Water in the Southern Cone in the Colonial Period

Socio-Natural Colonization: The Hydro-Social Legacy of the Sixteenth, Seventeenth, and Eighteenth Centuries

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Water systems in all their forms – atmospheric, surface, and groundwater – are key to the economic, social, and political life of the Southern Cone. The Río de la Plata Basin, the sixth largest in the world, and others whose waters flow into the Atlantic and Pacific provide transportation, irrigation, drinking water, and energy to the main cities of Argentina, Chile, Uruguay, Paraguay, and southern Brazil. Historically, hydro-social conflicts around pollution, access inequality, and disastrous events such as droughts and floods have increased in severity and frequency as the current industrial socio-metabolic regime has consolidated (Bakker 2012: 618; Fischer-Kowalski and Weisz 2016: 22). However, the roots of this water relations system are older, and some of its fundamental elements can be traced back to the arrival of Europeans in the southern part of the continent. The water problem in the Southern Cone is linked to one of the central questions surrounding the Anthropocene: How does one define it, and when did it start as a distinctive era? In this sense, this chapter differs from the positions that limit their analysis of the period to the effects of human actions at a planetary level; this supposes the universalization of the human condition under the mold of the globalization of "the West" (Machado Aráoz 2023: 413). These reductionist logics circumscribe current problems to questions of substances and energy sources, which is insufficient; it is instead necessary to historicize the causes of concrete anthropogenic changes (Horn and Bergthaller 2020: 25; Machado Aráoz 2023: 410), and to critically analyze the cultural, historical, and economic diversity of human life and systems of socio-ecological relationships, temporally and spatially situated, as a starting point for understanding the trajectories that led to the Anthropocene (Horn and Bergthaller 2020: 37: De Hoop et al. 2022: 200; Machado Aráoz 2023: 413).

Consequently, this chapter begins from the understanding of Anthropocene's history as a sequence of thresholds or "leaps" that represent a prolonged process towards the transformation of landscapes, forms of energy, economic and social regimes – the beginning of industrialization here not only as an asynchronous tran-

sition from an energy regime of cyclical sources (such as wind, water, and solar) to fossil fuels but also as an era of new forms of technology and social organization (Horn and Bergthaller 2020: 160; De Hoop et al. 2022: 201). Thus, the Anthropocene is the product of a more complex, multi-scale geographic process imbricated in the synchronized transformations of multiple local, regional, and global spaces. From this approach, the European expansion into the Americas triggered a process of interconnection and reconfiguration of enormous geographical relevance within the framework of a colonial management system for the organization and administration of commodified energies and living beings (Machado Aráoz 2023: 416). Without the profound transformations in scale and significance acquired by mercantile and war practices in the shift from the Mediterranean to the Atlantic and Indian Ocean economies, it is impossible to understand the transformation of the American territories and their current insertion in the world system (Wallerstein 1979).

This chapter will give an account of the entanglement between the social and biophysical dynamics of water in the shaping of a distinctive hydro-social territory in the southern part of the Spanish and Portuguese empires within the frame of this global multi-scale reconfiguration, from their arrival in the sixteenth century until the end of the eighteenth century (Boelens et al. 2022: 11). Water marked the possibilities and limits for the emergence and reproduction of the colonial system discussed in this chapter, and social dynamics were entangled and in turn influenced water dynamics. These socio-environmental transformations of early modernity played a key role in the modality of the occupation and production of geographical space, conceived more as a zone of exploitation than as a habitat (Machado Aráoz 2023: 424; Moore 2017: 27). In this sense, these territories were colonized by the Spanish and Portuguese through the foundation of cities and their jurisdictions, which were "socio-natural sites" constituted through a reordering of the nexus between practices and assemblages (arrangements) of water's biophysical, infrastructural, and social elements, guided by pre-reflexive elements (interests and traditions) (Winiwarter and Schmid 2020). Sustaining these systems of interactions required the constant work of humans, animals, and machines, as well as a continuous "colonization of nature" that was crossed by power relations, conflicts and resistances, vulnerabilities, risks, and impacts whose spiral effects defined the continent's place both at that time and in the anthropocenic world system of the twenty-first century. The correlation between these foundational nodes' importance and their current relevance explains the centuries-old continuities in their link and the hydro-social problems (Grau and Foguet 2021: 126). Therefore, it is necessary to interpret these systems' historical genesis to critically examine the present and envision new possible paths (Garnero 2018).

Hydrologically Unequal Territories

Southern Cone landscapes at the beginning of the sixteenth century offered, as today, a strong contrast between dry and humid areas. The Arid Diagonal of South America covered the current northern part of Chile (Atacama), northwestern and central western Argentina, and eastern Patagonia, while rainy areas corresponded mainly to the great basin of La Plata and its tributaries, with its plains (Pampa and Chaco), savannas, wetlands (Iberá and Pantanal), and forests (Tucuman and Atlantic), as well as western Patagonia (Valdivian Forest). This area concentrates more than 85 percent of the world's largest surface flows and wetlands. Significant latitudinal extension explains its climatic amplitude, from tropical to cold. North of 40° S, the humidity provided by the Atlantic winds decreases in an east-west direction to the Andes' great orographic barrier, and on the other side lies the Atacama Desert. South of 40° S, the reverse phenomenon occurs with the humid winds from the Pacific reaching the arid Patagonian plateaus.

