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Shifting paradigms in stormwater management – hydrosocial relations and stormwater hydrocitizenship

Matthew Wilfong[a], Michael Paolisso[b], Debasmita Patra[c], Mitchell Pavao-Zuckerman[a] and Paul T. Leisnham[a]

[a]Department of Environmental Science and Technology, University of Maryland, College Park, MD, USA; [b]Department of Anthropology, University of Maryland, College Park, MD, USA; [c]University of Maryland Extension, College of Agricultural and Natural Resources, College Park, MD, USA

ABSTRACT

Stormwater management has recently begun a paradigm shift away from traditional top-down approaches in response to climatic changes, urbanization, and regulatory pressures. This paradigm shift is characterized by two key developments: the implementation of additional decentralized green infrastructure, and the practice of individuals managing stormwater from their privately-owned property. This transition involves redefining who is responsible for managing stormwater and the infrastructure used within stormwater management. Using insights from two urban watersheds, Watershed 263, Baltimore, MD and Watts Branch, Prince George's County, MD and Washington, DC, where this shift is underway, we assess changes in the hydrosocial relationships underpinning this paradigm shift including the emergence of stormwater hydrocitizenship. We investigate stormwater hydrocitizenship as the role and responsibilities of individuals within stormwater management. We focus on the role of government at several levels, drawing insights from the concept of biopower. Our findings suggest that this paradigm shift and the emergence of a stormwater hydrocitizenship remains embedded in top-down governance, which in turn creates significant tension among different stakeholders. Arising from this critical analysis, we seek to promote a reimagining of how, where, and who manages stormwater towards more sustainable, resilient, and equitable outcomes.

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1. Introduction

Stormwater management in the United States of America (USA) typifies expert-based, technocentric governance where decision-making, discourse, and practices are shaped predominately by scientists, engineers, and policymakers (Cousins, 2017a; Dhakal & Chevalier, 2016; Roy et al., 2008; Wilfong & Pavao-Zuckerman, 2020). Arising from this top-down governance, stormwater has typically been managed using centralized, built infrastructure. This infrastructure, referred to as gray infrastructure, is designed to transport, retain, and treat stormwater through a complex network of pipes, storage tanks, and treatment facilities (Dhakal & Chevalier, 2017; Ehlers, 2009; Karvonen, 2011). This style of management separates individuals from stormwater, primarily with the aim to protect public health from the potential adverse effects posed by uncontrolled stormwater runoff. Gray infrastructure remained the status quo until the early 2000s, when stormwater flooding and nonpoint source pollution concerns returned to the public purview due to climatic changes, increasing urbanization, and a resurgence in environmental advocacy (Cousins, 2018; Dhakal & Chevalier, 2016; Finewood, 2016; Roy et al., 2008).

CONTACT Matthew Wilfong mwilfong@umd.edu Department of Environmental Science and Technology, University of Maryland, College Park, MD 20742, USA
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There is currently the beginning of a paradigm shift in how stormwater is managed across the USA (Ahiablame et al., 2012; Balsells et al., 2013; Brown et al., 2009; Cousins, 2017b; Roy et al., 2008; Wong et al., 2020). This paradigm shift is characterized by two key developments: the implementation of additional decentralized green infrastructure, and the practice of individuals managing stormwater from the privately-owned property. In contrast with centralized, gray infrastructure – green infrastructure is characterized by small-scale, decentralized practices that mimic natural processes like infiltration and evapotranspiration. This paradigm shift also focuses on expanding the participation of individuals into stormwater management and governance (Hacker & Binz, 2021; Lieberherr & Green, 2018). Individuals' participation is a necessity, especially in urbanized areas, where public land available for stormwater management infrastructure is often minimal (Brown et al., 2009; Cousins, 2018; Dhakal & Chevalier, 2016; Wong & Brown, 2009). Currently, however, many individuals have little knowledge of where, how, and who manages stormwater due to the decades of centralized management. As a result, a reframing of how individuals view their responsibilities and duties to manage stormwater is required. In this paper, we analyze individuals' involvement with stormwater management and governance as stormwater hydrocitizenship (Gearey et al., 2019; Jones et al., 2019; McEwen et al., 2020; Sarmiento et al., 2019).

Building upon existing hydrocitizenship scholarship, we explore how processes and mechanisms of governance help to produce specific hydrosocial relationships, specifically drawing on Foucauldian concepts of biopower, the mechanisms through which governance shape the lives individuals (Foucault, 1991; Foucault et al., 2008; Gearey et al., 2019; Sarmiento et al., 2019). *The goal of our paper is to understand the hydrosocial processes that influence, shape, and control how and why individuals partake in stormwater management and the shaping of stormwater hydrocitizenship.* We analyze how emerging hydrosocial relationships are influenced by the techniques and processes of stormwater governance that can be characterized by Foucauldian concepts of biopolitics and discipline, two modalities of biopower used by governments to influence the behaviors and ideals of individuals (Foucault, 1991; Foucault et al., 2008; Gearey et al., 2019; Sarmiento et al., 2019). We argue that the modalities of biopower employed by governments shape the hydrosocial relationships with stormwater, including the emergence of stormwater hydrocitizenship. The result is tension and conflict among stakeholders as individuals and communities are limited in their ability to define their role within stormwater management and governance. We contend that these conflicts surrounding hydrocitizenship will continue to limit the ability of stormwater governments to bring individuals into the management of stormwater. We show that the current shift in stormwater management paradigm remains predicated on top-down governance and struggles to cope with climatic changes, increased urbanization, and heightened focus on environmental health, justice, and equity.

