refined into alternative proposals of technology-aided development that rejected the notion of physical limitations for the developing world.

The interwoven histories mapped out here not only reveal the fundamental conflicts between industrial development priorities and considerations about environmental and planetary limits in the 1970s, but also the link to and persistence of the corporate development model propagated by Peccei, ADELA, and the Club de Dakar. In the end, technology assumed many roles, as technology transfers and innovation were praised for enabling industrial development, but also identified as a problem for creating an imbalance between humans and environment, as well as the developed and developing world. At the same time, the technology of computer modeling became a crucial tool for conceptualizing and simulating the future of growth and development, not only through the Club of Rome's famous *Limits to Growth*, but also through the lesser-known work of the Fundación Bariloche.

Part 2: **Producing and Challenging Expertise**

Veronika Eszik

From well to tap: social and technical water innovations in nineteenth-century Budapest

Introduction

After years of political paralysis,[1] the 1867 Settlement between Austria and the Hungarian Kingdom made it possible for the latter to create a new capital city: Budapest.[2] With the administrative unification in 1873 of three formerly independent settlements (Pest, Buda, and Óbuda), the Hungarian government sought to create a national capital, a Central European industrial hub, and a Habsburg royal city comparable to Vienna. The metropolis in the making was suddenly shaped by a myriad of human activities and concepts, and this transformation deeply affected the perception of the borders of the city in relation to its natural environment as well. To understand how these new concepts affected nature–culture relations and the urbanites' attitudes towards innovation, this article examines conflicts related to the developing water infrastructure.

Infrastructures are both technical and social innovations that change our relationship to nature and require substantial mental adaptation to the individual's growing dependence on central supply systems.[3] In this article, I argue that the

1 The research on which this article is based was funded by the project of the Hungarian National Research Development and Innovation Office: NKFIH FK 142451 "Budapest – egy várostérség környezettörténete" [Budapest – the environmental history of an urban region].

2 The Settlement or, as it has often been called in the earlier secondary literature, the Compromise was a treaty concluded between Emperor and King Franz Joseph and the Hungarian ruling elites. It constituted the legal foundation of a state formation that is difficult to define in terms of political science, Austria–Hungary. The two parts of the state were granted autonomous home rule with shared foreign and military affairs, as well as the financial background of these two fields (the so-called common affairs). The most inspiring assessment of the dualist system created by the Settlement is Pieter M. Judson, *The Habsburg Empire: A New History* (Cambridge and London: The Belknap Press of Harvard University Press, 2018). More specifically on the countries of the Hungarian Crown see: Gábor Gyáni, ed., *The Creation of the Austro-Hungarian Monarchy: A Hungarian Perspective*, (New York: Routledge, 2022).

3 András Sipos, "Bevezetés [Introduction]," *Urbs. Magyar várostörténeti évkönyv* 2, no.1 (2007): 9–11.

Veronika Eszik, Eötvös Loránd University, Budapest

https://doi.org/10.1515/9783111611358-006

numerous conflicts around the construction of a waterworks system in Budapest shed light first on a major shift in perceptions and management of nature and, second, on the difficulties of adapting to this shift. Technical innovations, which in this case included pipelines, taps, sanitary fittings, and water meters, symbolized urban modernity and victory over the unpredictable forces of nature. At the same time, the introduction of these innovations also multiplied the city's bonds to its natural waters and was a clear embodiment of the state's growing control over the individual. Infrastructures, after all, are at the core of urban societies in both cultural and material terms, so they form an excellent subject of research for the larger project of linking the history of ideas (ideas about progress and nature) with the history of technologies.[4]

Pipeline water seemed to be the most urgent modernization challenge for the new capital's decision makers, first because it formed an integral part of the comprehensive development plan conceived by the newly activated national government and, second, because the municipality had to face its first devastating catastrophe, cholera, in 1873, the very year of its official creation.[5] The last very serious wave of the epidemic had made it clear that the neighborhoods which had tap water (the right side of the Danube, or what had formerly been the independent settlement of Buda) suffered far less contamination than the neighborhoods that relied on wells. It seemed that the principles of the development plan addressed practical urgencies in the early days of the new Hungarian capital. The plan stipulated that, in addition to creating favorable conditions for economic activities

---

4 As explained in detail by Dieter Schott, who focuses mainly on path dependencies created by urban infrastructures and is interested in the rise of the "networked city." Dieter Schott, *Die Vernetzung der Stadt. Kommunale Energiepolitik, öffentlicher Nahverkehr und die "Produktion" der modernen Stadt, Darmstadt – Mannheim – Mainz 1880–1918* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1999). See also Martin V. Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000).
5 This development plan was created as an official memorandum for the government by the Ministry of Public Works and Transport at the end of 1869. The document formed the conceptual foundation of the urban works of the following decades. Following the urban planning conception of the so-called haussmannization, the document aimed to create a city which could rival the appeal of Vienna, offer a model of comfortable urban middle-class lifestyle, and be without rival in southeastern Europe (regarded as Hungary's principal sphere of influence). As such, the city of Budapest was intended to have influence as an attractive cultural and economic center and thus to offer some counterweight to the competing regionalisms that were characteristic of the multiethnic Hungarian Kingdom. András Sipos, "'Világváros' Nyugat és Kelet határán? Várospolitikai törekvések Budapest nemzetközi vonzerejének erősítésére, 1870–1918 ['Global city' at the Borders of West and East? Urban Policies to Increase the International Appeal of Budapest, 1870–1918]" in *A "világváros" Budapest két századfordulón* [Budapest the Metropolis at Two Turns of the Century], ed. Barta, Györgyi et al. (Budapest: Napvilág Kiadó, 2010), 309–310.

(mainly by securing railway connections and providing flood protection for the industrial areas), the city's most important challenge was to create a "metropolis-like milieu" and a level of grandeur. The latter goal, however, was not narrowly understood as a matter of elegant or imposing architecture. On the contrary, the document stated that the envisioned grandeur stemmed "first and foremost [from] the city as a place of healthy living."[6]

It therefore seemed a pressing duty to build proper water infrastructure in Budapest in order to provide clean drinking water for every household. Once the decision was made, the capital city needed two decades for the completion of the so-called left-bank waterworks, which finally provided enough clean water for the growing city. This prolonged procedure was criticized as belated, but it offered an opportunity to learn lessons from cities that already had functioning water networks. More than any other city, Vienna provided a both desired and criticized model for Budapest. Vienna's experts had developed a water supply system in the early 1870s, a system that Carl E. Schorske described as "superb" and qualified as an extraordinary achievement of Vienna's liberal municipality.[7] However, as Gerhard Meißl, for instance, has shown, the Viennese system was characterized by significant spatial and social inequalities and permanent pressure to increase the scope of the service.[8] Budapest had an opportunity to design a system that *a priori* anticipated a demographic boom and the spatial extension of the city. Because these factors were taken into consideration, the plans created less tension between neighborhoods and social strata in general.

This being said, during the lengthy process of waterworks construction in Budapest, a prolonged lawsuit, press campaigns, a duel between two members of parliament, and the abdication of two waterworks' directors under pressure from the public indicated the seriousness and complexity of the difficulties of introducing new technologies and *modi vivendi.* First, as a prelude to this infrastructural innovation, there was a need for a change in theoretical approach and legal framework, specifically, the emergence of the notion of the public good, as opposed to private interest and state property. This notion and the codification of

6 Sipos, "'Világváros' Nyugat és Kelet határán? ['Global city' at the Borders of West and East?]," 309–310.

7 Carl E. Schorske, *Fin-de-siècle Vienna: Politics and Culture* (New York: Knopf, 1985), 60.

8 Gerhard Meißl, "Hochquellenleitungen und Unratsschiffe: Zur Geschichte der Wiener Wasserver- und -entsorgung vor 1914," in *Umwelt-Geschichte. Arbeitsfelder – Forschungsansätze – Perspektiven*, ed. Sylvia Hahn and Reinhold Reith (Munich: R. Oldenbourg Verlag, 2001); Gerhard Meißl, "Netzwerke oder Hierarchien? Zur Entstehung metropolitaner Produktionsräume im Spannungsfeld von historischer Einbettung und ökonomischer Rationalität am Beispiel Wiens im 19. und frühen 20. Jahrhundert," *Jahrbuch für Geschichte der Stadt Wien* 59, no.1 (2003): 197–217.

the term “public water” on a national level provided the theoretical and legal context of the shifts in urban water management. Second, an important consequence of the construction of the left-bank waterworks was the emergence of the need to measure water consumption. As it became possible to measure the water running from the taps, the leaders and the inhabitants of Budapest found themselves faced with important questions. Who, for instance, is responsible for the use of public goods? What are the appropriate uses, and what are the abuses of these goods? What are the individual, municipal, and national responsibilities related to water consumption? Who has the right or power to control the consumption of a public resource by others, and to what extent and by what means? How should the price of this public resource be set to motivate consumers to avoid waste without prompting them to return to using wells? The answers to these questions and others were shaped through intense negotiations between experts, policymakers, and urbanites, whose arguments tell volumes about clashes between teleologies of progress and, at times, unwanted modernities. In this chapter, I trace the path of these negotiations from the birth of the public water discourse through the controversies provoked by this technical and social innovation to the general acceptance of the new infrastructure as a “civilizing” achievement.

Prelude—a duel over public water

Both the shift in legal thinking (i. e. the acceptance of the category of public good) and the questions related to responsibilities brought about conflicts, even scandals. The first scandal broke out when it turned out that the ideal plot for the waterworks construction happened to be a parcel owned by a certain Count Sándor Károlyi (1831–1906), an agrarian politician and a man known as the father of the cooperatives’ movement in Hungary.[9] Count Károlyi immediately gave his parcel

9 For a recent biography see: György Fehér, *A származás kötelez: gróf Károlyi Sándor, 1831–1906* [Origins Oblige: Count Sándor Károlyi 1831–1906] (Budapest: Gondolat Kiadó, 2019). The so-called agrarians and the cooperative movement shared a critical vision of capitalism. “Agrarian” in its first sense referred to all kinds of organized advocacy of agricultural interests. Károlyi’s movement took shape as a modern conservative political party in the 1880s and 1890s. This party attempted to encourage mass mobilization, the introduction of protective tariffs in Austria–Hungary, and increased state subsidies for agriculture. András Vári, “Vízszabályozások, tulajdonjogok és gazdálkodás Magyarországon az 1820-as és az 1870-es évek vége között [Water Regulations, Property Rights, and Agricultural Systems in Hungary Between the 1820ies and the End of the 1870s],” in *A felhalmozás míve: történeti tanulmányok Kövér György tiszteletére* [The Work of Accumulation: Historical Studies in Honor of György Kövér], ed. Károly Halmos et al. (Budapest: Századvég Kiadó, 2009), 313–323.

to the municipality when asked (early 1893), as he did not want to hinder the undertaking, but he and the municipality of Budapest had very different ideas (to say the least) concerning the amount he was to be paid in compensation, as shown in the table below.[10]

Table 1: Compensation sums according to the parties concerned.

The sum offered by the municipality of Budapest:	140,000 Ft
The second and final offer made by the city:	800,000 Ft
The sum demanded by Count Károlyi:	2,172,118 Ft
The compensation ordered by the Supreme Court:	674,610 Ft (+ 5% interest from 1893)

The significant difference in the appraisals of the plot's value and a quick glance at the contemporary press, which contained numerous newspaper articles accusing Károlyi of being a hypocrite, show that the issue was bigger than a simple conflict over an expropriation. One of the Count's co-deputies even provoked a duel in the Hungarian parliament when he interrupted a speech Károlyi was holding about the vices of economic liberalism. The assaulter claimed that the count should not speak about social injustice while he was neglecting his patriotic duties and forcing the municipality to pay an astronomical sum in compensation for the parcel he had lost (and after he had even been given and had accepted a decoration of thanks by the capital).[11] The public pressure on Károlyi was so weighty that the Count explained his position in several open letters, and in the end, he spent the money he had been given as compensation in deliberately noticeable ways on charity purposes.[12] The question arises: why did the public feel that Károlyi

10 Sources: *Budapesti Napló* [Budapest Journal] April 29, 1898, 7, and *Hazánk* [Our Homeland], October 20, 1899. 6. Concerning the lawsuit, we must rely on press accounts, as the trial went to the Supreme Court, the documents of which were destroyed in a fire during the 1956 Revolution in Budapest.

11 According to the parliamentary minutes (also published in the press), Sándor Károlyi was criticizing liberalism for its profit-maximizing character when deputy Ödön Gajári shouted his defamatory words. Károlyi was incredulous, but Gajári simply repeated the insult. *Pesti Hírlap* [Pest Newspaper] July 27, 1897, 3. The duel didn't result in serious injuries. The 72-year-old count regarded the insult as avenged. Among the personal papers of Sándor Károlyi, eight letters congratulating him on the successful duel can be found. MNL OL P 389 3. Central Archives of the Hungarian National Archives, Personal files of Count Sándor Károlyi.

12 "Az ujpesti liberalizmus. Károlyi Sándor gróf nyilatkozata [Liberalism in Újpest. Declaration of Count Sándor Károlyi]," *Budapesti Hírlap* (Budapest Newspaper), August 3, 1897, 4–5. He did not manage, through these efforts, to convince the public of his good intentions, as evidenced by should have given his narrow, 3.5-kilometer-long parcel to the city for no or only minimal, symbolic compensation? [13]

The answer, I would argue, lies precisely in the abovementioned shift in legal thinking with the emergence of the notion of the public good and public water as part of this public good. In the decades preceding the outbreak of the conflict, the Hungarian Kingdom carried out the biggest water regulation undertaking in Europe, mainly river channelings and drainage works. Related to these undertakings, the state enacted a new law about water rights (Act XXIII/1885), which was based largely on earlier water laws in other European countries, such as France and Austria. The preparatory phase of the legislation process was led by a committee consisting of the most notable Hungarian engineers of the era, a couple of authoritative associations (such as the Tisza River Regulation Company, the Chamber of Trade and Industry of Budapest, and the Association of Engineers and Architects), and policymakers.[14] The committee met 33 times between December 14, 1882 and May 16, 1883, and the most vivid discussion concerned its very first agenda item, as a decision had to be made about whether a private or public water system should be developed. Based on a decades-long history of water engineering studies and on the theoretical backgrounds of various water legislation regimes in other countries, the committee unanimously opted for a public water system, in which all water (except for rainwater) was regarded as a public good.[15] Water is a gift of nature, the committee argued, so it should be available to everyone for use, regardless of the dimensions of the given body of water and whether it is navigable or not. The decision referred to previous legislative discussions concerning water in Europe during which the idea had already taken form according to which water

---

the jokes printed about his alleged hypocrisy in the satirical press. E. g. *Borsszem Jankó* [Jack the Bean], November 19, 1899, 9.

13 The exact spot was chosen by water engineer János Wein, who had done promising exploratory drilling on the territory. In addition to the three test wells, which provided good quality groundwater, the area on the bank of the Danube River also contained three large gravel basins suitable for natural filtering, which was, according to Wein, the preferable technical solution for water purification. Despite the professional opinion of William Lindley, the renowned designer of the water and sewerage systems of Hamburg, who was invited to comment on Budapest's dilemmas and who preferred artificial filtration, the municipality opted for Wein's version. Budapest's drinking water has been naturally filtered through the gravel beds of the Danube River up to the present day. György Hajdu, "A főváros vízellátása [Water Supply of the Capital]," *Hidrológiai Közlöny* 53, no.7 (1973): 297–305, 298.

14 Irma Dobos, "Megemlékezés. A 100 éves vízjogi törvény [Commemoration: The Water Law is One-Hundred-Years Old]," *Hidrológiai Tájékoztató* 25, no.1 (1985): 8.

15 As opposed to both private and state property. *Pesti Napló* [Pest Journal], January 3, 1883, 7.

should be treated as a public resource, as this was essential (according to this theory) to a productive national economy.[16]

This developing discourse on water as a public resource had far-reaching consequences for perceptions of natural resources and property in general. Water regulations constituted both the context and the main catalyst for the transformation in property regimes and thus facilitated the emergence of new theoretical and legal relationships to the environment.[17] Although the notion of the public good referred originally to an economic consideration (namely, to the fact that private property is not necessarily the optimal legal framework for the use of natural resources), it placed the state in the role of the assigned manager of the natural environment, and this assigned manager then had to act in the service of the common good, as this was understood in the discourse widely disseminated by the press. [18]

The massive difference between Sándor Károlyi's evaluation of his parcel of land and that of the city originates in two different visions of property. The conflict of interests was rather a clash of two different property regimes. Károlyi acted like a traditional landowner, meticulously assessing the value of old feudal benefits, such as riverbed usage rights, fishing, milling, and mooring rights, etc., and then adding them to the amount he was to be paid in compensation. The municipality and the capital's public, in contrast, saw the parcel as a place where a natural resource, namely water was found which belonged to the public. Károlyi's behavior seemed hypocritical rather than simply outdated because he had been the president and energetic leader of the water law preparation committee and, therefore, a spokesman of the evolving discourse around public waters. This discourse made its way to the public, which increasingly regarded natural resources such as water as belonging to everyone (instead of belonging to individuals or the kingdom) and thus increasingly expected the state to fulfill a manager's role in the treatment of these resources.[19] When the citizenry of Budapest needed clean

16 As explained for example in the Austrian case by Corentin Gruffat, "The Beautiful Public Danube: Water Uses, Water Rights, and the Habsburg Imperial State in the Mid-Nineteenth Century," *Austrian History Yearbook* 54 (2023): 136–158. An interesting exception among the converging European regulations is the Italian water law, which, partly due to the *Risorgimento*'s already complicated legislative harmonization, maintained certain forms of private water property. Valenti, Salvatore, *Water in the Making of a Socio-Natural Landscape: Rome and Its Surroundings, 1870–1922* (New York–London: Routledge, 2023).

17 Vári, "Vízszabályozások, tulajdonjogok és gazdálkodás [Water Regulations, Property Rights, and Agricultural Systems]," 323.

18 Gruffat, "The Beautiful Public Danube," 150.

19 Károly Mike et al., "Víz, ami összeköt. A történetírás és a közgazdaságtan együttműködésének lehetőségeiről [Water that Connects: About the Possible Cooperation between History and Ecodrinking water, it hardly seemed appropriate for a prominent figure like Károlyi to behave like a landlord, and this shift in attitudes was due precisely to the mental shift shaped by the national water regulations and legislation promoted by Károlyi himself. In his person, a banal conflict between private and public interests became a conflict in roles, and this conflict was itself a consequence of a fundamental change in the ways in which nature and natural resources were perceived.

The struggle for the public's trust

These legal conflicts notwithstanding, the construction of the left-bank waterworks began in 1893. Mihály Kajlinger, a mechanical engineer and the main designer of the project (whose father happened to be an accountant on Sándor Károlyi's estates), faced various challenges.[20] Kajlinger was a passionate innovator, who fully internalized the nascent expert culture, and he fiercely argued in favor of rational, planned, and statistically justified measures in his field of expertise. His argumentation and measures were more than once questioned by decision-makers and the public, as he recounted in a both proud and bitter tone in his essay about the early history of public water in Budapest.[21]

As noted above, Budapest's water supply system leans on natural filtering carried out on gravel beds that lie on the banks of the Danube River. This technical solution was implemented in spite of the opposing recommendations by the invited scientific authority, William Lindley, and it was questioned by many.[22] Interestingly enough, the first major challenge that Kajlinger had to face occurred in relation to *artificial* filtering, which was used as a temporary means until the com-

nomics]," in *Víz és társadalom Magyarországon a középkortól a XX. század végéig* [Water and Society in Hungary from the Middle Ages to the End of the 20th Century], ed. Krisztián Gergely Horváth (Budapest: Balassi Kiadó, 2004), 13–36.

20 Kajlinger's life and work are summed up in a praiseful necrology: "Kajlinger Mihály," *Magyar Mérnök- és Építész-Egylet Közlönye* 58, no.17–20. (1924): 61. In addition to serving as the designer of the left-bank waterworks, he was also head of the Hungarian Association of Engineers and Architects (1909–1912, 1916–1919), and with a short interruption he served as director of the Budapest Waterworks between 1896 and 1923.

21 Mihály Kajlinger, "Budapest vízellátása az 1897–1900. évek alatt I [The Water Supply in Budapest in the Years 1897–1900 I]," *Magyar Mérnök- és Építész-Egylet Közlönye* 36, no.1 (1902): 33–49; Mihály Kajlinger, "Budapest vízellátása az 1897–1900. évek alatt II [The Water Supply in Budapest in the Years 1897–1900 II]", *Magyar Mérnök- és Építész-Egylet Közlönye* 36, no.2 (1902): 61–77.

22 See note 13.

pletion of the left-bank waterworks, which Kajlinger himself regarded as an acceptable stopgap measure.[23] However, the capacity of the artificial filtering system was insufficient, and every now and then, the drinking water had to be diluted with unfiltered water taken from the river. More and more complaints were made concerning insufficient quantities of drinking water and the poor quality of the available water, which at times seemed muddy or rusty on both sides of the river.

Considering that Budapest was one of the most rapidly growing cities in Europe at the time, the fact that there were supply problems should not have been a surprise.[24] Indeed, what perhaps is surprising is the extent to which the reactions of the city's inhabitants to these problems were intense, sometimes even hysterical. According to one anecdote, during a city council meeting, an enraged council member gave Kajlinger a bottle of watery mud and tried to make him drink it, claiming that ever since the new infrastructure had been under construction, the quality of the available water had been intolerably poor. When Kajlinger tried to defend his work and his colleagues' efforts, his adversary told him that he must have been drinking beer if he dared make the patently false claim that the water was drinkable.[25]

The man making the complaint clearly blamed technology for the poor quality of the water. He claimed that now the water was being brought into people's homes through pipelines that no normal citizen could examine. Before, he insisted, anyone could follow the path of the water from well to kitchen table, and the water supply had been more reliable. His lack of confidence in the new technology was not an isolated case. In 1897, another conflict broke out in the course of which similar arguments were made. That summer, Budapest had to face a rather serious wave of typhoid fever, and unfortunately, the intense spread of the epidemic overlapped with the installation of new artificial filtering basins. The coin-

23 Kajlinger, "Budapest vízellátása az 1897–1900. évek alatt II [The Water Supply in Budapest in the Years 1897–1900 II]," 61.

24 Budapest had roughly 300,000 inhabitants in 1870 and almost a million in 1913. Károly Vörös, "A világváros útján: 1873–1918 [Becoming Metropolis 1873–1918]," *Budapesti Negyed* 6, no.2–3. (1998): 106–172, 106.

25 István Horváth, "Erre beszéljen Kajlinger uram! A főváros vízellátása a századfordulón [Let's Talk about this, Mister Kajlinger! Water Supply of the Capital at the Turn of the Century]," *A Magyar Hidrológiai Társaság XXIX. Országos Vándorgyűlése* 29, no.1 (2011): 1083–1089, 1087. The indignant council member's words are in fact an example of untranslatable word play, as he cited a Hungarian saying referring to hypocrisy, "He preaches water while drinking wine," in a distorted form. The man claimed that Kajlinger was preaching water while drinking beer, and beer was considered a less noble (and not a biblical) drink than water. This thus added to his satirical tone.

cidence provided fertile soil for speculation about the filtering system as the root cause of the problem. The public's concerns rapidly escalated to panic when the city's Chief Medical Officer, Adolf Schermann, also agreed that pipeline water might be responsible for the spread of the disease and ordered a two-day stop in the water supply (which, on hot summer days, obviously only aggravated the situation). Alongside Schermann and the broader public, the City Council also was not free of superstitious fears, and it ordered a thorough examination of the water system. Furthermore, it entrusted a newly established committee with the task, which consisted of renowned foreign experts, like Otto Lueger, a technical college professor from Stuttgart. Lueger assured the Council that the pipeline water had been of better quality at each sampling point than the water from the wells, and he also expressed his deepest conviction that "the actual directorate of the Budapest Waterworks proceeds according to appropriate principles. Each of its measures is profoundly meditated, its newest constructions are essentially carried out in a flawless and elegant manner." The professor showed collegial solidarity with his expert confrères and insisted that in questions concerning the city's water supply, "Budapest can rely on the directorate with complete confidence."[26]

As director of the Budapest Waterworks, Kajlinger found himself in the middle of a crisis of confidence and controversies between experts and the public, which was, furthermore, something inconceivable for him. His statistics clearly showed that there was no relationship between the filtering methods and the spread of the epidemics, and Kajlinger expressed his irate astonishment over the fact that people were not convinced straightaway by data. On the contrary, as he wrote, "Dread invades the citizens, they withdraw their confidence from the waterworks to such an extent that even the construction of the left-bank waterworks, which were considered so urgent, has been suspended, [the public] demands investigations and relies on the opinions of foreign experts."[27] Kajlinger perceived the episode both as a personal affront and a general crisis of rational thinking. He was shaken to see that facts and scientific results can be overridden by fear, and he arrived at the embittered conclusion that "this is what awaits every technician who builds and manages water infrastructure these days."[28]

26 His letter is cited in Lipót Vedres, "Kájlinger Mihály élete és szerepe Budapest ivóvízellátásában [Life and Work of Mihály Kájlinger in the Water Supply of Budapest]," *Hidrológiai Közlöny* 46, no.12 (1966): 574 – 579, 576.

27 Kajlinger "Budapest vízellátása az 1897– 1900. évek alatt II [The Water Supply in Budapest in the Years 1897– 1900 II]," 61.

28 Kajlinger "Budapest vízellátása az 1897– 1900. évek alatt II [The Water Supply in Budapest in the Years 1897– 1900 II]," 61.

The insightful use of rumor theory by historian Irina Marin in her research on peasant protests in Romania in 1907 offers a useful tool in a discussion of the fears of the citizenry of Budapest and the fake news they spread about dangers of the pipeline water as a cause of typhus and the alleged betrayal they had suffered at the hands of the authorities, who had been perfectly willing to let them drink contaminated water. Marin shows that even if rumors or misunderstood realities seem completely irrational, they shed light on a strategy to use pieces of information to serve the interests of the peasants, or in this case, the interests of the citizens of Budapest. These mythologies, Marin argues, facilitated coping and control in situations of extreme vulnerability.[29] The Budapest urbanites, who had lost control over their autonomous ways of accessing drinking water, had suffered what to them was a similar trauma, and they saw the (to them) invisible supply system as a source of danger. Their desire to go back to the use of wells seems nostalgic and reveals that modernities were sometimes unwanted, or at least they forced people to accept a certain loss of personal control over their lives.

Kajlinger, his colleagues, and the investigating committee cleared the Budapest Waterworks' name relatively quickly, but another, eerily similar conflict broke out in 1902. This time, the concerns had nothing to do with an epidemic, but the expertise of the engineers was again contested by the public and several prominent politicians, much as had happened in 1897. During the hot summer days of 1902, water consumption suddenly increased manyfold. The abrupt growth of pressure in the tubes dislodged the debris that had formed in the pipelines, resulting in a sudden and spectacular deterioration of water quality. Kajlinger and the directorate of the Budapest Waterworks decided to lower the water pressure, while the City Council insisted on the necessity of increasing water pressure to clean the tubes. During a tumultuous session of the City Council, various politicians and even the mayor accused Kajlinger of being incompetent and of refusing to take responsibility for the calamity. The debate went so far that Kajlinger, who "felt like a hunted animal," tendered his resignation, which was in turn refused. In the end, the Council gave Kajlinger a chance to prove his point while still hanging on to some doubts. Kajlinger was given two days to address the problem by lowering the water pressure, with the stipulation that after the deadline had passed, the opposite solution would be used.[30]

29 Irina Marin, *Peasant Violence and Antisemitism in Early Twentieth-Century Eastern Europe* (London: Palgrave Macmillan, 2018).

30 "Az állandó vizvezetéki bizottság 1902. évi junius 9-én tartott ülésének jegyzőkönyve [Minutes of the Permanent Water Supply Committee's Session on 9 June 1902]," *Fővárosi Közlöny* 13, no.47 (1902): 777. It is worth emphasizing that no scientific argument was presented in support of the

On this occasion, Kajlinger openly expressed his view that the public needed to be educated about the appropriate uses of infrastructural technologies and resources. He claimed that the citizens should have reported the problems they were experiencing directly to the waterworks, much as they would call the fire brigade, and not the press, if their houses were on fire. He angrily noted that he had warned the public many times that turning to the press wouldn't solve their problems, and the press should not overestimate its role when discussing questions that required expertise.[31] In an offended tone, Kajlinger insisted that living with new infrastructural resources was indeed a learning process, and this process had to be carried out under the scrutiny of a turbulent public sphere. He also referred implicitly to a hierarchy when it came to resource management and to the relationship with the forces of nature. In this hierarchy, the Budapest Waterworks' professionals should lead the way.

These conflicts shed light on a period when experts, especially engineers, became the central figures of nature–non-nature relations. Society saw these experts as agents whose task was to tame and control nature through technology and human labor. However, precisely because these experts were the embodiment of this modernizing fever, they easily became scapegoats or targets of hostility. As James C. Scott argues in his seminal *Seeing Like a State*, in the eyes of the public, experts often embodied the perceived arrogance of modernizing campaigns, and at times, this perception of the expert as an unacceptably haughty figure even contributed to the failure of ambitious nature transformation projects.[32] Recent historiography has finetuned this consistently negative portrait by emphasizing the social embeddedness of experts and their role in making the borders between nature and civilization permeable and blurred.[33] In the case of the construction of Budapest's water infrastructure, one encounters this at times ambivalent perception of the roles of experts. Kajlinger had a long career as a decision maker. He was decorated by different government institutions and by King

---

opposite procedure (flushing the tubes with high quantities of water at high pressure). This idea was based merely on an appeal to "common sense," as was noted more than once during the session.

31 "Az állandó vizvezetéki bizottság 1902. évi junius 9-én tartott ülésének jegyzőkönyve [Minutes of the Permanent Water Supply Committee's Session on 9 June 1902]," 778.

32 James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed,* Veritas paperback edition, Yale Agrarian Studies (New Haven: Yale University Press, 2020).

33 For a summary of this historiography see: Gatejel, Luminita, *Engineering the Lower Danube: Technology and International Cooperation in an Imperial Borderland.* (Budapest: Central European University Press, 2022), 16.

Franz Joseph himself.[34] Yet at the same time, more than once, he was put under investigation and even assaulted.

As far as the citizens' ability and willingness to adapt to the new supply system is concerned, several cases of crises of confidence indicated that the previous, autonomous ways of attaining water represented a lower level of vulnerability to a central supply system, even if the quality of well water was less reliable and the water sold from the Danube River was unreasonably expensive and also unreliable.[35] Technical innovation was not accepted as good *per se,* but was rather the subject of criticism and doubt. Moreover, uncertainties about the beneficial nature of the technology were amplified by another source of hostility: aversion to (state) control.

Ways of measuring water consumption—and resistance to them

The control of water consumption was a central legal and practical question concerning the nascent infrastructure. In legal terms, the problem refers back to the newly formed notion of the public good. If the natural resource belonged to everyone, who had the right to control its uses and abuses? On a practical level, the Budapest Waterworks wished to set prices that would discourage consumers from wasting water while still being fair to every customer.

In nineteenth-century Budapest, water consumption of a given household was not measured by a water meter. The water bills were determined by a calculation based on the characteristics of a given consumption site (such as the size of the property, the number of water-consuming facilities, whether the household had a garden or a greenhouse, whether it included horses or other animals, etc.). Kajlinger was genuinely unsatisfied with this system, as flat rates left people more likely to waste water and, therefore, money and resulted in neglected pipes and sanitary fittings. He did research, collecting data from all over Europe on water

34 He received the Officer's Cross of the Imperial Order of Franz Joseph and later was appointed to Court Councilor for designing the water supply system of a newly constructed neighborhood in Budapest, the so-called Wekerle estate (Wekerletelep). "Kajlinger Mihály," *Magyar Mérnök- és Építész-Egylet Közlönye* 58, no.17–20 (1924): 61.

35 Dunavizes [Danube-water seller], *Vasárnapi Ujság* [Sunday Paper], January 29, 1865, 52–53. Water from the Danube River was used for purposes other than drinking, such as washing or irrigation. Its price generally grew when purchased farther from the river or on an upper floor. Water from the river was brought to people's households by different means, most often by water carts.

consumption in cities in which citizens paid flat rates (like in Budapest) and in others where water was meticulously measured by water meters. The results were striking from two perspectives. First, Budapest was among the most wasteful European cities, with an average daily water consumption of 206 liters per capita (as opposed to, for instance, Berlin, where this figure was only 77.8 liters per day per person). Second, there was no connection between the volume of water consumption and overall health conditions or mortality rates.[36] The meticulous examination of water use in the two cities led Kajlinger to the conclusion that the almost threefold difference between the two cities was due almost entirely to leaking pipes and sanitary facilities, or in other words, waste.

As in principle the controllers of the Budapest Waterworks went around the entire city over and over again to check the facilities, reporting leaks and levying fines on the consumers for having neglected their estates, the following conclusion was natural: the controlling system was not effective enough, and the Waterworks should have made it more rigorous.[37] Except that, according to Kajlinger, this intensification of control would have been impossible for decidedly psychological reasons. “Human nature,” he warned, “does not endure permanent oversight and the consequence [of this kind of oversight], the constant threat of reprisal.” He also noted that the Budapest Waterworks had difficulty finding an adequate labor force to fill the controller positions, given that “this activity is one of the most obstructed and thankless jobs ever.”[38]

In Kajlinger’s eyes, the only logical solution was the introduction of water meters. The City Council turned again to foreign authorities. The water meter committee of fifteen experts agreed with Kajlinger on the necessity of introducing water meters. Interestingly, the City Council refused to proceed accordingly based on a

36 Kajlinger, “Budapest vízellátása az 1897–1900. évek alatt I [The Water Supply in Budapest in the Years 1897–1900 I],” 35.

37 However, the Budapest City Archives contains hundreds of pleas to exempt consumers from paying these fines, these are also published in the Minutes of the of the City Council of Budapest 1873–1949, accessed 21 June, 2025, https://library.hungaricana.hu/hu/collection/mltk_bfl_bpszkj/.

38 Kajlinger, “Budapest vízellátása az 1897–1900. évek alatt I. [The Water Supply in Budapest in the Years 1897–1900 I.],” 33; The problem was discussed in City Council sessions as well, where the town councilors suggested that a pay rise could contribute to the solution. We can refer here to the incident concerning water quality. The same intruder who wanted to make Kajlinger drink muddy water expressed his indignation about the urban presence of the Waterworks’ controllers. He was infuriated by the fact that Kajlinger had “eight controllers a day coming and going, examining the water everywhere and finding it everywhere good.” He was frustrated mostly by the automatic acceptance of their accounts. Vedres, “Kájlinger Mihály élete és szerepe [Life and Work of Mihály Kájlinger],” 576. This episode sheds light on how citizens’ lived experiences were ignored or pushed into the background when they contradicted findings of the experts.

similar argument that Kajlinger had used in relation to the Waterworks' controllers. Although they agreed that in principle those who consume more should pay more, the councilors claimed that in practice, the abolition of "free water use" of citizens would engender strong reactions or even complete resistance, and the measure would "make the citizens nervous more than necessary."[39]

Resistance was also palpable among the town councilors. In November 1897, only one of them voted in favor of the committee's proposal, while another, Miksa Kurfürst, was indignant even at the debate. He did not see the sense of negotiating a "stillborn" motion and proposed introducing "word counting meters instead of water meters" to avoid superfluous talk about the issue. The only benefit, he claimed, of the long discussion was that, hopefully, the capital would be "left alone for a while" with the question. Other councilors, if less fervently, argued that water meters were not reliable, as the various meters in use, which were mechanically not the same, had given different readings during the testing period. These councilors did not reject the idea of measuring individual consumption completely, but they authoritatively claimed that the appropriate technical solution was not yet available.[40] They also mentioned psychological concerns. One of them, a man named Gyula Steiger, asked his confrères if they "should really regard the citizens as enemies and commit such cruelties against them." Steiger emphasized that the actual situation was, if not ideal, at least tolerable, and it would be a mistake to fiddle with it by forcing poor people to think about water consumption when drinking or showering. Steiger's final argument, which met with loud applause from fellow councilors, was that "the people cannot be deprived of the most essential [natural] element." Limiting water consumption, he insisted, could not be justified, neither by social nor by public health-related arguments, and he went so far as to claim that "he personally would rather not use pipeline water and reopen his well than expose himself to such bullying."[41]

Thus, the first attempt to introduce water meters in Budapest failed, as did many others later. Kajlinger resigned from his position as director of the Water-

39 "A fővárosi vízvezeték [The Waterworks of the Capital]," *Gazdasági Mérnök* 11, no.28. (1887): 111. The decision was made not only in spite of the experts' standpoint but also despite the explicit demand of the incumbent interior minister.

40 "Nem lesz vizmérő óra [There won't be Water Meters]," *Pesti Hírlap* [Pest Newspaper], November 12, 1897, 5.

41 "Nem lesz vizmérő óra [There won't be Water Meters]," 6. The engineers were represented in this debate not by Kajlinger but, this time, by Dezső Nagy, a professor at the Technical University of Budapest. He was barely capable of pronouncing a couple of words partly due to his astonishment and partly because the councilors howled him down. He made a short allusion to civilizational hierarchies when he exclaimed, "But all of Europe is backing us [the experts' committee] up! Where are we, are we in Asia?"

works following one of these attempts for a short time in 1909, and he succeeded in implementing the mandatory use of water meters only in 1921, after a history of restrictions during World War I and under a completely different political regime, which no longer considered political and economic liberalism its unquestioned foundation.[42] The fact that it took so long for these measures to be taken clearly shows that attitudes towards water use did not change overnight. Much as it had taken a considerable amount of time for the population to accept that wells, over which people had some control, were being replaced by a central water supply system engineered and managed by the state, the process of defining responsibilities for the use of public goods was also lengthy. These responsibilities were expressed in numbers at a time when quantifying everything, including the daily, weekly, or monthly use of clean water, was once again a bureaucratic practice of a controlling and centralizing state that was perceived with hostility by many. The City Council meeting makes clear that the introduction of water meters was regarded as an attack on freedom that even some politicians found intolerable. This particular freedom was the right to use natural resources quasi without constraint. People's hesitancy to surrender this freedom indicates a partial refusal on their part of the state's role as the assigned manager of these resources. However, their willingness, eventually, to comply indicates the influence of the increasingly prevalent notion of the public good as the most important responsibility of the state.

Conclusion

In summary, Budapest's new water infrastructure generated several conflicts, some of which were intense. Count Sándor Károlyi's struggles were rooted in his outdated attitudes towards water and property, while the difficulties encountered by engineer Mihály Kajlinger originated in his modern, technoscientific view of urban infrastructures. This simple dichotomy can be developed further, and it can be stated that the conflict-ridden history sketched above sheds light on four developments. It illuminated the transformation of attitudes towards natural resources and the way a certain teleology of modernity was contested and negotiat-

42 At this point, the use of water meters was mandatory in industrial facilities (which complained a lot about being forced to use and pay for filtered water for industrial purposes), but flat rates were still in use for households. Kajlinger's name was linked to malfeasances concerning the implementation of meters, and he was accused of promoting water meters for personal gain, which he denied. He returned to his position approximately a year later and stayed there until 1923. Vedres, "Kájlinger Mihály élete és szerepe [Life and Work of Mihály Kájlinger]," 576.

ed. Zooming in on water meters, one of the important technological innovations in this context, made visible the specific features of the modernizing campaign that irritated the public, namely the intensification of central control and the state's insistence on its prerogative to measure and monitor the citizenry's consumption of a natural resource.

Attitudes towards nature were transformed first by the introduction of the new legal category of the public good and were then further changed when experts became the assigned managers of natural resources. In the urban context, the emphasis was not really on taming nature's forces but on channeling them into a form that was appropriate for the improvement of an increasingly "civilized" society, in this case through the creation of an infrastructural network. Thus, together with street lighting and the sewerage system, pipelines marked the boundaries of the "civilized" world. In a contradictory manner, however, they also constituted an entity that was both manmade and natural at once, a hybrid phenomenon, or, to put it differently, a socio-natural site.[43] Innovations in water management seemed to challenge the nineteenth-century assumption that urban development should further the separation between nature and culture, environment and civilization. With the words of Maria Kaika, we can state that "although the programming vision was to render cities independent from nature's processes, the materialization of this vision was predicated upon establishing intricate networks and flows of natural elements, […], which, in fact, not only did not separate nature from the city but instead wove them together more closely into a socio-spatial continuum."[44] In the case of Budapest, this meant that the boundaries of the city were strictly drawn by the endpoints of the water system infrastructure, but in the meantime, this same infrastructure brought groundwater into every household.

The creation of socio-natural sites was led by the vanguard embodiments of modernity: experts. A great deal has been said about the nascent expert culture of late nineteenth-century metropolises, and Budapest was not an exception to the rule: the city entrusted engineers with control over the forces of nature. As several examples show, the experts' credibility was also defined by civilizational hierarchies; that is, when problems arose, experts were invited from Western Europe and more specifically from Germany, the home country of engineering expertise according to the technical intelligentsia of the Hungarian Kingdom. In spite of the fact that experts seemed to dominate discourses about the environment and its

43 Winiwarter and Schmid, "Socio-Natural Sites."
44 Maria Kaika, *City of Flows: Modernity, Nature, and the City* (New York–Oxford: Routledge, 2005), 5.

uses, the present case study enumerated episodes when their credibility and position were contested. The experts reacted with stupefaction, and they defended themselves from behind the ramparts of rationalism, trying to discredit their adversaries as irrational, but these conflicts still clearly show that progress was not accepted as automatically beneficial and was sometimes critically assessed by the public. This adds to our understanding of popular perceptions of modernity.[45]

Citizens also refused a certain level of institutional control. The placement of a technical device in their households seemed to be the boundary not to be violated. The at times violent resistance to the introduction of water meters shows how repulsive the centralizing state was in the eyes of some of the public. Water meters came to symbolize increased dependencies, which are inherent characteristics of infrastructural networks,[46] as much as intrusion into the private sphere. When city councilors spoke of people taking showers in their bathrooms or drinking a glass of water in their kitchens, they were conjuring scenes in which, in the eyes of the broader public, state administration had no place. Adaptation to new elements of infrastructure and the process of learning how to use these elements meant accepting what at first may have seemed unacceptable.

There are various ways of exerting control, and measuring things is one of them. Historiographical evidence shows that the act of requiring or taking measurements often met with hostility, to which we can now add the use of water meters.[47] Words applied to the use of these devices (e.g. cruelty, attack, or bullying) indicate the intensity of emotions related to measuring practices as well as the perfectly accurate perception that measuring things is a form of practicing power. It took a great deal of trust to convince the people of Budapest to let the state exercise power in this form in their very homes, and trust was sorely lacking during this period of consecutive crises of confidence. Experts were astonished that the public could not grasp that these devices could help the city arrive at more precise figures and thus further the emergence of a more just society. Yet the public may well have understood this. It may simply have prioritized autono-

45 Modernity and modernization are frequently regarded as extremely complex phenomena that could be grasped exclusively by high intellectuals, if ever. I am interested in cases when popular perceptions of modernization can be understood, for instance Veronika Eszik, “Rural Reactions to Modernization: Anti-Modernist Features of the 1883 Anti-Hungarian Peasant Uprising in Croatia,” *Hungarian Historical Review*, 12, no.1 (2023): 37–65.

46 As described in relation to the electrical grid in Alain Gras, *Grandeur et dépendance: Sociologie des macro-systèmes techniques* (Paris: PUF, 1993).

47 In addition to the countless case studies on violent reactions to surveying, for a thorough analysis of the hatred of the meter system, see: Ken Alder, *The Measure of All Things: The Seven-year Odyssey and Hidden Error that Transformed the World* (New York: Free Press, 2002).

my over precision and liberty over social justice. As Ken Alder puts it, "Our methods of measurement define who we are and what we value."[48]

The history of the creation of urban water infrastructure in Budapest, a process which involved decades-long preliminary studies, negotiations concerning legal, administrative, technical, and political decisions, and a lengthy process of mental adaptation by the public, brings environment, technology, and social development into dialogue. It shows that infrastructure is not only a material consequence of a monumental modernizing project but also a catalyst of transformations of ideas about nature, modernity, expert culture, state control, and measuring practices. As such, it forms an excellent subject for research that seeks to connect social history with urban environmental history and the history of ideas. Seen from the intersection of these fields, Budapest shows a different face than what we have seen before.

48 Alder, *The Measure of All Things*, 14.

Bryan U. Kauma

"Agriculture is a scam!": Agrotechnologies and the agrarian fallacy among African grain farmers in colonial Zimbabwe, the 1920s to 1970s

List of Abbreviations

DDT	Dichlorodiphenyltrichloroethane
GMB	Grain Marketing Board
NAD	Native Affairs Department
NLHA	Native Land Husbandry Act
SRFU	Southern Rhodesia Farmers Union
SR-52	Southern Rhodesia–52

Introduction

Addressing delegates at a private function for non-governmental organizations in Japan in 2023, former US president Jimmy Carter argued that "Africa needs genetically modified crops" to address its deteriorating food security and scarcity woes. He added that it was "misguided to tell people that genetically modified seeds are poisonous…misleading sometimes gullible and ill-informed African and other leaders, that we cannot accept these seeds."[1] Fast forward to early 2024, political analyst and social media commentator Rutendo Matinyarare was served a cease-and-desist letter, filed by Innscor Africa in response to his protracted claims that the food giant was producing products that contained "GMOs (genetically modified organisms) and were harmful to the general Zimbabwean population." Matinyarare added that these food products were "destroying the taste of Zimbabwean food" and had no nutritional value. They also adversely altered the natural cycle for quality produce by relying on chemicals widely shunned globally. This case divided social opinions, mainly because of Rutendo's political leanings and commentary that fueled tribalism, as well as previous allegations of pedophilia.

The subject of genetically modified food crops remains widely contentious and unresolved. On one hand, while many believe that such innovations aim at

1 "Africa needs GMO crops: Carter," *The Chronicle*, September 5, 2023.

https://doi.org/10.1515/9783111611358-007

addressing the imploding global food security crisis amid an anthropogenic slow violence of climate change, many others are concerned that the cocktail of chemicals and processing methods involved poses a harmful threat to humans, animals, and environmental welfare. Some scientific studies have even argued that the consumption of GMO food crops can lead to severe short-term and long-term illnesses among consumers.[2] Quoting Albert Schweitzer, environmentalist Rachel Carson laments that "man can hardly even recognize the devils of his own creation."[3] Until now, agricultural and food innovations such as GMOs, chemical fertilizers, and hybrid seeds have become the main way towards sustaining food security.

In southern Africa, particularly in Zimbabwe, agrotechnologies, including chemical fertilizers, herbicides, insecticides, and hybrid seeds, were increasingly introduced from the early 1920s to save hard-hit colonialists by increasing their yields and generating wealth from agricultural production.[4] From white settlers' arrival and colonialism in 1890, the modification of the environment was becoming increasingly noticeable, characterized by tracks of vast cash crop agriculture and environmental exploitation. Adding to this, these changes also altered local cultures and the everyday life of different African communities. For example, colonialists violently lobbied to dismantle African agricultural and economic dominance by replacing the African staple small grains of sorghum and millet with white maize.[5] Through land alienations and financial and material initiatives for white farmers, the colonial state embarked on an agrarian agenda that underlined "maize is Rhodesia's friend," and invested heavily in boosting white maize production.[6] The next few decades were characterized by heightened agrarian

---

2 Joël Spiroux de Vendômois et al., "Debate on GMOs health risks after statistical findings in regulatory tests," *International Journal of Biological Science* 5;6, 6 (2010): 590–598. Also see David Zilberman, Tim G. Holland, and Itai Trilnick, "Agricultural GMOs—What We Know and Where Scientists Disagree," *Sustainability* 10, no.5 (2018): 1514.

3 Rachel Carson, *Silent Spring* (London: Hamish Hamilton, 1963), 3.

4 James McCann, *Maize and Grace: Africa's encounter with a New World crop, 1500–2000* (Cambridge, Mass.: Harvard University Press, 2005), 141–147.

5 Bryan Kauma and Sandra Swart, "'Many of the dishes are no longer eaten by sophisticated urban Africans': A social history of eating small grains in Bulawayo, Southern Rhodesia (Zimbabwe) c. 1920s to the 1950s," *Revue d' Histoire Contemporaine de l' Afrique* 2 (2021): 86–111.

6 Arriving in present-day Zimbabwe in 1890 with the hope of finding mineral prospects similar to those in South Africa, early white colonialists instead worked towards transforming the colony into the agricultural hub of the region through cash crop production of mainly maize, tobacco, and cotton. Government funding and support for white commercial farmers was through various material, policy, and financial initiatives such as the creation of a Land Bank, the production of a Farmer' s Handbook, and the pronouncement of Diet Ordinances from 1908, inter alia, aimed at promoting the local agrarian sector. Also see Victor Machingaidze, "The Development Of Settler transformation from subsistence production to widespread commercial cash cropping of maize, tobacco, and cotton. By the early 1950s, the gospel of fertilizer use to improve agricultural and maize harvests was commonplace across most parts of Southern Rhodesia. By 1953, the state-controlled Agricultural Rural Development Authority had deployed over 680 agricultural demonstrators across the country to educate Zimbabwean farmers on the use of fertilizers to counter the yield and acreage concerns associated with the 1951 *Magna Carta* Native Land Husbandry Act (NLHA), which reallocated cultivation spaces.[7] In parts of Europe and the Americas, Arturo Warman notes, the use of modified hybrid seeds, herbicides, and fertilizers revolutionized and tremendously improved both the quality and quantity of farmers' yields.[8] Similar outcomes were expected in Southern Rhodesia.

Drawing on primary and secondary sources, this chapter revisits Zimbabwe's agrarian history and explores Zimbabwean grain farmers' experiences with agrotechnologies—notably chemical fertilizers, herbicides, and hybrid seeds—during the colonial period. The response of black Africans to the agrotechnologies varied, marked by growing racial and cultural skepticism, misuse of new technologies, and significant economic barriers to access. These innovations had uneven effects on production. While some black farmers thrived, foiled yields became a recurring motif for others. Some farmers believed their agricultural failure was tied to ancestral retribution against adopting white-introduced fertilizer and hybrid seeds that slowly eroded their spiritual connections with the land, ancestors, and cultures connected with grain production.[9] This chapter further shows how poor instructional use of different fertilizers, hybrid seeds, and pesticides left many farmers confounded with poor harvests.

Meanwhile, overshadowing indigenous concerns, the Department of Native Agriculture paternalistically continued to promote chemical fertilizers, pesticides, and hybrid seed, leaving a toxic footprint on African productivity. African yields remained meagre with extended episodes of hunger. Adding to these troubles, these innovations spurred rapid environmental decay, cultural dilution, and

Capitalist Agriculture In Southern Rhodesia With Particular Reference To The Role Of The State, 1908–1939" (PhD diss., University of London, 1980).

7 R.W. Johnson, "African agricultural development in Southern Rhodesia, 1945–1960," *Food Research Institute Studies, Stanford University, Food Research Institute* 4, no.2 (1964), 1–59.

8 Arturo Warman, *Corn Capitalism: How a botanic bastard grew to global dominance* (Chapel Hill: University of North Carolina Press, 1988), 73.

9 Ian Scoones, "Religion and agriculture: reflections from Zimbabwe," Zimbabweland, accessed January 24, 2025, https://zimbabweland.wordpress.com/2022/11/21/religion-and-agriculture-reflections-from-zimbabwe/.

white monopolistic control within grain production infrastructure. Southern Rhodesia's grain sector became the center of racial, cultural, and economic tensions and power struggles.

Endangered African grains – A historical conversation

The history of land, agrarian and food production is long and deeply contested in Zimbabwe. Historiographically speaking, for Africa, this conversation is enduring and often emotive as it encapsulates the traumas and legacies of land disenfranchisement, racial inequality, and cultural alienation from the colonial period. James McCann observes how, for example, the introduction of agricultural technologies, including hybrid seeds and fertilizer use in southern Africa, marked a significant shift in agrarian practices that reconfigured racial relations and exposed the widening inequalities within colonial economic and social policies in Zimbabwe.[10] As this chapter adds, the politics of access to and postharvest agrotechnologies exposed the class and cultural tensions that underlie agrarian society. Meanwhile, introducing agricultural extension services in colonial Zimbabwe provided support and resilience for white farmers while imposing unfamiliar agrarian patterns on black smallholder farmers.[11]

Globally, agricultural transformation through the introduction of agrotechnologies and innovations has produced diverse outcomes. In Mexico, during the 1940s to 1960s, Ronald L. Phillips argues that the development of high-yielding wheat and rice varieties was able to revive food production and increase food supplies, thus staving off widespread starvation.[12] In stark contrast, across parts of Africa, the introduction and use of similar agrotechnologies over the nineteenth century increasingly led to extensive agricultural exploitation and a focus on non-food crops like tobacco and cotton. As Elijah Doro and David Hughes observe, the methods used culminated in massive deforestation, displacement, and hunger.[13] Frederick Cooper summarizes that, because many communities' livelihoods

10 McCann, *Maize and Grace*, 94.

11 Eira Kramer, "The Early Years: Extension Services In Peasant Agriculture In Colonial Zimbabwe, 1925–1929," *Zambezia* 24, no.2 (1997): 160.

12 Ronald L. Phillips, "Green Revolution: Past, Present, and Future," in *Encyclopedia of Agriculture and Food Systems*, ed. N. K. Van-Alfen, vol. 1 (London: Elsevier, 2014), 529–538.

13 Elijah Doro, *Plunder for Profit: A Socio-Environmental History of Tobacco Farming in Southern Rhodesia and Zimbabwe* (Cambridge: Cambridge University Press, 2023), 97 and David Hughes, relied on agriculture, agrarian capitalism and agrarian reforms impacted productivity and determined African exposure to poverty.[14] The use of different chemical fertilizers was targeted at reorganizing and “modernizing” the Zimbabwe landscape.[15]

Different studies have reflected on how African lives and intimacy with their environment have been violently disrupted by settler colonialism and ecological domination, which have committed environmental injustices against local people.[16] Smallholder African farmers faced several operational constraints, including being relegated to cramped spaces with low soil fertility, having limited access to inputs, and facing stiff competition from government-supported commercial white farmers. Compounding this, labor shortages in African resettlements across Zimbabwe soared as more and more Africans migrated to work on white farms and industries in response to growing hunger in communal reserves. At the same time, by the early 1960s, a distinct class of African agrarian bourgeoisie was developing, and suggestions by traditional leaders to use cow dung as a substitute for more expensive fertilizers recommended by agricultural demonstrators, for example, stirred resentment among farmers.[17] As Baxter Tavuyanago et al. contend, black farmers’ growing social and class actualization localized the adoption and widespread use of various agrotechnologies within African spaces. However, this was not without its challenges.[18]

From Enslavement to Environmentalism: Politics on a Southern African Frontier (Seattle: University of Washington Press, 2011), 127–130.

14 Frederick Cooper, *Africa in the world: Capitalism, Empire and Nation-state* (Cambridge, Mass.: Harvard University Press, 2014), 3.

15 Esbern Friis-Hansen, *Seeds for African Peasants: Peasants’ Needs and Agricultural Research–The Case of Zimbabwe* (Uppsala: Nordic Africa Institute, 1995), 19–21.

16 Jessica Urwin and Rohan Howitt, “Histories and legacies of extraction and toxicity: An introduction,” *International Review of Environmental History* 9, no.2 (2023): 3.

17 Trevor Ncube, “Peasant Production and Marketing of Grain Crops in Zimbabwe 1890–1986: An Overview,” *Handerson Seminar Paper* 72 (1987): 15.

18 Baxter Tavuyanago, “Traditional Grain Crops In Pre-Colonial And Colonial Zimbabwe: A Factor For Food Security And Social Cohesion Among The Shona People,” *Journal Of Sustainable Development in Africa* 12, no.6 (2010): 6–8. By the 1960s, whiteness and its social and economic influence had gained significant traction across the colony. Scholars like Michael West note how the development of an African bourgeoisie middle class was largely influenced by cross-racial interactions that exposed black Africans to a myriad of spaces to experience, and some enjoy, the services and experiences preserved for whites and elites. This inspired upward social and economic mobility among Africans and equally accounts for the motivation by many Africans to explore the Master Farmer certificate, which was a gateway to closer proximity to whiteness. See Michael O. West, *The Rise of an African Middle Class: Colonial Zimbabwe, 1898–1965* (Bloomington: Indiana University Press, 2002).

Debates about the use of agrotechnologies, such as hybrid seeds, fertilizers, and pesticides, grew in momentum at the turn of the twentieth century amid growing concern over their impact on the earth's ecological systems. Julie Guthman highlights the paradox of organic farming, noting the conflicts between big and small farms in agrarianism, particularly regarding social justice and ecological sustainability.[19] For farmers in California, USA, and black farmers in Southern Rhodesia alike, farming was not just a business but a lifestyle that encapsulated their spiritual, social, and political well-being. However, with the advent of venture capital, agriculture became heavily commercialized, pushing more farmers to adopt and rely on agro-innovations to meet growing market demands. California and Southern Rhodesia became the highest users of pesticides in agriculture. California became renowned as the agricultural capital of the US, while Southern Rhodesia earned the title of the region's breadbasket. However, as Eira Kramer,[20] Eira Punt,[21] and Victor E. M. Machingaidze,[22] point out, successes in agriculture were not enjoyed across the board, and in Southern Rhodesia, agricultural services and technologies remained largely unevenly distributed, with African farmers not reaping the same benefits as their white counterparts.

Reinforcing this point, Bryan Kauma and Sandra Swart,[23] along with Aisha Machingauta,[24] observe how policies such as the Maize Control Act of 1931 acted as a buffer against the economic impacts of the great depression for white farmers. These policies brought no positive benefits to black African farmers who were effectively barred from trading their grain in lucrative markets at competitive prices. In addition, institutional support for postharvest logistics, such as storage, transport, and marketing crops, was highly skewed against African farmers, further contributing to their ongoing struggles to adequately finance and support their production in the following agricultural season. Dharam Ghai and Lawrence D. Smith argue that agricultural policy introduced during the colo-

19 Julie Guthman, *Agrarian dreams: The Paradox of Organic Farming in California* (Oakland: University of California Press, 2004), 12.

20 Kramer, "The Early Years," 161–164.

21 Eira Punt, "The Development Of African Agriculture In Southern Rhodesia With Particular Reference To The Interwar Years" (Master's diss., University of Natal, 1979), 35.

22 Victor E.M. Machingaidze, "Agrarian Change from above: The Southern Rhodesia Native Land Husbandry Act and African Response," *The International Journal of African Historical Studies* 24, no.3 (1991): 557–588.

23 Bryan Kauma and Sandra Swart, "Hunger and Power: Politics, Food Insecurity and the Development of Small Grains in Zimbabwe, 2000–2010," *Historia* 67, no.1 (2022): 189.

24 Aisha Mashingauta, "Power and hunger: the state, farmers, and the Grain Marketing Board in Zimbabwe, c. 1980–2017" (PhD diss., Stellenbosch University, 2022).

nial years manifested variously in hunger and poverty.[25] It slowed economic growth and undermined agricultural performance among black farmers, who struggled against settlers who received state institutional support that maintained their economic and ideological hegemony in key areas of national development. As a result, the gap between food production and availability widened, and agrarian stagnation deepened on black farms, resulting in increased vulnerability. Indeed, Geoffrey Banda's analysis of the evolution of grain markets reveals how a lack of control of seeds undercut African agricultural production, thereby severely compromising food security for most Zimbabweans."[26] For many desperate farmers, their "harvest was stolen" by embracing new crops and agro-innovations that promised to improve agricultural output rapidly but ultimately did not.[27]

In a balanced thirty-two-chapter volume, Richard Sikora et al., comprehensively analyze the multifaceted challenges affecting agricultural production and food security in Southern Africa.[28] The second part of the book, attentive to shifts within agrarian policy, underlines the role of historical antecedents in causing widespread hunger and poverty in the region. This serves as a strong introduction to part four, which presents a focused discussion on emerging technologies that address growing food and agricultural concerns in postcolonial southern Africa. The chapter by Paul Vlek, Lulseged Tamene, and Janos Bogardi draws attention to the application of chemical fertilizers and underscores how their use has resulted from unregulated land use and management. They argue that most parts of southern Africa are conducive to cultivation. However, natural vegetation has suffered significantly due to intensive cash crop production, which ushered in new farming systems that altered soil and water mineralization, thus reducing their productive functions.[29] The volume clearly identifies both the positive and negative ecological and cultural impacts of emerging agrotechnologies, such as hybrids and fertilizers, on fostering sustainable agricultural development.

Today, different scholars attribute cycles of food insecurity to poor agricultural practices that have been exacerbated by years of soil degradation. The exten-

---

25 Dharam Ghai and Lawrence D. Smith, *Agricultural Prices, Policy, and Equity in Sub-Saharan Africa* (Colorado: Lynne Rienner, 1987), 99–102.

26 Geoffrey Banda, "Evolution of Zimbabwe' s maize innovation ecosystems: Building an institutional innovation infrastructure that supports food security," *Africa Development and Resources Research Institute (ADRRI) Journal* 47, no.3 (2022): 167–195.

