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The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water

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ABSTRACT

The relationship between water and society has come to the forefront of critical inquiry in recent years, attracting significant scholarly and popular interest. As the state hydraulic paradigm gives way to modes of water governance, there is a need to recognize, reflect and represent water's broader social dimensions. In this article, we advance the concept of the hydrosocial cycle as a means of theorizing and analyzing water-society relations. The hydrosocial cycle is based on the concept of the hydrologic cycle, but modifies it in important ways. While the hydrologic cycle has the effect of separating water from its social context, the hydrosocial cycle deliberately attends to water's social and political nature. We employ a relational-dialectical approach to conceptualize the hydrosocial cycle as a socio-natural process by which water and society make and remake each other over space and time. We argue that unravelling this historical and geographical process of making and remaking offers analytical insights into the social construction and production of water, the ways by which it is made known, and the power relations that are embedded in hydrosocial change. We contend that the hydrosocial cycle comprises a process of co-constitution as well as material circulation. Existing work within the political ecology tradition considers the co-constitution of water and power, particularly in relation to processes of capital accumulation. We propose the hydrosocial cycle as an analytical tool for investigating hydrosocial relations and as a broader framework for undertaking critical political ecologies of water.

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1. Introduction

The relationship between water and society is as complex an historical, sociological, and regional problem as any that can be imagined (Mosse, 2003, p. 1).

The relationship between water and society has attracted significant scholarly and popular interest through issues such as global water scarcity, transboundary river basin management and water privatization. Much of this interest stems from the acknowledgement that water management is not merely a technical field that can be addressed through infrastructure provision and scientific expertise, but a political one that involves human values, behavior and organization. A notable development has been the increasing recognition that it is not just society's relationship with water that is at stake, but the social nature of water itself. This im-

plies a shift from regarding water as the object of social processes, to a nature that is both shaped by, and shapes, social relations, structures and subjectivities.

In this article, we build on scholarship in critical geography, political ecology and cognate fields to advance the concept of the hydrosocial cycle. While the term 'hydrosocial cycle' has been present in scholarship for around a decade, there is little coherence in how it has been defined and employed. The contribution that we seek to make through this paper is to define and mobilize the hydrosocial cycle as a socio-natural process by which water and society make and remake each other over space and time. Our aim is to present a concept that researchers will find useful as a framework for investigating hydrosocial relations and for undertaking critical political ecologies of water. Our conceptualization of the hydrosocial cycle is radically different from the concept of the hydrologic cycle. Originally presented as a framework for the hydrologic sciences, the hydrologic cycle has become the dominant popular means of representing flows of water in the hydrosphere. The hydrosocial cycle, in contrast, attends to the social nature of these flows as well as the agential role played by water, while highlighting the dialectical and relational processes through which water and society interrelate.

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Our approach diverges from many existing approaches to water–society relations and water politics by calling the very nature of water into question. We start from the premise that water internalizes social relations and politics, as opposed to being merely the object of politics. Through the hydrosocial cycle we seek to transcend the dualistic categories of ‘water’ and ‘society’, and employ a relational-dialectical approach to demonstrate **how instances of water become produced and how produced water reconfigures social relations**. We argue that **unravelling this historical and geographical process of making and remaking offers analytical insights into the social construction and production of water, the ways by which it is made known, and the power relations that are embedded in hydrosocial change**.

Following this introduction, Section 2 considers the genealogy and the political consequences of the hydrologic cycle, arguing that it has the effect of separating water from its social relations and privileging a particular type of hydrologic expertise. As the state hydraulic paradigm has increasingly given way to modes of water governance, we argue that there is a need to recognize, reflect and represent water’s broader social dimensions. Section 3 responds to this need by locating the concept of the hydrosocial cycle in current theoretical debates in geography and cognate disciplines around socio-natural hybridity and dialectics. Section 4 proceeds to develop and advance the concept in line with a view of hydrosocial relations that regards water and society as making and remaking each other. Section 5 then discusses the analytical potential of the hydrosocial cycle, reflecting on how the concept orients and facilitates the investigation of hydrosocial relations so as to serve as a framework for undertaking critical political ecologies of water. We conclude by outlining the contributions of the hydrosocial cycle, suggesting that it provides a way of conceptualizing water that is compatible with emerging forms of governance, and that might be mobilized to inspire change in hydrosocial relations.

2. From the hydrologic cycle to the hydrosocial cycle

Our starting point is that the hydrologic cycle¹ is not merely a neutral scientific concept, but can be regarded as a social construct with political consequences. Tracing the genealogy of the hydrologic cycle reveals that it emerged in a specific historical context in pursuit of particular objectives and interests, and that it was constructed according to a vision of nature that authorizes the realization of these objectives and interests by deploying a particular form of expertise.

2.1. The political work of the hydrologic cycle

While philosophers and scientists have always had (and debated) ideas concerning hydrologic phenomena, the concept of the ‘hydrologic cycle’ and its diagrammatic representation are actually recent inventions (Linton, 2008). They were first presented by the American hydrologist, Robert Horton, in a paper read before a meeting of the American Geophysical Union in 1931. The hydrologic cycle was introduced as a framework for the emerging science of hydrology in the United States. Making the case for this new science, Horton argued:

[H]ydrology may be regarded as charged with the duty of tracing and explaining the processes and phenomena of the hydrologic cycle, or the course of natural circulation of water in, on, and over the Earth’s surface. This definition has the advantage that it clearly outlines the field of hydrologic science (Horton, 1931, p. 192).

In his paper, Horton also introduced what appears to be the first diagram of the hydrologic cycle. (Fig. 1).

The original purpose of the hydrologic cycle was thus not simply to describe hydrologic processes, but also to constitute a separate field of scientific enquiry and a community of technical experts known as hydrologists. Hydrology is defined in one classic textbook as ‘the science that treats of the various phases of the hydrologic cycle’ (Wisler and Brater, 1949, p. 3). The hydrologic cycle remains ‘the most fundamental principle of hydrology’ (Maidment, 1993, p. 1.3), and a variation of the diagram representing it is featured in the introductory pages of practically every hydrology textbook.