These factors explain the contrasting distribution and drainage of surface waters. On the one hand, in the northeast, long, fast-flowing, navigable rivers formed the Río de la Plata basin. In contrast, the rivers of the Arid Diagonal have low flow and are shorter, with significant summer floods due to snowmelt. In southern Patagonia, the rivers that drain into the Pacific are abundant but short, while those that flow into the Atlantic, such as the Chubut or the Santa Cruz, cross the arid plateau without major tributaries. In the center of the Southern Cone, the great Pantanal and the Chaco-Pampa plains – with their gentle slopes towards the estuary of La Plata – made the currents that cross it changeable, with seasonal lagoons and extensive wetlands. This general description is key to understanding how the European settlers entered and founded their cities and the different links they established with the hydrologies and societies that already existed there, dynamic elements subject to annual and long-term cycles. This chapter will focus on the former but recognizes that the perception and impacts of their effects were different between the sixteenth and eighteenth centuries. The following sections will describe the possibilities and limitations that water availability in its various forms offered to this incipient network of interconnected cities, both in the arid and wetter zones outlined above, and then analyze how these societies coped with contrasting water dynamics. The climatic and hydrographic characteristics, their spaciality and temporality, entangled with the Hispanic and Portuguese colonizing process, were key factors in the appropriation, linkage, settlement, economic activities, and these territories' structuring in the modern world system.

Water as an Opportunity and Constraint in the Shaping of the Colonial Socio-Natural Regime

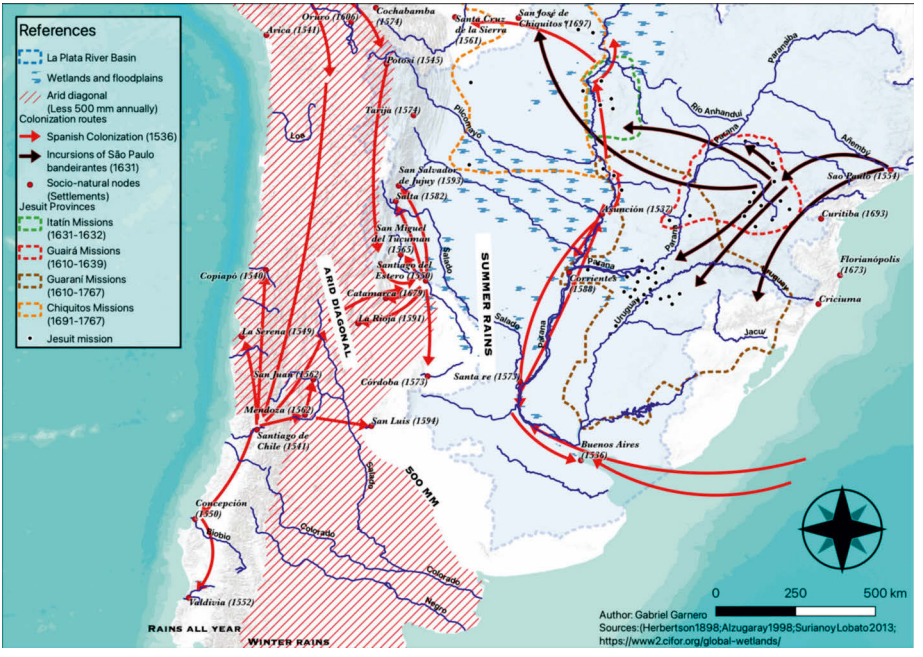
Water for the Cities: Socio-Natural Nodes

The distribution of both Indigenous societies and Hispanic and Portuguese colonization was marked by the influence of climatic and hydrological disparities. Their effects can be analytically divided between opportunities and constraints to social, economic, and cultural processes and developments. Among the main opportunities was that of founding towns. Since the sixteenth century, these nuclei on the periphery of their respective empires housed most of the European population, concentrated commercial activities and institutions, and acted as centers for the organization of productive activities in their respective jurisdictions or hinterlands (Map 1). This development was the result of a larger-scale geographical process that overlapped and transformed vast local, regional, and global territories within the framework of a colonial system, and these first urbanizations became spatial technologies for the control of territories and populations subjected to the dynamics of forced mercantilization (Machado Aráoz 2023: 416). The Europeans selected healthy, fertile areas with pastures for their crops and livestock, forests for firewood, water for irrigation and drinking, Indigenous people to convert, and good land and sea communication.

The impetus for settling in the Southern Cone was the strategic interest in connecting the metalliferous centers of Peru with the metropolis, and this was carried out in waves. The first wave, lasting until 1650, took place via three routes: the Atlantic, the Pacific, and the North. The Atlantic route, from 1536, used the La Plata River Basin as a channel of entry, establishing cities such as Buenos Aires (1536), Asunción (1537), Santa Cruz de la Sierra (1561), Santa Fe (1573), and Corrientes (1588). In addition, an extensive network of Jesuit missions was established in the upper basins in Paraguay, Guaira, Itatí, and Chiquitos. River exploration continued northward until reaching non-navigable stretches in the Pantanal area. Throughout the basin, mighty rivers such as the Paraná, Paraguay, and Uruguay, as well as their tributaries, offered water in large quantities, but ironically, supply quality was a significant problem (Concolorcorvo 1773; González Fasani 2015). For much of the period, major cities had no public water or sanitation systems, and those who wanted clean water had to pay water carriers or settle for cloudy water carried in jars. Another way of collecting water in these cities was through *aljibes* (tanks), cisterns, or wells that stored rainwater, but only some families could afford to build them. Paradoxically, despite being close to some of the largest rivers in the world, drinking water was an expensive commodity with unequal access (Paniagua Pérez and Arciello 2020: 297). For their part, the Indigenous people of the basin moved around, taking advantage of the seasonality of water, which varied the availability of animal and plant species

and had an impact on demographic dynamics, defining communities' grouping or dispersion (Nesis 2005; Sartori, Galligani, and Balducci 2016: 87).