27 Vandana Shiva, *Stolen Harvest: The hijacking of global food supply* (Cambridge: South End Press, 2000), 22.

28 Richard A. Sikora et al., eds., *Transforming agriculture in Southern Africa* (London: Routledge, 2020).

29 Paul Vlek, Lulseged Tamene and Janos Bogardi, "Land rich, but water poor," in *Transforming agriculture*, Sikora et al., eds., 39.

sive and widespread use of chemical fertilizers and intensive cultivation has led to a rapid decline in soil fertility. To combat this, agriculture experienced an era of experimental growth with heightened soil, water, and plant science experiments aimed at optimizing food productivity. Building on Helen Tilley's view of rural Africa as a "living laboratory" for European growth, William Masters argues that the introduction of (chemical) fertilizer and hybrid seed use in (southern) Africa was largely experimental.[30] This chapter highlights how perilous this was to African farmers anticipating bumper harvests. In the early 1960s, Western post-war aid programs in Africa, promoted under the banner "Decade of Development," aimed to harness modern technologies to transform rural spaces into highly productive agricultural factories based on experimental models trialed in Latin America. The Green Revolution introduced hybrid seeds, chemical fertilizers, and pesticides to "awaken the agricultural and economic dormancy of developing nations."[31] Yet, for example, the short-lived American rust crisis affecting white maize in Southern Rhodesia revealed how introducing chemical fertilizers was not only an object of scientific empirical study but also part of a new strategy to globalize intensive grain production.[32] This was Carson's central critique: chemicals were used without accounting for their biological and ecological consequences on human and nonhuman life.

Works by Malene Friis-Hansen,[33] and Mandivamba Rukuni,[34] highlight how seed sovereignty has been a historically contested issue in Zimbabwe's agrarian history. Control over maize seed enabled farmers to have more control over their agrarian trajectory. By extension, this helped provide more economic and social mobility opportunities. Conversely, other postcolonial scholars have positively viewed the paternalist hand of the colonial and postcolonial state in African agriculture. Maintaining colonial policy, following independence, more than 85% of smallholder farmers continued to use hybrid maize seed and a combination of chemical fertilizers. From the late 1970s onwards, improvements within African agriculture have been characterized by what scholars, including Mandivamba Rukuni and Carl K. Eicher, have described as Zimbabwe's 1980s Agricultural Rev-

30 William Masters, *Government and agriculture in Zimbabwe* (Westport: Praeger, 1994), 63.
31 David Kinkela, *DDT and the American Century: Global Health, Environmental Politics, and the Pesticide That Changed the World* (Chapel Hill: University of North Carolina Press, 2011), 107.
32 McCann, *Maize and Grace*, 121–125.
33 Friis-Hansen, *Seeds for African Peasants*, 55–56.
34 Mandivamba Rukuni, "The evolution of irrigation policy in Zimbabwe, 1900–1986," *Working paper AEE* 4, no.86 (1986): 14.

olution.[35] Ian Scoones et al. would further demonstrate that historical government support, through farm mechanization and the distribution of (hybrid) maize seed, fertilizers, and pesticides, greatly contributed to the successes of Zimbabwean farmers. They argue that this support extended to the land reform exercises of the early 2000s.[36] However, Eric Makombe maintains that, without structural reforms within key institutions such as the Grain Marketing Board (GMB), African producers could not enjoy the full economic value of their crops.[37] These ongoing issues impacted food security as farmers shifted to non-food crops like tobacco, which received better investment from the state and private sector.[38] Helen A. Curry concludes that the state's continued lack of investment in proper education regarding the correct application of fertilizers, herbicides, and pesticides for food crops exacerbated food insecurity.[39] This enabled settler farmers to dominate and monopolize the food production sector throughout the colonial period (and beyond).

Mtakati ya vayungu ('Magic of the white man'): The development of agro-innovations

To this day, much of Zimbabwean society, like in many other countries, continues to view the use of genetically modified, hybrid seeds and chemical fertilizers in food production with incredulity, seeing them as a panacea to food insecurity. When chemical fertilizers were first introduced in Southern Rhodesia by American-educated Emory D. Alvord in 1921 in Mount Silinda, Chininga district, local farmers and community leaders alike marveled at the results of his "proper tillage" methods. This earned Alvord the title *mtakati ya vayungu* ('white man's magic') from nonplussed African farmers who were curious about the quality and quantity of the maize and other crops grown on the demonstration plots next to their withered plots. That year, the best maize yield was about 32 bags of 200

35 Mandivamba Rukuni and Carl K. Eicher, *Zimbabwe Agricultural Revolution* (Harare: University of Zimbabwe Publications, 1994).

36 Ian Scoones et al,, "Livelihoods after Land Reform in Zimbabwe: Understanding Processes of Rural Differentiation," *Journal of Agrarian Change*12, no.4 (2012): 503–527.

37 Eric Makombe, *Agricultural Commodity Pricing Policy in Colonial Zimbabwe: with Particular Reference to the Settler Maize Industry: 1950–1980* (Riga: VDM Verlag Dr. Müller, 2011), 52.

38 Geoffrey Banda, "Evolution of Zimbabwe's Maize Innovation Ecosystems: Building an Institutional Innovation Infrastructure That Supported Food Security," *Africa Development*, 47, no.3 (2022): 167–95.

39 Helen A. Curry, *Endangered Maize* (Oakland: University of California Press, 2022), 99, 127.

lbs. per acre.[40] Some African farm workers, including those who participated in the crop cultivation, were convinced that the white agriculturalist had "gone out in the night to sprinkle magic medicine on the crops," as none of them had ever seen a harvest half as good as this one.[41]

The initial excitement surrounding the use of fertilizers in agriculture triggered a slow but steady growth in the sector over the following decade. By 1932, Southern Rhodesia had established a domestic fertilizer industry, producing phosphatic fertilizers at an affordable cost for the local commercial market.[42] Alvord emphasized that using fertilizers was a revolutionary step towards improving yields and enabling farmers to counter the vagaries and unpredictability of nature, such as soil infertility, pests, and low rainfall. The post-depression years further accentuated the need for greater control of agrarian production by both black and white farmers. Alvord's position was bolstered when successive dry spells during the planting season, stretching over nine weeks in the late 1930s and early 1940s, scorched vast areas of cultivated land beyond recovery.[43] The severity of these successive dry spells did not spare the crops of white farmers, who suffered similarly. Yet, crops on the demonstration plots in Mount Silinda managed to survive and flourish, barely affected by the vagaries of the drought.[44] This prompted the Agriculture Department to advocate for the intensified use of fertilizers across the farming districts to improve maize yields.

Meanwhile, African millet and sorghum fared comparatively better. However, Alvord added that there was an essential need to explore alternative maize grain varieties that could survive these perilous dry periods. As Kauma and Swart argue, this aimed to exclude the reliance on African small grains produced by African farmers.[45]

The Department of Agriculture brought together scientists from the little-known Matopos Research Station to develop a local hybrid maize seed suited to Rhodesia's climate. Speaking in 1948, an official from the Department of Native Agriculture expressed growing concerns over what they believed were unresponsive seeds, attributing the issue to the degradation of the soil after years of con-

40 A. G. Davis, "The work of ED Alvord," *Zambezia* 19, no.1 (1992): 48–49.

41 E. D. Alvord, *The development of native agriculture and land tenure in Southern Rhodesia*, 1958, 6.

42 Masters, *Government and Agriculture*, 63.

43 Various agricultural crop assessment reports by the Department of Native Affairs between 1931 and 1945 labelled Agriculture Department Crop reports, *Rhodesia Agricultural Journal.*

44 Alvord, *The development of native,* 7–8.

45 Kauma and Swart, "Many of the dishes," 86–111.

tinued misuse by African farmers.[46] The official pointed to the increasingly erratic application of a combination of natural and commercial fertilizers, which led to poor cultivation patterns. Notably, there was no regulatory control over fertilizer use among African farmers, who continued to make extensive use of these fertilizers, even in times of good rainfall. In good seasons like 1946, grain crops grew three times more than usual, producing a bountiful harvest.

In stark contrast, crops perished irretrievably within a short time during dry seasons, as was the case the following year. The department's main observation was that soils and pests were fast becoming impervious and resistant to the current forms of fertilizers and pesticides.[47] According to the Pasture Research Chemist report in 1950, although crops displayed positive nutritive value during the early weeks of planting, herbage declined during the growing season, and further, by the time of harvesting in March of the following year, they lacked protein and mineral elements (measured in lbs. per acre).[48] Crop survey reports in 1951 noted that existing seed and fertilizer combinations produced an average total of 353 bags of maize, a decrease from 474 bags per year. Fertilizers were no longer efficient, and this rapid decline justified the essential need for a hybrid seed that would revitalize the agricultural landscape.

Fertilizers and hybrid seeds: "Winning the hearts and minds" of farmers

Colonial rule saw government intervention in agricultural production through the implementation of ambitious agricultural development schemes. These development initiatives were primarily aimed at increasing and controlling the production and marketing of cash crops, including maize. Within a decade, the government's Department of Native Agriculture had built on work initiated by Alvord, bringing years of work by scientists from the Federation of Rhodesia and Nyasaland to fruition with the introduction of a hybrid maize seed variety in 1952. This new hybrid seed was called SR-52 (Southern Rhodesia–52) and was developed from the commercial maize seeds produced at the Henderson Research Station and

46 "Annual report by the Commissor for Native Affairs, year ended 1948", *Native Affairs Department Annuals* (hereafter NADA), 12.

47 *NADA*, "Annual Commissioner Report", 1950, 12.

48 H. Weinmann, *Agricultural research and Development in Southern Rhodesia* (Salisbury: University of Rhodesia, 1975), 138.

marketed by the Southern Rhodesia Seed Maize Association.[49] This was a momentous feat as Southern Rhodesia became the first country in the world to produce a single cross-hybrid grain seed locally. Despite unpredictable and unfavorable rainfall patterns, this seed was tailor-made to boost maize production. White commercial maize farmers welcomed this innovation and hailed it as a "miracle…one that would transform African landscapes." In stark contrast, the introduction of the seed sparked racial tensions regarding African diets and culture, as it received a lukewarm response from African farmers. These reactions were not uncharacteristic nor surprising, especially to the officials of the Native Affairs Department (NAD), who had had several tense encounters with African communities opposing settler attempts to change their agrarian livelihoods and diet.[50] Since the introduction of chemical fertilizers and herbicides to African farmers, the Department for Native Agriculture had increasingly recorded complaints, cases of illness, and even deaths, due to suspected "vegetable poisoning."[51] Some farmers complained about the foul smell emanating from the plants and soils, noting that the fertilizer had altered the taste of their food. Others observed changes in the color and texture of the soil.[52] Over the next few years, the Chemistry Branch within the government's Agriculture Department became inundated with carrying out soil sample tests to identify the best soil, fertilizer, and seed combinations.[53]

The 1953 agricultural season produced over 12,000 bags of hybrid maize, with 1,600 bags available for export. According to James McCann, in the first two decades after its release, SR-52 performed well, raising maize yields on commercial farms by more than 300% over the previous decade.[54] Undoubtedly, the entry of hybrid seed to the market was a significant innovation, but selling it to African farmers remained a challenge. Around two years after the introduction of SR-52, about 55% of the country's large-scale white-owned farms were planting hybrid maize. This number was notably lower on African plots, with records indicating almost 22% acreage. However, these dynamics would shift as agricultural demonstrators increasingly encouraged farmers to combine hybrid seeds and fer-

49 Memorandum by the Director of Agriculture for 1952, December, 1952, National Archives of Zimbabwe, Box S482/781/39, 21.

50 Report of the Chief Native Commissioner, January,1925–1939, *The Native Affairs Department Annuals*, 12–19. NAZ, Box S482/781/39.

51 "Agricultural lives of Natives," *NADA*, 1955, 29

52 Muneta. G Manzeke, "The Effectiveness of Different Fertilizer Formulations in Alleviating Zinc Deficiency in Smallholder Maize Production Systems in Zimbabwe" (Master's diss., University of Zimbabwe, 2013), 67.

53 "Report on Overseas visit concerned with Seed and Soil testing and production," *Rhodesia Agricultural Journal*, 1939, 25.

54 McCann, *Maize and Grace*, 141.

tilizers. As the following section will show, by 1967, more than 93% of cultivated land used SR-52 and a form of fertilizer.

The combination of hybrid maize seed and chemical fertilizers yielded positive results, compensating for the enormous investments made in agricultural research since the interwar period. Disruptions from the war witnessed scores of African farmers reverting to bone meal, blood meal, and bat guano fertilizer options as chemical fertilizer deliveries imported via the Beira port were affected.[55] The freight cost further rendered these fertilizers expensive, adding to the burden of restrictive, lucrative grain prices for African grain set by the Maize Board (which became the Grain Marketing Board two years later in 1954).[56] The discovery and exploitation of phosphate deposits at Dorowa, in eastern Zimbabwe, was a significant game-changer for the local fertilizer and grain industry, promising growing economic prospects. White commercial farmers quickly began using phosphate chemical fertilizers, applying about 150–200 lbs. per acre of superphosphate every other year. This rotation was largely due to the high price of chemical fertilizers. As a more cost-effective alternative, farmers more commonly mixed two-thirds superphosphate, a third bonemeal, and SR-52, which yielded an average of 170 lbs. of grain per acre.[57] Similarly, a complete NPK fertilizer application was ideal for tobacco plants, costing a hefty £4 per acre in the 1940s. The 1950s witnessed a growing use of nitrogen-based fertilizers for tobacco, but these were not used for maize due to the strong and lingering odor they imparted to the crops. This period marked a notable increase in agriculture fertilizer imports, from £49,105 in 1924 to over £175,118 by 1940, and a steep postwar rise to £605,575 in 1950. Southern Rhodesia was on its way to rebooting its agrarian productivity.[58]

The relationship between fertilizer imports and the total area of cultivated land reflects the considerable investment in intensifying fertilizer usage. By 1955, African farmers had cultivated about 27,296 acres under state support

---

55 Report of the Secretary of Agriculture, October, 1954, Box, NAZ 1070/1, 56.

56 Commodity Marketing Board increasingly became the colonial state’ s central mechanism to monitor and control production within the colonies. These boards were given supervisory power to regulate terms and conditions for commodity production and distribution. In practice, they formalized and protected white monopoly interests within key agricultural and production sectors through pricing, zone delimiting, and market allocations. Also see William O. Jones, “Food-Crop Marketing Boards in Tropical Africa,” *The Journal of Modern African Studies* 25, no.3 (1987): 375–402 and Godfrey Hove, “Creating order and stability? The Dairy Marketing Board, milk (over) production and the politics of marketing in colonial Zimbabwe, 1952–1970s,” *Historia* 58, no.2 (2013): 119–156.

57 Weinmann, *Agricultural*, 171.

58 Alvord, *The development of native*, 62.

through irrigation and fertilizer use. In 1956, grain yield reached a peak of around 156,256 bags, and the NAD noted how this was an increase of on average just under 6 bags per acre.[59] For a program in its infancy, using hybrid seeds, irrigation, and fertilizers proved promising, especially in an area with a long history of crops that often suffered during periods of low rainfall. As the NAD celebrated this milestone, not all local African farmers were caught up in the excitement, with some raising their concerns about overreliance on scarce water from the dams shared with animals and the declining annual rainfall. Needless to add, irrigation and fertilizer schemes seemed to benefit those in closer proximity to the dams.

Over time, agricultural systems evolved, shifting farming patterns along with the mutating socio-ecological and political landscape. Historian Tinashe Takuva argues that agricultural production was political, as historically, African agriculturalists believed that "rains come from the gods."[60] A bountiful harvest was an ancestral blessing, and thus some African farmers opposed using the white man's agricultural innovations, such as irrigation, fertilizers, and hybrid seeds that were said to help plants grow.[61] The massive drought that coincided with the arrival of the white settlers in 1890 and other successive natural disasters, including locust invasions, when farmers first experimented with fertilizers, were naturally taken as a sign of disapproval from the ancestors by many farmers.[62] But these innovations stirred more indignation as some crops seemed to thrive while others struggled aesthetically, leaving their owners disappointed. Johnson observes how farmers who failed to recognize the potential of fertilizers, hybrid seeds, and irrigation would later emulously note how crops planted using these innovations reached a peak height above one and a half meters and displayed a robust

59 Alvord, *The development of native*, 64.

60 Tinashe Takuva, "'Rains Come from the Gods!': Anthropocene and the History of Rainmaking Rituals in Zimbabwe with Reference to Mberengwa district, c. 1890 – 2000," *South African Historical Journal* 73, no.1 (2021): 138 – 161.

61 Hilda Kuper, Hilda, A. J. B. Hughes, and J. Van Velsen, *The Shona and Ndebele of Southern Rhodesia* (London; Routledge, 2017), 36. Over the years, African agriculture had been expanding, incorporating the use of various tools and ideas, some brought by early European traders and settlers. For example, tools, such as the plough was introduced around 1908 and revolutionized the time and ability to till the soil. New crops, including maize, different varieties of fruits and herbs/spices were also introduced to African farmers.

62 "Rain and their traditions in the low Mzingwane and Beitbridge area," *NADA*, 1961, 55 – 57. Also see Admire Mseba "Politics, Techno-Science, and the Environment: The Late Twentieth-Century Challenges of Locust Control in Post-Colonial Southern Africa," *Journal of the History of Medicine and Allied Sciences* (2024).

dark green color for most of the planting season.[63] Different records from the Department for Agriculture underline how beautifully hybrid crops grown with fertilizer turned out, bringing jubilation to their farmers.[64] These crops grew to huge, unprecedented sizes and experienced fewer issues from pests or the vagaries of nature. Farmers rejoiced at the sizes of their crops, and by extension, this encouraged others to embrace these agrotechnologies. By the end of the 1950s, over 2,500 acres of demonstration breeding plots were cultivated, and SR-52 occupied about 22 % of the total area, yet produced over 43 % of the total crop.[65]

At the same time, the superabundant crops attracted the attention of local authorities, who took the opportunity to subtly coerce more African farmers into embracing and using chemical fertilizers and hybrid seeds. One common strategy was to reward farmers with incentives, including subsidized agricultural inputs, such as fertilizers, seeds, pesticides, or financial aid to assist and offset labor and other production and marketing costs.[66] As the succeeding section will further elaborate, African farmers whose crops showed significant quality and quality improvements were also recognized with a revered Master of Tillage certificate. This certificate offered unveiled contract farming opportunities to enable them to further increase the amount of land under their acreage.[67] Perhaps more importantly, this recognition became an essential social and economic marker and a gateway towards accessing lucrative markets for their crops. This was significant because it had the potential to increase their income from their crops.

According to Liza Grandia, the introduction of both new crops and new agrotechnologies have historically faced notable resistance. For example, in Guatemala, she discusses the "milperos dilemma," where locals defended their sacred maize grain production against "an invisible technology threat in a world of interconnected trade and corporate aggression" in the food production sector.[68] These new introductions would essentially reconfigure their social connections with agricultural production. Similarly, in Zimbabwe, using compound fertilizers and hybrid seeds like the SR-52 brought new social complications, unexpected by farm-

63 RWM Johnson, "African Agricultural Development in Southern Rhodesia, 1945 – 1960," *Food Research Institute Studies, 4, 1963 – 4, no.2,* 179.

64 "A preliminary report on the distribution of SR-52 in Marandellas and Mrewa", *Rhodesia Agricultural Journal*, 1957, 3.

65 Weinmann, *Agricultural*, 196.

66 Weinmann, *Agricultural*, 196.

67 Admire Mseba, *Society, Power, and Land in Northeastern Zimbabwe, ca. 1560 – 1960* (Athens, OH: Ohio University Press, 2024), 111.

68 Liza Grandia, *Kernels Of Resistance, Maize, Food Sovereignty And Collective Power* (Seattle: University of Washington Press, 2024), 7.

ers. For example, Karanga and Ndau farmers relied on plant ash to help protect their seeds from soil weevils and other pests that often ate the hearts of the grain seeds.[69] Under these so-called primitive agricultural conditions, the farmer had few insect problems. The intensification of agriculture and the devotion of immense acreages to a single crop unsettled the natural ecosystem. As Carson summarizes, these fertilizers and pesticides "simplified it" without considering the "built-in checks and balances by which nature holds the species within bounds."[70] Insects that helped the crop grow became adversely affected by the increasing use of fertilizer, triggering a chain reaction affecting soil fertility and texture, and nutrient quality of grain crops. Adding to this, the lack of strict and careful attention to measurements further risked crop damage.[71] Although some agricultural demonstrators emphasized the need for accurate measurements when applying fertilizer and pesticides, many farmers traditionally relied on visual estimations when using other natural agricultural methods, tools, and aids.[72] Unlearning these practices was not without its short and long-term consequences, including scant crop growth, yellowish burns on maize crops, and uneven stock counts on individual maize stems.

In response, to ameliorate soil productivity, African farmers began to move away from using chemical fertilizers and instead often deployed traditional agricultural techniques, which relied less on expensive and inaccessible external resources.[73] Legume-cereal rotation of maize and cowpeas boosted soil fertility while also addressing food scarcity concerns, by reducing the risk of crop failure associated with sole cropping. Increasingly into the 1970s, the colonial state intensified its research into the interplay between agriculture, soil, and nutrient uptake when using hybrid seeds and fertilizers in Zimbabwe.[74] The Department of Agriculture led efforts to conduct soil fertility surveys across the country's agroecological regions, with varying results. A notable finding related to seasonal variations and how season-to-season crop patterns impacted peasant production, primarily

69 Silindiwe Zvingowanisei, Sophia Chirongoma and Ezra Chitando, "Karanga Women and Indigenous Knowledge Systems (IKS): Towards enhancing Agricultural Production and Food Security in Zimbabwe," *African Thought: A Journal of Afro-centric Knowledge*, special edition 2, no.1 (2022): 217.

70 Carson, *Silent Spring*, 3.

71 Paul Harrison, *The greening of Africa* (London: Paladin Grafton Books), 107–108.

72 "In line with modern day concepts," *The Bantu Mirror*, August, 14, 1967, 3.

73 "In line with modern day concepts," 3.

74 Bryan Kauma, "Winner of the Southern African Historical Society' s Student Essay Prize in 2019: 'Small Grains, Small Gains': African Peasant Small Grains Production and Marketing in Zimbabwe during the Colonial Period, c.1890–1980," *South African Historical Journal* 73, no.2 (2021): 257–287.

because farmers tended to alter their cultivation practices based on the previous season’s outcomes. The increased use of hybrid seeds and fertilizers struggled to compensate for dwindling fallow periods, adversely impacting yields. The gospel of fertilizer and hybrids was emphasized to regulate cropping even within poor soil areas. However,, low yields and soil infertility adversely affected livestock, with fertilizer solution often leading to livestock risking cross-contamination.[75]

Meanwhile, in other areas such as Nyanyadzi in the eastern highlands of Zimbabwe, the chemical fertilizer and SR-52 combination was popular among the over 300 families occupying the floodplains. In 1954 alone, these households were able to produce more than 10,000 bags of grain from the Nyanyadzi irrigation project.[76] Although this amount was lower than the projected output of 15,000 bags, the outcome demonstrated the potential of fertilizer and irrigation programs. The Agriculture Department planned a quadrupled harvest with the use of hybrid seeds. This alerted the colonial state to the agricultural potential of African producers. They believed that intensified use of fertilizers, insecticides, and hybrid seeds would positively transform the trust lands, thereby reducing African reliance on state food support.[77] This was thus used as justification for further appropriation of African lands by the colonial state, and intensification of the agro-innovations with hybrid seeds, fertilizers, and insecticides becoming a significant cornerstone of the Land Husbandry Act. African socio-economic interests had been sacrificed at the altar of settler political and economic hegemony through the intensified use of hybrid seeds and fertilizers.[78] While there were some discussions about their adaptability to differing climatic and soil conditions, this interest was brief and ultimately short-lived.

Master farming and agricultural toxins from above

Land was an important capital asset in Southern Rhodesia and globally. By the mid-1950s, blacks made up over 85 % of the population and occupied 30.4 million acres of land, while the minority white population of 6.8 % occupied 48 million

75 “Report of the Dept of Agriculture, dated 31st March 1971,” NAZ, Box 32986.

76 Dickson Mungazi, *Colonial agriculture for Africans* (New York: Peter Lang, 1998), xxvii.

77 Peter Uledi and Godfrey Hove, “Developmental inequality and living on the margins in post-colonial Zimbabwe: the case of Musana District,” *African Affairs*, 13, no.3 (2021): 56 – 70.

78 Machingaidze, “Agrarian Change,” 562.

acres.[79] Analyzing the land tenure system, Machingaidze underlines how spaces occupied by black populations experienced overcrowding and overstocking. Land is necessary in order for people to survive. However, poor soils due to agricultural fatigue caused overcropping was common.[80] The introduction and widespread use of compound fertilizers and hybrid seeds in African areas was thus primarily targeted at improving agricultural prospects in these densely populated spaces.

Moreover, investments by the state aimed to curtail the negativity that the NLHA and agrotechnologies had generated over the years. For black and white farmers alike, their early experience with hybrid seeds coincided with a lengthy series of ecological drawbacks, including a massive red locust invasion and extended periods of low rainfall.[81] These challenges intensified rumors that worsened soil infertility was due to the overproduction of alien cash crops.[82] Over time, many shortcomings became apparent with the use fertilizers and hybrids. Their application largely ignores the diverse local flint types that African farmers cultivated on their intercropped farms. Unlike heirloom grain seeds, many felt that hybrid crops did not produce the same savory and nutritional qualities enjoyed by lactating women and used for solemnization in birth, marriage, and circumcision rituals.[83] Meals and opaque beer consumed at various traditional and communal gatherings received unfavorable reviews, leading to declining sales for local breweries.[84] Farmers whose grain was known to be sourced from hybrid seeds or heavily fertilized were tacitly shunned by breweries, which offered better prices for African grain compared to the GMB.[85]

Even agriculturally, there were noticeable differences among farmers who used fertilizer on their crops. For example, in the 1962–3 season, hybrid maize seed planted early in different districts in Manicaland performed well, producing yields occasionally in excess of twenty-five bags per acre and averaging between

79 D. G. Clarke, "Land Inequality and Income Distribution in Rhodesia," *African Studies Review* 18, no.1 (1975): 1–7.

80 Machingaidze, "Agrarian Change," 559.

81 Banda, "Evolution of Zimbabwe' s maize innovation ecosystems," 167–195.

82 Bryan Kauma and Sandra Swart "'Our stomachs are still hungry': The colonial state, African Nutrition and small grains in Southern Rhodesia (Zimbabwe), c.1950 to 1970s," *Critical African Studies* 16, no.2 (2024): 179–199.

83 Melissa Graboyes, "Good food, ridiculous diets, and a well-fed Swahili: British approaches to food in colonial Zanzibari institutions," *Boston University African Studies center Working Paper* 262 (2009): 4–6.

84 Steven J. Hagngade, "Sorghum beer in Botswana: The impact of factory brew on a cottage industry" (PhD diss. *Michigan State University*, 1984), 136.

85 Hagngade, "Sorghum beer in Botswana," 138.

eight and thirteen bags per acre on dry land.[86] During a farm visit by members of the British royal family in 1960, crops on the demonstration plots and Master Farmers' lands looked stellar, showcasing steady growth with dark green and full, plump ears. A crop assessment review conducted by the Department of Agriculture would later show how, between 1965 and 1967, farmers who used chemical "Compound D" fertilizer experienced an increased biomass productivity of between 20 % and 300 % compared to non-fertilized areas.[87] In contrast, crops planted with chemical fertilizers in drier African areas experienced stunted growth due to the dry spell.[88] Something was amiss. In Southern Rhodesia, government support for maize research was not just a commitment to agricultural modernization but part of a larger plan to ensure the economic and social base of white rule. The emphasis on improving hybrid maize production aligned with systematic attempts to undermine African maize production and secure valuable agricultural lands for the settler economy.

These disparities are illustrated in a complaint published in the *Bantu Mirror*, where a disgruntled African corn farmer expressed concern that some agricultural demonstrators, when introducing fertilizers, often failed to account for farmers' vernacular understanding of local ecosystems in their explanations of how fertilizers and hybrid seeds worked.[89] As Machingaidze aptly describes, it was "agrarian change from above," and this reinforced the stifling of African voices within agrarian policy and local development, including in African-dominated spaces. Despite the presence of the Department of Native Affairs and Native Agriculture, these institutions showed little willingness to promote African indigenous knowledge systems in agrarian development. Adding to this, for many African farmers, agricultural information and messaging from agricultural demonstrators, whether it pertained to new techniques, products, or concerns, was often shared by either close neighbors, family, or cordial agricultural extension officers.[90] This created spaces for distortions and misunderstandings. Occasionally, when crops performed poorly, some farmers accused the local agricultural input traders and suppliers of selling them a different product from that sold to farmers in other districts.[91]

86 "Report of the Secretary for Native Agriculture for 1964," NAZ, Box 32986.

87 Mungazi, *Colonial agriculture*, 94–95.

88 "Letters to the Editor," *The Bantu Mirror*, February 19, 1961.

89 "Letters to the Editor."

90 Stephen Whitfield, *Adapting to climate uncertainty in African agriculture: Narratives and knowledge politics*, (London: Routledge, 2016), 68.

91 "Letters to the Editor."

However, perhaps the most efficacious advance in agriculture was the introduction of Dichlorodiphenyltrichloroethane (DDT) to support the use of maize hybrid seeds and fertilizers. The entry of DDT onto the Zimbabwean market was a mixed blessing, leading to periods of prosperity and difficulty for agriculturalists. Unlike other fertilizers and chemicals, DDT was advertised as the “Messiah” that would solve pest, soil, and plant insects attacking and destroying farmers’ crops.[92] Its potency and efficacy were cost-efficient, especially as it did not require being used in large amounts compared to other pesticides on the market. Various promotional campaigns by the Agriculture Department, as shown in Figure 1, highlighted how combining hybrid seeds, fertilizer, and DDT would allow farmers to predict their harvest, thereby giving them more control over their finances “to spend more without fear.”[93] It was prudent for the colonial state to lead DDT campaigns with well-articulated African trainers whose presence would inspire economic and social mobility among the emerging bourgeois African laborers.

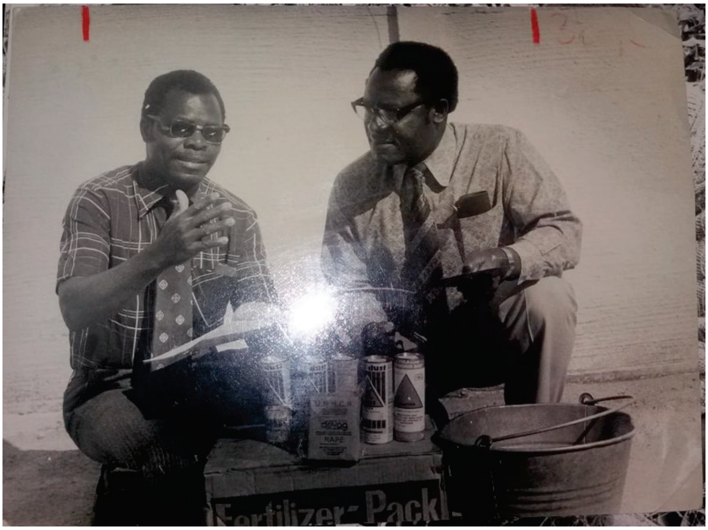


Figure 1: Agricultural demonstrators advertising the farmer’s pack, which included a variety of maize fertilizers and pesticides, including DDT.

92 Kinkela, *DDT*, 107.
93 “Africans in SR have advanced in agriculture,” *The Chronicle*, September 13, 1958.

More quietly, demonstrators raised awareness about the perilous nature of DDT, underlining the need for its limited and careful use.[94] However, many farmers disregarded this cautionary advice. They often maintained their habit of visually gauging measurements when applying chemical fertilizers and pesticides. The sharing and spreading of unclear oral instructions and advice among one another was rampant, as farming was firmly rooted in kinship ties.[95] Little attention was paid to written instructions, worsening these toxin inputs' already dire environmental consequences. In the past, such methods often went without consequence; however, unbeknownst to many, DDT was much more lethal, worsened by its much longer incubation period in the soil, plants, and air. Repeated use resulted in toxic sludge that changed the color of the underground soil and burned the plant from a vibrant green to a rustic yellow with a pungent smell.[96] The agricultural rains no longer filled the air with the refreshing smell of promise. Farmers and consumers alike noticed how even the freshly harvested crops were reproducing a pungent, toxic stench.[97]

From the sixties onwards, the use of chemicals in agriculture became increasingly visible within the local environmental architecture. Rural farmers were gaining access to the various brands of fertilizer and pesticides sold widely in their locales.[98] The combination of hybrid seeds, chemical fertilizers, and pesticides transformed the yields of some plants, including tobacco and cotton. However, as farmers used these toxic chemical innovations, many also fortuitously overlooked how these "sprays stayed in the soil, entering into living organisms, passing from one to another in a chain of poisoning and death."[99] In *The Chronicle*, one African farmer commented that since farmers started using chemical fertilizers, they enjoyed more stable harvests.[100] However, another observed that increasing over-fertilization and pesticide use were causing vivid toxin spills into the river, evident from the greasy multicolored stains on the water surfaces.[101] This contamination affected humans and livestock, which relied on these water sources. Over time, the underground water table also became contaminated, caus-

94 Doro, *Plunder for profit*, 178–180.
95 "Native cultivation: Maize," *Rhodesia Agricultural Journal*, August 1968, 101.
96 "Native cultivation: Maize."
97 "Letters to the Editor."
98 Mungazi, *Colonial agriculture*, 51.
99 Carson, *Silent Spring*, 5.
100 "Peasant production: Fertilizers," *Rhodesia Agricultural Journal*, 1969, 12.
101 "Grain Harvest review," *The Chronicle*, May 11, 1963.

ing various waterborne diseases.[102] Soil fertility was not spared, and as Sergiy Zorya argues, the chemical imbalance of the soil delayed the natural development of crops.[103] As more and more chemicals remained in the soil, this amalgamation killed microorganisms, bugs, and insects that contributed to the fertilizing of the soils and extended plant root life.

Some farmers had developed a habit of mixing different varieties of fertilizer, and while this was manageable for legumes and tobacco, the same was not applicable to cereals, cotton, and other horticultural plants.[104] Furthermore, inconsistencies in hybrid seed, fertilizer, and pesticide use heightened the toxic impact on local landscapes, increasing the occurrence of failed harvests. It was not uncommon for farmers, in attempts to maximize the little inputs (fertilizers, pesticides, or seeds) they had, to experiment with stronger yet toxic varieties such as DDT. It was also common for farmers to either over- or under-dilute liquid or powder fertilizer and pesticide concoctions, hoping to cover more area space or double down on their efficacy.[105] Dosages were never consistent and varied depending on how the farmers felt their crops were performing. Consequently, there was never a clear, transparent, or traceable record of the amounts used, making it increasingly difficult to calculate the efficacy or harm of these substances.[106]

Counterintuitively, this led to an increased, albeit inconsistent, use of these agrochemicals by African farmers. The cross-contamination with different fertilizers and seed varieties resulted in stunted growth, ultimately reducing the quality and value of the crop. Although financial limitations were often the reason for this cross-mixing and inconsistent use, it turned out to be more costly as many farmers failed to achieve even a breakeven return on their investments. Farmers had previously been taught by demonstrators about the advantages of intercropping maize with legumes to help with soil fertility, household nutrition, and food security. Legume crops, for example, could be harvested at least four times at different stages, before the maize was also finally ready for harvesting. Thus, farmers ad-

102 Sergiy Zorya, *Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa, Report No, 60371-AFR* (Washington DC: The International Bank for Reconstruction and Development, 2011), 83.
103 Zorya, *Missing Food*, 78.
104 Kauma, "Small Grains, Small Gains," 260.
105 "Letters to the Editor."
106 Whitfield, *Adapting to climate uncertainty*, 71–72.

versely misinterpreted mixing ideas, which exacerbated the cycle of debt and nutritional challenges faced within African households.[107]

The rush to get Master Farmer or tillage certification from the Department of Agriculture drove many Africans to adopt chemical fertilizers and hybrid seeds, even without adequate information.[108] As the government gradually moved towards relying on African producers, chemical fertilizers, hybrid seeds, and pesticides became increasingly available for sale at private and local general dealers. One Mr. Jacha, a Southern Rhodesia Farmers Union (SRFU) member, expressed joy at how the SRFU and colonial state were progressively working closely together to tackle common farming problems and expand agriculture in white and black areas.[109] The SRFU appreciated its recognition by the state for its role in advancing the use of hybrid seeds to produce the nation's staple.[110] African farmers did not delay and rely on donations or demonstrations from state agricultural demonstrators as they chased certification that would hopefully grant them access to lucrative grain markets.[111] By 1966, it was common practice that state enterprises, including the Cold Storage Commission, Rhodesia Cotton Growers' Association,[112] and Dairibord,[113] would only accept commodities from farmers who were able to provide Master Farmer certificates, which demonstrated that the farmers engaged in regular livestock dipping and followed the guidelines set by the Department of Agriculture for operations. In many ways, access to a Master Farmer certificate enabled Africans to elevate their social and economic status by moving out of the reserves and acquiring land in the purchase area, where commodity grades and prices were more lucrative.[114] In reality, this system perpetuated white settler

107 "Letters to the Editor." Remarks shared by a distraught farmer complaining about how they felt the agricultural demonstrators sabotaged their crop through inadequate explanations on how fertilizers and hybrids operated.

108 B.F. Masell and R.W. Johnson, *African agriculture in Rhodesia: An Econometric study* (Santa Monica, CA: The Rand Corporation, 1966), 79.

109 "Govt move to bail out farmers," *African Weekly*, March 22, 1968.

110 Different *NADA* accounts (in years 1947, 1955 and 1962) suggest that some personnel involved in the development of hybrid SR-52 were part of the SRFU, and they appreciated their work being included in the agrarian trajectory of the colony.

111 Oliver B. Pollak, "Black Farmers and White Politics in Rhodesia," *African Affairs* 74, no.296 (1975): 263–277 Also see Robin Palmer and Neil Parsons, *The roots of rural poverty* (London: Heinemann, 1977).

112 Pius S Nyambara, "The politics of locating the third spinning mill in Southern Rhodesia, 1951–1953," *Historia* 59, no.2 (2014): 46–68.

113 Godfrey Hove and Sandra Swart, "'Dairying Is a White Man' s Industry' : The Dairy Produce Act and the Segregation Debate in Colonial Zimbabwe, c.1920–1937," *Journal of Southern African Studies* 45, no.5 (2019): 911–925.

114 Masell and Johnson, *African agriculture,* 88.

capitalist hegemony as they monopolized the production and distribution of seed and fertilizer, which denied localized food sovereignty.

Mixtures were not limited to fertilizers alone. Heirloom seeds, some from previous harvests, were mixed with hybrid seeds in the same field. After all, communally, seed sharing was a major part of everyday socialization and cohesion, and was also a means of augmenting seed supplies.[115] As noted by Alejendro Ortega and Esbern Friis-Hensen, such seed mixtures merely made seeds more easily susceptible to moisture, molds, and frequent attacks from maggots, weevils, and worms that ate the hearts of the seeds, rendering them useless for cultivation.[116] These concerns extended to postharvest storage as some chemicals, such as *Chirambadura dust* (the colloquial name given to one familiar local brand), sprayed on grain in the silos did not alleviate all the issues related to safekeeping. A significant challenge was that it could remain harmful to humans unless the grain were thoroughly cleaned before milling or consumption. Even then, some families complained about how these various chemicals left a foul odor on the grain, making it unpalatable. The reality was that adopting chemical fertilizers, pesticides, and hybrid seeds was not bringing in the promised lucrative rewards that many farmers anticipated.

"Agriculture is a scam"

The introduction and widespread adoption of fertilizers, pesticides, and hybrid seeds in Southern Rhodesia was heralded as a giant progressive leap towards agrarian control and efforts to produce cheaper food. According to Munyaradzi Mawere and Artwell Nhemachena, Europe looked towards Southern Rhodesia in the years after the Second World War for affordable cash crops, and the use of synthetic pesticides and fertilizers such as DDT held great promise for this purpose.[117] At the time, they firmly believed that they would not harm humans and branded them as "the miracle chemicals" that would spearhead the agricultural and industrial revolution. The long-term consequences meant they became a "weapon of mass destruction, operating from outer atmosphere and destabilizing

115 Friis-Hansen, *Seeds for African Peasants*, 195–196.
116 Alejendro C. Ortega, *Insect Pests of Maize A guide for field identification* (Mexico City: International Maize and Wheat Improvement Center, 1987), 5–10.
117 Munyaradzi Mawere and Artwell Nhemachena, *GMOs, Consumerism and the Global Politics of Biotechnology: Rethinking Food, Bodies and Identities in Africa' s 21st Century* (Bamenda and Buea: Langaa RPCIG, 2017), 4.

agricultural and ecological systems around the world."[118] In Southern Rhodesia, while the use of such agrotechnologies as DDT significantly revived the post-war agrarian economy, it equally led to hazardous chemicalized work environments, crop and land poisoning, exposure of workers to toxic pesticides, and abuse by small-scale farmers.[119] Early warnings, including waterbed stains and pollution, foul air pollution, and changing soil color, were ignored, especially since these innovations targeted unwanted insects such as borer bugs and weevils that attacked plants. Yet, as Carson predicted, society was fast moving towards self-inflicted extinction, with the dystopia of agrochemicals continuing to contaminate the air, rivers, and soils essential for sustaining livelihoods.

By the 1960s, there was a steady boom in the cash crop economy globally. Europe and American markets favored African produce due to its lower prices and qualities. Additionally, the connections between white farmers in Southern Rhodesia and lucrative regional and international markets, economically steered African producers toward both increased use of agrotechnologies and the rigged cash crop economy, where white settler farmers held monopoly and control over the rate, flow, and nature of agrarian production.[120] Unsurprisingly, many African farmers' crops struggled in terms of the number of bags per acre and the quality of the grain harvested. Maize grain from African areas did not have consistent size or color. The Master Farmers observed concerns within the government regarding what they believed to be the continued failure of African farmers to differentiate between the fertilizers required for maize, tobacco, and cotton crops.[121] Each required a different application. However, this paternalistic view overlooked the reality that Africans had limited land, and that their soils were heavily contaminated with years of different fertilizers, which rotated between previously planted crops. Adding to these environmental woes, sustaining maize cultivation was a financial burden. Aisha Mashingauta notes that by the early 1970s, over 11,240 African farmers were deeply in debt to the GMB, owing either stocks in grain, cash, or implements granted on loan through different contracts or drought relief schemes.[122] This situation was worsened by continued low market prices at the GMB for African produce. Maize was not offering the relief many had hoped for.

The quality of cereal grains was measured and associated with their kernel number. That is, each seed's average size and weight determined its quality.

118 Mawere and Nhemachena, *GMOs, Consumerism*, 35.
119 Doro, *Profit and Plunder*, 2
120 Kauma, "Small grains, small gains," 271.
121 Masters, *Government and agriculture*, 81.
122 Mashingauta, "Power and Hunger," 479.

Using this method, plant and food scientists could calculate and estimate the nutritional value, length of life, and plant value among other determinants. In stark contrast, Peter Ndege,[123] and Mazarire,[124] observe that African agricultural practice was a testament to their shared intimacy with their environment, spirituality, and indigenous knowledge. Indeed, black farmers held the intellectual wherewithal to troubleshoot and address some of the issues that arose within their environments. For example, from observing the presence of certain insects and birds, farmers could almost accurately forecast rainfall potential. Equally, during planting, some farmers could estimate their harvest by analyzing the humidity and texture of the soil or the color and size of their plants during the planting season.[125] However, this experience was altered with hybrid seeds and chemically fertilized soils, as they introduced an unfamiliar growth pattern. For instance, farmers knew that their maize crops were ready for harvesting once they reached a peak of two meters high, with cobs maturing after about twelve weeks. However, hybrid seeds cut this time by almost half, while never growing to full length.

In some cases, the maize stock would remain a dark green, which was understood as not being ready for harvesting (*haina kuibva*). Moreover, the kernel count varied widely according to temperature, soil type, soil and ground precipitation, rain type and amount, seed type, and the fertilizer applied along with its quantities. It was a zero-sum game for African farmers fraught with more challenges than solutions. These agrotechnologies became increasingly political as they thwarted social and cultural rituals such as rainmaking, practices that served as established means of gatekeeping, and maintaining power and control over agrarian economies by a select few elites. With hopes and dreams shattered, "agriculture was a scam" for many African farmers.[126]

123 Peter Ndege, "Wheat: Why grain was heavily protected by colonial authorities," Nation, January 10, 2020, accessed September 19, 2024, https://nation.africa/kenya/business/seeds-of-gold/wheat-why-grain-was-heavily-protected-by-colonial-authorities-239734.

124 Gerald Mazarire, "'The politics of the womb': Women, politics and the environment in pre-colonial Chivi, Southern Zimbabwe, c.1840 to 1900," *Zambezia*, 30, no.1 (2023): 35–50.

125 Tavuyanago, "Traditional Grain Crops," 6.

126 Valerie Rumbidzai Jeche, "Corruption in Zimbabwe: The Command Agriculture Scandal," Future Africa, accessed December 12, 2024, https://futureafrica.net/corruption-in-zimbabwe-the-command-agriculture-scandal/.

Conclusion

The history of agrotechnologies in Southern Rhodesia is about power, indigeneity, and control. This chapter explored African grain farmers' experiences with agro-innovations, notably hybrid seeds, chemical fertilizers, and pesticides, over the colonial period between the 1920s and 1970s in Southern Rhodesia, now Zimbabwe. It reflects on the complex relationship between power, ecology, and culture in Southern Rhodesia. It revisits conversations on agrarian development to show how agro-innovations had a differential impact on African agrarian and cultural systems.

From their inception, the use of fertilizers and hybrid seeds involved a combination of both facts and emotion. Farmers were told that their use would improve their social and economic well-being, illustrated with vivid images of improved social mobility. However, owing to strained finances, improper mixtures by farmers were rife, which adversely impacted crop growth and the (toxic) nutrient balance within the soil and environment. Although the colonial state had its own ideas for solving Africa's agrarian and food problems, these problems had a long history, embedded in a combination of different cultural and environmental ideas on food production and preservation. Black farmers in Zimbabwe had a broader understanding of seeds, soil, and agriculture that the colonial state failed to grasp. However, this seemed to be under siege from the widespread introduction of various agrotechnologies. Food production systems became increasingly industrialized and exploitative, revealing deep-seated racial injustices affecting African livelihoods that stemmed from years of colonization. Additionally, poor agricultural choices made by farmers and policymakers worsened the poverty and nutrition traps throughout society. The use of agricultural technologies in the development of African peasant agriculture was contentious, as these innovations were closely linked to the politics of race and inequality during the colonial period.

Karolin Wetjen

Faith, empire, and weather: Missionary contributions to colonial climatology

In our times of climate crises, the history of climatology is one of the most rapidly growing research fields in the history of science. Traditionally, it has often emphasized the contributions of prominent male and white scientists, such as Julius von Hann, Eduard Brückner, Wladimir Köppen, and Vilhelm Bjerknes, presenting climatology as a narrative of scientific authority, rationalization, and linear progression toward the modern computer science it embodies today.[1] Recently, however, a new dimension has emerged in this narrative, as scholars increasingly explore the colonial history of the discipline. This shift has been fuelled by recent studies and archival discoveries that reveal the intertwinement of climatology with imperial and colonial frameworks.[2]

In a recent article, Harriet Mercer and Thomas Simpson provide an advanced overview of how imperialism and colonialism have shaped climate science, emphasizing themes such as the erasure of Indigenous knowledge, the development of imperial climate infrastructures, and the influence of colonial empires on data collection and theory formation.[3] The authors trace how empires like the British and French established meteorological networks to exert control, support econom-

---

1 See e.g. for an overview: James Rodger Fleming Fleming, *Inventing Atmospheric Science. Bjerkness, Rossby, Wexler, and the Foundation of Modern Meteorology* (Cambridge, MA/London: MIT Press, 2016); James Rodger Fleming, *Historical Perspectives on Climate Change* (New York/Oxford: Oxford University Press, 1998); Matthias Heymann, "The Evolution of Climate Ideas and Knowledge," *WIREs Climate Change* 1, no.4 (2010): 581–597; Robert-Jan Wille, "Colonizing the Free Atmosphere: Wladimir Köppen's 'Aerology', the German Maritime Observatory, and the Emergence of a Trans-Imperial Network of Weather Balloons and Kites, 1873–1906," *History of Meteorology* 8 (2017): 95–123; Philipp N. Lehmann, "Wither Climatology? Brückner's Climate Oscillations, Data Debates, and Dynamic Climatology," *History of Meteorology* 7 (2015); Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).

2 David Livingstone, *The Empire of Climate. A History of an Idea* (Princeton/Oxford: Princeton University Press, 2024); Philipp N. Lehmann, *Desert Edens. Colonial Climate Engineering in the Age of Anxiety* (Princeton: Princeton University Press, 2022); Philipp N. Lehmann, "Average Rainfall and the Play of Colors. Colonial Experience and Global Climate Data," *Studies in History and Philosophy of Science* 70 (2018): 38–49.

3 Harriet Mercer and Thomas Simpson, "Imperialism, Colonialism, and Climate Change Science," *WIREs Climate Change* 14, no.6 (2023).

https://doi.org/10.1515/9783111611358-008

ic ventures, and reinforce ideological narratives of racial and cultural superiority.[4]

While Mercer and Simpson highlight the growing body of literature on these intersections, their review also underscores significant gaps, particularly in the comparative analysis of different imperial contexts.[5] While the British developed a tight-knit network of meteorological stations in India in order to understand the tropical climate and its consequences for any kind of European rule and civilization since the middle of the nineteenth century, the establishment of a worthy meteorological observation network in the German African colonies took significantly longer for various reasons.[6] First, Germany became a colonial power notably later; it wasn't until 1884 that the first regions came under imperial rule. Furthermore, the German colonial administration, especially in the years leading up to 1900, was relatively weak, focusing mainly on military stations and coastal regions.[7] Additionally, colonial efforts were structurally underfunded, and the infamously brutal German colonial wars in German Southwest Africa (Namibia) and German East Africa (Tanganyika), along with costly infrastructure projects like building railways, consumed most of the limited budget, which was fiercely contested in the German Reichstag and among the public.[8] As a result, the German colonial administration was both structurally underfunded and understaffed. In some colonies, only a handful of German colonial officials were tasked with representing and managing imperial rule, and meteorological observations were not a priority for them. Although German meteorology soon became a focal point of meteorological research in Europe, hosting several international conferences, the collection of climate and weather data prior to the First World War was incomplete. The establishment of weather stations, where data was regularly gathered, occurred gradually in the German colonies, depending mainly on the commitment

---

4 See also: Martin Mahony and Georgina Endfield, "Climate and Colonialism," *WIREs Climate Change* 9, no.2 (2018): 1–16.

5 Heymann, "The Evolution of Climate Ideas and Knowledge."

6 Mark Harrison, *Climates & Constitutions. Health, Race, Environment and British Imperialism in India 1600–1850* (Oxford: Oxford University Press, 1999); Simon Schaffer, "Instruments and Ingenuity between India and Britain," *Bulletin of the Scientific Instrument Society* 140 (2019): 2–13.

7 On German colonialism: Sebastian Conrad, "Rethinking German Colonialism in a Global Age," *The Journal of Imperial and Commonwealth History* 41, no.4 (2013): 543–566.

8 Rebekka Habermas, "Protest im Reichstag: Kolonialskandale in der politischen Kultur des Kaiserreiches," in *Alltag als Politik – Politik im Alltag. Dimensionen des Politischen in Vergangenheit und Gegenwart*, ed. Michaela Fenske (Berlin: Lit Verlag, 2010), 281–303; Rebekka Habermas, *Skandal in Togo. Ein Kapitel deutscher Kolonialherrschaft* (Frankfurt a. M.: Fischer, 2016).

of individual volunteers. A significant group of these contributors to climate and weather research that has thus far been overlooked were Christian missionaries.

Missionaries collected weather and climate data at their mission stations and European research stations established in the colonies as part of and during their efforts to Christianize local populations. Their involvement illustrates how climatological knowledge was not only gathered but also actively produced through specific and powerful technological frameworks that shaped the tropical environment in ways that aligned with European scientific and religious worldviews. Furthermore, their measurements laid the groundwork for subsequent colonial development projects. Measuring and recording the environment was the basis for infrastructure initiatives and agriculture, while colonial knowledge production and science were fundamentally intended to enhance development.

The term *environing technologies*, as introduced by Sörlin and Wormbs (2018), refers to these instruments, practices, and systems through which environments are actively created, measured, and governed. In the context of colonial climatology, these technologies included barometers, rain gauges, and systematic weather observations, which enabled missionaries and colonial authorities to translate complex ecological conditions into data aligned with European categories of knowledge. This process was not neutral; it actively reshaped landscapes and weather patterns into forms that could be managed and utilized for colonial development and settlement projects.

Missionaries played a central role in this process by collecting weather data and integrating prediction and measurement practices into their daily mission work. Their ability to record and predict weather conditions became a tool of authority that influenced relationships with local communities and reshaped how space was used and controlled. Yet how did missionaries understand and use these practices? How did they navigate between European scientific frameworks and Indigenous weather knowledge? In what ways did their measurement practices support broader colonial ambitions while also serving religious aims? And how can these practices be seen as environing technologies that transformed both environments and social relations?

These guiding questions structure this article's analysis of missionaries as participants in climate research, showing how they contributed to colonial knowledge production and the technological shaping of environments, and how climate prediction itself became a form of power within the colonial context.

First, this chapter will explore the agendas of missionaries and their scientific roles across various disciplines before World War I, during the heyday of German colonialism. Next, the development of meteorological networks in the German colonies will be situated within the larger context of German climatological research. Thirdly, the contributions of missionaries to meteorological and climatological studies will be examined, focusing on their impact on science and colonialism in relation to the missionary mandate. Finally, the chapter will center on the ethnological research conducted by missionaries. In this context, famous missionaries like David Livingstone and Bruno Gutmann attempted to describe the so-called "superstitions" held by the people they were missionizing to identify points of contact for their preaching. However, the so-called "rainmakers" extensive ecological knowledge was significantly diminished in this research. This interplay of science and religion suggests that missionaries considerably contributed to the erosion of Indigenous knowledge and the standardization of meteorological and climatological research.

1 The missionary endeavour and its contribution to science

At the end of the nineteenth century, Protestant and Catholic missions worked all over the world to convert others to Christianity. In order to convince others of Christianity, missionaries had to carefully navigate various encounters with those they sought to evangelize. The Protestant missionary endeavor started in the eighteenth century, when the Danish-Halle Mission came to the Danish colony and trade center of Tranquebar in 1706. The first missionaries, Ziegenbalg and Plütschau, and others soon founded churches, schools, and orphanages, and they ran a print business in order to print the first versions of the Bible translated into Tamil. Throughout the century, numerous missionary societies were founded within Protestantism, aiming to spread the Christian faith in various non-European, primarily colonially occupied regions, such as the Basel Mission, the North German Mission, the Rhenish Mission, the Leipzig Mission, and the Hermannsburg Mission. These societies were organized as associations and initially operated independently of the churches, despite a significant overlap in personnel. Many of these missionary societies, some with a long history, established mission stations in diverse colonial areas. Several Protestant missionary societies, including the Basel and Leipzig missions, first worked in India under British colonial rule before increasingly expanding into Africa.[9] However, most Protestant

9 Because of a growing interest in colonial and global histories, the history of missions has become increasingly important for historians (see e. g. Kirsten Rüther, *The Power Beyond. Mission Strategies, African Conversion and the Development of a Christian Culture in the Transvaal* (Münster: LIT, 2001); Rebekka Habermas and Richard Hölzl, "Mission global. Religiöse Akteure und globale Verflechtung seit dem 19. Jahrhundert," in *Mission global. Eine Globalgeschichte seit* missionary societies did not perceive themselves as primary colonial actors; rather, the foremost task of their missionaries was not to promote German culture but to spread Christianity. Their religious mandate, based on the contemporary interpretation of the mission mandate, was – at least for the majority of German Protestant missionaries – their main impetus.[10] The "civilising mission" became a "secondary task," but nevertheless remained inseparably interwoven with the "formation of a Christian personality"[11].

Missionaries thoroughly studied the local culture, environment, and religion of their respective mission field. In order to convert as many people as possible and convince them of Christianity, it was considered an important missionary method to preach in the local language and find points of connection in local (religious) circumstances. With the help of interpreters and assistants, one of the first tasks of the missionaries was, therefore, to learn the local language and familiarize themselves with local religious conditions, study the local flora and fauna, and get to know the customs and traditions of the people among whom they were working. They looked for reference points for the sermons, defined prerequisites and levels of knowledge for baptism, or translated the Bible. Hence, missionaries and mission societies were key brokers of cultural contact, agents of cultural

dem 19. Jahrhundert, ed. Richard Hölzl and Rebekka Habermas (Köln/Weimar/Wien: Böhlau, 2014); Linda Ratschiller and Karolin Wetjen, eds., *Verflochtene Mission. Perpektiven auf eine neue Missionsgeschichte* (Köln/Weimar/Wien: Böhlau, 2018), 9–28. Significantly, the entanglements of colonialism and missions have attracted widespread interest. As suggested initially by Jean and John Comaroff in 1989, missionaries have been analyzed as colonial actors who, despite their apparent religious mandate, were essential factors in the so–called "civilization mission". Jean Comaroff and John Comaroff, *Of Revelation and Revolution. Bd. 1: Christianity, Colonialism, and Consciousness in South Africa* (Chicago: University of Chicago Press, 1991); Jürgen Osterhammel, "'The Great Work of Uplifting Mankind'. Zivilisierungsmission und Moderne," in *Zivilisierungsmissionen. Imperiale Weltverbesserung seit dem 18. Jahrhundert*, ed. Boris Barth and Jürgen Osterhammel (Konstanz: UVK Verlag, 2005), 363–426, predominantly because mission societies compiled more than any other colonial institution extensive and detailed archives. Further, recent works suggest that mission societies and their developing media empires were crucial transmitters of colonial imaginations and fantasies "at home," hence widely contributing to the popularization of empire (Susan Thorne, "Religion and Empire at home," in *At home with the empire*, ed. Catherine Hall and Sonya O. Rose (Cambridge, UK/New York: Cambridge University Press, 2006), 143–165; Rebekka Habermas, "Mission im 19. Jahrhundert. Globale Netze des Religiösen," *Historische Zeitschrift* 287 (2008): 629–679.

10 Karolin Wetjen, *Mission als theologisches Labor. Koloniale Aushandlungen des Religiösen in Ostafrika* (Stuttgart: Steiner, 2020).