By constituting a new field of scientific enquiry and an associated group of knowledge workers, the hydrologic cycle also helped legitimize a certain technical authority over water. Horton defined the hydrologic cycle as the *natural* circulation of water on, in and over the earth, a process that occurs independently of human involvement: ‘This immense water engine fuelled by solar energy, driven by gravity, proceeds endlessly in the presence or absence of human activity’ (Maidment, 1993, p. 1.3). Such a process can only be modified or disturbed by humans, which renders water the province of agencies and experts with technical knowledge of the hydrologic cycle and the power to engineer it:

For the hydrologist, there is a need to know as accurately as possible the modifications that man makes in the hydrologic cycle – past, present, and future – in the hope that man can progressively increase his ability to modify the hydrologic cycle to his advantage. By working with nature, adapting his needs to the natural cycle or adapting that cycle to his needs, man can obtain the greatest beneficial use of the water resources (Thomas, 1956, p. 548)

The political effects of this mode of hydrological expertise are increasingly being explored in a critical sense. Recent work in political ecology has demonstrated the partial and contested nature of hydrologic data (Bakker, 2000; Budds, 2009; Kaika, 2003; Sheridan, 1995; Swyngedouw, 1995), and has revealed how hydrologic concepts and studies are constructed according to particular views of nature, and mobilized in line with vested interests (Budds, 2009; Cohen and Davidson, 2011; Linton, 2004). This emerging literature shows how hydrology – as an ‘orthodox’ science (Forsyth, 2003) – is predicated upon ‘Western’ views of nature that reduce water to its material composition (H₂O) (Linton, 2010), the homogenization of different waters (Orlove and Caton, 2010), and the characterization of hydrologic processes as ordered and universal (Brown, 2004; Walker, 2005). These insights reveal hydrological knowledge as partial and situated, and suggest its limitations as a basis for policy- and decision-making.

2.2. Changing water paradigms and the need for a new concept of water

At the time when Horton coined the term ‘hydrologic cycle’, the ‘greatest beneficial use’ of water resources was defined and put into effect almost exclusively by state agencies in most industrialized countries (Solomon, 2010). During the twentieth century, understanding the hydrologic cycle and how to modify it could be described as the main task of state water agencies. In the United States, the concept was taken up by planning agencies of the federal government in the 1930s as a means of envisioning the nation’s water resources and rendering them ‘legible’, to use Scott’s (Scott, 1998) term (National Resources Board, 1934).

As a means of rendering water legible for administrative purposes, the hydrologic cycle has been convenient to what Gleick (2000) identifies as the ‘old’ water paradigm, characterized by an emphasis on the development of water supplies by state agencies,

¹ The terms ‘hydrologic cycle’ and ‘hydrological cycle’ are synonymous; in this paper we adopt the former.

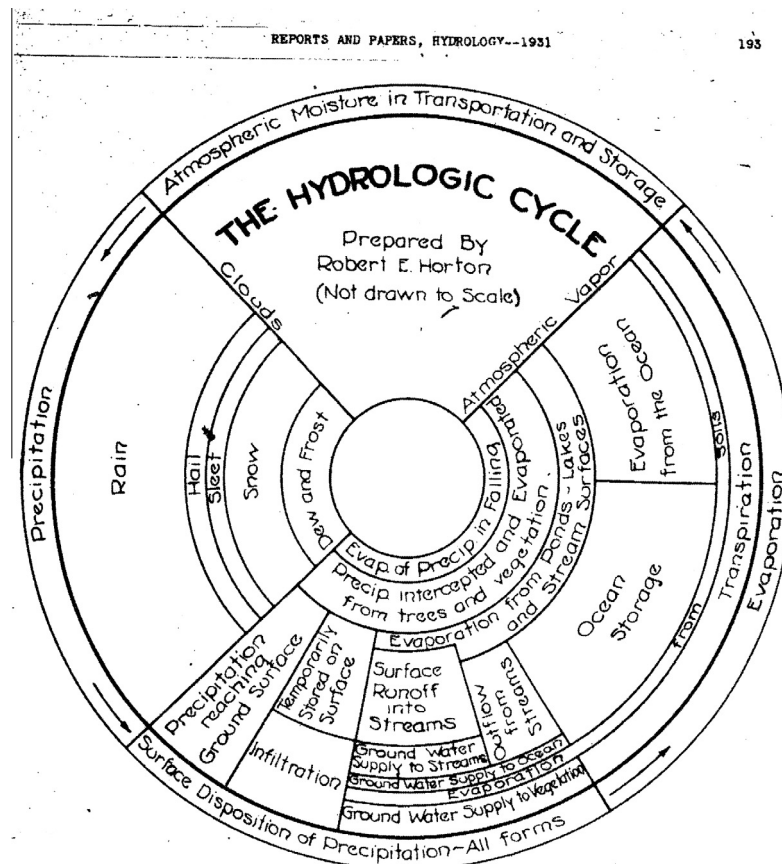


Fig. 1. The hydrologic cycle. Source: R. Horton 1931. Reproduced by permission of American Geophysical Union.

the view of water as a resource to be exploited, and the equation of water management to hydraulic engineering.

The hydrologic cycle is therefore a way of representing water that arose within a certain historical context to serve particular political ends. As a means of defining the scope of the hydrological sciences, and as a didactic tool to illustrate strictly hydrological processes, the hydrologic cycle remains useful. However, the historical circumstances that produced and sustained the hydrologic cycle are changing, which suggests the need for alternative concepts. Increasingly, water's entanglements with other ecological processes and with human society are recognized as integral to its management. Hydrological science itself is increasingly concerned with the integration of hydrological with ecological processes (e.g. Nuttle, 2002a,b). The idea, moreover, of managing water as discrete activity is increasingly untenable in recognition of water's social dimensions. Since the 1990s, Integrated Water Resources Management (IWRM) has become the dominant paradigm for managing water (Gleick, 2000). IWRM purports to "integrate" cultural, ecological and economic aspects of water with its purely hydrological dimensions, and calls for the inclusion of all relevant stakeholders in decision-making. The popularity of IWRM attests to a broad historical shift in the way water is understood. However, it is precisely this idea of *integrating* the hydrologic and the social – as if they were *a priori* separate and *unconnected* – that we seek to reposition, though the concept of the hydrosocial cycle.

Indeed, the discursive shift from water *management* to water *governance* over the last decade or so reflects an awareness of water's engagements with a broader range of social actors (Conca, 2006; Nowlan and Bakker, 2010). Water has to some extent been

freed from the technical embrace of state agencies and hydrologic engineers who had been entrusted with managing water supplies on behalf of civil society. To put it in the terms of the Global Water Council, now, 'water is everybody's business' (Cosgrove and Rijsberman, 2000), and it has become the business of civil society and critical scholars alike to explore the nature of the connection as well as to practice new modes of connecting water and people.

