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Structuring Hydrosocial Relations in Urban Water Governance

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This article concentrates on how hydro-social relations are differentially structured across technical experts engaged within diverse and multiple networks of institutional and bureaucratic practice and the implications this has for more inclusive forms of environmental governance and decision-making. I empirically focus on stormwater governance in Chicago and Los Angeles as a means to capture the range of geographical and institutional variations in environmental knowledge. Both cities face considerably different water resource challenges in the United States but are at the forefront of developing comprehensive and progressive urban water governance programs. In the article, I identify four visions of hydrosocial relations: hydro-reformist, hydro-managerial, hydro-rationalist, and hydro-pragmatist. Each of these represents a particular understanding of how hydrosocial relations should proceed. They all align around shared framings of integrated management and the utilization of the best available science and technology to drive decision-making. Consensus, however, masks fundamental differences among the varying groups of expertise. Differences center on the perceived effectiveness of different types of infrastructural interventions, of market and economic incentives, and the role of new institutions and rules to govern stormwater. I argue that each frame looks to structure hydrosocial relations to fit their own vision but consequently offer apolitical strategies that reduce water quality and quantity problems to their technical and hydrological components. *Key Words: infrastructure, political ecology, stormwater, urban metabolism, water governance.*

本文聚焦水资源—社会关系, 如何在参与各异且多样的制度与官僚实践网络的技术专家之间, 以不同的方式进行组织, 及其对于更具包容性的环境治理型式与决策的意涵。我在经验上聚焦芝加哥和洛杉矶的暴雨水治理, 作为捕捉环境知识中的地理与制度变异范畴的方法。这两个城市在美国面临相当不同的水资源挑战, 但却同时位于发展综合且进步的城市水资源管理计画的前沿。我于本文中, 指认四大水文社会关系的愿景: 水资源改革主义、水资源管理主义、水资源关系主义, 以及水资源务实主义。每一个愿景皆呈现对于水资源社会关系应如何进行的特定理解。它们共享了整合式管理和使用可取得的最佳科学与技术来进行决策之架构。但共识掩盖了这些多样专家团体之间的根本差异。这些差异集中在其认为不同类别的基础建设介入以及市场与经济诱因的有效性, 还有管理暴雨水的新制度与规范的角色。我主张, 每个架构皆企图组织水资源社会关系, 使其服膺自身的愿景, 但结果却提供了去政治化的策略, 将水质与水量问题简化成他们的技术与水文构成。 *关键词： 基础建设, 政治生态学, 暴雨水, 城市新陈代谢, 水资源管理。*

La atención se orienta en este artículo a establecer cómo se estructuran diferencialmente las relaciones hidro-sociales entre diferentes expertos técnicos involucrados dentro de diversas y múltiples redes de práctica institucional y burocrática, y a ver las implicaciones que esto tiene para formas más abiertas de gobernanza ambiental y toma de decisiones. Empíricamente, me enfoco en la gobernanza del agua lluvia en Chicago y Los Ángeles como medio de captar el ámbito de variaciones geográficas e institucionales en el conocimiento ambiental. En lo que concierne a los recursos hídricos, las dos ciudades enfrentan en los Estados Unidos retos considerablemente diferentes, pero están en la vanguardia del desarrollo de programas urbanos amplios y progresistas sobre gobernanza del agua. En el artículo, identifico cuatro visiones de relaciones hidro-sociales: hidro-reformistas, hidro-gerenciales, hidro-racionalistas e hidro-pragmáticas. Cada uno de estos tipos de visiones representa un entendimiento particular sobre cómo deben proceder las relaciones hidro-sociales. Todas ellas están alineadas alrededor de marcos compartidos de manejo integrado y de la utilización de la mejor ciencia y tecnología disponible que oriente la toma de decisiones. El consenso, sin embargo, esconde diferencias fundamentales entre los variados grupos de experticia. Las diferencias se centran en la efectividad percibida de los diferentes tipos de intervenciones infraestructurales, de los incentivos de mercado y económicos, y del papel que tienen las nuevas instituciones y reglas para gobernar el agua lluvia. Sostengo que cada marco busca estructurar las relaciones hidro-sociales de acuerdo con su propia visión, pero consecuentemente ofrece estrategias apolíticas que reducen

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los problemas de calidad y cantidad del agua a sus componentes técnicos e hidrológicos. *Palabras clave: infraestructura, ecología política, agua lluvia, metabolismo urbano, gobernanza del agua.*

Cities are complex ecosystems where plants, water, animals, and other elements of the material world come face-to-face with the politics, social norms, and rules of humans to create novel forms of urbanization. Stormwater, however, is an often overlooked but integral part of these urban ecological relationships. From flood risk to water quality, and from water supply to notions of urban sustainability and resilience, stormwater presents a particularly unique management challenge for cities. Overcoming and negotiating the challenges presented by water's multiple roles and functions requires particular modes of social, political, and economic control to enable transformations of how society and water interrelate (Bakker 2014; Linton and Budds 2014; Cousins 2016).

Traditionally, approaches to stormwater management in the United States sought to reduce the impacts of urban flooding or to mitigate public health concerns (Melosi 2000; Karvonen 2011). Progressive Era reforms, in particular, profoundly influenced the relationship between stormwater and the city. During this period, social and environmental problems came to the fore of policy making as ever more complex, necessitating the need for improved organizational structures to address them. Usually this meant an expansion of bureaucratic institutions meant to deal with societal problems and policy making through objective expert management. This new structure placed engineers in government bureaucracies to design management systems and public policy that would run systematically and efficiently. The emergent form of technocratic decision-making sought to impose order on the urban landscape through rational planning (Scott 1998). Engineers and technical experts focused on channeling large volumes of stormwater away from the city through conveyance systems and emphasized centralized structural approaches, such as storm drains, sewers, basins, and treatment facilities (Porse 2013). The legacies of these interventions to direct the flows of stormwater and create a systematic and efficient urban metabolism appear in the infrastructural forms and bureaucratic functions of the modern city.

Although the increased efficiency of urban stormwater metabolisms improved sanitary conditions and flood control in most cases, the approaches advocated during the Progressive Era conflicted with concerns over water quality. This came to fruition in the United States with the 1972 passage of the Clean Water Act (CWA) that initiated a basic regulatory structure for managing aquatic discharges of pollutants. The legislation set national policy to develop programs to control point and nonpoint sources of pollution. The diffuse character of nonpoint sources and urban runoff, however, created enormous challenges for municipalities and led to little progress in addressing stormwater through the 1970s and 1980s (Karvonen 2011). Amendments to the CWA in 1987 helped resolve this by establishing a permitting program—the National Pollutant Discharge Elimination System (NPDES)—to establish minimum standards for stormwater treatment. The introduction of this legislation marked a break from many of the traditional approaches to stormwater management, which favored centralized "end-of-pipe" solutions.