Map 1: Water and the Conquest of the Southern Cone (Sixteenth to Seventeenth Century)



Source: Author's elaboration from Herbertson (1898); Alzugaray and Alzugaray (1998); Suriano and Lobato (2013); SWAMP (n.d.)

Simultaneously, from the Pacific, a dynamic nucleus was established in the central zone of Chile with Santiago (1541) and Valparaíso (1543), which later translated into the foundation of other settlements. To the south, Concepción (1550) and Valdivia (1552) were established in the rainy Patagonian forests; to the north, in the Arid Diagonal, La Serena (1544) and Copiapó (1549); and to the west, Mendoza (1561) and San Juan (1562). In these regions, where rainfall was scarce, Indigenous groups such as the Atacamas, Diaguitas, and Huarpes took advantage of small rivers and streams with scarce but good-quality water for consumption and production by using complex hydraulic systems composed of dams and conduction systems (Giovannetti and Raffino 2014; García and Damiani 2020; Ponte 2015). In the systems of the Mapocho, Aconcagua, Coquimbo, Copiapó, Cuyo, and San Juan rivers, the Spaniards built their own hydraulic systems, with large canals and their *hijuelas* or irrigation

ditches channeled directly from the rivers, which became the axis of these cities' urban fabric (Varela 1993: 355; Sánchez-Rodríguez 2015: 42).

In southern Chile, abundant rainfall nourished the mighty Biobío River, and in the flooded areas of the Valdivia basin, important works were carried out to drain and order water circulation (Adán Alfaro, Urbina Araya, and Alvarado Pérez 2017: 372). In this region, the Mapuche-Huilliche communities were dispersed and associated with lake and riverine environments; the Europeans were surprised by their abundant water use, their elaborate hygiene customs, and their swimming habits (Molina 1788: 117; Solari et al. 2011: 60). Finally, from the north of the Southern Cone, colonization began with the founding of Alto Perú, Chuquisaca (1540) and Potosí (1545) and then extended southward into the valleys, pockets, and foothills of the sub-Andean sierras with their mountain rivers (the Arias, Grande, Salí, Suquía, among others). Salta (1580), Jujuy (1593), Tucumán (1565), and Córdoba (1573) were founded. Moving to the Chaco plains and wetlands of the Salado and Dulce rivers, several other settlements were established, of which only Santiago del Estero (1553) has survived (Fradkin and Garavaglia 2009: 25). The three great colonizing currents were connected through the formation of commercial links and routes between the arid and semi-arid zones of the west and those linked to the Río de la Plata basin's great rivers.

During the seventeenth century, the wave of Hispanic settlement weakened, and the Portuguese advance strengthened. After overcoming the Serra do Mar and settling in São Paulo, *bandeirantes* at the forefront of expansion penetrated the territories of La Plata, descending into its tributaries to obtain gold, Indigenous people, and a route to the mines of Upper Peru (Spósito 2012; Plens and Porto 2016: 111). This advance delineated a riverine frontier of conflict in the upper Paraná and Paraguay basins and resulted in the destruction of dozens of Jesuit missions, the abandonment of Guaira and Itatín, and the consolidation of major cities such as São Paulo and Curitiba (Owens 1993: 28; Souza 2019: 23). In the eighteenth century, the Bourbon reorganization and the foundation of the Viceroyalty of the Río de la Plata marked a new Spanish push (Map 2). Although pressure from Indigenous groups attacking via the tributaries of the Paraguay River increased, progress was made in the Chaco-Pampean plains, the Atlantic forest, and the eastern plains of the Río de la Plata, with the establishment of Montevideo (1726) being especially important. In addition, the Treaties of Madrid (1750) and San Ildefonso (1777) defined the boundary between the Spanish and Portuguese possessions following the course of rivers and watersheds (Corral 2015; Cherubini 2021: 241). Thus, the territorial framework was marked by the cities, socio-natural nodes, and political-economic devices of control and colonization that "dotted" these vast water spaces with which they were linked and attempted to transform (Suriano and Lobato 2013: 54; Sovarzo 2019: 119). Finally, in the gigantic expanses of plains, plateaus, and wetlands to the south and north of

the core areas, European presence was marginal; these spaces would only become part of the nation-states in the nineteenth century.