We structure this paper by presenting the theoretical framework for this research connecting the hydrosocial to power and political dynamics, specifically using the Foucauldian concepts of biopolitics and discipline. Next, we describe the historical context for stormwater management focusing on the Mid-Atlantic region, specifically within our study watersheds, Watershed 263 and Watts Branch. We then discuss the research methodology utilized to investigate the hydrosocial relationships and hydrocitizenship within our study watersheds. The remainder of the paper describes the emergence of hydrocitizenship within these study locations, specifically through the hydrosocial and Foucauldian lens. The paper concludes by providing some recommendations towards reimaging stormwater management beyond the technocratic, top-down form of governance and management firmly in place.

2. Theoretical frameworks: hydrosocial and foucauldian biopower

2.1. Hydrosocial cycle and hydrocitizenship

The hydrosocial cycle, as a theoretical framework, has gained popularity as a tool to explore the socio-natural dimension of water management, especially the role of power relations (Linton, 2014; Linton & Budds, 2014; Schmidt, 2014). Within the hydrosocial framework, 'water' is situated within a continuously adapting cycle shaped by social, physical, and technological drivers. The hydrosocial cycle emphasizes that water and society are related internally, each providing meaning and context to each other (Bakker, 2012; Linton & Budds, 2014; Schmidt, 2014). These co-evolutionary processes between water and society produce distinct hydrosocial relationships and can highlight how specific power dynamics shape, define, and reinforce these relationships (Boelens, 2014; Cantor, 2020; Linton & Budds, 2014; K. Meehan, 2013; K. M. Meehan, 2014).

Of particular interest in research on hydrosocial relationships is subject formation or subjectivity. Subjectivity has been described as the way in which individuals reflexively understanding themselves (Ekers & Loftus, 2008; Foucault, 2008; Gearey et al., 2019; Radonic, 2019). This subjectivity represents a distinct hydrosocial relationship and shaped by political, social, and cultural factors alongside the ever-present materiality of water. Subjectivities between individuals and water relate to and are influenced by dominant discourses and institutions, typically imposed by state and local governments (Tremblay & Harris, 2018; Wong & Sharp, 2009). Importantly, water, technology, and citizenship co-evolve, producing distinct relationships between citizens and water, typically resulting in inequities in water access, quality, and health (Anand, 2019; Schnitzler, 2021).

This subjectivity between individuals and water and citizenship arising from water infrastructure has also been described as hydrocitizenship. Branching from environmental citizenship, hydrocitizenship is the rights, duties, responsibilities of individuals within water management and governance (Gearey et al., 2019; Jones et al., 2019; McEwen et al., 2020; Sarmiento et al., 2019). Hydrocitizenship describes the way in which citizens envision or position themselves within the water management and governance structures and represents a newly identified hydrosocial relationship (Bakker, 2005, 2012; Gearey et al., 2019; Heynen et al., 2006; Linton & Budds, 2014; Sarmiento et al., 2019; Swyngedouw et al., 2002).

The drivers (sociopolitical, socio-economic, and sociotechnical) that influence the 'rights, duties, practices and identities' of hydrocitizenship has not been explored (Gearey et al., 2019). Under the predominantly Western epistemology of technocratic, top-down forms of water governance, hydrocitizenship is typically shaped through techniques of governance that individuals experience (Gearey et al., 2019; Jones et al., 2019; McEwen et al., 2020; Sarmiento et al., 2019). As a result, hydrocitizens actively engage within water management and governance; however, this participation is based upon the pre-existing structures and existing power relationships. The Foucauldian concept of biopower can help to assess and understand the mechanisms through which governments influence hydrocitizenship (Foucault, 1991; Foucault et al., 2008).

2.2. Foucauldian biopower and hydrocitizenship

Building and refining upon his work on governmentality, which is the ability of those in power to govern the conduct of subjects, Foucault introduced the concept of biopower (Foucault, 1991; Foucault et al., 2008). Alongside the generalized and abstracted force of biopower, he introduced two distinct modalities of governmentality: biopolitics and discipline (Foucault, 1991, 2008; Gearey et al., 2019; Sarmiento et al., 2019). Biopolitics can be defined as the power consisting of practices and techniques that govern and regulate behavior at the population-scale (Foucault, 1991, 2008; Gearey et al., 2019; Sarmiento et al., 2019). In contrast, discipline is the mode of governmentality where governments seek to produce behaviors and practices by individuals through influencing the ways in which they relate to and view the world (Foucault, 1991, 2008; Gearey et al., 2019; Sarmiento et al., 2019). Biopolitical governmentality aims to separate management from social variables and reduce the complexity of the system to quantifiable values and statistics. Alternatively, disciplinary governmentality seeks to reintroduce those same social variables into the system but controlling the range of possibilities and extent as to which those social variables manifest themselves. In combination, biopolitics is 'impersonal and totalizing' and discipline is 'intimate and individualizing' (Sarmiento et al., 2019). These two forms of governmentality operate in tandem to constitute biopower.

