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Political ecological perspectives on an indicator-based urban water framework

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ABSTRACT

Water security is a key challenge in the 21st century. Consequently, several indicator-based frameworks exist to evaluate this issue along with water management. We use a political ecological perspective to identify if the City Blueprint Approach (CBA) integrates aspects of hydrosociality to assess urban water security. Aiming to critically examine the CBA through the lens of political ecology and different concepts of hydrosociality, we identify three problems – hybridity, spatial scale and power structures – hindering the representation of hydrosocial relations within the CBA. Finally, the benefits of integrating hydrosocial and political ecological conceptualizations into quantitative urban water frameworks are discussed.

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Introduction

By 2050, according to United Nations (UN) (2019) projections, 68% of the world's population will be living in urban areas. Growing population numbers, economic development and increasing living standards with higher per capita water consumption will lead to a drastic increase in urban water demand (McDonald et al., 2014), which in the face of limited water resources will lead to greater water competition, not only between different economic sectors and society but also between human and environmental needs. This scenario therefore represents a threat to socio-economic development as well as urban water security. Ensuring water security in cities is one of the main goals of governments and policymakers, as insufficient water supply can endanger food security, economic prosperity and even national security (Aboelnga et al., 2019), and thus it is seen by Srinivasan et al. (2017) as one of the key challenges of the 21st century. The term 'water security'[1] has no single definition, but the fundamental objective is to find a balance between human and environmental water demands (Srinivasan et al., 2017).

Issues related to water security, water management and conflicts about water are also covered by political ecology – a critical approach in human–environment research (Perreault et al., 2015; Robbins, 2019). It is understood as a diverse field combining theoretical and methodological approaches with socio-ecological relations, generally with a common interest in the politics of natural resource management, access and control (Bassett & Peimer, 2015). Furthermore, it focuses on the study of power relations and the co-production of nature–society relations (Benjaminsen & Svarstad, 2018) and questions

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the relations between nature and society whilst building on the idea of the social construction of nature (Neumann, 2009). By applying a political ecological analysis of urban water, insights into the power structures constituting and affecting water within cities can be gained, which in turn will lead to a more nuanced understanding of urban water and its effects on different groups in society.

Applying this perspective to the study of water security and indicator frameworks provides new insights, as the political ecology of water subfield focuses on control over and access to water through the social relations and politics which constitute them (Budds, 2009). Water is studied both discursively and materially in order to concentrate on the politically driven modes of water management. Studying water and its human appropriation with political ecology leads to a better understanding of the intricate network between actors and their interests (Acharya, 2015). Such hydrosocial research attempts to overcome the nature–society binary by conceptualizing water as a social and physical process that is internally combined and produces distinct hydrosocial configurations (Swyngedouw, 2009). The concept of hydrosociality emerged from the critique of the classical hydrological cycle and included the co-construction of society and water (Octavianti & Charles, 2019). Hydrosocial analysis critically examines contested water systems and processes, their networks as well as the social relations of power between actors, structuring their individual and collective action (Mollinga, 2014), whilst different approaches consider the relations between water and society, such as waterscapes (Baviskar, 2007; Karpouzoglou & Vij, 2017; Loftus, 2007), socionatures (Castree & Braun, 2001), the hydrosocial cycle (Damonte & Boelens, 2019; Workman, 2019) and hydrosocial territories (Boelens et al., 2016; Hommes et al., 2019). Reflecting on these concepts contributes to consider, as possible, all dimensions of urban water security; however, the differentiated view of political ecology and hydrosociality has so far been lacking in various indicator-based frameworks, such as the City Blueprint Approach (CBA) (Van Leeuwen et al., 2012), which measures the sustainability of urban water cycles[2] and is described in detail in the section on 'Analysing the City Blueprint Approach'.

