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Hydrosocial cycles, territories, and scarcity: shaping inequalities and exclusion in water access - an integrative systematic review

Ciclos, territórios e escassez hidrossociais na construção de desigualdades e exclusão do acesso à água: uma revisão sistemática integrativa

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ABSTRACT: This article presents the findings of an integrative systematic review conducted in the field of political ecology, employing the concepts of cycles, territories, and hydrosocial scarcity to analyze water access inequalities and precarious ness. Through a systematic search across four scientific databases, a total of 24 articles published between 2009 and 2020 were identified. These articles employed the hydrosocial approach to explore asymmetries and exclusion in water access. The results reveal that most studies are focused on case studies conducted in developing countries, with a particular emphasis on Latin America. These studies investigate the implementation of market logics with intensive water use for rural export or examine significant social inequalities within urban settings. Furthermore, the strategies employed for water control and exclusion encompass a wide range of actions. These actions include disrupting traditional practices and cultural meanings associated with water among social groups, as well as manipulating hydraulic infrastructure and managing water supply services. Overall, this systematic review provides valuable insights into the understanding of hydrosocial dynamics and their implications for water access, highlighting the complexities and challenges faced in various socio-environmental contexts.

Keywords: hydrosocial cycles; hydrosocial territories; hydrosocial scarcity; inequalities in access to water.

RESUMO: Este artigo é resultado de uma revisão sistemática integrativa da literatura científica do campo da ecologia política, que faz uso dos conceitos de ciclos, territórios e escassez hidrossociais para a análise das desigualdades e da precariedade do acesso à água. A partir da busca sistemática em quatro bases científicas, foram identificados 24 artigos entre os anos de 2009 e 2020 que utilizam a abordagem hidrossocial para discutir assimetrias e exclusão do acesso à água. Nos resultados, obteve-se que os estudos que evocam esta análise caracterizam-se, em suma, como estudos de caso em países em desenvolvimento, em especial da América Latina, onde existe a implantação das lógicas de mercado com uso intensivo de água para a exportação no meio rural ou com grandes desigualdades sociais no ambiente urbano. Ainda, que as estratégias de controle e exclusão da água percorrem desde a quebra das práticas tradicionais e dos significados culturais nas relações de grupos sociais com a água à manipulação das infraestruturas hidráulicas e gestão dos serviços de abastecimento.

Palavras-chave: ciclos hidrossociais; territórios hidrossociais; escassez hidrossocial; desigualdades do acesso à água.

1. Introduction

The development of societies as we know them today is intricately intertwined with water. Water has transformed society, just as society has transformed the water cycle, creating a symbiotic relationship where both continually shape and reshape each other across space and time (Linton & Budds, 2014, p. 175).

In the field of critical political ecology, which emerged in the 2000s, the mutual transformation between water and humans, and humans and water, has become a central focus. This has given rise to the concept of the "hydrosocial cycle" (Swyngedouw, 2004), which reconfigures the natural water cycle by recognizing its circulation as a combined physical and social process (Swyngedouw, 2004; Budds, 2008; Linton, 2008; Bakker, 2012; Linton & Budds, 2014). The hydrosocial cycle acknowledges that the water cycle is not solely a natural phenomenon, but rather a product of interactions between humans and water, as well as interactions among humans within society, encompassing economic, political, social, environmental, and cultural dimensions.

Through these hydrosocial relationships established between various social actors and water, new territorial configurations in geographic space emerge. These territories become spatial arenas where water-related conflicts and disputes unfold. This leads to the concept of hydrosocial territories:

> the contested imaginary and socio-environmental materialization of a spatially boundmulti-scalar network in which humans, water flows, ecological relations, hydraulic infra-structure, financial means, legal-administrative arrangements and cultural institutions andpractices are interactively defined, aligned and mobilized through epistemological beliefsystems, political hierarchies and naturalizing discourses (Boelens *et al*., 2016, p. 2).

The emergence of new societal arrangements regarding water, manifested in the physical landscape, determines which social actors have access to the water resource and which ones do not. Social groups lacking social, political, and economic power are subject to exclusion from accessing water

due to the ongoing discursive and material struggles over water control. These groups experience a form of water scarcity that is not primarily driven by hydrological factors but is socially produced, as water resources are directed towards capital accumulation. This phenomenon is referred to as "hydrosocial scarcity," which is a result of specific hydrosocial cycles rooted in capitalist ideology. It leads to a segmentation of water access based on the availability of financial resources, conditioning individuals' participation in the hydrological cycle to their income level (Swyngedouw, 2004; 2009).

This article is motivated by the observation of the increasing interest in literature that explores the concept of "hydrosocial" and its various manifestations within the field of political ecology of water. Its objective is to analyze both international and Brazilian literature concerning the utilization of the hydrosocial approach in relation to the asymmetries of access to drinking water and socially produced scarcity. The article seeks to examine the contexts in which the term "hydrosocial" is employed and the specific aspects associated with it. Additionally, it aims to analyze the extent to which the concepts of "hydrosocial territories" and "hydrosocial scarcity" are employed in the literature, with the intention of highlighting their evolution towards more profound discussions on territorial inequalities and the challenges faced by socially vulnerable groups in accessing water, which lies at the heart of hydrosocial relations.

2. Methodology

This article presents an integrative systematic review of the literature on the term “hydrosocial” related to inequalities and the scarcity ofaccess to water. It seeks to address a guiding question using explicit and systematic methods for the selection and evaluation of relevant literature on the topic (Sampaio & Mancini, 2007). It also critically appraises and synthesizes the findings, aiming to contribute to reflections for future studies that adopt political ecology of water as a theoretical and methodological orientation (Mendes *et al*., 2008).

For this purpose, a systematic search was conducted onelectronic databases of scientific publications, namely: Web of Science, Scopus, Science Direct, and Springer. Access to these databases was obtained through the *Portal de Periódicos Capes* (Brazilian Federal Agency for Support and Evaluation of Graduate Education). Since the topic is considered relatively new, starting from the 2000s, no predefined publication period was set for the studies. It is worth noting that no systematic literature review study was found in the conducted searches that aims to gather and analyze studies in the field of political ecology of water that adopt the hydrosocial approach as a starting point to examine the issues of inequalities and precarious access to water. The searches were performed in May 2021.