11 Carl Paul, "Leistungen der Mission für die Kolonien u. ihre Gegenforderungen an die Kolonialpolitik. Vortrag von P. Paul auf dem Kolonial-Kongreß," *Evangelisch-lutherisches Missionsblatt* (1902): 496. Karl von Schwartz, *Mission und Kolonisation in ihrem gegenseitigem Verhältnis* (Leipzig: Missionsverlag, 1908), 9.

translation, and deeply involved with colonialism in various forms, although, and that has also become clear, mission societies and missionaries likewise acted as critics of the colonial rule or as "advocates of the local people."[12]

Missionaries were enthusiastic writers. Their observations and inquiries were not only integrated into their proselytizing efforts and Bible translations (one of their most essential tasks) but also into their depictions of everyday missionary life, which circulated in countless missionary publications for promotional purposes in the German Empire and even in scientific articles and monographs.[13] Recent studies in the history of knowledge have revealed that missionaries contributed to the establishment of various scientific disciplines like botany, ethnology, and linguistics, thereby playing a significant role in the development of a colonial knowledge system.[14]

2 Meteorology and climatology in the German-speaking world

By the end of the nineteenth century, climatology was emerging as a distinct subdiscipline of geography, seeking to establish itself as a natural science. This period marked a significant shift in the scientific approach to climate, often referred to as part of what Susan Faye Cannon described as "Humboldtian science," which was characterized by a growing emphasis on measurement, numerical analysis, and systematic comparison.[15] The term climatology, derived from the German *Klimatologie*, was also shaped by this evolution. Alexander von Humboldt, a pioneer of this method, proposed a methodology centered on mean temperatures and iso-

12 Richard Hölzl and Karolin Wetjen, "Negotiating the Fundamentals? German Missions and the Experience of the Contact Zone, 1850–1918," in *Negotiating the Secular and the Religious in the German Empire. Transnational Approaches*, ed. Rebekka Habermas (Oxford: OUP, 2019), 196–234.
13 Richard Hölzl, "Imperiale Kommunikationsarbeit. Zur medialen Rahmung von Mission im 19. und 20. Jahrhundert," *m&z* 2 (2016): 3–17.
14 Patrick Harries, *Butterflies and Barbarians. Swiss Missionaries and Systems of Knowledge in South-East Africa* (Oxford: Currey, 2007); Sara Pugach, *Africa in Translation. A History of Colonial Linguistics in Germany and Beyond, 1814–1945* (Ann Arbor: University of Michigan Press, 2012); David Chidester, *Savage Systems. Colonialism and Comparative Religion in Southern Africa* (Charlottesville/London: University Press of Virginia, 1996); Alexandra Przyrembel, "Wissen auf Wanderschaft. Britische Missionare, ethnologisches Wissen und die Thematisierung religiöser Selbstgefühle um 1830," *Historische Anthropologie* 19, no.1 (2011): 31–53; David Livingstone, "Scientific Inquiry and the Missionary Enterprise," in *Participating in the Knowledge Society. Researchers beyond the University Wall*, ed. Ruth Finnegan (Houndsmill: 2005).
15 Susan Faye Cannon, *Science in Culture: The Early Victorian Period* (New York: Dawson, 1978).

therms – lines connecting points with the same average temperature – as manifestations of natural laws. In his influential work *Kosmos*, Humboldt introduced the idea of a "comparative climatology," highlighting the statistical analysis of mean annual temperatures and their global patterns.[16] As a result, Humboldt's contributions advanced the development of systematic meteorological observations.[17] By the 1870s, most European nations had established national meteorological institutes, bringing a greater level of professionalism to weather observation. International collaboration began earnestly in 1872 with a meteorological conference held in Leipzig, which set the stage for the first World Congress of Meteorology in Vienna the following year. These meetings facilitated the standardization of meteorological practices, addressing matters such as uniform measurement units, instrumentation, observation schedules, and data sharing through telegraphy and print. This standardization solidified the quantitative nature of meteorology and its claims to scientific legitimacy, building on principles first articulated by the Societas Meteorologica Palatina, the first standardized network of weather observations, which operated thirty-nine stations across Europe and beyond in the eighteenth century.[18]

Climatology's dual focus emerged during this period: first, it aimed to generate knowledge on a global scale, as demonstrated by Humboldt's efforts to map isotherms around the world. Second, it fulfilled practical purposes by providing weather forecasts for navigation, agriculture, and public health. Unsurprisingly, these goals closely aligned with the interests of European colonial empires. Scholars like Katharine Anderson and Fiona Williamson have illustrated how the establishment of meteorological stations in colonial territories was motivated by economic and strategic reasons, particularly the desire to comprehend tropical cli-

---

16 Otto Ette and Oliver Lubrich, eds., *Alexander von Humboldt, Kosmos. Entwurf einer phhysischen Weltbeschreibung* (Frankfurt a.M.: Die andere Bibliothek, 2004); Birgit Schneider, "Die Sichtbarmachung von Klimazonen im Jahr 1817. Eine neue Visualisierung der Klimadaten Alexander von Humboldts," in *Bilder als Denkformen. Bildwissenschaftliche Dialoge zwischen Japan und Deutschland,* ed. Yasuhiro Sakamoto, Felix Jäger, and Jun Tanaka, Sichtbarmachung von Klimazonen (Berlin/Boston: De Gruyter, 2020), 79–90; Arthur Robinson and Helen Wallis, "Humboldt's Map of Isothermal Lines: A Milestone in Thematic Cartography," *The Cartographic Journal* 4 (1967): 119–123.

17 Karl-Heinz Bernhardt, "Alexander von Humboldts Auffassung vom Klima und sein Beitrag zur Einrichtung von meteorologischen Stationsnetzen," *Zeitschrift für Meteorologie* 34, no.4 (1984): 213–217.

18 Per Pippin Aspaas and Truls Lynne Hansen, "The Role of the Societas Meteorologica Palatina (1781–1792) in the History of Auroral Research," *Acta Borealia* 29, no.2 (2012): 157–176.

mates.[19] From its beginning, meteorology and climatology were deeply intertwined with colonial enterprises and attracted considerable public attention and scrutiny.

Gathering and producing meteorological data was, therefore, an integral part of all scientific expeditions. In the context of German colonial expansion during the late nineteenth and early twentieth centuries, scientific expeditions played a pivotal role in advancing climatological knowledge. These expeditions were not merely exploratory ventures but were often meticulously planned operations aimed at collecting empirical data on weather patterns, soil conditions, and other environmental factors and making the tropical environment.[20] German East Africa, Cameroon, and other colonial territories became key sites for such endeavors, as understanding the tropical climate was deemed essential for agricultural planning, infrastructure development, and addressing health concerns related to acclimatization.[21] Expedition leaders and participants, often funded by colonial administrations or scientific institutions, were equipped with standardized instruments for measuring temperature, rainfall, and atmospheric pressure.[22] Detailed instructions ensured that data collection adhered to established protocols, reflecting the broader efforts to professionalize and systematize climatological research, especially as a part of a subdiscipline of geographical research.[23] Beyond their scientific objectives, these expeditions also served as tools of colonial governance, legitimizing European dominance by framing the colonies as landscapes to be quantified and controlled. Additionally, a network of meteorological observations was gradually established in the German colonies. Although weather observations required particular precision and regularity, and weather data was espe-

19 Katharine Anderson, *Predicting the Weather. Victorians and the Science of Meteorology* (Chicago: University of Chicago Pressm 2005); Fiona Williamson, "Weathering the Empire. Meteorological Research in the Early British Straits Settlements," *The British Journal for the History of Science* 48, no.3 (2015): 475–492.

20 Iris Schröder, "Der deutsche Berg in Afrika. Zur Geographie und Politik des Kilimandscharo im Deutschen Kaiserreich," *Historische Anthropologie* 13 (2005): 19–44; Iris Schröder, *Das Wissen von der ganzen Welt. Globale Geographien und räumliche Ordnungen Afrikas und Europas 1790–1870* (Paderborn: Schöningh, 2011).

21 Helen Tilley, *Africa as a Living Laboratory. Empire, Development, and the Problem of Scientific Knowledge, 1870–1950* (Chicago/London: University of Chicago Press, 2011).

22 Jakob Vogel, "Public-private partnership. Das koloniale Wissen und seine Ressourcen im langen 19. Jahrhundert. Einführung," in *Von Käfern, Märkten und Menschen: Kolonialismus und Wissen in der Moderne*, ed. Rebekka Habermas and Alexandra Przyrembel (Göttingen: Vandenhoeck und Ruprecht, 2013), 261–284.

23 Philipp N. Lehmann, "Losing the Field: Franz Thorbecke and (Post-)Colonial Climatology in Germany," *History of Meteorology* 8 (2017): 152.

cially important for agriculture, the expansion of the observation network in the colonies progressed slowly.

For East Africa, the German Naval Observatory in Hamburg, known as the Deutsche Seewarte, the agency responsible for gathering data in the German Empire, recommended establishing two meteorological stations along the coast as late as 1889.[24] The situation in the colony seemed too delicate for the Hamburg scientists to justify the costs of acquiring and transporting sensitive instruments, including various thermometers, a barometer, and at least some rain gauges. After the turn of the century, the expansion progressed much more rapidly, and a main weather station was established in Dar es Salaam, where the only professional meteorologist in the colonial service worked. The situation was not much better in the other colonies either; in German South West Africa, it was mainly non-state actors who collected rainfall data; a full-time meteorologist's post was not authorized there, although many German farmers in this colony were particularly dependent on weather data. In the West African colonies, Togo and Cameroon, conditions were even worse. Therefore, the collection of weather data in the German colonies can be mainly credited to the initiative and dedication of private entities rather than professional meteorologists.[25] Undoubtedly, the recognition of weather observation as a bourgeois activity since at least the nineteenth century played a significant role in this development.[26]

Not least because of the difficult funding situation, as well as the constant workload, the data collection remained mostly unreliable and incomplete. Countless manuals were published to guide observers in taking precise measurements and correctly recording data in prepared measurement books. The Deutsche Seewarte, as the office responsible for overseeing meteorological data collection, emphasized strict adherence to standardized procedures. Observers were repeatedly reminded to diligently complete the forms provided and to exclusively use calibrated instruments to ensure consistency and reliability in their measurements. To reinforce compliance, the Seewarte regularly issued reminders and published detailed instructions, often in the official gazette, *Deutsche Kolonialblatt.* These instructions covered not only the operation of instruments but also specified their proper installation, ensuring uniformity across all observation sites. "Finally, the observer is earnestly requested not to make any inaccurate entries, as meteorology has already suffered much damage due to poor observations. One should al-

24 Jürgen G. Nagel, *Die Kolonie als wissenschaftliches Projekt. Forschungsorganisation und Forschungspraxis im deutschen Kolonialreich* (Habilitationsschrift FU Hagen, 2013), 368.

25 Nagel, *Die Kolonie als wissenschaftliches Projekt.*

26 Anderson, *Predicting the Weather.*

ways bear in mind that an empty space is far better than a dubious observation."[27]

In the colonies, it was primarily doctors who showed an interest in regularly observing weather data. Their scientific curiosity was influenced by longstanding and popular beliefs about the tropical climate and its effects on the body, psyche, and morals of Europeans.[28] However, doctors were mostly stationed at central locations in the colonies and typically arrived only after some colonial infrastructure had been at least partially established. In the hinterland, and even before or during the early days of colonial rule, it was missionaries who emerged as significant contributors to the collection of weather data and climate calculations.

3 Missionaries as climate researchers

As shown above, missionaries were interested in scientific research both as part of and in spite of their main missionary task. The missionaries of the Danish-Halle Mission at the end of the eighteenth century had already increasingly turned to scientific studies.[29] In their natural-theological mission concept, the missionaries assigned Indian nature and knowledge of it a central mediating and translating role between themselves and the Tamils they aimed to convert. Anne-Charlott Trepp argues that while the missionaries contributed to an intensified transfer of knowledge and culture between India and Europe, and although the contrasts between the different cultures tended to diminish at the macro level of a new kind of knowledge transfer, they seem to have deepened at the micro level of intercultural and direct exchange encounters.[30] In this tradition, it is not surprising that missionaries maintained a strong interest in scientific research in later years, especially when their activities aligned with the broader framework of surrounding technologies. Their meteorological studies were not only employed for climatological purposes but were also integrated into larger colonial development

27 Deutsche Seewarte, Instruktionen für meteorologische Beobachtungen in der Äquatorialzone, 73–86, 86; R 1001/6132, National Archives, Berlin Lichterfelde (BArch).

28 See e. g. the various letters in R 1001/6132, BArch; and David Livingstone, "Tropical Climate and Moral Hygiene. The Anatomy of a Victorian Debate," *The British Journal for the History of Science* 32, no.1 (1999): 93–110; Livingstone, *The Empire of Climate.*

29 Keyvan Djahangiri, "Die Dänisch-Englische-Hallesche Ostindien Mission," *South-Asia Chronicle* 2 (2012): 305–349; Ulrike Schröder, *Religion, Kaste und Ritual. Christliche Mission und tamilischer Hinduismus in Südindien im 19. Jahrhundert* (Halle: Verlag der Franckeschen Stiftungen, 2009).

30 Anne-Charlott Trepp, "Von der Missionierung der Seelen zur Erforschung der Natur. Die Dänisch-Hallesche Südindienmission im ausgehenden 18. Jahrhundert," *Geschichte und Gesellschaft* 36, no.2 (2010): 231–256.

strategies aimed at controlling and altering the environment for economic and infrastructural benefits. By incorporating their weather observations into colonial knowledge systems, missionaries actively influenced agricultural planning, settlement strategies, and the adaptation of European lifestyles to tropical climates, thereby reinforcing the interconnectedness of climate science and imperial development.

In the early years of the colony of German South West Africa, the origins of meteorological research lay entirely in the hands of the mission, which had already measured rainfall and temperatures through means of technology before the state took possession of the colony. The Rhenish Missionary Society had already founded the first missionary stations in the area that would later become German South West Africa in the 1840s and was therefore familiar with the environmental conditions of the subtropical colony and its rainfall and temperature conditions long before the German occupation. The Rhenish Mission Society opened its first mission station in Otjikango in 1844 under the leadership of Carl Hugo Hahn. Hahn was very interested in weather and climate records and descriptions, which he recorded in his diaries until around 1859. The detailed reporting system established by the mission also resulted in regular reports on weather and climate, at least regarding their effects on harvests and food security, and sometimes on the possibilities for mission work. His practice exemplifies "environing technologies" as missionaries actively participated in shaping the environmental understanding of the colonies through their structured documentation.

Station chronicles, monthly and annual reports, along with general descriptions of the station in mission papers, typically included references to weather and climate.[31] In later years, there were also missionaries like Johann Böhm (1833–1918), who were particularly invested in weather reports. Böhm first came to South Africa in 1867 and was stationed at a mission in what is now Walvis Bay from 1881 to 1904. After he had been promisingly provided with the usual instruments – various thermometers, a rain gauge, a barometer, as well as anemometer – by the Deutsche Seewarte, he recorded more or less reliable climatic measurement series, which were eventually also incorporated into climatological research and colonial policy considerations.[32] He was by no means alone in this.

Karl Dove, who undertook a study trip to South Africa in 1893, also makes significant reference to the (preliminary) work of the missionaries. In a letter to the

31 Stefan Grab and Tizian Zumthurm, "The land and its climate knows no transition, no middle ground, everywhere too much or too little: a documentary-based climate chronology for central Namibia, 1845–1900," *International Journal of Climatology* 38, no. 1 (2018): e643–e659.

32 Friedrich Stapf, "Notiz über das Klima von Walfischbay," *Deutsche Kolonialzeitung* 4 (1887).

Reichskolonialamt, the colonial office in Berlin, his father, Richard Dove, a church law professor from Göttingen, refers to this data, expressing his son's hope of being able to supplement it with precise calculations of the mean values. In a later publication, Karl Dove cited what he considered to be the flawed measurements made by the missionaries to advocate for an enhancement in the meteorological observation system. In doing so, he seems to consider it particularly important to take the practical aspects of colonization into account.[33] Karl Dove expressed specific concern regarding the proper use of instruments as well as their installation – a topic that was intensely debated in meteorology and climatology.[34] There is considerable evidence to suggest that Dove used data series from missionaries in his climate map of outer tropical Africa from 1888, but he obscured their exact origin.[35] In any case, he was aware of the measurements taken by Rhenish missionaries in Walvis Bay. Especially in the years before 1900, the supply of meteorological data from South West Africa was sparse and irregular. In some cases, the data only reached Hamburg via Berlin more than two years later.[36] This also seems to be a reason why an attempt was finally made to conclude an agreement with a member of the mission, the Rhenish mission "cultural engineer" Walter Borchardt-Ott. According to a contract, the mission representative was to be appointed "Head of Meteorological Observations," with the task of first setting up and then supervising this "branch of service" in the colony. His duties were also to include taking his own measurements. No salary was planned, only reimbursement of expenses, customs and tax benefits.[37] However, the governorate in Windhoek criticised his appointment because his place of work was too far away from Windhoek.[38] Freiherr Alexander von Danckelmann, the leading geographer and meteorologist at the Deutsche Seewarte, on the other hand, defended Borchardt-Ott's appointment, albeit more as a stopgap measure. A written declaration of consent from the Rhenish Mission So-

33 R1991/6139, S. 19 – 23, BArch.

34 Carl Jelinek, *Anleitung zur Anstellung meteorologischer Beobachtungen und Sammlung von Hilfstafeln. 2. Auflage* (Wien: Druck der kaiserliche-königlichen Hof- und Staatsdruckerei, 1876); Hugo Meyer, *Anleitung zur Bearbeitung meteorologischer Beobachtungen für die Klimatologie* (Berlin: Julius Springer, 1891); *Report of the Proceedings of the Meteorological Conference at Leipzig. Translated from the Official Report, Appendix to Vol. VII, Nr. 24, Zeitschrift für Meteorologie* (London, 1873).

35 Karl Dove, *Das Klima des außertropischen Afrikas mit Berücksichtigung der geographischen und wirtschaftlichen Beziehungen nach klimatischen Provinzen dargestellt* (Göttingen, 1888).

36 ,: Landeshauptmannschaft Südwestafrika an Reichskanzlei, 10.1.1896, R 1001, Nr. 6139, 26, BArch.

37 Vertrag, April 1898, R 1001, Nr. 6139, 39, BArch.

38 Gouv. DSWA an KA, 21.04.1898, R 1001, Nr. 6139, 43, BArch.

ciety was available in any case, even if a different solution was ultimately found, when a colonial official was appointed for the task.[39]

However, officials and scientists in other colonies also relied heavily on the help of mission members in order to even come close to meeting the standards of regular weather measurements. For instance, the missionaries of the Berlin Missionary Society for East Africa regularly took weather measurements and forwarded the results to their mission house. When the governor of the East African colony learned about this, he promptly suggested to the Imperial Colonial Office or the Naval Observatory that these values be utilized for scientific purposes.[40] Missionaries from the Leipzig Mission, for example, regularly supported the measurements at the scientific research station on Kilimanjaro in the colony of German East Africa. The advantage was obvious. The missionaries were stationed in one place for an extended period, were familiar with the local staff – even though their assistance with the measurements was not requested by the Deutsche Seewarte – so they took on this task, much like Borchardt-Ott, without any additional compensation. Their many years of experience also enabled them to better evaluate the typical or atypical nature of local weather events. Like the Rhenish missionaries, the Leipzig missionaries frequently reported home about the weather and climate in their updates. Accounts of drought, food scarcity, locust plagues, and floods during the rainy seasons provided essential information in the regular station reports, which aimed, among other things, to highlight the missionaries' significant readiness to make sacrifices. For instance, torrential rains did not deter Leipzig missionary Gerhard Althaus from celebrating Easter with several church services, nor did drought and rising prices compel him to cease his missionary efforts.[41]

As these examples have shown, missionaries made an important contribution to weather and climate measurement in the meteorological sense, especially in the early days of the development of meteorological research stations. Their engagement exemplifies how technology functioned as a means to form an environment, as they actively structured and mediated colonial climatic knowledge through systematic measurement practices, contributing to the further application of this knowledge in both scientific and practical environmental exploitation

39 Nagel, *Die Kolonie als wissenschaftliches Projekt*, 375.

40 Soden an Reichskanzlei, Daressalam 5.7.1892, R1001, 6135, 46–53, BArch.

41 Evangelisch-lutherisches Missionsblatt 1899, 307; Ostern in Mamba am Kilimandscharo, in: Lutherisches Missionsvolksblatt 18 (1906); Teuerung am Kilimandscharo, in: Lutherisches Missionsvolksblatt 21 (1909); Karolin Wetjen, *Das Globale im Lokalen. Die Unterstützung der Äußeren Mission im ländlichen lutherischen Protestantismus um 1900* (Göttingen: Göttinger Universitätsverlag, 2013), 75.

and development, particularly in agricultural initiatives, sometimes even undertaken by the mission societies themselves. At the same time, their contributions were not limited to collecting weather data or describing the climate. In their missiological research, weather and climate also played a role when they described the local ecological knowledge of the people they were trying to convert. In their research as well as their practices, they powerfully diminished local climate knowledge led by their Humboldtian vision of standardized numerical knowledge and rational epistemology.

4 Missionaries' ethnologies and the dismissal of local climate knowledge

Missionaries conducted comprehensive religious-ethnographic studies in which they sought references for sermons and lessons.[42] As a result, missionaries significantly contributed to the collection of ethnographic and religious studies materials, playing an important role in the formation of these sciences.[43] Especially before the First World War, missionaries had the opportunity to publish religious studies, as well as ethnographic or historical works about the people they missionized, through their missionary societies, which also functioned as agents in the (proto-)scientific community of these disciplines. Not all missionaries were as successful as the Leipzig missionary Bruno Gutmann, who earned two honorary doctorates for his ethnographic studies.[44]

42 This principle, which finds its starting point in the Areopagus speech, has been emphasised repeatedly by researchers. Altena, for example, asserts that missionaries were only interested in non-European religions to the extent that they could be exploited according to the quarry principle. Thorsten Altena, *Ein Häuflein Christen mitten in der Heidenwelt des dunklen Erdteils". Zum Selbst- und Fremdverständnis protestantischer Missionare im kolonialen Afrika 1884–1918* (Münster u. a.: Waxmann, 2003), 115–116; Wetjen, *Mission als theologisches Labor.*

43 A number of works have been published in recent years on the missionaries' research into religion. See, for example Rebekka Habermas, "Wissenstransfer und Mission. Sklavenhändler, Missionare und Religionswissenschaftler," *Geschichte und Gesellschaft* 36, no.4 (2010), 257–284; Chidester, *Savage Systems.*

44 Karolin Wetjen, "Entangled Mission: Bruno Gutmann, Chagga Rituals, and Christianity,1890–1930," in *Global Protestant Missions. Politics, Reform, and Communication, 1730s–1930s*, ed. Jenna Gibbs (London/New York: Routledge, 2020), 209–230; Klaus Fiedler, *Christentum und afrikanische Kultur. Konservative deutsche Missionare in Tanzania 1900–1940* (Gütersloh: Mohn, 1983); Ernst Jaeschke, *Bruno Gutmann – His Life, his Thoughts and His Work. An Early Attempt at a Theology in an African Context* (Erlangen: Missionsverlag, 1985).

Such studies were essentially collections of the customs and traditions of the people and other religious beliefs. Since the descriptions were essentially used to identify points of contact for doctrine, they followed European categories of religious studies when looking for a belief in God, for example.[45] In this sense, the missionaries often even "invented" religions when they pressed their mostly incomplete observations and reflections into a system of religious studies.[46] The category of superstition played an important role in this, characterising fetish practices, naturalistic belief in spirits or "idols." In the description of these religious practices, "rain-making" or "rain-binding" practices often played a role, which the missionaries dismissed as superstition in this context.[47]

Rainmaking has long been a central aspect of African traditional religious practices, deeply rooted in the careful observation of weather patterns, flora, fauna, and astronomical phenomena.[48] Rainmakers, often regarded as possessing sacred authority and unique knowledge, were believed to have the ability to influence or manipulate natural phenomena. Their expertise in rainmaking and rain prevention was built upon centuries-old climate knowledge, passed down through generations via proverbs, songs, and dances. This practice, varying across communities, remained shrouded in secrecy and held a prestigious status, often reserved for elite and powerful families.

The reliance on rainfall profoundly shaped the socio-political organization of African societies. Rainmaking rituals, believed to ensure the timely arrival of life-sustaining rains, were not only religious acts but also ways to exert control over the natural world. Anthropologist Todd Sanders has studied these rituals and their embedded gender concepts, focusing on the Ihanzu people of Tanzania, who lived in a semi-arid region of the German East African colony. Among the Ihanzu, the royal Anyampanda clan rainmakers held a position of immense influence within the regional rainmaking economy. Their climate expertise extended beyond rain rituals to preparing war medicine and mediating significant social and political matters. The prominence of the Ihanzu rainmakers even attracted

45 Wetjen, *Mission als theologisches Labor.*, 105–114 with further references.

46 See e. g. Geoffrey A. Oddie, *Imagined Hinduism: British Protestant Missionary Constructions of Hinduism, 1793–1900* (New Dehli/Thousand Oaks/London: Sage, 2006).

47 See for example: Johannes Ittmann, *Kameruner Manuskripte. Die Religion im vorderen Kamerun*, Chap. 1, https://www.johannes-ittmann.de/site/band3.htm.

48 N. G. Christian, 'The Impact of Climate Change on African Traditional Religious Practices', *Earth Science & Climactic Change*, 5 (2014); Onah, 'Rain-Making among the Igbo, with Particular Reference to Nsukka People', cited by A. Ossai and J. E. Madu, 'Exploring Rain-Making and Rain-Prevention as Instruments of Peace-Building in Ezimo Community, Nsukka Cultural Area of Igboland', *Ohazurume: Unizik Journal of Culture and Civilization*, 3 (2024): 31; J. S. Mbiti, *African Religion and Philosophy* (Ibadan: Heinemann, 1979), 181.

neighboring communities, who undertook pilgrimages to seek their assistance when their own rituals failed.[49]

One of the earliest and most groundbreaking descriptions of a missionary's encounters with a so-called rainmaker, who was confident in his local power, was written by David Livingstone.[50] Livingstone, a prominent nineteenth-century missionary and explorer, became one of the most iconic figures of his time. Renowned for his extensive expeditions across southern and central Africa, he pursued a dual mission: spreading Christianity and exploring the continent. Livingstone's detailed accounts of his travels captivated European audiences, shaping perceptions of Africa and its people.[51] In the 1840s, Livingstone converted the "rain doctor" Sechele to Christianity, with rainmaking being an important part of Sechele's life. Although Sechele eventually chose to abandon the practice in favor of Christianity, he initially sought to convince Livingstone of the effectiveness of his own practices and ecological knowledge. However, Livingstone, confident in his Christian faith and scientific training, insisted on a test, which Sechele vehemently refused. This dialogue revealed the clash between different cosmologies and rationales.

However, the resulting devaluation of rainmaking as superstition had two aspects: First, from a Christian missionary point of view, any form of magic seemed unacceptable. Secondly, by the nineteenth century, Christian missionaries were already highly trained in modern, scientific, rational methods. This was also reflected in the increasing devaluation of weather and land divination in Europe in the nineteenth century. This twofold rejection even led to missionaries presenting themselves as the "rain makers of a competing power," as Jean and John Comaroff show in their account of the introduction of irrigation systems by European missionaries among the Tsawana.[52]

---

49 T. Sanders, *Beyond Bodies. Rainmaking and Sense Making in Tanzania* (Toronto: University of Toronto Press, 2009), 74.

50 David Livingstone, *Missionary Travels and Researches in South Africa* (London: John Murray, 1857), 23–25; Brian Stanley, "The Missionary and the Rainmaker: David Livingstone, the Bakwena, and the Nature of Medicine," *Social Sciences and Missions* 27 (2014): 145–162; Jean Comaroff and John Comaroff, *Of Revelation and Revolution. Vol. 1: Christianity, Colonialism, and Consciousness in South Africa* (Chicago: University of Chicago Press, 1991), 206–213.

51 Anna Johnston, "British Missionary Publishing, Missionary Celebrity, and Empire," *Nineteenth Century Prose* 32, no.2 (2005): 32–47.

52 Jean Comaroff and John Comaroff, "The Colonization of Consciousness in South Africa," *Economy and Society* 18, no.3 (1989): 274.

As late as the 1930s, Catholic as well as Protestant missionaries still described rain magic as superstition.[53] The aforementioned Bruno Gutmann, for example, wrote a lengthy treatise on the "field cultivation customs of the Wadschagga," who lived on Kilimanjaro, the "highest German mountain" in the colony of East Africa. In the journal for ethnology, *Zeitschrift für Ethnologie*, Gutmann described the cultivation and irrigation methods alongside incantations against pests, and particularly addressed the practices of rainmaking associated with the rule, power and prestige of the Chagga:

> The art of rainmaking requires a great deal of preparation. More important to the rainmaker, however, is his oracle, which indicates when rain will come. To call upon his oracle, the rainmaker draws water from all the springs in the country into a pot that has been dug into the ground at the grave of his Yater. If bubbles rise, the father indicates rain. But if the water remains still, he says: 'The father does not want to announce anything.' However, the first cumulus clouds over the Pareb mountain are more reliable weather signs for him, indicating that rain will also fall on Kilimanjaro in a few days. He tries to delay the incantation until these first signs appear. If the chief, at the suggestion of his men, sends him gifts of beer and meat and asks him to bring the rain, then, depending on the signs, he will either quickly finish his preparations or try to extend them over as long a period as possible.[54]

The rainmaker, whose incantation is described in great detail, is exposed by Gutmann as a conjurer who, should the hoped-for rain fail to materialise, did not shy away from further accusations, demands for further sacrifices and lies.[55] Even sacrificing children for rain was not considered unlikely by Gutmann.[56] Such descriptions by missionaries were certainly effective narratives in the claim for colonial power and moral authority. Not only were the Germans already aware of the special power of the rainmakers and their claim to land and power during the colonial period, and therefore persecuted them particularly brutally as (supposed) instigators of uprisings.[57]

These descriptions of the knowledge of "rain magic" as a conjuring trick also had a long-term effect, not least because missionaries so clearly defamed the ecological understanding of rain, cloud formation, and climate, as well as the centuries-old observations of flora and fauna attributed to the "rain magicians." Such knowledge was not in line with the statistical and numerical measurements

53 Albert Aufinger, "Wetterzauber auf den Yabob-Inseln in Neuguinea," *Anthropos* 34 (1939): 277–291.

54 Bruno Gutmann, "Feldbausitten und Wachstumsbräuche der Wadschagga," *Zeitschrift für Ethnologie* 45, no.3 (1913): 486 [my translation].

55 Gutmann, "Feldbausitten und Wachstumsbräuche der Wadschagga," 487–488.

56 Gutmann, "Feldbausitten und Wachstumsbräuche der Wadschagga," 489.

57 Sanders, *Beyond Bodies*, 74.

based on measurement techniques in the Humboldtian tradition, which, with its emphasis on quantitative data, increasingly replaced qualitative weather observations. Hence, this knowledge found no justification in research into weather and climate through a Eurocentric epistemology, and it is only recently that this knowledge has been increasingly referenced, but it is still primarily used as a proxy in the IPCC's climate calculations.[58]

5 Conclusion: standardization, exclusion, and the layers of climatological knowledge

This chapter has demonstrated how climatology, emerging as a modern scientific discipline, became deeply entwined with the colonial agendas of European empires. German colonial territories serve as a compelling case of how missionary activities and the systematic collection of meteorological data intersected with both imperial ambitions and religious motivations. Missionaries, positioned at the nexus of colonial infrastructure and local communities, played a pivotal role in early climate research by establishing observation networks and contributing to climatological knowledge production. However, missionaries were not just passive observers but active participants in the construction of climatic knowledge through technological interventions. Their use of barometers, thermometers, and rain gauges at mission stations did not merely serve scientific ends but also functioned as tools of environmental control and colonial administration. The concept of *environing technologies* is crucial here, as it helps contextualize how mis-

58 Bianca van Bavel, Joanna Petrasek Macdonald, and Dalee Sambo Dorough, "Indigenous Knowledge Systems," in *A Critical Assessment of the Intergovernmental Panel on Climate Change*, ed. K. de Pryck and Mike Hulmes (Cambridge: Cambridge University Press, 2022), 116 – 125. Rain-making practices have only recently been further acknowledged as part of discussions on the severe impacts of climate change on African communities. In this context, several academic papers refer to rain-making practices as a traditional solution for local climate change resilience, or rather an additional source of knowledge for climate science today. E. g. Sussy Gumo, "Praying for Rain. Indigenous Systems of rainmaking in Kenya," *The Ecumenical Review* (2017), 386 – 397; Timothy Marango, Joseph Francis, and Mushaisano A. Mathaulula, "Insights Into The Potential Of Indigenous Rain Making Practices in Combating the Negative Effects of Climate Change in Chimanimani District of Zimbabwe," *Indilinga. African Journal Of Indigenous Knowledge Systems* 15, no.2 (2016), 187– 204; Anayo Ossai and Jude Emeka Madu, "Exploring Rain-Making and Rain-Prevention as Instruments of Peace-Building in Ezimo Community, Nsukka Cultural Area of Igboland," *Ohazurume: Unizik Journal of Culture and Civilization* 3, no.3 (2024), 26 – 43. On "resilience" as a focus: Dagomar Degroot et al., "Towards a rigorous understanding of societal responses to climate change," *Nature* 591 (2021), 539 – 550.

sionaries' scientific engagements contributed to the making of colonial climates, both materially and epistemologically. By mapping climatic patterns and defining what constituted reliable meteorological data, missionaries participated in the broader process of inscribing imperial authority onto the environment. This process also systematically excluded evidence-based practical climate knowledge from European scientific efforts to understand weather phenomena and climate patterns, creating a significant epistemological divide.

Rainmaking practices, a cornerstone of African societies' ecological knowledge, were a prime example of this marginalization. The intersection of missionary activities and local rainmaking practices often highlighted tensions between European and Indigenous knowledge systems. Missionaries like David Livingstone viewed rainmaking rituals as barriers to conversion and often sought to discredit them as superstitious or pagan practices. However, their efforts sometimes inadvertently documented the complexity and significance of rainmaking knowledge, as evidenced in the accounts of missionaries who recorded local practices while attempting to replace them with Christian rituals. Such interactions reveal the deep entanglement of climate knowledge with colonial and religious agendas. These agendas were shaped by missionaries' dual goals of promoting Christianity and supporting civilization. Missionaries influenced by enlightened, modern, and scientific thought, dismissed Indigenous practices, such as rainmaking, as superstitions incompatible with Christian teachings, framing them as obstacles to both religious conversion and civilization. This dynamic not only delegitimized Indigenous ecological expertise but also reinforced the broader power structures of imperialism.

German colonial authorities and missionaries, hence, actively sought to delegitimize these practices, framing them as incompatible with both Christian beliefs and modern scientific methods. At the same time, the climate expertise embedded in these traditions often found its way into missionary ethnographic accounts and colonial policy discussions, albeit stripped of its original context and significance.

The history of climatology cannot be disentangled from its colonial underpinnings. The discipline's reliance on standardized methods, calibrated instruments, and data infrastructures facilitated the centralization of Eurocentric knowledge systems while systematically excluding Indigenous ways of knowing. These processes shaped not only the scientific understanding of tropical climates but also the broader power dynamics between colonizers and the colonized, and they found their way into colonial development fantasies and dreams to alter the tropical environment through climate engineering.[59]

59 Lehmann, *Desert Edens.*

Eleanor Choo

Supplying and sustaining the nervous system of the world (c.1850 to 1939)

Introduction

> It is the duty of all States to foster, guard, and conserve the natural resources of the country …The King George V National Park…will create a permanent refuge for the fauna and flora of that portion of Malaya that lies directly around Gunong Tahan…It will [retain] the ancient beauties of a primeval wilderness.
>
> – Theodore Hubback, "Preserving Primeval Malaya for Modern Man," *The Straits Times*, May 10, 1939.

Between 1938 and 1939, Southeast Asia's first national park was negotiated into existence.[1] Located on the eastern side of the Malay Peninsula, the King George V National Park (renamed Taman Negara following Malayan independence from Britain in 1957) was formed by combining three bordering areas in the neighboring sultanates of Terengganu, Kelantan, and Pahang.[2] Theodore Hubback, a one-time rubber planter, engineer, and big-game hunter based in the eastern peninsular state of Pahang, took it upon himself to make the park a reality. First, he successfully harangued Britain's King George V for permission to survey the condition of the Malay Peninsula's forests and wildlife.[3] Following the results of this survey, he lobbied Sultan Sulaiman of Terengganu, Sultan Ismail of Kelantan, and Sultan Abu Bakar of Pahang to set aside portions of their lands towards this park, which they agreed to do as a silver jubilee gift to George, a fellow monarch.[4] Unlike the already existing forest reserves administered by the Straits Set-

Note: Research in this chapter is supported by the South, West and Wales Doctoral Training Partnership (SWWDTP2), which is funded by the Arts and Humanities Research Council (AHRC, part of United Kingdom Research and Innovation (UKRI).

1 H. Z. Pakhriazad et al., "Historical and Current Legislations of Taman Negara National Park Peninsular Malaysia," *Journal of Politics and Law* 2, no.1 (2009): 44 – 49.
2 Pakhriazad et al., "Historical and Current Legislations," 44.
3 Mathieu Guérin et al., "A favourable shift towards public acceptance of wildlife conservation in Peninsular Malaysia: comparing the findings of the Wild Life Commission of Malaya (1932) with a recent survey of attitudes in Kuala Lumpur and Taiping, Perak," *Malayan Nature Journal,* Special Edition (December 2017): 21 – 31.
4 Guérin et al., "A favourable shift," 22.

https://doi.org/10.1515/9783111611358-009

tlements and Federated Malay States Forestry Department (hereafter called the Forestry Department), which were expected to produce forestry products for commercial gain, the flora, fauna, and natural features of the new park would be protected from extraction, hunting, and commercial activities.[5]

Taman Negara's founding is often retold as a victory of one man's tenacity or, more neutrally, from the point when the three sultans agreed to its establishment.[6] This chapter will instead show that the foundations for Taman Negara, from concept to execution, were instead established earlier in 1850 with the success of the first submarine telegraph cable laid between Dover, England and Calais, France.[7] The key to the cable's "submarine" capability was a tree latex native to maritime Southeast Asia called gutta-percha, the best and only known undersea insulation plastic of its time.[8] Its thermoplastic properties enabled it to be molded into any shape when heated, hardening and retaining that shape when cooled.[9]

Simply put, without gutta-percha trees, the nineteenth-century revolution in global telecommunications that saw submarine telegraph cables laid across the world would not have been possible. Gutta-percha, this now-obscure latex, made global same-day cross-oceanic communications a reality for the first time in history. It was also the inspiration for the invention of commercial artificial plastic.[10] Not only was it waterproof and seawater resistant, but its insulation properties also improved with depth under seawater, hardening in cool temperatures without going brittle over time like rubber. Extracted from several species of trees (especially the *Palaquium gutta*, *Palaquium oblongifolium*, and *Payena leerii* trees, generally referred to as gutta-percha trees or Taban), the latex was known to be difficult to harvest due to how rapidly it hardened upon exposure to air.[11] It was also believed that industry-relevant gutta-percha only grew in the Malay Peninsula, and islands of Borneo, the Lingga and Riau archipelagoes, Singapore, and Sumatra.[12] As a result, the global cable network came at a price, the sacrifice of an estimated eighty-eight million trees, and what many at the time believed to

5 "Preserving Primeval Malaya."

6 Pakhriazad et al., "Historical and Current Legislations," 44.

7 G.L. Lawford and L.R Nicholson, *The Telcon Story 1850–1950* (The Fanfare Press, 1950).

8 Cassie Newland. "Economic Objects," in *A Cultural History of Objects in the Age of Industry*, ed. Carolyn L. White (London: Bloomsbury Publishing, 2022), 57–76.

9 Newland, "Economic Objects," 56.

10 Newland, "Economic Objects," 75.

11 Eugene de Obach, *Cantor lectures on gutta percha* (1898), 15., TCM/27/26, Telegraph Construction and Maintenance Company Ltd, Caird Library, National Maritime Museum, Greenwich, London.

12 Obach, "Cantor lectures," 15.

be its near extinction.[13] Politically, amongst the club of empires, the British and Dutch were seen to have been handed a monopoly on global communications due to their access to this specialized material that made this possible.

Thankfully, gutta-percha trees survived. Their current obscurity in modern-day society, however, disguises a complex late-nineteenth to early twentieth-century story about experimental sustainability in a transimperial world that has not yet been studied in historical scholarship. This chapter will show that, instead, from 1850 to 1900, it was not the British and the Dutch empires that monopolized the existence of global communications, but their trade partners in the Malay Peninsula and Indonesian Archipelago. The telegraph industry relied wholly on maritime Southeast Asia's centuries-old trade network, knowledge, and customs to access gutta-percha and learn its properties. These pre-colonial customs, economy, norms, and networks were preserved through the structures of local sultanates; themselves modeled off the memories of the many thassalocratic empires within the region that preceded them. For the British and Dutch empires to obtain the necessary materials to construct cables, posts, and telegraphs to showcase their enlightenment-driven empires, they had to appeal to the personal ambitions and priorities of local actors within this region. These latter parties monopolized forest access, gutta-percha knowledge, and labor.

By providing access to their gutta-percha knowledge and facilitating its supply, these maritime Southeast Asian actors became significant partners in the invention and construction of an effective global submarine telegraph cable network. The network would not have existed without them or their cooperation. This transimperial perspective challenges the conventional view that the world's first global telecommunications network was a European invention that was disseminated to the world.[14] Instead, through the myriad materials this network required, sourced from different regions of the world, this global network is revealed as a truly global invention that necessitated the various local expertise related to these materials. This chapter uses gutta-percha as a case study of maritime Southeast Asia's contribution.

At the turn of the century, however, power in gutta-percha's homeland increasingly shifted into British and Dutch favor as the latex featured less in conversations about communications technology, and more in those around conservation and sustainability. So far, this environmental chapter in telegraph and

---

13 John Tully, "A Victorian Ecological Disaster: Imperialism, the Telegraph, and Gutta-Percha," *Journal of World History* 20, no.4 (2009): 559–79, here 575.

14 See Tully, "Victorian Ecological Disaster," and Bruce Hunt, "Insulation for Empire: Gutta-Percha and the Development of Electrical Measurement in Victorian Britain," in *The Victorians: A Botanical Perspective*, ed. L.M. Mendonça de Carvalho (Cham: Springer Nature, 2024) as examples.

gutta-percha history has remained underexplored but deserves as much focus as its extraction-based years.

In Southeast Asia, gutta-percha instigated the British colonial government to experiment with forest conservation and gutta-percha sustainability in the Malay Peninsula, passing anti-extraction and export laws there in 1900.[15] This act separated the peninsula even more from the rest of the Malay archipelagic world, where forest harvesting continued as before. In this conservation Petrie dish, Britain established a forestry department to cement itself as the authority over the peninsula's natural resources, while the world's largest cable manufacturer, the British Telegraph Construction and Maintenance Company (Telcon) established a private gutta-percha plantation to both discourage wild felling and conduct chemistry experiments on gutta-percha in hopes of furthering cable innovation.[16] Back in Europe and America, industrialists established research departments to search for and create alternate materials for gutta-percha and recycled existing gutta-percha supplies.[17]

In most telegraph histories, gutta-percha is broadly discussed in early chapters to explain the origins of submarine telegraph cables. Following from these works, this chapter uses an inverse approach, broadly discussing submarine cables to explain the origins of gutta-percha's industrial demand, but using a gutta-percha-centric study instead. This simple shift opens new perspectives on telegraph history, including its environmental impact and influence on environmental movements, and provides deeper insight not just into the telegraph industry's relationship with governments, but also with non-Western regional actors.

This work is not the first to use this approach (Helen Godfrey's book *Submarine Telegraphy and the Hunt for Gutta Percha* is the most extensive work using this approach to date), but it is still relatively new in telegraph historiography, leaving much to be discovered. Where Godfrey focused on Borneo, this work examines the Malay Peninsula more closely, made distinct due to its forestry laws. It is essential to continue this approach of centering gutta-percha because it necessitates centering its Southeast Asian homeland within the context of telegraph his-

15 Helen Godfrey, *Submarine Telegraphy and the Hunt for Gutta Percha: Challenge and Opportunity in a Global Trade* (Leiden and Boston: Brill, 2018), 188.
16 Lawford and Nicholson, *Telcon Story*; J.W. Sewill, draft of an article entitled "The Great Pahang Flood of 1926," RCMS103 BAM, Fonds, Archives of the British Association of Malaysia and Singapore, Cambridge University Library, Cambridge, United Kingdom.
17 Chemical Branch Report on Gutta-Percha Resin substitute for sticky tape, Henley's Research Department, DOC/WTHTN/3/13, PK Porthcurno Archives, Porthcurno, United Kingdom; C. de F. Chandler, "Submarine Telegraph Cables," *Scientific American* 127, no.2 (August 1922): 90 – 91; Lawford and Nicholson, *Telcon Story.*

tory. This approach reveals previously overlooked actors and knowledge on how local interests and environments shaped innovations in communications technology. It becomes especially apparent that European botanical knowledge about gutta-percha was strongly influenced by their Southeast Asian trade partners. As harvesters, merchants, and rulers from these gutta-percha homelands benefited greatly from exporting gutta-percha to Europe, the information they shared was colored through their own priorities regarding their profits, time, and personal power.

Additionally, this gutta-percha-centric approach encourages looking past submarine telegraphy's boom years into 1939. Where previously, gutta-percha was central to global communications, its scarcity became the catalyst for the British government in the Straits Settlements and Federated Malay States to establish the peninsula's first forestry department and for the British to work more closely with the Dutch on economic botany.[18] Gutta-percha becomes a lens through which we can see the maritime Southeast Asian world's transition to the more terrestrial norms introduced by Europeans, and how early twentieth-century experiments with industrial sustainability and conservation were directly influenced by gutta-percha's scarcity.

By stopping the gutta-percha story in 1900, it seems to end with the telegraph industry "destroy[ing] the very trees that made its existence possible."[19] While an apt warning to us and future generations, it is also important to continue this story into 1939 to examine how the industry's dependency on gutta-percha compelled it to attempt reversing this damage. Their approaches to sustainability and environmental control, as well as the impact these actions had, also offer valuable insights for our present and future attempts to resolve our own conflicts between extraction and sustainability.

This gutta-percha story, from accessories to cables and conservation, also emphasizes the importance of seeing environment, technology, and development as integrated parts. Studies on resource extraction are incomplete without also delving into the necessary conundrum of sustained availability and the impact of this resource on society, and vice versa. Gutta-percha enabled people to develop a means of overcoming an environmental challenge – in this case, the wide expanses of the oceans that hindered communication. However, telegraph technology was limited, both by physical access to gutta-percha's natural environment and social access through the communities that lived within this environment. This en-

18 "Gutta in Malaya," *The Straits Budget*, October 13, 1900; James Gilbert Watson, "The Wealth of the Jungle," *Inter-Ocean Magazine – A Netherlands East-Indies Magazine Devoted to Malaysia and Australasia*, January 20, 1928, PK Porthcurno Archives, Porthcurno, United Kingdom.

19 Tully, "Victorian Ecological Disaster," 579.

vironment would be subject to change, as gutta-percha's industrial success brought more attention from imperial powers to maritime Southeast Asia, where the cycle would repeat as in many other places in the world.

Feeding the network and feeding the myths (c. 1845 to 1900)

When European explorers or telegraph industrialists mentioned their local partners in the gutta-percha trade, it was usually to complain: the harvesters were unenlightened and simple natives who cut down gutta-percha trees indiscriminately with no regard for the future, merchants were unscrupulous scammers who diluted gutta-percha blocks to charge more money, and local rulers were so unfair to the previously mentioned natives that European colonizers would rule more benevolently.[20] At face value, these complaints evoked a chaotic and haphazard image of gutta-percha's homeland. Beneath the surface however, the complaints also communicated the telegraph industry's lack of control over their most precious ingredient at all stages of the supply chain, from sourcing to pricing, and labor. While Britain and the Netherlands had colonies in the Malay Peninsula and Indonesian Archipelago at this time, their influence was limited to specific port cities and not the interior where gutta-percha lived. Even this influence largely relied on agreements with local rulers.[21]

Such a chaotic and haphazard society would not have possessed the organization required to manage the supply-chain or structures required to successfully meet the global industrial demand for gutta-percha during the boom years of cable construction. Not only did this supply chain have to be rapidly adaptive as gutta-percha was not a popular forestry product before the 1840s, but the latex had to be extracted at levels previously unseen in maritime Southeast Asia's long commercial history.

This section argues that the first submarine telegraph cable network owes its existence to Southeast Asia's centuries-old maritime trade network; a sophisticated system that had been designed for global trade and evolved over time from before the second century to adapt to ever-changing and expanding definitions of

20 Non-exhaustive examples of such literature includes Obach, "Cantor Lectures"; Logan, "Gutta in Malaya," and more that will be discussed later in this chapter.
21 "Netherlands-India government gutta percha plantations – Tromp de Haas, W.R," 1908, University of Leiden Special Collections, KIT Collection, Br G 79–78, Leiden, the Netherlands.

"global."[22] As long as fellow merchants and markets were reachable by sea, the network could, and ideologically, should, connect and sell to them. In a 1468 letter from Sultan Mansur of Melaka to King Shō Toku of Ryukyu, he expressed the importance of these maritime commercial connections as a responsibility for common betterment: "…to master the blue oceans, people must engage in commerce and trade, even if their countries are barren…All the lands within the seas are united in one body, and all living things are being nurtured in love; life has never been so affluent in preceding generations as it is today."[23]

Where did this network come from? Due to its maritime-based archipelagic geography and proximity to East and South Asia, the region has been home to numerous commercial archipelagic empires that enriched themselves by establishing trading ports and exporting forest goods throughout the Indian Ocean and South China Sea.[24] The most famous of these is the Melaka Empire, which reached its height in the late fifteenth century and fell to Portuguese conquest in 1511. After its fall, Melaka gave rise to two successor states, founded by each of the exiled Sultan's sons – Perak and Johor.[25] The Johor Sultanate, which later became the Johor-Riau Empire, would eventually establish dominion over the islands to its south (now Singapore and the Lingga islands), islands to its east (now the Riau archipelago islands, stretching across to Natuna Sea to Borneo), and Indragiri in Sumatra to its west.[26]

The most popular telling of how gutta-percha came to the attention of European industry is set in Singapore. In this story, in 1842, a Malay merchant (or hunter or laborer, the texts do not agree on the profession, but it is possible that he was a combination of any of these, depending on the opportunity) in Singapore taught a Scottish doctor about gutta-percha's properties and sold him a blade with a handle made of the latex. By 1846, even before gutta-percha was used in submarine telegraph cables, industrializing European states had fallen in love with gutta-percha for similar reasons that plastic has become so essential to our society today.[27]

---

22 Anthony Reid, *Southeast Asia in the Age of Commerce 1450–1680. Volume Two: Expansion and Crisis* (New Haven: Yale University Press, 1993), 1.

23 Reid, *Southeast Asia in the Age of Commerce, vol. 2*, 10.

24 M. C. Ricklefs, "The Arrival of the Europeans in Indonesia," in *A History of Modern Indonesia since 1300*, ed. M. C. Ricklefs (London: Red Globe Press, 1993), 23–24.

25 Leonard Y. Andaya, "Johor-Riau," in *Southeast Asia: A Historical Encyclopedia, from Angkor Wat to East Timor,* ed. Ooi Keat Gin (Santa Barbara: ABC-CLIO, 2004), 698

26 J.R. Logan. "The Orang Binua of Johore," *The Journal of the Indian Archipelago and Eastern Asia* 1, no.1 (1847): 261.

27 "Court of Common Pleas. Feb 6," *The Straits Times,* May 14, 1850.

Gutta-percha was used to make a large variety of products, ranging from small and intricate jewelry to large boats, to medical casts and listening devices.[28]

Before gutta-percha became a top-selling product in Europe, it was not a star forestry product for the communities based in the peninsula and Sumatra, these were usually aromatics and medicinal products such as camphor.[29] Local community uses for gutta-percha varied by area. Indigenous communities on the peninsula (hereafter called Orang Asli in line with the community's preferred naming) in Johor reportedly ate the seeds, while over the Malacca Strait in Sumatra, Minangkabau Malay communities in Siak also extracted vegetable oils from the seeds.[30] Other general uses included lining and waterproofing bowls, making sculptures and tools such as oxen whips, and handles for weapons and tools.[31]

With industrial demand coming from Europe in the 1840s, however, this changed. Temenggong Daeng Ibrahim, the most powerful man in the Johor Sultanate, saw an opportunity and declared a royal monopoly over gutta-percha.[32] He utilized Johor's centuries-long established trade network, including its manpower and connections, to specialize in supplying gutta-percha to the hungry European market. As profits and demand grew, the Temenggong forcefully relocated entire Orang Asli communities from their island homes in Singapore and the Riau-Lingga islands to Johor to scour those forests for gutta-percha trees.[33] Word of mouth brought in more labor as plucky entrepreneurs chased the rumored 400 per cent profits to further scour the islands between the Malay Peninsula and Borneo for more and more gutta-percha trees until it reportedly became extinct in Singapore, scarce in the Riau-Lingga archipelago, and increasingly difficult to find in Johor. During this time, those plying their trade on the seas also hijacked boats to steal others' gutta-percha harvests.[34]

28 Logan, "Orang Binua," 263.

29 Carl L. Hoffman, "The 'Wild Punan' of Borneo: A Matter of Economics," in *The Real and Imagined Role of Culture in Development: Case Studies from Indonesia*, ed. Michael R. Dove, (Honolulu: University of Hawaii Press, 1988), 108.

30 Graham Brown. "Vulcanite or Gutta-Percha? That is the Question," *The Journal of Gemology*, 22, no.5 (1991): 293; Logan, "Orang Binua," 263; Newland, "Economic Objects," 58.

31 Logan, "Orang Binua," 295.

32 Logan, "Orang Binua," 295.

33 Logan, "Orang Binua," 295; Koh Keng We, "Gateway and Panopticon: Singapore and Surviving Regime Change in the Nineteenth-Century Malay World," in *Reframing Singapore: Memory – Identity – Trans-Regionalism*, ed. Derek Heng and Syed Muhd Khairudin Aljunied (Amsterdam: Amsterdam University Press, 2009): 39–68, 58.

34 "Received," *The Singapore Free Press and Mercantile Advertiser*, September 5, 1846; Obach, "Cantor Lectures."

This trade was so successful that Daeng Ibrahim's son Abu Bakar would later, with British and Dutch support, replace the existing Sultan and proclaim himself Maharaja of Johor.[35] Daeng Ibrahim's ability to call upon vassals from across the Johor-Riau Empire (Figure 1) should not have been possible. As of 1824, this state no longer existed. It had been broken up by the Anglo-Dutch treaty signed that year (Figure 2); the same parties who later supported Abu Bakar's ascension.[36] It is tempting to cast the British and Dutch colonial presence in the region in terms of absolute power due to their ability to use European laws to break up a centuries-old empire. Doing so, however, would be too simplistic, as this case also shows that by 1843, Daeng Ibrahim's influence did not begin and end at the southern tip of the Malay Peninsula.

Centuries-old customs and laws of vassal-client relationships, and the importance of continuing local cultural, social, and economic norms based on tradition and daily practice, simply held more influence on the ground than that of foreign powers. As for the British and the Dutch, they had to accept this disregard of their authority because Johor-Riau's still living trade networks controlled their access to gutta-percha, and therefore, to telegraph technology. Furthermore, as the telegraph network, along with its partner (the railway), were upheld as symbols of the civilizing force that only European-modelled empires could provide, Daeng Ibrahim's harvesters and merchants held the keys to "civilization" itself.

How did European empires find themselves relying on a defunct empire to make submarine cables a reality? Simply put, until 1900, local peoples held a monopoly on the knowledge of their seas and forests, leaving the gutta-percha supply entirely in their hands. Secondly, to the peoples living on the lands that the British and Dutch now claimed, their de facto realities were still more defined by generations of Johorean rule and its resulting long-standing client-vassal relationships, rather than the claimed dominion of empires that were based far away. For the purposes of gutta-percha, the local people's lived reality in Johor simply mattered more.

These realities are reflected in the lives of gutta-percha harvesters who plied their trade on both sea and land, as described through the writings of explorers and journalists in 1846 and 1847. In addition to showing that gutta-percha was already a much-demanded product before its use in cable construction, which was already rumored to be increasingly difficult to find, the importance of Johor-Riau's

---

35 H. R. C. Wright "The Anglo-Dutch Dispute in the East, 1814–1824," *The Economic History Review* 3, no.2 (1950): 229–39.

36 Benjamin Khoo, "Celebrations during a royal wedding," Biblioasia, National Library of Singapore, July – September, 2022, https://biblioasia.nlb.gov.sg/vol-18/issue-2/jul-sep-2022/wedding-bugis-uprising-singapore-riau/.

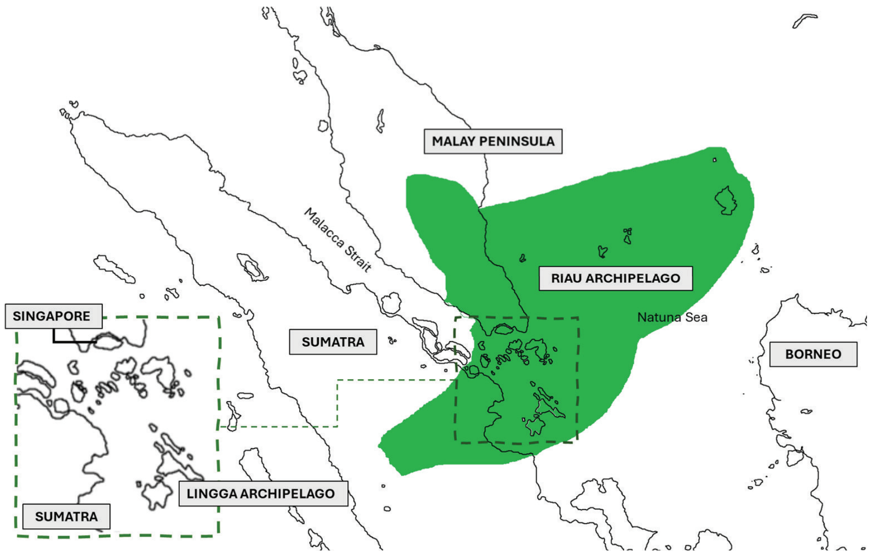


Figure 1: The green area shows the borders of the Johor-Riau Sultanate before the Anglo-Dutch Treaty of 1824. Author-drawn map based on information from: Khoo, "Celebrations during a royal wedding."

de facto power on the ground is apparent. However, while present, it would also be inaccurate to overemphasize their power. In both following examples, in the Johor Sultanate's interior and from Singapore island respectively, Britain's growing presence is evident.

Snippets from this 1846 article in Singapore provide a snapshot of the maritime gutta-percha harvest, while also showing the Malay maritime world and European terrestrial world overlapping:

> PIRACY – On Thursday last [Wahap] and 11 other [Singapore] Malays were proceeding to an island named Ayer Etam…to collect Gutta Percha, when about 7 o'clock in the evening they saw a number of persons on a spar…who were shouting and beating gongs… on turning a point they met two large boats containing [Galang] Malays, by whom they were immediately attacked. The pirates fired six times with muskets and rifles, by which one man was wounded…The Singapore boats had 1 kris panjang, 3 krisses, 9 spears, and 1 blunderbuss on board…The quantity of arms carried by the Singapore Malays is rather suspicious and might lead to an inference that if occasion offered they themselves were not unprepared to do a little piracy.[37]

37 "Received," The Singapore Free Press and Mercantile Advertiser. Note: Krisses are daggers originating from maritime Southeast Asia that have become famous for the wavy design of their

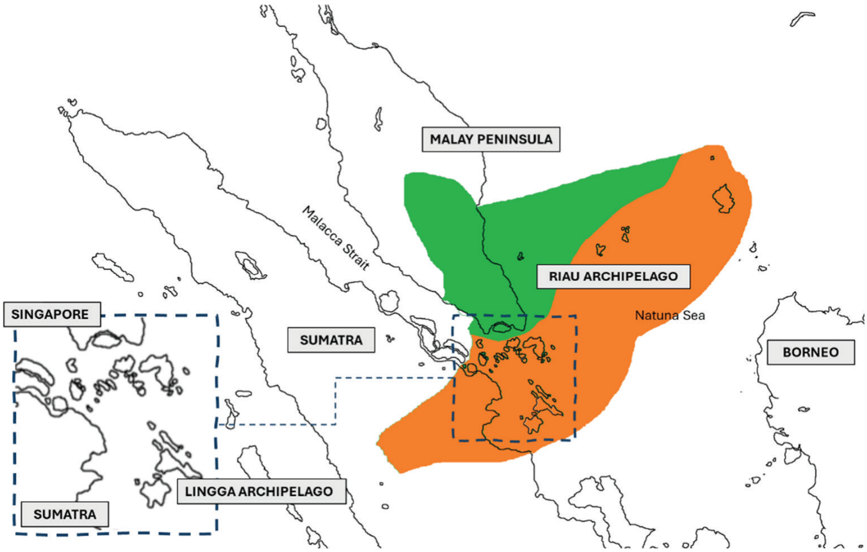


Figure 2: After 1824, the green area formed the new Johor Sultanate, and the orange became the Riau-Lingga Sultanate. By 1900, the green would include several entities: the Johor Sultanate, Pahang Sultanate, and British Crown Colony of Singapore. The Dutch would dissolve the Riau-Lingga Sultanate in 1911. Author-drawn map based on information from: Khoo, "Celebrations during a royal wedding."

By this point, Singapore was the capital of the Straits Settlements, a British colony made up of four small, spread-out territories on the Malay Peninsula: Penang Island, Singapore Island, and Melaka and Dinding on the west coast. However, the Lingga Archipelago (which Galang Island is a part of) was part of the Dutch East Indies and was a close neighbor to the south.[38] Wahap and his crew were taking a sea voyage that was the equivalent to how one would have a long daily commute to work today, based on a historical map where the Singapore and Lingga islands were not located in separate states. Wahap's ability to report the crime to a British authority, however, shows the blending of the old world with that of the new.

As for gutta-percha harvesting on land, an article from 1847 provides a glimpse into an Orang Asli village in the northern interior of Johor. The author

blades. A kris Panjang is a long kris, and a blunderbuss is a pistol that needs to be loaded in the same way as a musket.