Within environments characterized by expert-based, top-down governance and management, hydrocitizenship is arguably shaped, in part, by the governmentalities of biopolitics and discipline practices (Bakker, 2012; Ekers & Loftus, 2008; Sarmiento et al., 2019; Swyngedouw et al., 2002). These two modes of governmentality represent a portion of the hydrosocial cycle through which distinct relationships are being produced and controlled, typically benefiting those governments in power (Gandy, 2004; Schmidt, 2014). As a result, hydrocitizenship can be understood through a hydrosocial lens where Foucauldian ideas of biopower, biopolitics, and discipline play integral roles in defining hydrocitizenship. Using these theoretical approaches, we assess the hydrosocial relationships within the shifting stormwater management paradigm and the emergence of stormwater hydrocitizenship.

3. Framing stormwater management and governance in the mid-atlantic

3.1. Historical approach to stormwater management and government

In the USA, stormwater management and governance are regulated through the Clean Water Act (CWA) and the subsequent amendments (301 and 402), which place the legal requirements on state and local governments to control and treat stormwater prior to release into waterways (Ehlers, 2009). As a result, state and local governments, through the National Pollutant Discharge Elimination System (NPDES) program, issue Municipal Separate Storm Sewer System (MS4) permits, and total maximum daily loads (TMDLs) permits at the county-level that dictate the amount of pollution that each county can export into surrounding waterways. These values are determined through quantitative modeling and stormwater management infrastructures are assessed on their performance using similar modeling approaches. This legal structuring of stormwater management promotes the use of quantifiable monitoring and statistical models to enact and enforce stormwater regulations.

As a result, state and local governments typically employ gray infrastructure, characterized by technocentric, centralized conveyance systems that temporarily detain or slow the flow of stormwater prior to treatment at large-scale treatment plants, to manage stormwater from urban areas (Brown et al., 2009; Ehlers, 2009). Gray infrastructure systems can be readily modeled and calculated, a necessity to fulfill legal requirements outlined within the NPDES. Overall, this management paradigm has greatly improved stormwater management throughout the United States, reducing the hazardous impacts of stormwater flooding and pollution in cities compared to pre-CWA management. Despite these improvements, centralized gray infrastructure struggles to cope with increasing urbanization and climatic changes occurring throughout cities across the USA. As a result, stormwater flooding is increasingly becoming a public health and safety concern in cities along with stormwater pollution concerns in surrounding waterways. Stemming from these concerns, there has been a substantial shift towards more decentralized, green infrastructure for stormwater management.

3.2. Shifting paradigm: towards decentralized, green infrastructure

Beginning in the early 2000s, many states began implementing stricter stormwater management regulations in response to consent decrees by the EPA because of violations of the CWA and NPDES programs. These consent decrees act as an agreement between state and local governments and the EPA to begin actions towards improving stormwater treatment, rather than paying the costly fines associated with violating the CWA and NPDES program. Both Maryland and the District of Columbia (D.C.), passed enhanced stormwater management acts in 2007 and 2013, respectively (Ehlers, 2009). These new regulations require the management of stormwater on-site through more decentralized, green infrastructure, specifically from new development. Previously developed areas were not required to adhere to these new, stricter regulations and typically continued to rely on centralized, gray infrastructure to manage stormwater. The passing of these more stringent regulations marks the beginning of a shift in the stormwater management paradigm across the region.

In most urbanized watersheds, public spaces and new development are a small portion of the total area producing stormwater (Cousins, 2018; Dhakal & Chevalier, 2016, 2017; Karvonen, 2011; Roy et al., 2008). As a result, the enhanced stormwater management regulations are insufficient to create noticeable changes in how and where stormwater is managed in highly urbanized watersheds. The majority of stormwater emanates from the privately-owned property where governments do not have the authority to implement stormwater best management practices (BMPs), due to the legal framework of the CWA and state stormwater regulations (Dhakal & Chevalier, 2016, 2017; Finewood et al., 2019). This issue, coined the 'private vs. public dilemma', prevents governments from directly regulating stormwater emanating from private property and places the responsibility to manage this stormwater onto state and local governments, rather than the landowner (unless new development occurs on the privately-owned land) (Cousins, 2017a, 2018; Dhakal & Chevalier, 2016, 2017; Finewood, 2016; Roy et al., 2008). This dilemma has pushed governments to begin fee and rebate systems and coupled outreach programs to influence private landowners to partake in the management of stormwater on their own properties (Keeley et al., 2013; Maeda et al., 2018; Patra et al., 2021; Turner et al., 2015).