Recent approaches to stormwater management incorporate decentralized and distributed methods that focus on local source control through on-site retention and recharge. Influenced by Phase II of the CWA to implement "minimum control measures," cities are beginning to experiment with ways to increase public education and outreach, public involvement, illicit discharge detection and elimination, construction and postconstruction site runoff control, and pollution prevention (Environmental Protection Agency [EPA] 2005). These efforts typically center on developing structural and nonstructural best management practices (BMPs). Nonstructural BMPs focus on developing ordinances and education initiatives to improve water quality, whereas structural BMPs entail physical changes to infrastructure or the landscape to reduce the environmental impact of stormwater, often through green infrastructure (GI) or low-impact development (LID). GI is one type of infrastructural intervention that is intentionally designed to use ecological processes to retain and treat stormwater. The decentralized and distributed character of these infrastructural interventions to manipulate the flows of stormwater enroll a wide range of stakeholders into the governance process, including landowners, businesses, community groups, nongovernmental organizations (NGOs), and a range of government agencies. In the United States, this creates a multilevel governance system where connections between vertical tiers of government form a hierarchical structure (local, regional, state, national) alongside horizontally

(nonhierarchical) organized forms of governance, which link together multiple city departments, environmental advocacy groups, and civic organizations through interagency working groups, task forces, public participation, and informal networks (Betsill and Bulkeley 2006; Porse 2013; Dhakal and Chevalier 2016). These efforts entail changes to physical, bureaucratic, and institutional infrastructures to reorient stormwater flows.

Although recent shifts in urban stormwater management signal a pronounced shift from the Progressive Era logic of urban drainage, technical experts continue to dominate the realm of urban environmental governance. In many cases, stormwater remains a fluid object, embodying different social, political, and bureaucratic lives as it flows across the landscape. It is at once a nuisance, a hazard, a commodity, and a resource. This multiplicity reflects the ways in which stormwater is a social and political construct, embodying a plurality of individual and institutionally based subject positions and competing interests in how to manage, control, and capture stormwater. This is despite new rules and regulations to facilitate integration and reduce "vertical fragmentation" between levels of government and "horizontal fragmentation" across levels of government. How then do we account for the variations in the ways in which rules and regulations shape thought and actions in and between institutions, as well as those tasked with managing stormwater, and to what effect on urban stormwater governance?

To answer this question, I engage with scholarship taking critical approaches to urban water governance to understand the relationship between urban stormwater flows and subject formation (Linton and Budds 2014; Cousins and Newell 2015; Finewood and Holifield 2015). I empirically focus on how technical experts situated within diverse networks of institutional and bureaucratic practice come to different understandings of stormwater governance in Chicago and Los Angeles. By characterizing expert attitudes toward stormwater in cities with different political, technological, and climatic regimes, this research allows for a broader analysis of subject formation that accounts for variations in environmental practices and geographical differences but also how negotiations between diverse forms of expertise come to shape urban political ecologies. I argue that perspectives form through geographically and institutionally based practices that seek to control the flow of stormwater, albeit through apolitical strategies that reduce water quality and quantity problems to their technical components and conceal fundamental differences in the ways hydrosocial relations are structured.

The following section outlines the theoretical framework, which draws on scholarship in urban political ecology at the interface of urban metabolism and the hydrosocial cycle. Specifically, I use this literature to draw attention to how different modes of expertise and environmental practice structure divergent visions of how hydrosocial relations should proceed. I then review stormwater challenges in Los Angeles and Chicago before outlining the methods. The results and discussion focus on how different ways of knowing urban water systems interact, and to what consequence on more equitable forms of urban environmental governance.

Urban Metabolisms and Hydrosocial Relations

Urban political ecologists draw on notions of metabolism to characterize the socionatural relations that transform urban ecosystems through the exchange and circulation of resources, capital, humans, and nonhumans into and out of the spaces of global urbanization (Swyngedouw 2006; Newell and Cousins 2015). Similarly, the hydrological processes, social practices, infrastructures, technologies, and landscapes that comprise the hydrosocial cycle influence how water circulates as a resource through nature and society (Bakker 2003). Urban water metabolisms thus reflect a range of social and technical systems, as well as the hydrological cycle in a "socio-natural process by which water and society make and remake each other over space and time" (Linton and Budds 2014, 170). Bringing a sociomaterial focus to stormwater, where, on the one hand, it is a material flow that unevenly circulates through the city and, on the other, an object of social and political action, allows for an investigation into the ways power and knowledges, subjectivities, and institutions interact to influence environmental governance (Cousins 2016).

Research at the interface of urban political ecology and hydrosociality drawing on the metabolism metaphor excels at showcasing the complex networks of power that entangle nature, society, and technology (Domènech, March, and Saurí 2013; March 2015). Meehan (2013, 333), for example, took a biopolitical approach to water theft where "the monitoring and tracking [of] infrastructure and bodies" maintains hydrosocial order and disciplines informal

development. Anand's (2011) theoretical development of "pressure" also works as a useful analytic to understand the formations of hydraulic citizenship: "a form of belonging to the city enabled by social and material claims made to the city's water infrastructure" (545). Other work has examined the water–energy nexus (Delgado-Ramos 2014; McDonnell 2014), the ways in which hydrological science and social order become coproduced through the categorization of the environment (Bouleau 2014), and the modernization of water systems and hydraulic control (Kaika 2005; Banister and Widdifield 2014; Swyngedouw 2015). Although these studies take diverse analytical and methodological approaches, they succeed in revealing the power dynamics shaping urban hydrosocial metabolisms and highlight the coproduction of human and nonhuman networks (Latour 2005; Banister 2014).

Nonetheless, many gaps remain in the ways in which scholars approach the relationship between metabolic urbanization and subject formation. As Arboleda (2015) noted, "The extent to which these urban metabolisms can also translate into the production of urban subjectivities has not yet been fully developed" (36). Arboleda addressed this shortcoming by engaging with Hardt and Negri's (2001, 2009) theorizations of immaterial labor and biopolitical production, which argue that the dominant form of labor under the current political economic paradigm is immaterial—meaning that labor produces "immaterial products, such as knowledge, information, communication, a relationship or emotional response" (Hardt and Negri 2004, 108). This framework is then applied to a case centered on struggles over water threatened by large-scale mining projects to show how collaborative engagement from below, rather than top-down, produces new forms of community and social subjects.

Other scholars address the perceived lack of subject-forming dimensions within urban environmental governance by engaging with poststructural and feminist political ecology to understand the situated knowledge practices and forms of urban metabolic interaction that structure urbanization processes (Grove 2009; Lawhon, Ernstson, and Silver 2014). Kooy and Bakker (2008), for example, drew on Foucaultian theories of governmentality to explore the interrelated formations of subjectivities, urban spaces, and urban infrastructure that influence water access in Jakarta. Loftus (2012) also accomplished this by centering everyday subjectivity at the heart of environmental politics.

