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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.

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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

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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]

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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 de-

velopment 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

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