Initially, several keywords and commonly used expressions from the literature on the topic were used to compose the search descriptors. After multiple attempts, the successful descriptors were: "*hydrosocial*”; "*scarcity*”; "*water scarcity*"; and "*hydrosocial territories*”. Combinations were then made using the Boolean connectors "*and*" and "*or*" in the "*Title and/or abstract*" + "*keywords*" field.

The inclusion criteria for articles election were established as follows: studies that addressed the asymmetries of access to water in regions or social groups related to the hydrosocial theme; published

in the predetermined databases; and written in Portuguese, English, or Spanish. The exclusion criteria were as follows: studies that did not qualify as peer-reviewed articles; studies that did not address the hydrosocial theme; studies that did not include the established descriptors in the title, abstract, or keywords; and studies that did not address inequalities related to access to water or water scarcity. To determine the selected articles, both abstracts and full-text articles were read.

3. Results

The search in the four databases yielded a total of 112 articles, all in the English language. After applying the defined exclusion criteria, 24 full articles remained to be critically analyzed regarding the context and application of the hydrosocial approach in discussions on asymmetries in access to water and socially produced scarcity. The synthesis of the results of the systematic search is presented in the following flowchart (Figure 1).

Table 1 displays the 24 selected articles for analysis, organized by authors, year, country of publication, and their titles.

Out of the total selected articles, only one is of a conceptual nature. The vast majority – 23 articles

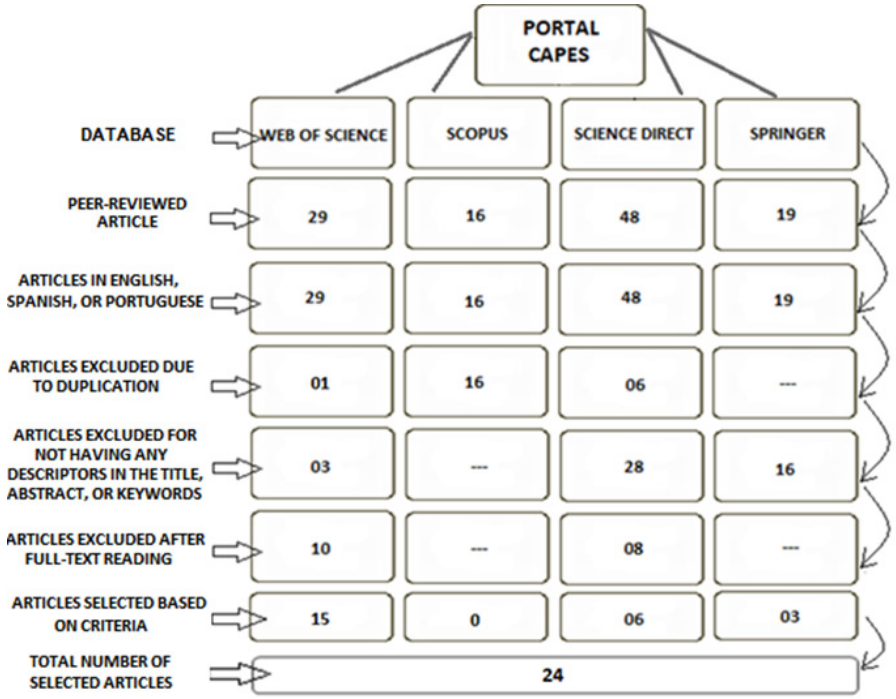

FIGURE 1 - Systematic flowchart of the search.
SOURCE: The authors, 2021.

TABLE 1 - List of selected articles for analysis.

Authors	Year	Country	Title
Budds, Jessica	2009	United Kingdom	Contested H2O: Science, policy and politics in water resources management in Chile
Boelens, Rutgerd	2014	Netherlands and Peru	Cultural politics and the hydrosocial cycle: Water, power and identity in the Andean highlands
Linton, Jaime; Budds, Jessica	2014	France, Canada, and United Kingdom	The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water
Loftus, Alex; March, Hug	2016	United Kingdom and Spain	Financializing desalination: Rethinking the Returns of Big Infrastructure
Rogers *et al.*	2016	Australia	Governmentality and the conduct of water: China's South–North Water Transfer Project
Ioris, Antônio A. R.	2016	United Kingdom	Water scarcity and the exclusionary city: the struggle for water justice in Lima, Peru
Usón, Tomás J. *et al.*	2017	Germany and Chile	Disputed water: Competing knowledge and power asymmetries in theYali Alto basin, Chile
Haeffner *et al.*	2017	United States	Urban water development in La Paz, Mexico 1960-present: a hydrosocial perspective
Hommes, L. e Boelens, R.	2017	Netherlands	Urbanizing rural waters: Rural-urban water transfers and the reconfiguration of hydrosocial territories in Lima
Paerregaard, Karsten	2018	Sweden	Power in/of/as water: Revisiting the hydrologiccycle in the Peruvian Andes
Millington, Nate	2018	South Africa	Producing water scarcity in São Paulo, Brazil: The 2014-2015 water crisis and the binding politics of infrastructure
Hommes, L.; Boelens, R.	2018	Netherlands	From natural flow to 'working river': hydropower development, modernity and socio-territorial transformations in Lima's Rímac watershed
Workman, Cassandra L.	2019	United States	Ebbs and Flows of Authority: Decentralization, Developmentand the Hydrosocial Cycle in Lesotho
Damonte, Gerardo H.	2019	Peru	The constitution of hydrosocial power: agribusiness and water scarcity in Ica, Peru
Goldman, M.; Narayan, D.	2019	United States	Water crisis through the analytic of urban transformation: an analysis of Bangalore's hydrosocial regimes
Ženko, M.; Menga, F.	2019	Spain and United Kingdom	Linking water scarcity to mental health: Hydro-social interruptions in the Lake Urmia basin, Iran
Damonte, G.; Boelens, R.	2019	Peru, Netherlands, and Ecuador	Hydrosocial territories, agro-export and water scarcity: capitalist territorial transformations and water governance in Peru's coastal valleys
Lopezetal.	2019	Netherlands and Bolivia	Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara watershed
Budds, Jessica	2020	United Kingdom	Securing the market: Water security and the internal contradictions of Chile'sWater Code
Laituri, Melinda	2020	United States	The hydrosocial cycle in rapidly urbanizing water sheds
Fragkou, Maria C.; Budds, Jessica	2020	United Kingdom and Chile	Desalination and the disarticulation of water resources: Stabilising the neoliberal model in Chile