I use these studies as a departure point to explore how urban metabolisms structure subjectivity and to what effect on hydrosocial relations. I argue that to understand how stormwater circulates through the hydrosocial cycle, one needs to interpret the politics of urban metabolism as conditioned by the material flow of resources into and out of cities, as well as a domain of subject formation fostered through differentially situated practices that unevenly bring humans into relation with resources. I suggest that the conditions influencing the emergence of a particular subjectivity unevenly formulate out of the institutional and regulatory mandates that task water resource managers with addressing problems related to the material flow and circulation of stormwater. Government interventions to resolve water quality and quantity issues, for example, impose management systems that organize the flow of stormwater by restructuring social and natural processes. These systems, however, are not uniform. Instead, drawing on Foucault's notion of a *dispositif*, they are

> A thoroughly heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, and philanthropic propositions—in short, the said as much as the unsaid. Such are the elements of the apparatus [*dispositif*]. The apparatus itself is the network that can be established between these elements. (Foucault 1980, 194)

My goal is to understand how the elements of the *dispositif* relate to one another and structure the subjectivities of stormwater experts. This investigation into governmentality encompasses the "ensemble formed by institutions, procedures, analyses and reflections, calculations, and tactics that allow the exercise of this very specific, albeit very complex, power" (Foucault 2007, 108). Many variations exist, however—both geographically and across institutions and organizations—in terms of the type of social and political power relations that shape how one comes to interact with and understand the environment (Agrawal 2005). My analysis teases apart the particular ways in which these variations structure different forms of knowing and regulating the environment and how different modes of expertise differentially attempt to assert control over how hydrosocial relations should occur.

Stormwater Challenges in Chicago and Los Angeles

Managing stormwater in cities like Chicago and Los Angeles is an enormous task that fosters many

different types of governmental and infrastructural interventions to control and manipulate it (Cousins 2016, 2017). Both cities are recognized leaders in addressing stormwater challenges in the United States (Chen and Hobbs 2013), but their unique concerns stem from their particular legacies of urban development and climate and precipitation patterns.

In the 1850s, Chicago was among the first cities in the United States to construct a stormwater conveyance system that combined wastewater and stormwater to direct the flows of water away from people and urban development toward treatment plants (Burian et al. 2000). The construction of combined sewers became the predominant sewerage system through the late nineteenth century for most U.S. cities and was based on scientific understandings of the time that proposed that running water purified itself—this was used to justify the deposition of sewage into nearby waterways (Tarr 1979). In Illinois, stormwater management devolved to the county level. In Chicago, the Metropolitan Water Reclamation District is in charge of developing a countywide stormwater management program for Cook County and maintaining compliance with the federal and state NPDES Phase II requirements. The Illinois Department of Natural Resources is also involved as the regulatory agency tasked with construction occurring in floodways and waterways and providing floodplain management.

In contrast, Los Angeles developed a municipal separate storm sewer system (MS4). Unlike the combined sewers found in Chicago, the MS4 in Los Angeles only contains untreated stormwater, which can include suspended metals, trash, pesticides, and fertilizer. This water discharges to the Los Angeles and San Gabriel Rivers, eventually arriving in the Pacific Ocean. The MS4 is a legacy of governmentalized efforts to improve flood control and protect and encourage urban development. Although 1914 marked the establishment of the Los Angeles County Flood Control District (LACFCD), the passage of the Flood Control Acts of 1936 and 1938 would bring them into partnership with the Army Corps of Engineers. Together they would develop a comprehensive flood control plan known as the Los Angeles County Drainage Area (LACDA). The LACDA consists of more than 500 miles of open channels, including portions of the Los Angeles River, 2,800 miles of storm drains, and numerous flood control and debris basins (LA County Department of Public Works 2015). The California State Water Resources Control Board is in charge of issuing the NPDES permits for Los Angeles County, with the LACFCD designated as the principal permittee to coordinate and facilitate activities directed toward improving water quality and maintaining compliance with regulatory requirements. This creates a complicated network of stakeholders that emerge in relation to addressing problems of water quality and quantity in Los Angeles.

Despite important differences in infrastructural form and governance, both cities face similar challenges in meeting their water quality targets established in NPDES permits and in establishing financial mechanisms to fund stormwater infrastructure projects. Many uncertainties also remain in knowledge around actual costs and benefits to manage stormwater, the effectiveness of decentralized and distributed systems like GI and LID, maintenance, and finding space within the city. Strategies in both cities include market-based approaches like mitigation banking to citywide ordinances and rebates to incentivize stormwater capture projects, GI and LID, and regulatory structure reform. These are all technical approaches, however, that partially look to value stormwater as a resource through the utilization of GI and new forms of participatory and market-based governance (Cousins 2016). Although the expert logic is based on finding solutions that advance economic growth and environmental conservation, it consequently depoliticizes the power-laden social relationships under which different forms of knowledge are debated and become normalized among communities and individuals. With many forms of expertise existing at multiple scales of governance, from the national level to the neighborhood and community, it is important to ask how different forms of environmental practice influence different ways of understanding how stormwater governance should proceed.

Methods

This article analyzes subject formation around different discourses of stormwater governance. Research progressed through multiple phases of fieldwork between December 2013 and September 2015. Between December 2013 and May 2014, key governmental and nongovernmental organizations (NGOs) that work on stormwater issues were identified and researched in both cities, including the U.S. EPA, U.S. Army Corps of Engineers (USACE), Los Angeles Department of Water and Power (LADWP), and the Metropolitan Water Reclamation District of Greater Chicago (MWRD), among other entities. The aim was to identify the range of distinct actors enrolled in debates over

urban water governance and management in each city, including the range of formal city, county, regional, state, and federal government agencies and departments; community and environmental groups; and NGOs. Between May 2014 and June 2015, I conducted semistructured interviews with key actors and representatives from these organizations and attended meetings and workshops on stormwater management in each city. The results of the interviews and participant observation, along with archival work examining academic articles, policy documents, formal government plans, and NGO publications, were then analyzed to determine the different types of claims being made about how stormwater governance should proceed. From these sources, I assembled a concourse of 376 direct statements and quotes that captured the *range* and *diversity* of perspectives and opinions on stormwater management strategies, goals, challenges, and opportunities. The concourse was then narrowed down to forty representative statements, some of which were slightly paraphrased.

The next phase asked the interviewees, in addition to new participants identified from a snowball sample, to sort the selected statements in a grid from +3 (*most agree*) to −3 (*most disagree*) during a follow-up survey and interview. In contrast to traditional sorting exercises that use a preset scale (e.g., Likert-scale surveys), the sorting exercise allows participants to structure and express their own worldview in relation to a set of stimuli (e.g., the statements). This allows participants to reveal and contextualize the multiple and conflicting perspectives they might hold about a topic, such as stormwater. In total, forty respondents participated, which included officials from federal ($n = 4$), state ($n = 3$), regional ($n = 3$), and municipal ($n = 10$) agencies and departments, as well as nongovernment officials ($n = 18$) and academics ($n = 2$) actively involved in shaping urban water governance.