38 Hydrographic chart, *Riouw en Lingga – Archipel. Blad 1*, Recorded in 1896–1899 by HNLMS Vessel Melvill van Carnbee, Sheet 1, 1:250,000 scale (Hydrographic chart, 1820). National Archives of Singapore, HC000032, Singapore.

calls them the Orang Binua, however, he also notes that this name simply means "people of the country," and their Malay neighbors referred to them either with offensive labels or generic names such as Orang Ulu (people of the interior).[39] As there are several possible peoples who could fall under this name, it is unclear which peoples they were. He describes this community as living a semi-nomadic lifestyle in the deep jungle, travelling between belukar, where they had previously planted groves with fruit trees and other edible plants such as durian, cempedak and plantains, within one to two days' walk of the other.[40] They would return after a few years to the appropriate belukar for a few months to harvest the fruit. These Orang Asli communities would also harvest valuable forest goods for barter with their Malay neighbors, such as rattan, camphor, damar, and gutta-percha; in return for goods such as rice, sugar, cloth, earthenware, iron tools, coconuts, and tobacco.[41]

There are broad cultural distictions made between Malay and Orang Asli settlements on the peninsula with regards to forest exploitation. From the fifteenth to nineteenth centuries, Malay traders living along rivers or more urban settlements along the coasts, earned their living through the maritime trade within their sultanates. Orang Asli usually collected forest resources for barter with Malay neighbors.[42] There were different Orang Asli peoples, with distinct ethnicities, spiritual and religious beliefs, and lifestyles across the peninsula. The same can be said for the peoples distinguished in literature (and in the current day) as Malay, but of course these are broad distinctions and intermarriage and cross-cultural exchanges were frequent. Trade with the Orang Asli was controlled by the leaders or headmen (*Penghulu*) of Malay settlements along key river points, usually by limiting access to outsiders through the rivers that led into the meeting places where the Orang Asli would barter their wares.[43] Once traded, these forest goods would be sold through the peninsula's riverine highways until they crossed the straits and seas in this archipelagic region to arrive in an urban center such as Singapore (or in older times, Melaka), to be repackaged and shipped overseas.[44]

39 Logan "Orang Binua," 259. Note, belukar means secondary jungle.

40 Logan "Orang Binua," 261.

41 Logan "Orang Binua," 279.

42 Abu Talib Ahmad, Mahani Musa, Nazarudin Zainun, Nasha Rodziaadi Khaw, Hisham Atan Edinur, and Geoffrey Keith Chambers. "A multidisciplinary account of the Orang Asli in Peninsula Malaysia." in *Resource use and sustainability of Orang Asli: Indigenous communities in Penninsular Malaysia*, eds. Mohd Tajuddin Abdullah, Candyrilla Vera Bartholomew, and Aqilah Mohammad (London: Springer Nature, 2021), pp. 157–188, 164.

43 Logan "Orang Binua," 286.

44 Logan "Orang Binua," 261.

This distinction is worth mentioning because of how their somewhat distinct gutta-percha knowledges were eventually institutionalized in imperial science. One glaring example is the name "gutta-percha" itself, the Malay name used to represent the tree latex preferred by submarine telegraph cable manufacturers. In the 1847 article, the Orang Asli harvesters told the author that gutta-percha was the name of an inferior tree latex, but their name for the superior latex was Taban.[45] Although the word taban would later be used interchangeably with gutta-percha, the latter won out as the more popular name that was adopted amongst the imperial public, in the cable industry, and in science. In this small example of who held more influence over the information passed to the cable industry, it is not surprising that the name preferred by Singapore and Johor's merchants won out over that of the harvesters. After all, Europe's popular exposure to the latex occurred in Singapore, which also became the center of the gutta-percha trade due to the Johor-Riau trade network.

In Johor and Singapore, European botanists harvested local knowledge of gutta-percha and its properties, whether through merchants or harvesters. Given these realities, it makes sense to see the early success of submarine cable adoption and construction as a product of transimperial collaboration between European and Johor-Riau empires. As examples such as how taban became gutta-percha show, however, plenty of knowledge was transformed in transport or translation. As this transformed knowledge became institutionalized, it would have a lasting impact on the technological and scientific research that depended on it.

One such example is the central belief that industry-specific trees only grew on the Malay Peninsula and islands of Borneo, Riau, Singapore, and Sumatra. The botanists, chemists, and other agents specializing in gutta-percha on behalf of either the cable companies or Western empires failed to notice that the "native" distribution of the most demanded gutta-percha trees conveniently aligned with the old borders of the Johor-Riau Empire. In a maritime region where borders were either drawn across seas or dense jungle, the geographic range of the trees should not have been so serendipitous. Indeed, they were not. The trees had a wider spread that included the Philippines, but that gutta-percha was mixed with the rest of the supply from Borneo and their actual origins deleted in the process.[46] Efforts to promote the Philippines as an alternate and non-British or Dutch monopolized source, failed, indicating that new parties could not break into the early stronghold established by the Johor-Riau network.

45 J.R. Logan, "Range of the Gutta Taban Collectors and Present Amount of Imports Into Singapore," *The Journal of the Indian Archipelago and Eastern Asia* 2 (1848): 529.

46 Penoyer L. Sherman, *The Gutta Percha and Rubber of the Philippine Islands* (Manila: Department of Interior Bureau of Public Printing, 1903), 18.

European gutta-percha experts did not acknowledge or realize that the reports they heard about the trees' limits were as much commercially driven as natural. Gutta-percha prices rose not only because of increasing demand, but also because the supply was unreliable due to its reputed scarcity.[47] An aspect that is not directly acknowledged in historical documents is that gutta-percha supply also wholly relied on harvesters finding it worthwhile to access the difficult areas where the trees grew – both physically and socially. Of course, it also benefited local merchants to tell their foreign buyers that prices had to rise as this specialized resource was becoming increasingly limited.

Sustaining "civilization" (1900 – 1933)

The sustainability conundrum around gutta-percha's excess extraction and increased societal expectation for fast communications was, at heart, a familiar problem for industrializing states around their needs for mass production and sustaining essential materials. With regards to forestry and wood resources, it was thought that a solution had been found in the mathematically based German approach to forestry management that was implemented in the 1820s.[48] This approach challenged foresters to calculate how much wood any specific forest could mass-produce over one to two centuries to meet the long-term demands of industry.[49] Faced with a mathematical question, German foresters turned to conceptualizing "average" trees (*Normalbaum*) for use in their calculations, i. e., ideal trees with predictable traits such as sustained yields and mass.[50] Over time, the *Normalbaum* was transformed from conceptual average into reality as foresters encouraged the trees under their care to grow into this predictable ideal, creating forests populated with trees of the same type, size, and age.[51] In this way, German forestry management championed the uses of government-controlled forest reserves, which had effectively become tree plantations. Thus, forest resources could be

47 As seen in a letter from H.W. Jewsbury and Co. to Telegraph Construction and Maintenance Company, 24 October 1870, TCM/21/13, National Maritime Museum, Greenwich.

48 Ravi Rajan, "Imperial Envrionmentalism or Environmental Imperialism? European Forestry, Colonial Foresters and the Agendas of Forest Management in British India, 1800 – 1900," in *Nature and the Orient*, ed. R. Grove, V. Damodaran, and S. Sangwan (Oxford: Oxford University Press, 1998), 329.

49 Rajan, "Imperial Environmentalism," 331; "Forest Administration in Malaya," *Nature* 143 (1939), 571 – 572.

50 Rajan, "Imperial Environmentalism," 331.

51 Rajan, "Imperial Environmentalism," 331.

controlled by the state and meet market demands in a predictable manner. Seemingly an answer for the gutta-percha problem, this forest-management approach was brought to the Malay Peninsula in 1901.[52]

It must be said, however, that sustaining natural resources was not just a problem for industrializing states in the 1800s. As previously mentioned, for centuries, the kingdoms of maritime Southeast Asia had relied on increasingly globalized trade from their entrepot capitals for their livelihoods. While these first- to seventeenth-century trades did not have to manage the same excesses in demand as eighteenth-century industrializing states, demands were still high enough to exhaust best-selling resources if not managed. On the Malay Peninsula, some strategies for managing this challenge included royal monopolies on popular goods or integrating their agency into local beliefs.[53] For example, camphor was another forestry good that originated from the region (Borneo and Sumatra are especially credited).[54] It became popular for its various uses, including medicinal, spiritual, culinary, and beauty practices across Eastern Asia, Southern Asia, the Middle East, and Europe, but the origins of this trade and its popularity are so ancient that it is difficult to pinpoint its beginnings with accuracy. The earliest known mention of camphor is in the Classical Sanskrit medicinal text, the *Suśrutasaṃhitā,* which various scholars have argued originated sometime between the pre-fourth to the sixth centuries.[55]

By 1847, camphor was still a much-demanded forest commodity, and Logan provides one example of how it was sustained in northeast Johor despite centuries-long global demand.[56] He noted that both Orang Asli and Malay communities in the region shared the same beliefs and practices around camphor collection, writing, "While searching for it they abstain from certain kinds of food, eat a little earth and use a kind of artificial language called the *bássá kápor* [camphor language]."[57] These practices are even credited within the local community with sustaining camphor trees:

52 "Forest Administration in Malaya," 571.

53 Jeyamalar Kathirithamby-Wells, *Nature and Nation: Forests and Development in Peninsular Malaysia* (Copenhagen: NIAS Press, 2005), 10.

54 G. J. Meulenbeld, "Suśruta and the Suśrutasamhitá," in *History of Indian Medical Literature*, vol. 1a, ed. G. J. Meulenbeld (Groningen: Robert Forsten, 1999), 345; Ranabir Chakravarti, "Aroma Across the Sea, Camphor – To India, beyond India c. 1000 to 1300CE," in *Early Indian History and Beyong, Essays in Honour of B.D. Chattaopadhyaya*, ed. Osmund Bopearachchi and Suchandra Ghosh (Delhi: Primus Books, 2019), 383.

55 Meulenbeld, "Suśruta and the Suśrutasamhitá," 348–350.

56 Logan, "Orang Binua," 264.

57 Logan, "Orang Binua," 263; Kathirithamby-Wells, *Nature and Nation*, *xxx*.

> It is believed that if care be not taken to use the [*Bahasa Kapor*] great difficulty will be experienced in finding camphor trees, and that when found the camphor will not yield itself to the collector. Who-ever may have been the originator of this superstition, it is evidently based on the fact that although camphor trees are abundant it very frequently happens that no camphor can be obtained from them. Were it otherwise, said an old Binuá who was singularly free from superstitions of any kind, camphor is so valuable that not a single full grown tree would be left in the forest.[58]

Gutta-percha trees were not given the same level of care. Interestingly, they informed Logan that the good-quality Taban only came from mature trees and believed this would spare younger trees to meet future demand.[59] In just three more years, however, gutta-percha's indispensable role in submarine-telegraph cables would drive demand to previously unimagined levels in the peninsula.[60]

In response, the Federated Malay States and Straits Settlements Forestry Department was founded in 1900.[61] Like its sibling departments established in Australia, the Cape Colony, Ceylon, Cyprus, the Gold Coast, Kenya, Mauritius, Nigeria, and Sierra Leone, the department was an offshoot of the Imperial Forest Department that the British Raj had founded in India in 1864. Headed by Dietrich Brandis, a German forest officer, its staff were trained in Germany and France before moving on to found other forestry departments in the same vein as India's.[62]

State-controlled German forestry management was not only an effective way for the state to increase and centralize its power over natural resources, but by promising resource sustainability through science and mathematics, it was also upheld as a practical implementation of enlightenment ideals.[63] When it was first introduced in German states, foresters faced increasing vitriol from villagers who had lost their access to nearby forest lands and resources.[64] In return, foresters blamed local practices for forest damage, accusing them of being uncontrolled and short-sighted.[65] As the opposing other, villagers and their local practices were cast as uncivilized, wasteful, and therefore as inappropriate for land management. This practice of blaming local customs and practices as inferior, uncivilized,

58 Logan, "Orang Binua," 263.

59 Logan, "Orang Binua," 263.

60 Kathirithamby-Wells, *Nature and Nation*, *xxx.*

61 Richard Hölzl, "Historicizing Sustainability: German Scientific Forestry in the Eighteenth and Nineteenth Centuries," *Science as Culture* 19, no.4 (2010): 431–460.

62 Hölzl, "Historicizing Sustainability," 446–447.

63 Hölzl, "Historicizing Sustainability," 446–447.

64 Hölzl, "Historicizing Sustainability," 447; De Haas, *Netherlands-India government gutta percha plantations* (Tjipetir: Batavia Government Gutta-Percha, 1908).

65 Hölzl, "Historicizing Sustainability," 447.

and responsible for environmental damage remained when the technique was exported on a global scale.

"Native" harvesting practices took the blame for gutta-percha's rumored increasing rarity.[66] Although harvesters explained that they utilized tree-felling to meet the large-scale demand for gutta-percha in the time required, industrialization was not considered a valid enough reason for unsustainable practices. In line with German forestry management, Europeans sought a civilized system of resource extraction, to meet the global demand for cables and preserve the flora and fauna and natural resources required to build the foundation of civilized society. By the 1900s, it was not only infrastructure such as posts, rail, and telegraph that were the symbols of civilized empires, but also the conservation of natural Edens – that is, the natural flora and fauna that many empires laid claim to. The link between the telegraph and forest conservation as a responsibility of a civilized empire is directly acknowledged by the Dutch government over the founding of the government gutta-percha plantation on Java Island in 1900:

> For the insulating of 236,840 miles of submarine cable, it would thus be necessary, at a moderate estimate, to fell twenty-seven million gutta-percha trees. With these figures before them and bearing in mind the great interest that all civilised nations have in common in the continued existence of the submarine cables, the Netherlands Indian Government soon realised that on their part steps must be taken to prevent the entire extermination of the gutta-percha yielding trees.[67]

The Dutch plantation was not just an opportunity to showcase the Dutch empire's botanical knowledge, it was also a fallback after they were forced to acknowledge their limited control over local harvesters. As described by Tromp de Haas, the Dutch government's superintendent of plantations, rules to restrict harvesting to mature trees failed because "in practice…the maintenance of these regulations in the almost inaccessible uninhabited, virgin forests of Sumatra and Borneo was most difficult, if not impossible."[68] At their Tjipetir Plantation, the Dutch intended to introduce further scientific innovations by extracting guta-percha from mechanically harvested leaves from young trees (called the Ledeboer method). After the trees reached maturity at around fifteen to thirty years, they would tap gutta-percha from the trunk.[69] Armed with German forestry as a conceptual background and Dutch plantations as practical examples to emulate for local conditions, the British hoped to apply these enlightenment principles to conserving

66 De Haas, *Netherlands-India*, 2.
67 De Haas, *Netherlands-India*, 2.
68 De Haas, *Netherlands-India,* 2.
69 De Haas, *Netherlands-India,* 9.

natural forest resources and gain more centralized control over the Malay Peninsula.

By 1900, despite having the Straits Settlements colonies and the sultanates of Negeri Sembilan, Perak, Pahang, and Selangor as a centralized protectorate under the Federated Malay States, Britain still did not have official control over the entire peninsula. There were five remaining sultanates required to achieve this goal. Four of them, Kedah, Kelantan, Perlis, and Terengganu, were vassals to the Kingdom of Siam to the north, and Johor maintained its independence. This changed in 1909 when Britain signed an agreement with the Kingdom of Siam to become the new suzerain of the four northern sultanates, naming them the Unfederated Malay States.[70] Johor, the same sultanate that controlled the early gutta-percha trade, was the last holdout. They agreed to become a British Protectorate in 1914 after a five-year political tug-of-war between Sultan Ibrahim and British officers.[71]

In 1905, the Telegraph Construction and Maintenance Company (Telcon), Britain's largest cable manufacturer, established Selborne Plantation in Pahang based on the Tjipetir model.[72] Over the next thirty years, both plantations failed to curb wild felling or turn a profit.[73] As the Ledeboer method relied on harvesting leaves mechanically for efficiency, trees had to be planted fairly close together to accommodate the machine.[74] When it became clear that planting based on mechanical convenience was ineffective for growing gutta-percha trees, the plantations had to start again, allowing for space and shade for the young seeds to grow.[75] Still, the machinery for separating gutta-percha from leaves was available, so the companies asked for leaves and small branches from trees, believing that this practice would still aid the tree populations by saving them from felling. This request had the opposite effect, as time-strapped harvesters felled young trees that resembled branches instead.[76]

Effectively, the plantations did not achieve their stated goals: encouraging sustainable gutta-percha harvesting methods and simply serving as sites of enlightened scientific understanding. This would not be a surprise considering how

70 Godfrey, *Submarine Telegraphy*, 118.

71 Nesamalar Nadarajah nee Ramanathan, "The Struggle for Control, 1910–1914," in *Johore and the Origins of British Control, 1895–1914* (Kuala Lumpur: Arenabuku, 2000), 179.

72 A.B. Walton, Selborne Estate, Report, 20 September 1930, 1957/0638393, National Archives of Malaysia, Kuala Lumpur.

73 Walton, "Selborne Estate"; Godfrey, *Submarine Telegraphy*, 118.

74 Watson, "The Wealth of the Jungle."

75 Walton, "Selborne Estate."

76 Godfrey, *Submarine Telegraphy*, 118.

they were envisioned as a fresh start and replacement for local harvesting methods. Reputationally, however, the plantations were a success story for both Britain and the Netherlands. Their effectiveness mattered less than how their presence was received back in imperial nations – for Britain, the Forestry Department and plantation further cemented their image as the creator and master of the global telegraph cable network; and for the Dutch, as scientific masters in expanding the priorities of civilized (i. e., imperial) nations. Most importantly, perhaps, was claiming control over the gutta-percha supply, the key to one of the most important symbols of enlightened civilization.

Plantations served another role that was essential to imperial nations, which justified their dominion over resource-rich lands. Although there were few gutta-percha plantations, their existence promoted the plantation model as a preferred means of obtaining and controlling forest produce. Where plantations were established, transport and settlements needed to be built to support and incorporate them into the European-based legal trade network. They were part and parcel of a land-based system to replace the former maritime-based riverine trading highways that led directly into the forest.

The Forestry Department made up another part of that system. By appointing itself as the superior caretaker of the peninsula's flora and fauna, and making the sale and export of gutta-percha illegal, it challenged the local monopoly over the forest. Despite demonizing local harvesting practices, the peninsular-based Forestry Department knew that they could not effectively conserve or claim any forest lands without local staff and knowledge. Local harvesters and forestry staff were also thus essential to this sustainability mission. Following the peninsular ban on gutta-percha exports, the Forestry Department hired former harvesters for expeditions to find remaining gutta-percha trees, after which, these trees were tallied and placed under protection.[77] This strategy was effective, as former harvesters were given new incentives to reveal the locations where they had previously left trees alone. As a result, trees were tallied in forests where they were thought already extinct, such as in Melaka in 1901. In just twenty years, however, the changes that Britain brought to the peninsula led to the drying up of local forestry knowledge. Writing in 1928, James Gilbert Watson, a government forest economist, lamented the opportunity cost of lost forest lore:

> the number of Malays versed in jungle craft and jungle lore is rapidly dying out. It is becoming increasingly difficult even to secure information about, and practically impossible to pro-

77 "Gutta Percha in Selangor," *The Straits Times*, May 23, 1901.

> cure supplies of products which individually occur in insignificant quantities but which collectively are of incalculable value.[78]

Gutta-Percha turned Britain's attention over to maritime Southeast Asia and gave its empire a good reason to consolidate more control over such vital resources. To properly accomplish this, the colonial government needed to either take over the centuries-old maritime trade network or replace it altogether. From 1874 to 1931, they opted to combine the smaller railroad lines in disparate states to form the Federated Malay States Railway.[79] Eventually covering areas in the later-acquired Unfederated Malay States, this new railway became the new main thoroughfare for resource and commercial transport on the peninsula. Stretching from Singapore in the south to Perlis in the north, it replaced the riverways as the legal center of peninsular movement and economic life. The riverine network did not entirely disappear, however, remaining an effective alternative for smuggling or trade away from official eyes.

As previously mentioned, Britain kept their experiment with sustainable gutta-percha on the Malay Peninsula. In the lands they claimed in Borneo, gutta-percha extraction continued as before.[80] Forest officers also had economic responsibilities to identify resources that could have industrial use and sell these to companies back in Britain.[81] However, the sultanates that made up the peninsula were not colonies, but protectorates where the sultans still retained power over local cultural and religious affairs.[82] Although the balance of power on the peninsula was shifting towards British interests, it was also within British interests to maintain positive, or at least working, relations with the sultans.

Conclusion

Within this context of a rapidly transforming peninsula, spurred on by gutta-percha and global communications, the foundations for maritime Southeast Asia's

78 Watson, "The Wealth of the Jungle,"693.

79 Amarjit Kaur, "Road or Rail? – Competition in Colonial Malaya 1909–1940," *Journal of the Malayan Branch of the Royal Asiatic* Society 53, no.2 (1980), 45–66.

80 Godfrey, *Submarine Telegraphy*, 79.

81 Note of interview with Mr. B.H.F. Barnard, Deputy Conservator of Forests, Malaya, 12 March 1928, Gutta Percha and the Federated Malay States, AY4/2009, The National Archives, Kew.

82 Eleanor Choo, "A Shared Frontier: Interrelationships of Power Through Iron on the Malay Peninsula (1920–1941)," in *Southeast Asia as a Site of Imperial Contestation*, ed. Amy Freedman and Joseph Tse Hei-Lee (New York: Pace University Press, 2022), 69–70.

first National Park were laid. Beginning with a centuries-old legacy of maritime trade built on forestry goods, gutta-percha was introduced to an enlightenment-driven, industrializing Europe as the key to making the world's first global telecommunications network a reality. As these worlds collided and negotiated their merger, they adjusted to the opportunities and restrictions of each other's norms. On the Malay Peninsula, where Britain decided to experiment with sustainable gutta-percha, they brought their ambitions of centralized bureaucratic control and their enlightenment-inspired industrialization. Hand-in-hand with that industrialization, however, came their approach to sustainability. This brought changes in the landscape as rivers and forests were changed to meet British industrial needs and present the appearance of sustainability.

As the public in Britain fell in love with gutta-percha from their introduction to it in 1843, and then to their fascination with the telegraph, they heard about the tree's harvesting methods and scarcity. Due to fears that they would lose the telegraph network, and inspired by forestry management practices from the continent that strengthened the narrative of civilized enlightenment, a strong trend in support of conservation was transported back to the Malay Peninsula. This was the background that inspired Theodore Hubback, the one-time plantation manager, to petition for the founding of a national park – different from a reserve, it would be exempt from resource extraction or profit motives. Although he is often credited with the park's founding, he could not have succeeded without both the support of the European public on the peninsula and the neutrality of the Malay aristocracy to the idea.

Despite his strong personality, Hubback's complete vision for the park was not realized. He had advocated for the park to be free of people itself, pitting himself against the local villages that had long relied on gathering resources from neighboring forests. Although in Germany, forest management was used to restrict local usufruct rights, on the Peninsula, British civil servants objected to Hubback and lent their weight behind protecting these rights. Why did they do this? The situation was different because Britain had not (as of 1939), colonized the peninsula, and needed to keep the sultans as partners. The National Park had been established only because Britain agreed to the conditions set by the Sultans of Pahang, Kelantan, and Trengganu. For example, in Pahang, the Sultan stipulated that surrounding villages retain their rights to collect and tap resources from the forest, as well as utilize them at burial grounds.[83] British civil servants stood by this agreement against Hubback.[84]

83 Memorandum about Pahang Enactment No.2 1939, 20 July 1949, File no.69 – 49, King George V National Park. State Archives of Pahang, Kuantan, Pahang.

It is also possible that these administrators learned from their history in the peninsula. Their strategies worked best when they cooperated with local knowledge and what was already there, for example, in their forest reserves where they hired locals and surveyed the forests rather than tried to drastically change them. Gutta-percha plantations only met with narrative success but otherwise failed due to their approach that disregarded the natural environment and local practices. Development, therefore, was limited to what the environment would allow. Technology enabled some pushback, with the railway succeeding at connecting the north of the peninsula to Singapore and laying down a framework not just for replacing the old trade routes on the rivers, but for forming a newer centralized identity that combined what used to be several different sultanates.

This, too, was not entirely devoid of local interests, however. For a region that had thrived so long on maritime connections and international trade, it made sense that local practices adapted well to the commercial land-based infrastructure that partially replaced their riverine highways. These trains and roads connected the region to the new maritime-based global communications system for the industrial age – the submarine telegraph cable network that was the heir to the trade routes of old.

84 Memorandum about Pahang Enactment.

Part 3: **Techniques and Experimentation**

Robert Batchelor

Extrastate development: Marshallese stick charts and the politics of infrastructure in the nineteenth-century Pacific

Objects are always looser than they appear.

– Lauren Berlant, *On the Inconvenience of Other People* (Durham, NC: Duke University Press, 2022), 25.

If left unchecked, the ocean that has sustained us for so long will take my home.

– Hilde Heine, former president, Republic of the Marshall Islands, "Forewords," in *Sea Change: An Atlas of Islands in a Rising Ocean*, Christina Gerhardt (Oakland, CA: University of California Press, 2023), viii.

Infrastructures of knowledge and development

Since the late 1970s, a particular artifact of the "Second Hawaiian Renaissance" has hung on my wall in various places I have lived – a Marshall Islands stick chart.[1] It is "Hawaiian" in the sense that I got it on Maui in the late 1970s as an eleven-year-old at a shop aimed at ethnographic tourism. It presumably served – to me and to others – as an emblem of Hawaii's place in Oceania and Polynesian culture as a whole. I brought it back to Oklahoma and hung it next to a National Ge-

1 The first Hawai'ian Renaissance is associated with the nationalist objectives of King Kamehameha V (r. 1863–1872), including replacing the anthem written by Christian missionaries and building a new Iolani Palace (1879). The second Hawai'ian Renaissance from the late 1960's is associated with movements for indigenous land rights and connected with renewed interest in cultural practices like slack-key guitar music, hula dancing, and Polynesian voyaging that had been lost or actively suppressed by missionaries. The reproduction of the chart, and its sale in Hawai'i, should also be understood as part of the broader set of debates about a transcultural Pacific, using the 1970 phrase of the first Prime Minister of Fiji, Kamisese Mara, "the Pacific Way." Ratu Sir Kamisese Mara, "Address to the United Nations," [orig. October 1970] in *The Pacific Way: A Memoir* (Honolulu: University of Hawai'i Press, 1997), appendix 4; Stephanie Lawson, "'The Pacific Way' as Postcolonial Discourse: Towards a Reassessment," *Journal of Pacific History* 45, no.3 (December 2010), 304. Later, the Tongan and Fijian anthropologist Epeli Hau'ofa also tried in his famous "Our Sea of Islands" (1993) essay to transcend the divisions articulated by Europeans starting in the early nineteenth-century between Melanesians, Micronesians, and Polynesians. Epeli Hau'ofa, "Our Sea of Islands," in *A New Oceania: Rediscovering Our Sea of Islands*, ed. Epeli Hau'ofa, Eric Waddell and Vijay Naidu (Suva: School of Social and Economic Development, University of the South Pacific/Beake House, 1993), 2–17.

https://doi.org/10.1515/9783111611358-010

ographic map of the world that my half-Cherokee grandfather had given me.[2] In comparison with the flatlands and empty blue oceans of the National Geographic map, the Marshall Island chart layered oceanic temporalities and rhythms. It spoke to how I physically understood the ocean as a child, as a space of waves and swells. This possibility for a shift in perspective mirrors broader historical and theoretical debates about how knowledge infrastructures shape, and are shaped by, their cultural and political contexts. In particular, the Marshallese stick charts have offered and continue to offer an alternative to the dominant Western paradigms of technological development, challenging the imposed logics of imperial mapping and colonial infrastructure-building.

Lauren Berlant's concept of "infrastructural objects" – "living meditations" that shape and are shaped by ("bind and extend") relational processes – offers a productive framework for understanding Marshallese stick charts.[3] Unlike Western infrastructures that prioritize materiality and permanence, these charts have been a dynamic, adaptive technology, binding space, time, and knowledge in ways that defy imperial classification. In this way, they offer a counternarrative to the dominant colonial frameworks of technological progress and development, which have historically marginalized oral and embodied knowledge systems. Moreover, they better enable the understanding what have been called "borderwater" and "hydrocolonial" processes in the Anthropocene.[4] The history of infrastructural ob-

2 On National Geographic maps as promoting a primitive/civilized hierarchy of conservative humanism for the American middle class in this period see Catherine Lutz and Jane Collins, *Reading National Geographic* (Chicago, IL: University of Chicago Press, 1993).

3 Berlant, *On the inconvenience of other people*, 20 – 21. Berlant takes this concept in part from Marshall Sahlins's commentary on the work of Claude Lévi-Strauss in Marshall Sahlins, "Infrastructuralism," *Critical Inquiry* 36 (Spring 2010): 371 – 385. See more broadly Paul Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey and Andrew Feenberg (Cambridge, MA: MIT Press, 2002),185 – 225. Elsewhere Edwards writes about "knowledge infrastructures for the Anthropocene" (*Anthropocene Review* 4, no.1, (2017): 34 – 43. I see this literature as an alternative way of talking about ocean "media," compare Melody Jue, *Wild Blue Media: Thinking Through Seawater* (Durham, NC: Duke University Press, 2020).

4 Among the many places stick charts have been used as evocative but silent illustrations is next to the Marshall Islands poet Kathy Jetñil-Lokomer's "Dear Matafele Peinam," read at the opening ceremony of the UN Climate Summit in New York City in 2014, and recently republished in Gerhardt, *Sea Change*, 136 – 137. On "borderwaters" and the archipelagic see Brian Russell Roberts, *Borderwaters: Amid the Archipelagic States of America* (Durham, NC: Duke University Press, 2021), and on hydrocolonialism see Isabel Hofmeyr, *Dockside Reading: Hydrocolonialism and the Customs House* (Durham, NC: Duke University Press, 2022). For "between" spaces as they relate to ocean science see Michael Reidy and Helen Rozwadowski, "The spaces in between: Science, ocean, empire," *Isis* 105, no. 2 (2014): 338 – 351. On development see Immanuel Wallerstein, "The Develjects broadens the very limited material and mechanical terms that Westerners (or "moderns") often use to conceptualize "technology" by including embodied, mnemonic, and oral traditions that the discipline of anthropology has traditionally framed as cultural rather than technical. This chapter examines Marshallese stick charts as infrastructural objects that challenge conventional models of development and imperial knowledge-making. Specifically, it asks: How did these charts function as indigenous infrastructures of knowledge, resisting colonial mapping and working towards an alternate conceptualization of development? And what do they reveal about how infrastructures of development can operate beyond state control in multipolar imperial contexts? By positioning stick charts within the framework of infrastructure rather than primitive or culturally alternative mapping, this paper reframes them as tools for managing uncertainty and crisis, whether environmental, political, or epistemological. In keeping with this volume's broader rethinking of development as a historically contingent and contested process, it argues that Marshallese stick charts resist both imperial mapping and the developmental narrative of epistemic hierarchy. At the same time, the charts offer a distinctive mode of *environing*, a means of actively shaping relationships among people, movement, and oceanic space in ways that exceed imperial classification and extractive logic.

Development historiography has often focused on the expansion of state-driven infrastructure, from roads and railways to hydroelectric projects. However, starting in the 1990s, scholars such as Arturo Escobar and James Scott critiqued these paradigms for ignoring indigenous infrastructures of knowledge that operate beyond state control.[5] Historians of science and technology, including Geoffrey Bowker and Susan Leigh Star, began to highlight how even state- or imperial-driven infrastructures work as both technical systems and cultural forms, shaping and mediating power relations.[6] More recently, Brian Larkin further complicated this

opment of the Concept of Development," *Sociological Theory* 2 (1984): 102–116; and Corinna Unger et al., eds., introduction to *Perspectives on the History of Global Development* (Berlin: De Gruyter Oldenbourg, 2022), 1–14. On distinctions between colonial and post-colonial understandings of development see Frederick Cooper, "Development, Modernization, and the Remaking of an Imperial World Order," in Unger et al., eds., *Perspectives*, 81–102.

5 Arturo Escobar, *Encountering Development: The Making and Unmaking of the Third World* (Princeton, NJ: Princeton University Press, 1995); James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998).

6 Geoffrey Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999); Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (November 1999): 377–391; Susan Leigh Star, "Infraspicture by showing that infrastructures are not just material objects but also ideological constructs embodying competing visions of modernity.[7] Finally, Keller Easterling's framing of *extrastatecraft* demonstrated how non-state infrastructures actively resist and reconfigure dominant models of governance and control as well as definitions of modernity. By applying these insights to Marshallese stick charts, this chapter examines how indigenous maritime infrastructures operated within and against competing imperial orders.

Easterling's concept of extrastatecraft describes how infrastructure operates beyond state governance as a "web of active forms" tied to stories.[8] Marshallese stick charts represent an early form of such extrastate knowledge, emerging not from land-based institutions, but from oceanic borderwaters shaped by movement, memory, and adaptation. Rather than fitting neatly within a binary of imperial versus traditional epistemologies, stick charts mediated indigenous understandings of territory and environmental change on their own evolving terms, resisting absorption into colonial frameworks of mapping and development. Yet, in contrast to European printed maps – designed for fixity, duplication, and central authority – stick charts were pedagogical tools embedded in lived, localized practices. They were not standardized but personalized, taught through kinship relations, ritualized apprenticeship, and embodied mnemonic systems.

The arrival of the first printing press in the Marshall Islands in 1859 – a hand press with a Hawaiian font brought by missionaries – signaled an effort to replace performative, oral infrastructures with textual systems: ones that could be legible to imperial governance and scalable across missionary and colonial networks in the South Pacific, China, and Southeast Asia. As Richard Lingenfelter notes, printing presses were often associated with the consolidation of royal authority and the emergence of official nationalism – Pōmare in Tahiti, Keeaumoku II in Hawai'I – supported by missionization and education. Yet the Marshall Islands proved resistant to this model. Although American missionaries established a Congregational Church on Epoon Atoll in 1857 with the aid of Hawaiian missionaries,

tructure and Ethnographic Practice: Working on the Fringes," *Scandinavian Journal of Information Systems* 14, no. 2 (September 2002): 107–122.

7 Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42 (2013): 327–343. This reviews the anthropological literature.

8 Keller Easterling, *Extrastatecraft: The Power of Infrastructure Space* (New York: Verso, 2014), esp. "Afterforward" 239–241. Going further back, this is what Paul Radin spoke of as "plasticity" or "the free play of participants and story-tellers" in relation to Indigenous conservatism. Paul Radin, *Primitive Man as Philosopher* (New York and London: D. Appleton and Company, 1927; New York: New York Review of Books Classics, 2017), 48. Citation refers to the New York Review of Books edition.

no centralized sovereignty or print-based nationalism emerged. The press failed to displace older epistemologies in the way it had elsewhere.[9]

Marshallese charts were part of this resistance. They persisted not merely as cultural symbols but as operational infrastructures attuned to the rhythms and uncertainties of oceanic life. Their contrast with print-based knowledge highlights the broader stakes of infrastructural control in colonial development projects: whether knowledge could be abstracted, stored, and governed, or whether it remained adaptive, relational, and embodied.

Though embedded in a context of multipolar imperial competition, stick charts retained their epistemic distinctiveness. They offered ways of navigating spatial complexity that escaped colonial legibility. By placing these charts in conversation with wider debates about infrastructure, epistemology, and colonialism, this chapter rethinks the relationship between indigenous knowledge and development. It suggests that development is not a linear, universal trajectory, but a contested, ecologically situated negotiation over forms of knowing, teaching, and surviving.

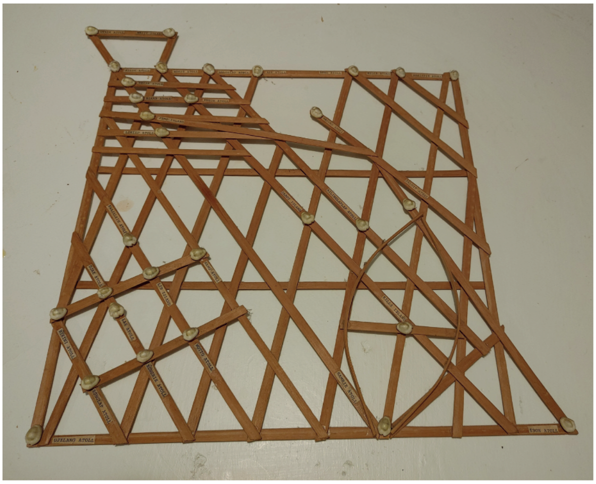
As an eleven-year-old, I was neither aware that what was on my wall did not equate to a "map" nor that Marshall Island charts had become iconic in a variety of ways on a global scale. During the period of the Pacific "cultural renaissance" of the 1970s, they had started to play a largely symbolic role as icons of loss in efforts to revive traditional navigation practices in the Pacific. This is still the case in some ways. A version of the chart appears, for example, on the cover of *Life in the Republic of the Marshall Islands* (2004), a book dedicated to the efforts of the Marshall Islands mayors' conference to revive the long-dormant Ailinglaplap canoe races on the twenty-fifth anniversary of the founding of the Republic.[10] The map on my wall was perhaps the first time I encountered the geographical marker "Bikini Atoll," yet I remained unaware of the legacy of nuclear testing for what would become the Marshallese 1979 Compact of Free Association (1979), let alone the still unconceptualized Anthropocene.

The charts had been enshrined from the 1960s in revisionist versions of "natural history" museums, notably by Margaret Mead in her "Hall of Pacific Peoples" at the New York Museum of Natural History, where they were used symbolically

---

9 Richard Lingenfelter, *Presses of the Pacific Islands, 1817–1867: A History of the First Half Century of Printing in the Pacific Islands* (Los Angeles: Plantin Press, 1967).

10 Anono Lieom Loeak, Veronica C. Kiluwe and Linda Crowl, eds., *Life in the Republic of the Marshall Islands = Mour ilo Republic eo an Majõl / written by Marshall Islanders*, trans. Veronic C. Kiluwe, Maria Kabua Fowler and Alson J. Kelen (Majuro: University of the South Pacific Centre, 2004).



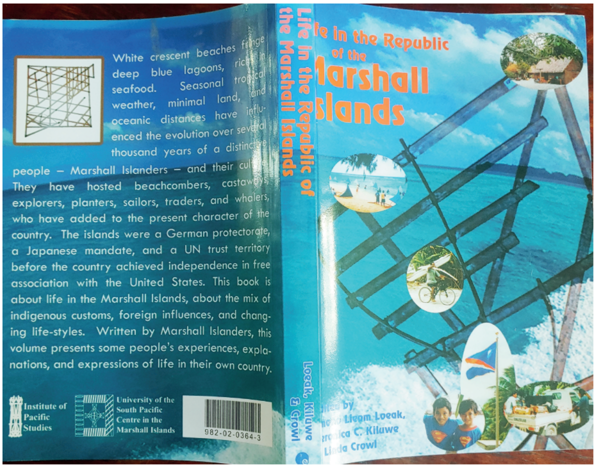


Figure 1: Marshal Islands *rebbelib* chart reproductions associated with the Second Hawai'ian Renaissance.
1a Personal copy of a Marshall Islands stick chart, created ca. 1979. [Personal Photo].
1b Reproduction of a similar chart from that period (upper left) on Anono Lieom Loeak, Veronica C. Kiluwe and Linda Crowl, eds. *Life in the Republic of the Marshall Islands* (University of the South Pacific Centre, 2004). [Personal Photo].

to hold the collection (in this case largely her collection) together.[11] The general idea was that the museum, the anthropologist, and the Indigenous groups represented by them were all allies or at least fellow travelers. Mead wanted to decenter the idea of Western science, mirroring the projects of Claude Lévi-Strauss, Joseph Needham, and her mentor Franz Boas.[12] I realized, while working in the ethnographic collections of the University of Pennsylvania, that the first surviving version of what hung on my wall (and all of the other tourist copies from the 1970s onward) had been obtained in the Marshall Islands by Robert Louis Stevenson in 1890.[13] Of two different full charts of the islands that Stephenson brought back, the Penn chart is largely forgotten while the New York one has been extensively replicated. For Mead's Hall, the American Museum of Natural History restored its Stevenson chart twice, in 1965 and 1979, putting it on display prominently after the Hall opened in 1971 and photographing it. By enshrining these charts firmly within the realm of natural history and a Boas-derived cultural anthropology as well as downplaying their differences, Mead in New York neutralized their earlier role as extrastate knowledge systems, framing them as iconic cultural mementos rather than living and evolving infrastructures. Yet for myself, and presumably Mead, these charts still alluded to a complex multimodal and technical world of sea swells, ocean currents, and island relations, embodied in the dimensionality of shells and sticks (palm midribs on the chart obtained by Stevenson, bamboo on mine) rather than the flatness of paper.[14] Understanding this tension requires

11 See "Margaret Mead Hall of Pacific Peoples," American Museum of Natural History, accessed July 3, 2025, https://www.amnh.org/exhibitions/permanent/pacific-peoples.

12 See more recently the work of particle physicist John Huth also voyaged with Korent Joel. Notably his Harvard class on "Primitive Navigation" (2013), the teaser for which is: "Primitive Navigation – Course Trailer," uploaded August 17, 2012, https://www.youtube.com/watch?v=E7M2MMm6iv8; and his book John Huth, *The Lost Art of Finding Our Way* (Harvard: Harvard University Press, 2013). This approach has been framed as reenactment for the Anthropocene, see Krista Langlois, "Science and Tradition are Resurrecting the Lost Art of Wave Piloting: Can Marshall Islanders' unique heritage help them navigate a rising ocean?" *Smithsonian Magazine* , February 2, 2016, https://www.smithsonianmag.com/arts-culture/science-and-tradition-are-resurrecting-lost-art-wave-piloting-180958005/.

13 The Penn chart is "Navigational Chart," Penn Museum, accessed July 3, 2025, https://www.penn.museum/collections/object/266112. See the early assessment by H. U. Hall, "A Marshall Islands Chart," *The Museum Journal* 10, no.1–2 (1919): 35–42, https://www.penn.museum/documents/publications/journal/10-1and2/marshall_islands_chart.pdf.

14 This has inspired and continues to a large public history literature, such as this piece by Stephen Nash, "Lost or Found? A Stick Chart From the Marshall Islands," *Sapiens*, July 25, 2016, https://www.sapiens.org/culture/stick-chart-marshall-islands/ from the Denver Museum of Natural Science, A.926.1/DMNS, accessed https://www.sapiens.org/culture/stick-chart-marshall-islands/; and this using Library of Congress charts uploaded to Wikipedia, Amelia Soth "Cabinet of Curiosities:

moving between two interlinked frames: first, how Marshallese stick charts functioned as indigenous infrastructures dynamic, embodied, and oral in character, and second, how these same charts were appropriated by colonial science and recast as static artifacts, revealing the limits of imperial developmental frameworks.

Stick charts as navigational technologies or infrastructures?

The interpretation of Marshallese stick charts has long been debated, reflecting broader tensions between indigenous epistemologies and Western knowledge systems. Were these charts tools for reading ocean currents, mapping swells, or something else entirely? Each interpretation, from nineteenth-century missionaries and German ethnographers to twentieth-century anthropologists, reveals shifting colonial and scientific frameworks that sought to categorize and, at times, control Marshallese knowledge. This section examines these competing readings, arguing that stick charts should not be viewed as static artifacts but as adaptive infrastructural tools embedded in social and navigational practices.

In the 1860s, writing the first detailed reports of Marshallese charts, the American missionary L. H. Gulick thought that the wooden bars represented ocean currents.[15] Currents are notoriously difficult to define. Moreover, navigation in the Marshall Islands is unique because the Pacific's Northern Equatorial Current

Marshall Islands Wave Charts," JSTOR Daily, February 23, 2023, https://daily.jstor.org/marshall-islands-wave-charts/. Starting in 1960, Mead (d. 1978) and her husband Gregory Bateson (d. 1980), active practitioners of visual anthropology from their time in Bali in the 1930's, had planned the new hall at the American Museum of Natural History as a multimedia experience – including panoramic visuals, lighting, and sound effects. On the planning of the Hall see Diane Loche, "The Fate of the Senses in Ethnographic Modernity: The Margaret Mead Peoples of the Pacific Hall at the American Museum of Natural History," in *Sensible Objects: Colonialism, Museums, and Material Culture*, ed. Elizabeth Edwards, Chris Gosden and Ruth B. Phillips (Abingdon, Oxon: Routledge, 2006). Mead's efforts also drew renewed attention to the chart at the University of Pennsylvania, see William Davenport, "Marshall Islands Cartography." *Expedition Magazine* 6, no. 4 (July 1964), https://www.penn.museum/sites/expedition/marshall-islands-cartography/. Davenport, who had been at Pearl Harbor during the Japanese bombing, studied at the University of Hawai'i in the early 1950's as well as the Bishop Museum and then completed his dissertation at Yale under the Caribbean anthropologist Sidney Mintz.

15 L. H. Gulick, "Micronesia – of the Pacific Ocean," *Nautical Magazine*, 31 (1862), 303–304. See also a Hawai'ian missionary's manuscript report written in 1862–3, published as Hezekiah Aea, "The History of Ebon," *Fifty-sixth Annual Report of the Hawai'ian Historical Society* 56 (1947): 9–19.

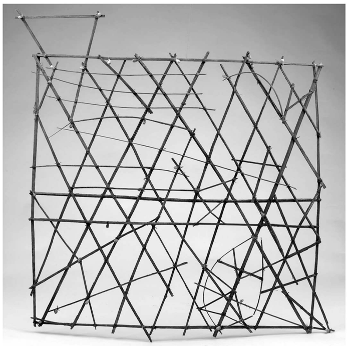


Figure 2a

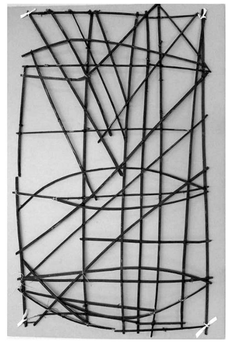


Figure 2b

Figure 2c

Figure 2: Two late nineteenth-century stick charts collected by Robert Louis Stevenson in the Marshall Islands, oriented to match the photograph from the 1914 auction where they were purchased by the two museums.
2a Chart American Museum of Natural History, New York, 80.0-3317. Courtesy of the Division of Anthropology, American Museum of Natural History.
2b Chart University of Pennsylvania Museum, P3297. Courtesy of the University of Pennsylvania Museum.
2c Photograph from *Autograph Letters, Original Portraits, Books, Portraits, and Curios from the Library of the Late Robert Louis Stevenson Consigned by the Present Owner Mrs. Isobel Strong of Santa Barbara, Calif.* (Anderson Auction Company, 1914).

and Equatorial Countercurrent run in different directions through the twenty-nine atolls and five islands of the Ratak ('sunrise' to the east) and Ralik ('sunset' to the west) chains. The northern boundary of the Equatorial Countercurrent heading towards the Americas are Kwajalein and Lae islands, although what a current "boundary" precisely is has remained to this day difficult to determine because of eddies as well as gradual changes in motion at the edges. The southern boundary of the Northern Equatorial Current is just south of Bikini Atoll. A 1955 report using Japanese data (1933–1941) and then US data from Operation Crossroads (1946) offered the first American models of these currents in response to the Castle Bravo hydrogen bomb test in 1954.[16] In relation to the broader Pacific, ocean currents in the Marshall Islands had been so poorly understood before the 1950s that nobody expected large amounts of radiation to flow along the Northern

16 Han-Lee Mao and Kozo Yoshida, *Bikini and Nearby Atolls, Marshall Islands: Oceanography in the Marshall Islands Area* (Washington, DC: US GPO, 1955). This public report includes no data from Castle Bravo the previous year. See also the early report by M.W. de Laubenfels, "Ocean Currents in the Marshall Islands," *Geographical Review* 40 (1950): 254–259.

Equatorial Current up to Japan. One aspect of reading the charts has always been the idea that indigenous peoples might understand these processes better.

While Gulick's current-based interpretation sought to frame the charts within a familiar hydrological paradigm with the hope of local informants, German colonial officials like Captain Otto Winkler took a different approach. By the 1890s, as German control in the Marshalls expanded, Winkler and others attempted to redefine stick charts as representations of ocean swells, reinforcing an ethnographic view of Marshallese knowledge that emphasized difference rather than continuity with Western navigation. Winkler, working for the German government in the aftermath of Robert Louis Stevenson's visit in 1890, used a series of informants to interpret the wooden bars on the charts as patterns of ocean swells generated by trade winds and the way that islands interfere with them. Post-Winkler, swells, not currents, became the dominant interpretation, suggesting a more anthropological and academic approach that emphasized cultural difference. Winkler's work was almost immediately translated into English by the Smithsonian and published in 1901.[17] He argued that the map indicated four kinds of swells – *rilib* ('backbone' or strongest), *kaelib*, *bungdockerik*, *bungdockering.* Currents could also be seen on charts as bent swells or bent pieces of wood, notably when an island split a current. But the significance of the charts came out of the depiction of interactions between winds, swells, and islands, and the height of the sea could guide a navigator towards or away from an island or let them know if they overshot their target.

Then, in the early 1990s, the American anthropologist and surfer Ben Finney put forward a third argument in the context of J. B. Harley's and David Woodward's broad rethinking of the history of cartography. He argued that the *rebbelib* charts resembled Western maps – particularly Tupaia's eighteenth-century Polynesian charts developed on board James Cook's HMS *Endeavour* – raising important questions about how indigenous mapping traditions intersected with colonial epistemologies. Finney had founded the Polynesian Voyaging Society in the 1970s during the Second Hawaiian Renaissance to recreate journeys between islands using traditional methods. He came to this conclusion about the charts not only because of the map-like distribution of islands (similar to Tupaia's charts from the Cook expedition) but also because of scale, the really large maps are, because

17 Captain Otto Winkler, "Über die in früheren Zeiten in den Marschall-Inseln gebrauchten Seekarten, mit einigen Notizen über die Seefahrt der Marschall-Insulaner im Allgemeinen," *Marine-Rundschau* 10 (1898): 1418–1439. Translated into English, "On Sea Charts Formerly Used in the Marshall Islands, with Notices on the Navigation of These Islanders in General," *Annual Report of the Board of Regents of the Smithsonian Institution, 1899* (1901): 1:487–508.

of scale, necessarily poor on swells.[18] Tupaia's chart – recorded by Cook but generally unintelligible to European officers – demonstrates the risks of assuming that visual form equates to epistemic structure. Like Marshallese stick charts, it embodied a relational infrastructure whose logic was encoded not in geometry but in storytelling and kinship. That it could resemble a Western map while resisting its frame underscores the deeper challenge these knowledge systems pose to developmental classification.

Rather than a hybrid product of Western influence, stick charts reflect a different form of infrastructure: one that evolved in response to both indigenous needs and multipolar imperial pressures. This tension between indigenous adaptation and colonial categorization underscores the challenge of historicizing extrastate knowledge systems in the Marshall Islands. Finney made an extensive survey of charts in museum collections made before 1940, but oddly he seems to have been unaware of the earliest documented collection at Cambridge University dating from 1875. They had been given to the Royal Colonial Institute by George Le Hunte, the private secretary to Sir Arthur Hamilton-Gordon, Governor of Fiji from 1875 to 1880.[19] These charts offer crucial insight into pre-colonial Marshallese navigation before the full force of German and British imperial interventions.

Unlike later charts, which were increasingly framed as ethnographic curiosities and found on the walls of colonial outposts, these earlier examples were likely still embedded in active training and navigational use. Their survival in British collections nevertheless highlights the colonial process of extracting and recontextualizing indigenous knowledge as part of the emerging imperial infrastructure.

18 Ben Finney, "Nautical Cartography and Traditional Navigation in Oceania," in *Cartography in the Traditional African, American, Arctic, Australian, and Pacific Societies*, ed. David Woodward and Malcolm G. Lewis (Chicago, IL: University of Chicago Press, 1970), 482, 485. Finney's argument is subtle, but he does argue that it is a fundamental error to think "that the charts portray currents on which the navigator guides his canoe, not the ocean swells."

19 The information on their acquisition is spotty, coming from a 1928 article about the donation, which misleadingly states that George Le Hunte donated them in 1875 as Governor of Fiji. He appears to have started as secretary to the governor in 1875 and probably acquired them after that point. They were first described by Henry Lyons, "The Sailing Charts of the Marshall Islanders," *The Geographical Journal* 72, no.4 (October 1928): 326. Finney does cite this article for a different part of the table. The four surviving Cambridge charts are RCS/ORCS.9.03.1 (*rebbelib*) former ref: 1927–8; RCS/ORCS.9.03.2 (*mattang*) former ref: 1927–6); RCS/ORCS.9.03.3 (*meddo*) former ref: 1927–7); RCS/ORCS.9.03.4 (*mattang*) former ref: 1927–27. A fifth *mattang* chart (1925–7) seems to have been lost sometime between 1962 and 1982. See also Rachel Rowe, "Marshall Island sailing charts", Cambridge University Library, accessed July 3, 2025, https://www.lib.cam.ac.uk/collections/departments/royal-commonwealth-society/collections/marshall-island-sailing-charts; and personal communication with Sally Kent, Curator, Royal Commonwealth Society Collections, Cambridge University Library.

They include one overall chart, a *rebbelib* in the same genre as the two Stevenson charts, as well as one regional chart (*meddo*) and three training or abstract charts (*mattang*). The *meddo* chart is very similar to one at Stuttgart described in 1902 by the German sea captain and amateur scholar Albert Schück as representing Ebon, Memorik, Kili, Ailungslablab, and, in the center, Jaluit. The shell representing Jailut has fallen off the Cambridge copy.[20] The *mattang* in Figure 3b is an abstract representation of water patterns around Jailut Atoll, a ninety-one-island atoll with only 13.4 square kilometers of land and a 690 square kilometer lagoon. The *meddo* and the *mattang* are the strongest arguments for the provenance of these charts as specific products of Jailut.

Because the Cambridge charts have been relatively neglected in the literature, the question of how they were obtained has also been ignored. Indeed, the desire to abstract Marshallese charts from their material history has obscured how museums acquired them in almost all cases. From anthropological work done starting in the 1950s, as well as some comments in the earlier literature, it is almost certain that any use of charts would be accompanied by Marshallese chants (*roro*), a practice used for many things but especially navigation (*meto*). The educational and sailing process involved reciting navigation signs or sea marks (*koklal* or *kaikolle*) in a *roro* to help train the navigator (*ri-meto*) to remain mindful of his task under stressful conditions. Navigator *roro* were secret, as were similar *roro* for divination (*ri-bubu*), magic (*ri-anijnij*), weather (*ri-lale-lan*), and medicine (*ri-wuno*). By the 1950s, all were spoken in what was called the archaic language (*kajin etto*). They had hidden or deep meanings (*mwilal*, similar to Hawaiian *kaona*) ascribable to both the language and the teacher.[21] In the context of competing scholarly and imperial interpretations, with the first focused anthropology coming with American occupation in the 1950s, the charts become striking but ultimately strange emblems. However, when considered in this broader sense as elements of a transforming late nineteenth-century Marshall infrastructure that survived various imperial overlays of knowledge, they suggest something far more complex.

20 See Albert Schück, *Die Stabkarten der Marshall-Insulaner* (Hamburg: Kommissionsverlag von H. O. Persiehl, 1902), plate VII, fig. 42. Schück was the first to try to make a survey of known charts – citing forty-three, with twenty-nine in Germany, six in the United States, three in Honolulu, two in Sydney, two in Great Britain, and one in Vienna. He too had been unaware of the Cambridge Charts. See also his first publication, Albert Schück, "Die astronomischen, geographischen and nautischen Kentnisse der Bewohner der Karolinean und Marshallinseln in westlichen Grossen Ozean," *Aus Allen Welttheilen* 13 (1882): 51–57. The latter publication is perhaps the first to consider these as knowledge (*Kenntnisse*) systems.

21 See Jack Tobin, *Stories from the Marshall Islands: Bwebwenato Jan Aelon Kein* (Honolulu: University of Hawai'i Press, 2002), 7–8.

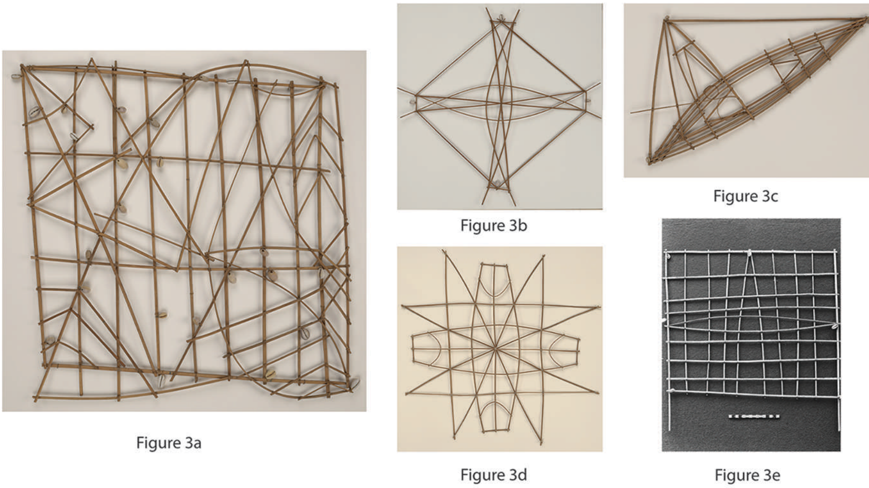


Figure 3: The Cambridge Marshall Islands charts, ca. 1875. Collection of five Marshall Island charts, given to the Royal Colonial Institute by Sir George LeHunte, then private secretary to Sir Arthur Hamilton-Gordon, Governor of Fiji. Royal Commonwealth Society Library. The *rebbelib* chart (RCS/ORCS.9.03.1) was on display at the Science Museum (London) until 2024, when it along with the other three surviving charts were returned to the Royal Commonwealth Collection, Cambridge University Library.
3a *Rebbelib* chart, RCS/ORCS.9.03.1 (formerly 1927-8), Cambridge University Library.
3b *Mattang* chart, RCS/ORCS.9.03.2 (formerly 1927-6), Cambridge University Library.
3c *Meddo* chart, RCS/ORCS.9.03.3 (formerly 1927-7), Cambridge University Library. Former ref: 1927-7.
3d *Mattang* chart, RCS/ORCS.9.03.4 (formerly 1927-27), Cambridge University Library. Former ref: 1927-27
3e *Mattang* chart. Now lost. Former ref: 1925-5.
Reproduced by kind permission of the Royal Commonwealth Society/Cambridge University Library and the Science Museum.

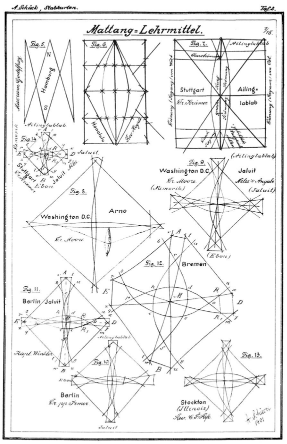


Figure 4a

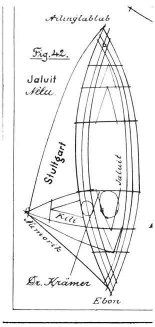


Figure 4b

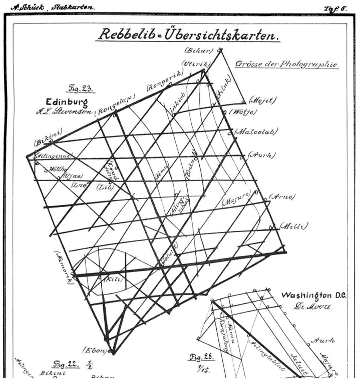


Figure 4c

Figure 4: A selection of Marshall Islands charts drawn by Albert Schück, *Die Stabkarten der Marshall-Insulaner* (Hamburg: Kommissionsverlag von H. O. Persiehl, 1902).
4a Different charts dating from the 1890's that match the *mattang* chart now at Cambridge in Figure 3b. All of these represent Jaluit. Table 2, figures 5 to 13 in original.
4b A *meddo* chart of Jaluit from Stuttgart very similar to the one at Cambridge, Figure 3c. Table 7, figure 42 in original.
4c Schück's identification of places on the Stevenson map (at the time on display in Edinburgh). Table 5, figure 23 in original.

Imperial entanglements: Stick charts in the context of nineteenth-century colonialism and climate

Materially, 1875, the year the Cambridge charts were obtained, was a very important date. In 1875, one of the worst typhoons in the history of the Marshall Islands struck. This helps explain how George Le Hunte acquired such a remarkable and diverse collection of charts, which were generally kept as secrets among different lineage groups connected to rituals.

Made up of twenty-nine coral atolls and 1225 islands and islets, the Marshall Islands comprise ten percent of all coral atolls in the world, including the largest, Kwajalein. None rises more than twenty feet (six meters) above sea level, averaging six-and-a-half feet (two meters). Because of this, they are extremely vulnerable to the storm surge of typhoons (*ļañ* or the loan word *taibuun*). The result can be the depopulation of whole islands as storm surge sweeps across the islands. In addition to deaths from drowning, this can also result in the complete loss of food supplies – especially coconut and breadfruit trees, which take a long time to replenish. The first recorded typhoons date from the 1840s, although no doubt many occurred before that. The more severe storms seem to correlate with ENSO (*El Niño*) events when sea surface temperatures are higher. The November 1875 typhoon occurred in a non-ENSO year and unusually late in the season, which begins in July and peaks in August and September.[22] There is an open and likely unresolvable question of whether such late nineteenth-century climate disasters have any relationship to planetary warming as a whole, as the depopulation and reforestations of Columbian Exchange cooling gave way to renewed warming in the nineteenth century. This shift would have altered ocean weather patterns in both the early modern period and then again in the nineteenth century.[23]

Regardless of causality, as well as the impossibility of measuring shifts in intensity and frequency in this period, because of the 1875 typhoon Kwajalein, the largest atoll in the world, was completely depopulated by an eight-foot storm surge. The storm surge affected the other atolls as well. On Jaluit Atoll, where the Cambridge charts come from, three ships belonging to the German trader Adolph Capelle as well as a Russian ship, the *Julie Reitz*, were driven ashore and their copra cargoes lost. Mary Colcord, the wife of the captain of the missionary ship *Morning Star*, wrote in her diary that Jaluit was,

> quite a desolate sight; ships bilged on the beach, trees up rooted in every direction, and blocking the roads and paths. Hardly a green leaf to be seen; even the leaves of the bushes shriveled and blackened. Some of the trees bent halfway to the ground by the wind still remain, so one can almost imagine the tornado still going on! The people are very downcast; so many breadfruit and coconut trees uprooted, and most of those standing [with] leaves all dead. They fear a famine.[24]

22 Dirk Spennemann and Ian Marschner, *Stormy Years: On the Association between the El Niño/ Southern Oscillation Phenomenon and the Occurrence of Typhoons in the Marshall Islands* (Albury, N.S.W.: Johnstone Centre of Parks, Recreation, and Heritage, Charles Strut University, 1994).