We argue that the broad historical circumstances that gave rise to the hydrologic cycle are changing in ways that favor the introduction of new ways of conceptualizing water so as to reflect and draw attention to its social dimensions. In political terms, water flows increasingly in accordance with flows of capital. The compelling diagram by Kate Ely reproduced in Fig. 2 provides a good illustration of this. Ely is a hydrologist who works with the *Confederated Tribes of the Umatilla Indian Reservation*, located on the Columbia River Plateau in the north-west United States. She illustrates how the recruitment of the Columbia River into global flows of capital causes water to flow 'to money', resulting in the dispossession of water among First Nations. The hydrologic cycle, as it exists in this and most other places, flows in accordance with forces that are political as well as hydrological.

In strictly material terms, various forms of water pollution, river regulation, and the hydrologic implications of anthropogenic climate change mean that virtually all water sources on earth now bear a human imprint. Here as well, the nature of the circulation of water on earth has to be described in *social* as well as *hydrologic* terms. Indeed, recent work in the hydrologic sciences shows that the very 'character' of the hydrologic cycle is being affected by human society (Vörösmarty et al., 2004). We hasten to add that

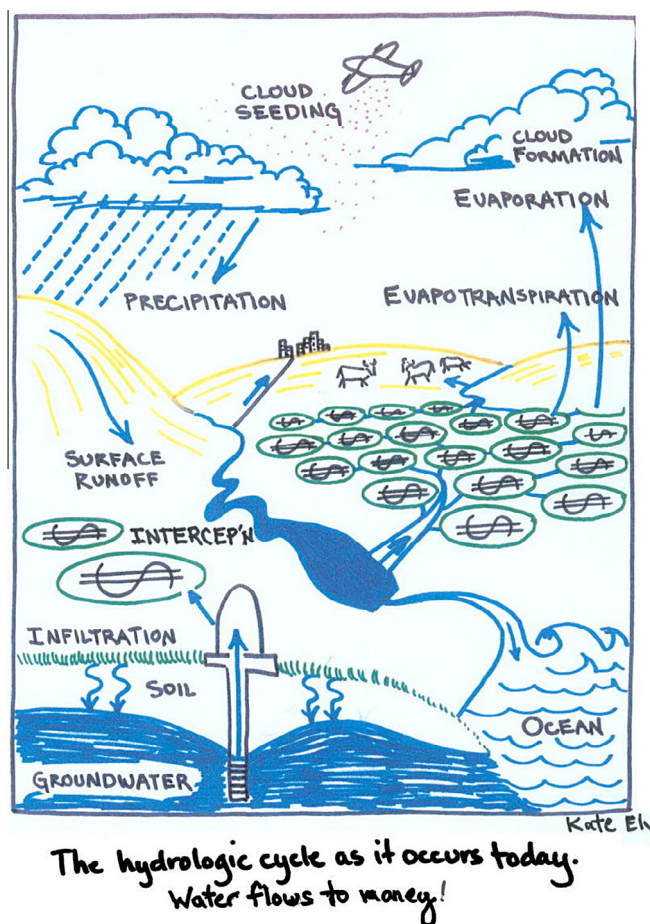


Fig. 2. The hydrologic cycle as it occurs today: water flows to money. Source: K. Ely. Reproduced by permission of the author.

the ways in which water flows over space and time is also shaped by human institutions, practices and discourses that determine modes of control, management and decision-making.

3. Hydro-social relations

In this section, we review relevant research in geography and cognate fields that theorizes the relationship between water and human society. Before drawing from this research to elaborate the concept of the hydrosocial cycle in the following section, we conclude the present section by citing several instances where the term “hydrosocial cycle” has already been used by critical geographers.

Geographers have long attended to the relationship between water and society as one aspect of the relation between nature and society (Glacken, 1967). Earlier accounts took an environmentally deterministic stance by considering how water shaped human organization (Semple, 1911). A subsequent generation explored how water linked physical and human environments (Chorley and Kates, 1969, p. 3). These investigations were less successful than they might have been, partly because they failed to question the water-tight identities of the natural and the social. It is only when geographers and cognate scholars began to develop more critical approaches from the 1990s that the exploration of the relationship between water and society became more productive.

3.1. Hydro-social dialectics

Among the most productive of these approaches has been to consider the articulations of water and social power. This question was first theorized by Karl Wittfogel, through his seminal study of ‘hydraulic society’ (Wittfogel, 1957), which builds on Marx’s dialectical interpretation of the labor process. Marx described this as:

... a process between man and nature, a process by which man, through his own actions, mediates, regulates, and controls the metabolism between himself and nature. [...] He sets in motion the natural forces which belong to his own body, his arms, legs, head, and hands, in order to appropriate the materials of nature in a form adapted to his own needs. *Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature.*... (Marx, 1971 (1867, p. 283), cited in Swyngedouw (2004, p. 15, emphasis added)).

Applying this approach to water, Wittfogel described a dialectical relationship between large-scale irrigation systems and centralized state power in the ancient irrigation civilizations of China, Egypt, Mesopotamia and India. Wittfogel showed how, by coordinating the construction and maintenance of hydraulic infrastructure, by associating themselves with religious leaders, and by developing economies with redistributive features, elites in hydraulic societies were able to entrench their power, eventually developing ‘despotic’ regimes. For Wittfogel, the transformation of the hydraulic environment produced changes in society, which brought further changes in non-human nature, in a continuous process: ‘an ongoing spiral of challenge-response-challenge’, as Worster (1985) put it, ‘where neither nature nor humanity ever achieves absolute sovereign authority, but both continue to *make and remake each other*’ (Worster, 1985, p. 22). Much subsequent research on the relation between water and society has demonstrated that the ways societies organize themselves in response to the need to control and manage water, and the geometries of power that are embedded in this dialectic, are extremely varied (Swyngedouw, 2006).

3.2. Hydrosocial hybridity

The hydro-social dialectic as described above is evident in Swyngedouw’s work (Swyngedouw, 1997, 1999, 2004, 2006, 2007). However, Swyngedouw makes an important advance on the hydro-social dialectics by insisting that components of the process – water and social power – are related *internally* rather than *externally*, and should thus be considered as *hybrids* rather than pre-given entities that fall within the realm of either nature or society.

Understanding things as related internally means that the properties that constitute them emerge as a function of their relations with other things and phenomena. It implies a shift from thinking of relations *between* things – such as the impacts of humans on water quality – to the relations *constituting* things – such as the cultural, economic and political processes that constitute the particular character of desalinated water, treated drinking water or holy water. Considering internal relations thus means that things do not relate to each other as preformed entities (like ‘water’ and ‘society’), nor do they emerge from these relations as independent entities (Castree, 2005).