To analyze the results, I applied a second-order factor analysis to generate a set of "super factors" that capture the similarities and differences within and between the subjectivities, or viewpoints, of those in Chicago and Los Angeles (Watts and Stenner 2012). Factor analysis works by creating new variables, or factors, that identify and group together the common and consistent orderings of statements among the respondents. This analytical approach into subjectivity, known as Q-methodology, couples qualitative and quantitative techniques to reveal different arrangements of subject formation around a topic, instead of revealing the distribution of viewpoints across a population (Brown 1980; Robbins 2006; Webler, Danielson, and Tuler 2009; Watts and Stenner 2012). As Robbins and Krueger (2000) noted in describing its application in human geography, "by allowing the participation of the researched in the construction and manipulation of the categories of a quantitative form of analysis, Q proves itself a rigorous and porous mix of qualitative and quantitative method" (646).

The final output of the analysis produces an idealized sort for each factor or group, which represents a distinct viewpoint or domain of subjectivity. This includes a set of statistically significant distinguishing statements that represent the key points of difference between the other factors or perspectives (Barry and Proops 1999). The interpretation and analysis of the distinguishing statements relied on the "crib sheet system" to maintain consistent and holistic factor interpretation (Watts and Stenner 2012). In this article, I use Q-methodology to reveal different expressions of hydrosocial relations to understand the discourses that structure how environmental problems and solutions are defined and articulated.

Results: Structuring Hydrosocial Relations

Four factors, or knowledge groups, emerged from the factor analysis and interviews (statistics summarized in Table 1). I define them as (1) hydro-reformist, (2) hydro-managerialist, (3) hydro-rationalist, and (4) hydro-pragmatist (Table 2). Each group is a "descriptive archetype" of a perspective on how hydrosocial relations should be structured through different arrangements of market, scientific, and regulatory approaches (Davies and Hodge 2012). Collectively, the knowledge groups capture the range of variability in response. Results of the analysis indicate that subject formation converges around shared framings of integrated water resource management and the utilization of science and technology to drive

Table 1. Factor characteristics

	Group			
Factor characteristics	1	2	3	4
Eigenvalue	6.88	3.67	4.87	5.79
No. of defining variables	10	5	7	7
Composite reliability	0.976	0.952	0.966	0.966
Standard error of factor scores	0.156	0.218	0.186	0.186
% total variance	36.35	8.43	3.94	4.32

Table 2. Factor array of Chicago and Los Angeles perspectives of stormwater governance

Statement		Group 1	2	3	4
1.	One of our biggest barriers is increased regulation.	−2	**1**	−2	−2
2.	Implementation is a barrier in large part due to NIMBY type of concerns. People do not want to be liable.	−1	1	0	0
3.	We lack the data needed for the adoption of green infrastructure and to accurately quantify its performance.	**0**	**2**	−2	−1
4.	The trouble within the city is that we are so congested and built up we do not have the space for many types of green infrastructure; space is a significant limitation.	−1	2	1	−1
5.	Climate uncertainty is the most difficult challenge for proactive adaptation planning for stormwater management.	−1	0	**−3**	**1**
6.	Land-use change presents the most difficult challenge to stormwater management.	−1	−1	−1	**0**
7.	I think there is a cultural problem. Stormwater engineers see only engineering solutions and green infrastructure is not part of that.	1	**−2**	0	**0**
8.	Getting people to apply to incentive programs is problematic because people do not care about stormwater management and lack knowledge of water issues.	0	**−3**	0	−1
9.	We need stricter laws and regulations to address stormwater because change is not going to happen voluntarily.	1	0	**3**	1
10.	Failure to address stormwater, like climate change, is a fault of political leaders; they are the ones who need to be educated and incentivized to innovate.	0	**−1**	0	1
11.	Science and data should direct decisions on stormwater and infrastructure. We need data-driven and fact-based approaches drawing on the best available science and engineering.	3	**2**	2	2
12.	Development of a tradable credit system, with appropriate regulatory safeguards, will encourage investment in green infrastructure and help deliver stormwater mitigation at the lowest possible cost.	**−1**	1	1	1
13.	We need market-based approaches and fewer government interventions and regulations to finance stormwater management.	−2	**0**	−2	**−1**
14.	Stormwater management needs economic instruments to put a value on stormwater and make it a resource rather than a hazard.	**0**	1	2	2
15.	Corporations and private interests should have the chance to develop their own targets for stormwater abatement.	**−3**	**0**	**−2**	**−1**
16.	A mitigation bank for stormwater will help foster public–private partnerships to address stormwater by allowing developers to meet LID requirements by paying into that bank.	**0**	1	**2**	0
17.	Stormwater, or water more generally, should not be guided by market, economic, or financial principles.	**1**	**−2**	−1	−1
18.	Wastewater, water supply, flood water, water quality and all of that stuff is just water. If you just think of it as one water then you can manage it much more efficiently.	**2**	**−1**	1	0
19.	We do not need more integrated approaches. We need better enforcement of existing regulations and improvement of local codes and ordinances; integrated water resource planning is not the answer.	−2	**−2**	**0**	−3
20.	An integrated management approach is critical. There needs to be a shift toward more integrated approaches across all of the institutions and sectors concerned with the management of water.	3	3	**2**	3
21.	We need stormwater fees. Municipalities need fees and cost sharing plans.	2	1	**3**	1
22.	Stormwater fees are not feasible, nor are they enough for successful implementation in the long term. Stormwater fees are problematic.	−1	−1	−3	−2
23.	Stormwater needs to be held and used on-site; there are too many concerns about unregulated off-site mitigation.	1	−1	0	0
24.	Stormwater mitigation should be able to occur off-site; it offers more flexible opportunities. Off-site approaches lead to better outcomes than on-site.	**−1**	0	0	0

(*Continued on next page*)

Table 2. Factor array of Chicago and Los Angeles perspectives of stormwater governance *(Continued)*

Statement		Group 1	2	3	4
25.	We need to maintain the narrative of engagement by redefining city services and bringing the expertise to the neighborhoods. We need a grassroots, community-driven approach to create better outcomes.	1	0	0	1
26.	Homeowners need to be educated and they need to educate each other about the benefits of improved stormwater management. They need to be the targets of interventions because community-driven approaches tend to be more effective than data-driven approaches.	1	0	1	1
27.	Local residents' contributions to decision-making usually show a lack of expertise, are not factual, or are biased.	**0**	0	−1	−1
28.	Big systems and dams or reservoirs are important for floods and stormwater mitigation, but after the rain, how you handle that water is important for water quality and/or supply.	2	**2**	2	**0**
29.	Centralized urban water systems are maladapted to address climate change impacts and environmental stressors.	1	−1	−1	2
30.	Larger centralized projects for handling and capturing stormwater are typically more cost-efficient than trying to treat it at thousands of small sources. Centralized stormwater projects make more financial sense than distributed and decentralized stormwater projects.	−1	**3**	0	**−3**
31.	LID offers economic benefits, such as deferring or even replacing costly large gray stormwater infrastructure projects. LID is more cost-effective than gray infrastructure.	2	**0**	1	2
32.	Resilience of urban water systems will be improved by moving away from the centralized model and using more distributed solutions like green infrastructure.	1	**−2**	1	**2**
33.	Distributed projects are not effective; they do not scale up across the city or to other sites and will never meet the level of stormwater abatement and/or capture needed.	−2	−1	−1	−2
34.	As we build green infrastructure we are going to change the nature of neighborhoods. We are going to push working-class people out as we build more economic development around green space.	−2	−1	−2	−1
35.	For every dollar we spend on a water quality project that is one less emergency service dollar, recreation dollar, or funds for other services. It is hard to justify money for stormwater management.	**−3**	−2	−1	−2
36.	I am really opposed to creating new institutions or rules to manage stormwater. There are too many agencies and there is too much diversity already.	0	**2**	0	**−2**
37.	I think there definitely will be a need for new institutions and rules to manage stormwater.	**0**	**−3**	**−1**	**3**
38.	With many community groups and NGOs there are issues with them maintaining the infrastructure or with them focusing too narrowly on certain issues.	0	1	1	0
39.	I think there is enough NGO capacity within the city to have a better coordinated and more strategic approach to green infrastructure.	0	0	1	0
40.	Rather than focusing on new development, we need to focus on the existing development and encourage retrofitting. Only looking at new developments hurts us.	2	1	**−1**	1