23 Recent scholarship has pointed to the disease epidemics of the Columbian Exchange creating cooling in the seventeenth century because of reforestation of the Americas, which would have disrupted island navigation patterns as well as crops. This pattern reversed would be reversed in the eighteenth and nineteenth centuries, with population growth, deforestation due to shipping and agriculture, and the increasing use of coal. Simon Lewis and Mark Maslin, "Defining the Anthropocene," *Nature* 519 (2015): 171–180; Simon Lewis and Mark Maslin, "A transparent framework for defining the Anthropocene Epoch," *The Anthropocene Review*, 2, no.2 (2015): 128–146.

24 Mary Colcord, *Journal aboard the Missionary packet "Morning Star" on voyage to Micronesia-1875* (1875), 42, typescript by Joanna Colcord, NSW State Library, 279.9/C. Colcord was the wife of

The disaster came on the heels of a widespread syphilis epidemic that started among the elite in the 1850s, which had supposedly been brought back by two clan heads who returned from a shipwreck on Kosrae in the Caroline Islands. By the 1870s, a large amount of ship traffic was visiting the islands, coming from Hawaii, the United States, Germany, France, Britain, and various missionary and private groups.[25] Arguably, the disaster could be understood as a mixture of late Columbian Exchange patterns of disease and of storm intensity. Of course, no European or Pacific Islander in the 1870s would have conceptualized change in this manner.

The mid-1870s thus launched a key phase in the contestation and redefinition of indigenous oceanic knowledge. Spain had claimed the islands in 1874, the year before the great typhoon, as part of Manila's expansion of sovereignty eastward from the Carolines. Fearing that the United States might move in, Britain began secret negotiations with Germany in 1875. After the typhoon, which the Spanish had no resources to address, Germany claimed the islands were unoccupied. They eventually purchased most of them from Spain in 1885 during the scramble for the Pacific. Ben Finney was thus right to be suspicious of such charts, especially those acquired, classified, and described after the 1880s. But it does seem like 1875 might have been the turning point, a moment of imperial competition marked by natural disaster that created the conditions on Jailut for once tightly controlled objects to begin to circulate on a global scale.[26]

Subsequent typhoons also had important regional effects on the balance of imperial powers and techniques of development, and by 1890, when the Stevensons arrived, substantial changes had taken place in both navigation and mapping. In 1889, another devastating tropical cyclone or typhoon at Apia, Samoa, ex-

the missionary and ship captain Andrew Colcord. The typhoon caused significant damage on Kili, Jaluit, Namorik, Kwajalein. Ebon, and possibly Mile. The information on the complete destruction of Kwajalein comes from James Young, *Diary* (1875–1877), 152, entry for July 14, 1877, and 153, entry for July 17, 1877, Mitchell Library, Sidney (Canberra: Pacific Manuscripts Bureau, n.d.) PMB 21. Young was a trading station manager for the copra firm of Thomas Farrell, the competitor of Capelle and Co from 1876. The typhoon of 1875 was such an important event that according to Young, indigenous survivors on other islands used it as a reference point for preparing for storms that followed. On Capelle and Farrell see Francis Hezel, *The First Taint of Civilization: A History of the Caroline and Marshall Islands in Pre-Colonial Days, 1521–1885* (Honolulu: University of Hawai'i Press, 1994), 216–225

25 See the database compiled by Dirk Spenneman, "Ships visiting the Marshall Islands (until 1885)," accessed July 3, 2025, https://marshall.csu.edu.au/Marshalls//html/Shiplist/Year-1875.html.

26 On the broader issue of loot in relation to German colonialism in the Pacific see Götz Aly, *The Magnificent Boat: The Colonial Theft of a South Sea Islands Treasure* (Cambridge, MA: Harvard University Press, 2023).

acerbated the broader power struggle among the United States, Britain, Germany, and different elite factions on different islands in both Samoa and the Marshalls. New "unprotected" (lightly armored) German cruisers designed to serve as floating administrative platforms, the SMS *Sperber* (1889) and SMS *Bussard* (1890), arrived after the Apia Cyclone sank six ships from the US and German navies. These new mobile infrastructures would shift the nature of colonialism in the region. Germans encouraged the planting of coconut palms to generate both an economy and population growth, concentrated in plantations. This trade had previously been dominated by private firms and pirate slavers from the 1860s to the 1880s. Sail-powered trade ships looking to collect and carry copra (dried coconut cores) had arrived in large numbers during the 1870s, as did increasing corporatization of the copra trade by German firms using typhoon refugees. The colonial-era copra industry exemplifies the imposed developmental infrastructures that sought to transform Marshallese society into a profitable site for German colonial extraction. The *Deutsche Handels- und Plantagen-Gesellschaft* (DHPG) established large-scale copra plantations in Jaluit (Jaluit Gesellschaft) and Ebon Atolls in the 1880s, enforcing a system of coerced indigenous and imported Micronesian labor. These plantations became the primary economic foundation of German control in the region, integrating the islands into a global commodity trade network. The shift to plantation-style copra production displaced indigenous farming, fishing, and exchange practices, aligning the Marshall Islands with an external logic of developmental progress that prioritized monocrop export production for imperial markets.

Robert Louis Stevenson wrote about this new world of copra in *The Beach of Falesá* (1892) and *The Ebb-Tide* (1894) just after the new German cruisers shifted the nature of maritime governance in the region.[27] The Marshall Islands charts given to Robert Louis and Fanny Stevenson are artifacts from the world of 1890, not 1875, and they were clearly embroiled in imperial competition between the British, the Germans, Americans, and even the Japanese in the scramble for the Pacific. Commercial competition related to copra had by this point become entangled in the colonial imaginations of the "great powers."[28] The Stevensons acquired them at the German seat of government on Jailut on the voyage of the *Janet Nichol* in June 1890. Fanny Stevenson tells the story of seeing these German trophies of colonial dominance,

27 See Roslyn Jolly, "Piracy, Slavery, and the Imagination of Empire in Stevenson's Pacific Fiction," *Victorian Literature and Culture* 35, no.1 (2007): 157–173.
28 Ann Colley, *Robert Louis Stevenson and the Colonial Imagination* (Routledge, 2017); Rosalind Williams, *The Triumph of Human Empire: Verne, Morris, and Stevenson at the End of the World* (University of Chicago Press, 2013).

> The [German] commissioner's [Max Bierman] room was decorated with trophies of native arms, armour, etc. He promised to have a native sailing chart made for Louis. These charts are very curious things, indeed, made of sticks, some curved, some straight, caught here and there by a small yellow cowry. The cowries represent islands, the sticks both currents and winds and days' sailing. The distances between the islands have nothing to do with miles, but with hours only. These charts are very little used now, only one old chief knowing how to make them, but the time was when each young chief must pass his examination in the charts, knowing them by heart, as they were never taken to sea but kept at home for reference and continual study.

The Stevensons returned to Jailut on the 26th of June, and Fanny wrote,

> Went to see the commissioner where we found our island charts awaiting us. Louis and the commissioner and Captain Brandeis [a German spy who had fled from Samoa] tried to make out the names of the islands by comparing the charts with our European map, but failed; a man who had been thirty years in the islands was consulted, and afterwards a native, but still they were baffled. It was finally settled that the thirty-year resident should see the maker of the charts (now absent) and get a complete key to be sent to Samoa.[29]

If Fanny Stevenson is to be believed, the large *rebbelib* charts were already in 1890 artifacts of an earlier, perhaps pre-typhoon era. But the charts had become more map-like than they had been in 1875, and the Stevensons brought back no *meddo* or *mattang* charts.

The Stevenson maps seem to have remained behind to be marked up (the Penn copy has inscriptions on it in pencil in a German hand). They were sent to the Stevensons after they had returned to Samoa and moved into the larger Vailima house in April 1891, where Robert Louis died three years later. Fanny's daughter, Isobel Strong, who had worked as Robert's literary assistant in Samoa, sold off the charts as part of a large auction in 1914. Fanny had died that February, and Isobel married her mother's secretary as well as published posthumously Fanny's diary of the voyage. That same year, the Japanese took control of the Marshall Islands as the Germans went to war in Europe. Penn and the American Museum of Natural History bought the charts, anticipating the new emerging world order in the Pacific.[30] In the University of Pennsylvania *Museum Journal* of 1919, Henry Usher Hall, the Ethnology Curator, criticized Fanny Steven-

29 Fanny Van de Grift Stevenson, *The Cruise of the 'Janet Nichol' Among the South Sea Islands* (New York: Claude Scribner's sons, 1914), 151, 160.

30 *Autograph Letters.* One (Penn, lot 613) is rectangular 2ft. 3in x 4ft, and the other American Museum of Natural History is square (2ft 10 x 2ft 8, lot 614). In addition, Stevenson brings a large amount of Marshall Island ebony bead and orange and white shell money back (lots 564–575).

son's interpretations of the charts as uninformed, misreading from a more naive era before German scholarship, especially the idea that some of the sticks represented currents rather than ocean swells.[31]

Hall, in particular, relied on the work of the German writer "Captain Winkler," who had been canonized in the United States by a translation of his 1898 German work by the Smithsonian in 1901. Although nobody in the United States seems to have known his first name, Otto Winkler began his work trying to understand the charts as swell diagrams in 1896. That year he received from a Dr. Irmer, the German land inspector, two charts. Irmer knew nothing about them, claiming they were surrounded with "great secrecy" among the older chiefs. Winkler then interviewed one of the old chiefs in Jaluit named Lojak by way of Irmer's assistant and translator Ladjur. But Lojak refused to tell Winkler or Ladjur anything substantial. Winkler then asked around and only got the explanation about the charts showing currents, which he did not believe because "the current cannot be seen in open water." The next year, Winkler interviewed Lojak a second time, with the help of a new half-Portuguese interpreter named Jochem de Brun. He found that as a "chief" rather than a navigator, Lojak himself did not know what he was talking about. Instead, Jochem interviewed his own navigator, Laumanuan, although this too produced vague results. Such interactions hardly count as the work of "go-betweens" or "native informants." Winkler attributed poor communication to a decline in knowledge on the part of the Marshall Islanders.[32]

It was out of these and a few other conversations that Winkler pieced together the story about swells, arguing the charts were mainly for educating young "chiefs" because the knowledge of navigation was increasingly disappearing among the older generation. These kinds of charts could also be useful authoritative reference points in debates about which direction to go in, when "water indications were not plain and varying interpretations had been made." Winkler thus suggested (as Ben Finney would later) that the charts were in fact nineteenth-century artifacts, representing an effort by male elites, shattered by both disease and typhoons, to create new kinds of local authority through ritual and education. Here, Winkler anticipates the controversial "big man" argument made by Marshall Sahlins in the early 1960s.[33] New techniques would address new needs

31 Hall, "A Marshall Islands Chart," 35–42. Hall's real expertise was in 'aboriginal Siberia,' as he had led along with the Polish anthropologist Maria Antonina Czaplicka a joint expedition sponsored by the Pitt Rivers and Penn Museums to the Yenisei River.

32 Winkler, " Über die in früheren Zeiten in den Marschall-Inseln gebrauchten Seekarten," 1418–1439; see also Schück, *Die Stabkarten der Marshall-Insulaner*, 24–7.

33 Winkler also anticipates the argument of the Catholic missionary Bernard August Erdland, *Die Marshall-Insulaner: Leben und Sitte, Sinn und Religion eines Südsee-Volkes* (Münster: Aschendorff and create new authority infrastructures in relation to both post-disaster migrations. They would allow localized island kinship groups to think of the Marshall Islands as a collective entity. Even before he published the details of his investigations, Winkler's findings would be embedded in the new German Colonial Atlas in 1897. The shift to clearly defining the charts as maps also helped define relations in the short-lived archipelagic colony of "German New Guinea" (1884–1920). The results were a positivist victory over primitive and fragmented knowledge, a dominance over new and emerging forms of authority in the colony itself. The idealized blue landscape of the German colonial archipelago superseded the old, limited knowledge of the regional *meddo* and its alternate system of authority.

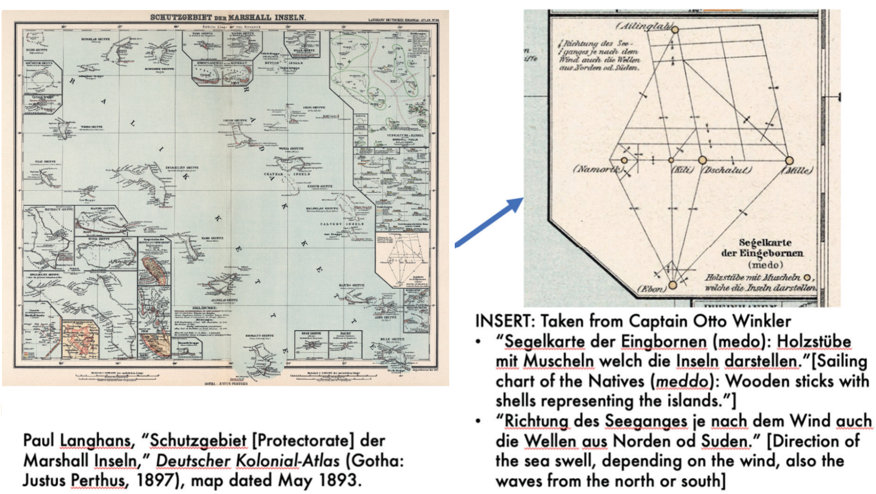


Figure 5: Paul Langhans, "Schutzgebiet [Protectorate] der Marshall Inseln," *Deutscher Kolonial-Atlas* (Gotha: Justus Perthus, 1897), map dated May 1893, with insert after Captain Otto Winkler.

The Stevenson charts, created just before the Winkler charts, thus represent a moment when both the German and the American states and their respective knowledge communities were becoming aware of the value of such charts as an infrastructure for building what Benedict Anderson has called "official nationalism" out

Verlag, 1914). See the summary in Joseph Genz, *Breaking the Shell: Voyaging from Nuclear Refugees to People of the Sea in the Marshall Islands* (Honolulu: University of Hawai'i Press, 2018), 66–70. Erdland argues that German colonialism reduces the social structure into a more patriarchal system with commoners (*ri-jerbal*), lineage heads (*alap*), and chiefs (*roij*), the latter having direct relationships with German colonial authorities in an effort to push the development of the copra trade and end inter- and intra-island fighting over food resources.

of indigenous infrastructures. For Anderson, official nationalism was a conservative and anticipatory response to popular nationalism, adopted by dominant and especially imperialist groups in order to control the struggles and rivalries emerging in the late nineteenth century.[34] In 1899, two years after Winkler published his map, Charles Townsend and H. F. Moore of the United States Fish Commission would acquire a set of charts comparable to what the British and the Germans had on the USS *Albatross* Expedition.[35] This expedition is famous for discovering manganese nodules on the ocean floor, now the target of an ocean mining rush.

These four moments – 1875 (typhoon), 1890 (Stevenson), 1896 (Winkler), and 1899 (*Albatross*) – in the collecting of Marshall Island charts suggest that it is problematic to think of these charts as static, as if they belonged to a people without history, or even to think of a single tradition of "stick charts."[36] Rather than seeking origins, it is more important to think about what specific charts at specific times might have been trying to do, especially in the context of devastating typhoons, famines, and epidemics. There is now general agreement among both scholars and current Marshallese navigators that they depicted currents, swells, and super swells in an effort to understand wave patterns.[37] There also seems to be general agreement that the fragile charts were used in educational settings on land rather than for navigation at sea. Unlike the maps supposedly replicated from examples created in Tahiti (Tupaia) and the Carolines, maps explicitly created in response to queries generated by Europeans, the Marshall Island charts have generally been seen as a kind of trade secret. They formed part of the educational process for navigators from different islands, handed down from masters to apprentices and that education both evolved and differentiated.

The charts were in some ways an emerging ocean science for people who found themselves increasingly displaced by both oceanic and imperial changes.

34 See Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London and New York: Verso, 1991), 83–112; as well as Benedict Anderson, *The Spectre of Comparisons* (London and New York: Verso, 1998), 47–55, 233–237.

35 Smithsonian Institution Archives, Record Unit 95, Box 77, Image No. 13037, https://siarchives.si.edu/collections/siris_arc_308085.

36 Note that the phrase stick chart comes from the German "*Stabkarten.*" The comprehensive Marshallese term is a loanword from English – "*jaat*" – and there are three different pre-colonial words.

37 The most detailed and recent assessment of this can be found in the work of the anthropologist and student of Ben Finney, Joseph Genz with captain Korent Joel, a nuclear refugee from Rongelap, esp. Joseph Genz, "Complementarity of cognitive and experiential ways of knowing the ocean in Marshallese navigation," *Ethos* 42, no.3 (2014): 332–351; Joseph Genz, "Resolving ambivalence in Marshallese navigation: Relearning, reinterpreting, and reviving the 'stick chart' wave models," *Structure and Dynamics* 9, no. 1 (2016): 8–40; and Genz, *Breaking the Shell.*

They served multiple purposes – education, navigation, and social cohesion. Rather than a linear progression from "indigenous" to "colonial" knowledge, the charts gave definition to contested spaces where different actors sought to define, appropriate, or erase local epistemologies. This explains why the same artifacts appear across British, German, and American expeditions, each reinterpreting the charts to fit their own developmental and scientific narratives.

Proto-anthropology, development science, and the objectification of Indigenous knowledge

Maps tend to be thought of as stable and official representations – an aura conveyed by print and mechanical reproduction. Berlant notes, by contrast, that "infrastructures… manage ongoing relational disturbances."[38] It is perhaps not surprising, then, that the charts have become the subject of debates surrounding notions of indigeneity. Were they imitations of charts brought by sailors and missionaries, or had they predated the European and American arrival in the Pacific? If there was some kind of borrowing, could it have occurred in the early sixteenth century when the Spanish arrived early in the Columbian Exchange (1526) and then developed into a rich and independent tradition over the next three centuries?[39]

For these kinds of questions, the period of analysis must shift to the early nineteenth century, when the proto-anthropological record began to take shape. From the arrival of the British captains John Marshall and Thomas Gilbert in 1788 in the Marshalls to the first description of the charts in 1862, this period rep-

38 Berlant, *Inconvenience*, 22.

39 The Marshall Islands received a small number of Spanish visitors after their sighting by Alonso de Salazar in 1526. This began with the brief visit of the expedition of Álvaro de Saavedra Cerón on the *Florida* in 1529, which anchored (*surgí*) at three low islands (*tres islas bajas*) at 11.5 degrees N (possibly Bikini, Rongelap, and Rongrik or Enewetak). See "Relacion del iage que hizo Alvaro de Saavedera" in *Colección de los viages y descubrimientos.* 5, Martín Fernández de Navarrete (Madrid: Royal Printing House, 1825), 475. A six-ship fleet arrived under Ruy Lopez de Villalobos in December 1542. The Afro-Portuguese pilot Lope Martin first came in the *San Lucas* (January 1565) and then in the *San Jerónimo.* which he seized and landed at Ujelang Atoll. He was marooned with 26 crewmen in July 1566. See Andrés Reséndez, *Conquering the Pacific: An Unknown Mariner and the Final Great Voyage of the Age of Discovery* (New York: Houghton Mifflin, 2021]. In September 1568, Álvaro de Mendaña and his pilot Hernán Gallego landed at Namu Atoll ("San Mateo Shoals"), where they found a Spanish nail and rope. Alvaro De Mendaña, *The Discovery of the Solomon Islands*, trans. Wiliam Amhurst and Basil Thomson (London: Hakluyt Society, 1901), 185.

resents the emergence of the region as a "borderwater" understood through a Russian-led proto-anthropology that emerged before the typhoon of 1875. After 1788, when the British "first fleet" created the colony of New South Wales in Australia, the Marshall Islands became part of the "easternmost route" to China from Sydney. Both the *Charlotte* (captain Thomas Gilbert) and the *Scarborough* (captain John Marshall) had been part of the "First Fleet" to Port Jackson, NSW, and had left in 1788 to travel to the Pearl River Delta. This "easternmost route" to China from Sydney meant that ships regularly passed by Namu and avoided the difficult passages of the archipelagos as well as the western intensification of the South Pacific Gyre.[40] The British colonization of the supposed *terra nullius* of Australia turned the Marshall Islands into a borderwater between the Qing and the British empires, which demanded a reconceptualization of space, but the region itself attracted the interest of Russia, which in an effort to pursue the trans-Pacific sea otter pelt trade with China had built Fort Ross in what is today Northern California.

Most accounts of the charts begin in 1862, and they skip over the 1875 typhoon, and they include, with the partial exception of Finney, quite limited if any information about the new role of the Marshall Islands from the 1790s as part of the trade between Sydney and China or the involvement of Russian explorers.[41] As a borderwater, missionaries, whalers, traders, and a range of imperial powers (Britain, France, Spain, Russia, the newly-formed United States) using ships with multi-ethnic crews quickly moved into these Pacific spaces from the late eighteenth century, and they brought with them a range of technical media.

But only during the second Hawaiian Renaissance of the 1970s was there a conceptualization of what Roger Green and Ben Finney called "Remote Oceania," a space settled "using deep-sea voyaging canoes, ways of navigating far out of sight of land, and a portable system of agriculture."[42] The history of Remote Oceania, as

40 Rhys Richards, "The Easternmost Route to China and the Robertson Aikman Charts," *The Great Circle* 8, no. 1 (April 1986): 54 – 67; Rhys Richards, "The Easternmost Route to China: The British Pioneers," *Great Circle* 8, no. 2 (October 1986): 104 – 116; Rhys Richards, "The Easternmost Route to China: The American Pioneers and the Trans-Pacific Traders," *Great Circle* 9, no. 1 (April 1987): 48 – 59.

41 See James Clifford, "Fort Ross Meditation," in *Routes: Travel and Translation in the Late 20th Century* (Cambridge, MA: Harvard University Press, 1997), 333, about the shifting ecologies and temporalities of Pacific borderlands.

42 Ben Finney, "The Pacific Basin: An Introduction," in *History of Cartography*, vol.2, book 3, ed. David Woodward and Malcolm G. Lewis (Chicago, IL: University of Chicago Press, 1998), 419. For the definition see Andrew Pawley and Roger Green, "Dating the Dispersal of the Oceanic Languages," *Oceanic Linguistics* 12, no.1 (1973): 1 – 67; Roger Green, "Near and Remote Oceania – Disestablishing 'Melanesia' in Culture History," in *Man and a Half: Essays in Pacific Anthropology* a borderwater between the Pacific and maritime East Asia, goes back much further than the 1790s. The argument is largely about technical achievement and abstract environmental conditions, with innovations in Near Oceania setting up the possibility of Remote Oceania. As Paul D'Arcy argued in a more environmentally deterministic way, because of large gaps between islands and archipelagos as well as limited land area, "Remote Oceania is a truly oceanic environment, one of the few settled by humans."[43] However, one could also turn this argument on its head. The Marshall Islands have been on the front of Anthropogenic climate change since the 1870s, and before that, for two thousand or even four thousand years, people living there had to embrace a radical sensitivity to Holocene climate and sea level changes – warm periods and little ice ages – demanding an equally flexible infrastructure.

The British captains Marshall and Gilbert were not particularly attentive to these kinds of questions in 1788, nor were more broadly the Cook expeditions in that period, which did not visit the islands. Otto von Kotzebue's arrival in the *Rurik* in 1817 on the second Russian expedition into the Pacific was different, however, and more sensitive to the question of extrastate infrastructure. Kotzebue visited both the Ratak and Ralik Island chains of the Marshalls, working with the naturalist Adelbert von Chamisso and the artist Louis Choris. Inspired by Cook's work with Tupaia, Kotzebue worked with the elderly Lagediack, as a "friend and teacher," among other islanders to make the first comprehensive map of the islands.[44]

---

and Ethnobiology in Honor of Ralph Bulmer, ed. Andrew Pawley (Auckland: Polynesian Society, 1991), 491–502; Ben Finney, "Colonizing an Island World," in *Prehistoric Settlement of the Pacific*, ed. Ward Goodenough (Philadelphia, PA: American Philosophical Society, 1996), 72. This two-fold division was pioneered by Marshall Sahlins in the early 1960s for different purposes. Unlike Finney and Green (who do not cite Sahlins), he argued that it had fundamentally political rather than technical implications, with larger and male-chief dominated polities emerging in Polynesia (Remote Oceania) as opposed to Melanesia (Near Oceania), see Marshall Sahlins, "Poor Man, Rich Man, Big-Man, Chief: Political Types in Melanesia and Polynesia," *Comparative Studies in Society and History* 5, no.3 (April 1963): 285–303. The first major critique of Sahlins's argument was Bronwen Douglas, "Rank, Power, Authority: A Reassessment of Traditional Leadership in South Pacific Societies," *Journal of Pacific History* 14, no.1 (January 1979): 2–27, arguing that a highly diverse set of political formations characterized the region, something particularly true of Micronesia.

43 Paul D'Arcy, *The People of the Sea: Environment, Identity, And History in Oceania* (Honolulu: University of Hawai'i Press, 2006), 9.

44 The report of the privately-financed expedition was published first in Germany, then in London, and finally in Russian, see *Entdeckungs-Reise in die Süd-See und nach der Berings-Strasse zur Erforschung einer nordöstlichen Durchfahrt unternommen in den Jahren 1815, 1816, 1817, und 1818, auf Kosten Sr. Erlaucht des Herrn Reichs-Kanzlers Grafen Rumanzoff auf dem Schiffe Rurick*

In accounts of the expedition, Kotzebue's encounter with Lagediack on Wotje Island receives a relatively extensive description as a "writing lesson" along the lines of Lévi-Strauss.[45] It begins with the notion of writing as magic – if Lagediack's name is written down it will metamorphose the person into letters – but then it took a strikingly different turn. Maps were different kinds of signs than names for Lagediack. Lagediack exhibited no fear in tracing out and marking with coral rocks the islands, channels, atolls.[46] Kotzebue has another elderly man named Langemui describe the Ralik chain, where he had been severely scarred from wounds received in a battle. The double island chains of the Marshalls may have encouraged mapping because of the distance between the two, but perhaps so did regular interactions with the more distant and linguistically distinct Caroline Islands. Kotzebue meets the castaways Edock and Kadu from Woleai in the Caroline Islands, and they also draw a chart for him.[47] Castaway Caroline Islanders had drawn charts in the early eighteenth century for Spanish Jesuits in the Philippines, and Kotzebue was aware of this tradition of charting, as he was of the Tupaia example from the Cook expedition.

Kotzebue arrived on 1 January 1817 at Mejit, which he called New Year Island. Mejit was and still is one of the most remote and poorly resourced of the islands. It pokes out with Utrik on a little trapezoid on the Stevenson-type maps to the northeast. There, Kotzebue encountered seven canoes, each with five or six men (*tibnol*) "entirely made of very small boards" patched together, which he argued, not unpersuasively, "proved a want of timber." Mejit had, in 1817, according to Kotzebue's Lieutenant Schischmareff, lots of pandanus for food as well as basket and housing thatch, limited large breadfruit (used for the hull), and very few coconut trees (used for various parts, including rope).

---

unter dem Befehle des Lieutenants der Russisch-Kaiserlichen Marine Otto von Kotzebue (Munich: Hoffmann, 1821); translated as *A Voyage of Discovery into the South Sea and Beering's Straits, for the purpose of exploring a North-East Passage, undertaken in the years 1815–1818, at the expense of His Highness the Chancellor of the Empire, Count Romanzoff, in the Ship Rurick*, 3 vols. (London: Longman, 1821); and Атлас к путешествию лейтенанта Коцебу на корабле Рюрике в Южное море и в Берингов пролив (St. Petersburg: n.p, 1821–1823).

45 "C'est un étrange chose que l'écriture… Le seul phenomenon qui l'ait fidèlement accompagnée est la formation des cites et des empires… elle paraît favoriser l'exploitation des hommes avant leur illumination." [Claude Lévi-Strauss, "Leçon d'écriture," *Tristes tropiques* (Plon, 1955), 352–354.

46 Kotzebue, *A Voyage of Discovery*, vol.2, 69–70.

47 See Kotzebue, *A Voyage of Discovery*, vol.2, 132–133 and chart. Ben Finney argues that this chart may be a synthetic effort using the 1722 chart made by the Jesuit Juan Antonio Cantova, who interviewed Caroline castaways in the Philippines. See Finney, 453–456.

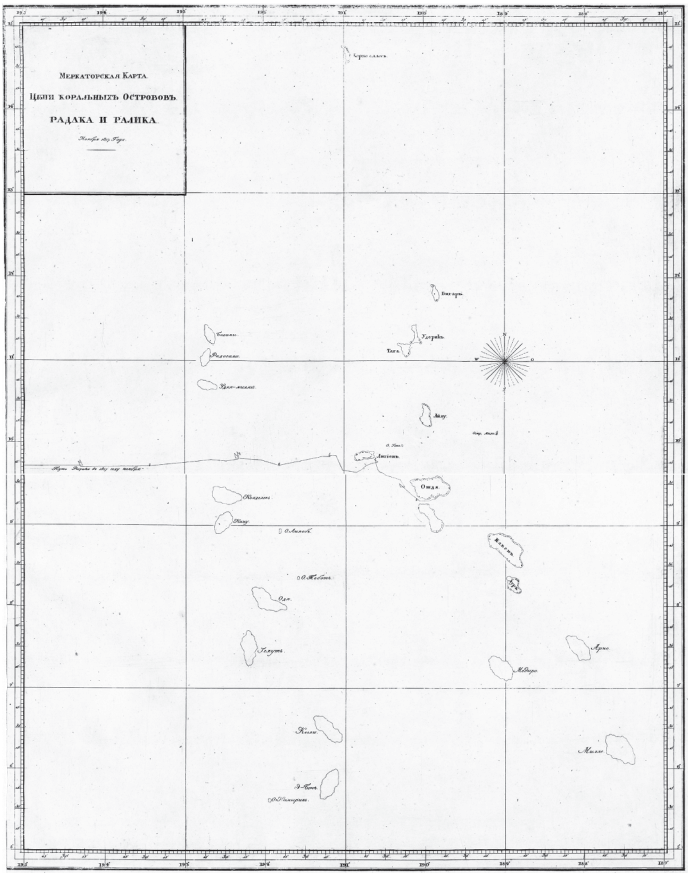


Figure 6: Otto von Kotzebue, Louis Choris, and Langemui, “Меркаторская карта Цепи коральных островов Радака и Ралика. Ноября 1817 года” [Mercator map of the chain of coral islands of Radaka and Ralik. November 1817] (St Petersburg: n.p., 1821 – 3).

Pandanus, breadfruit, and coconut were the three key trees. Kotzebue would later see, and be impressed by, larger canoes with outriggers and sails, but it was the coconut coir lashings that initially caught his eye as a sailor. Marshall Islanders developed an elaborate language for these big boats, and they are symbolically represented on the charts. The charts, in their nineteenth-century versions, are tied together with coir (the tourist examples use glue). For such lashings, there is a set of words. *Elmakwot* is the first lashing to hold together while building; *emem* is the main knot holding hull together and other principle parts, which has a different style on different islands; *ino kutileik* are lashings for the *ere* connecting the lee side to the outrigger (*lifr*); *ino in rewa* attaches the outrigger float;

ino in Jobarbar attaches two sail booms together; *ieplik* is for the block in center of lower boom; *eloko* is the lashing of main outrigger booms to shelf in center of main hull; *ino in erer* ties the sacrificial keel or *erer* under main hull. When Kotzebue does later encounter more resource-intensive boats with finely braided sails, carrying twenty-five people, thirty feet long, with lots of rigging and a high mast (a *walap* 'canoe'), they recognize Kotzebue's ship as a species of their own, calling it a "*ellap wa*" ('big boat').

Timber for such large was already in short supply in 1817. The reasons for this could be manifold, ranging from overharvesting and population growth to drought and typhoon damage. Life in a borderwater could be precarious. Shortages meant problems with building canoes as well as food. "The water which runs in is obliged to be constantly baled out; and as they can only leave the island in a perfect calm, they have neither masts nor sails."[48] What is clear is that in the aftermath of Kotzebue's voyage and with the steady arrival of more and more European ships seeking materials for repair and an increase in the frequency of typhoons, there would be increasing losses to larger trees in the very small forests. This was radically exacerbated by the shift to copra (coconut) cultivation over the course of the nineteenth century.

Ideas related to what might be called development seem to stem from Kotzebue's voyage. Even more than his late eighteenth-century predecessors, he was attentive to the ecological dimensions of life in the Marshalls. In 1817, he described the forests as dense pandanus (*bōb*), the main food source, with very tall and thick breadfruit trees (*ma*) with the occasional coconut (*ni*). Some islands had newly planted stands of coconut, and others fully grown ones. There were small taro and banana patches, which seem to have been status and luxury plants.[49] There was already iron (*māāl*) economy for nails and sheet metal as well, perhaps from passing ships but clearly from flotsam as well – as evidenced by beach findings.[50] Kotzebue reported all of this, but he also began actively encouraging the development of Pacific-style market gardens using yams, watermelon, and other seeds brought from Hawai'i to both encourage population growth, provide supplies for passing ships, and prevent famine due to an over-reliance on breadfruit monoculture.[51] This was development science, creating a political economy and stable development that could support visitation by ships in need of resupply (water, food, wood) rather than formal incorporation into an empire.

48 Kotzebue, *A Voyage of Discovery*, vol.2, 6.
49 Kotzebue, *A Voyage of Discovery*, vol.2, 28, 52, 57, 103, 117. The three trees put one in mind of the 'three sisters' of North American indigenous agriculture.
50 Kotzebue, *A Voyage of Discovery*, vol.2, 37, 63.
51 Kotzebue, *A Voyage of Discovery*, vol.2, 24, 26–27, 70–71, 75, 83, 106, 118, 210, 212

ENSO cycles (*El Niño*) have historically created droughts in the Marshall Islands, something that presumably predates any Anthropogenic climate change, killing off large numbers of coconut and breadfruit trees as well as taro and arrowroot. Pandanus, along with fish and other marine life in the atolls, are the basic safety net. Tropical cyclones (typhoons/hurricanes) are also more frequent in *El Niño* years, raising the risk for both coastal flooding and tsunamis. There is a way of viewing these environments that is abstract, like a *mattang* chart that sometimes shows swells as a pure geometric form and other times shows swells as they would occur around an idealized island. But abstraction was only one way of viewing the ocean for Marshall Islanders, and the charts, made of pandanus, coconut, and cowrie shells, were always of constant reminder of the materiality of both the ocean and its connection to the resources of the land, which could become scarce or unevenly distributed in times of crisis. Russian strategies, while extending the Columbian Exchange into the ecologies of the Marshall Islands, did little to solve the question of crisis, while the arrival of large-scale shipping traffic did much to exacerbate it.

Conclusion: Rethinking development through infrastructure

The history of Marshall Islands stick charts offers more than an ethnographic curiosity or a relic of lost navigational knowledge. These artifacts challenge dominant paradigms of development, technology, and infrastructure by revealing an alternative way of conceptualizing spatial knowledge in the oceanic world. Rather than serving as primitive prototypes of Western cartography, they operated as dynamic infrastructures for education, environmental understanding, and political negotiation within a rapidly shifting colonial order. Reframing Marshallese stick charts as infrastructures – as living technologies embedded in indigenous epistemologies – invites us to look beyond their museum status and recognize them as tools for surviving environmental and political precarity.

By positioning stick charts within the framework of infrastructure, this chapter reframes them as tools for managing uncertainty and crisis – whether environmental, political, or epistemological. Marshallese charts were not static; they adapted in response to climate events (typhoons, ENSO cycles), colonial interventions (Russian, German, British, and American mapping projects), and the introduction of new economic pressures (copra production, labor migration). These responses complicate traditional narratives of development as a linear progression from "indigenous" to "modern" knowledge and instead highlight a continuous, adaptive process of knowledge-making in oceanic borderwaters.

The Western imperial obsession with categorizing and objectifying these charts mirrors a larger imperial anxiety about controlling and rationalizing maritime space. While colonial authorities and scientists sought to absorb the charts into a framework of scientific positivism, the charts themselves resisted such containment. They remained embedded in oral traditions, mnemonic techniques, and embodied practice, making them illegible to outsiders who relied solely on material artifacts divorced from their performative and cultural contexts.

The historiography of development has often privileged Western models of infrastructure and progress, portraying non-Western knowledge systems as incomplete or primitive. However, as this study has shown, stick charts are an example of an alternative knowledge infrastructure, one that resists colonial classification, remains embedded in indigenous practices, and continues to serve as a model for understanding complex environmental systems. The very act of mapping – and by extension, developing – is not neutral. It encodes assumptions about what counts as knowledge, who gets to produce it, and how it is used. By reinterpreting stick charts as infrastructural knowledge rather than mere relics of "pre-modern" navigation, this chapter challenges conventional hierarchies of development, progress, and civilization. In doing so, it invites a broader reconsideration of how we conceptualize indigenous epistemologies, oceanic governance, and the legacies of colonial science in the present day. This analysis of Marshallese stick charts as infrastructural objects also offers broader insights into contemporary debates about indigenous resilience and climate adaptation. Today, the Marshall Islands face existential threats from rising sea levels and environmental degradation, echoing historical cycles of adaptation and displacement. In this context, traditional navigation knowledge is not merely a cultural relic but a critical tool for understanding and responding to planetary change.

By the end of the nineteenth century, the Marshallese stick charts had been absorbed into museum collections, ethnographic studies, and colonial mapping projects. Yet their significance extends beyond their material form. As Berlant argues, infrastructures "manage ongoing relational disturbances" – they mediate between past and present, knowledge and power, stability and flux.[52] They are active forms of cultural survival under conditions of precarity.

The history of Marshallese charts is not a story of "discovery" by Western observers but rather one of negotiation, adaptation, and survival within shifting imperial and environmental forces. Marshall Islander work on navigation – both in

52 Berlant, *Inconvenience*, 22.

the nineteenth century and today, as seen in the research of Joseph Genz (a student of Ben Finney) – suggests an understanding of infrastructure that resonates with Bronisław Malinowski's concept of borderlands and borderwaters in *Argonauts of the Western Pacific* (1922). Unlike Franz Boas, who emphasized historical and cultural reconstruction, Malinowski saw limited value in the archive alone. He believed that cultures had to be studied through participant observation, as lived practices entangled with broader environmental and social processes.[53] Indeed, his ahistorical approach was in many ways an Eastern European (Austro-Hungarian) and borderland reaction to nineteenth-century German historicism, which inflected both German and American universities with nationalist and imperialist ideas about science and knowledge.[54]

While both Western and indigenous infrastructures are dynamic in practice, it is the logic of imperial development that demanded infrastructure be rendered static, legible, and extractable. These were qualities at odds with the embodied, adaptive use of Marshallese stick charts. The contrast, then, is not a fixed opposition between Western and indigenous systems, but the result of epistemic violence, in which imperial frameworks attempted to universalize their own standards of abstraction and fixity.[55]

Rather than mapping a clean divide, this chapter has shown how categories such as development and infrastructure themselves emerge from contested encounters between overlapping, and often incompatible, knowledge traditions. Stick charts resist not because they are timeless or traditional, but because they reveal how infrastructures operate across registers of embodiment, memory, and power.

American harvesting of whales, the copra rush of the mid-nineteenth century, and the continued spread of "Columbian Exchange" diseases, plants, and animals

53 Bronisław Malinowski, "The Group and the Individual in Functional Analysis," *American Journal of Sociology* 44, no. 6 (1939): 940; Bronisław Malinowski, *A Scientific Theory of Culture and Other Essays* (Chapel Hill: University of North Carolina Press, 1944), 37. Among Malinowski's most environmental works are *Argonauts of the Western Pacific* (London: Routledge, 1922) and *Coral Gardens and their Magic* (London: Routledge, 1935).

54 For a broader context here in relation to the 'official nationalism' argument of the previous section, see Ernst Gellner, *Language and Solitude: Wittgenstein, Malinowski, and the Hapsburg Dilemma* (Cambridge Cambridge University Press, 1998).

55 Walter D. Mignolo, *The Darker Side of Western Modernity: Global Futures, Decolonial Options* (Durham, NC: Duke University Press, 2011); Benedikt Korf, "Hydraulischer Imperialismus, Geographie und epistemische Gewalt in Sri Lanka," in *GrenzWerte: Tagungsbericht und wissenschaftliche Abhandlungen. 55. Deutscher Geographentag Trier 2005*, ed. E. Kulke (Leipzig: Deutsche Gesellschaft für Geographie, 2006), 627–633.

had devastating effects on Pacific populations during the nineteenth century.[56] Imperial and colonial activities by a huge range of actors – including the Russians and, by the 1890s, the Japanese – meant that supposed moments of encounter were always multipolar and complex. These entanglements required equally complex infrastructures in response. *Mare liberum* (free and undifferentiated oceans) was as much a myth as *terra nullius* (empty land).[57]

In relation to such changes, Marshall Islanders did not produce a flat or empty image of the blue ocean. Instead, they developed a layered and textured approach to complex aspects of persisting cycles and of increasing entropy.[58] These charts, designed largely for teaching and memory, still hold lessons for the oceanic Anthropocene, with its human and non-human actors. They reveal how environing practices – embodied, flexible, and relational – can persist in the face of extractive and imperial development schemes.

This underscores a central theme of this volume: that development, far from a linear or universal trajectory, emerges through layered contests over knowledge, environment, and infrastructural form.

56 It is also likely but difficult to prove definitively, that warming brought about by agricultural changes and deforestation from the sixteenth to eighteenth-century "industrious revolution" as well as the early industrial revolution and end of the "Little Ice Age" would have changed the frequency of ENSO related typhoons near the equator.

57 For a nuanced comparative approach to colonial understandings of land in the Pacific see Stuart Banner, *Possessing the Pacific* (Cambridge, MA: Harvard University Press, 2009).

58 Charne Lavery's "The Southern Indian Ocean and the Oceanic South," *Global Nineteenth-Century Studies* 1, no.1 (2022): 63–72, emphasizes the need to draw in "colder, wilder, more oceanic regions," to see how "distinct oceanic, political, and ecological space[s]" are mediated (71–72).

Evelyne N. Tegomoh

From thatched to corrugated roofs: Technological development of houses within the Papiakum landscape

Introduction

The United Nations recognizes shelter — in common with food and clothing — as a basic human need. However, while the need for shelter is universal, the form it takes varies significantly across people and cultures in terms of appearance, material, and construction techniques. While it is common to view shelter as a basic dwelling for humans and animals alike, shelter is never purely functional but deeply embedded with meanings and values shaped by the norms and beliefs of those who create and inhabit it. These symbolic dimensions are clearly illustrated among the Papiakum people of the western Grassfields of Cameroon. For the Papiakum, like others in the Grassfields, the house is not merely a place of shelter to satisfy a human need, but is culturally coded, layered with different meanings from its very inception. Within any society, the socialness of things makes them actors in a web of social practices and cultural values. They become nodes in a web of knowledge. Eghosa Noel Ekhaese, Bayo Amole, and Oladunni Izobo-Martins, in their study of housing types and characteristics in Benin, Nigeria, affirm that “house mean different things to different people.”[1] The “house could be a dwelling, home, hut, place for; entertainment, rest, sleeping, receiving guest, and a palace.” This is corroborated by Tomas Ariztia, who argues that investing in a home is not just about an idea or a space but an active cultural process in which home-making practices allow inhabitants to embed personal and social meanings into their new residences.[2]

1 Eghosa Noel Ekhaese, Bayo Amole, and Oladunni Izobo-Martins, “Prefiguring houses in a traditional city: a case for Benin house types and characteristics,” *Journal of Architecture and Urbanism* 1, no.2 (2017): 1–15.
2 Tomas Ariztia, “Decorating the New House: The Material Culture of Social Mobility,” in *Consumer Culture in Latin America*, ed. J. Sinclair and A.C. Pertierra (New York: Palgrave Macmillan, 2012), 95.

Evelyne N. Tegomoh, Department of Sociology and Anthropology, FSMS, University of Buea, Cameroon

https://doi.org/10.1515/9783111611358-011

The range of roofs found in various parts of Africa fall into different categories. The technology of terrace roofs was very common in Mauritania and the Upper Niger region. These were achieved by laying mating or short poles in a herringbone pattern on top of roof beams and plastering huts with mud. The houses of the Bamileke of the Grassfields in Cameroon have conical roofs resting on square walls. The conical roof was constructed of two circular platforms built on a pyramid structure, which rested on the house walls. In the Western African region, houses with thatched roofs varied greatly in shape, materials used, and construction techniques. Some roofs rested on pillars independent of the walls below them, while saddleback roofs nearly always rested on wall plates supported on forked uprights within the walls. The ridge pole was sometimes supported by upright poles but usually rested between the gable ends. Beams were occasionally used. The shape of the roof usually adhered to the shape of the walls. Roofs above round walls could be conical, and roofs above rectangular walls could be saddle-backed, and heaped on a pyramid, debunking T.O. Odeyale and T. O. Adekunle's generalization that thatched roofs in Africa were just conical.[3]

In this chapter, I will discuss the technological advancement of houses with a focus on their roofs, revealing the techniques, materials, and meanings they embody with reference to lived experiences and their centrality to the changing architectural landscape. In more recent times, imported building materials have lent prestige and status to houses and their inhabitants, and reflect how increased mobility has led to "an intensified exposure to urban and 'western' housing styles, be it in design, ground maps, materials, or interior objects."[4] This chapter goes beyond a simplistic westernization narrative as it allows the voices and the thought processes of people in the community to be heard.

Experience

When I began my doctorate in 2009, I settled with the Papiakum people of Baba I on the Ndop plain. I found it intriguing how little had been written about them.

3 T. O. Odeyale and T. O. Adekunle, "Innovative and sustainable local material in traditional African architecture–Socio cultural dimension," in *Structural Analysis of Historic Construction: Preserving Safety and Significance*, vol. 2, ed. Dina D'Ayala and Enrico Fodde (Florida: CRC Press, 2008), 991 – 998.

4 Ann Cassiman, 'Home and Away: Mental Geographies of Young Migrant Workers and their Belonging to the Family House in Northern Ghana', *Housing, Theory and Society* 25, no.1 (2008):14 – 30; Evelyne Tegomoh, "The story of houses in the grassfields: mobility, belonging and hierarchies in urbanising North-West Cameroon" (PhD diss., Leiden University, 2022).

The village was already familiar to me; as a child, I stopped at it on my way to boarding school in Kumbo or during the return trip home for the holidays. Although stopping at the main market told me little about the people, it did spark my curiosity. Almost twenty years later, my interest in houses brought me back as I wanted to research a place that had been little studied in the Grassfields. I had the opportunity to travel through the hills, cross the rivers and take long walks across the plains. These undulating landscapes revealed the settlement patterns of the Papiakum people. Understanding their settlement style led me to explore various issues within the community, such as hierarchical structures, land management, identity, material culture, and gender dynamics. I eventually ended up writing a thesis titled "The story of houses in the grassfields: mobility, belonging and hierarchies in urbanizing North-West Cameroon." This edition of the *Yearbook* on environment, technology and development presented an opportunity me to write on an often overlooked subject: the roof of houses and the environment.

What type of roof did people have over their heads, and how did it affect the environment? These are the central questions of this chapter. At some point, most of us have thought not only about the ways in which architecture has changed but also about transformations in roof designs. The English saying "a roof over one's head" is very apt because of the types and attributes of roofs in this context. The history of roofs is long and multifaceted, shaped by time, place and cultural context. Broadly speaking, the narrative begins with mammals, and especially humans, emerging from caves into open environments, where they started to use plants in the natural environment, such as leaves, grass, straw, sticks, wood, and earth, to construct houses. This impulse is as natural and enduring as the instinct to cover one's head from rain, snow, or sun.

People depended on their natural environment to fulfil their basic need for shelter. In doing so, they developed techniques for adopting and adapting to the natural resources that their environment provided. Beautiful structures were constructed with materials gathered from or around settlement areas. This also led to specialization within the construction business. Roofs have evolved over decades and centuries at a varied pace with different levels of impact on the environment. The craftsmanship involved in thatching is highly regarded, with skilled artisans often passing their knowledge down generations. This transfer of traditional knowledge not only ensures the structural integrity of the roofs but also contributes to the aesthetic appeal of the buildings, as thatched roofs can be shaped and styled in various ways to reflect cultural identities.[5]

5 A. Ngwa, "The Aesthetic Value of Traditional Architecture in Contemporary Africa," *International Journal of Architectural Heritage* 15, no.3 (2021): 345–360.

This chapter takes us into a hybrid society, where thatched roofs have been gradually phased out in favor of corrugated zinc/metal roofs, and reintroduce them back into the society. This evolution has been closely tied to ascribed or acquired social status and class. In a hierarchical society where everything new was expected to originate from the palace, roofs evolved along with the buildings. The durability and risks involved prompted the gradual movement away from environmentally friendly materials that could not disintegrate.

Thatched roofs and African architecture

Odeyale and Adekunle, in their exploration of the sociocultural dimensions of innovation and sustainability in traditional African architecture, not only critically evaluate various local building materials available in south-west Nigeria but also give historical examples of structures built using readily available local resources. This includes the ziggurat built from mud and stones (2640 – 2621 BCE); the Bight of Benin (17^{th} C) made from stabilized mud brick and plaster, thatch, timber, shingles; Kofa Buka 10^{th} C), the Kano wall, made from mud and vegetable mat; Centenary Hall in Ake (1930), Abeokuta, made from stone, mud, timber; and Tomb, Places in Egypt – The Zoster's stepped pyramid at Saggara (2686 and 2181 BCE).[6] They additionally highlight how fragmented the historic accounts of African art and architecture have been. Notable exceptions include the sixteenth and seventeenth century accounts of the kingdoms of Benin and Congo provided by traders and missionaries from Portugal. Arab scholars documented the medieval African empires of Ghana, Mali and Songhai, and the East African coast. Yet the interpretations of early foreign adventurers to the continent often varied considerably. There is still a persistent misconception that precolonial Africans lived almost exclusively in circular mud and thatch dwellings. Since the mid-nineteenth century, publications have associated most traditional Africans with round, thatched-roof and mud-walled huts. However, historical research indicates that square and rectangular forms of housing can be traced back to antiquity and have existed in diverse geographical regions.

Thatched roofs have a long history worldwide, across Africa and Cameroon in particular, serving as a traditional roofing material for many communities. The origin of thatched roofs can be traced back to the need for shelter that is both functional and adapted to the local environment. According to Oppong, the use of thatch for roofing goes back as far as the Bronze Age. Thatched cottages and

6 Odeyale and Adekunle, "Innovative and sustainable," 991.

farm buildings were the norm in rural Britain for more than a millennium. Theatres were even built and roofed with thatch. In Africa, thatched roofs have been used since the earliest times, but have not been perfected from generation to generation thus far.[7] Thatched roofs, if properly constructed, can last for over half a century depending on the climatic conditions. Thatched roofs are typically made from locally available materials such as grass, reeds, palm leaves, or other vegetation. The choice of material often depends on the local climate, availability of resources, and cultural practices.

In countries like Nigeria, Ghana, and Senegal, thatched roofs are also prevalent, with variations in style and material based on local customs and available resources. In regions like Kenya and Tanzania, traditional huts often feature thatched roofs, with designs reflecting the local culture and environment. In Cameroon, like in many other African countries, thatched roofs are commonly found in rural areas, particularly among the Bantu and other ethnic groups. The roofs are often conical or sloped, designed to shed rainwater effectively.

In some parts of the world, thatched roofs are seen as exotic, while in others, they are the norm. In many African cultures, the style and construction of thatched roofs can signify social status, community identity, and cultural heritage. Different ethnic groups may have unique styles of thatching, which can reflect their traditions and craftsmanship. Thatched roofs are particularly well-suited to the tropical and subtropical climates found in many parts of Africa. They provide excellent insulation, keeping homes cool in hot weather and warm during cooler nights. The natural materials used in thatching also allow for good ventilation. Thatched roofs are often seen as an environmentally friendly building practice. The materials are renewable, and the construction techniques are generally low impact, making them sustainable options for housing.

While modern building materials such as metal and concrete have become more common and even politicized, as seen in Tanzania, thatched roofs continue to be used in many rural areas and are sometimes incorporated into eco-tourism projects.[8] They are valued for their aesthetic appeal and cultural significance, as well as their environmental benefits. In summary, the origin of thatched roofs in Cameroon and Africa is deeply rooted in the region's history, culture, and environmental conditions. Their use reflects a blend of practicality, sustainability, and cultural identity—elements that have persisted across generations. Thatched roofs

7 R. A Oppong, "'Loosing the Sense of Thatch' (A Trio Sub-Saharan African Compendium)," 2009, accessed 22 July, 2025, https://dev.ecoguineafoundation.com/uploads/5/4/1/5/5415260/thatched_roofs.pdf.

8 E. Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar es Salaam* (Pittsburgh: University of Pittsburgh Press, 2020) have been a significant architectural feature in many cultures worldwide, and Cameroon is no exception. The use of thatch in roofing is deeply rooted in the country's historical, cultural, and architectural landscape, made possible by its prevailing environmental conditions. This chapter explores the development of thatched roofs in Cameroon, examining the materials used, cultural significance, and the reasons behind its continued use despite the advent of modern roofing materials. The tradition of thatching in Cameroon can be traced back to the indigenous communities that have inhabited the region for centuries. Historically, thatched roofs were constructed using locally sourced grass, palm leaves, and reeds. These materials were not only abundant but also provided excellent insulation against the tropical climate, which is characterized by high temperatures and heavy rainfall. The use of thatch can be seen in various ethnic groups across Cameroon, including the Bantu, the Fulani, and the Sawa, each employing unique techniques and styles that reflect their cultural heritage.[9]

The primary materials used for thatching in Cameroon include grass species such as elephant grass (*Pennisetum purpureum*) and palm fronds from the oil palm tree (*Elaeis guineensis*). These materials are chosen for their durability, availability, and insulating properties. The thatching process entails several steps, including harvesting, drying, and bundling the materials before they are applied to the roof structure. Traditional constructions often involve a framework made of wooden poles, which is then covered with layers of thatch, creating a waterproof and insulated barrier.[10] The craftsmanship involved in thatching is highly regarded, with skilled artisans often passing down their knowledge through generations within family circles or through apprenticeship. Apprenticeship is not unique to Africa, as Sarah Vickerstaff, reflecting upon the historical evolution of the apprenticeship model in Britain between 1944 and 1982, showed how young people gained skills over time depending on their masters.[11] This traditional knowledge transfer not only ensured the structural integrity of the roofs, but also contributed to the aesthetic appeal of the buildings, as thatched roofs can be shaped and styled in various ways to reflect cultural identity.[12]

9 Martin Zachary Njeuma, "William F.S. Miles. Hausaland Divided: Colonialism and Independence in Nigeria and Niger. Ithaca, NY and London: Cornell University Press, 1994. Xviii+368pp. Appendices. Bibliography. Figures. Glossary. Illustrations. Maps. Tables. $49.95. Cloth," *African Studies Review* 39, no.2 (1996): 194–196.

10 Tegomoh, "The story of houses in the grassfields."

11 Sarah Vickerstaff, "'I was just the boy around the place': What made apprenticeships successful?," *Journal of Vocational Education and Training* 59, no.3 (2007): 331–347.

12 A. Ngwa, "The Aesthetic Value of Traditional Architecture in Contemporary Africa," *International Journal of Architectural Heritage* 15, no.3 (2021): 345–360.

In Cameroon, like in other African countries, thatched roofs are more than just functional elements of architecture; they are symbols of cultural identity and heritage. Many communities view thatched roofs as representative of their way of life, connecting them to their ancestors and traditions. For instance, in the Western Highlands, thatched roofs are often associated with traditional houses known as "bantu huts," which are integral to the communities' cultural practices and social structures.[13] Moreover, thatched roofs play a role in social gatherings and community events. In many villages, communal spaces with thatched roofs serve as venues for celebrations, meetings, and rituals, reinforcing social bonds and cultural continuity.

The social meaning of houses among the Papiakum people

The Papiakum people of Baba I village belong to one of the thirteen villages that make up the Ndop plain of Ngoketunjia Division of the Bamenda Grassfields of the North West Region of Cameroon. Their settlement in this present area is recent compared to the other ethnic groups of the Ndop plain.[14] Like most of the peoples of the Bamenda Grassfields, they claim a Tikar origin from Rifum.[15] Elisabeth Chilver states the Papiakum were found in central Bamum in today's West Region of Cameroon in the eighteenth century.[16] They eventually migrated and settled on the Nso-Oku foothills, between 1850 and 1880, during the reign of Kemshi III. During Zintgraff's passage through the Ndop Plain in 1889, Kemshi III was still on the throne. As M. Muafue-Mbarem has highlighted, Menkaki, who was very unpopular, ascended the throne after Kemshi III.[17] Thereafter, Nkanggaper III, Shanghamagia IV, and Kemshi IV were enthroned in 1989. Nkanggaper IV ascended the throne in 2023.[18]

13 Njeuma, "William F.S. Miles. Hausaland Divided," 194–196.

14 Elisabeth Chilver and Phyllis Kaberry, *Traditional Bamenda: The Pre-colonial History and Ethnography of the Bamenda Grassfields* (Buea: Government Printers, 1967), 20.

15 Chilver and Kaberry, *Traditional Bamenda*, 2.

16 Elisabeth Chilver, "Chronological Synthesis: The Western Region, Comprising the Western Grassfields, Bamum, the Bamileke Chiefdoms and the Central Mbam," in *The Contribution of Ethnological Research to the History of Cameroon Cultures*, ed. Claude Tardits (Paris: Editions de Centra National de la Recherche Scientifique, 1981), 464–472.

17 M. Muafue-Mbarem, *Baba I History and Culture 1394–2011*(Mimeo, 2012), 69.

18 Tegomoh, "The story of houses in the grassfields," 24–33.

The topography of Baba 1 is rugged. It consists of undulating hills, valleys and plains. As one drives along the Bamenda ring road towards Kumbo, the capital of Bui Division, the road splits the Baba I village into two parts (upper and lower). The upper section of the village to the north covers about 60 % of the surface area, and is where the palace, the seat of traditional authority, is situated. The lower section comprises 40 % of the total area and contains the majority of the rice fields on the plain. The Papiakum people are known on the Ndop plain for their engagement in trade and their mobility, which has brought about changes to the architectural landscape. Although the area is in the process of urbanizing with modern state structures and urban amenities, it has kept its traditional socio-political organisation centered on its chiefdoms with the Fons as paramount rulers. Today, the Fons are auxiliaries of state administration and still command authority among the people.

Like other peoples of the Grassfields, the people of Baba were not spared from the trading activities that took place in the middle of the nineteenth century, when there were already specialised production and trade centers linking various peoples. The Papiakum people created alliances in the Grassfields between chiefdoms to maintain their hegemony over smaller or weaker chiefdoms. Trade routes were usually means through "which commercial, religious and cultural contacts were established and formed, with the Fon and notables acting as patrons and young able bodied men serving as carriers or distributors in the supply chain'. From Baba I, carrier boys moved merchandise to Nigeria via Nso or Oku, an established trade center, or from Nigeria via Nso to Baba I. These traders and their carrier boys eventually created connections and friendships in the trade centers where some Papiakum people have settled. In the various urban trading centers in Cameroon, it is not uncommon to find pockets of Papiakum people, as they are known for being mobile. Their involvement in commercial activities also opened opportunities for educational and professional growth that led to the establishment of state and private social institutions and the installation of urban amenities. The results of this are seen in the various constructions dotted across the Papiakum architectural landscape in Baba I.

According to the Papiakum people, houses are masculine as they qualify and represent a person's place in society. Ownership is considered masculine in that it is traditionally attributed to men and regarded as the first visible sign that qualifies men as mature adults. Having a house also represents a young man's independence and serves as a physical and symbolic marker of his place within his people.[19] As pointed out by Dominique Malaquais, "human beings and their dwell-

19 Chilver and Kaberry, *Traditional Bamenda*; Elisabeth Chilver, "Chronological Synthesis: The ings are linked in a symbiotic relation, at the heart of which stands one fundamental concern: the acquisition of status."[20] Responsibility, in this context, centers on managing and maintaining the smooth running of the household. When taken at face value, the association of masculinity with houses can obscure many underlying dynamics. One such example is women's capability and participation in land acquisition and house construction negotiations.[21] Women's contribution in these processes is pivotal in the successful completion of housing projects, whether for their husbands or their sons, because they till the land and gain deep knowledge about its history.