The idea of hybridity is consistent with that of internal relations, because it regards things as constituted in the process of their relation with other things, rather than in and of themselves. Hybridity re-joins what has been driven apart by dualistic thinking by acknowledging that all things – at least so far as they enter into our consciousness, our production of knowledge, and our material

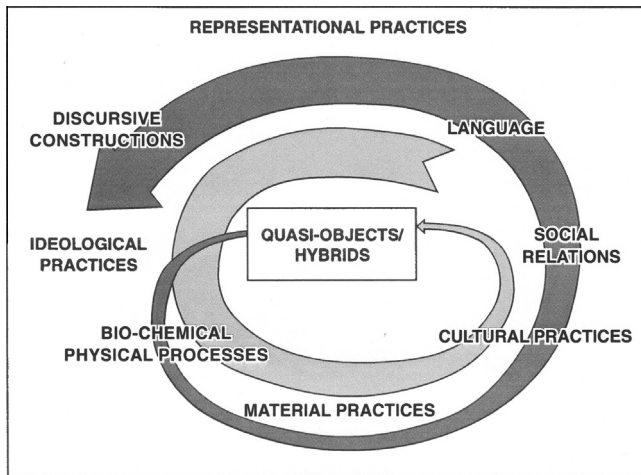


Fig. 3. The production of socio-nature. Source: E. Swyngedouw 2004. Reproduced by permission of the author.

practices – are simultaneously social and natural (Latour, 1993). For Swyngedouw (2004), moreover, it is the process of the production of socio-natural hybrids that takes precedence over the objects themselves, hence his emphasis on 'the production process of social nature' by which hybrid objects participate in a dialectical engagement as both product and agent of socio-natural change (Fig. 3).

This process is cyclical in the sense that these hybrid objects are produced out of material, cultural and discursive practices, and they in turn enter into and constitute those very practices in a recursive manner. At the same time, the production of water as socio-nature entails a more complex (internal-relational) process by which any change in the physical presence of water, in institutional arrangements, in discursive constructions of water, or in the uses to which water are directed, has the potential to shift constellations of socio-nature towards a different set of relations.

3.3. Relational and material approaches to water

There has been a growing appreciation for relational and dialectical thought in relation to water in critical geography and political ecology. In essence, a relational and dialectical approach holds that things become what they are in relation to other things that emerge through an overall process of mutual becoming. (Linton, 2010) Recent scholarship has explored how society shapes, and is shaped by, water, both materially and discursively, and how water is not external to social relations but rather embeds and expresses them. (Bakker, 2012; Bear and Bull, 2011; Budds and Hinojosa, 2012; Gandy, 2002, 2004; Kaika, 2004, 2005; Linton, 2010; Loftus, 2009, 2011; O'Reilly, 2006; Swyngedouw, 1999, 2004, 2007)

This process of mutual shaping reveals that water is not an inert backdrop for social relations, but that it plays a positive role in social formations (Bakker, 2012). In the context of water privatization, Bakker (2003) has argued that water's physical properties and cultural meanings have been significant in some of the barriers to this policy shift. Bear and Bull (2011) have advanced these analyses by stressing the importance of recognizing an **active and dynamic agential role of water**, arguing that its multiplicity of states, forms, spaces, materialities, and temporalities serve to differentially shape social relations (see also Strang (2004)):

[Water] is not merely a resource to be managed, nor just a product to be valued and consumed, but *actively shapes new geographies* (Bear and Bull, 2011, p. 2261, emphasis added).²

Moving away from the specific characteristics of water, other authors have shown how people's encounters with water shape histories and subjectivities. For instance, Gandy's (2002) account of the development of urban water supply in New York City demonstrates its central role in producing modernity, while O'Reilly (2006) has contended that the introduction of piped water to rural Indian households has rendered 'traditional' women 'modern'. Swyngedouw's (1999, 2007) account of the production of the Spanish waterscape in the nineteenth and twentieth centuries demonstrates how political power was pursued and consolidated through a programme of large-scale hydraulic engineering, which sought to foster Spain's development, regional integration and national identity.

3.4. Meanings and knowledges of water

Another body of literature, largely situated within anthropology and cognate fields, asserts that water and people are not just related in a material sense, but are also connected in experiential, cultural and metaphorical ways. This work draws attention to how people's material, sensory and imaginative interactions with water become encoded in discourse as well as in water itself (Mosse, 2003; Orlove and Caton, 2010; Strang, 2004). It reflects relational and dialectical thought, as water takes on meanings by virtue of its social circumstances, while people's interactions with meaning-full water also co-constitute human identities and imaginaries (Strang, 2004).³ As Strang states:

Water is experienced and embodied both physically and culturally. The meanings encoded in it are not imposed from a distance, but emerge from an intimate interaction involving ingestion and expulsion, contact and immersion (Strang, 2004, pp. 4–5).

Such perspectives weave together water's material and discursive dimensions. The point is not to determine where social constructions end and materialities begin, but to recognize their mutual constitution. (Orlove and Caton, 2010, p. 403). For instance, the fact that Hindus still perform their ablutions in the highly polluted river Ganges due to their belief in its healing power is not necessarily a reflection of misguided cultural beliefs in the face of scientific fact, but illustrates that water quality is a thoroughly social category. (Alley, 2002, cited in Orlove and Caton (2010)).

Exploring experiential relationships with water, often ethnographically, yields insights into context-specific and non-scientific forms of knowledge (Mosse, 2003; Orlove and Caton, 2010). While such alternative knowledges are often local and indigenous, they illustrate both the complexity and diversity of hydrosocial practices and relations, and the deep intertwining of water's material and spiritual dimensions. For instance, Boelens (this issue) shows how Quechua communities possess intricate knowledge systems to manage water in the Andean highlands, which emerge from a particular form of engagement with water, and have proven far superior to that of hydraulic engineers. It is this particular 'hydro-cosmological' cycle that guides irrigation practices and water rituals, which in turn underpin collective identity and communal cohesion in these communities.

² These issues of water's materiality and agency are the focus of two special issues: 'Water matters: agency, flows, and frictions', *Environment and Planning A* 43(10), 2011, and 'Water worlds', *Social Studies of Science* 42(4), 2012.

³ See, for example, the Canada-based 'Thinking with Water' programme, <http://www.thinkingwithwater.net>, accessed September 2012.