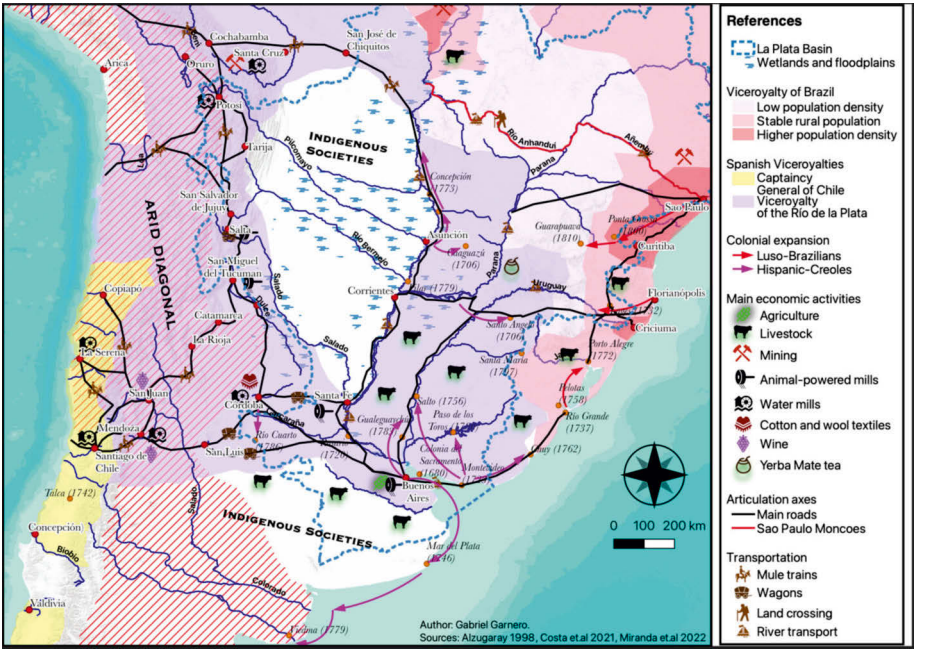
Water for Transportation: Territorial Articulation Axes

The rivers of La Plata were "highways" for the penetration of humans, animals, and plants from the Old World, as well as for Indigenous societies' exchange and mobility (Siqueira 2009: 7; Silvestri and Williams 2016: 9). For the Europeans, canoes and other Indigenous knowledge were essential in the intensely aquatic environment that seasonally changed configuration due to the waters' rhythm (Costa 1999: 207; Saccone 2020: 243). Initially, the Spanish believed they could connect the Atlantic and Pacific front fluvially, which was of great geostrategic interest (Gascón 2017: 444). Although this proved impossible, the cities of La Plata persisted, and river exchange was vital for their survival, enabling the emergence of an internal market and transatlantic trade that linked them to the world system (Errecart 2019: 255; Gascón 2017: 447; Jumar and Biangardi 2014: 32; Moore 2014). River transport was significantly faster than overland, especially in densely jungled areas, and this was directly related to the circulation speed of goods and commercial capital turnover (Rosal 1990: 137; Reitano 2016: 140). At the end of the eighteenth century, the La Plata River port complex reached its peak as an axis of regional articulation, both upstream and downstream and between both shores (Jumar and Biangardi 2014: 76). In addition, the borders of the Paraná and Paraguay's upper basins were areas of circulation and incursions into river territories inhabited by Guaycurúes, Mbayás, and Payaguas Indians (Funes 1816: 16; Alves de Arruda 2018).

Water dynamics were also entangled with the interconnection of land. The rivers of the Río de la Plata basin often served as boundaries for cross-communication, requiring the construction of bridges or the use of rafts to cross them (Levinton 2009). For example, the Luso-Brazilians advanced westward by moving canoes overland from the Paraná to the Paraguay basin, and seasonal Monçõense river expeditions connected the Pantanal with the Paulista power center (Costa 1999; Pedroni 2012: 4; Lucidio 2013: 38). The Spanish also established commercial and military connections between their Pacific possessions and the Río de la Plata basin through overland routes. The royal road from Buenos Aires to Upper Peru acted as the main axis, linking the socio-natural cities/sites created by the northern edge of colonization and ensuring a water supply during the journey (Errecart 2019: 238). Another important axis was located on the southern border, linking the dry and humid areas. Caravans traveled between Chile and Santa Fe and then sailed to Paraguay, exchanging wines and yerba mate (Gascón 2017: 447; Sovarzo 2019: 347). From Buenos Aires to Mendoza, they traveled more than 900 km on progressively more arid plains, overcoming long stretches of salty land without drinking water, meaning they had to carry it with them (Cioccale 1999: 258; Lacoste 2005: 182; Martínez de Sánchez 2019: 294). In ad-

dition, seasonal variability – the recurrent fluctuations of climatic variables during the seasons of the year, influencing aspects such as agriculture, ecosystems, and human health – influenced the availability of livestock pasture and drinking water for people and animals. Therefore, trips in search of water sources were made after the rains and the paths had varied, sometimes going deep into Indigenous territories inhabited by the Querandíes and Puelches (Gascón 2014: 53; Martínez de Sánchez 2019: 294). The crossing of the Andes through the Uspallata pass represented another challenge, taking a full week and only being possible in summer. In the Andean and sub-Andean mountain ranges of the Southern Cone, snow, heavy rains, or rushing rivers made the roads difficult to maintain and impassable for wheeled vehicles, thus becoming the domain of mule drivers (Gascón 2017: 441; Lacoste 2005: 111).