Houses are also a sign of wealth and social status. Investments in houses (zinc roofs) have given men a social standing which is much admired and talked about. "The use of these materials (imported iron sheets and cement) adds to the prestige and status of the house and its inhabitants" and reflect how increased mobility has led to "an intensified exposure to urban and 'western' housing styles, be it in design, ground maps, materials, or interior objects."[22] This has been embedded into the Papiakum social system, a people well known for their mobility, especially when it comes to trade. Long-distance trade involving the peoples of the Grassfields has been one of the oldest means of accumulation of capital in this region of the country.[23]

From pre-colonial times until the 1940s, houses were mostly built using readily available local materials like bamboo sticks, brown earthen mortar, soft grass straw and fiber ropes. They started as single room dwellings, partitioned or demarcated into sleeping and sitting spaces. At first, houses were hidden and

Western Region, Comprising the Western Grassfields, Bamum, the Bamileke Chiefdoms and the Central Mbam," in *The Contribution of Ethnological Research to the History of Cameroon Cultures*, ed. Claude Tardits (Paris: Editions de Centra National de la Recherche Scientifique, 1981), 453–473.

20 Dominique Malaquais, "You are what you build: architecture as identity among the Bamileke of west Cameroon," *Traditional Dwellings and Settlements Review* 5, no.2 (1994): 22–36.

21 Tegomoh, "The story of houses in the grassfields," 34.

22 Cassiman, "Home and Away," 20.

23 Francis Nyamnjoh, "A Child is One Person's only in the Womb': Domestication, Agency and Subjectivity in the Cameroonian Grassfields," in *Postcolonial subjectivities in Africa*, ed. R. Werbner (London: Zed Books, 2002), 111–38; Michael Rowlands, "The Material Culture of Success: Households and consumption in Bamaenda," in *Conference on the Political Economy of Cameroon: Historical Perspectives*, ed. P. Geschiere and P. Konings (Leiden: African Studies Center,1989), 503–523; Michael Rowlands, "Accumulation and the Cultural Politics of Identity in the Grassfield," in *Itineraire accumulation au Cameroun:Pathways to accumulation in Cameroon*, ed. P. Geschiere and P. Konings (Paris: Karthala, 1993), 71–99; Jean Pierre Warnier, *Echanges, développement et hiérarchies dan le Bamenda précolonial (Cameroun)* (Stuttgart: Steiner 1985); Jean Pierre Warnier, "The transfer of young people's working ethos from the Grassfields to the Atlantic Coast," *Social Anthropology* 14, no.1 (2006): 93–98.

were close to water sources, so they had to be constructed on raised molds to avoid floods. Bigger and stronger sticks were strategically placed as pillars to form and hold the rectangular structures. Then, smaller or bigger bamboos were split and interlaced on the form with the aid of fiber from wet bamboo. After the pegging and lacing of the structure, the owner invited the community to assist him with the plastering. Earth mortar was then prepared and used to build the walls, wedging the pegged structure, and leaving space for a door.[24]

There were no windows, just a single door leading into the house. When windows were eventually introduced, they were so tiny that not even a baby could pass. Permission had to be sought from the palace to have more than one door or window in a house, and this was controlled by titled women of the palace, *Na'ah*, and palace servants, *Tchinda.* Payments of door and window taxes were made by all those who wanted to have more than one window. Limited permission was granted to those who wanted a back door. After consideration, only highly placed notables were allowed to have more than one door in their house. This is illustrated by the story of Moh Tanghongho's grandfather, whose house mysteriously crumbled to the ground after a visit by notables who claimed they could not find their way out by hitting themselves against the walls of the house. Either he had not obtained proper permission to have a back door, or the house was considered superior to the palace.[25]

A rectangular ceiling made of closely laced bamboo sticks was then mounted on the constructed form of the house. The ceiling was not completely sealed off. A rectangular opening was left on one side providing access to the attic or garret, which served as the main storage room or space for the most valuable possessions. While the majority of the space was reserved for grains and dried vegetables, prestigious and ostentatious items, including household utensils especially for women, occupied a place of honor. This practice echoes Michael Rowlands' (1989) observations about the consumption and placement of prestigious household goods in conspicuous locations in the houses in Bamenda.[26] Additionally, a bamboo shelf was attached just below the ceiling along the room's walls to store other items. Interestingly, this main storage place was also used as sleeping space in highly infested mosquito areas with bamboo ladders used to gain access.

If not capable of constructing it themselves, the house owner could hire someone to do the formwork for them. The roof, typically shaped like a triangular prism, was made using wet bamboos laced in a way that left small gaps for insert-

24 Muafue-Mbarem, *Baba I*; Brownell, *Gone to Ground.*

25 Tegomoh, "The story of houses in the grassfields," 36.

26 Rowlands, "The Material Culture of Success."

ing straw. Each side of the roof was constructed separately but assembled at the end using fiber ropes. Soft straws were collected from the hills and tied in bundles before being transported on the head to the building site. Each bundle was then taken up onto the roof one at a time and wedged with the aid of a bamboo stick to prevent it from rolling off. Starting from the base of the roof, handfuls of straw were fitted in between the laced bamboo. This tight knit assembly continued to the top to prevent any leakages. At the top ridge, wet bamboo spikes were used to hold the folded straw in place, protecting it from being lifted by wind. The roof edges were trimmed using a piece of wood and a cutlass to give it a nice shape. Over time, rain would further compact and smooth the straw, producing a smoother and more cohesive appearance. The door was fashioned from an alignment of bamboo sticks reinforced with an additional stick to secure the house, particularly during nighttime. The house was not immediately inhabited upon completion. The head of the family had to come in and light the first fire inside. This symbolic act, referred to as the "opening of the house," signified the planting of the household in the land among the people, and invited peace and prosperity to prevail.[27]

Figure 1: One of the few compounds with thatched roofs. Photograph by the author, Baba I, 2011.

As illustrated in Figure 2, building practices evolved from plastered huts to sun-dried brick houses and stone houses for a few wealthy people. The introduction of cement houses marked a new phase, though builders eventually reverted to

27 Tegomoh, "The story of houses in the grassfields,"67.

using sun-dried bricks with cement mortar. Stone foundations were introduced during the period when stone houses were under construction.

Changes to walls and roofs after 1940

However, the typical house structures before 1940 were built using local materials like bamboo sticks, brown earthen mortar, soft grass straw and fiber ropes as mentioned above. By 1970, construction had progressed to fully sun-dried brick houses, although still with thatched roofs. The production of sun-dried bricks involved the community who was invited to help with molding the bricks using a form, while a designated person carried out the construction works. Emily Brownell similarly observed this communal approach in her analysis of building materials in Tanzania during the 1970s and 1980s, noting how communities rallied together to build houses.[28] By this time, houses were constructed in more visible and accessible places as raids had come to an end and village boundaries were defined. Eventually, in men's houses, the surface and floor of the bamboo attic were plastered with mud mortar—forming a kind of decking that acted as fire barrier for the house.

The corrugated or zinc house in the palace stuck in the minds of all my research partners aged above seventy (Figure 3). It was a source of inspiration for the villagers more generally. There were, however, several reasons for the changes in materials used from around 1950. Raids were less common, the risk of fires was high, and trade and prosperity increased. Those who were involved in trade and coffee farming spearheaded the construction of houses with zinc roofs. Through their trade routes and economic transactions, they became exposed to new building materials that were not yet common at home but available in trading centers, like the neighboring country of Nigeria. Acquiring this building material for construction was an outward sign of prosperity, which quickly became a status symbol and something many aspired to own. This was especially so as fire used to cause untold pains and sufferings by razing houses down to dust. Many of my research partners recounted the havoc caused by fire to these thatched houses and personal possessions. The experiences they gained through their mobility in the service of trade and commerce opened up new ways of addressing their housing challenges.

The acquisition of valuable manufactured goods had risen. The zeal for acquiring and safeguarding these possessions precipitated the move from thatched

---

28 Brownell, *Gone to Ground.*

to zinc roofs to prevent losses from fire incidents. Additionally, people preferred more permanent rather than temporary roofs, which in the long run were more expensive. Thatched roofs required constant maintenance to avoid leakages and decomposition of the straw, the weight of which could eventually bring down a roof or house. Transitioning from thatched to corrugated zinc roof became an source of social pride and way to elevate one's social status. For parents who could not afford corrugated iron sheets for their roofs, it became a priority for their children to help secure this upgrade, as they wanted to avoid their parents being mocked for having thatched roofs.[29]

Figure 2: Thatched houses beside houses with aluminum sheet roofs. Photograph by the author, Baba I, 2011.

However, only a few thatched grass houses are dotted around the village today. Nearly everyone wants their roofs to be covered with zinc sheets. Thus, they must work hard to save money and view it as a sign of achievement that allows them to progress within the community's social hierarchy. These days, having a thatched roof house in the village is associated with misfortune and poverty (Figures 1 and 2). This situation can be embarrassing to friends and family, leading to either abuse or empathy. However, in urban centers, thatched roofs are making a

29 Tegomoh, "The story of houses in the grassfields," 37; Warnier, *Echanges*; Lamtur Tanlaka Kilian, "We are all one. Kola, the nut which brings peace, joy and life in Nso'society, Cameroon" (Master's thesis, Universitetet I Tromsø, 2013).

comeback as a sign of wealth and prestige. These roofs are constructed in *Boukar-ou* forms, using bamboo, bricks and cement, as an exterior unit for the entertainment of special guests or as relaxation spaces. In urban areas, such thatched-roof buildings also serve as tourist sites.

As roofing styles evolved, so did the main body of the house in terms of design, material, and size. There was a brief period when stone houses, or as they were called, half concrete houses, were in vogue despite the availability of this material, especially in the upper part of the village on the hills where the *Ntoh* palace is situated. Interestingly, stones were a common natural resource readily available but very few stone houses were constructed. These houses were built around the same time that corrugated roofing sheets were introduced. However, this trend did not catch on and was restricted to the affluent of the village who were mostly involved in trading, coffee farming and animal husbandry. Later, a few urbanites also constructed similar homes, but very few can still be seen today.

Figure 3: Nda Tarsah or Nda Woh (Stone House) at the palace. Photograph by the author, Baba I, 2009.

These half-concrete houses introduced stone foundations, which are now widely used. The mud brick houses have stood the test of time, although they now compete with cement brick houses. These sun-dried brick houses have become bigger, especially for women who now have separate sleeping rooms from children, along with cooking, eating and sitting space.

Figure 4: New Guest House replacing demolished Nda Tarsah. Photograph by the author, Baba I, 2012.

As the sun-dried brick houses became more common, cement bricks were introduced to further distinguish between urbanites and villagers. Like the half-concrete structures, cement brick houses are limited. Instead, there is a move towards what is known as *semi-dure* houses. These are constructed from sun-dried bricks and cement mortar, built on solid dug-in stone foundations with concrete pillars, and completely plastered with cement (Figures 4 and 6). Over time, these houses have evolved from single-room designs to two- and three-room houses with external kitchens and toilets attached. Most of the recent houses built by urbanites are self-contained, as well as having external kitchens and toilets. In polygamous homes, each wife had her own apartment, and children took turns to share the husband's space. In all the houses that I went into, owned by those living in the village, the kitchens were separated from the sleeping rooms. The toilets are closer to the houses, although some people still prefer to use the bushes. It should be mentioned that until the 1970s, toilets were not common. Nearby bushes were used, while the back part of the house was used for bathing. It was surprising to discover that not all the compounds in the village have a pit toilet, although the sanitary service is now mounting pressure for every household to have a toilet.

Architects and builders

The construction and design of these houses began very simplistically and have evolved into the more complicated structures we find today. The architects/builders behind the houses initially relied on individual creativity and effort. Then local guilds were formed to manage various stages of house construction. This further shifted with the introduction of half concrete houses, which led to the importation of architects/builders, especially from Nso, where these types of houses were already commonplace. The Nso had historically developed expertise in this field due to their engagement in trade, education and dynamism as an ethnic group. The roles of architect and builder were often merged, with the same individual fulfilling both functions. Local architects, mostly from the neighboring village of Nso, came with a team and negotiated their contracts with their employers depending on the size of the house. They had relative freedom in choosing the design although most chose simple designs according to the norms of the time. Their exposure to different architectural designs through travel influenced their work, and employers would sometimes reference previous houses they had seen when describing their preferences. With the advent of formal education this would change, although Nso architects continued to dominate the trade, as schools were introduced to them earlier than to the Papiakum people.

Depending on the source of inspiration for the design of the houses, workers would come from neighboring villages, towns or cities and stayed a week, fortnight or a month to do their job according to their contract. They were provided with sleeping and cooking space, or arrangements were made to supply them with meals. In either case, they received cooked meals from family members/relatives as a gesture of support for the job being done. In most cases when work was going on close to the main compound, the mothers (stepmothers inclusive), siblings, wife (*ves*) and friends sometimes provided food for the workers. Generally, since constructing a house at home is considered as a significant life milestone and a source of family pride, support for the project is usually offered at various stages by family, friends and the community as a whole. The level of assistance one receives usually reflects prior social investments. The communal effort witnessed during the decking of storey buildings, in particular, highlights the group's sense of conviviality and strong social bonds that define these undertakings.

We got to the Baba I when storey buildings were in vogue and teams of builders were still largely dominated by those from Nso, Bamenda and even Douala. Architects from Bamenda or Douala handled specific aspects of projects, like roofing and furnishing. Historically, the migration routes of the Nso people of Kumbo and the Papiakum people have been linked as they are from the same stock. They did not just cross paths but are tied socio-culturally as the author experienced during her fieldwork amongst the Papiakum when emissaries came to perform rites/rituals at the *Nikwa* shrine.[30] According to historic accounts, the Nso and Papiakum people assisted and hosted each other during their migrations. Their eventual separation might had been promoted by population pressure and the desire for expansion as it was a common phenomenon during the period (1850 and 1880). There was however an exchange of sacred objects that can somehow explain their ties to each other. It should also be noted that these two ethnic groups, Nso and Papia belong to two distinct linguistic groups.

The Nso people have been long settled in their current location where they have established their built environment by drawing inspiration from their trade routes and partners. Quoting Jean-Pierre Warnier (1985), Lamtur Tanlakka Kilian noted that the Hausa kola nut traders from northern Nigeria had identified the Nso region as a kola forest in 1860.[31] Before the 1920s, the Nso were apparently known as the largest producer, originally marketing kola through the intermediate market at Nkor and insisting on doma and salt in exchange, which was the most important source of income in Nso.[32] The Papiakum would inevitably get involved in the trade directly bringing home new material objects as well as new knowledge. The Nso people were also influenced by white missionaries, who settled among them building churches, hospitals and schools, and later the government through the lobbying efforts of their elites who were now serving the state in various institutions/capacities. As a result, their craftmanship in architectural development would be older and more advanced than those of the surrounding ethnic groups. Giving the dynamic nature of the Nso people, labor migration for construction become another source income, especially for younger individuals who sought to establish themselves.

It was only natural for the Papiakum people to turn to Kumbo—the divisional headquarter of Bui, and predominately inhabited by those of Nso descent—for health care, education and also access to specialist craftsmen/professionals for house construction, due to its geographic proximity. The design of many houses were simply copied from Kumbo or drew inspiration from its more advanced construction practices. Similarly, migrant workers were often brought in from urban centers for specific jobs on various construction sites.

With increasingly complex designs, migrant workers are often brought in just to handle the construction of the roofs/ceilings, doors/windows and floors/walls.

30 Tegomoh, "The story of houses in the grassfields," 32.

31 Kilian, "We are all one," 7.

32 Warnier, *Echanges*, développement et hiérarchies dan le Bamenda précolonial (Cameroun); Kilian, "We are all one," 23.

These houses, with their roofing materials, do not only introduce foreign elements into the architectural landscape but also incorporate material that can impact the environment. A closer examination of several of these houses, as illustrated by Figure 5, reveal their physical and socio-cultural impacts (new architectural designs with building materials on the landscape).

Impact on the environment

The various constructions opened up access roads, which makes getting around easier. These access roads also saw the introduction of more motorbikes and cars into the landscape. Though seen as visible indices of development and growth, these vehicles also introduced environmental challenges in terms of atmospheric and physical pollution. The emissions and waste material left behind meant that people had to learn to deal with new types of inorganic and non-biodegradable properties and objects (Figures 9 and 10).

The houses, according to estate and urban developers, undoubtedly add aesthetic and economic value to the place (Baba I), particularly when one looks at the position of these structures in the undulating landscape. It should be noted that social structures and housing layout are entangled within this community, just like in other parts of the Grassfields. However, these developments infringe on the traditional architectural landscape. Traditionally, family compounds featured clusters of interconnected houses, often linked by footpaths within a walkable distance, making it easy to send children on errands between the houses (Figure 7). The social structures and housing layout are entangled in everyday lives.

With a growing population, the demand for land has become very high. This has, in turn, changed the socio-cultural dynamics of land management. Farmlands are being converted into residential areas. People are acquiring land outside their designated family property for construction. This shift has not only led to a reduction in green space—with home gardens reducing in size or disappearing—but has also affected the socio-cultural hierarchy of the village. Figure 8 illustrates a common pattern in which a family successor, having lived in the city, returns to erect modern structures within the family compound, disturbing or distorting the traditional layout. These structures push older buildings in the background as they are usually positioned in strategic locations that overshadow them. Economic affluence is allowing some community members to enter spheres they were formerly excluded from.

These new architectural structures often incorporate imported material that are foreign to the environment. In the northern parts of Cameroon, especially among the Fulani people, as Odeyale and Adekunle have pointed out, Africans'

Figure 5: Collage of pictures from author's collection showing the evolution of houses/roofs. Photograph by the author, Baba I, 2009 to 2016.

Figure 6: A blend of local and imported construction material within the palace, 2009 and 2010, Baba I. Photograph by the author.

Figure 7: Cluster of houses linked with foot paths representing a family compound. Photograph by the author, Baba I, 2011.

have traditionally used natural clays as paints. Today brightly colored acrylic paints have become popular. Most of their floors are either polished with cement or tiled (Figures 9 and 10).[33] One would argue it is to facilitate cleaning, but on the other hand, it has rendered the traditional techniques of cleaning and polishing the walls and floor obsolete. Improper management of waste from these structures has become an issue and wanting in the method of disposal. This, in the long run, adversely affects the environment. As pointed out by Bjørn Berge, "in a time when environmental labelling is becoming increasingly popular and the producers of building materials are urged to be more environmentally aware, it is obviously important that we are acquainted with these alternatives."[34]

33 Odeyale and Adekunle, "Innovative and sustainable local material in traditional African," 993.
34 Bjørn Berge, *Ecology of building materials* (London: Routledge, 2007).

Figure 8: Modern structures in the family compound (showing new building materials) relegating the old buildings to the background. Photograph by the author, Baba I, 2011.

Thatch is a natural, renewable resource and, when sourced sustainably, has a lower environmental impact compared to synthetic materials. Thatch roofing is often made from locally sourced materials, making it a more sustainable option compared to metal or synthetic roofing materials. As awareness of environmental issues grows, many people are opting for eco-friendly building practices. Thatch is biodegradable and has a lower carbon footprint, appealing to those concerned about sustainability. This calls for an in-depth analysis of the advantages and disadvantages of sustainable building materials, weighing their benefits in terms of environmental health and sustainability against potential challenges such as cost and availability.[35] Thatch roofing is often perceived as more aesthet-

35 George Baird, *Energy performance buildings* (Boca Raton: CRC Press, 1984); Chong Lin, "The role of sustainable building materials in advancing ecological construction," *Journal of Energy and Environmental Policy Options* 4, no.1 (2021): 15–21.

Figure 9: Interior design elucidating paint, tiles, staff, iron rail, vanished balusters. Photograph by the author, Baba I, 2016.

ically pleasing and harmonious with the natural environment. As urban areas become more homogenized with the use of modern materials, some individuals and communities seek to differentiate their homes through traditional designs that reflect local character and beauty.[36]

In some regions, thatch roofing has been found to perform better in specific climatic conditions, such as in heavy rainfall or extreme heat. Traditional roofing methods can offer better insulation and ventilation, making them more suitable for local environmental conditions compared to modern materials.[37] The process of building with thatch often involves community participation, fostering social ties and cooperation among residents. This communal aspect can be a significant

36 Rachel Charlotte Smith et al., "Decolonizing design practices: Towards pluriversality," in *Extended abstracts of the 2021 CHI conference on human factors in computing systems*, ed. Yoshifumi Kitamura et al. (New York: Association for Computer Machinery, 2021), 1–5.
37 Cara Steger, "A roof of one's own: choice and access in global thatch sustainability," *World Development Sustainability* 3 (2023): 100088.

factor in the choice to revert to traditional methods, as it strengthens community bonds and promotes collective identity.[38]

The shift from corrugated roofing back to thatch methods is a multifaceted phenomenon influenced by cultural, economic, environmental, aesthetic, and social factors. As communities navigate the challenges of modernity and urbanization, many are finding value in traditional practices that resonate with their identity and sustainability goals.

Figure 10: Retaining walls, paved spaces with greeneries and water fountains. Photographs by the author, Baba I. 2012 and 2016.

Conclusion

If we consider roofs as not just mere objects or a part of a house, but, like Steger, dwell on the human-plant relationships related to the provisioning of roof thatch for human housing, we encourage a greater understanding of the basic material and social conditions that support human well-being.[39] Roof thatch is both a subsistence and commercial product, and is often considered an ecosystem service of secondary importance. As such, thatch has played a hidden role in the global economy to this point, and its cultural importance has been obscured. When African societies, in their quest for "modernity," relegate these roofs because they now represent a symbol of poverty, then we undermine local knowledge on ecology and environment.

Thatched roof is critical to human well-being, inextricably linked to the identities and sovereignty of rural and indigenous communities. A long-term, place-

38 Brownell, *Gone to Ground*; Tegomoh, "The story of houses in the grassfields," 37.
39 Steger, "A roof of one's own," 100088.

based transdisciplinary work that seeks to understand and foster human-thatch relationships in specific contexts holds great potential for promoting future roof thatch sustainability in equitable ways. Though these thatched roofs and mud houses are quickly fading away in the Papiakum architectural landscape, they are gaining renewed attention elsewhere in the world. This resurgence is driven by several factors, including the growing emphasis on sustainability within global development discourses and researchers' enthusiasm to explore low-energy, sustainable building techniques. Eco-friendly vernacular housing methods are making a comeback. These traditional techniques are applied to develop eco-friendly modern housing. According to Heon Song, they are no longer recognized as outdated products.[40] In our part of the world, they are seen as a 'new' social symbol for a new elite class.

Mud has a number of properties which make it a perfectly suitable material for construction aimed at achieving thermal comfort at a low cost. Just like mud blocks, rammed earth walls have a very high capacity to store heat energy—commonly referred to as "thermal mass." The high thermal mass of rammed earth walls means they naturally regulate the internal temperature of a building. They do not readily prevent the flow of heat energy, but, owing to their high density, can absorb and store it. The energy required to both heat and cool the building can be greatly reduced, which further reduces the carbon dioxide emissions of the building. Rammed earth naturally regulates the internal relative humidity of the building, producing an improved air quality. Rammed earth is perfectly able to act as load-bearing element within a structural system. As an ancient building method, rammed earth has experienced a revival in recent years as people seek more sustainable building materials and natural building methods. Such alternative construction techniques can be widely used in all types of construction. Traditionally in rammed earth wall construction, the earth is mixed thoroughly with water to produce a homogeneous humid mix. According to A. Madhumathi, J. Vish-

40 Heon Song, "Analysis of the Thermal Environment Characteristics of Thatched Roof for Eco-friendly Rural Housing Development-Focused on the Neolithic Thatched Roof Dugout Hut," *Journal of the Korean Institute of Rural Architecture* 16, no.1 (2014): 35 – 42; Smaranda Bica, Liliana Roşiu, Radu Radoslav, "What characteristics define ecological building materials," in *Proceedings of the 7th IASME/WSEAS International Conference on Heat Transfer Thermal Engineering and Environment*, ed. Siavash H. Sohrab, Haris J. Catrakis and Nikolai Kobasko (Moscow: WSEAS Press, 2009), 159 – 164.

nupriya and S. Vignesh this humid earth is poured into a form in thin layers and then rammed to increase its density.[41]

Thatch is a natural insulator, and air pockets within the straw thatch insulate a building in both warm and cold weather. A thatched roof ensures that a building will be cool in summer and warm in winter. The thermal insulation value is high, so thatch roofs are comfortable in warm climates. In the past, the biggest disadvantage of thatch roofing was its flammability, but today's thatched roofs include a fireproof barrier base, such as rockwool, that protects the underside of the roof from spreading fire. The thatch itself is sprayed with a fireproof material to resist flames. Modern-day thatch, when treated and industrially improved, can be used on a large scale in rural areas, due to its low-cost and excellent thermal properties.[42]

Just like in other parts of the world where these roofs are experience a resurgence, it might not be too long before the Papiakum community return to their old architectural materials and forms. The Papiakum community is facing significant pressure on land, and energy resources are dwindling, creating fertile ground for a future shift towards more sustainable, eco-friendly houses, especially as conversations around sustainability gain momentum and practical application. However, it is necessary to reiterate that the changes we see among the Papiakum are not linear or merely driven from the outside. This chapter has elucidated how 'local technological landscapes and material cultures' are intertwined with the everyday lives of people.[43] In alignment with Clapperton Mavhunga's work (2017), it fundamentally challenges the idea of African countries as recipients of technological innovation and insists that we place technological change within a longer context of indigenous or vernacular material culture.[44]

41 A. Madhumathi, J. Vishnupriya, and S. Vignesh, "Sustainability of traditional rural mud houses in Tamilnadu, India: An analysis related to thermal comfort," *Journal of Multidisciplinary Engineering Science and Technology* 1, no.5 (2014): 302–311.

42 Madhumathi, Vishnupriya, and Vignesh, "Sustainability"; Mikael Hård, *Microhistories of Technology: Making the World* (Cham: Palgrave Macmillan, 2023); Clapperton Mavhunga, *What do science, technology, and innovation mean from Africa?* (Cambridge, Mass.: The MIT Press, 2017).

43 Hård, *Microhistories of Technology*, 5.

44 Mavhunga, *What do science, technology, and innovation mean from Africa?*

Giovanni Tonolo

Getting the most without transforming the environment: The bumpy road to the oil mills in the French colony of Dahomey

Introduction

In late 1927, in a laboratory of the *Institut national d'agronomie coloniale* (INAC) in Nogent-sur-Marne, two well-established professors staged a curious experiment. Paul Ammann, a professor of technology, sat before a pile of palm nuts and began rhythmically striking each one with a stone. Max Ringelmann, a professor of agricultural engineering, kept time. For an hour, Ammann mimicked the West African artisanal method of crushing palm nuts, where women traditionally used stones to break the nuts one by one to extract the kernels. By the end of the hour, Ammann had processed just two kilograms of shell. Ringelmann calculated this to be nearly five times less efficient than INAC's smallest mechanical nutcracker. From this experiment, Ringelmann concluded that "mechanical sorting is ideal."[1]

Although the first attempts to introduce cracking machines in West Africa date back to the mid-nineteenth century, this episode shows that as late as the 1920s, experts were still conducting experiments to prove the alleged ineffectiveness of indigenous methods. The fact that it was a professor of technology hitting the stones is particularly indicative of the relationship between development and technology. Technology has been recently defined as "any artifact or system and the knowledge and skill employed to use it."[2] In turn, development is not just about introducing technology but introducing a technology believed to be superior.

Palm products played an important role in the industrial revolution, being used for making soap and candles, as well as for lubricating machinery. From the turn of the century onwards, palm oil also entered the food industry, which remains its primary use to this day. At that time, the main region of production was West Africa. From the twentieth century onwards, colonial powers increas-

1 Max Ringelmann, preface to *Les Concasseurs à Noix de Palme*, by Gilbert Passelègue (Paris: Librairie Émile Larose, 1927), ix.

2 Mikael Hård, *Microhistories of Technology: Making the World* (Cham: Springer, 2023), 6.

https://doi.org/10.1515/9783111611358-012

ingly introduced various technologies to develop palm oil and kernel production. Their efforts centred on two main areas: improving the palm tree through breeding high-yielding varieties and improving the processing of palm fruit through mechanization.[3] This chapter focuses on the latter. Mechanization of processing progressed along two paths: one was the introduction of small hand-operated or motorized machines for farmers; the other, more transformative shift, was the establishment of motorized oil mills.

Jonathan Robins has investigated the progress and misfortunes of small palm fruit processing machines in British Africa. He has argued that African farmers did not reject these machines out of cultural backwardness, but because artisanal methods made better economic sense. In doing so, Robins challenges Eurocentric narratives of technology transfer that have attributed the slow mechanization of African agriculture to cultural conservatism.[4] In this chapter, I take a slightly different angle by focusing on the larger oil mills. Rather than understanding why small machines had limited success with African farmers, I explore why the French hesitated to build oil mills for so long, despite considering them the pinnacle of oil palm development. I argue that the colonial administration recognized that the oil mills required a different environment: homogeneous plantations that enabled efficient harvesting. As such a transformation of the environment was costly and politically risky, the French sought to avoid building mills.

This case study illustrates how the adoption of technology often required environmental change. I use environment in a broad sense to refer not only to the physical characteristics of the landscape, but also to the relationships that the people who inhabit it establish with each other and the landscape as a result of its physical characteristics. From James C. Scott's characterization of high modernism as "a nearly limitless ambition to transform nature to suit man's purposes" to the study of the most spectacular development schemes, historiography has often portrayed development as a hegemonic force that profoundly dominates and shapes the environment.[5] In response, some studies have emphasized the unpredictable agency of the environment in thwarting modernization schemes.[6] In this chapter, I

3 For selected plant and tree varieties as technologies, see Suzanne Moon, *Technology and Ethical Idealism: A History of Development in the Netherlands East Indies* (Leiden: CNWS Publications, 2007), 49.

4 Jonathan E. Robins, "Smallholders and Machines in the West African Palm Oil Industry, 1850–1950," *African Economic History* 46, no.1 (2018): 69–103.

5 James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven and London: Yale University Press, 1998), 94.

6 See for example Heather J. Hoag, *Developing the Rivers of East and West Africa: An Environmental History* (London: Bloomsbury, 2013); Martin Kalb, "Water, Sand, Molluscs: Imperial In-

argue that French colonial developmentalists recognized the risks posed by the environmental upheavals required for mechanized palm oil production and sought to avoid them. Rather than embracing environmental change, they aimed to reap the benefits of new technologies without disrupting the status quo.

This chapter is organized into three sections. The first section examines early efforts at mechanization at the beginning of the twentieth century, highlighting the critical importance of controlling the land around oil mills to ensure a steady fruit supply. The second section deals with the interwar period, analyzing the political and economic arguments that either promoted or delayed the construction of oil mills in French West Africa. The third section, which spans the period from the Vichy regime to the end of French colonial rule, explores how France managed to maintain oil mills in Dahomey without fundamentally transforming the environment. Throughout these debates and industrialization attempts, a recurring theme emerges: a growing recognition that oil mills required a specifically adapted environment that could only be created at a political cost. Crucially, an adapted environment was a necessary but not sufficient guarantee for oil palm development.

The first oil mills and the problem of supply

The French conquest of Dahomey was driven by its rich palm groves. After Marseille merchants Victor and Louis Régis established a trading post in Ouidah (1841), Dahomey's palm products became increasingly important in Marseille's soap and candle industries.[7] The appeal of palm products grew in the 1860s when the Germans and Dutch started using previously discarded palm kernel oil by-products for animal feed, improving milk fat content and making firmer butter. While the port of Hamburg received no palm kernels in 1860, it had become the world's largest importer by 1885.[8] In the 1880s, faced with the British occupation of Lagos and the creation of German protectorates in what would become the colony of Togoland, Marseille merchants lobbied the French Foreign Ministry to defend their interests in Dahomey. By then, Dahomey was the leading

frastructures, the Age of Hydrology, and German Colonialism in Swakopmund, Southwest Africa, 1884–1915," *Environment and History* 26, no.2 (2020): 175–206.

7 Xavier Daumalin, *Marseille et l'Ouest africain : l'outre-mer des industriels (1841–1956)* (Marseille: Chambre de Commerce et d'Industrie Marseille-Provence, 1992), 23–30.

8 Daumalin, *Marseille et l'Ouest africain*, 112; Yves Péhaut, *Les oléagineux dans les pays d'Afrique occidentale associés au Marché commun : la production, le commerce et la transformation des produits* (Paris: H. Champion, 1976), 385–386.

West African supplier of raw materials to Marseille industries.[9] This led to the first skirmishes in 1889 and ultimately to the military conquest of the kingdom of Abomey, which was completed in 1894 and would prove to be the most difficult French military operation in West Africa.[10]

One of the goals of the newly established colony was to increase the production of palm products. In terms of weight and value, palm kernels were Dahomey's most important export throughout the colonial period.[11] Long before Ammann grappled with the stones, the French were already concerned that the Dahomeans largely discarded the kernels, considering palm kernel oil as inferior to palm oil and the nut-cracking process as too laborious to be worthwhile. In 1901, the first French agronomist to study the Dahomean oil palm, Jean Daniel, estimated that 4,600 tons of kernels were lost annually.[12] In the same year, general inspector of colonial agriculture Jean Dybowski claimed that replacing the Dahomean "barbaric methods" with "industrial" ones could double palm oil and kernel production and improve "the situation of the indigenous people."[13] In 1902, Dybowski became director of the newly founded *École nationale supérieure d'agriculture coloniale* (ENSAC), where he held the chair of colonial agriculture. Among his colleagues were Max Ringelmann and Paul Ammann.[14] Twenty-five years later, the two were still testing the "barbaric" technologies.

The first machines for cracking palm kernels emerged almost simultaneously with the expansion of the kernel trade. In the 1840s, African American settler Samuel Herring introduced mechanical crackers to Liberia, where the first oil-pressing machines were also being tested.[15] In French West Africa, private companies trading palm products introduced cracking machines by the late nineteenth cen-

---

9 Roland Caty and Eliane Richard, *Armateurs marseillais au XIX siècle* (Marseille: Chambre de Commerce et d'Industrie de Marseille, 1986), 284–285, 293–294.

10 Daumalin, *Marseille et l'Ouest africain*, 120–138; Anthony Clayton, *France, Soldiers and Africa* (London: Brassey's Defence Publishers, 1988), 78.

11 Patrick Manning, *Slavery, Colonialism and Economic Growth in Dahomey, 1640–1960* (Cambridge: Cambridge University Press, 1982), appendix 4.

12 Jean Daniel, "Le palmier à huile du Dahomey," *Revue coloniale* (1902): 201.

13 Jean Dybowski, Rapport au Ministre, 15 March 1901, 3, Archives Nationales de l'outremer, Aix-en-Provence (hereafter ANOM), DAHO III 8.

14 Serge Volper, *Une histoire des plantes coloniales: du cacao à la vanille* (Versailles: Quae, 2011), 39–42; René Tourte, *Histoire de la recherche agricole en Afrique tropicale francophone*, vol.4, *La période coloniale et les grands moments des jardins d'essais: 1885/1890–1914/1948* (Rome: Organisation des Nations Unies pour l'Alimentation et l'Agriculture [FAO], 2005), 93. The ENSAC changed its name to INAC in 1921.

15 Jonathan E. Robins, *Oil Palm: A Global History* (Chapel Hill: University of North Carolina Press, 2021), 60; Robins, "Smallholders and Machines," 73.

tury.[16] The testing and improvement of palm fruit processing machinery had become a trans-imperial undertaking by the early 1900s. The French were familiar with the German presses and crackers of Togo and Cameroon.[17] In 1909, Paul Ammann himself visited the British colony of the Gold Coast to test nut-cracking machines.[18]

After constructing crackers and presses, the next logistical step was to combine them to create steam-driven complexes that extracted both oil and kernels from palm fruit: these were the first oil mills. One of the earliest such initiatives came from Eugène Poisson, an agent of the *Association Cotonnière Coloniale* in Dahomey and the son of Jules Poisson, an eminent botanist specialized in palms. In 1904, in Cotonou, Poisson developed a kernel cracker based on a German model.[19] Three years later, with the help of two Marseille trading companies, Fournier and CFAO (*Compagnie Française de l'Afrique Occidentale*), he set up the first palm oil mill in Dahomey.[20] It consisted of five hydraulic presses, two grinders and two kernel crackers, and was powered by a steam engine fueled entirely by palm shells and fibers.[21] The main innovation of Poisson's process was that the processing was dry, which allowed for more and better quality oil to be obtained.[22]

However, Poisson's enterprise was ultimately undermined by his choice of location. The coastal area around Cotonou had one of the lowest densities of palm trees in southern Dahomey, making a consistent supply of fruit difficult to guarantee.[23] The decision to locate the factory there revealed a disregard for the critical role of the environment. French colonial officials initially understood the environment of southern Dahomey as a vast and self-sustaining plantation of oil palms, ripe for exploitation.[24] Within this idealized, Eden-like environment, colo-

16 Passelègue, *Les Concasseurs*, 8–9.
17 Jean Adam, *Le palmier à huile* (Paris: Augustin Challamel, 1910), 244–245.
18 Yves Henry and Paul Ammann, "Recherches sur le traitement mécanique des fruits de l'eloeis," *L'Agriculture pratique des pays chauds : bulletin mensuel du Jardin colonial et des jardins d'essai des colonies françaises*, no.112 (1910): 137.
19 Adam, *Le palmier à huile*, 248; Auguste Chevalier, *Documents sur le palmier à huile* (Gorée: Imprimerie du Gouvernement Général, 1910), 107; Passelègue, *Les Concasseurs*, 9.
20 Chevalier, *Documents*, 108.
21 Adam, *Le palmier*, 243–244; Chevalier, *Documents*, 111–112.
22 Antoine Bories, "Préparation Industrielle et Indigène de l'Huile de Palme," *Bulletin des Matières Grasses*, no.1 (1919): 43.
23 Service de l'agriculture du Dahomey, Rapport 1909, Archives Nationales du Bénin, Porto-Novo (hereafter ANB), 1R3/3.1; Chevalier, *Documents*, 113; Antony Houard, "Étude sur l'exploitation industrielle du palmier à huile," *Bulletin des Matières Grasses*, no.1 (1919): 184.
24 Giovanni Tonolo, "An Environmental History of Palm Oil Development in Dahomey in the Twentieth Century," *Comparativ* 32, no.6 (2022): 730.

nial agents were likely convinced that any technology could be applied. Poisson's failed factory served as an early warning of the importance of paying attention to environmental conditions.

To secure fruit supply, companies could seek land concessions, but this was difficult in Dahomey. Since the founding of the colony, Governor Victor Ballot rejected numerous requests, arguing that the densely populated Dahomean palm belt left little room for land alienation.[25] In 1897, the Marseille trading company Mante & Borelli requested a concession for building a railway, asking for 2,500 hectares of land for every kilometer of track.[26] The colonial administration rejected this proposal twice, but ultimately relented under pressure from the Ministry of Colonies. In June 1900, despite the hesitancy of the local government, Borelli was granted a 300,000-hectare concession. The decision caused significant unrest. The Dahomean landowners feared losing their lands, while European trading companies worried that Borelli would have a monopoly on palm products. In the end, the Government General of French West Africa, together with the colony of Dahomey, assumed full responsibility for the construction of the railroad. Borelli relinquished the concession, though not without receiving substantial compensation.[27] Most other land concessions in Dahomey quickly dissolved due to conflicts with the local population.[28] In 1902, in a joint venture with Borelli called the *Compagnie Coloniale du Dahomey*, Poisson was also granted a concession of 36,550 hectares scattered in eight parcels in the Dahomean palm belt. This venture too dissolved soon after.[29]

In an economic report from 1910, the colonial administration admitted that the fact that European concessions could not be established in Dahomey posed a major obstacle to industrializing the oil palm sector.[30] The contrast with neighboring colonies like the Ivory Coast was striking. There, the palm region was so much less densely populated that the colonial government enacted by decree the policy of the *cantonnement*, which declared all oil palms that the indigenous

---

25 C.W. Newbury, *The Western Slave Coast and Its Rulers: European Trade and Administration among the Yoruba and Adja-Speaking Peoples of South-Western Nigeria, Southern Dahomey and Togo* (Oxford: Clarendon Press, 1961), 155.
26 Xavier Daumalin, "Commercial Presence, Colonial Penetration: Marseille Traders in West Africa in the Nineteenth Century," in *From Slave Trade to Empire: Europe and the Colonisation of Black Africa 1780s-1880s*, ed. Xavier Daumalin (Abingdon: Routledge, 2004), 225.
27 Daumalin, "Commercial Presence," 226.
28 Hélène d'Almeida-Topor, *Histoire économique du Dahomey, Bénin, 1890–1920*, vol. 1 (Paris: L'Harmattan, 1995), 270–273.
29 Péhaut, *Les oléagineux*, 591.
30 Service des Affaires Economiques de l'AOF, Exploitation des palmiers à huile en AOF, 13 August 1910, ANB, 1R6/9.2.

were unable to harvest as the private property of the colony. The administration also allowed Europeans to take possession of the land through unequal agreements and, at times, by force. In 1916, farmers were forced to take their harvest to the oil mills.[31]

Following Poisson's experiment, several oil mills were built in other African colonies. They varied greatly in size, with capacities ranging from 2.5 tons of fruit per day, as in the case of the oil mill of Impérié (Ivory Coast), to 300 tons per day.[32] Some of them were explicitly based on the Poisson model.[33] All the oil mills, including those in the Ivory Coast, eventually experienced supply difficulties.[34] This occurred even when they were located near a European concession. A notable example is the case of the *Huileries du Congo Belge* (HCB), a subsidiary of Lever Brothers, which secured significant land concessions in the Belgian Congo in 1911 and established several oil mills. As has been pointed out, the location of the concessions was often decided hastily, as if securing the rights to a certain number of hectares and the approval for constructing a factory would ensure success. As the HCB soon discovered, there were not enough wild oil palms to supply an oil mill.[35] To "improve" the palm groves, the HCB cut away the young palms and kept the tallest ones – a logic that may have corresponded to the European ideal of what a plantation should look like, but that made harvesting more difficult.[36] As Lord Leverhulme, the founder of Lever Brothers, noted, the oil mills had to wage "a war against nature."[37] Securing control of land did not mean having suitable land; the environment had to be understood first.

31 Atta Kouame Jacob Brindoumi, "La création des huileries coloniales et ses conséquences en Côte d'Ivoire de 1912 à 1929," *Revue ivoirienne d'histoire*, no.23 (2014): 49–69.

32 Houard, "Étude".

33 This was the case of the oil mill of Maka, built in German Cameroon in 1911: Rapport de M. Annet sur l'extraction industrielle de l'huile de palme au Cameroun, 1 September 1916, in Antoine Stieltjes, "Machinerie pour la Préparation de l'Huile et des Amandes de Palme," *Bulletin de la Section des Matières Grasses*, no.6 (1918): 32–35.

34 See Houard, "Étude," 189–193.

35 David Kenneth Fieldhouse, *Unilever Overseas: The Anatomy of a Multinational 1895–1965* (London: Croom Helm, 1978), 502.

36 Robins, *Oil Palm*, 111.

37 Cited in Benoît Henriet, *Colonial Impotence: Virtue and Violence in a Congolese Concession (1911–1940)* (Berlin/Boston: de Gruyter, 2021), 146.

The interwar stalemate: hopes and fears of industrialization

In 1919, Antony Houard, director of Dahomey's agricultural service, claimed that "the entire future of the industrialization of palm oil" depended on whether oil mills "must necessarily be concessionaries" of palm groves or "could rely solely on the constant supply of fruit from the indigenous population." In his view, the Dahomean landscape, with its homogeneous palm groves and available water, was "sufficient to supply several factories."[38] However, while Houard believed that the Dahomean landscape was suitable for industrialization, the same was not true of its environment, considered in terms of both its physical features and social relations. Homogeneous palm groves were not necessarily available to oil mills. Farmers may not have been interested in harvesting more palm fruit than they needed for their own consumption, either because they considered the oil mills' purchase price too low, or because harvesting other crops took up the majority of their time. Even with the concessions of palm groves, industrial production depended on the availability of indigenous harvesters willing to climb over the trees on behalf of the oil mill. In summary, the industrialization of the oil palm sector required the disciplining of both the environment and its inhabitants, which in turn required financial and political resources that colonial officials recognized that they could not afford. Houard therefore recommended the creation of small-scale oil mills in Dahomey, arguing that "the time has not yet come for the large factories." He directed his criticism at the trading companies operating in the colony, which had "always confined themselves to commercial transactions" and had not "shown the slightest initiative to improve production conditions by creating factories." "Now," Houard concluded, "is the time for them to make up for this mistake and to increase their commercial capacity by setting up oil mills."[39]

Significant obstacles stood in the way, chief among them the weakened state of French companies trading in palm products after the First World War. By the end of the conflict, the United Kingdom had increased its palm kernel imports tenfold, enabling the production of cheaper British soap, which began to enter the French market. Simultaneously, the expansion of the Anglo-Dutch margarine industry prevented the emergence of a comparable French sector.[40] After the war,

38 Houard, "Étude," 194.
39 Houard, "Étude," 201–202.
40 Louis Pierrein, *Industries traditionnelles du port de Marseille: Le cycle des sucres et des oléagineux 1870–1958* (Marseille: Institut historique de Provence, 1975), 248–250.

the dominance of the pound sterling, combined with rising demand from the margarine industry, allowed the British trading companies in Dahomey to gain ground over their French counterparts.[41] Both British and French companies also had to contend with a more distant but significant threat: the rise of the Southeast Asian oil palm sector.

One of the key figures in the oil palm boom in the Dutch Indies was Belgian businessman Adrien Hallet, who had left Africa after a series of unsuccessful ventures, including a short-lived concession in Dahomey in 1900.[42] In Sumatra, he found that adapting the environment to suit oil mill operations was much easier, given that both land and labor could be controlled on a larger scale. Moreover, the ecological conditions, with higher and more evenly distributed rainfall, were much more favorable to the palm tree than in West Africa.[43] For example, while Sumatra's east coast could receive up to 6,000 millimeters of rain annually, southwestern Dahomey averaged just over 1,100 millimeters in the 1920s.[44]

French businessmen involved in the West African trade fought back. Immediately after the war, the Colonial Institute of Marseille sent Belgian scientist Gaston Van Pelt on a mission to West Africa to study how the oil palm sector could benefit from new methods being developed in Asia. Referring to Dahomey, Van Pelt argued that the colonial administration needed to establish "scientific plantations" and factories.[45] His recommendations persuaded both the director of the Colonial Institute, Émile Baillaud, and the general governor of French West Africa, Gabriel Angoulvant, that high-capacity oil mills were essential to prevent Southeast Asia from dominating global palm oil production.[46]

Yet, despite their general support for industrialization, the colonial government remained reluctant to intervene directly. On the one hand, the colonies still had to strive for self-sufficiency, and private companies, weakened by the

41 Cazaux, Rapport d'ensemble sur la situation économique du Dahomey, 25 April 1924, 50, ANOM, 1 AFFECO 876.

42 Péhaut, *Les oléagineux*, 591.

43 Jonathan E. Robins, "Shallow Roots: The Early Oil Palm Industry in Southeast Asia, 1848–1940," *Journal of Southeast Asian Studies* 51, no.4 (2020): 538–560.

44 André Aubréville, Les possibilités de la production d'huile et d'amandes de palme en AOF, undated [March 1938?], 1–4, Archives of the Centre de Recherches Agricoles Plantes Pérennes, Pobè (hereafter ACRAPP), ARMO/1900/0062, "Rapport Palmier à huile – Aménagement, développement, amelioration".

45 Gaston Van Pelt, "Le Palmier à Huile : L'Exploitation des Peuplements Naturels et la Culture Rationnelle," *Bulletin des Matières Grasses*, no.1 (1919): 217–241.

46 Émile Baillaud, "Le Rôle du Palmier à Huile dans la Production Mondiale des Matières Grasses", *Bulletin des Matières Grasses*, no.1 (1919): 132–133; Gabriel Angoulvant, "L'Arachide et le Palmier à huile en Afrique Occidentale," *Bulletin des Matières Grasses*, no.1 (1919): 9.

war and lacking concrete administrative support, were reluctant to undertake such ventures independently. On the other hand, the associationist shift in French colonial policy, which viewed Africans as "traditionally" farmers, emphasized that change should be gradual and respectful of local traditions. This approach, reinforced by workers' strikes in French West Africa in 1919 and 1921, insisted that the industrialization of the colonies and the potential formation of a colonial proletariat had to be resisted.[47] Governor General Jules Carde argued that oil palm development in Africa had to be carried out "by the indigenous people themselves". Without hiding the racist logic through which he viewed the world, he added that "a parallel" between "the Indies" and West Africa revealed "a truly unimaginable ignorance."[48]

Even influential agronomists like Yves Henry and Antony Houard dismissed Southeast Asia's oil palm boom as temporary. As late as 1930, Houard wrote that the oil palm in Malaya was not "in its true environment."[49] In summary, a stalemate emerged during the 1920s: French companies, organized under the Colonial Institute of Marseille, pushed for more rapid intervention, while the colonial agricultural services and the federal government of French West Africa favored a more gradual approach. Only two oil mills were constructed in the late 1920s, both of which encountered supply issues and operated for less than two years.[50]

The Great Depression hit France between 1930 and 1931, leading to a credit crunch and a loss of foreign markets. In response, French companies turned to the Empire as a market for their high-priced goods and as a source of raw materials.[51] However, the selling prices of exportable West African products fell dramatically.[52] With the collapse of the credit system, only the largest trading companies with sufficient cash reserves could continue buying palm products, while

47 Martin Thomas, *The French Empire between the Wars: Imperialism, Politics and Society* (Manchester: Manchester University Press, 2005), 83; James E. Genova, *Colonial Ambivalence, Cultural Authenticity, and the Limitations of Mimicry in French-Ruled West Africa, 1914–1956* (New York: Peter Lang, 2004), 62.

48 Quoted in Gaston Van Pelt, 'La culture du Palmier à Huile et la préparation des huiles et amandes de palme', in *Mémoires et Rapports sur les Matières Grasses*, vol. 4, *Le Palmier à Huile* (Marseille: Institut Colonial, 1930), 109–110.

49 Antony Houard, Le palmier à huile au Dahomey, 21 February 1930, 40–41, ACRAPP, ETAG/2014/0003.5. See also Yves Henry, "Documents sur le palmier à huile à Sumatra," *Bulletin économique de l'Indochine* (1926): 1–19.

50 Jules Marcel de Coppet, Note pour le Gouverneur à la suite du rapport de l'Inspecteur Général sur l'exploitation de la palmeraie, undated [January 1934?], 31, ANOM, 1 AFFECO 101BIS.

51 Thomas, *The French Empire between the Wars*, 105–107.

52 Péhaut, *Les oléagineux*, 663–664.

smaller companies went out of business.[53] Although these companies were hesitant to commit capital to the construction of oil mills in the fragile economic climate of the 1930s, the debate about the mills continued. Antony Houard contended that it was not possible to transform the environment of Dahomey, as had been done in the Dutch Indies, because it would mean displacing farmers who already owned the land. If the environment could not be changed, he suggested, then the people should be changed. One issue with the oil presses introduced in the 1930s was that the farmers preferred their palm oil to come exclusively from their own palm fruit and not be mixed with others. As a result, the machines could not be used to their full capacity. Houard argued the Dahomeans needed to be taught to work cooperatively, so that they could be persuaded to bring their own share of palm fruit to the factory for processing.[54]

As the economic situation improved and in response to Asian competition, the Minister of Colonies appointed a commission in 1938 to study how to improve the West African oil palm sector. Professor of technology Paul Ammann was among the experts involved. The commission's final report once again recommended the construction of oil mills.[55] In the meantime, André Rancoule, the new director of Dahomey's agricultural service, set up a small experimental oil mill in Pobè.[56] The colonial government also began to take a more proactive approach. In July 1939, the administration decided to establish a cooperative oil mill in Coli, north of Allada. Although there were no specific plans for a cooperative, farmers were instructed to bring the fruit to the oil mill. In return, they would receive the same amount of palm oil that they would obtain from artisanal processing, along with an additional quantity of kernels. The onset of the Second World War interrupted and ultimately ended the project before it could progress.[57]

---

53 Xavier Daumalin, "Le patronat marseillais face à la politique de la préférence impériale (1931–1939)," in *L'esprit économique impérial (1830–1970): Groupes de pression & réseaux du patronat colonial en France & dans l'empire*, ed. Hubert Bonin, Catherine Hodeir, and Jean-François Klein (Paris: Publications de la SFHOM, 2008), 291.

54 Antony Houard, Le palmier à huile au Dahomey, 21 February 1930, 30–35, ACRAPP, ETAG/2014/0003/5. On the problems encountered by the oil mills, see Germain Moulères à Armand Annet, 28 June 1938, 2, ANB, 1R1/9.

55 Ministre des colonies au Gouverneur Général de l'Afrique Occidentale Française, 6 May 1938, ANB, 1R1/9.

56 André Aubreville, L'aménagement des palmeraies, 18–21, attached to Léon Geismar à Ernest Gayon: Aménagement des palmeraies, 24 October 1938, ACRAPP, ARMO/1900/0062, "Palmier à huile – Aménagement, développement, amelioration".

57 André Rancoule, Observations sur l'huilerie coloniale à feu nu Colin et sur son fonctionnement éventuel dans un centre de traitement coopératif, 18 July 1939, ACRAPP, ARMO/1900/0062, "Palmier à huile – Aménagement, développement, amelioration". On cooperative and rural de-

The shaky foundations of late colonial oil mills

Many of postwar France's modernization policies had their roots in the Vichy government.[58] The regime's most ambitious economic plan for France, although ultimately not ratified by the government, explicitly called for public intervention in the industrial sector of the colonies. Industrial investment in the colonies was planned to exceed that in metropolitan France in relative terms, but it was limited to industries that could not directly compete with those in France.[59] A distinctive feature of the Vichy planning policy was corporatism, which empowered representatives of large companies and state technicians to steer the course of modernization. In December 1940, the regime created the *Groupements Professionnels Coloniaux* (GPCs), hierarchical corporatist bodies that brought together all the French companies in the colonies with the aim of reconciling state interventionism and private interests.[60] Within the GPC for agriculture and forestry, the president of the subsection for oleaginous products was Robert Michaux, a prosperous planter of rubber and oil palm in Malaya.[61] In July 1941, the Secretary of State for the Colonies, Charles Platon, asked him to prepare a development program for West African oilseed products.[62]

The GPCs developed a harsh critique of the practices of the colonial administration and the trading companies operating in West Africa.[63] These criticisms

---

velopment, see Nikolay Kamenov, "Pooling Resources in the European Countryside: Cooperative Models, Rural Capitalism, and Beyond," in *Living with the Land: Rural and Agricultural Actors in Twentieth-Century Europe – A Handbook*, ed. Liesbeth van de Grift, Dietmar Müller, and Corinna R. Unger (Oldenbourg: De Gruyter, 2022), 109–132.

58 Philippe Mioche, *Le plan Monnet: Genèse et élaboration 1941–1947* (Paris: Publications de la Sorbonne, 1986); Christophe Bonneuil and Frédéric Thomas, "Purifying Landscapes: The Vichy Regime and The Genetic Modernization of France," *Historical Studies in the Natural Sciences* 40, no.4 (2010): 532–568.

59 Catherine Coquery-Vidrovitch, "Vichy et l'industrialisation aux colonies," *Revue d'histoire de la Deuxième Guerre mondiale* 29, no.114 (1979): 81–83.

60 Christophe Bonneuil and Patrick Petitjean, "Les chemins de la création de l'ORSTOM, du Front Populaire à la Libération en passant par Vichy, 1936–1945," in *Les sciences coloniales : figures et institutions*, ed. Patrick Petitjean, vol. 2, *Les sciences hors d'Occident au 20. siècle* (Paris: ORSTOM, 1996), 129–130.

61 "Robert Michaux (1901–1962)," *Journal d'agriculture tropicale et de botanique appliquée* 9, no.11–12 (1962): 540–541.

62 Robert Michaux, "Le développement du palmier à huile en Afrique française," in *Semaine du palmier à huile et du cocotier* (Paris: IRHO, 1943), 106.

63 Mesures proposées par la Conférence des oléagineux, tenue à Vichy du 12 au 13 novembre, 14 November 1941, ANOM, 1 AFFECO 77; Christophe Bonneuil, "Mettre en ordre et discipliner les opened the door for planters and managers, such as Michaux, who had not been directly involved in the development of West African palm products during the previous decade. The Japanese occupation of both the Malay Peninsula and the Dutch East Indies in late 1941 also redirected these businessmen's focus back to the African colonies.[64] Michaux aimed to transplant the intensive oil palm cultivation methods developed in Asia to Africa. He urged the creation of medium or large oil mills with an annual capacity of at least 2,000 tons of palm oil, warning that insisting on "the creation of a multitude of small workshops would be like bowling a regiment on roller skates to catch up with a motorized enemy."[65]

In June 1943, the *Institut de recherche pour les huiles et oléagineux* (IRHO), a research institute established at Michaux's suggestion eighteen months earlier, organized a week-long conference on palm oil and coconut in occupied Paris. The first day of the conference was devoted to Asian oil palm plantations, held up as the exemplary model to follow. The first speaker revealed that when he first visited a West African palm grove, having come from Malaya, he did not even recognize the tree. It was so much more delicate and taller than the Asian palm that he initially thought it was a coconut. African processing methods, he added, were "a curious spectacle at the very least."[66] The speaker argued that the industrial plantation was the best solution for Africans, whom he described as "indolent by nature," lamenting that the French had not followed the examples of the Belgian Congo and Malaya.[67] He claimed that Africans' supposed inferiority necessitated a form of shock therapy through agricultural intensification. It should be noted that the racist views of the businessmen differed in certain respects from those held by colonial agronomists. Both argued that Africans' backwardness prevented them from appreciating technological innovations. However, while the agronomists remained confident that the farmers could be persuaded to adopt new machinery, the planters believed that nothing could be expected from them, so high-capacity oil mills and large plantations had to be introduced.

tropiques: Les sciences du végétal dans l'empire français, 1870–1940," (Phd diss., Université de Paris VII, 1997), 496.

64 Valeria Giacomin, "The Transformation of the Global Palm Oil Cluster: Dynamics of Cluster Competition between Africa and Southeast Asia (c. 1900–1970)," *Journal of Global History* 13, no.3 (2018): 390.

65 Robert Michaux, Le palmier à huile en AOF et le développement de la production d'huile de palme. Rapport de mission (mai-juin 1942), Annexe A – Plan de réorganisation de la production de palme en AOF, 13 September 1942, 5, ACRAPP, ARMO/1900/0062, "Palmier à huile – Aménagement, développement, amelioration".

66 H. Regnauld, "Le palmier à huile dans le monde," in *Semaine du palmier à huile et du cocotier* (Paris: IRHO, 1943), 7.

67 Regnauld, "Le palmier," 10–12.

The next speaker was Michaux himself, who boasted of the most spectacular achievements in Malaya. He insisted on the ability of Europeans to clear jungle land and to bring in Tamil labor, which was "neither more industrious nor more favored than the majority of the races of black Africa."[68] During his presentation, Michaux focused on the establishment of the Johore Labis plantation, which was constructed on a 10,000-hectare concession and projected to produce as much palm oil as the total exports of French West Africa. As he described it, "eighteen months after the first axe fell, 3,000 hectares had been planted […] 120 kilometers of roads completed, a permanent population of 2,000 souls, all imported, supervised, trained, housed, treated, etc."[69] Michaux showed an impressive series of images illustrating the transition from the ecocide of the pre-existing forest to the new plantation. For Michaux, environmental destruction was not accidental but methodically orchestrated. He commented:

> The felling technique is very advanced: the undergrowth is felled first, followed by the large trees. The aim of this technique is to ensure that the total height of the felled wood does not exceed one meter, so that when the block is set on fire a few months later, most of the leaves, branches and trees that have fallen to the ground will disappear in one fell swoop [*d'un seul coup*].[70]

The GPC was not without its opponents. Jean Desanti, former lieutenant governor of Dahomey before being made responsible for political affairs for the Secretary of State for the Colonies, criticized Michaux's plan on several grounds. Concerning the oil mills, he argued that the solution lay in "the multiplication of small factories […] less expensive and wisely distributed."[71] Oblivious to the ambitious plans being devised in Paris – French West Africa remained under Vichy's control only until the end of 1942 – colonial officials in Dahomey continued to debate the best location for a small cooperative factory similar to the one in Pobè.[72] Rancoule maintained that, due to supply constraints, only small oil mills with a maximum annual capacity of 1,250 tons could operate in southern Dahomey.[73] In December

68 Robert Michaux, "Les palmeraies modernes d'extrême-orient," in *Semaine du palmier à huile et du cocotier* (Paris: IRHO, 1943), 23–24.
69 Michaux, "Les palmeraies modernes," 24.
70 Michaux, "Les palmeraies modernes," 34.
71 Jean-Hyacinthe Desanti, Note au Directeur des Affaires Economiques: Bureau du palmier à huile, 16 May 1944, 3–4, ANOM, 1 AFFPOL 2555.
72 Colonie du Dahomey, Rapport économique: année 1943, 85; Colonie du Dahomey, Rapport économique pour les années 1944 et 1945, 43, ANOM, 1 AFFECO 912.
73 André Rancoule, Traitement mécanique de la production du palmier à huile au Dahomey, 25 October 1944, 2–3; Id., Plan de mise en valeur de l'AOF, 5 March 1945, 10; ACRAPP, ARMO/1900/0062, "Palmier à huile – Aménagement, développement, amélioration".