This paper illustrates the relationship between water and society in urban areas and identifies if quantitative urban water security frameworks integrate aspects of hydrosociality, and what such an integration would contribute to those frameworks. Furthermore, problems within urban water security frameworks are examined from a political ecological perspective by analysing the example of the CBA. First, the paper briefly introduces the idea of hydrosociality and its four classical conceptualizations: socionatures, waterscapes, the hydrosocial cycle and hydrosocial territories. The idea of hydrosociality is applied as a theoretical background for the analysis herein, and its different conceptualizations are examined, thus helping to consider all dimensions of urban water security from a political ecological perspective. The identified dimensions of urban water security are then applied, to analyse critically the CBA. Second, the three main problems within CBA frameworks – hybridity, spatial scale, power structures – are identified. Finally, the benefits of integrating the political ecological conceptualization of hydrosociality into quantitative urban water frameworks are discussed.

Hydrosociality

Political ecological research of water centres around the idea of hydrosociality, that is, the co-production between water and society, and vice versa, and it is analysed and studied by concepts such as water as socionature, waterscapes, the hydrosocial cycle and hydrosocial territories. In the following, these four different classical conceptualizations are described in brief.

The idea of water as *socionature* overcomes the nature–society dichotomy (Bear, 2017), as nature and society are acknowledged as ontologically inseparable entities (Gellert, 2015). The concept emphasizes the production, enactment, mediation and contestation of people, places and things (Sze et al., 2009) and offers a source for politics and political work 'seeking to better both human society and non-human nature' (Alkon, 2012, pp. 663–664). Gellert (2015) argues that the examination of socionature contributes to a better understanding of power structures in time and place. Its co-creation recognizes the constant motion and the numerous shifts in social, environmental and ideational relations that are continuously constructed and deconstructed (Peluso, 2012). Water systems consist of myriad connected and interwoven pipes, canals and taps, all transporting water through the network, thereby illustrating the deep relations within a socionature, and yet they contain numerous contradictions, tensions and conflicts (Swyngedouw, 1999).

Flows of water are entangled in countless social, political and economic power relations, and they are also integrated and expressed through different scales, actors and institutions (Ridolfi, 2014). These relations are often studied by applying the *hydrosocial cycle* concept, which is based on three central ideas. First, the management of water affects the organization of society, and thus the spatial formation of water, and so a historical perspective is needed here, as this process reoccurs over time in an (ir)regular temporal pathway (Linton & Budds, 2014; Schmidt, 2014). Second, water and society are co-constitutive and internally linked, so they therefore produce specific kinds of water, depending on social relations and vice versa (Linton, 2010). Third, the materiality of water can structure or disrupt social relations (Linton & Budds, 2014). The hydrosocial cycle analyses the reciprocal reconfiguration between the hydrological cycle and social developments (Damonte & Boelens, 2019) whilst illustrating the linkage between water flows and power relations, emphasizing the societal and ecological effects emerging from these interdependencies and exposing the politicized nature of water (Budds et al., 2014).

The *waterscape* concept is concerned with socionatural networks constituted by the hydrosocial cycle in a distinct techno-political context, manifesting territories as historical socio-physical constructs (Damonte & Boelens, 2019).

Bakker (2003) studied the unequal power relations through privatized water networks in cities, whilst other studies focused on river basins such as Budds (2009) in Chile, regions such as south-eastern Anatolia (Harris, 2006) or whole countries, for example, Spain (Swyngedouw, 1999). However, waterscapes are not just a different spatial scale, they also articulate and express power through water-related artefacts, institutions and imaginaries (Budds & Hinojosa, 2012). Budds and Hinojosa (2012) state three distinct characteristics of waterscapes, first, the emphasis on the co-production of the waterscape; second, the shaping of waterscapes by socioecological processes over various scales of space and time; and third, the co-production of their power relations through various

water flows, technologies, institutions, meanings and discourses allows the concept of waterscape to analyse hydrosocial relations (Budds & Hinojosa, 2012).

Lastly, the *hydrosocial territories* concept builds on different conceptualizations and materializations regarding the flow of water whilst also integrating the relations between social, natural, technical and physical spaces (Damonte & Boelens, 2019). It focuses on the multitude of territories and their imaginaries, all of which exist in the same geographical space (Hommes et al., 2018).