Map 2: Iberian Viceroyalties and Southern Cone Water (Eighteenth Century)



Source: Author's Elaboration from Alzugaray and Alzugaray (1998); Costa, Andrade, and Maluly (2021); Salas Miranda et al. (2022)

Water for Production: Hinterlands

Water was also central to economic production, whether for subsistence or exchange. First, its spatial and temporal distribution helps to explain the agricultural

expansion of European crops during the sixteenth, seventeenth, and eighteenth centuries (Crosby 2009). Ecological colonization involved using native and introduced crops and substantially differed between the humid areas east of the 600 or 700 mm isohyet lines, where rainfed agriculture was practiced, and the arid areas, where irrigation was used. In the former, crops that required more water predominated, such as wheat, barley, rice, and in the northeast, cotton, bananas, beans, sugar cane, and yerba mate, as well (Jorge and Ulloa 1748: 123; López de Albornoz 1997: 141; Prieto and Herrera 2001; Giovannetti 2005; Arruda 2015: 221). On the other hand, in the latter zones, where irrigation was relied upon, there was an abundance of potatoes, corn, and fruit trees such as apples and peaches, in addition to vines, citrus fruits, flowers such as lilies, lilies and carnations, and vegetables (Sánchez-Rodríguez 2015: 44). Europeans took advantage of Indigenous waterworks for the establishment and expansion of their own plantations, and these works served both for the provision of drinking water and the production and irrigation of fields and gardens (willows and poplar groves) (Parish 1853: 100; Giovannetti and Raffino 2014; Sánchez-Rodríguez 2015: 44; Quiroga 2015: 12; Lacoste 2018: 7). Added to this was the expansion of cattle, horse, goat, and sheep farming, which also related to water dynamics (Prieto and Jorba 1991; Serres 2018: 49; Maeder 2021).

In the border plains of the Pampas-Patagonian and Chaco regions, this increase of large herbivores had an impact on inter-ethnic relations, mainly due to the movement of cattle in search of water and pasture. The concentration of cattle, Indigenous groups, and Hispanic-Creole cattle ranches around rivers, lagoons, and wetlands generated deep tensions (Gascón 2014: 51; Frias and Montserrat 2017: 51). Within the Indigenous communities themselves, horses began to play a central role; this meant that mediating water access was tantamount to controlling animals and people (Villar and Jiménez 2013: 12). Finally, the rivers and wetlands of the Río de la Plata were used for hunting and fishing, which was of secondary importance to Europeans but fundamental to the subsistence practices of Indigenous peoples such as the Guaycurúes and Tupí-Guaraníes, who also benefited from the environment's humid conditions in their resistance to colonization. Traveling through their river territories was dangerous, and during the rainy season, they would make incursions and then take refuge among islands and wetlands (de Sousa 2004: 19; Prieto 2010; Lucidio 2013: 99). In short, water had a profound impact on the redefinition of the positions, distances, connectivities, rhythms, flows, and borders that shaped the colonial domination process of these territories.

Water Scarcity: Droughts

Cities, jurisdictions, and axes of articulation faced limits entangled with extreme water events, with water scarcity being one facet. Here, it is necessary to distinguish between aridity (a structural aspect of the environment) and drought or "dryness"

(when rainfall is lower than average over a large area for a long period of time, generating imbalances in water's social use). The correlation between one phenomenon and the other is not direct and unequivocal but rather contextual (Prieto and Herrera 2001: 138; Noria Peña 2018: 147; Quiroga and Lapido 2011: 46). The thresholds for drought or "dryness" definition are more geographical than climatic, deriving from the territorial contrasts analyzed in terms of water demand and consumption, without being exclusive to the arid region. In rainfed areas, the problem of "dryness" was significant, given that rainfall determined agriculture and livestock farming in large territorial extensions (Prieto and Jorba 1991; Noria Peña 2018: 328). Where irrigated agriculture was practiced, water generally came from snow and glaciers, providing more regularity and reducing the risk of water shortage (Prieto and Herrera 2001: 138; Jumar and Biangardi 2014: 145). Although there were drier periods during the sixteenth century, droughts were recurrent in the seventeenth and eighteenth centuries, linked to demographic and productive transformations such as dependence on a particularly affected crop, population increase, or competition with other uses. Shortages could stop mining and flour mills, as well as drive livestock away from urban centers. This economic paralysis had a profound effect on prices (Buechler 1989: 71; Gómez Saavedra 2022: 659). Finally, extreme scarcity sometimes affected urban supply and combined with social inequalities that hindered drinking water access (Varela 1993; Gayán, Castillo, and Figueroa 2019).

Excess Water: Floods and Flooding

On the other extreme were tidal surges and floods, increased water volume in streams, or prolonged ground accumulation. The flat regions of the Río de la Plata basin were among the most exposed to the risk of flood-related disasters in South America (Prieto and Jorba 1991; Prieto 2007: 40; Noria Peña 2022). The extensive floodplains, river lowlands, and wetlands were periodically reconfigured by slight hydrological changes, and the society's agricultural base was particularly vulnerable to these events (Prieto and Herrera 2001; Prieto 2010: 23; Silvestri and Williams 2016: 3). Since the sixteenth century, flooding in the cities of the river coast and nearby plains was recurrent, and several Jesuit missions had to be relocated because they were surrounded by swampy waters or flood zones (Páez 2013: 168). In addition, vast flooded areas could isolate towns or cities by both river and land from other urban centers, reducing vital trade and resulting either in the loss of livestock or their stranding by land from these centers of consumption. Parasitic and fungal diseases such as rust (*Puccinia graminis tritici*) could also decimate crops (Prieto and Jorba 1991; Prieto 2010: 25). On the other hand, seasonal avenues impacted the nodes of this colonial fabric (Salas 2014; Simón Ruiz and Noria Peña 2017).