Mena-Vasconez *et al.*	2020	Netherlands	Roses: the latest chapter in the conflicted history of controlling irrigation water in the Ecuadorian Andes
Mills-Novoa *et al.*	2020	United States, Netherlands, Ecuador, and Mexico	Governmentalities, hydrosocial territories & recognition politics: The making of objects and subjects for climate change adaptation in Ecuador
Bell, Martha G.	2021	Peru	Overlooked legacies: Climate vulnerability and risk as incrementally constructed in the municipal drinking water system of Lima, Peru (1578–2017)

SOURCE: The authors, 2021.

(95.8%) – consists of case studies. Among these cases, 18 are situated in Latin America, including one in Brazil. The other case studies are conducted in China, England, South Africa, India, and Iran. Additionally, one study presentsthree cases located in Kenya, Indonesia, and Ethiopia

The expressions and keywords associated with the hydrosocial theme found in this review were: *"modern water", ‘‘rationality’’, "rationalization", "hydrocosmological", "hydrological information", "infrastructure", "discourses", "dominant discourses", "techno-science", "financing", "water rights", "water control", "water scarcity", "hydrosocial networks", "hydrosocial imaginaries", "hydropower", "governability", "languages of water rights legitimation", "materialization", "hydraulic infrastructure", "hydraulic projects", "hydraulic technologies", "hydraulic investments" and "hydraulic property".*

In the selected articles that focus on case studies, it was observed that the conflicts presented within hydrosocial relations occur between social actors belonging solely to rural areas, between social actors from rural and urban areas, and between social actors belonging solely to urban areas. Given these spatial characteristics at the core of hydrosocial relations, the results employing this approach, categorized as case studies, have been classified based on where these conflicts manifest: Inequalities and water scarcity in hydrosocial relations developed in rural areas (item 3.1); Inequalities and water scarcity in hydrosocial relations developed between rural and urban areas (item 3.2); and Inequalities and water scarcity in hydrosocial relations developed in urban areas(item 3.3).

Conceptually, Linton and Budds (2014) establish a connection between the hydrosocial cycle and water inequalities as well as socially produced scarcity. They emphasize the historical nature of the hydrological cycle, recognizing that the relationship between water and society is a multifaceted issue with historical, sociological, and regional complexities. In this context, the hydrological cycle is viewed as a representation of water that was created within a specific historical context, driven by specific political motives, thus highlighting its political dimension.

The authors delve into the process of water modernization, where water is transformed into reservoirs, canals, and networks for supplying drinking water. This process is shaped by institutions, practices, and discourses that dictate modes of control, management, and decision-making. Consequently, the social transformations and reconfigurations surrounding water determine the diverse ways in which this socio-natural hybrid flows in space and time.

The concept of the hydrosocial cycle allows us to move beyond the conventional view of the hydrological cycle, which regards water merely as a resource mobilized and exploited through hydraulic infrastructure for socio-economic development - a perspective often associated with the engineering field, dominated by technical discourses. While not disregarding the hydrological cycle, the hydrosocial cycle encompasses new dimensions derived from it. Unlike hydrology, which focuses solely on the physical dimension and isolates water from its social context, the hydrosocial cycle deliberately recognizes the social and political nature of water within a historical and relational-dialectical process through which water and society continuously shape and reshape each other.

According to the authors, the analytical perspective introduced by the concept of the hydrosocial cycle allows, for instance, the examination of the concept of virtual water by identifying the "hidden" water flows embedded in commodity production. This sheds light on the exclusionary social processes that are deeply intertwined with it. Lastly, the authors discuss the social and political factors contributing to the lack of access to clean water in Southern countries, which are not primarily driven by physical scarcity, population pressure, or technical limitations, but rather by the way water services are organized and managed, resulting in the deprivation of access for low-income groups.

3.1. Inequalities and water scarcity in hydrosocial relations developed in rural areas

Boelens (2014) and Workman (2019) demonstrate the rationalization of water as a neoliberal hydrosocial instrument that generates transformations in the individual identities of traditional communities and their relationship with water. According to Boelens (2014), within the field of political ecology, water rationalization consists of standardizing and externalizing local perceptions, rights, and cultures associated with water in accordance with dominant interests. Rationalization thus becomes a fundamental strategy for establishing control over representation and water regimes. Through rationalization, dominant hydrosocial cycles can be implemented, altering and establishing the materiality of water as H_2O, its flows, distribution, rules, and rights according to hegemonic interests.

Regarding the case presented, Boelens (2014) relates the rationalization Cinstigated by a neoliberal hydrosocial cycle to the Quechua peasant communities in the high Andean lands of Mollepata, Peru, which transformed their culture, symbolism, and rituals associated with water, historically inherited from Inca culture.

In Mollepata, rationalization completely extinguished the traditional hydrosociological cycle[1] of Quechua communities and replaced it with a cycle driven by market forces. Cultural, historical, spiritual identities, and beliefs of the communities, which

[1] The Andean "hydrocosmological cycle," described by Boelens (2014), describes the physical-natural and metaphysical-cosmological relationships of Quechua communities with water through their experiences that interconnect physical, human, and spiritual factors. For the Quechua communities, water rites and myths play a fundamental role in the annual agricultural cycle. The rituals present in the hydrocosmological cycle involve, for example, praying for rain during periods of severe drought and holding festivals in the periods leading up to the irrigation season, offering offerings near water sources or water entrances.

not only integrated the local social reality but also guided practices for human water use, were undone. In their place, new concepts, technical discourses, and identities were introduced - referred to by the author as "*socio-technical stabilizers*" (Boelens, 2014, p.236).