In 2012, there were almost 1,400 jurisdictions where a stormwater utility fee was in place across 39 states, including Maryland and D.C. (Chesapeake Bay Foundation, 2020; The Watershed Protection & Restoration Act – HB 987 A Stormwater Management Utility to Clean Water, 2015). The purpose of this fee is two-fold: provide a source of revenue for municipalities solely for the construction and maintenance of publicly owned stormwater infrastructure and to incentivize individuals to manage their stormwater from their property through the adoption of BMPs. A typical individual homeowner in both Washington D.C and Baltimore pays between $2-10 per month towards the stormwater utility fee (Stormwater Fee Background, 2021). Alongside of the stormwater utility fee, municipalities introduced rebate systems to provide credits against homeowners' stormwater utility fee. The rebate systems allow individuals to decrease their monthly fee by installing stormwater BMPs on their properties (like rain barrels, rain gardens, and bioretention cells) based upon their size. Importantly though, few programs provide any financial support and individual property owners can only adopt and receive the rebate on BMPs that are approved by a given municipality. Despite these stipulations, the rebate system provides a financial incentive for property owners to manage the stormwater emanating from their property, beginning to circumvent the 'private vs. public' dilemma by increasing stormwater management on private properties.

4. Methodology

For stormwater governance and management, reshaping hydrocitizenship is a primary goal of governments and highlighted by scholars as a necessity towards the decentralization of stormwater management (Cousins, 2018; Dhakal & Chevalier, 2016; Roy et al., 2008). A major question and challenge facing state and local governments is how to motivate individuals to partake in stormwater management. Many scholars have and are currently researching the effectiveness of government-led outreach and education programs to recruit individuals to manage stormwater. Despite this, there is little research on the underlying hydrosocial relations that are embedded within and driving the shifting stormwater paradigm and the resulting production of stormwater hydrocitizens. To investigate these hydrosocial relationships, we utilized semi-structured interviews to delineate the influence of biopower within the stormwater hydrosocial cycle.

4.1. Study watersheds

Our research focused on two Mid-Atlantic urban watersheds: Watts Branch watershed and Watershed 263 (Appendix A, Figure 1). Watershed 263 in Baltimore City, Maryland and Watts Branch, which straddles the two jurisdictions of Prince George's County, Maryland and Washington, District of Columbia (DC) (Patra et al., 2021). Watershed 263 and Watts Branch were chosen through Community-Based Participatory Research (CBPR) approach alongside local nonprofit organizations, government organizations, and University of Maryland Extension (UME). Watts Branch and Watershed 263 differ in socio-economic and physical characteristics, but both contain predominantly African American populations (Appendix A, Table 1) (Patra et al., 2021).

Both Watershed 263 and Watts Branch watershed primarily utilize centralized, gray infrastructural systems to manage stormwater. Watershed 263 has a separated sewer system, meaning that household wastewater and stormwater pipes are separated from one another, while Watts Branch watershed uses a combined system where stormwater and wastewater are transported together in the same pipes. In both watersheds, these centralized systems are frequently overwhelmed during storm events due to a host of synergistic factors including increasing urbanization and more frequent high-intensity storms. As a result, incidences of flooding, stormwater pollution, and combined sewer overflows have increased significantly in these watersheds.

As a result of the added stress on these stormwater management systems, the implementation of additional decentralized, green infrastructure and heighted outreach efforts by governmental groups and Non-Government Organizations (NGOs) to educate, empower, and recruit residents and communities into stormwater management efforts has increased (Giacalone et al., 2010; Maeda et al., 2018; Patra et al., 2021; Turner et al., 2015). These watersheds are currently undergoing a shift towards decentralizing stormwater management and governance providing an excellent platform to explore the evolving hydrosocial relationships and emerging stormwater hydrocitizenship.

4.2. Semi-structured interviews

A Community Advisory Board consisting of residents and stormwater professionals from local nonprofit organizations, government organizations, and the University of Maryland Extension was formed (Patra et al., 2021). The purpose of this Community Advisory Board was to understand stakeholder's perspectives about stormwater management before and during the project. Purposive sampling methodology was used to recruit stormwater 22 professionals, including government officials, university researchers, stormwater experts with nonprofit organizations, funding agency officials, policy makers, and environmental activists, and 20 household residents for interviews (42 total), split evenly across each study watershed (Patra et al., 2021). Semi-structured interviews were conducted by Debasmita Patra between March and November 2019 and lasted between 45 and 90 min each.

These interviews employed questions to understand the conceptualizations surrounding stormwater and stormwater management of stakeholders from these watersheds. The open-ended questions that were asked of each respondent throughout the interviews are in Appendix A, Table 2. Otter.ai (Liang, 2021) was used to transcribe each coded interview and all identifying information was removed to maintain confidentiality. Names of the watersheds have been used with the quotes throughout the results section to illustrate our analysis. In this article, we use the term stakeholder to denote stormwater professionals and residents alike, as all are actively invested and concerned with stormwater management.