Note: The statements are direct, or slightly modified, quotes drawn from participant interviews and archival sources written by participants or their affiliated organizations. Values shown in bold are distinguishing statements (significant at $p < 0.05$). NIMBY = not in my backyard; LID = low-impact development; NGO = nongovernmental organization.

decision-making. Although this cohesive set of framings exists along a spectrum of those involved in stormwater governance, they formulate through apolitical practices that reduce complexity and conceal fundamental differences in the ways in which hydrosocial relations are structured through ongoing processes of social, political, and ecological change. Contrasting perspectives center on the effectiveness of different types of infrastructural interventions, on economic incentives, the role of regulation in either enabling or constraining stormwater governance, and how new institutions and rules should be crafted.

Hydro-Reformist

Ten respondents comprise the hydro-reformist group, including two academics, five water resource experts from NGOs (four from Los Angeles, one from Chicago), one regional water manager (Los Angeles), and two municipal water managers (Chicago). The hydro-reformist is defined by an articulated skepticism of market-oriented approaches and a progressive vision that looks to reform current regulations and codes to alter urban environmental governance. This group reflects a strong commitment toward integrated strategies that are "data-driven" and directed toward transforming the existing environment in socially and environmentally just ways. The perspective is unique, however, in its skepticism of market-oriented approaches and the involvement of private interests in stormwater governance. This group also supports more regulations and more stringent code enforcement to drive reform. Although this perspective recognizes the apolitical character of market-oriented approaches and looks to structure alternative forms of social–ecological relationships in the city through regulatory reform, the progressive discourse of the hydro-reformist is tempered through technical forms of engagement with administrative bodies.

The resulting picture of stormwater is that it is much more than simply a matter of conveyance but a matter of better science, stricter requirements, and better enforcement. Under this perspective, science needs to guide the formulation of improved stormwater governance. A common concern, however, is the lack of data to foster science-driven approaches. Without data or models sophisticated enough to identify the type of projects needed, where they need to go, or the volumes of water captured, implementing GI and attaining water quality and supply benefits might remain elusive for the hydro-reformist. Although it is perceived that this lack of standards and quantifiable aspects of water supply and water quality benefits impedes the implementation of GI, it is also understood that redevelopment will not occur fast enough or at a large enough scale for LID and GI to have a significant impact without focusing on the existing environment.

For the hydro-reformist, not only does the science have to improve but the regulations have to get better as well. One respondent noted:

> Current regulations continue to allow pollution at levels that endanger the environment and human health; we need stricter requirements and enforcement, not looser regulations. The current approaches are full of loopholes and opportunities for regulated parties to escape responsibility, a path unfortunately too many cities or other [private] entities have taken. (Respondent 33, April 2015)

This is a common discourse for hydro-reformists, who perceive regulations as the primary driver fostering transitions in the ways in which cities relate to water. To develop stringent regulatory oversight, hydro-reformists perceive legal and bureaucratic mechanisms as a key tool to direct liability and garner state-backed authority in stormwater governance. This is best articulated through litigation efforts undertaken by NGO groups to stop illegal discharges of stormwater (e.g., *Los Angeles County Flood Control District v. Natural Resources Defense Council, Inc., et al.* 2013), but the utilization of regulatory mechanisms also reveals divisions between perspectives centered on water quality and quantity. Hydro-reformists, for example, support more regulations to improve or clarify different roles in stormwater governance aimed at water quality, but hydro-managerialists perceive many regulatory structures as inhibiting their water supply mission. These differences highlight the difficulties of governing complex social–ecological processes through legal frameworks that are materialized through a system traditionally designed to bifurcate human–nature relationships (Jepson 2012; Cantor 2016) and might not adequately account for the range of geographically distributed social practices contributing to stormwater problems across the urban landscape.

The preference for increased regulations among hydro-reformists resides in their skepticism of market-oriented approaches. This group does not want private interests to have an opportunity to develop their own targets for stormwater abatement. Here, involving private actors would allow them to evade accountability. For the hydro-reformist, government interventions and regulations need to respond to societal needs, and involving the market or private actors is less likely to accomplish desired outcomes. They also strongly disagree with the statement, "For every dollar we spend on a water quality project, that's one less emergency service dollar, recreation dollar, or funds for other services. It's hard to justify money for stormwater management" (#35, −3). A common sentiment among the group was that the statement showed "a lack of appreciation for the value of water" (Respondent 38, April 2015). This group acknowledges the difficulty of justifying public funding for stormwater management, but as one respondent noted, it stems from "the lack of expertise and pervasive apathy demonstrated by the

general public and elected officials [toward stormwater]" (Respondent 18, April 2015). Overall, the hydro-reformist vision looks to structure hydrosocial relations through legal and scientific discourses rather than market-based approaches. This creates a powerful, but contradictory, discourse that seeks to provide a political–ecological alternative to corporate and economic elites but falls back on apolitical modes of governance that commensurate their perspectives with more powerful technical and administrative bodies—whether or not a particular actor works within a formal administrative body.

Hydro-Managerial

The hydro-managerial perspective consists of five officials from Los Angeles. The name derives from Worster's (1985) framing of water resource development in the U.S. West as "dependent on, a sharply alienating, intensely managerial relationship with nature" (5). Four respondents have a background working for municipal water utilities. The final respondent addresses stormwater issues at the federal level. What distinguishes the hydro-managerialist is an apolitical view of stormwater as an unharnessed resource that requires modification to management regimes to maximize economic gain and resource capture. Power for this group derives from their ability to exert engineering and technological control over large volumes of water but also their ability to define environmental problems and solutions to them. Their emphasis on quantity leads respondents toward preferring volumetric solutions that translate stormwater into market calculations of how many acre-feet are captured and stored. This reflects part of an inherited paradigm of water resource management in the U.S. West and concerns over the increasing uncertainty and instability of imported water supply sources.