Although the significance of human and material loss does not compare with those of today, the floods from the mountain rivers constituted significant threats,

as they destroyed water infrastructure, streets, farms, and crops essential for subsistence. In some cases, the magnitude of their impact forced entire cities to relocate. The Spanish-Creole and Portuguese-Brazilian populations used different strategies to confront these threats. Defensive infrastructures such as cutwaters and embankments were built, which gave a sense of "cities against the water" (Buechler 1989: 71). Otherwise, specific rules were instituted to protect livestock, such as sheltering them on islands during dry periods but keeping them on dry land when the rivers rose. Indigenous societies were affected differently due to their land use, population density, and subsistence systems. In the La Plata system, these groups moved through the territories according to seasonal water variability. During floods, they sheltered in boats – some even with living spaces –staying in them until the waters receded or built houses in tall trees (Prieto 2010: 30).

Water Extremes and Bodies: Health and Disease

Water extremes also had synergistic effects: torrential rains, floods, droughts, and plagues; price increases and generalized hunger recurrently impacted Chile, Tucumán, and the Río de la Plata basin. Hunger and malnutrition facilitated the emergence of pockets of poverty, immunological weakening, and increased deaths from infectious diseases such as smallpox, typhoid, leprosy, and cholera, which affected food production capacity, thus closing negative feedback loops (López de Albornoz 1997: 4; Prieto and Herrera 2001: 140). This was entangled with organizational and infrastructural deficiencies in the settlements, where there was a lack of minimum hygiene conditions or prevention despite knowledge of the "putrid miasmas" effects on health (Rezende, Heller, and Queiroz 2009: 61; Frías and Montserrat 2017: 30). The epidemiological impact was greater among African and Indigenous people, who were especially vulnerable due to the breakdown of their adaptive systems and their immunological deficiencies against introduced pathogens. Furthermore, their enslavement and concentration in *estancias* or *haciendas*, as well as their relocation to missions, facilitated contagions (Fajardo-Ortiz and Ferrer-Burgos 2003: 618). Diseases also circulated along the analyzed axes of articulation. However, their impact on the nodes was less than in Europe or other parts of the Americas due to the settlements' small size and dispersion (Frias and Montserrat 2017: 57). During the eighteenth century, the Bourbon reformist zeal involved initiatives establishing the monarchs' responsibility for public health and sought to avoid "infections" by relocating or eliminating concentrations of corruptible elements (González Fasani 2015; Rezende, Heller, and Queiroz 2009: 62).

The Reconfiguration of the Hydro-Social Territories of the Southern Cone

Portuguese and Spanish authorities, guided by their metropolises' needs, established a fundamentally extractivist matrix of organization and exploitation of the water commons (Kauffer Michel 2018: 36). As a whole, the colonial system's structuring redefined on a large scale the biophysical elements and practices around water throughout the territory. In addition to its temporal and spatial distribution, other axes of analysis serve to demonstrate the unprecedented transformation that conquest and colonization implied. Among them, this section highlights the reconfiguration of the organization (forms of allocation and distribution), the socio-technical apparatus (technology and infrastructure), and the power relations around water (control and resistance) (Garnero 2022).

Organizational Reconfiguration: Water Law and Governance

The first capitulations of the sixteenth century had water as a common good, although, with the *Derecho de Indias,* it acquired the status of a real estate asset (Sanjurjo 2012: 160; Ferreyra 2017; Gayán et al. 2019: 118). Thus, officials authorized by the king granted concessions, *repartimientos,* or royal grants to reward those who rendered services to the Crown (Figueroa 2018: 99). Titles of this type allowed land and water access and remained in force until the eighteenth century. The *Ordenanzas De Alfaro* (1611) – a set of laws enacted by Francisco de Alfaro in compliance with a royal ordinance of Felipe II, with the objective of mending abuses against the Indigenous, prohibiting their sale and purchase, establishing remuneration, and regulating the *mita*, among other provisions – provided a legal basis, but the demographic, cultural, and geographic heterogeneity of the Southern Cone meant that local regulations had to be adapted to these realities. The *cabildos*, the centers of political and economic government in the cities, were also in charge of planning, executing, and controlling water assets (Martínez de Sánchez 2011: 233; Sanjurjo 2012: 163; Barriera 2019: 66). If a contentious issue arose, it could become a matter of justice and require the intervention of the courts, with the ordinary mayor's offices playing a central role. Mayors or water judges were in charge of distributing, constructing, and maintaining the irrigation networks and arbitrating conflicts between irrigators, and in the seventeenth century, they were joined by the Water Commissioners (Palerm 2009: 254; Quiroga and Lapido 2011: 48; González Fasani 2015). In the centralizing context of the Crown during the eighteenth century, the *Ordenanza de Intendentes del Río de la Plata* (1782) brought together the various existing codes in terms of water rights, and the *intendentes* became responsible for controlling irrigation and water supply systems, delegating to the local authorities the application of the rules and the arbitration of conflicts.