3.5. Emergence of the hydrosocial cycle

The term “hydrosocial cycle” has been employed by geographers for about a decade to refer to the inseparable social and physical dimensions of water (Bakker, 2002, 2012; Budds, 2008, 2009; Linton, 2008, 2010; Swyngedouw, 2004, 2006, 2009).⁴ Bakker offered an initial explanation:

Whereas H₂O circulates through the hydrologic cycle, water as a resource circulates through the hydrosocial cycle – a complex network of pipes, water law, meters, quality standards, garden hoses, consumers, leaking taps, as well as rain-fall, evaporation, and runoff. . . [W]ater is simultaneously a physical flow (the circulation of H₂O) and a socially and discursively mediated thing implicated in that flow. . . (Bakker, 2002, p. 774).

Swyngedouw (1999, 2004, 2007, 2009) builds on the simultaneity of water as a physical flow and as something that is socially and discursively mediated. For him, the hydrosocial cycle denotes a hybrid physical-social process, the examination of which provides a way of gaining insights into wider processes of capital accumulation, uneven development and social inequality, and the power relations therein (see also Strang (2004)). Building on Swyngedouw's work, Linton (2010) proposes the hydrosocial cycle as a framework for a relational-dialectical approach to water, whereby particular instances of water become embedded in social relations while at the same time providing sites for changing those relations.

The hydrosocial cycle is used in the work described above to draw attention to water's social context and dynamics, and to reposition water as inherently political. However, the concept has not been precisely defined or conceptualized. It is to this task that we turn in the following section.

4. Defining the hydrosocial cycle

We define the hydrosocial cycle as a socio-natural process by which water and society make and remake each other over space and time. This concept incorporates several key ideas drawn from the theoretical work described in the previous section; they are summarized here and elaborated below:

First is the idea that the need to manage water has an important effect on the organization of society, which in turn, affects the disposition of water, which gives rise to new forms of social organization and so on, in a cyclical process.

Second is the idea that by virtue of this relationship, water and society are related internally, which means that particular kinds of social relations produce different kinds of water, and vice versa.

Third is the idea that despite this production of water, and despite the social construction of representations of water, the material properties of water play an active role in the hydrosocial process, sometimes structuring social relations and sometimes disrupting them (as in the case of a major flood).

4.1. The hydrosocial cycle as hydro-social dialectic

Our use of the term ‘cycle’ as a way of defining the water-society relation entails an element of recurrence, yet is more complex than is usually implied by the concept of a cycle.⁵ The hydrosocial

cycle is iterative in the sense that it comprises a dialectical relation between water and society, whereby interventions in the hydrologic cycle will produce changes in society, and so on.

The influence of Wittfogel, and Worster might be discerned from our conceptualization: In its simplest form, the hydrosocial cycle represents the process by which alteration or manipulation of water flows and quality affect social relations and structure, which in turn affect further alteration or manipulation of water. As a cycle, there is no necessary beginning or end to this process: alteration of the hydrologic cycle is always preceded by, or presupposes, a social structure and the application of social power to technological interventions, such as building a dam, introducing piped water supply or operating a desalination plant, or to policy reforms such as introducing water privatization, shifting the unit of governance to the watershed, or framing water as a human right. Each intervention in the hydrologic cycle – every instance of the production of water – can be regarded as the product of a particular kind of social structure and geometry of power (Swyngedouw, 2009). The cyclical aspect of this process is suggested by showing that once in place, or through being put in place, the production of water then exerts its own political and social effects.

4.2. The hydrosocial cycle as a socio-natural process

The hydrosocial cycle is also more complex than is implied by the hydro-social dialectic described above. We identify the hydrosocial cycle as a socio-natural process, suggesting other than a dualistic conception of the relationship between water and society. As described so far, the dialectic frames water and society in a set of external relations, implying that ‘phenomena are constituted prior to the relationships into which they enter’ (Castree, 2005, p. 224). In the hydrosocial cycle, things like water, society and social power retain their positive identities but are understood to relate internally, whereby they are neither considered as already-existing entities, nor ones that can maintain independent identities following interaction with each other (ibid.).

Linton (2010, pp. 231–234) provides an example of the internal relations involved in the hydrosocial cycle by showing how specific technologies for providing drinking water are internally related to particular kinds of waters and particular kinds of social relations. A public drinking fountain, he argues, sustains water as a public good, while simultaneously producing a kind of public/citizenship – or ‘body public’ – in which all members of society have equal access to its water. The fountain, the provision of drinking water, free access and the public itself are sustained by the vested interests of fountain-users in maintaining this service.

The diversion of this cycle through a commercial bottled-water vending machine, however, has the effect of producing a different kind of access, with the corollary of producing individual consumers rather than a body public, and producing water as a commodity, rather than as a public good (Linton, 2010). This example illustrates how different kinds of waters are realized in different hydrosocial assemblages; in one such assemblage, water is constituted as a public good, while in another, it is constituted as a commodity.

There is no necessary contradiction between a dialectical process by which water and society make and remake each other as both an historical process, and one that relates water and society internally. Bakker (2012, p. 618) comments on the dialectical relationship between ‘the modernization of water’ (through dams, regulated rivers, drinking water supply networks), ‘new forms of governance, and newly-emergent processes of state formation. . .’. This is essentially the notion, which can be traced to Wittfogel and Marx, that the control of water produces certain types of social power relations and structures of governance. However, in addition, Bakker notes that ‘water is thus inherently political, not only

⁴ We are concerned here with the concept of the hydrosocial cycle, rather than other uses of the term ‘hydrosocial’ (such as ‘hydrosocial contract’).

⁵ It is worth noting that the hydrologic cycle itself is more complex than is implied by the term ‘cycle’. This is evident in Horton's original diagram (Fig. 1), which presents a wide range of possibilities for the trajectory of a water molecule in the hydrosphere. At many points in the ‘cycle’, the directionality of flux may actually be reversed: for example, precipitation may be re-evaporated before being intercepted; runoff may be evaporated before reaching streamflow. Moreover, residence times in storage may vary widely between phases of the ‘cycle’, from minutes to hours in a pond or lake, to centuries or even millennia in aquifers.

because it is an object of conventional politics, but also because of its material imbrication in the socio-technical formations through which political processes unfold' (Bakker, 2012, p. 618). The materiality of water, moreover, is imbricated in particular ways in relation to the 'socio-technical formations' in which it takes shape. As Barnes and Alatout assert:

Water is not a singular object... Rather, water reveals its complex, multilayered biophysical identities for particular enactments, depending on assemblages that are in place or still in the making. As a result of the assemblages in which it finds itself, water can be and become a border, a resource for regeneration, a foundation for empire, a means of nation building, and a material linkage between past and present (Barnes and Alatout, 2012, pp. 484–485).