Following IRB approval (University of Maryland Institutional Review Board – #1709048-2), content analysis of each transcript was conducted in MAXQDA using coding techniques to extract overarching themes and conceptualizations of stormwater described by each interviewee (Friese, 2014; Weston et al., 2001; Zhang & Wilermuth, 2005). For the content analysis, each of the 42 interview transcripts was read thoroughly and statements were coded into a total of seven themes which were deemed pertinent to hydrosocial and Foucauldian theoretical perspectives: (i) Motivation for Managing Stormwater, (ii) Definition of Stormwater Management, (iii) Responsibility to Manage Stormwater, (iv) Stormwater Management Practices, (v) Opportunities for Stormwater Management, (vi) Obstacle for Stormwater Management, and (vii) Personal Management of Stormwater. These seven themes focus on topics which were frequently discussed across respondents and support exploring hydrosocial relationships between stakeholders and stormwater and instances where biopolitical and disciplinary governmentalities arise. The codebook and description of each code can be found in Appendix B. After sorting, each theme yielded anywhere from 13 to 300 coded segments.

From above content analysis, coded segments were further sorted to highlight specific hydrosocial relationships, the processes driving these relationships, and the implications of these relationships. These 8 subthemes included: (i) Equity, (ii) Biopolitical Policy, (iii) Tax and Rebate, (iv) Disconnect from Stormwater, (v) Educational Outreach, (vi) Discipline, (vii) Responsibility, (viii) Motivation. This added layer of sorting allowed for a more pointed analysis prominent hydrosocial relationships and the processes shaping them. Through this methodology, we set out to identify the hydrosocial relationships underpinning and forming within the ongoing paradigm shift in stormwater management.

5. Foucauldian biopower and hydrocitizenship in stormwater management

Throughout the interviews, stakeholders discussed the technocratic, top-down style dominating stormwater management and the ongoing decentralization through targeted governmental programs. These perspectives and knowledges highlight the current hydrosocial setting and the underlying power and political dynamics driving the shifting paradigm in stormwater management.

5.1. Biopolitics of technocratic governance and management

5.1.1 Technocratically aligned hydrosocial relationships

Throughout both study watersheds, local and state government actions towards managing stormwater revolves around meeting regulatory requirements outlined by the CWA, MS4 permitting, and TMDLs limits. Many of the stakeholders understood current stormwater management as using a top-down approach focused on meeting quantitative regulatory goals. One stormwater professional who works with NGOs to implement stormwater BMPs in Watershed 263 described the dominance of MS4 permits and credits in stormwater management decision-making:

> It's very much a top-down sort of decision-making and some of that is driven by the fact that Baltimore City, like many cities, has an MS4 permit that they have to meet the requirements for. And so, they're looking for where they can get the most credit. You know that that seems like a very top-down approach, and I don't think it's good for the city in the long term. (Watershed 263 Stormwater Professional #10–27 May 2019)

Stakeholders repeatedly discussed how this top-down approach focuses solely on reaching permit requirements, creating a technocratic atmosphere that is difficult to understand and interact with. It was clear from most interviews that the technical knowledge and requirements needed by individuals to understand and participate in stormwater management were a substantial hurdle for residents' engagement with the process. For example, one Watts Branch stakeholder reported:

> The first time I ever heard TMDL, I had no clue what it was. I was reading about it, you know, and I had no clue until I finally met someone and asked them what the hell is … . (Watts Branch Stormwater Professional #8–11 May 2019)

As a result of this technocratic knowledge barrier, many residents and stormwater professionals discussed how most of the public had little-to-no knowledge of stormwater and its management. For example, one resident described how many individuals are unaware of stormwater and stormwater management:

> Well, people don't know what a big problem it is. They don't know what they can do about it. (Watershed 263 Resident #4–8 July 2019)

This suggest that most residents are either: (1) disengaged with stormwater management, or (2) primarily learning about stormwater management through the technocratic language and approach utilized by state and local governments. The latter process contributes to the emergence of a stormwater hydrocitizenship.

These two hydrosocial relationships between residents and stormwater highlight the outcomes of biopolitical policies and management decision-making. Using MS4 permits and TMDLs, governments attempt to reduce this complexity using quantitative endpoints. This reliance on quantitative modeling for stormwater management produces a process through which planning, and decision-making must be done with MS4 and TMDL requirements at the forefront. As a result, extensive knowledge of urban planning, hydrology, engineering, water chemistry, and stormwater regulations is required to participate in stormwater governance and management. The implications of this biopolitical posturing is two-fold: solidifying the position of 'experts' within management and decision-making and producing a knowledge barrier for individuals and communities to participate in the process.