Stormwater problems, in this view, center on developing approaches that offer the lowest cost per unit volume of stormwater captured and increasing the beneficial use of stormwater as a supply. The hydro-managerialist agrees that integrated approaches are critical but views large centralized facilities as more cost-efficient than distributed solutions when considering the amount of water captured and infiltrated for flood control and water supply. This vision is best articulated in the cost–benefit analyses in Los Angeles Department of Water and Power's Stormwater Capture Plan (Geosyntec 2014), which calculate centralized projects as offering the lowest cost per unit volume captured and distributed stormwater capture remaining in excess of the cost of imported water. As one municipal official noted, "Distributed capture is problematic in that no one ever wants to be responsible for maintenance. In a centralized facility, the [costs of] operation and maintenance is also centralized" (Respondent 11, April 2015). The respondent went on to explain that the disagreement over the statement that "resilience of urban water systems will be improved by moving away from the centralized model and using more distributed solutions like green infrastructure" (#32, −2) is rooted in the data, which shows that centralized approaches are cost effective. The perspective centers on utilizing economic calculations capable of forging stormwater into a supply source, rather than drawing attention to the diffuse ways in which people come into relation with water. More critically, however, the claimed objectivity of economic calculations conceals the very political nature of this perspective, which is rooted in technical feasibility, open markets, and resource capture.

This is further manifested in the hydro-managerialist's preference for centralized solutions, despite disagreeing that stormwater engineers do not see GI as part of the solution to the stormwater problem. As one participant answered, "Engineers greatly see the social benefits of green infrastructure; however, when it comes to decision-making, particularly of public funds, measureable and tangible benefits are much easier to argue for" (Respondent 12, April 2015). This is also reflected in the sentiment among this group that space for implementing GI is a significant limitation. Although these respondents value the function of GI, their role as public officials compels them to prefer centralized solutions, which can hold up to a business case scenario.

Although the valuation of stormwater might necessitate the formation of new institutions, the hydro-managerialist opposes the creation of new institutions and sees increased regulation as a major barrier. As one official noted, "Better enforcement of existing rules and development of new policy is a better option [for managing stormwater as a resource]" (Respondent 22, April 2015). The aim of this perspective is to develop policy that creates an efficient market and allows economic and financial principles to guide integrated forms of stormwater governance. As another respondent noted, "I disagree with the idea that stormwater should not be guided economically. This creates a major burden on taxpayers without much benefit" (Respondent 12, April 2015). As a matter of preference, economic and market principles should be

utilized to create incentive programs that encourage integration "at all levels with all stakeholders, including commercial, household, and NGOs," one respondent noted, because "the federal, state, and local governments cannot do this alone" (Respondent 22, April 2015).

Moreover, a common attitude among hydro-managerialists is that if stormwater is economically valued as a resource, more people will become interested in its management. They disagree that incentive programs are problematic because people do not care about stormwater or lack knowledge of water issues but instead see the problem as creating incentive programs that effectively encourage residents to participate. A shared sentiment among the group is that people respond to incentive programs, as long as the "price is right." Beyond price, however, distributed projects and GI are seen as a mechanism to engage people about water resource issues at the neighborhood and household scales and influence their relationship with water. Distributed projects, however, are typically not viewed as a tangible way of securing adequate volumes of water supply. Overall, hydro-managerialism looks to structure hydro-social relations through apolitical means that connect individuals, land owners, and water through market and economic principles.

Hydro-Rationalist

The hydro-rationalist describes seven individuals. Two are water resource engineers in Los Angeles, one is a federal official, another is a water resource engineer in Chicago, two are representatives for NGOs based in Chicago, and one is a state official in California. I define the hydro-rationalist based on a shared emphasis on expert problem solving that seeks to establish better linkages among science, technology, and the market to foster social change and direct decisions on water and infrastructure governance. This position is bolstered through their engineering expertise and training that reduces complex social–ecological problems to objective and scientifically based assessments of water and technology.

This perspective looks to structure the technical aspects of hydrosocial relations through the harmonization of legal, economic, and market-based approaches. Although respondents disagree with the statement that we need market-based approaches and fewer government interventions and regulation to finance stormwater, it is not rooted in an opposition to market-based approaches. Rather, stormwater needs more government interventions and market mechanisms to rationalize governance interventions. As one respondent noted,

> A combination of environmental requirements and stormwater performance standards, along with economic incentives and flexibility to select tailored solutions for meeting performance standards based on site-specific conditions will be most effective and most cost-effective for meeting stormwater goals. (Respondent 8, April 2015)

A distinguishing perspective of this group, however, is their strong disagreement with the statement that climate uncertainty is the most difficult challenge for proactive adaptation planning for stormwater management. These respondents understand that climate change is going to present many challenges in the future, but it is perceived at a longer timescale. As one respondent noted:

> Climate uncertainty is not important to me at this time as it potentially may become a problem, but only in the very long term. The real challenge is to figure out what to do over the next ten to twenty years, and, in short, make sure that it will work. From a water quality perspective, stormwater needs regulations otherwise chances are that it doesn't happen. Market-based approaches have more chance of success for stormwater management for the purpose of using stormwater as a water resource. (Respondent 27, April 2015)

Similarities exist with other groups, in that stormwater needs mechanisms to attribute an economic value to it, but the hydro-rationalist differs from other perspectives by seeing a broadened role for public–private partnerships and NGOs. This is articulated best in their distinguishing stance toward mitigation banking as a means to foster public–private partnerships to address stormwater by allowing developers to meet LID requirements by paying into a bank. Here the perspective views market-based approaches, in particular mitigation banking, as a mechanism to integrate actors across sectors and scales of environmental governance. Science and engineering, however, become the means and the ends of this process by providing credibility and by legitimizing the effectiveness of market-based approaches in achieving water quality and quantity goals. In other words, the perspective is rooted in a vision where science and engineering are needed to rationalize nature in a manner that renders it visible to the market. This is articulated through efforts to develop mitigation banking schemes in both cities but

is reflective of similar types of efforts across North America and other parts of the world (Robertson 2004; Lave 2012; Valderrama et al. 2013; Huber 2016).

Although an economic and scientific rationality is important for this perspective, they still see other gaps to fill. The hydro-rationalist might disagree that there is a lack of data for the adoption of GI and to accurately quantify its benefits, but postsort interviews suggest that this disagreement is not entirely due to having quality data. As one respondent noted,

> The technology is working. But specific technological investments. A permeable parking lot is working, but what is not working are our planning and decision-making processes on where is the optimal location for that thing. Like if I only had $500,000 and I want to invest it in GI, how do I know I'm investing it where I'll get the biggest bang for my buck? That's not happening. So we end up with something that looks like GI but actually isn't infrastructure because it's not part of a network or system designed to solve the problem. (Respondent 10, April 2015)

The problem is not a lack of data or how well a piece of technology works, but one of how to strategically utilize the resources at hand and connect GI into a broader system of water conveyance. They do not see the development of new institutions as a way to improve the efficiency of resource use either. Rather, they see enough governmental and nongovernmental capacity within the city to have a better coordinated approach to GI. The final decisions, however, should be guided by proper scientific and economic calculations.