4.3. The materiality of water in the hydrosocial cycle

The hydrosocial cycle relates a variety of heterogeneous entities including social power and structures of governance, technologies, infrastructure, political policies, and water itself. The latter, which is identified as 'H₂O' in our diagram of the hydrosocial cycle (see Fig. 4) represents the idea of the *agential* role of water in hydrosocial relations:

Of particular relevance is that fact that water is a resource upon whose constancy (of both quality and quantity) we depend; and yet, *water engenders attempts to regulate its inherent variability in time and space – which are in turn frustrated by ecological, technological, and economic barriers to human control* (Bakker, 2012, p. 617, emphasis added).

Water's unruliness not only provokes attempts to bring it under control; it also actively disrupts structures of social power:

Water is rarely a medium of rigid social structures. Because water moves, it erases as well as makes social boundaries; it changes landscape, provides the basis of new claims and threatens established orders (Mosse, 2008, p. 944).

Hydrologic processes thus find their place within the *hydrosocial cycle* as not merely material flows of water, but as agents of social change and organization. Flows (or instances) of water, as in the seasonal changes in river regimes, produce rhythms against which human societies organize and structure their economic and cultural activities (Bear and Bull, 2011, pp. 2262, 2263). **Water held behind a dam or regulated in an irrigation system can exert a stabilizing influence on the social relations that it helps hold in**

place, while dramatic hydrologic events, such as floods, can break these rhythms and disrupt these relations, producing ruptures or opportunities for change (e.g. Berry, 1998). The materiality of water is thus an important element in the relations involved in the hydrosocial cycle.

4.4. The operation of the hydrosocial cycle

A socio-natural process by which water and society make and remake each other over space and time is represented by Fig. 4. Considering this diagram, water's materiality (H₂O) intervenes in the process, perchance stabilizing, perchance disrupting society (social power/structure), which gives rise to forces that intervene in the process by altering or manipulating the quantity/quality of flows in the hydrologic cycle (technology/infrastructure), and which in turn intervenes in the process by affecting the materiality of water (H₂O), and so on. This cyclical process is also socio-natural in the sense that water, society, and technology are all hybrid objects, internalizing the relation they have with each other. Different meanings of water emerge as the product of this process: 'Water' (identified in the center of the diagram) is the particular type, discourse, construction, idea, or representation of H₂O that pertains in any given assemblage occurring as a moment of the hydrosocial cycle. The particular kind of hydrological (or scientific) knowledge that reflects and buttresses the social order of which it is part is thus represented by 'water' in the center of the diagram. The hydrosocial cycle, in short, embodies the processes by which water becomes and reveals itself as a socio-nature.

The case of hydroelectric power production in northern Canada exemplifies this:

The water held in place behind dams in northern Canada is not merely the liquid H₂O measured in cubic metres that falls through penstocks and turbines to generate hydroelectricity; this water is held in place by state-run power utilities, the human labour that is extracted to produce the dams, penstocks, and turbines; abstract hydrological calculations; water management protocols; discourses linking national identity with the generation of hydroelectricity; networks of transmission wires; consumer expectations; construction consortiums; and political discourses, which together have the effect of fixing it in a particular way. This water is what it is by virtue of events and processes that transcend the place and time of the water itself (Linton, 2010, pp. 30–31).

The hydrosocial cycle, moreover, is a dynamic historical and geographical process, meaning that the assemblage that gives rise to a particular kind of water and a particular socio-political configuration is always changing. **To use the example above, environmentalists may mount political pressures to alter the technology of dam regulation so as to reduce disturbance of flow regimes; climate change may alter hydrologic processes such that the entire hydro-electrical assemblage is disrupted; the identity of water as a resource for generating electricity may be successfully contested by indigenous groups for whom water constitutes an entirely different socio-natural assemblage; patterns of demand for hydro-electricity may shift so as to make dams less economically feasible and thus affecting the power relations that produce and sustain them; the social structure into which the hydro-electrical assemblage fits may undergo crisis so as to make it unable to raise sufficient capital to construct or maintain dams. A change in any moment of the process, moreover, has the potential to affect all the others, such that the entire hydrosocial assemblage is constantly in the process of transformation** (see Section 5.4 below).

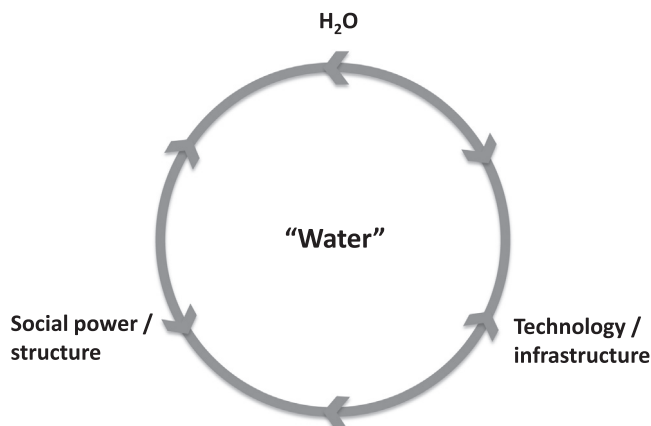


Fig. 4. The hydrosocial cycle (see Section 4.4 for explanation).

5. Mobilizing the hydrosocial cycle

Water is not about water, water is about building people's institutions and power to take control over decisions (Sunita Narain, acceptance speech for 2005 Stockholm Water Prize).

The hydrosocial cycle calls attention to how 'water' becomes produced in, and how it configures, social relations. Through the hydrosocial cycle, water becomes a means of investigating and analyzing social practices and relations, and of tracing how power infuses these connections such that these can be *revealed* and, potentially, *acted upon*. The hydrosocial cycle works as an analytical tool by compelling us to look for relations and patterns that we might otherwise ignore. To begin with, **the hydrosocial cycle compels us to identify the assemblage of historical, hydrological, political, and technological circumstances that produce a given instance of "water" as well as to consider what might bring about change in the assemblage.**

5.1. Defining 'water' in the hydrosocial cycle

Water in the hydrosocial cycle is not taken for granted. As illustrated in Fig. 4, **the hydrosocial cycle configures 'water' as the product of H₂O and the social (including the scientific) circumstances in which it becomes constituted.** Each instance of 'water' thus embodies the socio-natural processes by which it is produced. Rather than regarding water as existing in a 'natural' state, the hydrosocial cycle compels us to ask how it is shaped by virtue of these processes. In this way, defining 'water' in the hydrosocial cycle provides an approach for analyzing hydrosocial relations.