The author discusses how the traditional hydrosocial cycle in Mollepata was gradually transformed by capitalism, initially through the construction of canals (hydraulic infrastructure) that stripped away the spiritual aspect of water access. Through hydraulic canals, community members were gradually transformed into "*water users*", "*beneficiaries of development*", "*responsible customers for water services*" and "*progressive producers for the international market*" (Boelens, 2014, p.244). Ultimately, they were excluded from access to water and replaced by large agro-exporting properties within a new rational hydrosocial pattern.

Workman (2019) presents the case of rural communities in Lesotho, South Africa, whose sole economic source is the export of water to industries. The author discusses how the decentralization of water resources and the government's choice of local chiefs to manage community tanks and water taps have impacted the social and hydrosocial relationships of the communities and individuals. The conflict of identities and legitimacy between government representatives on water boards and traditional community chiefs directly affected collective access to water and ultimately restricted access for individuals who disagreed with the established model. Workman (2019) elucidates how the scarcity and exclusion of access to the remaining water (not exported to industries) experienced by individuals in rural communities in Lesotho reflects a hydrosocial cycle that combines a neoliberal logic on a macro scale (exporting already scarce water resources from the country) and an artificial disruption of social and political tradition on a micro scale (through the establishment of government representatives on local councils).

The works of Usón *et al*. (2017), Budds (2009; 2020), and Damonte (2019) focus on the Yali, Quillota, and La Ligua River Basins in Chile, as well as the Ica region in Peru. In common, these studies demonstrate how hydrological data can be manipulated and used as instruments to favor dominant social actors. In these cases, the production of specialized knowledge and bureaucratic management became drivers of scarcity for social groups with less influence, while legitimizing access through discourses of technological efficiency for others. Scientists and technicians played central roles in excluding access to water by deciding which information would be used in reports and assessments. In this context, the authors associate the efficiency of instrumentalizing science with the formation of "*coalitions*" (Damonte, 2019) or "*strong socio-technical networks*" (Usón *et al*., 2017). In the studies, these socio-technical networks consisted of agribusiness, governments, scientists, and technicians. According to the works, such hydrosocial networks exert control over water through three interrelated dimensions of power: "*economic capacity, technical knowledge, and coercive capacity*" (Damonte, 2019, p. 3).

In the cases discussed, with the depletion of groundwater levels, agribusiness funded the production of reports that led to changes in legal frameworks regarding water rights, hindering access for small farmers and rural residents who were deemed inefficient users. Some of the impacts of these new hydrosocial cycles included the extinction of irri-

gation canals and shallow wells, the abandonment of small properties, the supply of rural communities through water trucks, and the implementation of desalination for water supply with tariffs imposed on rural users. Finally, Damonte (2019) refers to the power of the hegemonic coalition over water, which transformed all rural hydrosocial relations in the basins, as "*hydrosocial power"*.

The articles by Lopez *et al.* (2019), Ženkoe Menga (2019), Mills-Novoa *et al*. (2020), and Mena-Vasconez *et al.* (2020) analyze the formation or reconfiguration of hydrosocial territories in rural environments.

Through a conflict over water control between two communities in the Pucara Basin, Bolivia, Lopez *et al.* (2019) demonstrate how the notion of hydrosocial territories allows for the examination of claims of water rights expressed in diverse and divergent "languages of legitimation." In this regard, the power to legitimize is closely related to specific normative dynamics in each location, historical political-cultural processes, and socionatural configurations.

By illustrating the premise through the conflict in the Pucara Basin, the authors demonstrate how investment in hydraulic infrastructure for irrigation was used in the dispute and legitimization of water control between the two communities. Additionally, they show how changes in political and institutional scenarios at various scales altered water rights and created new hydrosocial territories, in which water became detached from land ownership and linked to infrastructure ownership.

As a central axis of the article, through the presented conflict over water control, the authors illustrate how multiple imaginaries of hydrosocial territories coexist, revealing different interests and powers within the same geographical space. They address the dynamic nature of water rights claims (and their acceptance) within and between key water governance actors. Within these claims, different and conflicting perceptions of water rights emerge, developing alongside local irrigation processes: those centered on static legal doctrines, those based on traditional rights of peasants and indigenous communities, and those driven by market forces. Finally, they present how the establishment and alteration of a favorable institutional framework and structure became the determining factor in legitimizing traditional territorial claims in the basin and altering water rights.

Mills-Novoa *et al.* (2020) relates the configuration of hydrosocial territories in Ecuador to climate change. The study examines how governance strategies were used to recognize, formally and selectively, previously "invisible" local communities in order to implement two hydrotteritorial projects that would address the country's climate changes.

The FORECCSA[2] and PACC[3] projects, funded by multilateral organizations, altered the practices of local communities with water, excluding them from the final purely technical decisions. As strategies used to materialize hegemonic imaginaries and reconfigure the hydrosocial territories of the communities in question, they mention: the creation and modification of laws; the production of rational and economically maximizing individuals; the diffusion

[2] *Enhancing Resilience of Communities to the Adverse Effects of Climate Change Effects on Food Security* (FORECCSA).

[3] *Adaptation to Climate Change through Effective Water Governance in Ecuador* (PACC).

and internalization of dominant discourses within communities; and the oppression of contrary or divergent positions. The authors conclude how the application of a discourse (climate change) about a specific object (vulnerable hydrosocial territories in need of intervention) and dominable subjects (local communities) can make hegemonic hydrosocial territorial projects materialize and become unquestionable.

Mena-Vasconez *et al.* (2020) present how the production of flowers for the international market in the Pisque Basin, Ecuador, transformed local hydrosocial territories. The study demonstrates how the hydrosocial territory of the watershed was imagined and materialized in very different ways by different actors (small farmers - flower industry - water supply for Quito). Also, how small rural landowners, within the created neoliberal logic, were gradually marginalized and excluded from irrigation rights.

In their conclusions, the authors raise the question of prioritizing an export industry of a non-edible product over other uses, as constitutionally, water use for these purposes has lower priority than human supply or food production. They emphasize that the new logic for water use legitimizes the disappearance of traditional hydrosocial territories and the creation of hegemonic hydrosocial territories, amplifying the water insecurity of the already water-sensitive basin.