Analysing urban water security

Urban water security is a broad concept that can be differentiated from water security through a distinct spatial focus on an urban area, a municipality or an urban agglomeration (Hoekstra et al., 2018). Jepson (2014) defines 'human development', 'ecological sustainability', 'geopolitics and international relations' and 'vulnerability and risk' (p. 108) as the four themes of water security. Hoekstra et al. (2018), in the meantime, argue that 'increasing economic welfare, enhancing social equity, moving towards long-term sustainability or reducing water-related risks' (p. 2) are the four different focuses which water security concepts incorporate to different extents. Countless definitions and conceptualizations of (urban) water security exist which approach the topic from many different angles, depending on the disciplinary perceptive. For example, studies rooted in the field of engineering often focus on water-related hazards such as droughts, floods and protection against these hazards, whereas studies located in environmental domains mainly target issues regarding water access, water availability and waters services for humans and the environment (Hoekstra et al., 2018). The thematic as well as the spatial focus points differ depending on the discipline; whilst hydrologists generally analyse issues on a catchment scale, scholars from the social sciences often study water security on a community level (Cook & Bakker, 2012).

Departing from the political ecology of water and the concepts of hydrosociality, we identify seven different dimensions constituting urban water security: history, culture, discourse, physical environment, economy, politics and governance and society.

These dimensions were selected to account for the hydrosocial nature of water and enable a more holistic understanding into the structures and relations of urban water security from a political ecological perspective. The dimensions are based on a literature review of journal articles from the subfield of the political ecology of water (e.g., Baviskar, 2007; Budds, 2009; Damonte & Boelens, 2019; Hommes et al., 2019; Linton & Budds, 2014; Ridolfi, 2014; Swyngedouw, 2009) as well as on methodological and theoretical approaches of political ecological studies (e.g., Acharya, 2015; Bassett & Peimer, 2015; Benjaminsen & Svarstad, 2018; Neumann, 2009). As historical and discourse analysis are common approaches within political ecology (Neumann, 2009), we selected the dimensions of history and discourse. As Boelens (2014) highlights the cultural politics regarding water in the Andean highlands, we added the cultural dimension. Additionally, political ecology studies of water analyse the relations between political, social, economic and ecological dimensions and examine how the flow of water is embedded in and influenced through space (Ridolfi, 2014). Thus, the dimensions politics and governance, society, economy and physical environment are integrated as well. In the following, a rough overview of the seven dimensions and their included topics is given:

- The *historical* dimension contributes to a better understanding of the city's development and infrastructure. Historical processes and events are an integral part of the establishment of contemporary cities and still affect them and their inhabitants today. This is especially visible in previous colonial cities (Niasse & Varis, 2020).
- The *cultural* dimension is concerned with the topic of water as a cultural object and how it is traditionally valued and conceptualized in local[3] or indigenous communities. Even though diverse meanings of water exist, it is often understood by indigenous communities as a living or a spiritual being. These indigenous perspectives differ drastically with the Western notion – viewing water as a material substance to be used and extracted for human benefit (Wilson et al., 2019).
- The *discursive* dimension informs about the discourse around water and is related to questions such as how knowledge claims and rules are produced and established, how true and untrue knowledge is distinguished and what power relations exist to produce and sustain such claims (Boelens & Vos, 2012).
- The dimension of the *physical environment* involves the spatial and temporal availability of water, infrastructure and different water sources utilized within a city. Availability is spatially and temporally heterogeneous, and changes in this regard occur due to natural variabilities and the increasing human influence stimulating global climatic changes (Konapala et al., 2020).
- The dimension of *economy* is related, for instance, to the structure of water markets as well as pricing. Water privatization is concerned with organizational change in ownership and management from public to private control, whilst the commercialization of water leads to changes in water management institutions through the employment of private-sector institutions such as markets, principles of competition and efficiency measures (Bakker, 2002).
- The dimension of *politics and governance* is concerned with formal water management as well as water governance on different spatial scales. In today's society, scientific and technical knowledge is highly valued (Octavianti & Charles, 2019). Understanding of water governance has been dominated by the Western scientific concept of the hydrological cycle; thus, a significant part of water governance focuses on technological solutions (McDonald, 2018).
- Finally, the *social* dimension informs about different groups in society, the strategies they employ to access water and how they are affected, for example, by economic or political decisions regarding the provision of water. Many planners, government bodies and organizations believe that water access in cities is mainly conducted through formally managed piped water systems (Allen, 2019).