For instance, seen through the hydrosocial cycle **desalinated water is a particular instance of 'water' that gets produced in a set of relations involving such things as seawater, configurations of technology and infrastructure, flows of energy, international agreements, and flows of capital. The politics of desalinated water are thus entirely different from other instances of water:** In Peru, for example, some mining companies have proposed 'water swaps', whereby they would draw water in the high Andes for mines and replace it in downstream towns with desalinated water, seeking to reduce tension and conflict around the diversion of water to mining operations. Yet, local civil society groups reject this solution, with one activist stating that the mines were seeking to replace 'live' mountain water with 'dead' desalinated water (Budds and Hinojosa, 2012). What is at stake here is not simply H₂O. Desalinated 'water' exerts particular effects that can be revealed through the hydrosocial cycle: When produced at scale, it engenders radically new waterscapes through transforming economic possibilities (e.g. rapid urban development), ecological conditions (e.g. artificial aquifer recharge) and social identities (e.g. Westernization) (see the article by McDonnell in this issue).

Instead of treating water as homogenous, the hydrosocial cycle directs analysis towards the hybrid nature of different waters by attending to water's different states, forms and qualities, which make it act and give it meaning in distinct ways. For example, the social relations around groundwater can be entirely different from those around surface water. Groundwater flows and volumes are invisible to the observer, which makes them more complex to assess and measure, either by hydrologists or by users (Budds, 2009). In Peru, for example, highland communities accepted a mine's proposal to draw surface water, but categorically rejected their plans to extract groundwater (Budds and Hinojosa, 2012). Groundwater has characteristics that may either increase demand among users (such as being more continuous in dry periods or car-

rying less sediment) or reduce it (by having a high saline content or representing expensive drilling and pumping costs), and which may consequently affect distribution among different social groups. Thus, when analyzed through the hydrosocial cycle, specific instances of groundwater may reveal important aspects of hydrosocial relations.

An analysis of 'virtual water' through the hydrosocial cycle can yield important relational knowledge that is otherwise obfuscated. Virtual water is a useful tool for identifying the 'hidden' flows of water embedded in the production of commodities (Allan, 2011). However, it tends to ignore the social processes involved in these flows as well as the wider context-specific implications of abstracting water. To return to the example above, a virtual water analysis might draw attention to the large volumes of water needed to produce one kilogram of copper (through ore extraction, processing, cooling and waste disposal), and would highlight issues around water use and degradation of water quality in Peru. However, it would typically disregard much of the complexity and social dynamism involved in the intervention in hydrologic processes which makes such water available to mining companies. Referring to Fig. 4, the 'water' produced in this particular configuration of the hydrosocial cycle is also the product of social power relations shaped by state promotion of extractive industries and the mining sector's lobbying in water law reforms. Analyzing virtual water through the hydrosocial cycle can therefore be regarded complementary to a strictly virtual water analysis, by directing attention to questions such as why water becomes a key site for contestation through struggles over allocation and contamination or through clashes over the meaning of water.

The hydrosocial cycle draws analysis towards questions relating to how 'water' is made known and represented, and its effects. The way in which water is represented in the hydrologic sciences is an important field of inquiry, given its dominance in water management and policy (Budds, 2009). Interrogating the hydrologic cycle itself by placing it at the center of the hydrosocial cycle can yield insights into its political effects as described in Section 2.1 (see also Linton (2008)). In this way, examining hydrological concepts, methods and data can shed light on the assumptions therein, and the political work that they do. For instance, Cohen and Davidson (2011) have critiqued the concept of the watershed – promoted as the ideal unit of governance under IWRM – highlighting its problematic definition: 'as small as a sidewalk puddle or as large as the Great Lakes – St. Lawrence basin' (p. 2), its 'natural' boundaries that are drawn by humans and change as techniques improve, and its potential to restructure social relations and resource access (see also Blomquist and Schlager (2005) and Budds and Hinojosa (2012)). Through the hydrosocial cycle, therefore, knowledge and understandings of water cycles are reiterated as situated and cultural.

5.2. Analyzing power and politics through the hydrosocial cycle

Examining water through the hydrosocial cycle can yield insights into questions of politics and power. As Swyngedouw contends:

Just as the investigation of the circulation of money and capital illustrates the functioning of capitalism as an economic system, the circulation of water – as a physical and social process – brings to light wider political economic, social, and ecological processes (Swyngedouw, 2004, p. 2).

As seen in the hydrosocial cycle, the relationship between water and politics is repositioned in a way that compels an examination of how water and its circulation internalizes and expresses politics, as opposed to simply treating water as the *object* of politics. To give an

example, Feitelson (2005) examines the overexploitation of aquifers for irrigation in Israel, despite widespread knowledge that this practice is unsustainable. In this analysis, the contradiction is explained in terms of the different political interests of the stakeholders involved, suggesting that decision makers are reluctant to heed the advice of state water experts to restrict groundwater pumping among commercial farmers, as the latter are well-organized and powerful, and face little public opposition. Feitelson points out that because political decision makers are certain to lose the support of farmers if they restrict their water use, they act reasonably when they allow overpumping against the advice of water managers. His prescription is therefore to 'overhaul the decision-making structures in the water-sector' (Feitelson, 2005, p. 414) by putting more power into the hands of state water authorities, who have the expertise to manage aquifers sustainably.

As Linton (2010) has suggested, this analysis can be expanded by considering how these relations articulate in the hydrosocial cycle, which demands a consideration of how the water involved in this set of circumstances differs among the different actors involved. In this case, farmers are interested in water itself as a concrete input to agriculture, water managers are interested in the more abstract notion of the aquifer and the need to balance aquifer abstraction and recharge, while decision makers regard water as an abstract resource to be allocated so as to produce the greatest social and political benefit. A fourth group of actors, identified by Feitelson as the general electorate, can be taken to regard water as a historical preoccupation associated with discourses of national security. The four groups of stakeholders – and the four corresponding 'waters' – are interrelated in complex ways. Nevertheless, analyzing these dynamics of water management through the hydrosocial cycle draws attention not just to the different actors and the different interests at play, but to the different views, understandings and discourses of 'water' that underpin their positions. In addition to strengthening technical expertise and authority over water, an alternative way forward may be to promote mutual recognition of, and mediation between, these different readings of water (Linton, 2010).