Ženko and Menga (2019) present the case of the community in the Lake Urmia Basin in Iran. The authors demonstrate how interventions and disruptions in water flows, through the construction of irrigation dams and water transfers for urban supply, have resulted in a scarcity in the hyper-saline lake of the water source.

The authors mobilize the notion of hydrosocial imaginaries, manifested in the direction of water flows, which result in an unequal distribution of burdens and benefits for different social groups and regions, reflecting their social and political power. In the case of the Lake Urmia Basin, they elucidate how the use of state regulation mechanisms (discourses, rationality, efficiency, and implementation of hydraulic infrastructure) has modified the hydrosocial territories of the region, creating winners and losers in terms of water resources and ultimately excluding the traditional community of the lake.

As a result, the socially produced scarcity and hydrosocial reconfiguration in the basin territory have triggered irreparable mental health problems (emotional and psychological) for the local community. It has also caused severe social damage (male emigration, changes in family structures, competition for remaining water), environmental damage (sand and salt storms, water scarcity for small-scale agriculture and supply), and economic consequences (poverty). By delving into the mental health impacts on the community, the authors have found cases of stress, solastalgia, anxiety, depression, feelings of despair, sadness, hopelessness, isolation, helplessness, loss of identity and belonging to the environment, denial of reality, among others. They have also observed an increase in diseases such as cancer, kidney stones, respiratory problems, and ophthalmic issues, possibly as a consequence of salt storms and food salinization.

In their considerations, Ženko and Menga (2019) shed light on how the consequences of water-induced scarcity can be more severe than physical scarcity, as they promote emotional reflections such as a sense of powerlessness in the face of hegemonically established hydrosocial realities.

3.2. Inequalities and water scarcity in hydrosocial relations developed between rural and urban spaces

Rogers *et al*. (2016), Haeffner *et al.* (2017), Paerregaard (2018), and Fragkou and Budds (2020) present hydrosocial cycles that subject rural water access logics to the needs of urban water supply.

In China, Rogers *et al*. (2016) present the construction of a capitalist hydrosocial cycle through large-scale hydraulic infrastructure for water transfer in economically representative regions such as Beijing and Shanghai.

The authors associate the implementation of the new cycle with the mechanism of governability. In discussing the issues associated with the hydrosocial approach, they elucidate how water has become the object to be governed, and the ecological imbalance between the economically developed but water-scarce North and the economically "backward" but water-abundant South as the problem to be solved. In their analysis, they highlight the absence of discussions on the real causes of water insecurity in the North, which is a result of the adopted political and economic model.

They conclude that the hydrosocial relations established in favor of the economy penalized the rural population in the South with significant social impacts. According to the authors, with the assistance of governability, the impacts were justified by "*a great responsibility, and sacrificing their own interests and development*" (Rogers *et al*., 2016, p. 436).

Haeffner *et al*. (2017) describe how the established hydrosocial cycle in La Paz, Mexico, completely altered the natural hydrological cycle to meet the needs of the city's urban growth. The authors compare the hydrosocial cycle established in La Paz to an "inverted hydrology", where urban residents in the desert coastal zone are served first, and rural residents in the aquifer recharge zone, physically outside the city's political boundaries and hydraulic infrastructure, are served last. They emphasize that the new hydrosocial cycle promotes socio-environmental impacts and inequalities as water is "plentiful" in the urban environment and "scarce" in the peri-urban or rural environment.

In turn, the research conducted by Paerregaard (2018) and Fragkou and Budds (2020) demonstrates how hydro-social changes in rural areas have impacted access to water in urban areas. Paerregaard (2018) examines the transformation of water from the "hydrocosmological" cycle[4] to modern water[5] in the Peruvian Andes. Through two case studies, the author shows how the new hydro-social cycles established through water modernization have created two different perceptions of this socio-ecological element. While the rural community of Cabanac, located in the highlands, completely extinguished the hydrocosmological cycle of their ancestors in exchange for access to water through a state-managed canal system, the population of the city of Huancayo, in the lower part of the Andes, began to suffer from water rationing, pollution, increased tariffs, mining contamination, and the implementation of hydropower plants. The water crisis in the urban area, the lower part of the Andes,

[4] Physical-natural and metaphysical-cosmological cycle of individuals with water, laden with symbolism and spiritual beliefs.

[5] It unifies and transforms the various meanings, symbols, and representations of water into a single material element H_2O.

led the population to oppose the new hydro-social relationships imposed by the state in the highlands and to demand the revival of extinct rituals for "the water gods" in order to highlight the imbalance and the social, environmental, and economic impacts of the modernization of traditional water for the population at the receiving end of the system.

Fragkou and Budds (2020) analyze the introduction of desalination in the urban water supply of Antofagasta and Petorca, Chile, and the allocation of groundwater for mining and agriculture. The authors identify the economy as the key actor in accessing scarce freshwater and highlight three major implications of the established hydro-social cycle: the shift in water relations and control that has turned citizens into dependent users of desalination plants, with associated risks and tariffs; the maintenance of a capitalist perspective focused on profit maximization and intensive use of natural resources; and the public demobilization following reforms in the Chilean water code, which included desalinated water in the hydro-social cycle to mask existing and projected scarcity to the population, based on a market-based water model.

Ultimately, they find that desalination in Chile reinforces the role of the private sector in decision-making and reshapes social actors and institutional power, as desalinated water is considered a private product and remains unregulated. They conclude that the introduction of desalination into the hydro-social cycles of Antofagasta and Petorca reproduces the logic of scarcity for which it was designed, leading to increased disconnections of low-income individuals from the public water supply system, forcing them to rely on expensive and precarious methods of water storage, treatment, and conservation.

The studies by Hommes and Boelens (2017; 2018) discuss how the needs created by the urban imaginary for Lima, the capital of Peru, have transformed hydro-social relations and expanded into new territories. Both studies address how the discourse of "modern Lima, yet water scarce, and rural areas with abundant water but lagging behind" has legitimized the argument for greater hydro-territorial control by the capital.