With this paper we contribute to the growing literature of urban water security through the lens of political ecology of water and the concepts of hydrosociality. The dimensions introduced herein represent the central components of urban water security from a political ecological perspective, which needs to be examined in order to uncover the relations and structures embedded and enacted within and through water. These dimensions were identified in relation to the hydrosocial nature of water and contribute to a more diverse understanding into the structures and relations within a city's urban water security from a political ecological perspective. Time and scale are an integral part of each dimension, and they are thus considered as well. Due to the multitude of relations

and the hydrosocial character of water, the identified dimensions cannot be studied on their own, as they are interwoven with each other on multiple levels. Therefore, their connections to and dependencies on other dimensions need to be considered and acknowledged as well. Studying water through a political ecological lens highlights the complexity of urban water security and governance as the cultural dimension is for example, directly linked to the dimension of politics and governance as well as the social dimension. Thus, through analysing water with political ecological concepts, such as the hydrosocial cycle, water itself is conceptualized much broader than in existing indicator frameworks, as those mainly focus on the hydrological aspects of water. However, the presented seven dimensions are not able to represent the complete spectrum, as they are individually diverse and can change according to geographical location. As a result, the identified dimensions represent a generalization, as they are not case specific; nevertheless, valuable insights into structures and relations within urban water security are gained if these dimensions are applied.

Analysing the City Blueprint Approach

The City Blueprint Approach was developed at the KWR Water Research Institute in the Netherlands. It aims to equip municipalities with a functional and broad framework to assess the sustainability and resilience of their water cycle and to support them in improving their water management (Koop & van Leeuwen, 2017). The CBA is composed of three subframeworks: the Trends and Pressures Framework (TPF) indicates the social, environmental and financial challenges influencing a city's water, whilst the City Blueprint Framework (CBF) assesses the current state of the integrated water resource management (IWRM) in the city. The Governance Capacity Framework (GCF) evaluates the handling of water-specific governance challenges by stakeholders (Aartsen et al., 2018). Figure 1 shows the three subframeworks of the CBA and the corresponding dimensions and categories.

The CBA has been applied to over 45 cities within Europe (Van Leeuwen et al., 2016), for instance, Amsterdam in the Netherlands (Van Leeuwen & Sjerps, 2016) and Sabadell in Spain (Šteflová et al., 2018). Outside Europe, cities such as Ho Chi Min City in Vietnam (Van Leeuwen et al., 2015), Melbourne in Australia (Van Leeuwen, 2015) or Ulaanbaatar in Mongolia (Munkhsuld et al., 2020) have been assessed. The development of the CBA and its subframeworks has continuously been improved through the integration of constructive feedback submitted by the cities themselves (Feingold et al., 2018). Due to the gradual development of the three subframeworks, not all have been applied to the total number of the studied cities. For example, the TPF and the CBF have been applied to approximately 70 cities so far, whilst the GCF has only been applied to around 15 cities (Aartsen et al., 2018; Koop, 2019). In the following, the TPF, CBF and GCF are presented in further detail.