Socio-Technical Reconfiguration: Water Technology and Infrastructure

In addition to legal and organizational changes, there were important infrastructural transformations (Brailovsky and Foguelman 2009: 25; Ponte 2015: 321; Lacoste and Salas Miranda 2021: 6). In this sense, the main environmental alterations resulted from the scale and rapidity of technological transformation, including physical objects and the processes of the design, production, maintenance, and knowledge involved in their creation (Jorgensen 2014: 480). Thus, European colonization implied a reconfiguration of local technological systems and their alignment with the interests of regional and global actors, representing a highly relevant qualitative change in the framework of the Anthropocene transformations. As mentioned above, the Europeans took advantage of the Indigenous hydraulic systems of the arid and semi-arid regions and reconfigured them to their advantage. Cities such as Santiago de Chile, Mendoza, San Juan, San Luis, La Rioja, and Catamarca created rudimentary systems of irrigation ditches and water intakes to divert the flow with gravity from mountain rivers (Quiroga and Lapido 2011: 50). In addition, hydraulic mill technology was introduced to harness the rivers' energy, and the implementation of an extensive network of these devices transformed Chuquisaca and Cochabamba into the milling center of the Americas in the sixteenth century, defining the Alto Peruvian mining landscape (Lacoste 2018: 118). Artisans and carpenters who mastered the art and the prestige that its possession granted brought the process to Chile, Tucumán, and the La Plata River (Lacoste and Salas Miranda 2021: 19).

Likewise, there was a notable geographic division between the water mills near mountain rivers and the animal-powered mills (*tahonas*) on the flat plains, whose milling costs were much higher (García and Damiani 2020; Lacoste and Salas Miranda 2021: 19). Financing and controlling these hydraulic devices were expensive and associated with the political and religious elite. However, locals carried out construction, and when possible, Indigenous or slave labor was used (Quiroga and Lapido 2011: 50; Tell and Olañeta 2011). Hydraulic infrastructure's reconfiguration and maintenance caused one of the greatest sixteenth-century environmental changes, contributing to the Europeanization of the landscape and identity of the Spanish cities founded in the arid region. Finally, attempts to control water also included a ritual facet. Hydrological dynamics were seen as part of divine design in the deeply Catholic society, and to alleviate their effects, residents attempted to mediate providence through prayer (Noria Peña 2018: 331). These public liturgical practices, generally in the Hispanic world, were prayers for the cessation of droughts and epidemics, although in the Río de la Plata Basin, those that prayed for the end of rains and floods were also important (Lopez de Albornoz 1997: 10; Prieto and Herrera 2001: 142; Gascón 2014: 50).

Reconfiguration of the Power System: Conflicts and Resistance over Water

The restructuring of hydro-social dynamics meant controlling activities of production and social reproduction, generating profound inequalities, conflicts, and impacts. In this sense, far from universalizing human agency, historicizing water in the Anthropocene involves highlighting differential human experiences, responsibilities, and policies (De Hoop et al. 2022: 197). The Southern Cone's hydro-social fabric was not an "act of the human species," as the term Anthropocene might portray it (De Hoop et al. 2022: 198). Rather, the tensions uncovered a markedly asymmetrical social fabric in terms of land and water access as well as environmental impacts, in which officials, *encomenderos,* and religious orders made obtaining and controlling water one of the bases of their privileged social position (Plens and Porto 2016: 111; Ferreyra 2017; Astudillo Pizarro 2018; Gayán, Castillo, and Figueroa 2019). Thus, there was a proliferation of disputes between neighbors, institutions, millers, encomenderos, and peasants over the distribution and use of drinking and irrigation water. It was common for well-connected Spanish-Creole or Portuguese-Brazilian families to bring together economic power with government and justice functions, this being a fertile ground for arbitrariness in distribution (Varela 1993: 354; Sanjurjo 2019: 177).

In the arid region (Chile, Cuyo, and Tucumán), water was as important, if not more so, than land access since production could not take place without it, and water problems remained recurrent from the sixteenth century onwards. Where Indian villages were created, conflicts abounded around Hispanic-Creole monopolization (Tell and Olañeta 2011; Astudillo Pizarro 2017; Escolar 2021). Additionally, the cleaning and reconstruction of hydraulic infrastructure was another source of ongoing conflict. Canals became clogged with mud and limescale, ponds filled with debris or algae, and torrential rains and mountain thaws damaged conduction and distribution systems (Bell 2015; Noria Peña 2018: 158). These conflicts were also entangled with commercial disputes between farmers and ranchers for political hegemony as well as inter-ethnic conflicts (Varela 1993: 357; Briones Valentin 1999; Trettel and Oviedo 2007). A proliferation of petitions, complaints, commissioners' opinions, and chapter documents captured this collision between diverse interests and evidenced the power disparities within these colonial societies (Astudillo Pizarro 2017; Farberman and Boixadós 2015).

Control over water often fell to legally authorized actors, while others whose economic and political power allowed them to transgress the general provisions employed water thieves or force (Noria Peña 2018: 339). In doing so, they attempted to ensure a continuous water supply to increase their lands' productive capacity. During droughts, this generated vicious cycles: shortages were compounded by hoarding, the deficit worsened, and conflict broke out. On the other hand, subaltern sectors such as impoverished Hispanic-Creole, Indigenous, and Black populations

also resisted, complaining to the authorities, rioting, and freeing currents that had been seized by force or through transgressions in daily practices. The claimed right to water was recognized by the *Real Audiencias* of Chile and Buenos Aires, but local Spanish-Creole power networks usually managed to undermine or dismantle organized resistance (Escolar 2021: 35). These sectors, through judicial processes or the use of force, reasserted their social control over the flow of water (Astudillo Pizarro 2017; Briones Valentin 1999; García and Damiani 2020; Gayán, Castillo, and Figueroa 2019).