Hydro-Pragmatist

This position is based on the understanding that new rules and institutions will be needed to improve urban resilience by fostering integration and distributed stormwater capture. Three of the respondents work for major environmental NGOs based in the United States. Another respondent is a director of an NGO working solely within the Chicago region. The remaining respondents include a state official from Illinois, a director of a Los Angeles–based NGO, and a water resource engineer from Los Angeles. Drawing on Dryzek (1997), this view reflects "democratic pragmatism" in that they believe in "interactive problem solving in a world full of uncertainty but situated within the basic institutional structure of the current political economic system" (99–100).

The hydro-pragmatist strongly supports the development of new institutions and rules to manage stormwater and strongly disagrees with the perspective that large centralized facilities are more cost-efficient. This is the exact inverse of the hydro-managerial perspective. Here, new institutions and rules are key for fostering sustainability transitions and the diversity of opinions becomes an asset rather than a barrier to better stormwater management. As one respondent noted after conducting the sort, "I disagreed with the statement that there is too much diversity and not enough room for new stormwater institutions, because to manage stormwater sustainably and efficiently, there needs to be some changes in management sources" (Respondent 16, April 2015). As another respondent also noted, "I think there definitely will be a need for new institutions and rules. Among those will be some permission or maybe a creation of mechanisms for stormwater agencies to collaborate and cooperate with water agencies" (Respondent 20, June 2015). Furthermore, a different respondent noted,

> The MS4 permit is really the Big Kahuna [in driving changes in stormwater management]. And making sure municipalities fully integrate green infrastructure into their requirements, because otherwise, it's a good idea. It's an aesthetic preference. It's not changing the way a city makes its investments or manages their stormwater. (Respondent 37, April 2015)

Unlike some of the other perspectives, however, climate change is perceived as an important dimension influencing integrated approaches to stormwater governance. As one respondent noted, "There needs to be an integrated approach to stormwater management. With climate change becoming a big reason in the shift of stormwater management, there needs to be different perspectives in decision-making" (Respondent 16, April 2015). Here a plurality of perspectives is embraced as a way to find novel approaches to stormwater management and foster more sustainable and cost-efficient approaches through more distributed solutions. This perspective, more generally, embraces distributed GI projects as necessary due to a perception that centralized urban water systems are maladapted to address climate change impacts and environmental stressors. Hydro-pragmatists do not perceive centralized facilities as more cost-effective and efficient than distributed, integrated, green approaches due to their inability to provide co-benefits. As one respondent noted:

> Centralized projects may have worked in the past when rain events were less frequent and intense, and when less of the land was covered with impervious surfaces. The outdated infrastructure of centralized systems is crumbling in many cities, and this is forcing people to reevaluate the logic behind these systems and their effectiveness. The need to repair this infrastructure or find alternate ways to deal with stormwater has opened the opportunity for the use of distributed solutions like green infrastructure. With increasing knowledge and awareness of these methods and the efforts of organizations and progressive leaders to encourage their use, as well as their proven success (and revealed challenges), I believe now is the time to reenvision urban water systems. (Respondent 1, April 2015)

Stormwater problems, in this view, are a product of too much emphasis on traditional engineering approaches and not scientific advances drawing on the latest developments in green infrastructural design. Hydropragmatists tended to be the most vocal about the role of GI in mitigating the impacts of climate change and fostering more sustainable cities. Climate uncertainty is certainly considered a challenge for planning, but proper planning can only move forward if the available data are used to their full potential. As one respondent from Chicago noted, "We also need to take advantage of the vast amount of data available and new technologies that can be utilized to manager stormwater and use it as a resource" (Respondent 1, April 2015).

Convergence and Divergence in Structuring Hydrosocial Relations

How do different and competing frames of hydrosocial relations interact with one another? Although they all look to assemble different governance mechanisms to structure their own vision of how hydrosocial relations should proceed, they converge and diverge on a number of important points. Results indicate a number of shared perspectives across groups. First, actors strongly agree that integrated approaches that connect all of the institutions and sectors concerned with the management of water are critical in meeting stormwater regulations. As one actor noted,

> Taking an integrated watershed perspective in attempting to address stormwater management is paramount. Within the existing agencies tasked to manage different forms of water within a jurisdiction, too often agency management strategies do not consider impacts outside their mandates. In other words, often the right hand does not know what the left hand is doing. (Respondent 18, April 2015)

Without a more coordinated approach across all sectors of water management, actors do not see appropriate change happening or successfully reaching regulatory requirements.

The second major unifying point centers on utilizing science-based approaches. On the surface, this point might seem insignificant. In theory, decision-making and regulations should rely on the best available science and engineering. The significance of the alignment, however, lies in the production and utilization of knowledge. With a preference for science-driven approaches over community-driven approaches, the concern becomes one of whose knowledge counts and for what type of outcomes. This is further revealed in a shared disagreement with the statement that GI has the ability to change the nature of neighborhoods and push working-class people out of their neighborhoods as more economic development revolves around green space. With evidence suggesting that urban greening can have unintended consequences such as gentrification and displacement (Dooling 2009; Wolch, Byrne, and Newell 2014), it raises concerns about how the implementation of GI might proceed across cities and the ways in which apolitical frames conceal the distributive politics of GI and urban development. This is particularly important as actors tend to converge around the idea that distributed and decentralized projects reflective of GI can scale up across cities and meet federal and state stormwater regulations. As Finewood (2016, 1005) noted, this might be less of a convergence around alternative approaches, such as GI, than a reframing of "grey epistemological" strategies that continue to serve powerful and elite interests, albeit under a greener guise. In other words, the preference for science and data-driven approaches might only work to reinforce dominant and powerful planning paradigms, rather than looking to engage in more experimental forms of environmental governance (Landström et al. 2011; Lane et al. 2011; Braun 2015).

Convergence on integration and science-driven approaches, however, only masks the real differences between expert viewpoints and removes stormwater from its social and political context and contestation. Actors across groups, for example, disagree over the role of centralized and distributed infrastructure, market and economic incentives, and the role of new institutions and rules. The hydro-managerialist, with a

focus on water supply and economic development, and the hydro-pragmatist, with a water quality focus, are the two domains of knowledge with the most dissimilar perspectives. First, they hold opposing views of centralized and distributed infrastructure. They disagree over the costs of centralized urban water systems as well as their role in addressing climate change impacts and environmental stressors. This also appears in their diverging stances toward the statement that the resilience of urban water systems will be improved by moving away from the centralized model and using more distributed solutions like GI. These divergences stem from different ways of knowing the urban environment but also different visions of urban hydrosocial relations. Although subtle, these disagreements play out with material consequences in the day-to-day politics of urban water governance. In cities like Los Angeles, for example, where water suppliers derive much of their power through their ability to exercise technological control over the flows of water, alternative visions of hydrosocial relations might be subverted for the sake of water supply reliability.