The TPF was developed in order to better comprehend the overall context in which a city is situated (Feingold et al., 2018). To evaluate the performance of a city's water management, the context – urban water governance and infrastructure – has to be assessed as well (Kim et al., 2018). The TPF was established as a separate framework to distinguish better between the general complex situation in which the city is situated, the social, financial, and environmental settings and the performance of the city's IWRM

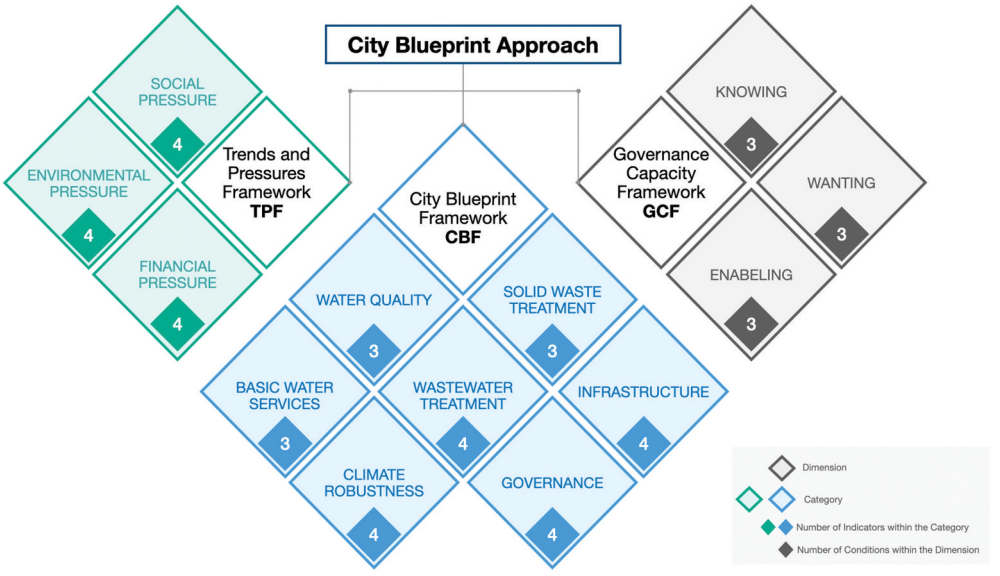

Figure 1. Overview of the city blueprint approach and its frameworks. Source: Adapted from Koop (2019).

(Feingold et al., 2018; Koop & van Leeuwen, 2017).[4] The framework focuses particularly on the trends and pressures affecting the overall context of water management in the studied city (Kim et al., 2018), and it is based on policy documents, reports, scientific papers and grey literature as well as the involvement of different water-related actors within city departments and organizations (Koop, 2019). Trends and pressures are evaluated using 12 indicators[5] in the three categories: social pressure, environmental pressure and financial pressure (Koop, 2019).

The CBF is a baseline assessment providing a quick overview of the state of the IWRM's sustainability (Van Leeuwen & Sjerps, 2016). The data used for the CBF are preferably assessed at city level, but data from international organizations such as the World Health Organization (WHO), the United Nations Environment Programme (UNEP) or the World Bank are also used – along with literature or official reports – to calculate the indicators (Munkhsuld et al., 2020). The CBF assesses the following seven categories, in order to depict the entire urban water cycle: (1) water quality, (2) solid waste treatment, (3) basic water services, (4) wastewater treatment, (5) infrastructure, (6) climate robustness and (7) governance, and these contain 25 indicators (Aartsen et al., 2018). The category governance is included in order to gain a short overview of the management, action plans, public participation and measures in terms of water efficiency. This is especially valuable for cities choosing not to conduct the GCF (Aartsen et al., 2018).

The GCF analyses the following five challenges related to water governance: flood risk, water scarcity, urban heat islands, wastewater treatment and solid waste treatment (Aartsen et al., 2018). It consists of three dimensions – knowing, wanting and enabling – all three of which are assessed for each of the five governance challenges. The knowing

dimension aims to assess the involvement of actors, their awareness and the need to learn continuously about the risks and impacts following strategic choices and policies. The wanting dimension refers to the commitment, cooperation and ambitions of actors solutions, whilst the enabling dimension assesses the potential of networks, resources and instruments the actors need to engage in water challenges. Each dimension is separated into three governance conditions, and every condition is assessed with three indicators (Koop et al., 2018). Data for the GCF indicators are obtained by using a triangular approach in three consecutive steps: (1) the analysis of documents, (2) interviews with key actors and (3) feedback from the actors on preliminary indicator scores (Koop, 2019).