1944, the agricultural service of Dahomey drafted a long-term plan to install 81 small cooperative mills between 1947 and 1960.[74]

The liberation of France did not result in a change of experts, and Michaux remained in charge of the development plan for colonial oilseed products. At the same time, the main use of palm oil shifted from soap-making to margarine production, increasing the demand for refined palm oil from oil mills and further sidelining artisanal production.[75] The authors of the postwar French plan for the development of West African palm products, led by Michaux, admitted that even "the most ingenious tricks of modern technology" could not "entirely correct the unsuitability of the environment" of Dahomey for oil palm cultivation.[76] Michaux's approach closely resembled that of the experts who, around the same time, were designing the East African Groundnut Scheme. As Joseph Hodge aptly put it, they were "like Goethe's Faust, driven by an insatiable and illusory vision of what was possible which blinded them to the basic economic and ecological facts."[77] Although it was well known that irregular rainfall prevented the Dahomean oil palms from yielding as much as elsewhere, this did not alter the plan's core commitment to constructing four large mills. These mills were financed by the *Fonds d'Investissements pour le développement économique et social* (FIDES), the French development fund created in 1946. However, despite the grand ambitions, the environment surrounding the factories remained largely untouched.

This disregard for environmental constraints meant that the first oil mill, inaugurated in Avrankou on 13 July 1949, with a capacity of 4,000 tons of palm oil, encountered serious supply problems from the outset. The mill operated only a few days a week, as local farmers rejected the purchase prices it offered, which were lower than those paid by Dahomean women who continued to trade and produce artisanal palm oil for both export and domestic consumption.[78] Shortly thereafter, the Gbada oil mill was also built. Both Avrankou and Gbada were run by Fournier-Ferrier, the same company that had been involved in the construction of Poisson's oil mill nearly half a century earlier.[79] In its first year of op-

74 Service de l'Agriculture du Dahomey, Programme de mise en valeur de la palmeraie du Dahomey, December 1944, ACRAPP, ARMO/1900/0062, "Palmier à huile – Aménagement, développement, amélioration".

75 Pierrein, *Industries traditionnelles*, 297.

76 Commissariat Général du Plan, Développement de la production de matières grasses d'origine végétale dans les territoires d'Outremer, undated [1946?], ANB, 1R16/9.

77 Joseph M. Hodge, *Triumph of the Expert: Agrarian Doctrines of Development and the Legacies of British Colonialism* (Athens: Ohio University Press, 2007), 213.

78 Rapport agricole de l'année 1950, 182, ANOM, 14 MIOM 1923

79 Péhaut, *Les oléagineux*, 852.

eration, Avrankou produced only 1,150 tons of palm oil instead of the planned 4,000 tons. Rumors of the project's "total failure" soon circulated, casting doubt on the viability of the two existing mills and raising the prospect that the construction of the other mills would be abandoned.[80]

In February 1952, to save the oil mills, the French state obliged metropolitan consumers to buy oil products from the French Union instead of foreign products.[81] This protectionist measure allowed the mills to pay more to Dahomean farmers, but both Avrankou and Gbada remained closed during the low season.[82] The Gbada mill remained shut throughout 1953 as well. As experts from Dahomey's agricultural service noted, these modern factories were forced to compete with "a huge factory of artisanal production."[83] The Bohicon oil mill, inaugurated in 1953, was assigned to the IRHO because no private company wanted to take it over, as was the case with the Ahozon factory, which began operating the following year.[84] By 1954, the Gbada oil mill was still operating as a buffer-factory, absorbing the peak of production between March and May. French managers argued that Gbada could only become profitable if it were supported by a dedicated plantation.[85]

In the first half of 1954, thanks to French trade policies, most palm products exported from Dahomey came from the oil mills for the first time.[86] Metropolitan users, forced to buy overpriced products from West Africa, received a form of compensation in March 1954. Overseas producers of low-acid vegetable oils, namely the oil mills, could benefit from an import price much higher than the world market rate. In return, metropolitan users were allowed to purchase a proportional quantity of duty-free foreign palm oil.[87] In October, all export duties on the low-acid palm oil produced by the oil mills were abolished.[88] These measures temporarily saved the oil mills, but their economic viability continued to be uncertain. Avrankou and Gbada, which had the potential to produce 6,500 tons of palm oil per year, produced an average of 4,700 tons in the period between 1955 and 1963. Similarly, Ahozon and Bohicon, with a combined potential of 6,000 tons, pro-

80 Rapport économique 1951, 112–13, ANOM, 14 MIOM 1938.
81 Péhaut, *Les oléagineux*, 838.
82 Rapport annuel 1952, 6 February 1953, 62, ANB, 1R17/3.1.
83 Service de l'agriculture, Rapport agricole de l'année 1953, 36, ANOM, 14 MIOM 1973.
84 IRHO, Rapport annuel 1953, 41–42, ACRAPP, ARMO/1900/0066.
85 Procès-verbal du Comité consultatif créé auprès de la SHMD – Séance du lundi 22 novembre 1954, 4–5, ANB, 2Q1.
86 Subdivision Banlieue, Rapport économique 1er semestre 1954, 2–3, ANB, 1R18/8.
87 Péhaut, *Les oléagineux*, 839.
88 René Carrière de Belgarric, "Les huileries de palme du plan: équipement et exploitation rationnelle des palmeraies naturelles de l'Afrique française," *Oléagineux* 10, no.6 (1955): 385.

duced only 3,600 tons.[89] While women in eastern Nigeria organized riots against the competition posed by the oil mills starting in 1948, the Dahomean oil mills – despite having significantly higher capacity than the "Pioneer" mills introduced in Nigeria – never became truly competitive. For farmers, selling palm fruit directly to women remained more profitable. The Dahomeans brought only the surplus fruit that the women could not process to the oil mills.[90]

In 1960, Dahomey gained formal independence, and its first development plan prioritized the creation of plantations of high-yielding selected palms, with the explicit goal of enhancing the profitability of existing oil mills and facilitating the construction of new ones.[91] Through a system of so-called "compulsory cooperatives," the state could expropriate farmers and tie their labor to the plantations.[92] The perceived greater political legitimacy of the postcolonial state, combined with increased funding from international aid organizations, enabled environmental transformations that the colonial administration had previously been unwilling to undertake. Even then, however, the plantations could only partially meet the capacity of the three new oil mills built in the late 1960s, which often had to reduce their processing volumes.[93] One of the key reasons for this was that the price offered by Dahomean women producing artisanal oil was higher than what the oil mills were willing to pay. Additionally, the yield of the plantations was severely affected by theft.[94] Eventually, the oil mills built under colonial rule, which continued to rely mainly on subspontaneous palm groves, were closed at the end of the 1970s due to supply shortages. Avrankou, Gbada and Pobè closed

89 SNAHDA au Ministre des finances, 8 April 1964, Historical Archives of the European Commission, Brussels (hereafter HAEC), BAC 249/1980_123.

90 Jean Baudot, Untitled document, 2 May 1958, 22–32, ANB, 1Q11/2. On the riots in Nigeria, see Gloria Chuku, *Igbo Women and Economic Transformation in Southeastern Nigeria, 1900–1960* (New York and London: Routledge, 2005); John Oriji, "Igbo Women, Technological Changes and Protests (1946–1953)," *Moebius* 1, no.1 (2003): 11–21; Anthony I. Nwabughugu, "Oil Mill Riots in Eastern Nigeria 1948/1951: A Study in Indigenous Reaction to Technological Innovation," *Africa Development* 7, no.4 (1982): 66–84; Nina Emma Mba, *Nigerian Women Mobilized: Women's Political Activity in Southern Nigeria, 1900–1965* (Berkeley: Institute of International Studies, 1982).

91 Société générale d'études et de planification, *Dahomey, plan de développement économique* (Leiden: IDC, 1962), 13–14.

92 Moïse Mensah, "L'expérience dahoméenne en matière de coopératives de production dans le cadre des périmètres d'aménagement rural," *Études dahoméennes*, no.6–7 (December 1965): 73–80.

93 SOBEPALH, Enquête dans la palmeraie naturelle du Bénin – Deuxième partie : Caractéristique de la palmeraie naturelle, July-August 1976, 24, ACRAPP, ARMO/1900/0058.

94 Christian Blanchard à la DGVIII, 14 January 1977, 2–3, HAEC, BAC 190/1992, 943; IRHO, Étude de la rénovation de la palmeraie naturelle et de l'amélioration de la collecte en République Populaire du Bénin, November 1984, 2, ACRAPP, ETAG/2014/0008/2, "1984 départ".

between 1977 and 1978, with Ahozon following soon after. The Bohicon mill was converted into a mixed seed oil mill in 1981.[95]

Conclusion

This chapter has explored the relationship between development, environment, and technology through the case of oil palm development in colonial Dahomey. I have focused on oil mills because this technology was designed based on specific assumptions about the environment and its future transformation. Although French experts almost unanimously advocated for the creation of oil mills, very few were actually built, revealing a great deal of caution on the part of both the colonial administration and private entrepreneurs. Part of the reason why colonial ambitions failed to meet industrial expectations lay in the French administration's reluctance to fundamentally alter the colony's environment.

The construction of oil mills required significant changes to the environment, whether through the reorganization of existing palm groves or through the creation of entirely new plantations directly controlled by the mills. The rise of the Southeast Asian palm sector seemed to prove that the plantation-factory model was the way forward and that West African landscapes should be similarly adapted. However, the conditions in Dahomey were quite different: land was scarce and labor was difficult to control. Private companies were hesitant to embark on such high-risk ventures without strong backing from the colonial administration, which, in turn, was reluctant to make environmental changes that might provoke unrest or destabilize local communities. Instead of a grand, Promethean effort against a hostile environment, colonial development unfolded as a continuous search for technologies that would minimize environmental change: officials aimed for smooth improvements rather than radical upheavals.

Under Vichy, French businessmen with experience in Asia played a key role in advancing the large factory model: four oil mills were built in Dahomey in the 1950s. The margarine industry's demand for low-acid palm oil, combined with the protectionist measures taken by the French state, made it possible for the oil mills to operate in Dahomey without dramatically altering the environment. Although the agricultural service had distributed hundreds of thousands of high-yielding palms in the colony from the late 1920s, most of these selected palms died shortly

95 E. Edoun au Directeur Général de la SOBEPALH, 6 December 1978, ACRAPP, ETAG/2014/0004.3, dsn; Esther Mètolé Catraye, 'La Société Nationale pour l'Industrie des Corps Gras: Un exemple d'agro-industrie en République Populaire du Bénin' (Master's thesis, Abomey-Calavi, Université Nationale du Bénin, 1988), 2, 22.

after being planted. By the late 1950s, it was generally agreed that the introduction of selected oil palms had no impact on the palm groves of Dahomey.[96] Plant breeding was a technology aimed at *adapting* the environment.[97] In contrast, while oil mills did transform the environment – for example, through industrial discharges into watercourses and the construction of connecting roads – their establishment ultimately depended on an *adapted* environment. The tumultuous history of Dahomey's postcolonial oil mills, built within standardized plantations, suggests that even an adapted environment was insufficient to ensure their survival. Although the environmental context was crucial, it was only one among many factors influencing the outcomes of development projects.

96 Jean Baudot, Untitled document, 2 May 1958, 21, ANB, 1Q11/2.
97 On this kind of technologies see Sverker Sörlin and Nina Wormbs, "Environing Technologies: A Theory of Making Environment," *History and Technology* 34, no.2 (2018): 101–125.

Corentin Gruffat

Animal improvement in the age of illustration: Visual technologies, breed selection, and cattle husbandry in the nineteenth-century Habsburg monarchy

For many European agronomists of the early nineteenth century, animal husbandry was "the soul of agriculture." This representation rested on the key functions that animals played in the agricultural systems of the time. It also related to the broader conception that agriculture was at the heart of an idealized approach to using natural resources that bound together increased productivity with specific visions of society. In Central Europe, many projects of the agricultural revolution sought to increase the productivity of animals to yield fertilizers, draught work and valuable products like wool, milk or meat. For promoters of such intensified husbandry like Joseph Liechtenstern, what was at stake behind agricultural growth was to elevate the Habsburg monarchy to the 'level of civilization' (*Grad von Kultur*) it ought to attain.[1] Throughout the century, agronomists, landowners, governments, and peasants designed varied plans for what they called 'agricultural improvement' or 'uplift' (*Verbesserung* or *Hebung*). These projects also involved processes of environmental transformation. Beyond the increased use of resources required to rear more cattle, agricultural improvers paid meticulous attention to the animals and how to "improve" them. Over the course of the century, reared cattle became, on average, fatter, stronger, and yielded more milk. This transformation of the bodies of whole populations of domesticated animals is associated with a process of selection that is often presented as the "birth of modern breeds."[2]

Many scholars identify the association of breed selection with the search for increased productivity as a triumph of the Cartesian idea of the "animal-ma-

1 Joseph Freyherr von Liechtenstern, *Allgemeine Bemerkungen über den Zustand der Landwirtschaft in den Ländern des Oestereichischen Erbmonarchie. Mit einer summarischen Übersicht der wesentlischsten Geschäftsgegenstände bey der Verwaltung der Landgüter. Nach der Abhandlung über diesen Gegenstand, in der Skizze einer statistischen Schilderung des östereichischen Staats neu bearbeitet* (Vienna: [no publisher], 1802).

2 See the periodization proposed by Marleen Felius et al., "On the History of Cattle Genetic Resources" *Diversity* 6, no.4 (2014): 705–750. For a general historical overview of the nineteenth century, see Éric Baratay, *Bêtes de somme: Des Animaux au service des hommes*, 2nd ed. (Paris: La Martinière/Seuil, 2011).

https://doi.org/10.1515/9783111611358-013

chine." They focus in particular on the emergence of a discipline called "zootechnics," or the discipline of the rational management of animals.[3] To a certain extent, nineteenth-century zootechnicians endorsed an idea of the "animal machine" in their textbooks. This representation rested on a simplified consideration of the cattle as a transformer, capable of turning an input (grass) into valuable outputs (energy, milk, meat etc.).[4] Taking this discourse at face-value, a straightforward narrative has emerged: breeders confused their animals with actual machines and engaged in forms of proto-genetic engineering,[5] eventually leading to the development of "industrial husbandry" in the twenty-first century.[6] This narrative locates the origins of the modernization of animal husbandry in a set of ideas and representations, in which technology came to determine every aspect of the relationship between breeders and animals, and reduced the latter to a form of technology.

In this article, I explore another approach to the history of husbandry, moving away from the idealist narrative of the animal-machine, to focus on reconstructing a specific aspect of the working process of the actors involved in defining cattle breeds in the nineteenth century. As several historical studies have already suggested, examining the empirical practice of these actors reveals aspects of this process that challenge the notion of animals being treated as mere machines, as

3 This term emerged in France in the 1830s, and some agricultural experts tried to import it in the German-speaking context. Although the term was much less used there, I will use "zootechnics" to refer to ideas of animal improvement circulating in the German-speaking area, and "zootechnicians" to designate the experts in cattle because the practices of Austrian and French breeders were similar and even connected (see below on international exhibitions).

4 For an Austrian example, see Joseph von Schreibers, *Die Milchwirthschaft im Innern großer Städte und deren nächster Umgebung* (Prague: J.G. Calve'schen Buchhandlung, 1847), 3. The zootechnicians' representation of the machine was however very different from the Cartesian mechanism. See Nathaniel Wolloch, *The Enlightenment's animals: Changing conceptions of animals in the long eighteenth century* (Amsterdam: Amsterdam University Press, 2019), 173, 207; Benedetta Piazzesi, *Del governo degli animali: Allevamento e biopolitica* (Macerata: Quodlibet studio, 2023), 202–203.

5 Although genetics developed only in the early twentieth century and had little influence on breeding practices until the second half of the century. See Bert Theunissen, "Breeding without Mendelism: Theory and practice of dairy cattle breeding in the Netherlands 1900–1950," *Journal of the History of Biology* 41, no.4 (2008): 637–676; Pierre Cornu, "Génétique animale et modernisation de l'élevage dans la France de l'après-guerre. Essai d'épistémologie historique de la selection," *Revue de synthèse* 145, no.1–2 (2024): 213–260.

6 For example Catherine Larrère and Raphaël Larrère, "Actualité de l'animal-machine," *Les Temps Modernes* 630–631, no.2 (2005): 142–163; Jocelyne Porcher, *Vivre avec les animaux: Une utopie pour le XXI[e] siècle* (Paris: Éditions la Découverte/M.A.U.S.S., 2011).

well as technicist narratives.[7] It enables us to ask whether early zootechnicians interpreted their work as a form of engineering, or whether they saw their work, and more broadly their relationships to animals, in other ways. Since this amounts to asking how the actors saw the animals they were working on (or "with"?), I will start this exploration with a particular set of sources often overlooked in the histories of zootechnics: the visual material produced by zootechnicians.

Zootechnicians produced a wide range of visual material, like cattle portraits and maps of breeds. This paper will focus on a set of publications circulated within the Habsburg monarchy between 1850 and 1900, along with archives that enable us to reconstruct how actors used emerging imagery technologies for animal improvement. This visual material could be included in textbooks, journals and herdbooks, or published independently as albums and atlases.[8] Depicting cattle was not something new in itself. European painting had a centuries-old tradition of representing these animals. However, artists depicted cattle more often as symbolic elements of an idealized rural landscape, rather than out of genuine interest in animals.[9] A new tradition of naturalist drawings of cattle had emerged in the late eighteenth and early nineteenth centuries, which aimed to describe the animals for scientific purposes, although this perspective did not necessarily eliminate symbolic discourses from the imagery.[10] In Austria, the imperial family hired, for instance, professional painters to produce a series of watercolors representing the whole animal realm for their natural history collections. Their large collection of naturalist paintings featured nine depictions of cattle, made between 1822 and 1848.[11] In the mid-nineteenth century, a shift occurred, as zootechnicians

7 Barbara Orland, "Turbo-Cows: Producing a competitive animal in the nineteenth and early twentieth centuries," in *Industrialising organisms: Introducing evolutionary history*, ed. Susan Shrepfer and Philip Scranton (New York / London: Routledge, 2004), 167–189; Emily Pawley, "The Point of perfection: Cattle portraiture, bloodlines, and the meaning of breeding, 1760–1860," *Journal of the Early Republic* 36, no.1 (2016): 37–72; Stephanie Triplett, "Bovine reproductions: Animal husbandry and acclimatization in the cattle paintings and prints of Rosa Bonheur," *Art History* 46, no.1 (2023): 12–37.

8 I will indicate in the footnotes when digitized versions of the albums are accessible online.

9 Florian Reynaud, "Les bêtes à cornes et l'art pictural. Une étude iconographique pour servir l'Histoire," *Histoire & Sociétés Rurales* 30, no.2 (2008): 31–66; Wolloch, *Enlightenment's animals*, 184–185.

10 Harriet Ritvo, "Race, breed, and myths of origin: Chillingham cattle as Ancient Britons," *Representations* 39 (1992): 1–22.

11 These watercolors are still today in the Austrian National Library. Patrick Poch, "Tiermaler im Naturalienkabinett: Die zoologische Bildersammlung Kaiser Ferdinands I.," in *Des Kaisers schönste Tiere: Bilder aus den habsburgischen Sammlungen* [Katalog der Ausstellung im Prunksaal began to use photography and chromolithography to systematically incorporate similar depictions into studies limited to cattle. These documented in greater detail the diversity within this species.[12] Publishing extensive albums of breeds became an essential component of the work of breed selection. These images served not just as illustrations or a neutral form of visual record-keeping, but tools that helped shape the "improvement" of husbandry in multiple, often ambivalent ways and set up complex relations between diverse actors in husbandry and the animals involved.

The zootechnicians' visual material can serve as a historical source in several ways. First, these images remind us that the work of husbandry improvement relied not only on textbooks, which form the basis of most historical accounts, but also on specific visual material. Their visual analysis brings to the fore some ambiguities in the relationship between improvers and their animals, especially regarding the blurred distinction between animals as productive machines and living organisms. In this way, the images draw our attention to practices of improvement beyond what zootechnicians wrote about, thereby allowing us to de-center our perspective from their narratives.[13]

Second, the conditions under which this imagery was produced and used help us recover the perspectives of other historical actors concerning the place of domestic animals in agricultural improvement projects. The new imagery around cattle expanded the work of improvement beyond just the dual relationship between breeder and animal. It created a space of intervention for zootechnicians as experts, and the Habsburg government also seized the opportunity to intervene in cattle selection.[14] This raises the question of how the visuality of cattle interacted with broader visions of husbandry improvement and the environmental transformations they entailed.[15] From this perspective, we can analyze these visual sources as part of what Sverker Sörlin and Nina Wormbs have called "environing

der österreichischen Nationalbibliothek], ed. Monika Kiegler-Griensteidl and Patrick Poch (Vienna: Kremayr & Scheriau, 2022), 141–158.

12 Triplett, "Bovine reproductions," 14.

13 Such an approach bears some similarities with Nathaniel Wolloch's call to enlarge the study of eighteenth-century conceptions of animals beyond the philosophical and scientific ones to historiographical and economic conceptions, though this author remains within the field of intellectual history. Wolloch, *Enlightenment's animals*, 13.

14 On the idea that, in modern husbandry, breeders don't make the selective choices on their own, see Pierre Cornu, "L'élevage bovin entre technosciences, marché et politiques publiques: Une mise en perspective historique," *Pour* 231, no.3 (2016): 77–79.

15 According to Gillian Rose, *Visual methodologies: An introduction to the interpretation of visual materials*, 2nd ed. (London: SAGE Publications, 2007), 2: visuality is "the way in which vision is constructed in various ways."

technologies," i.e. tools that enable a process of making the environment occur. With this concept, these authors call attention to two entangled sides of the process of "environing": the shaping of the material world by humans as well as the "conceptual work" to "bring into being understandings of the environment."[16] Visual sources open up possibilities to link the history of agricultural knowledge with the environmental history of agriculture, particularly the evolutionary history of cattle breeds.[17] This possibility has been partly suggested by twenty-first-century zootechnicians, who tend to approach these visual sources as snapshots of how cattle looked at the time of the "birth of modern breeds."[18] However, the images should be approached with caution, since the visual material produced by nineteenth-century zootechnicians presented specific visions about the future of cattle husbandry. Despite the authors' efforts, this visual material did not correspond to the reality of animal husbandry at the time, and its influence on agricultural programs unfolded in complex ways.

The use of the same visual material by actors beyond zootechnicians, and especially by the Habsburg government, suggests more indirect ways in which the creation of knowledge about animals impacted rearing practices. Increased government engagement in the production and circulation of this visual material highlights how the prospect of spreading more productive cattle was connected to broader self-representations of the empire. Zootechnical knowledge played a crucial role in shaping policies to support the improvement of husbandry, while some lasting ambiguities and uncertainties provided local actors with possibilities to advocate for their own interests as well. The environing work of cattle "improvement" unfolded within a larger set of intentions and programs, and the zootechnicians' visual material contributed to broader visions of development, in which socio-economic and political rationales played a role as crucial as that of technology.[19] Focusing on multifaceted empirical practices that were less coherent than the idealist narrative of the "animal-machine" suggests, we can thus propose a less linear and straightforward history of European (agricultural) modernization

---

16 Sverker Sörlin and Nina Wormbs, "Environing technologies: A theory of making environment," *History and Technology* 34, no.2 (2018): 103–107.

17 Edmund Russell, "Evolutionary history: Prospectus for a new field," *Environmental History* 8, no.2 (2003): 204–228; Joshua Specht, "The Rise, fall, and rebirth of the Texas longhorn: An evolutionary history," *Environmental History* 21, no.2 (2016): 343–363.

18 Bernard Denis, *Les Vaches ont une histoire : Naissance des races bovines* (Paris: Delachaux et Niestlé, 2016).

19 On "visions" of development, see Iris Borowy et al., "Introduction: What is development, why should we be concerned about its history, and why is a new serial publication needed?," in *Yearbook for the history of global development*, Corinna Unger et al., eds., vol.1 (Berlin and Boston: De Gruyter, 2022), 5–8.

and how it reshaped the entanglements between economic developments and environments.

The first section of the article analyses the contexts in which zootechnicians produced visual materials about the breeds, and uncovers the several, and at times ambiguous, meanings that they attached to the animals through this medium. The next section will analyze how zootechnicians progressively redefined the concept of breed, and how this conceptual work interacted with the ongoing evolutionary history of cattle. Finally, the last section will explore how different agricultural actors tried to utilize this form of knowledge to shape the development of improvement programs.

1 Looking for productive cattle, from exhibitions to albums

In the Habsburg monarchy, the publication of the first albums of cattle breeds in the mid-nineteenth century was an outgrowth of efforts to improve husbandry that had begun several decades earlier. Agronomists in the late eighteenth and early nineteenth centuries insisted that animal husbandry was a pivotal component of the agricultural systems of the time, and that any prospect of agricultural growth depended on more productive animals. Landowners, especially the nobility who owned large estates, were particularly interested in such schemes. After the Napoleonic Wars, they also attracted the attention of the Habsburg state, which had a direct fiscal interest in more productive agriculture since the implementation of the land tax in 1817, and more broadly, a political interest in stabilizing the monarchy's economy that had been weakened during the wars. In several provinces of the empire, agronomists, landowners, and their estate managers founded a network of agricultural societies under the distant supervision of the imperial government. Members of these societies, who saw themselves as the political elite of the monarchy, aimed to widely promote the most productive agricultural methods of the time in a "patriotic" spirit.[20] In the 1820s, these societies started to organize yearly cattle exhibitions, first in large cities (Vienna, Prague, Brno,

20 "Geschichtliche Darstellung der Gründung der k.k. Landwirthschafts-Gesellschaft in Wien," *Verhandlungen der kaiserlich-königlichen Landwirthschafts-Gesellschaft in Wien* 1, no.1 (1816): 1–9; Ernst Bruckmüller, "The Agricultural Society of Vienna and its Connections to Southern and Western Europe between 1812 and 1857," *Acta Histriae* 28, no.2 (2020): 279–296. For a more general overview: Peter Jones, *Agricultural enlightenment: Knowledge, technology, and nature, 1750–1840* (Oxford: Oxford University Press, 2015).

Budapest) and, after a few years, in some parts of the countryside, particularly in Lower Austria.

For the agronomists and noble landlords who organized them, the exhibitions had two aims. First, they tried to promote more intensive practices related to animal husbandry, such as the abandonment of common grazing and the adoption of stable feeding. In this respect, the exhibitions sought to teach improved practices to allegedly ignorant and backwards peasants, often in a very paternalistic manner.[21] Second, the organizers used the exhibitions as an opportunity to gather knowledge on the livestock that was already present in the empire. Confronted with the diversity of the exhibited cattle, agronomists soon acknowledged that they had limited knowledge about what animals were available for the purpose of improvement. Seeing and classifying the animals during exhibitions thus became an essential part of the knowledge regime that should sustain the improvement process.[22] With the development of new imagery technologies like chromolithography and photography, agronomists aimed to complement their direct observation of the animals with illustrated publications. As the veterinarian Georg Eckel explained to his colleagues of the Viennese Agricultural Society in 1848, in the "era of illustration," the "sensually tangible" (visual representations) had become "a need of our time" at the expense of "the ideal" (purely abstract knowledge).[23] The Agricultural Society started to work on an album with a Viennese printer, but this first project ultimately failed due to the latter's death.[24]

The first albums published in the 1850s were linked to two large cattle exhibitions, the Concours universel agricole in Paris of 1856 and the fiftieth anniversary of the Viennese Agricultural Society in 1857. In both cases, the organizers of the exhibitions photographed what they considered to be the most "beautiful" animals, which were chosen from among the prize-winning animals of the contest. The albums served as temporal extensions of the exhibitions. The French

21 Anton Freyherr von Bartenstein, "Vorschlag des Gesellschafts-Ausschusses zu öffentlichen Ausstellungen von veredeltem Horn- und Schafvieh," *Verhandlungen der kaiserlich-königlichen Landwirtschafts-Gesellschaft in Wien* 3, no.1 (1822): 16–28.

22 Sophie Corbillé and Emmanuelle Fantin, "Les Animaux dans les expositions universelles au XIX[e] siècle : monstration, ordonnancement et requalification du vivant. Paris et Londres, 1851–1889," *Culture & Musées. Muséologie et recherches sur la culture*, no.35 (2020): 215–220.

23 Franz Georg Eckel, "Antrag des beständigen Ausschusses zur Herausgabe einer bildlichen Darstellung und Beschreibung der in Niederösterreich vorkommenden Rindvieh-Racen auf Kosten der Gesellschaft," *Verhandlungen der kaiserlich-königlichen Landwirtschafts-Gesellschaft in Wien und Aufsätze vermischten ökonomischen Inhaltes. Zweite Folge* 5, no.1 (1848): 48–53.

24 Files No. 86, Box 115 and No. 400, Box 125, Landwirtschaftsgesellschaft (Agricultural Society, LWG), Landwirtschaft (Agriculture, LW), Allgemeines Verwaltungsarchiv (General Administrative Archive, AVA), Österreichisches Staatsarchiv (Austrian State Archives, OeStA), Vienna, Austria.

and Austrian governments respectively published the images as either a photographic album or a lithographic album, which was five times cheaper.[25] The Viennese album was even colorized through chromolithography. According to the editors of both albums, the photographic technique ensured accurate representation of the outlines of the animals, while professional painters present at the Austrian exhibition assured an accurate rendition of the colors. Overall, the representations were supposed to be "true to nature."[26]

The decision to show the animals in profile, which remained a consistent element throughout the century in all cattle albums, was also essential for creating a sense of scientific objectivity. Zootechnicians considered this angle to be the best suited for showcasing the unique physical characteristics of each type, since it displayed a larger portion of the body.[27] By choosing this perspective, they also departed from other existing modes of representing cattle in the agricultural press, like the engravings showing the back of the animals according to the Guénon-system, a popular technique developed by a French cattle trader to select dairy cows.[28] Moreover, profile images visually structured the image around the lines of the animal's body, organizing the picture in rectangular shapes. In this way, the animal was shown in a kind of squared grid and the image lacked any sense of perspective (Figure 1).[29] When brought together in a format of unprece-

25 *Abbildungen österreichischer Rindvieh-Racen, herausgegeben im Auftrage des k.k. Ministeriums des Innern* (Vienna: k.k. Hof- und Staats-Druckerey, 1859); Émile Baudement, *Les Races bovines au concours universel agricole de Paris en 1856. Études zootechniques publiées par ordre de s. exc. le ministre de l'agriculture, du commerce et des travaux publics* (Paris: Imprimerie impériale, 1862), accessed July 15, 2025, https://gallica.bnf.fr/ark:/12148/bpt6k318130c/f9.planchecontact.

26 *Abbildungen österreichischer Rindvieh-Racen*, vi.

27 Julius Ritter von von Blaas and Ferdinand Kaltenegger, *Album der Rinder-Racen der österreichischen Alpenländer. Nach Original-Aufnahmen* (Vienna: k.k. Hofbuchhandlung Wilhelm Frick, 1894), accessed July 15, 2025, https://sammlung.volkskundemuseum.at/bibliothek/content/titleinfo/109094.

28 Compare with the engravings in "Concours Agricole Universel – Espèces Bovines," *L'Illustration, Journal Universel*, June 14, 1856, 392 – 393, accessed July 15, 2025, https://gallica.bnf.fr/ark:/12148/bd6t513855115/f5.item. On the Guénon-system and its critiques from mid-nineteenth-century zootechnicians: Fabien Knittel, "Le système Guénon : Une innovation technique pour l'amélioration de la sélection des vaches laitières (années 1830–années 1900)," *Technologie et innovation* 6, no.4 (2021): 1 – 9.

29 On photography and "mechanical objectivity," see also Triplett, "Bovine Reproductions," 26 – 28.

dented size, the representations enabled the viewer to “recognize with certainty” the attributes of different kinds of animals.[30]

Figure 1: “Bull. Bernese Breed [*Race*]. 3 ½ years old. Property of H.[is] i.[mperial] Highness archduke Albrecht. In-breeding of the archducal swissery [dairy farm] in Wieselburg [/Moson] in Hungary.” (Source: *Abbildungen österreichischer Rindvieh-Racen, herausgegeben im Auftrage des k.k. Ministeriums des Innern*, Vienna, k.k. Hof- und Staatsdruckerei, 1859, plate XXI [Österreichische Nationalbibliothek].)

Despite the images’ claim to objectivity, the albums’ classifications of cattle into breeds were ambiguous on several counts. On the one hand, we can compare these images to the tables used by juries of agricultural exhibitions to reconstruct the zootechnicians’ gaze on animals in the mid-nineteenth century. In that respect, the primary factor in the definition of the ‘beautiful cattle’ (*das schöne Vieh*) was a set of external characteristics. Breeders were supposed to pay great attention to the general shape and proportions of the body, as well as to a series of details about the legs, tail, breast, neck, head, horns, color, and even the look and “temper” of the animal.[31] The album images suggested that these external characteristics could be extended to a group of animals more generally to define a “type.” The lithographs from the albums were thus more than simple portraits of outstanding individuals, like those circulating simultaneously in agricultural

30 As the Habsburg administration argued when advertising the subscriptions to the Viennese album: File No. 8657/1724, Box 6, 498 Središnje agronomsko društvo Zadar (Central Agronomic Society in Zadar, 498 SADZ), Državni Arhiv u Zadru (Croatian State Archive in Zadar, HR-DAZD).
31 File No.176, Appendix No. 12 and No. 13, Box 22, LWG, LW, AVA, OeStA.

newspapers and analyzed by Emily Pawley.[32] In the design of the album, the animal's individuality was progressively pushed to the background to benefit the larger entity it was supposed to embody almost perfectly: the breed. However, this way of looking at the album made it easy to forget that the depicted animals were the prize-winners of a contest, i. e. the animals who could already be considered "improved" versions of their counterparts. In other words, and as zootechnicians' repeated complaints in agricultural journals also suggest, most animals in the herds of Austrian breeders probably looked different from the ones depicted in the album.

On the other hand, beneath their identification as a "type," the animals depicted in the 1850s still appeared as individuals as well. Especially in the Viennese album, short notes indicated many contingent details about the estates from which they came. The authors of these notes, probably the breeders themselves, used a language of kinship to refer to the animals' grandparents, brothers and sisters. Some Austrian exhibitors won prizes in both the Parisian and Viennese exhibitions, which allows us to identify animals depicted in both albums as siblings.[33] This attention to genealogy corresponded to larger debates among zootechnicians about the "heredity" of physical characters, which were considered attributes of particular "blood lines."[34] In that respect, the genealogical notes of the Viennese album paved the way for the publication of the first herd books in the 1860s and 1870s. By then, genealogy information became a necessary complement for breeders looking for animals capable of maintaining productive capacities over several generations. Although zootechnicians studied animal bodies in increasingly geometrical and arithmetic terms, their main way of improving cattle was to selectively pair animals for reproduction.[35] Whereas the mere appearance of an animal could deceive a breeder concerned about its future offspring, zootechnicians considered genealogical records a warrant of quality.[36]

32 Pawley, "The Point of perfection."

33 For example the bull from Zillertal in *Abbildungen österreichischer Rindvieh-Racen*, 11, and the cow in Baudement, *Les Races bovines*, plate xlix; or the Pinzgauer cattle in *Abbildungen der österreichischen Rindvieh-Racen*, 2, and in Baudement, *Les Races bovines*, plate xlv

34 Roger J. Wood and Vítězslav Orel, "Scientific Breeding in Central Europe during the Early Nineteenth Century: Background to Mendel's Later Work," *Journal of the History of Biology* 38, no.2 (2005): 245 – 252; Bernard Marty, 'L'Hérédité pour les zootechniciens français de la seconde moitié du XIX[e] siècle', *Bulletin d'histoire et d'épistémologie des sciences de la vie* 13, no.1 (2006): 57– 87.

35 Éric Baratay, *Le Point de vue animal : Une autre version de l'histoire*, L'Univers Historique (Paris: Seuil, 2012), 75 – 92.

36 Hugo Hitschmann, "Heerdbücher," in *Allgemeine land- und forstwirtschaftliche Zeitung, 14. Jahrgang* (Vienna: Carl Gerold's Sohn, 1864), 401 – 405; "Ein Heerdbuch für Nieder-Oesterreich," Such representations, close to the language of human nobility, helped zootechnicians frame the idea of improvement as one of 'ennoblement' (*Veredlung*).[37] Within both German- and French-speaking contexts, they also framed the selection of animals in a specific temporality spanning over several generations, and through notions of race.[38]

Finally, producing the images enabled zootechnicians to strengthen the idea of an intrinsic link between the animals and their environment. The latter could not be displayed at the exhibition, where zootechnicians photographed animals in front of a curtain.[39] But in the album, each breed was referred to by a name denoting its regional origin. The transformation of photographs into lithographs enabled editors to reintroduce the environment surrounding the animals. This operation also involved the erasure of herdsmen who held the animals for the photograph. Cattle from Alpine regions were presented against high mountains and steep pastures, while a Hungarian ox was usually staged on a plain. The details of these environments were intentionally minimal They were rather meant to be suggestive of the animals' *Heimat* (home). The outline of a typical draw well and high grass were enough to represent the Hungarian plain.

This practice led to apparent contradictions between images and explanatory notes. Although the "Bernese" cattle from Figure 1 were represented on an alpine pasture, the notes indicated that the animal came from an estate in the Hungarian plain and spent most of its time in a cowshed. This rearing practice followed the mainstream agronomic recommendations of the time, which promoted new patterns of land use favoring the replacement of pastures with fodder crops and the feeding of animals all year long in large cowsheds. Zootechnicians usually praised the development of stable feeding, but they represented it only marginally in their albums of breeds. If the representation of the Bernese bull on an Alpine pasture instead of its Hungarian cowshed could seem paradoxical at first sight, it made more sense in relation to the album's larger narrative about the possibility of settling breeds in new locations. The 1859 Viennese album presented "Swiss" cattle as originally "foreign" to the "Austrian" empire. However, the authors emphasized that several decades of imports had shown that these animals were

in *Allgemeine land- und forstwirtschaftliche Zeitung, 15. Jahrgang* (Vienna: Carl Gerold's Sohn, 1865), 97–99.

37 Joseph von Hazzi, *Ueber die Veredelung des landwirthschaftlichen Viehstandes zugleich die Grundlage des Wohles und Reichtums einer Nation* (Munich: Joseph Lindauer'sche Buchhandlung, 1824).

38 In the nineteenth century, the English concept of "breed" corresponded most of the time to the French *race* and the German *Rasse.*

39 See the photographs reproduced in Denis, *Les Vaches ont une histoire.*

able to settle in the monarchy and become fully part of its animal population. The author of the introduction to the album used the term *sich einbürgern*. This was probably not meant in the literal sense of 'becoming citizens,' but such language denotes that zootechnicians could consider the question of animal circulation in terms analogous to the circulation of human populations.

The analogical proximity between human and cattle populations was even more present in the visual language of maps. The editor of the Parisian album, Émile Baudement, commissioned five maps representing the origins of cattle breeds. Baudement used geological maps as a source of inspiration, as if the cattle had emerged from the ground of their native region. However, as he admitted in his introduction, the result was not satisfying since, unlike geological layers, cattle breeds "migrated" and "mingled" with each other.[40] In these same years, Austrian cartographers and statisticians developed a new cartographic language suited to the visualization of statistical data, particularly regarding human populations.[41] As Jason Hansen has emphasized, advances in chromolithography provided new technical possibilities that enabled them to reframe the concepts of nationalities in a territorialized way.[42] The most famous instance of this development was Karl von Czörnig's ethnographic map of Austria, which presented the distribution and overlaps of nationalities within the empire's territory (as defined by their language). Czörnig's map aimed overall to stage the Habsburg Empire as a multi-national polity capable of integrating the different peoples of Central Europe, though nationalist politicians would eventually use the same tool for the opposite purpose. Similarly, in the case of cattle in the 1870s, zootechnicians started to produce similar maps using the same techniques to visualize statistical data from animal censuses. Such maps were meant to display the "homes" of cattle breeds, as well as the regions where they had subsequently (been) more or less successfully settled.[43] From this perspective, the issue of husbandry improvement became akin to population management.[44]

* * *

40 Baudement, *Les Races bovines*, lxxiv.

41 Ingrid Kretschmer, Johannes Dörflinger, and Franz Wawrick, *Österreichische Kartographie. Von den Anfängen im 15. Jahrhundert bis zum 21. Jahrhundert*, Wiener Schriften zur Geographie und Kartographie 15 (Vienna: Institut für Geographie und Regionalforschung der Universität Wien. Kartographie und Geoinformation, 2004), 188–193.

42 Jason D. Hansen, *Mapping the Germans: Statistical science, cartography, and the visualization of the German nation, 1848–1914* (Oxford: Oxford University Press, 2015).

43 *Cultur-Atlas von Nieder-Oesterreich nach den neuesten statistischen Erhebung. Aus Anlass der Wiener Weltausstellung* (Vienna: Verlag der k.k. Landwirtschafts-Gesellschaft in Wien, 1873), The mid-nineteenth-century albums were ambiguous tools that encompassed several contrasting visions of the animals. They demonstrate that the management of cattle escaped the scope of the metaphor of the "animal-machine" in many ways. The albums suggest that zootechnicians could assign very different meanings to their work with animals. They might see themselves as working with individuals that belonged to a particular "bloodline," which carried connotations of nobility, working with generic breeds belonging to a particular environment, or also working with racialized populations of diverse animals that could acclimatize to new homes. The visual material produced by zootechnicians crystallized these multiple aspects and shaped the definition of cattle breeds, at both the levels of scientific conceptualization and material selection.

2 Evolving animals, from breed definition to cattle selection

Zootechnicians intended their albums to advance a larger scientific debate about the definition of cattle breeds that had started with the improvement projects of the 1820s. Their original aim was to bring some coherence to the rather chaotic classification of animals within the species. However, this research yielded a vision of the animals that, ambiguously, emphasized both heredity and evolution, as well as original home and migratory circulation, and only imperfectly reflected transformations that were already ongoing on the ground.

In the early nineteenth century, breeders used relatively broad geographic names to refer to breeds such as the "Swiss" or "Styrian" cattle. Moreover, the terminology related to 'breeds' or 'races' (*Raçe, Stamm, Schlag*) of cattle was very loosely defined and varied from one user to the next.[45] In exhibitions and albums, zootechnicians referred to increasingly refined types of cattle with more accurately pinpointed geographical homes. Maps played an important role in visually associating one breed with a territory on a very small scale. The "Styrian" cattle dis-

plates 20 and 21; Joseph Ritter Lorenz von Liburnau, ed., *Atlas der Urproduction Oesterreichs in 25 Blättern mit erläuternden Texte* (Vienna: R. v. Waldheim, 1878), plate xxi; Franz Zoepf, *Rinder des Oberen Donauthales in Ober- und Niederoesterreich. Zweites Heft. Niederoesterreich*, Die Oesterreichischen Rinder-Racen (Vienna: Wilhelm Frick, 1884), also included a map representing the spread of breeds with arrows.

44 Sara Wilmot, "Breeding farm animals and humans," in *Reproduction: Antiquity to the present day*, ed. Nick Hopwood, Rebecca Flemming and Lauren Kassell (Cambridge: Cambridge University Press, 2018), 405–406.

45 File No. 61, Box 39, LWG, LW, AVA, OeStA.

appeared, while the albums fixed the type of Mürztaler, Mariahofer, Murbodner, or South Styrian cows, which could be easily differentiated through their external characteristics. This standardization of the breed's look had a normative effect, particularly regarding colors. It operated at the expense of some individual animals that had formerly been considered representative of a breed. In the case of Mürztaler cows, for instance, records from rural exhibitions in the 1830s show that they displayed a wide variety of colors, ranging from white to different shades of grey. By the 1850s, the Mürztaler cattle were presented in albums as predominantly, if not uniquely, "badger" grey.[46] As the geographical names became more precise, the lists of breeds originating from the Habsburg monarchy became longer as well. The visual representation of territorialized breeds raised challenges for the zootechnicians, starting with the question of which cattle present in the empire's countryside were worthy to be categorized as a breed strictly speaking, and how the different groups of cattle should be organized in relation to each other.

As the work of zootechnicians went on, the concept of breed was more strictly defined in order to make clearer distinctions between actual cattle met on the ground and the idealized types represented in the albums. An album published in 1894 even invited "practitioners" to compare the look of their herds with its images.[47] By the end of the century, zootechnicians reserved the term *Rasse* to describe animals that transmitted their external characteristics in a constant way over generations. In contrast, they defined a different category, the mere "*Landschläge*" (local varieties), for animals that did not meet this definition. According to a survey published in the 1870s, which was one of the first surveys to count cattle on the basis of breeds, the *Landschläge* accounted for a majority of the empire's livestock (ca. 54 %).[48] Although such local animals lacked rigorously constant characteristics, some of them could be improved through crossbreeding with animals that belonged to a breed in the more narrow sense of the term. Between the *Rasse* and the *Landschlag*, zootechnicians described some animals as

---

46 See for example the reports of the countryside exhibitions of 1838 in Files No. 652, No. 653, No. 656, No. 672, Box 72, LWG, LW, AVA, OeStA in which "badger grey" Mürztaler cows account for only two thirds of the exhibited animals. The Mürztaler bull depicted by Leopold Brunner for the imperial collection of watercolors was also white and black. "*Mürzthaler Stier*," 1849, watercolor, Kunstsammlung Kaiser Ferdinand I. von Österreich (Art Collection of Emperor Ferdinand I of Austria), Österreichische Nationalbibliothek (Austrian National Library), Pk 509, SUPPL1, 18.

47 Von Blaas and Kaltenegger, *Album der Rinder-Racen der österreichischen Alpenländer.*

48 Lorenz von Liburnau, *Atlas der Urproduction Oesterreichs.* On the issue of identifying "breeds," see also Tadej Pavkovic's study on Carniola: "Razvoj pasem in pasemskega razvrščanja goveda na Kranjskem v 19. Stoletju," *Filozofski vestnik* (forthcoming).

intermediary forms or “breeds” in the making. This was, for example, the case of the “Stockerauer” cattle, which were described for the first time in the 1850s and eventually entered a photographic album of the 1873 Vienna world exhibition.[49] This group of animals, originating from Lower Austria, was described as the result of the crossing of local cows with Mürztaler bulls imported from Styria. These overlapping categories considerably blurred the distinctions between the different categories of animals. Joseph Lorenz distinguished, for instance, eighteen “fixed types to be considered as breeds” from eight *Landschläge*, to which he further added five “foreign” breeds that had “influenced” the local varieties. As the author himself admitted, the concept of breed was still relatively vague.[50] His classification and groupings of breeds were indeed different from the classifications proposed in other publications of the time, highlighting the instability of the category. Martin Wilckens, a professor at the Universität für Bodenkultur in Vienna, emphasized that the categorization was further complicated, if not falsified, by the efforts of individual breeders to have their local cattle recognized as a full breed to enhance their market value.[51]

As the Stockerauer cattle’s status of breed “in the making” emphasizes, the instability of breed classifications can also be explained by the fact that zootechnical surveys documented groups of animals that were not stationary, but in a process of evolution. In the 1870s, a complementary type of cattle depiction emerged to support theories that modern domestic cattle had descended from wild cattle. According to Wilckens, one of its proponents, this evolutionary theory was best proved by anatomical comparisons of the cattle’s skull.[52] His handbook on the natural history of domestic cattle included ten classical depictions of breeds in profile, and a more systematic presentation of cattle faces for the thirty-three varieties that he described. The images were once again created during exhibitions. Cattle faces (or skulls) emerged in the 1870s as the standard second picture to de-

49 *Notes sur l’élevage du bétail des espèces bovine, ovine et porcine de l’Empire d’Autriche. Publié par ordre du ministère autrichien de l’intérieur* (Paris: Firmin Didot frères, fils et cie., 1856); Heinrich Schnaebeli, *Album der oesterreichischen Melkviehracen ausgestellt von den betreffenden landwirthschaftlichen Gesellschaften auf dem Weltausstellungsplatze in Wien* (Berlin: H. Schnaebeli, 1873), accessed July 15, 2025, https://opendata.uni-halle.de/handle/1981185920/33587.

50 Lorenz von Liburnau, *Atlas der Urproduction Oesterreichs*, 10 and plate xxi.

51 *Martin Wilckens, Die Rinderrassen Mittel-Europas. Grundzüge einer Naturgeschichte des Hausrindes* (Vienna: Wilhelm Braumüller, 1876), accessed July 15, 2025, https://digital.onb.ac.at/OnbViewer/viewer.faces?doc=ABO_%2BZ219237703, 8–9. Lorenz’s and Wilckens’ lists of breeds could for example be compared with their colleagues’ lists in Zoepf, *Rinder Niederösterreichs* or von Blaas and Kaltenegger, *Album der Rinder-Racen der österreichischen Alpenländer.*

52 Wilckens took inspiration from the work of the Swiss paleontologist Ludwig Rütimeyer. See *Die Rinderrassen Mittel-Europas*, 6–7 and chapter 1.

scribe the breeds and make the distinctions clear by relating the image of current cattle to the skulls of one of the four (allegedly) original ancestors of the species. This method provided an additional base for discussions around the classification of cattle breeds but never solved the problem in a definitive manner.[53]

Naturalists and zootechnicians used this imagery to make visible a long-term evolution of cattle breeds that was linked to the process of domestication. Wilckens opened his book by taking issue with the theory that cattle had been "created" as domesticated animals. He used the anatomical evidence of skulls and faces to demonstrate that the process of evolution had started at a time prior to the written historical record. But Wilckens' ultimate interest was in understanding the transformations of cattle in the present to offer breeders a guide to choose the breeds they would allow to reproduce. For that matter, he also identified climate, soil and "culture" (which he also called 'artificial breeding' – *künstliche Züchtung*) as the origins of the differentiations between the main "races" of cattle.[54] If the classification of breeds was a social construction of nineteenth-century zootechnicians, the latter saw these breeds as a combined product of natural forces on the one hand, embodied in physiological laws and climatic influences, and of human interventions on the other hand. Whereas the metaphor of the machine seemed to attribute the development of cattle breeds to human ingenuity, zootechnicians admitted that they operated within possibilities limited by "natural" constraints.[55] According to Ferdinand Kaltenegger, the author of a reference survey of Alpine cattle breeds, breeds were as much the product of a "natural history" as that of a "*Culturgeschichte.*"[56] Crucially, this "cultural history" of cattle was not merely a history of human artifices. As Kaltenegger saw it, it was inseparable from histories of animal and human migrations, especially during prehistoric times and the Early Middle Ages (known in German as the *Völkerwanderung*). According to him, drawing on zootechnical measurements as well as on historical texts and archaeological remains, contemporary cattle breeds were the descendants of several encounters of moving people and animals.

In the eyes of zootechnicians, the evolution of cattle was not necessarily a long-term process; it could unfold very quickly as well. As surveyors conducted their studies, they found themselves confronted with short-term transformations of cattle breeds, often linked to recent imports of animals. In his book published in

53 Ferdinand Kaltenegger, *Die geschichtliche Entwicklung der Rinderracen in den österreichischen Alpenländern. Landesculturhistorische Skizze* (Prag: J.G. Calve'sche Buchhandlung, 1881), 2.

54 Wilckens, *Die Rinderrassen Mittel-Europas*, 14–23.

55 Baudement, *Les Races bovines*, iv–vi.

56 Kaltenegger, *Die geschichtliche Entwicklung der Rinderracen*, 28. See also page 4 on the relation between histories of human and animal migrations.

1876, Wilckens reported how recently imported cattle breeds had failed to settle in the province of Bukovina. The animals imported from the Western provinces of the empire would quickly "take bodily forms similar to the native steppe-breeds," something Wilckens attributed to climatic influences.[57] A few years later, in 1878, the Ministry of Agriculture commissioned August Günther to study husbandry in Bukovina. As part of his report, Günther produced a series of pencil drawings of the breeds in profile and face, which testifies to how such images had become a visual norm. Nevertheless, when the report was finally reviewed prior to its possible publication in 1893, members of the Bukovinian Agricultural Society judged Günther's report "totally outdated." Among other critiques, they emphasized that the "grey steppe-cattle" depicted by Günther was becoming very rare following major shifts in the local husbandry. In 1882, the Austrian government had decreed a border closure against imports of cattle from Russia and Romania. Bukovinian breeders had seized the occasion to import "foreign" breeds and cross them with the "*Landschlag.*" A sector of cattle fattening relying on more intensive techniques, such as stable feeding, had emerged, which involved other types of animals than the traditional grey cattle. According to a local veterinarian, Bukovinian husbandry found itself "in the moment when a new *Landschlag* is just taking shape."[58] This process entailed both the rise of desirable breeds like the Bernese or the Mürztaler and the progressive disappearance of the less productive *Landschläge.*

* * *

Zootechnical studies were part of a range of tools used by zootechnicians to create more accurate knowledge about the animals "indigenous" to the monarchy's territory or that could acclimatize there. The illustrated albums enabled their authors to collectively develop a classification of individual animals within groups and make local breeds visible in a literal sense. But this classification also entailed several tensions tied to the ongoing transformations of husbandry, particularly the tension between the idea of "native" and "circulating" breeds, and the tension between the search for the "heredity" and the evolution implied by the project of

---

57 Wilckens, *Die Rinderrassen Mittel-Europas*, 18.
58 B3 (drawings) and No. 11420/1521, Annexes, Landeskultur (Land improvement, LK), Ackerbauministerium (Ministry of Agriculture, AM), LW, AVA, OeStA. See also Emil Baier, "Die Rindviehzucht in der Bukowina," in *Geschichte der österreichischen Land- und Forstwirtschaft und ihrer Industrien 1848–1898. Zweiter Band* (Vienna: Commissionsverlag Moritz Perles, 1899), 661–670.

improvement.[59] Visual materials were an essential part of the studies that tried to make sense of and rationalize these ongoing and complex dynamics. They shaped an understanding of improved cattle breeds as the combined result of a physiological evolution following the laws of nature on the one hand and a process tied to human history and agricultural progress on the other hand. The classification of animals into breeds and the transformations of animals were two simultaneous processes. In that respect, zootechnicians' efforts to document cattle and to create a shared definition of breeds also enabled other actors to shape programs for agricultural development. The albums helped the zootechnicians and, more crucially, the Habsburg government to advance the project of improvement from a shared horizon of expectations to a more standardized and regular plan for action.

3 Breed promotion and the design of improvement programs

The work to produce visual material about cattle breeds opened up space for more actors to intervene in matters of husbandry than the sole breeder and his animals, and to introduce their own agendas into the realm of animal improvement. For many of their authors and editors, the purpose of the illustrated albums of breeds went beyond simply creating more accurate knowledge for its own sake.

Particularly for the Habsburg government that funded or published many of these studies, the illustrated albums were meant to facilitate the circulation of the most productive animals. The use of a technology of reproducible images, especially lithography (at the time more easily reproducible and cheaper than photography), was key to this function. Whereas the traditional naturalist paintings had a very limited reception in Vienna, reproduction technologies enabled the government and agricultural associations to promote the albums at local levels of representation across all the provinces.[60] The diplomatic services ensured the diffusion of the albums in other European states with the hope of supporting the monarchy's cattle exports, or for use in negotiating trade agreements.[61] In addition to

59 On this point, see more particularly Rebecca J. H. Woods, *The Herds shot round the world: Native breeds and the British Empire, 1800–1900* (Chapel Hill: The University of North Carolina Press, 2017).

60 For the example of the Lower Austrian Agricultural Society: File 767, Box 173, LWG, LW, AVA, OeStA. For the example of the Habsburg Governorate in Dalmatia: Files No. 8657/1724, No. 11139/2333 and No. 12148/2523, Box 6, 498 SADZ, HR-DAZD.

61 File No. 6371–581, Folder 7, Box 192, LK, AM, LW, AVA, OeStA; File No. 1228–120, Folder 7, Box 210, LK, AM, LW, AVA, OeStA.

their association with a home region, the cattle breeds acquired an “Austrian” identity, which in the context of the 1850s referred to the empire as a whole, and was supposed to enhance their value in international markets – or at least government agents hoped.[62] As the introduction to the Viennese album of 1857 emphasized, this “Austrian” identity also acquired a political dimension as it demonstrated the empire’s ability to keep pace with the other European countries in the movement towards agricultural progress.[63] The albums functioned as a catalog of breeds available for improvement, presenting the empire’s animal assets in a luxurious manner. The government subsidized the purchase of such albums by agricultural schools within the monarchy, as well as similar images printed on wall tables for use in primary schools.[64] However, as the president of the Agricultural Society of Vorarlberg Count Carl Belrupt-Tissac put it, with a touch of frustration, the ministries in Vienna seemed to consider illustrated albums of Austrian breeds and maps primarily as a “business card” of the empire aimed at neighboring states.[65] In this way, the albums served a dual purpose in supporting a governmental agenda. Politically, they aimed to present Austria as a modern empire that ruled over improved animal populations. Economically, the goal was to stimulate market demand, which would enhance the value and distribution of the most productive breeds.

Although such a marketing perspective was central to governmental communication around the albums, these catalogs were not solely intended for use by individual breeders who could afford to buy increasingly famous and expensive reproducers belonging to a “pure breed” in the narrow sense of the term. The Ministry of Agriculture and the agricultural societies used the albums and maps produced by zootechnicians to formulate larger agricultural policies on what they believed to be a “scientific” basis.[66] Breeds thus became the basic category underpinning such programs. From the 1850s, these institutions tried to ex-

62 See for example the instructions sent by the Ministry of Interior to provincial agricultural societies in preparation for the Paris exhibition in 1856: File No. 4701, Folder 1856, Box 316, Cultur (Culture) 1856–1857, Statthalterei Tirol und Vorarlberg (Lieutenancy of Tyrol and Voralberg), Tiroler Landesarchiv (Tyrolean State Archives, TLA), Innsbruck, Austria.

63 *Abbildungen österreichischer Rindvieh-Racen*, vi–x.

64 Such as the ones published by the publisher Hartinger & Sohn. File No. 5302, Folder 1867, Box 01, Collection F23 Landeskultur (Land Improvement), 1.2.1.3 Landstände und Landesausschuss (Diet and Executive Board, LSt. u. LA.), Niederösterreichisches Landesarchiv (Lower Austrian State Archives, NÖLA), Sankt Pölten, Austria.

65 File No. 2314/706, Folder 7a, Box 57, LK, AM, LW, AVA, OeStA.

66 In charge of the supervision of the husbandry policy within the ministry of Agriculture, Joseph Lorenz spoke about it as a “*wissenschaftliche Hebung*” (scientific uplift): File No. 6853/2381, Folder 7a, Box 19, LK, AM, LW, AVA, OeStA.

pand the process of husbandry improvement to make small landholdings of peasants economically viable following the agrarian reforms of 1848.[67] In the 1860s and 1870s, rural exhibitions formed the foundation of a public subsidy program aimed at helping rural municipalities purchase reproducing bulls of specific breeds. This program was supposed to settle locally improved breeds over several generations of animals through careful selection of the reproducers. This sparked intense discussions about how to choose the breeds most suitable for a given locality, especially since many of these animals had to be imported from other parts of the empire or from abroad. While the Viennese government provided the funds, the selection of subsidized bulls fell to the members of the agricultural societies, and first and foremost to their central boards. In Lower Austria, the central board of the association selected mainly Mürztaler, Allgäuer and Montafoner cattle based on their dairy abilities. They expected that peasants would either adopt the new breeds or at least improve their local cattle through crossbreeding. In 1873, facing increased difficulties in purchasing enough bulls from abroad, agricultural societies created 'nurseries' (*Pepinèren*) to ease access to selected breeds and accelerate the growth of improved cattle populations.[68]

Count Belrupt-Tissac's ironic critiques of governmental uses of the cattle "business card" highlights that the shaping of the improvement programs could not simply derive from top-down decisions of the Viennese authorities but should also consider the interests of local breeders. Through his critique, expressed in a series of reports to the Ministry of Agriculture, the Count aimed to demand more autonomy for provincial authorities regarding the use of governmental subsidies, in order to ensure that they indeed benefited the smaller landowners.[69] In practice, provincial actors also managed to use the zootechnical studies to support their own interests. After a few years of experimentation and some disappointing reports about the Mürztaler bulls, the central board of the Lower Austrian Agricultural Society announced in 1876 that it would restrict its subsidies to Montafoner and Allgäuer cattle.[70] But some local agricultural associations opposed this

67 Ferdinand Kaltenegger, "2. Die Rindviehzucht. a) In Tirol-Vorarlberg, Salzburg, Kärnten, Steiermark, Ober- und Nieder-Österreich," in *Geschichte der österreichischen Land- und Forstwirtschaft und ihrer Industrien 1848 – 1898*, vol. 2 (Vienna: Commissionsverlag Moritz Perles, 1899), 595 – 598.

68 File No. 590, Box 297, LWG, LW, AVA, OeStA.

69 File No. 2314/706, Folder 7a, Box 57, LK, AM, LW, AVA, OeStA; File No. 10523/1278, Folder 7a14, Box 124, LK, AM, LW, AVA, OeStA.