The hydro-managerialist also conflicts with the hydro-reformist over the role of institutions and their perceptions of the culture and engineering of stormwater infrastructure. Whereas hydro-managerialists maintain that engineers see the social value of GI, it appears that actors within other knowledge groups do not see this translated into practice, and this is reflected in differences regarding limitations of urban space. Furthermore, the hydro-managerialist is at odds with both the hydro-rationalist and hydro-reformist over the role of incentive programs to incite behavior that aligns with stormwater quality and conservation goals. More fundamental, however, is the disagreement over data. The hydro-managerialist sees a lack of data for the adoption of GI, whereas the other perspectives, especially the hydro-rationalist, do not share this vision. This discord, however, is rooted in the different volumetric approaches applied by actors. Hydro-managerialists apply a form of volume control that derives from their work on estimating the range of water supply costs and benefits per acre-foot of stormwater capture, which typically leads to large centralized approaches capable of capturing large volumes of stormwater (Cousins 2016). In contrast, the other perspectives develop volume control measures as means to ensure that a specified volume of stormwater runoff is retained on site to meet water quality regulations. This outlook favors more distributed and decentralized forms of volume control that reduce runoff and provide water quality benefits. More fundamental, however, is how these differences play out in the everyday actions of those associated with each perspective.

Stormwater and the Politics of Urban Metabolism

I identified four visions of hydrosocial relations. Although it is clear that some perspectives align actors, whereas others are divisive, I show that despite a shared goal to link the social and hydrological (e.g., integrated approaches), they fall back on technocratic forms of governance that reduce hydrosocial relations to their various hydrological and technological components. Different forms of involvement in stormwater governance matter in shaping how environmental actors conduct themselves in relation to the hydrosocial cycle, but their subject positions are also based on contingent and idiosyncratic expressions of broader knowledge claims that lead them to propose or resist different forms of hydrosocial relations (Brannstrom 2011). In conclusion, I want to stress four points about hydrosocial relations and the implications this has for more sustainable forms of urban metabolic relationships.

First, like cities across the globe, Chicago and Los Angeles face considerable fiscal constraints. New ways to govern stormwater through market-oriented approaches are about trying to respond to environmental issues through profitable ventures. Although the uptake of this discourse is not universally accepted, it does show how new methods and technologies of governing stormwater are the result of changing perceptions about stormwater's use. In other words, stormwater needs to be governed as a resource rather than a nuisance, hazard, or liability. For both cities, this way of seeking environmental governance through profitable enterprise stems from funding gaps created at the state and federal level. The motivations driving this transition, however, vary between municipalities. In Chicago actors are utilizing stormwater as a resource to mitigate flood risks and pollution, whereas Los Angeles is seeking to garner more water supply benefits in addition to flood and pollution control (Emanuel 2014; Garcetti 2015).

Second, hydrosocial relations in Los Angeles and Chicago reflect regulatory structures that incent integration and collaboration through horizontal relationships and hybrid governance arrangements that bring together state and nonstate actors (Sletto and Nygren

2016). Part of the appeal of integrated plans and approaches is that they can work as boundary objects allowing different actors, in different domains of water governance, to engage in a collaborative setting without necessarily having to compromise differences of opinion or their structural position (Star and Griesemer 1989; Ward 2013). Integrated approaches also devolve decision-making powers and shift the scale of analysis to the entire watershed, which most actors view as the optimal scale to coordinate efforts across bureaucratic and jurisdictional boundaries and reduce fragmentation. This is evident with respondents in both Chicago and Los Angeles.

Although integrated approaches are perceived as a way to reduce bureaucratic, jurisdictional, and institutional fragmentation, the more participatory and inclusive approach to decision-making remains uneven. Some actors question the credibility and legitimacy of public participation and the participatory process is fraught with disagreements about the specific aspects of water management that need to be integrated (Bakker 2014; Hughes and Pincetl 2014). These challenges also lead to other questions about who should be involved in decision-making and in what capacity. The persistence of technocratic viewpoints espoused by the actors in this study, even among those not typically considered technocrats, confronts the broader impact of the so-called paradigm shift in water governance from a centralized approach to a distributed and participatory approach (Pahl-Wostl 2007; Cohen 2012). It also questions the effectiveness of rules that encourage participation, especially when final decision-making is at the discretion of agency leadership (Dhakal and Chevalier 2016). With power remaining situated within formal government-led processes, one should remain critical of the ways in which approaches that appeal to more integrated or greener approaches might work to obscure more democratic forms of hydrosocial relations and conceal difference through consensus building (Cohen and Bakker 2013).

Third, and related to participation, is the scientization of urban environmental governance, where science frames the issues and problems are identified and resolved through the application of scientific techniques and reasoning (Habermas 1970; Eden 1998; Blue 2015). A broad appeal to scientism permeates the subjectivities of actors across all knowledge groups and materializes from their desires for more science-based rules and methods. Although it is not surprising that the scientization of urban stormwater politics appears among technocratic decision-makers tasked to make credible and objective decisions about resource management, it consequently reduces hydrosocial relations to their technical and hydrological components. The scientization of stormwater governance also highlights the ways in which science can bound decision-making and define legitimate versus illegitimate forms of knowledge (Robards et al. 2011; Cohen 2012; Robbins 2012). Rather than fostering open debate and discussion among the competing values, preferences, or perspectives inherent among the different knowledge groups, the scientization of politics suppresses conversations that explore the variable subjectivities and constructions within each knowledge group. Instead, broad stakeholder involvement is driven toward establishing a record of participation rather than fostering collective experiments that bring science and society together to coproduce new forms of knowledge, assemble new connections, and redistribute knowledge and skills (Latour 1998; Lemos and Morehouse 2005; Landström et al. 2011). This is potentially problematic, as Blue (2015) noted, because it runs the risk of "disenfranchising legitimate dissent on the grounds that alternative perspectives are not perceived as sufficiently reasonable or rational" (71).

Finally, the conceptual frames used by water resource managers to manipulate the flows of stormwater reflect shifts in the metabolic relationship between nature and human knowledges, politics, institutions, and subjectivities. The work of water resource managers to transform urban stormwater metabolisms has relied on the deployment of a series of knowledges directed toward achieving goals in water quality and quantity. How particular strategies play out to achieve desired aims, however, is rooted in the geometries of power that influence socioenvironmental change. With a shared framing of technocratic governance to direct changes in the way humans relate to and manage water, power is rationalized through different forms of expertise. In the presence of ongoing water quality and quantity challenges, the modes of hydrosocial relations that align with dominant forms of environmental governance will continue to set and define how water and society should interrelate. Although subject formation around different forms of hydrosocial relations depends on the ability of an actor to exercise power in the pursuit of a goal (Agrawal 2005), the uneven ways in which environmental governance is achieved produces fragmented and differentiated subjectivities that at times enable actors to direct decision-making toward their own goals and

desires. It is within these gaps of dominant forms of governance, however, where the creativity within the processes of metabolism lies and the potential for new sociospatial formations exists (Smith 1984; Heynen 2014).

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