In order to gain knowledge, if the approach integrated aspects of hydrosociality, we analysed the CBA and its subframeworks. During this process, the mindset, methods and stakeholders of the CBA were closely examined. With the mindset, the general conceptualization of water, to gain a better understanding of the selected topics and indicators, was assessed. Additionally, we evaluated the topics and clustered them according to the seven dimensions of urban water security presented in the section on 'Analysing Urban Water Security', focusing particularly on the analysis of dimensions represented within the CBA as well as on those not assessed therein. Furthermore, the data used within the frameworks, focusing especially on the spatial scale of the utilized datasets, were investigated. The scale indicates whether or not the dataset is able to represent spatial heterogeneity within an urban area, which is especially important for water, as it is essential for life and has high spatial variability. Lastly, we investigated the results of the CBA, in order to determine if it improves cities' water management.

On the basis of this analysis, we identified three main weaknesses of the CBA, namely hybridity, spatial scale and power structures, which collectively hinder the representation and integration of the hydrosocial nature of water, as we now discuss.

Lacking hybridity

Within the CBA, water is understood according to the IWRM principle, which is known as a process or framework to achieve water security within a spatial scale by integrating the hydrological aspects of water with its social, cultural, ecological and economic components (Aboelnga et al., 2019; Jensen & Nair, 2019; Linton & Budds, 2014). However, with the IWRM calling for the integration of the hydrological and social dimensions of water, the conceptual distinction between these entities is emphasized (Götz & Middleton, 2020); thus, the core understanding of the IWRM and hydrosociality oppose each other. The hydrosociality concept understands the entities of water and society as co-constructive, with internal relations producing each other recursively (Linton & Budds, 2014). Due to the distinction between water and society, the IWRM paradigm builds on the hydrological cycle as a neutral scientific concept employed to manage water within a city (Götz & Middleton, 2020). However, considering the internal inseparability between water and society, the hydrological cycle itself is viewed as a social construct within the hydrosocial research perspective (Linton & Budds, 2014), which only serves to distance the two concepts further from each other, since their core understanding of water differs drastically, thereby affecting their approach to its management. The IWRM tries to solve water issues through scientific and technological

solutions, albeit this ignores the roots of problems, for example, diverse social or political issues due to embedded power structures. As a result of the technocratic approach applied by the IWRM, water problems are depicted as apolitical and can easily be solved through different forms of management or new technologies. This is opposed by the concepts of hydrosociality within the field of political ecology. Budds et al. (2014) argue that because water shapes social relations, it contributes to different modes of governance; consequently, it is inherently political: first, through the uneven relations embedded within water itself, and second, through the impact the flow of water has on social relations. Additionally, the management of water includes political actions and human values next to the technological and infrastructural administration of water. Consequently, studies on hydrosociality focus on the complex power relations between human and non-human actors, in the economic, social, ecological and political dimensions of water.

Simplifying spatial scale

The analysis of processes on different spatial scales, and how they relate to each other is an integral part of political ecological analysis. Swyngedouw (2004) states that spatial scales are constantly created through socio-economic and political processes. Moreover, water also shapes and reshapes spatial scales through its reciprocal impact on other processes. Therefore, water and its relations need to be studied on different spatial scales.

One of the main problems of the CBA indicators is the scale of analysis, in that they only assess the national scale, mainly quantitatively, which does not allow for the assessment of the hydrosocial character of water within a city. The political ecology of water studies the flow of water within and through space, but as water is an integral part of different spatial scales, the boundaries between those scales are blurred (Baviskar, 2007; Ridolfi, 2014). Scale is often studied in the form of multiscalar networks – including marginalized groups as well as state and corporate actors (Ross & Chang, 2020), which helps assess the structures and uneven relations that are shaped by and shaping water in the examined space. The CBA's generalization of the various relations and meanings of water on a national scale diminishes its countless relations on other spatial scales.