Through these approaches and style of management, stormwater governments can partially shape the hydrosocial relationships between individuals and stormwater. This was shown throughout the interviews as residents with intimate knowledge of stormwater discussed management using technocratic, regulatory languages that they had adopted through interactions with state and local governments and NGOs. Most residents also acknowledged that many individuals had little to no knowledge of stormwater management, due to a combination gray infrastructure that transports stormwater out of sight and technocratic language that stifles the involvement of many individuals. We found similar sentiments from both watersheds despite the difference in combined and separated stormwater infrastructural systems highlighting that both style of infrastructure divorce individuals from management. This is likely due to both forms of infrastructure remaining highly technical and removing stormwater from the everyday lives of individuals through complex, underground, hidden infrastructure. From this technocratic dominance, two distinct hydrosocial relationships arise between individuals and stormwater – one where individuals are completely removed from stormwater management and another where individuals relate to and participate in stormwater management through the technocratic lens of the expert-led governments in power. This empirically illustrates how Foucauldian biopolitical techniques are used by state and local governments to maintain control and power over management and decision-making.

5.1.2 Tensions arising from biopolitical policies

It was evident that the continued technocratic, quantitative outcomes from stormwater management created tension and conflicts among local governments, communities, and individuals. As one resident from Watts Branch watershed stated:

> We're just trying to solve the problem of how we get to the right MS4 number, as opposed to how do we create a healthy ecosystem in our space. (Watts Branch Resident #9–7 May 2019)

Another Watts Branch resident voiced similar concerns, describing how the quantitative endpoints and outcomes of stormwater management do not appear to benefit individuals and communities:

> If your policy goals is to better manage stormwater and make your community resilient to flooding – this [prioritizing quantitative indicators] is a really bad way to do it because it deters people from even engaging in the process because they think oh well it doesn't help me any. (Watts Branch Resident #6–2 May 2019)

Rather than creating healthy ecosystems or livable communities, stormwater management remains primarily concerned with adhering and meeting quantitative regulatory endpoints. Many residents discussed this underlying theme throughout their interviews and repeatedly voiced their frustration with the management choices of state and local governments towards stormwater. Importantly, residents frequently discussed their vision and goals for how stormwater should be managed in their communities within the broader context of improving their livelihoods and health of the community – in stark contrast with the technocratic, regulatory driven goals of state and local governments.

This biopolitics structuring continues to prefer a more scientific, engineering approach and reifies the power of technocratic forms of governance. In addition, the reliance on quantitative outcomes partially dictates how, where, and why stormwater is managed. In our two study watersheds, residents placed their goals of managing stormwater more within the broader realm of producing livable, healthy, resilient communities, prompting significant frustrations with how stormwater is being managed. We are not suggesting that meeting MS4 and TMDL permits to improve downstream water quality is not an important goal of stormwater management, but instead highlighting that these endpoints do not always align with the needs of individuals and communities. Individuals and communities are aiming to promote stormwater management that also directly benefit their everyday livelihoods. As a result, progress with the shifting stormwater management paradigm will remain heavily debated, as residents and communities perceive disconnected from any potential progress towards meeting regulatory requirements.

5.2. Discipline and emerging stormwater hydrocitizenship

5.2.1 Push towards decentralizing stormwater management

It was evident from the interviews that all stakeholders understood that governments are struggling to meet increasingly strict MS4 and TMDL permits. There was widespread agreement that the necessity to overcome the 'private vs. public' dilemma has increased efforts to involve individuals in managing stormwater. As one outreach coordinator from the Watts Branch watershed expertly described, local governments need individual and community involvement:

> All of the jurisdictions are reaching out to private property owners because they have to. There is not enough public property. If they managed every drop of the storm water coming off their public property, they would still be short of what they are required to do for their MS4 permits. (Watts Branch Stormwater Professional #3–6 May 2019)

Respondents discussed how the 'reaching out' by local jurisdictions has resulted in a shift in perception of who is responsible for managing stormwater. For example, one program coordinator at a prominent NGO focused on outreach, education, and community engagement from Watts Branch watershed argued for shared responsibilities and duties:

> So, whoever is responsible for the maintenance of that property, I think is responsible for the stormwater management associated with it. In terms of residential stormwater management, I think that some of the responsibility does lie on the homeowner. (Watts Branch Stormwater Professional #10–11 June 2019)

Some residents believed that managing stormwater was a universal responsibility. One resident from Watts Branch watershed echoed this sentiment in stating:

> It's everybody's responsibility. When people have properties, they need to understand that they're responsible. Everybody's property should be viewed as a sub watershed. (Watts Branch Resident #10–9 May 2019)

Evidence of the emergence of stormwater hydrocitizenship can be seen as stakeholders discussed the shared responsibility among individuals, communities, and governments to manage stormwater. This new sense of responsibility is the direct result of disciplinary policies and techniques (discussed at length in later section) by state and local governments through which they 'reach out' to individuals to change, dictate, and influence their behaviors stormwater management to align with their goals and ideals. These disciplinary processes are still underway and being actively contested as shown by this perceived responsibility was not shared among all respondents. As a result, while stormwater hydrocitizenship is emerging through disciplinary processes, their remains conflicts around the involvement of individuals.