Hommes and Boelens (2017) highlight the use of aggregated and total water supply data in Lima to legitimize the discourse of scarcity and the need for water supply from other sources to the capital. They also argue that the choice to use such data serves to mask and obscure internal inequalities in the capital, where wealthy neighborhoods enjoy water abundance and high *per capita* consumption while poor neighborhoods face scarcity. According to the authors, water scarcity in Lima is a socially and politically produced phenomenon that disproportionately affects different segments of the population and exacerbates existing socioeconomic and environmental inequalities.

In the other study, Hommes and Boelens (2018) address hydropower development and the hydro-social arrangements established to control access to water in the Rimac River Basin, also in Lima. They elucidate the discourses that supported and promoted the implementation of development and modernization projects in the capital and the construction of hydropower plants through the instrumentalization of the basin. In this context, they discuss how the formation of a strong hegemonic hydro-social network, composed of technicians, engineers, the state, and external funders, materialized through infrastructure, was fundamental for the establishment of the capital's development projects.

As consequences, they highlight how the governance structure created served to discredit contributions or questions from local communities and promote the internalization of hegemonic narratives, such as: the greater importance and overlapping of specific hydro-social territories to the detriment of others; favor, rather than the right, granted to communities for water access; the need for more water for the capital; and the promotion of a "necessary exclusion" of access to water for traditional communities due to the more severe effects of climate change on urban areas. They conclude that the internalization of the hegemonic imaginary triggered a collective local sentiment of "secondary social actors" and "responsible for a greater good than their own needs," as well as the practice of restricting and oppressing behaviors opposing or dissenting from the dominant discourses among community members themselves.

Analyzing the formation of hydrosocial territories in Peru, Damonte and Boelens (2019) elucidate how the "boom" in agro-export in the Ica Valley has put pressure on water demand, impacting the water availability in the basin and the water supply to the urban area. The authors explain how political-economic and socio-institutional forces triggered the emergence of a new hydro-social territory in the valley, transforming it into a virtual water extraction zone, producing luxury export crops for the North and China. Furthermore, they describe how agribusiness elites instrumentalized water governance and its imaginaries, infiltrating state structures and guiding them to serve their interests. As a result, through their influence in the state apparatus, the hydro-social territory of the valley was economically reconfigured.

At the core of water conflicts among the expanding urban population, small-scale farmers, and agro-exporters, the authors analyze how the relationships between the state, society, and market forces shape the socio-economic and technopolitical structures in the configuration of hydro-social territories. They emphasize how the state becomes a political arena with the power to design, plan, implement, and transform territories according to the balance of coexisting forces, in this case, leaning towards the agro-export economy. Finally, they discuss how the new agro-exporter hydro-social territories have caused the abandonment of small properties and the renting of wells for "efficient water use" in rural areas. In the urban environment, the population has been subjected to intermittent water supply (exacerbated in poor neighborhoods), high levels of manganese, and disputes over the control and sale of the remaining water between the official supply company and local organizations.

3.3. Inequalities and water scarcity in hydro-social relations developed in urban space.

Millington (2018) and Laituri (2020) describe how hydrosocial relations in rapidly urbanizing cities with significant social inequalities disproportionately impact vulnerable populations.

Millington (2018) highlights how a severe drought occurring between 2014 and 2015 in the metropolitan region of São Paulo, Brazil, affected different social groups based on income levels. The author analyzes the social impacts on the poorer population resulting from the technical choice of "reducing water pressure in the distribution subsystem" as a response to the water crisis and

metropolitan water supply system. It demonstrates how the spatial distribution of socioeconomic strata - higher-income groups in the urban core and lower-income groups in peripheral areas - coupled with the pressure reduction in distribution, resulted in water scarcity in the more distant and impoverished areas.

In light of the hydrosocial analysis, Millington (2018) elucidates that important factors were overlooked within São Paulo's complex urban water cycle, such as the distance of peripheral neighborhoods from treatment centers, the architecture of affected buildings often with multiple floors, and the existence of peripheral properties without water tanks. It emphasizes that purely technical management combined with factors of the hydrosocial infrastructure led to scarcity and varying perceptions of the crisis among different socioeconomic strata: residents of the periphery had their water usage reduced at a rate almost twice as much as the wealthier urban core.

Based on the presented findings, the author concludes that the São Paulo government, through the state water and sewage company, Sabesp, co-produced the scarcity of treated water as the "pressure reduction" action, technically feasible for the crisis, only maintained an adequate water flow to central areas of the metropolitan core.

Echoing Millington (2018), Laituri (2020) presents three case studies in watersheds in Kenya, Indonesia, and Ethiopia. The author highlights how changes in hydrosocial cycles due to rapid urbanization penalize informal communities, particularly women and children, becoming an indicator of asymmetrical power relations. It points out that political solutions for watershed water management often rely heavily on technical expertise and neglect gender and social inequality issues.

In the context of a country in the Global North, Loftus and March (2016) combine the hydrosocial approach with industrial ecology to analyze the characteristics of the new water supply system in London, England. The implemented desalination system was presented as necessary to meet the new demands arising from population growth and potential precipitation reduction due to climate change.

The authors demonstrate how the created discourse of scarcity legitimized the technological dependence on water desalination while disregarding any kind of demand management or loss reduction actions. In their analysis, they dissect the implemented hydrosocial system, which involves households as users of the water supply service and payers for the desalination technology, and a large group of foreign investors.

They conclude that the desalination plant for London's water supply is an example of a heavy infrastructure solution aimed at serving the logic of financialization of the economy that is being implemented in water supply services. By examining the scalar interactions between finance, waste, energy, and water flows throughout the urban hydrosocial cycle, they demonstrate that the choice for desalination is less related to the objective of providing water to the capital's population and more related to the instrumentalization of large-scale infrastructure assets aimed at maximizing financial returns for external economic investors.

Finally, Ioris (2016), Goldman and Narayan (2019), and Bell (2021) address how urbanization, coupled with socioeconomic inequalities, becomes a tool for reconfiguring hydrosocial territories, excluding the poor from accessing water, and

perpetuating social, economic, and environmental segregation.