The hydrosocial cycle offers a critical approach that prompts us to consider how water internalizes and reflects social and power relations that might otherwise remain invisible. This, in practice, implies that we need to think differently about water, attend to the social circumstances of water circulation, and ask questions about how water, social structures, power relations, and technologies are internally related (see Fig. 4). One starting point, as suggested above, is to question the meaning of water(s) in any given situation. This will entail asking what different waters, knowledges, and meanings are articulated and how these might internalize vested interests and power structures. For instance, using the hydrosocial cycle as an analytical approach, Bouleau (this issue) shows how the scientific characterization of river systems is not a neutral and universal hydrologic endeavor, but is shaped by the disciplines and research interests of different scientists.

5.3. Seeing beyond the water

As suggested by the quote by Sunita Narain at the beginning of this section, the hydrosocial cycle makes it impossible to imagine water issues as simply water issues, prompting us to ask how these issues are shaped by the social context, and directing our attention to the 'bigger picture' beyond the actual water in question. For example, by revealing water as *produced*, the hydrosocial cycle highlights the often counter-intuitive disjuncture between hydrologic conditions and access to water. The lack of access to drinking water in many parts of the global South is not explained

by immediate physical scarcity, or population pressure or technical incapacity; but by how water services are often organized and managed so as to deprive low-income groups of access (UNDP, 2006). Many water utilities refuse to serve low-income settlements, even if they could be easily connected, due to illegal land tenure, low political priority and/or fear of non-payment (Budds and Loftus, in press).

By drawing attention away from water itself, the hydrosocial cycle can also help to reveal the multiple scalar processes that produce water over space and time. As Swyngedouw points out, the hydrosocial cycle involves 'the transformations of, and in, the hydrological cycle at local, regional and global levels on the one hand and relations of social, political, economic, and cultural power on the other' (Swyngedouw, 2009, p. 56). An example is the scale of financial flows and the political processes that give rise to the flows of water represented in Fig. 2. Here, consideration of the hydrologic cycle provokes an assessment of hydrologic processes that occur at physical scales (e.g. the catchment). Consideration of the hydrosocial cycle, in contrast, helps to make obvious *social processes* occurring at various scales that influence water flows, including flows of capital and discourses of water, which directs analysis beyond the catchment unit and the present day.

5.4. Analyzing the hydro-social dialectic

Finally, the hydrosocial cycle directs analysis towards the dialectic by which any given instance of water is produced, and in turn, exerts an influence on the very social processes of production. This idea incorporates the internal dialectic by which specific instances of 'water' are constituted in hydrosocial relations, and recognizes this as a dynamic process rather than a fixed state of affairs.

To return to the example of dams in northern Canada, the water held in place behind dams in Quebec is the product of state-run power utilities, human labor, hydrologic modeling, discourses around hydro-nationalism, and economies of energy production and consumption. These have had the effect of fixing water in a particular way. And yet, as a historical fact, this very water has contributed to its own transformation: The dams originally built in northern Quebec in the 1970s resulted in massive alteration of the hydrologic regime, which had a devastating impact on the economy and society of the indigenous (Cree) communities in the region (Linton, 1991). As Desbiens (2004) has shown, this had the effect of galvanizing these communities to take collective action, constituting them as a 'nation', which itself has exerted an important influence on subsequent hydrosocial developments in the region.

Notably, the shelving of a major hydroelectric project on the Grande Baleine River in 1994 followed the cancellation of contracts to export of electricity to the United States, which was a consequence of successful Cree lobbying against the project. More recently, the negotiation of a 2002 agreement between the government of Quebec and the Cree nation has allowed for hydroelectric development in the region, but in a manner that alters the constellation of political and power structures that underpinned earlier developments, notably by giving the Crees an important measure of control over the resource. As Desbiens points out, 'Through these complex phases of negotiation and adaptation to a constantly changing landscape, the Crees have challenged stereotypes pertaining to native cultures and emerged as powerful economic and political agents' (Desbiens, 2004, p. 356). Seen through the hydrosocial cycle, these developments illustrate a dynamic and historical process by which the production of a particular instance

of water gives rise to changes in the political landscape, which in turn changes the processes by which waters are produced.

6. Conclusion

In this paper, we have conceptualized the hydrosocial cycle as a socio-natural process by which water and society *make and remake* each other over space and time, and have proposed it as an analytical tool for investigating hydrosocial relations. We argue that the hydrosocial cycle directs attention to three principal areas of insight: First, the hydrosocial cycle demands that we ask *what water is*. This ontological question builds on theoretical work on dialectical and relational thought that draw attention to how the nature of water internalizes social relations. The hydrosocial cycle is a process that relates water and society *internally*, which implies the presence of different waters in different assemblages of social circumstances.

Second, it advances the question of *how water is made known*. This question interrogates the epistemology of water in the hydrosocial cycle by attending to how water is constructed through discursive practices (e.g. a 'resource'), as well as through alternative ways of knowing (e.g. the Andean 'hydrocosmological' cycle), acknowledging that representations of water are politically charged and have political effects.

Third, it interrogates the ways in which *water internalizes social relations, social power and technology*. The hydrosocial cycle directs our attention towards the social relations, power structures and technological interventions that produce, and reproduce 'water', in any given context.

The hydrosocial cycle redefines the notion of *cycle* in relation to water. By internalizing a dialectical relation between water and society, the hydrosocial cycle enables us to reposition the cycle from a model of physical circulation to a historical and relational-dialectical process through which water and society constantly make and remake each other. This enables us to move from conventional, dualistic analyses of how social processes affect material water flows and vice versa, to how social relations and water co-produce new hydrosocial arrangements.

While existing work within the political ecology tradition considers the co-constitution of water and power, particularly in relation to processes of capital accumulation, we propose the hydrosocial cycle as a broader framework for attending to the ontology and epistemology of water within hydrosocial relations, and for undertaking critical political ecologies of water. This emerges from our contention that the broad historical circumstances that gave rise to the hydrologic cycle are changing in ways that favor the introduction of new ways of conceptualizing water so as to reflect and draw attention to its social and political dimensions. Using the hydrosocial cycle to analyze social relations that are internalized within instances of water has the potential of identifying sites for changing these relations. If the production of water as a socio-nature entails a complex process by which any change in the material form of water, in power relations, in framings of water, or in the uses to which water are directed has the potential to shift the whole constellation of socio-nature towards a different set of relations, then such potential can also be *harnessed* in order to identify sites for intervention, and to produce change. Our hope is that, by revealing the ways in which social inequalities and injustices become produced and sustained *through* water, the hydrosocial cycle might be useful in promoting more equitable hydrosocial relations.⁶

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⁶ See also special issue on 'Political ecologies of water and development', *Environment and Planning D: Society and Space*, 2013.

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