5.2.2 Tensions surrounding stormwater hydrocitizenship

A clear theme that emerged from the interviews was the role of individuals within stormwater governance and management as a source of significant contention despite the efforts by local governments to promote their involvement. While many interviewees discussed the responsibility of individuals within stormwater management, some suggested that the government was still solely responsible, including one biologist who had worked with multiple NGOs within Watershed 263 and one Watts Branch watershed resident, respectively:

> The public agencies. I mean we pay taxes … and they have their MS4 to meet … and so they are responsible for it. It's not the residents' responsibility. (Watershed 263 Stormwater Professional #4–29 March 2019)

> So, the thing about it is, the government has made the issue … I would say that the government's responsible. (Watts Branch Resident #3–29 April 2019)

These differences in perceived responsibility highlight the conflict and tension within stormwater management and defining the role of stormwater hydrocitizens more generally. While governments are attempting to recruit and enlist individuals to manage stormwater, there are still uncertainties among residents about their perceived responsibilities. Another frequent theme throughout the interviews among residents was concern about how these new duties and responsibilities would manifest within their everyday lives. One resident from Watts Branch watershed highlighted potential issues of these new responsibilities towards managing their environment, like stormwater:

> When you live in communities that are traumatized by poverty and violence and crime … we're generally always fearful … What do they want from me? And we don't have anything else to give. We're overwhelmed, we're stressed out. And the environment. Why should I clean the environment? My house isn't clean. (Watts Branch Resident #2–29 April 2019)

Individuals are concerned that they are being tasked with increased responsibility towards safeguarding the wellbeing of their home, communities, and surrounding environment – responsibilities that some suggest remaining with the state and local governments. Stormwater hydrocitizenship while being actively promoted is still being met with considerable pushbacks and concerns.

5.2.3 Outreach and fee-rebate system reinforcing stormwater hydrocitizenship

The shifting responsibility for stormwater management is further reinforced by fee-rebate systems and educational outreach programs organized by state and local governments and partnered NGOs. One resident from Watts Branch watershed discussed the roles that these governmental and NGO-partnered educational outreach programs play in establishing stormwater management practices on private lands:

> I think the local government is trying to implement programs … to help homeowners implement practices because they know that as a local government, you're not going to be able to meet your water quality goals without residential practices. (Watts Branch Stormwater Professional #2–30 April 2019)

Additionally, one Watershed 263 resident discussed how the fee-rebate system uses financial incentives to recruit individuals:

> Basically, there's a stormwater fee, and there's a program that exists to basically refund some of that stormwater fee back to residents for being involved in certain projects. (Watershed 263 Resident #8–30 August 2019)

Residents and outreach professionals discussed the specific purpose of these programs to involve individuals in managing stormwater on their own properties. We argue that stormwater hydrocitizenship is being actively promoted by and through specific governmental actions and programs. We suggest that the fee-rebate system and accompanying outreach programs are designed by stormwater governments to promote the internalization of knowledge and goals of stormwater management by individuals. Residents discussed how the fee-rebate system and outreach programs shaped their knowledge of and involvement within stormwater management. From a Foucauldian perspective, these techniques represent disciplinary processes where state and local governments attempt to align the knowledge, beliefs, and actions of individuals towards stormwater with their own. These programs promote a distinct hydrosocial relationship where individuals are internalizing the knowledge, goals, and outcomes of stormwater governments while participating in stormwater management on their own property.

As these governmental practices shape stormwater hydrocitizenship, they also significantly limit how individuals can be involved within stormwater management. Throughout the interviews, residents voiced their frustration with implementation of the fee-rebate system and outreach programs that are in place to facilitate their involvement. One urban ecologist from Watershed 263 described the process through which rain gardens could be implemented on residential properties to receive the rebate:

> They have a rain garden program where they'll come out to your home, and they'll look at how much impervious cover you have. And they will say, 'Okay, this is how much rain garden you need and square feet. (Watts Branch Stormwater Professional #12–13 June 2019)

Stakeholders viewed the fixed and narrow options available to participate in the rebate programs as frustrating constraints. Additionally, other respondents during the interviews discussed how ineffective and arduous the rebate system was due to institutional and technical barriers. One Watershed 263 residents described how the rebate system was difficult to interact with and utilize:

> It's onerous and difficult, and frankly, I've given up on even trying it, but I just pay the fee because the difficulty, the prior consent, and the documentation the city requires to go through the process is just too difficult to make it work. (Watershed 263 Resident #6–18 July 2019)

The fee-rebate system was designed to financially reward individuals who partake in the management of stormwater on their property; however, due to technical and institutional obstacles, many individuals feel overburdened by the process and either just pay the stormwater utility fee or implement stormwater BMPs and never apply for the rebate. This issue created significant tension as residents repeatedly cited the rebate system as ineffective, unduly burdensome, and did not provide sufficient rebates to offset the time, labor, and materials needed to implement certain BMPs.