Goldman and Narayan (2019) present the reconfiguration of hydrosocial territories in the city of Bangalore, India, which has disadvantaged the poorest communities, driven by the discourse of a global city. The (re)territorialization began with the replacement of the traditional canal system with a privatized, World Bank-funded piped water management system that only served middle and upper-class regions, industrial and technological hubs, and the airport. The poor population, excluded from water access, resorted to theft from the underground network and reliance on water tankers[6].

The authors discuss how the capitalist and developmentalist hydraulic project, materialized through the imaginary and discourse of a global city, disrupted the hydrosocial dynamics of the metropolis. They also highlight how financialization, promoted by multilateral institutions, played a crucial role in hydrosocial territorialization, as it created the need for high financial returns to repay the loans, leading to water supply being directed towards wealthier areas with greater returns, at the expense of poorer areas.

Lastly, the study demonstrates how water scarcity and the vulnerability of the poor were exploited for real estate speculation through the acquisition of land from small farmers and subsequent sale to investors, for the expansion of the water market through water tanker supply, and for electoral political interests by instrumentalizing and distributing water through water tankers in exchange for electoral support, votes, and favors to politicians.

Ioris (2016) and Bell (2021), as well as Hommes and Boelens (2017), discuss the production of hydrosocial territories and water scarcity in Lima, Peru.

Ioris (2016) associates the territorialization of water scarcity in the capital with the population's income. In his findings, the author determines that income differences among population strata are directly related to water service coverage rates. He notes that areas of the metropolis with medium and high income have nearly universal water supply, while low-income areas have much lower coverage rates and experience intermittent supply. Additionally, he finds that purchasing water informally in poor areas leads to a higher financial burden compared to the higher-income population served by the formal water supply system.

In his discussions, the author elaborates on how the physical water scarcity in the capital and the political changes that occurred led to public and public-private investments in locations and times with better financial and electoral returns. He highlights how the material and symbolic production of water scarcity in Lima is based on socio-spatial discrimination practices associated with the production of unequal urban development, which utilizes scarcity as a political instrument that maintains the population's poor expectations towards decision-makers. He states that "*scarcity of water has in effect become a central driving force behind interventions and public policies introduced by successive governments primarily to serve selective, non-democratic political and economic interests"* (Ioris, 2016, p.131).

[6] De origem ilegal, da própria companhia de abastecimento e/ou de políticos.

Finally, it concludes that water in the metropolis has become an instrument for privatization projects, with less investment than planned under public management; for the implementation of political-economic ideologies, using scarcity to promote institutional reforms, foreign loans, and public-private cooperation projects; and for corruption, through large engineering projects[7] associated with politicians, at the expense of actions in system management.

Bell (2021) analyzes the hydrosocial territorialization "of" and "in" Lima. Using the 2017 water crisis as a backdrop, she demonstrates that the widely disseminated discourse of water scarcity in the capital is not a new phenomenon but rather historically constructed.

The author addresses how hydraulic infrastructure and management have contributed to the current city's vulnerability and risk to climate change and to inequalities in the distribution and access to potable water in urban spaces. She discusses how lack of transparency in water supply data and the publication of total consumption and network access data contribute to: masking the vulnerability of specific population groups and decision-making criteria; selectively expanding the urban hydraulic system; justifying the increase in large water capture and storage infrastructure; as well as impeding regulation of service distribution to the population. She demonstrates how Lima's water supply infrastructure maintains the legacy of the colonial system to this day, particularly regarding: the geographic location of networks; the preference to provide service to economically and socially representative groups; the pursuit of expanding the hydrosocial territory of the capital, justified by the narrative of increased water demand; dependence on a single source for the entire capital's water supply; and the use of discourse on physical water scarcity to depoliticize socially produced scarcity targeted at the poorest segment of the urban population.

It concludes that the lack of transparency in Lima's data, which characterizes the capital as a water-scarce hydrosocial territory, obscures and impedes debates on inequalities in access to the public water supply system, with the poorest being the most vulnerable. It reinforces the discourse calling for greater investment in selectively directed large-scale hydraulic projects and neglects any alternative solutions for demand management.

4. Discussion

Based on the results, it was observed that the selected articles are mainly case studies conducted in Latin American countries, primarily Peru, Chile, Bolivia, and Ecuador. Only one article from South Africa was found that applied the hydrosocial analysis to water inequalities in Brazil. The research results also highlighted a significant number of publications from Europe, followed by North American ones. In all cases, the hydrosocial approach permeated water conflicts embedded in socio-economic contexts driven by capitalist logic. In these contexts, dominant social actors, due to their favorable political and economic positions in power structures, played a decisive role in introducing new cycles, shaping territories, and promoting hydrosocial scarcity, which primarily affects low-income and disempowered social groups.

[7] Como barragens e estações de tratamento de água.

In general, the review revealed that water modernization and rationalization, in line with dominant market-oriented values, changes in legal frameworks, and the ability to influence and exert economic control over governance structures were the most commonly used mechanisms to drive transformations in hydrosocial cycles.

Regarding studies applying the concept of hydrosocial territories formulated by Boelens *et al*. (2016), the creation or reconfiguration of these territories through hydraulic infrastructure that materializes hegemonic imaginaries and discourses stood out. It is worth noting that the alignment of water legislation with the neoliberal political-economic model and the interference of national institutions and development-oriented international organizations were decisive in reshaping territories marked by socio-economic inequalities and artificial water scarcity for vulnerable social groups - the hydrosocial scarcity conceptualized by Swyngedouw (2004; 2009).

In the field, the main hydrosocial conflicts observed are the result of the implementation of export-oriented agribusiness and mining activities in water basins sensitive to increased demand, particularly in contexts where users with intensive water use are introduced. In all cases, it was pointed out that export productions were favored, even at the expense of the qualitative and quantitative water security of the basins in question. In contrast, exclusion of traditional communities, small landowners, and rural residents was induced, either due to lack of capital to invest in technology for access or due to the discourse of "inefficiency" of their water use (for not maximizing economic value from available water) or changes in water rights legislation that disregarded social, cultural, and historical aspects within their framework.