Even though the examined spatial extent is not defined within the CBA, the assessment presents a time-specific picture of water within a city. Karpouzoglou and Vij (2017) describe the waterscape as a liminal landscape – representing the relational character of water – with dynamic, transgressive and fleeting attributes. However, the dynamic and fleeting character of water is not represented within the frameworks of the CBA, as interactions between water and society are overlooked. Therefore, the CBA does not consider associated spatial changes in management, distribution and the relations with and through water.

Ignoring power structures

Power is an integral part of hydrosocial and political ecological research, and it is studied by looking at actors, their relations and interests (Svarstad et al., 2018). Furthermore, power is examined on different spatial scales and geographical locations. Additionally, power is not only enacted by local actors on site, which directly influences the

environment, but also in national and international centres of power, for instance, in capital cities or at the headquarters of international organizations and companies (Svarstad et al., 2018).

The CBA framework only examines the different aspects of water within a city, but how and why these structures exist and how powerful actors influence urban water are not studied. As power is embedded within the structures and actors involved in the water sector and the city, it is indirectly integrated. However, power structures and their effects on and through water are not acknowledged within the CBA, as it only examines the material dimension of water and its effects.

The power structures between actors should be studied, in order to gain a better understanding of how water shapes and is shaped by power, thereby affecting social relations, and to gain insights into the uneven relations resulting from asymmetrical power relations. Only the GCF directly examines actors within the urban water sector, but within this subframework, only water experts are interviewed but no common water users. However, O'Leary (2018) stresses the importance of integrating everyday water users into the assessment, as they can contribute critical insights into systematic issues within the water sector, and their experiences can contribute to better comprehend the power relations and effects water has within a city. If everyday water users are not integrated into the research process, social and material inequalities are magnified, as power structures are studied purely from one perspective (O'Leary, 2018). As the CBA excludes everyday water users, it can be seen as a top-down approach, serving the status quo rather than improving it. Furthermore, the connections between the actors are not acknowledged. Neglecting the study of power relations within the CBA could, for instance, be due to a lack of resources, a result of the deliberate depoliticization of water management or due to a low understanding of the interrelations between the different (human and non-human) actors and the central role power plays between them.

Discussion: integrating hydrosociality into the City Blueprint Approach

Integrating the political ecological conceptualization of hydrosociality would have a positive impact on the indicator-based CBA. First, the understanding of water applied in the advanced CBA would be broader and more nuanced, due to the hybrid understanding of water, internally linking the social and physical processes constituting it. Broadening the definition would open up a more differentiated understanding of the water-related challenges and possibilities and thus deepen the knowledge of the relations between the materiality of water as well as the co-production of uneven social and power relations. Second, the analysis of multiple spatial scales and their relations is an integral aspect within political ecological research; more spatially heterogeneous data would be assessed to gain an enhanced insight into the water challenges and chances within different spatial scales of the city. Third, the embedded power structures and their impacts would be included into the advanced assessment, thereby leading to a better understanding of the web of relations connecting stakeholders and their interests. Examining the power structures within the lens of political ecology helps uncover uneven power relations shaping, for instance, the distribution, access and management of urban water.

The integration of hydrosociality would also need to extend the applied methods such as household surveys, interviews with different stakeholders – from policy makers to everyday water users – in various areas within the city or discussions with focus groups, desk-based research or collective mapping. The integration and incorporation of these additional methods would contribute to a more nuanced understanding of each of the assessed topics and thus provide an enhanced representation of spatial heterogeneity, as well as the power structures embedded within. Additionally, to improve and broaden already existing indicators and topics, the dimensions history, culture and discourse need to be incorporated as well. Through examining the historic dimension, the aspect of time would be included together with the cultural dimension, thereby increasing the understanding of how water was or is still used as a tool for power – creating disenfranchised groups in society in the process. Integrating the discursive dimension would contribute to a greater awareness of how language is used, for example, to legitimize the construction of water infrastructure by powerful actors, fostering uneven power structures and possibly changing the perception of water. Due to the integral understanding of water within the concept of hydrosociality, the advanced CBA would need to consist of one framework, which incorporates all dimensions of urban water security. This would allow the relations existing between the dimensions to be incorporated and assessed, as some indicators or qualitative results cannot be viewed separately.