We argue that the fee-rebate system promotes inequality as those with the inability to pay the stormwater utility fee and wish to implement stormwater BMPs to receive the rebate are often met with substantial time, institutional, financial, and technical barriers that prevent them from doing so. In contrast, those that can pay have the luxury of implementing stormwater BMPs on their property, receive the auxiliary benefits of doing so, and possibly not register for the rebate because the process is too 'difficult'. This produces uneven benefits throughout cities as higher-income communities can implement more stormwater BMPs on their properties, benefitting from the increased stormwater management and auxiliary ecosystem services. On the other hand, lower-income communities are left to pay the stormwater utility fee and rely on governmental interventions and infrastructures to be built in their neighborhoods to protect against stormwater. Coupled within this uneven dynamic is the added unevenness in how local and state governments implement stormwater BMPs, using revenue from the stormwater utility fee within cities, preferentially choosing higher-income neighborhoods for new and retrofitting projects (Baker et al., 2019; Berland et al., 2015; Kong et al., 2007; Schwarz et al., 2015).

6. Conclusions: reimaging stormwater governance and management

Stormwater governances and management are including more green infrastructure and increasing citizen involvement. However, top-down technocratic systems of governance and management continue to exert a disproportionate effect on hydrosocial relations and constrain greater participation of stormwater hydrocitizens. Our research demonstrates that while individuals are engaging with stormwater management, the avenue for their involvement is greatly constrained by both the biopolitical and disciplinary governmentalities. These constraints and the overall lack of autonomy felt by individuals in defining their role, duties, responsibilities, and desired outcomes within stormwater management results in significant conflicts, tensions, and inequity within the shift towards a more decentralization paradigm in stormwater management. Consequently, the emerging stormwater management paradigm is at risk of not meeting its sustainability, resilience, and equity goals. To help meet these goals, a more critical conversation about knowledge and power within stormwater governance is needed. Drawing on the findings presented above, we seek to contribute to a reimagining of stormwater management and a reworking of the hydrosocial relationships among governments, communities, individuals, and stormwater. We offer the following next steps as actions that can help advance this reimagining.

We suggest adopting more holistic approaches to stormwater management that will allow individuals and communities to better advocate for their goals and desires for stormwater management infrastructure and decision-making. We have shown how the dominantly technocratic approach to stormwater management continues to significantly shape how, where, and who manages stormwater. We contend that stormwater management must move past these technocratic forms of management and governance towards more participatory, collaborative planning and decision-making. Stormwater is not uniform spatially or temporally throughout cities and requires specific, local actions. Within this transition, the views, needs, and concerns of all stakeholders need to be incorporated into decision-making and planning. Additionally, a more holistic approach will allow stormwater hydrocitizens to participate in defining their roles, responsibilities, and rights within stormwater management, especially deciding the outcomes and goals of their involvement.

We suggest that there should be new regulations that approach stormwater management as an 'opportunity' rather than a 'liability' and stormwater as a 'resource' rather than a 'hazard'. Framing stormwater as a 'resource' rather than a 'hazard' will open more possibilities for how stormwater is managed and a wider, more holistic variety of desired regulatory outcomes and goals for stormwater management. Regulations should also be more adaptive and less reliant on quantitative outcomes, further allowing for more integrative, collaborative planning and decision-making across the diverse range of stakeholders within urban areas. Improving the accessibility of regulations will promote more involvement of individuals to partake in the decision-making process and promote more accountability for how and where governments decide to manage stormwater.

We need to better attend to the power and political dimensions of stormwater management and governance to highlight conflicts, tensions, and inequities within these systems. We have found Foucault's concepts of biopower, biopolitics and discipline useful in sharpening our research focus on the power and politics of stormwater management. Other political ecology approaches can offer additional and complementary approaches. Through similar research, important and powerful questions regarding stormwater governance can be further investigated, such as: What does a non-technocratic approach to stormwater management look like? How can stormwater hydrocitizenship become a tool for improving the livelihood of individuals and communities?

How can governments and citizens share decision-making power within a more decentralized form of stormwater governance? These questions and others are important starts to a more holistic effort to reimagine stormwater governance.

More broadly, throughout water management and governance, there is a heightened effort by state and local governments to promote and harness citizenship and subjectivity related to individuals' involvement with water resources and management. As citizenship becomes more intimately linked with water management, there must be attention and awareness of how hydrocitizenship can be controlled and dictated by entities in power. In addition, the rise of hydrocitizenship is part of a larger shift towards decentralized forms of water governance and management. As the process towards decentralization continues, it is important to consider the ways in which power and politics dictate who benefits from this decentralization, who is burdened, and why. These points convey the inherent and growing linkages between water, technology, infrastructure, and citizenship that must be at the forefront of water research to progress towards more sustainable, resilient, and equitable water futures.

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Notes on contributors

Matthew Wilfong is a postdoctoral scholar in the School of Sustainability at Arizona State University.

Michael Paolisso is a Professor Emeritus in the Department of Anthropology at the University of Maryland, College Park.

Debasmita Patra is Program Director of Evaluation and Assessment at the University of Maryland Extension.

Mitchell Pavao-Zuckerman is an Associate Professor in the Department of Environmental Science and Technology at the University of Maryland, College Park.

Paul T. Leisnham is a Professor in th Department of Environmental Science and Technology at the University of Maryland, College Park.

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