Impacts, Vulnerability, and Water Risk Spirals

For all these reasons, cities – colonial socio-natural nodes – generated impacts and acted as axes of the social construction of risks and vulnerability associated with water and its dynamics (García Acosta 2004; Gascón 2005). Silver mining in Upper Peru and gold mining in Brazil, focal points of the extractive metalliferous economy, transformed neighboring territories and impacted the fluvial landscapes of tributaries of the La Plata River, with the construction of hydraulic works such as dams, aqueducts, mills, and the use of large quantities of water, coal and firewood from neighboring areas (Plens and Porto 2016: 95; Gómez Saavedra 2022: 668). In Upper Peru as well as in Chile, Tucumán, and the great basin of La Plata, the Indigenous systems of social organization and linkage with water were broken down, and the Indigenous were either concentrated into villages or enslaved and organized for production according to European systems. In the Río de la Plata Basin, those incorporated into the colonial system had to abandon fishing, hunting, slash-and-burn agriculture, and seasonal mobility patterns according to water cycles. Likewise, water restructuring around economic, domestic, and disaster practices in the colonial nodes had an impact on water flows, both in quantity and quality (Bravo 2005: 77; González Fasani 2015).

The impacts of extractive and productive activities such as silver and gold mining, farm irrigation, cattle raising, grain and sugar milling, and tanning and dyeing, among others, were especially significant. For example, the "*copajira* waters" resulting from mining in Potosí contained numerous chemical elements such as copper, iron, lead, and tin, and other toxic residues used in metalliferous processing such as mercury, which ended up in the upper watersheds of La Plata (Bravo 2005: 78). Likewise, people bathed and washed their clothes and horses in irrigation ditches; they also openly dumped urine and sewage, and garbage and dead animals accumulated in the streets (Ardanaz 2003). Added to this was a lack of water treatment and the proliferation of waterborne disease vectors (Frias and Montserrat 2017: 30; Paniagua Perez and Arciello 2020: 148). Since the seventeenth century, there began to be some awareness of prophylaxis, although its progress was slow and precarious from

today's perspective; cities such as Buenos Aires were among "the most pestiferous in the world" (González Fasani 2015).

Exceptional events also occurred, whose consequences were entangled with the historically constructed conditions of vulnerability. The eruption of the Villarrica volcano in 1640, for example, polluted the headwaters of watercourses and made fishing and drinking impossible (Gascón 2005: 10); in 1626, the rupture of the San Ildefonso reservoir in Potosí, the most significant colonial hydraulic disaster, killed more than 2,000 people, destroyed or affected 132 sugar mills, and caused monumental economic loss (Gómez Saavedra 2022: 668). Although the impacts have generally been attested to in urban nodes, these changes undoubtedly radiated into the hinterlands. The effects of incipient land clearing in the arid and some of the forested areas, as well as agro-livestock expansion in the plains, are difficult to measure but probably had an impact on runoff dynamics, water infiltration, and fire frequency, processes in which hydrological dynamics are entangled with the intended and unintended effects of these economic activities. Far from being isolated, these factors were articulated among themselves and marked the emergence of a new system of links with water dynamics, marked by these territories' transformation into colonial domains of continental scope.

Final Considerations

As evidenced, the water linkage systems in the Southern Cone resulted from a territorial co-construction process that inextricably entangled spatial and temporal differences of biophysical water dynamics with Indigenous, African, and Iberian socioeconomic and cultural patterns. The link between water dynamics, catastrophic effects, and hydrological alterations in this part of America was not the result of a natural development or a pre-established civilizing process of the human species. Instead, European conquest and colonization broke down the Indigenous adaptive systems and reconfigured those hydro-social territories based on peninsular economic, geopolitical, and social interests within the framework of a system of global interconnections. At this stage, the interactions of urbanization, mercantilization, and other elements shared in the American territories in relation to how to approach and relate to water dynamics are not the result of a natural or supernatural mandate but emerged as a product of a contingent historical, geographical, and political process. This progressive contingency, rooted in history, politics, and geography, in which water became the object of colonization and exploitation, marks a qualitative difference from previous processes and can be considered evidence of the emergence of the Anthropocene. Likewise, this system of interactions was articulated with other territories on a global scale, representing a subordinate space subject to plundering.

The process was based on a system of interconnected cities, socio-natural nodes of novel extractive practices, and impacts related to water: regulations, power relations, socio-technical elements, conflicts, and environmental effects that radiated to a greater or lesser degree towards their extensive jurisdictions. In general, major cities such as Santiago de Chile, Buenos Aires, Asunción, Montevideo, and São Paulo retained their predominance, and the hydro-social configuration of the period was a good predictor of future problems. Despite the convergence mentioned above, the socio-natural restructuring differed based on interests, possibilities, and limits that originated in the entanglement with the distinctive water dynamics of the arid region, the Chaco-Pampa plains, the Atlantic and Valdivian forests, and the gigantic wetlands. Finally, the regime under analysis produced significant inequalities based on ethnic and social differences that persisted over time. The colonial foundations, far from being irrelevant, fed back, spiraled, and deepened throughout the nineteenth and twentieth centuries so that understanding the origins of this specific hydro-social fabric between the sixteenth and eighteenth centuries is an inescapable necessity to understanding the subsequent stages in the Anthropocene's current configuration.

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