However, the integration of hydrosociality within the framework would be accompanied by numerous challenges, such as the development of the advanced framework itself, the choice of indictors to represent all aspects of the hydrosocial character of water, the selection of methods to assess the indicators and dimensions and the assessment of the data itself. Here, the necessary amount of data as well as the selection of study sites to achieve representative results would need to be considered. The collected data should represent the different hydrosocial relations, socio-economic situations and power relations on different scales within the urban area. To evaluate the obtained data, a balance between the generalization and the depiction of various spatial scales would need to be found. This is especially important for the illustration of the results, as they should be easy to comprehend but also depict a high level of complexity in order to represent spatial heterogeneity, uneven power structures and different conceptualizations of water and its relations. Before a successful integration can be achieved, the issues mentioned herein need to be solved, and we should also be mindful that new challenges will emerge during the process.

Conclusions

The socionatures, waterscapes, hydrosocial cycle and hydrosocial territories concepts were briefly introduced, to gain insights into their conceptualizations of hydrosociality, which is understood as an internalized process of co-production between society and nature – more specifically water – whilst simultaneously acknowledging the materiality of water. However, every concept has diverse aims to gain insights of different fields and questions concerned with the hydrosocial nature of water. Therefore, an integrated approach of hydrosociality was applied in this study, in order to also include and analyse the spatial and political aspects related to and represented by water.

Through analysing the CBA, the extent to which it represents the hydrosocial nature of water was examined. Even if the IWRM mindset – which differentiates water and society in two separate entities – is neglected, the CBA only partially represents hydrosociality, and only the dimensions physical environment, politics and government, economy and society are represented within the framework. Furthermore, only certain aspects of hydrosociality are integrated, as the full extent of these dimensions is not completely assessed within the CBA. Additionally, the dimensions history, culture and discourse are not integrated into the CBA frameworks at all, thereby illustrating that they predominately analyse the material dimension of water. The aspects of hydrosociality that include the sociopolitical processes involved in co-producing water are not considered within the framework – as reinforced by the absence of integrating power and scale in the assessment. Moreover, even though the CBA and its frameworks contain valuable information about the urban water security of a city, the hydrosocial nature of water is not represented within the frameworks.

Future research could be conducted on the integration of hydrosociality on an indicator-based water framework such as the CBA. Additionally, studies on hydrosociality could also contribute to a better understanding of urban water security in general, as the perspective offers new approaches, and so multiple perspectives on water could be investigated. Furthermore, the different spatial scales where water acts within the city could be examined, to gain insights into the relations connecting the different spatial scales and the associated actors, their interests and power structures. This would in turn lead to a better understanding of the relations constituting urban water security.

Notes

1. UN-Water (2013) defines water security as 'the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability' (p. 1).
2. The term 'urban water cycle' describes all flows of water within an urban area, as the hydrological cycle is significantly altered due to anthropogenic influences and intervention resulting, for instance, from urbanization processes. It can be seen as an extension of the hydrological cycle – incorporating water services such as wastewater, drainage systems and water supply infrastructure (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2006). Therefore, the urban water cycle needs to be examined if water security within a city is to be analysed.
3. The use of the term 'local' in relation to culture acknowledges the multiple understandings, conceptualizations and values regarding water that exist within urban areas due to the diversity of the population.
4. IWRM is widely used as a framework for national water strategies, as it combines water-related and societal topics to ensure water security (Aboelnga et al., 2019). IWRM aims to integrate the hydrological dimension of water with its cultural, economic and ecological elements. However, the idea of IWRM understands hydrological and social dimensions as isolated entities.
5. Urbanization rate, education rate, burden of disease and political instability are assessed in terms of social pressure, whilst flooding, water scarcity, water quality and heat risk are assessed in the environmental pressure category. Financial pressure is measured with the indicators economic pressure, unemployment rate, poverty rate and inflation rate (Koop, 2019).

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