70 File No. 384, Box 297, LWG, LW, AVA, OeStA; File F13, Box 36, Rosenau 1/47 – 3: landwirtschaftlicher Bezirksverein Zwettl (Zwettl Agricultural Association), Special Holdings, Haus-, Hof- und Staatsarchiv (House, Court and State Archives, HHSA), OeStA.

choice. The Society for Agriculture and Forestry of Zwettl, in the district of Ober-Manhartsberg, sent petitions arguing that this region already possessed its own native breed, the Gföhler. The petitioners, led by notables who were at the same time key figures in the local branches of the Viennese Agricultural Society, gathered around 400 signatures from diverse groups of local actors, ranging from landowning notabilities to small peasants, butchers and cattle traders. They insisted that the unique characteristics of their animals required a specific orientation of the breeding of Gfohler as meat and work animals. As a result, they advocated for a distinct subsidy program that promoted different kinds of bulls compared to those used for dairy breeds.[71]

The ability of local breeders to publicize their animals was essential in contributing to the definition of which kind of animals should be subsidized as legitimate breeds. The Gföhler cattle was itself a product of earlier improvement efforts starting in the 1830s, when Viennese agronomists visited the first local exhibitions and found to their desperation that local cattle looked like "Pygmies" and could be mistaken for dogs.[72] In the following years, zootechnicians visiting local exhibitions reported a progressive increase in the sizes and strength of the cattle, which they attributed to changes in feeding practices and to a more cautious selection of reproducers.[73] From the 1850s, the (improved) Gföhler found its way to larger exhibitions, including the 1873 universal exhibition in Vienna and into the ensuing photographic album that featured the first depiction of the Gföhler breed.[74] Repeatedly taking the animals to the exhibitions and featuring them in the album enabled breeders to legitimize the breed in the long term. The breed's newfound fame for its distinctive qualities and look, particularly its colors that distinguished it from the grey Montafoner and Allgäuer, helped the breeders from Ober Manhartsberg to contest the improvement decisions made in Vienna. The increased visibility of the Gföhler as a proper breed also helped the breeders

71 File No. 430 to 433, Box 307, LWG, LW, AVA, OeStA.

72 Ferdinand Graf von Colloredo-Mansfeld, "Vortrag an die allgemeine Versammlung der k.k. Landwirtschafts-Gesellschaft in Wien am 17. April 1837, über die im letztvergangenen Herbste statt gefundenen Rindviehausstellungen und Preisvertheilungen," *Verhandlungen der kaiserlich-königlichen Landwirtschafts-Gesellschaft in Wien und Aufsätze vermischten ökonomischen Inhaltes. Neue Folge* 6, no.2 (1837): 73–74.

73 Ferdinand Graf von Colloredo-Mansfeld, "Bericht über die Viehausstellungen in Wien und auf dem Lande im Jahre 1841," *Verhandlungen der kaiserlich-königlichen Landwirtschafts-Gesellschaft in Wien und Aufsätze vermischten ökonomischen Inhaltes. Neue Folge* 11, no.2 (1842): 7–15; Ferdinand Graf von Colloredo-Mansfeld, 'Bericht über die Viehausstellungen in Wien und auf dem Lande im Jahre 1842," *Verhandlungen der kaiserlich-königlichen Landwirtschafts-Gesellschaft in Wien und Aufsätze vermischten ökonomischen Inhaltes. Neue Folge* 12, no.1 (1843): 8–13.

74 Schnaebeli, *Album der oesterreichischen Melkviehracen.*

from Ober Manhartsberg to have distinct animals accepted on the list of subsidized breeds in 1878. Their opinions eventually entered the large survey of Austrian cattle breeds published by the Ministry of Agriculture in 1884.[75] This example shows that the standardization of cattle breeds was not solely dictated from above: if sufficiently organized, local actors could leverage these tools to make the designers of agricultural policies endorse their own interests.

In the following years, the program of subsidies was refined following a similar trend of increasingly accurate territorialization. In 1877, the Ministry of Agriculture asked each provincial agricultural society to delineate 'breeding districts' (*Zuchtgebiete*), which associated a specific "orientation" of production (meat, milk, work, or simply pure-bred offspring for the neighboring districts) with specific breeds. These districts served as the basis for revising the distribution of subsidies.[76] This territorial segmentation was a systematization of practices which several provincial agricultural societies had engaged with before. The Lower Austrian central committee split the province into districts, depending on the existing production orientations aimed to encourage. This delimitation overlapped with the 1873 maps, which represented the statistical characteristics of cattle husbandry of Lower Austria, and provided a legible visualization of each district's orientation.[77] For each district, Lower Austrian zootechnicians provided a fixed list of breeds that were to be promoted. These breeds were all included in the albums of "Austrian" breeds and indicated on the existing maps.[78] In some cases, like in Upper Austria, the delimitation of these districts explicitly involved abandoning some local varieties in the long run to the benefit of a few select breeds.[79]

* * *

The zootechnicians' studies of cattle breeds occurred simultaneously with breed subvention programs. The visual material produced by zootechnicians was both an outgrowth of the work of improvement and a contributor to shaping its further

---

75 Zoepf, *Rinder Niederösterreichs*, 67–69 and 129–130.

76 "Erlass des Ackerbauministeriums an sämmtliche Landwirtschaftsgesellschaften, den Landesculturrath in Prag und die Statthalerei in Zadar," 1877, File No. 6594/1142, Box 332, Kultur, Statthlaterei Tirol und Vorarlberg, TLA.

77 See the map and explanations published in *Niederösterreichisches Heerdbuch für Rinder. Verzeichniss von Individuen und Stämmen edler Thiere* (Vienna: Selbstverlag der k.k. Landwirtschafts-Gesellschaft, 1873).

78 File No. 14058/2595, Box 01 (1868–1880), Collection F48 Veterinärwesen und Viehseuchen (Veterinary Service and Livestock Diseases), 1.2.1.3, LSt. u. LA, NÖLA.

79 See the proposal by Franz Zoepf in File No. 2768/292, Folder 7a10, Box 210, LK, AM, LW, AVA, OeStA which entailed a map that probably served as a basis for the one he published (with some modifications) in 1881 as part of the general survey sponsored by the ministry.

developments, especially by opening or closing possibilities regarding which breeds should reproduce or not. This last point draws our attention to another aspect of the work of zootechnicians: their work of improvement was a selection process that mainly took place during the reproduction stage of animals. More than a work of engineering *on* the body of individual animals, the work of zootechnics involved working *with* animal populations, which they tried to settle in given districts and favored or excluded from reproduction processes.

Conclusion

Cattle illustrations worked as multi-faceted environing technologies and played a crucial yet complex role in shaping the outcome of husbandry improvement projects. On a basic level, visual materials played an important role in creating knowledge about cattle and classifying the animals into breeds. This new classification primarily rested on the external characteristics of animals, which were supposed to stand for both their productive capacities and their ability to transmit these capacities to future generations. Alongside the emphasis on heredity, however, the surveys of different cattle breeds brought to the fore complex dynamics in their evolution. The conceptual definition of breeds did not take place prior to the implementation of improvement programs. Rather, the conceptual definition and the material selection of breeds were two simultaneous processes. Zootechnicians did not document "natural" or static breeds, but ongoing processes of transformations tied to human developments, and especially to processes of circulation. In that sense, the work of zootechnicians did not align with the modern "naturalist" distinction between nature and society.[80] Their practices, as documented by visual sources, encompassed more hybrid approaches to conceptualizing and dealing with cattle. Moreover, the visual material produced by zootechnicians embedded the process of breed selection within the geographies of the Habsburg Empire. This contributed to several dynamics taking place at different scales: a refinement of the definition of breeds towards more local geographical scales, mobilities of animals shaped by administrative boundaries and government policies, and a particular understanding of cattle as members of the empire in the form of "Austrian" breeds to be managed as a population. Finally, the uses of imagery technologies in the context of nineteenth-century Austria broadened the set of relationships that shaped the process of improvement. Beyond the breeder and

80 To borrow Philippe Descola's characterization of modern Europe in *Par-delà nature et culture* (Paris: Gallimard, 2005).

the animal, breeding experts and governmental agents seized the opportunity to intervene in the transformation of husbandry practices. This process of improvement did not affect all the animals in an equal way. It entailed the encouragement of productive “breeds” and the extinction of mere “*Landschläge.*”

An approach to cattle selection that focuses on the entangled practices of several actors highlights that the work of nineteenth-century zootechnicians was largely experimental and ambiguous. Expanding on this perspective sheds light on less straightforward narratives about the entanglements between technology, environments and development than the usual history of European agricultural modernization often suggests. Whereas the idealist narrative of the animal-machine implied that husbandry improvement was a straightforward application of Cartesian mechanism, the classification of cattle into breeds was never a fully coherent system. Nevertheless, this did not prevent zootechnicians and agricultural improvers more generally from proceeding with their selection. Furthermore, “improvement” was far from the result of a simple application of a technicist ideology. The case analyzed here suggests that imagery technologies helped to rationalize a largely empirical process that was already underway and to expand it on a larger scale. These technologies contributed to intertwining the practice of husbandry with broader economic and political networks, making the work of “improvement” a hybrid phenomenon of growing complexity. While animal reproduction, which remained the key moment in the breed selection process, still seemed very “low-tech” until the mid-twentieth century, this did not prevent some breeds from declining or emerging already in the mid-nineteenth century. Later technological developments in the twentieth century, like artificial insemination, might have reinforced some of these dynamics.[81] The tighter control over reproduction enabled by such technologies could even reverse the evolutionary trajectory of some groups of animals. Many thriving Austrian breeds from the nineteenth century are today considered “rare” or “endangered” and are subjected to conservation programs.[82] While technologies of knowledge and reproduction have an important influence on the fate of domesticated animals, their role did not play out with the same significance in the nineteenth and twentieth centuries, and the ambitions of “improvement” programs, and especially their shifting socioeconomic rationales, appear as equally strong factors in this evolution.

81 Wilmot, “Breeding farm animals and humans,” 409 – 412 ; Cornu, “Génétique animale et modernisation de l’élevage dans la France de l’après-guerre.”

82 Martin Haller, *Alte Haus- und Nutztierrassen neu entdeckt* (Graz / Stuttgart: Leopold Stocker Verlag, 2015).

Amalia Ribi Forclaz

Seeds and the technopolitics of environmental reconfiguration in wartime relief operations in Italy, 1945 – 1947

List of Abbreviations

ECA	Economic Cooperation Administration
USDA	United States Department of Agriculture
UNRRA	United Nations Relief and Rehabilitation Administration

In August 1945, during a meeting in London, Herbert Lehman, Director General of the United Nations Relief and Rehabilitation Administration (hereafter UNRRA), emphasized the significance of seed transfers within the agency's agricultural rehabilitation program:

> Seed is the most compact form of potential food value. The yield of grains runs around twelve times that of its seed. For peas and beans, the ratio is less, but for most vegetable seeds it is much greater. One-fourth of a pound of cabbage seed will plant an acre of land to produce some 15,000 to 20,000 pounds of cabbage. Seeds offered to starving peoples in Europe and China by the uninvaded countries are producing and will continue to produce the food that will eventually conquer hunger as the armies of the United Nations have conquered the foe.[1]

Lehman highlighted the critical role of seeds in addressing global food insecurity and presented them as a symbol of hope and recovery. His assessment reflects a pervasive opinion among international officials concerned with development issues in the mid-1940s: a belief in the power of seeds as a form of agricultural technology to steer agricultural development and food production in countries badly affected by the Second World War. As this volume posits, development practices and narratives have been shaped throughout history and across different contexts by the notion that humans possess the ability to create and utilize technology to manage, enhance, or safeguard the natural environment.[2] Agriculture, i.e. the

1 Standing Technical Committee on Agriculture, "Seeds for the Liberated Countries: Background Information on UNRRA's Agricultural Rehabilitation Program," 24 August 1945, United Nations Archives, New York (hereafter UNA), S-1208 – 0000 – 0003, 5.

2 See introduction to this volume.

https://doi.org/10.1515/9783111611358-014

process of imposing order on plants and manipulating the behaviors and characteristics of organisms for human benefit, has historically been and continues to be a central focus of development initiatives. Farmers have always lived in a close – though not necessarily harmonious relationship with the environment, being both dependent on it and actively shaping soil quality, local flora and fauna, crop species, and seed varieties.[3] This chapter examines UNRRA's relief operations and its importation of new agricultural resources in postwar Europe from 1943 to 1947 and how it affected the relationship between agriculture, technology and development. In line with broader historical studies on technological reforms, agrarian change, and environmental developments, the chapter explores how these efforts aimed to rehabilitate and improve farming and how they were received by farmers.[4]

Historian Courtney Fullilove has persuasively argued that seeds are "powerful signifiers because they compress future potential and deep past into objects both minuscule and abundant."[5] Given their role in large-scale biological processes accompanying cultivation, migration, and colonial expansion, seeds often come with metaphors of invasion, war, and conquest (as is the case in Lehman's quote, where he refers to conquering hunger), and they are potent markers of technological, environmental, and capitalist expansion.[6] In recent years, historians have questioned the implied biological determinism of such language and produced more fine-grained analyses of how crop transfers in the twentieth century were embedded in political, scientific, and economic processes that were purposefully planned and intended to change landscapes and that would ultimately affect the local nat-

---

3 Courtney Fullilove, *The Profit of the Earth: The Global Seeds of American Agriculture* (Chicago: The University of Chicago Press, 2017), 5.

4 Mikael D. Wolfe, *Watering the Revolution: An Environmental and Technological History of Agrarian Reform in Mexico* (Durham, NC: Duke University Press, 2017); Gabriela Soto Laveaga, *Jungle Laboratories: Mexican Peasants, National Projects, and the Making of the Pill* (Durham, NC: Duke University Press, 2009); Stuart McCook, *States of Nature: Science, Agriculture, and Environment in the Spanish Caribbean, 1760–1940* (Austin: University of Texas Press, 2002); Tore Olsson, *Agrarian Crossings: Reformers and the Remaking of the US and Mexican Countryside* (Princeton, NJ: Princeton University Press, 2017).

5 Fullilove, *Profit of the Earth*, 219.

6 Nick Cullather, "Miracles of Modernization: The Green Revolution and the Apotheosis of Technology," *Diplomatic History* 28, no.2 (2004): 227–254; Deborah Fitzgerald, *The Business of Breeding: Hybrid Corn in Illinois, 1890–1940* (Ithaca: Cornell University Press 1990); Jack Ralph Kloppenburg, *First the Seed: The Political Economy of Plant Biotechnology, 1492–2000*, 2nd ed. (Madison: University of Wisconsin Press, 2004).

ural environment.[7] As Deborah Fitzgerald has pointed out, understanding the relationship between technology and agricultural change is not only about technology as a set of objects and agricultural resources (tractors, milking machines, hybrid seeds, etc.); it is also about the institutions, individuals, ideas and practices behind the objects.[8] This raises questions not only about the power dynamics between experts and farmers who adopted the technology, but also about the complex relationships between humans, technology, and the environment, whose natural characteristics were crucial to the technology's success.[9]

I will argue in this chapter that UNRRA's seed program, which was part of a larger agricultural rehabilitation program, offers a multi-faceted lens through which to examine how historical actors in a specific moment of upheaval and change set out to manage nature: the program was a key moment in the history and evolution of agricultural development. UNRRA's agricultural rehabilitation program was planned by international experts, dominated by American thinking and experience, and it promoted the use of imported technology and mechanization in farming both in Europe and the Far East. The UNRRA case study highlights not only the expectations of experts about shaping and improving local agricultural systems in both economic and cultural terms, but also the existing obstacles and limits faced by these experts with regard to agricultural transformation and environmental modifications.[10] It also shows that awareness of the environment and of the fragility of the ecosystems within which this technological development was occurring – an awareness that would begin to emerge internationally in the 1960s and early 1970s – was absent from humanitarian considerations in the 1940s.[11]

7 The last two decades have seen several fascinating historical studies that zoom in on specific crops and commodities, such as sugar, rice, soy, or cotton against a backdrop of colonial and global governance, capitalist consumption patterns, and agricultural knowledge transfer. See for instance Francesca Bray et al., eds., *Rice: Global Networks and New Histories* (Cambridge: Cambrige University Press, 2017).

8 Deborah Fitzgerald et al., "Roundtable: Agricultural History and the History of Science," *Agricultural History* 92, no.4 (2018): 569–604.

9 Debashish Sen, Harro Maat, Dominic Glover, and C. Shambu Prasad, "Techno-Political Mythologies and Socio-Technical Flexibility: The Introduction of SRI in Uttarakhand, India," *Anthropologie et développement*, no.46–47 (2018): 100–126; Dominic Glover, Jean-Philippe Venot, and Harro Maat, "On the Movement of Agricultural Technologies: Packaging, Unpacking and Situated Reconfiguration," in *Agronomy for Development: The Politics of Knowledge in Agricultural Research*, ed. James Sumberg (London: Routledge, 2017), 14–30.

10 Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, eds., *New Natures: Joining Environmental History with Science and Technology Studies* (Pittsburgh: University of Pittsburgh Press, 2013).

11 See the opening of the introduction in this volume.

The chapter's main focus is on the planning and logistics of UNRRA's seed transfer mission in Italy. It examines the bureaucratic framework of the organization's planning efforts and, in particular, the data analysis and development of intervention programs. It focuses on a few key UNRRA figures, their ideas of agricultural progress, and their role in delivering seeds to Italy. Thus, through the eyes of seed expert Ely Pattison, the chapter highlights the environmental contingencies of UNRRA's seed operations, especially the attempts of relief workers to anticipate issues of transferability (ensuring the effective adaptation of transported seeds to local contexts), seed germination (ensuring that the seed provided in relief programs would sprout and grow successfully under local environmental conditions), and purity (guaranteeing the genetic and physical characteristics of seeds to avoid the introduction of diseases). In the final part, the chapter also looks at the power dynamics between UNRRA and local actors by examining the reception of the seeds and by tracing how local protagonists, agencies, and farmers accepted – and sometimes exploited – the arrival of seeds through the black-market. The chapter shows that the transformation of agriculture, and, through the latter, of the environment, was a multi-layered and complex process in which both humans and nature proved unpredictable.

Part I UNRRA's Agricultural Rehabilitation Program

Much has been written in recent years about European reconstruction after the Second World War and about the role of UNRRA, especially with regard to food and medical aid and the help offered to refugees and displaced persons. Despite its brief existence between late 1943 and 1947, historians have highlighted the organization's importance as an early experiment in international planning. They have shown how UNRRA established new frameworks and models for surveying and assessing local needs and for providing relief to European countries marked by destruction, food shortages, threats of epidemics, and streams of refugees.[12]

12 Ben Shephard, *The Long Road Home: The Aftermath of the Second World War* (New York: Alfred A. Knopf, 2011). See also Ben Shephard, "Becoming Planning Minded: The Theory and Practice of Relief, 1940–1945," *Journal of Contemporary History* 43 (2008): 405–419. On wartime planning, see Elisabeth Borgwardt, *A New Deal for the World: America's Vision for Human Rights* (Cambridge, Mass.: Harvard University Press, 2005). On UNRRA, see Jessica Reinisch, "Internationalism in Relief: The Birth (and Death) of UNRRA," *Past and Present* 210, suppl. 6 (2011): 258–289; Silvia Salvatici, "'Help the People to Help Themselves': UNRRA Relief Workers and European Displaced Persons," *Journal of Refugee Studies* 25 (2012): 452–473; Laure Humbert, "French Politics

Scholarly attention has focused on UNRRA's supply of food and health provisions, the repatriation of displaced persons, and the agency's efforts to ward off epidemics. But whereas food has been at the center of many historical accounts, no study so far has investigated the goals, organization and implementation of UNRRA's agricultural rehabilitation program, including the organization's role in supplying agricultural goods such as seeds, fertilizers, tractors, and pesticides, and its dispatch of technical expertise to various country missions.[13]

There is limited space here to detail the institutional history of UNRRA, which has already been extensively covered by observers of the time and more recent historians. The following paragraphs will succinctly sketch the birth of UNRRA and its agricultural rehabilitation division. As is well known, UNRRA was set up to manage the transition from war to peace. Ideas had started to circulate across diplomatic channels from the 1940s onwards about how to restore food production in countries damaged by war once they were liberated from German occupation. By 1943, based on various proposals by British, American and Soviet officials for an international organization that would carry out relief work and after extended diplomatic negotiations, a final plan was laid out for the creation of a centralized relief agency with a council of representatives of each member government and an executive, regional, and technical committee.[14] While UNRRA was conceived as a collective enterprise of the Allies, it very much identified as an American organization and most of its high-level staff were American nationals. The agency began work on 1 January 1944. From August 1944 onwards, the governments of the occupied countries submitted through the UNRRA office in London their respective requirements programs, known as the 2 A programs and largely based on the Inter-Allied Committees Report. These programs were used as a basis for planning operations. In Europe, these operations were scheduled to last only three years (until the end of 1946), but because of delayed shipments, they carried on into mid-1947.

---

of Relief and International Aid: France, UNRRA, and the Rescue of European Displaced Persons in Postwar Germany, 1945–47," *Journal of Contemporary History* 51, no.3 (2016): 606–663; Andrew John Williams, "Reconstruction Before the Marshall Plan," *Review of International Studies* 31 (2005): 541–558.

13 For an exception, see Amanda McVety's work on UNRRA's Rinderpest campaign, McVety, *The Rinderpest Campaigns: A Virus, its Vaccines and Global Development in the Twentieth Century* (New York: Cambridge University Press, 2018), chapter 3.

14 Grace Fox, "The Origins of UNRRA," *Political Science Quarterly* 65, no.4 (December 1950): 561–584. See also George Woodbridge, *UNRRA. The History of the United Nations Relief and Rehabilitation Administration*, vol. 1 (New York: Columbia University Press, 1950), 3–20.

UNRRA was a multifaceted organization whose various divisions focused on a range of operational activities, from the supply of essential goods to caring for and resettling refugees, organizing vaccination and disease control programs, providing welfare services to vulnerable groups such as orphans and widows, rebuilding industries and local infrastructure, and, last but not least, restoring agricultural production. UNRRA's agricultural rehabilitation division, based in Washington, was established early in 1944 as part of UNRRA's Bureau of Supply. The Division was headed by Edwin R. Henson, an agricultural economist and former official of the United States Department of Agriculture (hereafter USDA), a leading hub of agricultural research. The function of Henson's division was generally to assess what supplies were required by analyzing reports and data, to negotiate and organize their purchase and delivery with national procurement agencies, and to coordinate with other UNRRA divisions.[15]

In its first year, the Division focused primarily on gathering economic and statistical data on agricultural production in Eastern and Southern European countries, including Czechoslovakia, Greece, Poland, Yugoslavia, Albania, and Austria (Italy would only be considered later and become a recipient of UNRRA aid in the summer of 1945). Its experts also assessed war-related damage to farm machinery, livestock, fisheries, and supplies of seed, fertilizers, and pesticides through surveys that were published as so-called monographs.[16] These studies painted a bleak picture of agriculture in Europe's war-ravaged countries. As reports outlined, farm machinery had been commandeered for military purposes, while animals had been either slaughtered or stolen, resulting in a severe loss of draft power and limiting the ability to plough and cultivate fields. Fertilizers were scarce, and seed availability had waned because of the disruption in the international seed trade, and gaps in cultivation.

UNRRA's agricultural surveys not only highlighted the devastation of the agricultural sector caused by the war but also established the authority of (mostly American) agricultural development experts and laid the groundwork for intervention. Since the 1920s, the United States had undergone a process of agricultural industrialization and rationalization, galvanized by the rise and application of economic and scientific expertise and resulting in a shift from traditional to

15 Gerard Mahler, "UNRRA's Agricultural Rehabilitation Activities," UNA, S-1021–008–006, 57.
16 For an account of this preparation work, see Standing Technical Committee on Agriculture, "Report on Status of the Agricultural Rehabilitation Program of UNRRA as of June 1945: Origins and Development of Plans of Agricultural Rehabilitation', 1, UNA, S-1208–0000–0027. See also P.L. Slagsvold, "Considerations in the Analysis of Agricultural Data and Program Development for Liberated Areas," 2, UNA S-1208–0000–0001. Reports on these various resources exist in the form of a series of unpublished monographs in the UNRRA archives.

large-scale, mechanized farms.[17] The growing influence of US scientific and technological expertise was strongly reflected in the production of economic knowledge on agricultural resources within UNRRA. Significantly, whilst entirely focused on economic and developmentalist aspects of agricultural production, these surveys did not take into account consumption patterns, food preferences, or cultural traditions.

UNRRA's agricultural rehabilitation division was officially set up to offer temporary relief and re-establish pre-war agricultural production rather than long-term inputs that would overhaul the agricultural sector of the countries visited. In the words of UNRRA officer P.L. Slagsvold, who oversaw the analysis of production needs, "it should be understood clearly that UNRRA is not writing agricultural production programs for any country, because this, obviously, must be the responsibility of the respective countries themselves."[18] On the other hand, it was quite clear to other UNRRA agricultural experts that some of the material supplied by the organization, especially farm equipment and agricultural technologies, had not previously been extensively used and could potentially serve as an initial step toward a complete restructuring of the pre-war industrial-agricultural balance in the receiving country. While UNRRA officials argued that restoring food production for human consumption was the primary goal, they also acknowledged the possibility that UNRRA might recommend "shifts in the acreage of crops to be produced" and the establishment of production goals, especially with regard to high-protein crops and livestock production to meet existing dietary deficiencies.[19]

This aspect of agricultural aid was fully embraced by the agency. Implicit in UNRRA's agricultural rehabilitation program was a developmentalist stance: one of the objectives was "to help countries take advantage of techniques that have been developed during the war in countries not occupied by the enemy." This also involved providing "recognized" expertise from the United States, which at the time was the uncontested leader in the mechanization and intensification in agriculture, the expanded use of agrochemicals such as synthetic fertilizers

---

17 On the US and its leading position in agriculture in the interwar years, see Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (New Haven, CT: Yale University Press, 2003). On the rise of US expertise during the Cold War, see Andra B. Chastain and Timothy W. Lorek, *Itineraries of Expertise: Science, Technology, and the Environment in Latin America's Long Cold War* (Pittsburgh: University of Pittsburgh Press, 2020).

18 Slagsvold, "Considerations," 2.

19 Slagsvold, "Considerations," 5–6.

and herbicides, and plant breeding techniques.[20] This resulted in a sense of superiority amongst American experts. Since the interwar years, the general feeling amongst those that had visited Eastern and Southern European countries was that local agriculture was "primitive," relying on manual labor, plagued by fractioned land ownership, and based on antiquated methods of cultivation.[21] The use of new technologies was seen as a way to accelerate change and to shape and restructure agrarian environments in order to respond efficiently to increased food needs. Seeds were a central technological artefact in this process, and seed distribution became one of the pillars of UNRRA's agricultural program. As we have seen in the initial quote, seeds, due to their small size, were ascribed huge potential for the circulation and multiplication of foodstuffs. However, as it turned out, this view was rather simplistic and failed to consider some of the concrete challenges and local dynamics.

UNRRA's Seed Program

From the very beginning, one of the top priorities of UNRRA's agricultural rehabilitation program was the supply of seeds, alongside the provision of tractors, draught animals, and fertilizers.[22] Starting in 1943, UNRRA gathered seed estimates to prepare surveys and projections for postwar food supplies.[23] According to UNRRA experts, before the war, Europe not only met its own seed needs but also produced an exportable seed surplus. This was true for cabbage, cauliflower, broccoli, red clover, and many other seeds. However, the devastation caused by the war had changed the situation, and estimates showed that many European countries were short of edible legumes, especially beans and peas, as well as

20 See report of the Director General of UNRRA as quoted in Mahler, "UNRRA's Agricultural Rehabilitation Activities," 69.

21 Amalia Ribi Forclaz, "Agriculture, American Expertise, and the Quest for Global Data: Leon Estabrook and the First World Agricultural Census of 1930," *Journal of Global History* 11, no.1 (2016), 44–65.

22 For a summary of seed shipments, see Standing Technical Committee on Agriculture, "Seeds for the Liberated Countries," 24 August 1945, UNA, S-1208–0000–0003. See also Standing Technical Sub-Committee on Agriculture, "Priorities of Agricultural Requirements," UNA, S-1208–0000–0005.

23 Shortly after UNRRA was formed in 1943, these estimates were turned over to an expert committee, the Standing Technical Committee of Agriculture. The experts of the Committee, representing both the invaded and supplying countries, used them as their starting point for planning rehabilitation through the importation and management of seed supply.

wheat and other cereal and grass seeds.[24] The stated objective of UNRRA's seed program was "to reestablish a flow of seeds within Europe" from "surplus pockets to areas of need."[25]

To this end, in Autumn 1944, as part of its European Regional Office in London, UNRRA created the so-called seed unit, which focused on the procurement and shipment of seeds.[26] In contrast with other units such as those dedicated to tractors or to fertilizers, it was headed by a woman: Ethel Ely Pattison.[27] Pattison was an auto-didact, longtime seed analyst for the USDA, and the founder and director of an international seed business, the International Seed Incorporated (a post she relinquished to take up full time work at UNRRA). She also ran a farm in Connecticut. Qualified by others as a "damn capable woman," she threw herself wholeheartedly into her new job and remained as a full-time seed consultant until November 1946.[28] "From the mythical beginnings of mankind to the present day," she professed, "[seed] has been the first and most important single item in the history of man's struggle for the betterment of the species and it has played this same role in UNRRA's work."[29] Seeds were an "Act of God," their beginnings described in Genesis, yet despite their almost sacred, life-giving nature, in order to be successfully planted, they needed human intervention and careful planning.[30]

As Pattison knew all too well, given her background as a government official, expert, and international businesswoman, beyond its biblical and mythical dimensions and its endless potential for multiplication, seed also came with a range of problems. First and foremost, re-establishing the seed trade meant not only sourcing appropriate seed supplies but also re-establishing transportation, seed cleaning plants, and fuel and storage facilities, all of which were lacking in the countries that had experienced war.[31] Seasonal aspects also came into

24 Standing Technical Committee on Agriculture, "Seeds for the Liberated Countries," 2.

25 Standing Technical Committee on Agriculture "Seeds for the Liberated Countries," 2.

26 The UNRRA Seed unit worked closely with both the Fertilizer and Machinery units (the latter procured seed-cleaning equipment to nine countries). Moreover, the Seed unit always took part in the meetings of the Combined Food Board and the Emergency Economic Council for Europe, and entertained contact with the Research Centers at the University of Cambridge, the USDA, and the Canadian Department of Agriculture, as well as with other organizations such as the Seed Import Board of the United Kingdom and the British and American Seed Trade Associations.

27 Ethel Ely Pattison, "Report on Seeds for the Agricultural Rehabilitation Division," 30 June 1947, UNA, S-1021–0010–12.

28 Letter Calkins to Ed Henson with letter from Gaumnitz, 22 March 1945, UNA, S-1208–0000–0237

29 Pattison, "Report on Seeds," 1.

30 Pattison, "Report on Seeds," 1.

31 Standing Technical Committee- Agriculture "Seeds for the Liberated Countries."

play: planting and harvesting seasons needed to be respected, creating logistical headaches and the high risk of delays in the aid process. All agricultural goods supplied by UNRRA, including tractors, pesticides, and draught animals, were subject to seasonal requirements, and reports show that it was not always possible to respect them: in some instances, for example, tractors arrived too late to secure the 1946 planting season. Seeds, however, were by far the most time-sensitive supply. As Pattison noted, in stark contrast to Lehman's optimistic views, seed was a "non-cumulative commodity," which meant that its value could be realized only within a specific time frame, aligned with the particular requirements of each crop and with the local planting seasons, which varied from Greece to Norway.[32]

Moreover, the quality of seeds was far from guaranteed and needed to be carefully assessed. There were lengthy discussions within UNRRA's seed unit about the seeds' germination potential and purity – both essential requirements for the disease-free and successful growth of plants in the receiving regions.[33] Despite their small size and ease of transport (compared to other UNRRA supplies such as tractors or living animals), seeds came with their own problems of transportation, due to their variable perishability and the need for proper packaging and storage to avoid spoilage, mold growth, pest infestations, or mechanical damage.[34] Seeds also posed a major challenge in terms of adaptability, and Pattison had to take into account the growing conditions in their new environments and find ways to control some of the natural variables such as temperature, length of day, or rainfall. When procuring seeds, she also tried, where possible, to consider the local geological and climatic features, making sure that they corresponded to the seeds' original climate and soil. Finally, the transfer of seeds from one country to another also required advanced technical knowledge and seeds supplied by UNRRA had to be analyzed by agricultural experts on arrival, which not only demanded highly skilled staff but also could potentially delay their use.[35]

32 "Bases for Distribution of Agricultural Commodities among Countries," 21 July 1945, UNA, S-1208 – 0000 – 0002, 8.

33 Minutes of the meeting between the Italian government and UNRRA on procurement of seed wheat, August 1946, UNA, S-1465 – 0000 – 0098.

34 On the problems of seed transportation, see also Glover, Venot, and Maat, "Movement of Agricultural Technologies."

35 For a general discussion on seeds and the required knowledge about their features and ecological context, see Annalisa Managlia, Umberto Mossetti, and Ariane Dröscher, "Seeds of Knowledge: Unveiling Hidden Information Through Letters and Gardens in Bologna, Turin and Uppsala," *HoST, Journal for History of Science and Technology* 5 (Spring 2012): 17– 29.

What is more, the success of such transfers also depended on the knowledge of cultivation methods, preparation techniques, and consumption practices.[36] Last but not least, seed came with what Pattison called "a high psychological factor," by which she meant that farmers were often reluctant to adopt new seed varieties and had to be convinced either by demonstration of higher yields or by financial incentives and rewards.[37]

As soon became clear, UNRRA would face all the hurdles that Pattison had anticipated. In the spring of 1945, after Hitler's defeat in May, the UNRRA's seed unit shifted from preparation to active operations: Every four to five days, shipments began departing from American and Canadian ports (including Baltimore, Montreal, New Brunswick, Houston, and New York). Their volume varied greatly depending on the availability and importance of specific varieties: for example, 70,000 bags of rye seeds were shipped on board the *Constanza* from Baltimore to Czechoslovakia on 2 July, but only 934 bags of alfalfa left from Montreal to Yugoslavia. By the end of September 1945, an estimated total of 38,000 metric tons of seeds had been shipped to Greece, Yugoslavia, Albania, Poland, and Czechoslovakia, the recipients of full-scale UNRRA aid.[38] In selecting seeds, UNRRA's seed experts focused mainly on human consumption and priority was given to vegetable seeds and cereals. In a second stage, shipments would also include seeds for forage crops that would help the receiving countries restore their livestock count, a goal that was considered urgent by UNRRA.[39]

One of the main challenges for UNRRA's seed unit in this initial phase was the so-called procurement of seeds – in other words, the process of sourcing and acquiring seeds from suppliers located around the world to match demands and needs in the receiving countries in Europe.[40] Seeds were purchased from countries with an exportable surplus; the main supplier was the USA, together with Canada and the United Kingdom.[41] In addition to the Allied Powers, the seed unit also explored imperial sources of procurement, collecting information on possible surpluses in New Zealand, South Africa, Malta, Cyprus, and Tanganyika.

36 Marie-Noëlle Bourguet, "Measurable Difference: Botany, Climate and the Gardener's Thermometer in Eighteenth-Century France," in *Colonial Botany: Science, Commerce, and Politics in the Early Modern World,* ed. Londa Schiebinger and Claudia Swan (Philadelphia: University of Pennsylvania Press, 2005), 270–286.

37 Pattison, "Report on Seeds."

38 Standing Technical Committee on Agriculture, "Seeds for the Liberated Countries," 1–2.

39 Standing Technical Committee on Agriculture, "Seeds for the Liberated Countries," 3.

40 L. K. Macy and Alton M. Porter, Informal Notes taken at the Conference on the European Seed Situation, 25 April 1945, UNA, S-1209–0000–0253.

41 D.R. Sabin "General Outlook of the Agricultural Supply Situation: Seeds," 5 January 1945, UNA, S-1208–0000–0004, 1.

Seeds were selected based on both their variety and adaptability. Growing conditions such as temperature, length of day, rainfall, etc., were compared and matched between exporting and receiving country. For example, UNRRA seed experts decided that cereal seed for Czechoslovakia should be selected from areas in the USA and Canada, where growing conditions were similar to those in Eastern European countries. “Similarity of conditions,” the Committee stated, “plays an important part in obtaining the goal of highest productivity of the seed.”[42] Throughout the process of selection, the USDA and its experts played a key role, and their approval was crucial.[43]

Managing the supply chain globally during an ongoing conflict and keeping track of the complex agricultural calendar was a complicated operation, as internal notes reveal. Reflecting on the supply of winter barley for the year 1945/1946, UNRRA officials noted:

> Barley should be planted from November [1945] on for fall [1946] planting in Greece and Albania. They will need 10,000 metric tons of Barley seeds of the California type. It will be hard to get till after harvest and it was suggested that the contracts be ready so it could be shipped right out of the field. Liberia (North Africa) might have some seed barley but it is somewhat doubtful. A cable of enquiry will be sent to North Africa.[44]

A host of further challenges contributed to the complexity of the operations, including price negotiations, transport problems, unpredictable weather conditions, bureaucratic formalities (such as getting official approval for sailing and liaising with port authorities), and the labelling and storage of the shipped seeds.[45]

As shown by the statistics compiled by the seed unit, by June 1947, UNRRA had shipped a total of almost 300,000 metric tons of seeds, of which a small amount (4,500 tons) went to China, the bulk of it to Austria (89,000 tons), Poland (83,000 tons), Greece (42,000 tons), Italy (27,000 tons), Ukraine, and Yugoslavia (both around 15,000 tons), and smaller amounts to Albania and Byelorussia.[46] In the following paragraph, I will focus on UNRRA seed shipments to Italy.

---

42 Standing Technical Committee on Agriculture, “Seeds for the Liberated Countries,” 4.
43 Letter Edwin Henson (Chief of Agricultural Rehabilitation) to R. Herbert (Acting Deputy Director General of the Department of Supply, UNRRA London, 16 May 1945, UNA, S-1209 – 0000.
44 Macy and Alton M. Porter, Informal Notes, 2.
45 S. Frohlich and E.O’Mahony, diary notes, 6 December 1945 to 31 December 1945, UNA, S-1209 – 0000 – 0253.
46 Pattison, “Report on Seeds,” 1.

The Case of Italy

UNRRA's intervention faced an especially thorny situation in Italy, and UNRRA assistance became just one of several complex factors in Italy's postwar relationship with the United States and American-led aid initiatives.[47] The Allies had begun planning for postwar aid to Italy as early as 1943. In July 1944, an UNRRA observer mission identified an urgent need for imported food supplies, particularly for children and nursing mothers, along with medical provisions.[48] Additionally, support was needed for the resettlement and housing of internally displaced individuals. The political situation, however, was complex and the country was still divided: Allied armies held the South and the islands, while the German military and Mussolini ruled the North.[49] Because of Italy's role in the Axis and the political divisions, helping Italy was a controversial choice: in line with public opinion, some members of the UNRRA Council were initially against providing aid to a former enemy.[50] Following the swift political and military changes of early 1945 – marked by Mussolini's death in April and Germany's surrender in May – sentiments toward Italy became more favorable. At the Potsdam Conference in July and August 1945, Italy officially aligned with the Allies in their ongoing war effort against Japan.

In the summer of 1945, UNRRA resolved to treat Italy as it would any other liberated nation. Swift intervention was also prompted by the fear of a potential communist expansion in the country, fueled by economic hardship, social unrest,

---

47 On UNRRA's Italian mission, see Silvia Salvatici,"'Not Enough Food to Feed the People': L'Unrra in Italia (1944–1945)," *Contemporanea* 14, no.1 (2011): 83–99; Luigi Rossi, "L'UNRRA strumento di politica estera agli albori del bipolarismo," in *L'amministrazione per gli Aiuti Internazionali: La ricostruzione dell'Italia tra dinamiche internazionali e attività assistenziali*, ed. Andrea Ciampani (Milan: Franco Angeli, 2002), 47–82; Federico Romero, "Gli Stati Uniti in Italia: il Piano Marshall e il Patto Atlantico," *Storia dell'Italia repubblicana: La costruzione della democrazia. Dalla caduta del fascismo agli anni cinquanta*, ed. Federico Barbagallo, (Turin: Einaudi, 1994), 231–289; Victoria Belco, *War, Massacre and Recovery in Central Italy, 1943–1948* (Toronto: University of Toronto Press, 2010).

48 On the observer mission see Salvatici,""Not Enough Food to Feed the People," 83–99. More generally on UNRRA and American-Italian relations, see John Lamberton Harper, *America and the Reconstruction of Italy, 1945–1948* (Cambridge: Cambridge University Press, 1986); Rossi, "UNRRA."

49 Woodbridge, *History of UNRRA*, vol. 2, 257

50 Woodbridge, *History of UNRRA*, vol. 2, 259.

and political instability.[51] The worsening of already precarious conditions in rural areas further drove the push for an agricultural reconstruction policy. Especially in the South of Italy, growing tensions between landlords with large estates and landless peasants who occupied the land had been escalating since 1944. The Northern regions of Emilia and Tuscany were hit by a wave of strikes and demonstrations organized by the Italian Communist Party, demanding the renegotiation of share-cropping contracts and higher wages.[52]

The Italian program would ultimately become UNRRA's largest in terms of tonnage delivered to any single country: 10 million tons of goods valued at $418 million, supported by a workforce of around 4,000 staff members.[53] Of this extensive aid program, only a modest $13 million was destined to agricultural rehabilitation supplies, the largest share of which – $5 million – was allocated to importing fertilizers and machinery. The remaining $8 million covered shipments of pesticides, breeding equipment, veterinary and fisheries supplies, and seeds. As noted by UNRRA's official historian George Woodbridge, these resources, along with the deployment of agricultural experts, were intended "to bring to Italy the latest developments in agricultural and veterinary knowledge and practice from the outside world from which it had been cut off throughout the years of war."[54]

When UNRRA began its agricultural rehabilitation efforts in Italy, it entered a country where agriculture was central to the economy and had experienced decades of government intervention, scientific advancements, and socioeconomic reforms.[55] In 1945, about half of Italy's population was still engaged in agriculture, contributing roughly one-third of the nation's income. Italian agriculture was mainly focused on food production, especially wheat, alongside small grains, pulses, corn, potatoes, vegetables, citrus, wine, and olives. Significant regional differences in land and labor availability led to notable variations in production, farm sizes, and tenancy structures. These ranged from large estates, or *latifundia*,

51 Dimitri A. Sotiropoulos, "International Aid to Southern Europe in the Early Postwar Period: the Cases of Greece and Italy," *The Annals of the American Academy of Political and Social Sciences* 656 (November 2014): 22–40, 25.
52 Alessandro Bonanno, "Theories of the State: the Case of Land Reform in Italy, 1944–1961," *The Sociological Quarterly* 29, no.1 (1988): 131–147.
53 Woodbridge, *History of UNRRA*, vol. 2, 266 and 272.
54 As quoted in Woodbridge, *History of UNRRA*, vol. 2, 288.
55 Federico D'Onofrio, *Observing Agriculture in Early Twentieth-Century Italy: Agricultural Economists and Statistics* (Abingdon: Routledge, 2016); Lea D'Antone, "La Modernizzazione dell'agricoltura Italiana negli anni Trenta," *Studi Storici* 22, no.3 (1981): 603–629; Cesare Longobardi, *Land-Reclamation in Italy* (London: King, 1936); Federico Caprotti, *Mussolini's Cities: Internal Colonialism in Italy, 1930–1939* (Youngstown: Cambria Press, 2007).

in Lombardy and the South – a region heavily impacted by emigration – to the predominance of sharecroppers and small tenant farmers in areas like Tuscany and Veneto.

Since the beginning of the twentieth century, agricultural education and research in Italy had been institutionalized and professionalized, resulting in a well-established educational and scientific apparatus.[56] In the 1920s and 1930s, agriculture became a key component of the fascist modernization agenda. To address issues such as unproductive, marginal, and malaria-prone land, the fascist regime launched extensive land reclamation projects that significantly increased agricultural activity, particularly in the Pontine Marshes of Central Italy.[57] These modernization efforts were further supported by an internal colonization program, which planned the relocation of sharecroppers from Central Italy to the South, aiming to improve agricultural practices and boost production.[58] Attempts at making Italy independent of foreign wheat imports led to a series of economic policies: launched in 1925, the so-called *battaglia del grano* ('battle for wheat'), became a symbol of the regime's drive for greater food self-sufficiency. Wheat production increased at the expense of other foods that had been traditionally exported, resulting in increasing prices and food costs for the average Italian family and worsening their living conditions. This extensive and politicized propaganda campaign was accompanied by the creation of agricultural science laboratories that conducted extensive experimentation in crop breeding, including the development of high-yielding seeds.[59]

Agriculture and food production in Italy had suffered massively during the war. From June 1940 onwards, food was rationed, and by 1941, under-nourishment had become a national issue.[60] In addition to wartime destruction and dislocation of farming activity due to fighting on Italian soil, unfavorable weather had reduced Italian agricultural production.[61] In its survey report on the state of Italian

---

56 For an account of the system of agricultural extension and itinerant lectureship to disseminate practical techniques of modern farm management, see D'Onofrio, *Observing Agriculture.*

57 D'Antone, "Modernizzazione."

58 Longobardi, *Land Reclamation*; Caprotti, *Mussolini's Cities.*

59 Tiago Saraiva and Matthew Norton Wise, "Autarky/Autarchy: Genetics, Food Production, and the Building of Fascism," *Historical Studies in the Natural Sciences* 40 (2010): 419 – 428. See also Tiago Saraiva, *Fascist Pigs: Technoscientific Organisms and the History of Fascism* (Cambridge, Mass: MIT Press, 2016), 27– 40; Carol Helstosky, "Fascist Food Politics: Mussolini's Policy of Alimentary Sovereignty," *Journal of Modern Italian Studies* 9, no.1 (2004): 5.

60 Patrizia Sambuco and Lisa Pine, "Food Discourses and Alimentary Policies in Fascist Italy and Nazi Germany: A Comparative Analysis," *European History Quarterly* 53, no.1 (2023): 135 – 155.

61 G. Welk to Menshikov, 27 November 1944, Notes on Italian Agriculture, UNA, S-1210 – 0000 – 0107.

agriculture, UNRRA noted that "serious food shortage" was the most immediate challenge faced by Italy after liberation. A shortage of bread, pasta, and olive oil was leading to hunger and food riots, especially in urban areas. One of the most pressing problems, Allied authorities observed, was the lack of wheat, for which production had fallen by a third, forcing people to resort to the black market.[62]

UNRRA experts believed that persistent food shortages could be mitigated by importing agricultural resources such as fertilizers – whose domestic production had fallen during the war – and seeds, which were in short supply due to disruptions in trade and scientific collaboration.[63] While UNRRA's primary objective was to restore agricultural production as quickly as possible, experts also believed that there were long-standing issues from the prewar period that required long-term solutions. UNRRA officials, especially those from the United States, saw Italian agriculture as grappling with structural challenges, including a large amount of mountainous, semi-arid land, small farm sizes, poor livestock management, and a heavy reliance on manual labor, with little emphasis on labor-saving tools or machinery.[64]

Thus, UNRRA's agricultural rehabilitation program in Italy also intended to bring about a shift in the production of grains, from direct consumption to a grain-livestock economy that would boost meat production. This would entail a number of environmental consequences: the substitution of traditional and locally adapted seeds with new, imported ones, the introduction of new crop varieties and, as a result, a shift in the production and consumption patterns of specific crops. In practice, however, the organization soon ran into difficulties: While UNRRA officials considered the geological and climatic characteristics of the recipient regions to ensure that each seed type was suited to its native climate and soil, they appeared to be less attuned to the social factors – regional consumption values, patterns, and food traditions – liable to impact the acceptance of the seed

62 UNRRA Italian mission, "Economic Survey, Agriculture and Food," 26 July 1946, UNA, S-1465 – 0000 – 0086.

63 UNRRA Italian mission, "Economic Survey, Agriculture and Food"; Welk to Menshikov, "Notes on Italian Agriculture."

64 UNRRA Italian mission, Sub-Bureau of Relief Supply, Analysis Division, "Italian Livestock Population in Peace and War," 10 May 1946, UNA, S-1210 – 0000 – 0097; Charles W. Smith, "Livestock and Meat Products in Italy," 14 June 1946, UNA, S-1208 – 0000 – 0095; Hugh G. Calkins and Col. J R.G. Sutherland, "Report of F. G. Renner on Improvement of Grazing Lands of Central Italy," 25 May 1946, UNA, S-1210 – 0000 – 0096; Peter C. Borre to Mission Executive Officer, "Farm Machinery," 2 September 1946, UNA, S-1465 – 0000 – 0086.

supplies within farming communities. UNRRA also lacked the authority to control seed allocations or enforce the use of the provided seeds.

Successful seed distribution depended on the involvement of a variety of local authorities and actors that had been deeply shaped by fascist political and economic policies and that continued to exist and function after the demise of the regime. One such instance were the Consorzi Agrari, a centralized federation of local cooperatives set up during fascism. The Consorzi Agrari (which were put in charge of distributing UNRRA supplies) oversaw a grain collection system established by the fascist government that required local producers to sell their entire surplus of wheat and barley to a government stockpiling agency. The latter, the so-called Ammassi, then took care of the distribution of foodstuffs and was supposed, at least in theory, to prevent shortage and famine.[65] Fearing inflation, however, farmers were allegedly reluctant to sell their surplus, and were tempted to hoard their grains and sell them at much higher prices on the black market.[66]

Aware of these issues, UNRRA had anticipated problems with distribution: In Italy, the distribution of goods was managed by a local UNRRA mission, which transferred them to the Italian government only after the allocations had been determined. This approach, aimed at giving UNRRA greater control, ended up increasing the logistical burden for the mission without preventing misuse or misdistribution.[67] In theory, farmers who had applied for UNRRA seeds were supposed to pick them up with a receipt in their local rural cooperative. In many cases, however, the seeds never reached the intended recipients but were collected by black market dealers who signed the receipts using the farmers' names and resold the seeds to other traders. Some Italian distribution agents also sold the seeds at higher prices for profit.[68] As UNRRA noted, "irregular distribution was effected with the connivance of the Consorzio Agrario" and corrupt agents.[69] Yet, the fact that, according to UNRRA records, farmers resorted to the black market to buy UNRRA seeds to feed livestock also shows that UNRRA had misread and miscalculated local needs.

Even when picked up by the right person, the seeds were not necessarily used for planting as intended, but either resold on the black market or used to feed animals. Farmers frequently disregarded UNNRA instructions, particularly with

---

65 Welk to Menshikov, Notes on Italian Agriculture.

66 Welk to Menshikov, Notes on Italian Agriculture.

67 Woodbridge, *History of UNRRA*, vol. 2, 263.

68 C. B. Foglietti (Regional Director Emilia and Toscana), to chief of UNRRA Italian Mission, 11 December 1946, UNA, S-1465 – 0000 – 0098.

69 C. B. Foglietti (Regional Director Emilia and Toscana), to chief of UNRRA Italian Mission, 21 September 1946, UNA, S-1465 – 0000 – 0098.

crops that could be consumed directly (such as pea seeds). To address these issues – also present in other UNRRA missions such as the one in Austria – UNRRA set up a system of control and inspections with designated investigators, referred to as a "Protective Service," in early 1946. This service collaborated closely with civil and military police to combat black market activity and to detect any criminal misuse of UNRRA-provided goods.[70] The reports of these inspections paint a sobering picture of the failures and successes of seed distribution. Following intelligence that had led UNRRA to suspect that seeds were not used as planned, two special investigators were sent out to investigate potential "irregularities." In the farms that they visited, they found little evidence that the seeds had been planted. Farmers claimed to have stored the seeds but could not show where. Others told the inspectors they had redistributed the seeds to other farmers. One farmer admitted having used the seeds as fodder to feed his courier pigeons. Another had fed his sixty pigs with the seeds because he owned no land for planting. Others, who were thought to have retrieved the seeds, had never heard of the scheme. According to the investigators who interviewed the farmers, many farmers contradicted themselves or purposefully confused the interviewers, pretending not to be the person they sought. Farmers who were caught feeding seeds to pigs claimed they did not know that they should be used for sowing, although UNRRA argued firmly that instructions had been clear. Others yet could not be found. UNRRA inspectors concluded that in certain places, such as Tuscany, virtually none of the seeds provided by UNRRA had been planted.[71] In Ravenna, the sale of seeds had to be stopped to avoid their use for unintended purposes.[72]

Overall, in the Emilia region, UNRRA investigation proved "without any doubt" that there were groups of illegal traders, "who instead of distributing the seeds in small quantities sold them to unknown persons who were not farmers." Out of the ten investigated cases, "not one was carried out correctly" in compliance with UNRRA policy and procedures. 90 % of the 1,600 quintals of vetch seed ended up "on the black market or in the mouth of livestock."[73] Where distribution was more successful, such as in the case of bintje seed potatoes, other issues emerged: for instance, 90 % of the seeds did not germinate because they had

70 Woodbridge, *History of UNRRA*, vol. 2, 47.

71 C. B. Foglietti (Regional Director Emilia and Toscana), to chief of UNRRA Italian Mission, 13 September 1946, UNA, S-1465 – 0000 – 0098.

72 C. B. Foglietti (Regional Director Emilia and Toscana), on Forage Pea Seed Distribution in Emilia, 21 September 1946, UNA, 1465 – 0000 – 0098.

73 From Regional Director Emilia and Toscana to chief of UNRRA Italian Mission 11 December 1946, UNA, S-1465 – 0000 – 0098, 39 – 40.

been overheated during transport and started to rot.[74] Pests such as the Colorado beetle dorifera also proved important hazards, jeopardizing the successful harvest of the potato crop.[75] Thus not only did the UNRRA program suffer from structural flaws and logistical mismanagement, but external environmental factors such as pests and heat also negatively affected the already fragile recovery mission, highlighting the multi-faceted vulnerabilities of agricultural development programs.

Yet, the complexity of the local situation and the seeming lack of control did not deter UNRRA officials from experimenting with long-term seed activities. Towards the end of UNRRA's mandate, steps were taken to overhaul agricultural production by introducing hybrid corn strains, a variety of maize created by cross-breeding two genetically distinct parent plants to produce higher yields and increase disease resistance and uniformity. This set the stage for a hybrid corn program for Europe that would fully develop under the Marshall Plan after 1947.[76] In the summer of 1946, UNRRA expert Dr. P.S. Hudson, director of the Imperial Bureau of Plant Breeding and Genetics at the University of Cambridge, visited some Italian agricultural experimental stations. Upon his return, he wrote to UNRRA chief of Agricultural Supplies, emphatically requesting that UNRRA take provisions for hybrid corn strains to be imported from the United States in order to help revive an Italian maize breeding program that had existed before the war.[77] In particular, Hudson noted that the Italian maize research stations (*Stazione sperimentale di maiscoltura* in Bergamo) required "small samples of […] seed of as large a range now as possible of the hybrid corn strain" from agricultural experiment stations in the United States. The object, according to Hudson, was to compare the behavior of these hybrids with that of the local Italian varieties.[78]

Subsequently, UNRRA helped the implantation of hybrid-corn seeds in various ways: It imported 500 tons of US hybrid seeds for planting for forage purposes; and the Italian scientists who were in charge of the experimental station in Bergamo were sent to the United States to study the techniques and methods of hybrid corn production. UNRRA also provided 35 million lire ($60,000 at the time) to help

74 Report on seed potato cultivation by G. Sutty, 9 July 1946, UNA, S-1465 – 0000 – 0089.

75 Report on seed potato cultivation by Sutty.

76 Emanuele Bernardi, *Il mais miracoloso. Storia di un'innovazione tra politica, economia e religione* (Rome: Carocci, 2014).

77 Note P. S. Hudson of the Imperial Bureau of Plant Breeding and Genetics attached to Letter Darke (Chief Agricultural Supplies Officer) to Weintraub Deputy Director General UNRRA Bureau of Supply, Washington 18 June 1946, UNA, S-1209 – 0000 – 0251. For Hudson's original report see P.S.Hudson, 30 May 1946, 'Agricultural Research in North Italy' S-1210 – 0000 – 0109.

78 Note Hudson to Darke.

with experiments, and procured 58 varieties of American hybrids for testing.[79] From 1947 onwards, as UNRRA was phasing out its operations, these American varieties were planted alongside local ones for comparison. UNRRA experts continued to play crucial roles in subsequent seed activities.[80] Between 1948 and 1949, the import of new seed varieties from the US to Italy grew from 50 to 2,000 tons.[81] From 1948, new programs such as the Economic Cooperation Administration (ECA) and the Marshall Plan embraced the hybrid corn plan as a way to "revolutionize farming," against a backdrop of resistance by farmers and communists. UNRRA's seed program opened the door for these later activities which, as noted by one historian, "created new dynamics in seed production and marketing."[82] It also laid the foundation for widespread transformation not only of agriculture but also of the environment as a whole. The long-term impact of these changes would become evident over time: the focus on high-yield hybrids reduced genetic diversity and made farmers dependent on seed companies to obtain new seeds each year.[83]

Conclusion

UNRRA's seed program provides a valuable case study of how historical actors, during a period of significant upheaval and change, attempted to control and manage not only the transition from war to peace in countries ravaged by military conflict, but also the rebuilding of agricultural production and the development of food and crop systems. The organization's stated primary aim of bringing seeds to Italy was to help restore the agricultural sector and secure food production. Experts and seed technicians like Patterson were not primarily focused on long-term technological development; instead, they viewed their program as a response to the "deficiencies" caused by war. However, they recognized that seeds were not simply another agricultural "commodity" (like fertilizers, pesticides, machinery, or breeding equipment that UNRRA also supplied) but the starting point

79 Hybrids that were thought most likely to succeed were those from Wyoming, Montana, and Dakota. Andrew J. Nichols, *The Introduction and Spread of Hybrid Corn in Italy* (Washington DC: US Department of Agriculture, 1954), 3–4.

80 Nichols, *Introduction and Spread of Hybrid Corn*, 3–4.

81 On hybrid corn production under the Marshall Plan, see Bernardi, *Mais miracoloso.*

82 Helen Anne Curry, "Breeding Confusion: Hybrid Seeds and Histories of Agriculture," *The Journal of Peasant Studies* 50, no.3 (2023): 1037–1055.

83 Helen Anne Curry, *Endangered Maize: Industrial Agriculture and the Crisis of Extinction* (Oakland, CA: University of California Press, 2022).

of any crop and food production: once planted, they could have long-term impacts on the natural environment. They also understood that, compared to other forms of aid, seeds were a particularly complex commodity. Their natural characteristics – such as seasonality, availability, quality, germination, and susceptibility to deterioration – made them highly vulnerable to transport challenges and atmospheric conditions.[84]

As demonstrated by the Italian mission, UNRRA experts held high expectations for rebuilding and reshaping local agricultural production. However, they were less attuned to the local economic, political, cultural, and practical realities, as well as to the challenges and constraints that these would pose to UNRRA's plans. In particular, the organization's officials soon discovered that in addition to the logistical challenges of seed transfer, there was also the issue of human agency, over which they had far less control. Despite UNRRA's efforts to curb black market activities, the misappropriation of supplies by corrupt agents and the diversion of goods to the pre-existing black-market venues were especially pronounced in Italy.[85] Moreover, UNRRA had not anticipated the unpredictable ways in which local farmers would use the seeds, often disregarding the organization's guidelines and adapting them to their own needs. In this regard, UNRRA's seed program in Italy serves as an early lesson in the challenges of planning aid initiatives without adequate consultation with local communities.

In view of these difficulties, it may not come as a surprise that UNRRA's impact and legacy remained controversial for a long time: even contemporaries often ridiculed some of its efforts. Historians have frequently highlighted the frustrations and disappointments of UNRRA personnel, who faced numerous administrative obstacles and delays and believed that operations were ended too prematurely to allow the organization to achieve its full potential. Some of this frustration is also reflected in the activities of the seed unit. Yet, ironically, as historians continue to uncover the complex history of post-WWII international development programs and explore the work of international organizations, they also reveal UNRRA's pioneering role in shaping an emerging system of global humanitarian aid and development practices. In terms of organization and planning, UNRRA was instrumental in professionalizing and organizing systematic interna-

84 Woodbridge, *History of UNRRA,* vol. 1, 1, 494.

85 Woodbridge mentions Italy and Austria as cases where UNRRA needed to institute a protective service to fight corruption and black-market activities. It is not clear whether this problem also existed in other countries.

tional aid.[86] The organization also provided a testing ground for technical assistance operations that would go on to play a central role in development programs during the Cold War. Last but not least, UNRRA was the first international aid program that was not based on colonial control to test and evaluate whether it was technically and environmentally feasible to distribute agricultural supplies on a large scale. In the end, despite its challenges and initial shortcomings, UNRRA's seed transfer program laid the groundwork for agricultural development practices, influencing both the structure of future aid programs and the principles guiding global development in the second half of the twentieth century.

86 Jessica Reinisch, "Internationalism in Relief," 258–289; Silvia Salvatici, "Professionals of Humanitarianism: UNRRA Relief Officers in Post-War Europe," in *Dilemmas of Humanitarian Aid in the Twentieth Century*, ed. Johannes Paulmann (Oxford: Oxford University Press, 2016), 235–259.