Another point observed in the review results was the funding and selective use of hydrological data by dominant social actors and established hydrosocial networks (hydrosocial coalitions) to create narratives and maintain control over water resources - which supports Linton and Budds (2014) view that hydrology is a political product. The formalization of studies funded by market actors, the selective choice and dissemination of hydrological data, and the formation of coalitions with the state supported changes in legal frameworks and the exclusion of social actors lacking economic and political capital, considered as secondary social actors. Through the hydrosocial power to control water ("*hydrosocial power*"), scientists, technicians, and the state became key agents and institutionalizers of water inequalities and scarcity for individuals and social groups with less power.

Furthermore, in rural areas, according to the results, hegemonic control over water in traditional and historical communities was achieved through the introduction of modern logics associated with neoliberal capitalism and the rupture of cultural and historical connections with water. It was observed that the exclusion of existing water symbolism, representativeness, and meanings, transforming water into a single materialized element H_2O - a fixed, neutral, acultural, timeless element subject to rationalization of use and integration into market logics - not only transformed the hydrosocial practices of traditional communities with water but also altered their internal dynamics and social structures.

In the relationships between rural and urban areas, the results demonstrated that water flows were driven by the power of economic capital. In

most cases, interests in urban modernization and development created a greater demand for water and the expansion of hydrosocial territories in cities, reducing flows to traditional communities and water availability in river basins. However, in some cases, the introduction of agro-export or mining logics maintained water flows in rural areas, causing scarcity in urban environments and even the implementation of desalination systems for water supply - as shown by Fragkou and Budds (2020). In both relationships, the most vulnerable population from a social and economic standpoint was the most affected, having to cope with socially produced scarcity and its environmental consequences.

In urban areas, it was observed that socioeconomic inequalities, which are very prominent in these environments, are decisive in shaping hydrosocial cycles. In these spaces, the geographic distribution of higher-income social groups determines the orientation and intensity of water flows.

In the only case in this review that occurred in a developed country (London, England), the discourse of a possible future water scarcity was produced to justify the implementation of a desalination system in the hydrosocial cycle, with the aim of benefiting large financial investors. In Southern countries, as mentioned earlier, desalination was introduced in urban environments during water crises, with the choice to benefit rural economic elites. In these contexts, opting for desalination for population supply had social, economic, environmental, and political impacts, such as: increased tariffs burdening the population for the cost of the technology (at the expense of the productive sector); invisibility of the underlying causes of water insecurity; discouragement of demands for water law reforms; strengthening of capitalist perspectives in introducing a new productive market (desalination); maintenance of intensive water use; introduction of a product considered private and not subject to current regulation (desalinated water), among others.

Lastly, in urban areas, analyses focusing on the social territorialization of water reveal how supply management produces inequalities and exclusion of access in these spaces: Ioris (2016) correlates the territorialization of urban water distribution with the socioeconomic strata of Lima's population; Hommes and Boelens (2017) and Bell (2021) highlight the lack of transparency in data to mask the tendency of water supply and investments in higher-income areas; and Damonte and Boelens (2019) point out intermittent water supply in favor of directing flows to flower agro-export.

In this review, the analysis of the construction of inequalities and marginalization of water access from a hydrosocial perspective also reveals: the role of diffusing hegemonic discourses to accept inequalities and exclude access; manipulation, lack of transparency, and use of selective hydrological data or aggregated supply data as strategies to obscure and hinder debates on the causes of non-fulfillment of the right to water; preference for macro-hydraulic structures over demand management; reduction of water availability from water sources and aquifers as drivers of exclusion and hydrosocial deterritorialization of disempowered groups; strategies for water control that link access to water with economic and technological maximization of use; and the greater severity of the effects of socially produced water scarcity compared to physical scarcity, with severe emotional and psychological damage to individuals excluded from access.

As a final result, no studies were found in the search that directly use the concept of "hydrosocial

scarcity". Although some of the analyzed studies provide data that confirm socially produced and targeted scarcity to lower-income social groups, both in rural and urban environments, none of the authors directly used Swyngedouw's (2004; 2009) conceptual expression in their discussions. However, a greater use of the correlation "access to water x income" was observed in the urban environment (as highlighted by Swyngedouw) and "access to water x hydrosocial territories" in the rural/countryside setting.

5. Final remarks

This review sought to highlight, through systematic and analytical research, the evolution of studies on the political ecology of water that incorporate the concepts of hydrosocial cycle, hydrosocial territories, and hydrosocial scarcity. These concepts are closely intertwined and complementary in the analysis of water inequalities and selective water scarcity. As a primary conclusion, it becomes evidente that the main focus of study on this topic is the Global South, particularly in Latin America, where market-driven logics with intensive water usage are implemented in contexts markedby significant social inequalities.

The analysis of the studies revealed that strategies forwater control and exclusion encompass a range of actions, from breaking symbolic connections and human relationships with water through the rationalization and modernization of water guided by capitalist principles, to the manipulation of hydraulic infrastructures and water supply management. These actions aim to meet market demands and accumulate capital. Thus, the lenses of the political ecology of water unveil the mechanisms that lead to territorial asymmetries in water access and socially produced scarcity for specific social groups, know as hydrosocial scarcity.

As recommendations, this study encourages the expansion of this review to include other databases. It emphasizes the need for furtherre search on the urban context and the production of hydrosocial scarcity. Given the complexity and inherent conflicts in these spaces, particularly in developing countries characterized by deep social inequalities, the asymmetries and exclusion from participation in urban hydrosocial cycles may be linked to and indicative of hegemonic interests shaped by historical-urban processes of land use and occupation. These interests are materialized in sociotechnical systems that regulate access to water. Consequently, it is recommended to explore sociotechnical systems and the promotion of hydrosocial scarcity in relationships between central areas and urban peripheries.

Lastly, there is a need for more research examining the hydrosocial impacts on gender issues, the influence of climate change scenarios, and the introduction of desalination systems or other expensive water sources for public supply. Furthermore, in-depth discussions are needed regarding the interference of external financing institutions and their effects on local and/or traditional hydrosocial relationships. Finally, it is recommended to develop research that investigates the impacts of hydrosocial relationships on the routines, physical health, and mental well-being of populations that are socially excluded from accessing water.

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