Sociotechnical Adaptive Water Governance: A Case Study of Water Governance in Lombok Indonesia

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ABSTRACT

Navigating hydrological change and social-ecological complexity requires adaptive water governance. However, moving from premise to practice has been problematic, particularly in developing contexts. Strategies aimed at translating governance prescriptions into practical planning and sustained implementation are not well articulated nor understood. Thus, this paper examines a water governance paradigm in Lombok, Indonesia with the objective of expounding the dynamics between adaptive water governance and contextual conditions. This case study reveals an innovative pathway toward achieving governance prescriptions. In Lombok, decentralized technical decision-making acts as a fulcrum on which adaptive water governance processes are initiated. Further unpacking this approach suggests it can serve as a context-tailored transformative strategy that balances top-down and bottom-up approaches. Rather than radically alter contextual constraints, this strategy exploits them to produce adaptive governance opportunities. In doing so, it is more likely to overcome the traditional challenges of entrenched interests, high transaction costs, and institutional inertia. These findings underscore shortcomings in our understanding of the interconnection between technological and social dimensions of water governance. The importance of how social and institutional factors affect technical water management outcomes is well understood, however the converse of this dynamic is often overlooked. Therefore, this paper advocates for a more comprehensive integration of the many complex dimensions of water governance.

Keywords: water governance; adaptive water governance; adaptive water management; integrated water resources management; adaptive comanagement

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Paper presented at Joint International Conference of Scienced in the Tropics UM-UNRAM Mataram August 23-24, 2017.

1. Introduction

Global freshwater resources face immense human pressures in the Anthropocene. As climate change drives complex alterations to the spatio-temporal distribution of water, population growth and other demographic shifts intensify demand for the contested resource (Vörösmarty et al. 2010, Allan et al. 2013, IPCC 2014). Water connects social-ecological, economic, and biophysical systems at multiple scales. Thus, such intractable challenges have wide-ranging implications for human societies and ecosystems (Bates et al. 2008, Bogardi et al. 2012). It is now widely acknowledged that anticipating, mitigating, and adapting to the adverse impacts of

these changes requires dynamic governance. Governance structures must recognize social-ecological complexity, engage with system interdependencies, and meaningfully embrace emerging opportunities for social and biophysical innovation (Berkes et al. 2003, Folke et al. 2005, Olsson et al. 2005, Bakker, 2012).

These insights have undermined basic assumptions of traditional water management, setting forth a paradigm shift in water governance literature and practice (Pahl-Wostl 2007). This study applies the definition of water governance most widely referenced in the literature and commonly used among water professionals. Water governance signifies "the range of political, social, economic, and administrative systems that are in place to develop and manage resources, and the delivery of water services, at different levels of society" (Rogers and Hall 2003: 7). Whereas traditional water governance conceptualizes water management as a technical challenge, novel paradigms emphasize a transition away from command-and-control approaches in favor of holism, polycentric integration, organizational flexibility, social learning, and reflexivity (Pahl-Wostl et al. 2007, Lejano and Ingram 2008, Azhoni et al., 2017). The most notable of such approaches thus far have been integrated water resources management (IWRM), adaptive management (AM), and adaptive comanagement (ACM) (Medema et al. 2008, Huitema et al. 2009).

While such adaptive water governance approaches are theoretically sound, moving from premise to practice has been uneven, impractical, and potentially maladaptive (Medema et al. 2008, Huitema et al. 2009, Förster et al. 2017). Adaptive water governance has remained primarily prescriptive because of these implementation challenges. Because implementation is conducted within the constraints of broader social, political, and biophysical systems, capacity for adaptive governance is defined by context (Allan and Gunderson 2010). Implementation strategies that do not recognize such contextual constraints fail (Förster et al. 2017). Therefore, adaptive governance must be "able to 'navigate' the dynamic nature of multilevel and interconnected social-ecological systems" (Galaz et al. 2008:169). However, the dynamic nature and contextual preconditions are not well articulated nor understood (Medema et al. 2008, Munaretto and Huitema 2012, Huitema et al. 2016). Consequently, stakeholders have been slow, unable, and or unwilling to enact the systemic reforms because of high transaction costs, insufficient public participation, entrenched interests, and institutional inertia (Allan et al. 2013, Halbe et al. 2013, Varady et al. 2016).

Yet, these are manmade barriers and therefore malleable and surmountable with concerted effort to move water governance systems toward adaptive water governance (Moser and Ekstrom 2010). Although increasing change and uncertainty are already driving water governance systems to gradually shift toward adaptive water governance, this shift has thus far been inadequate, particularly in the developing world (Allan et al. 2013, Azhoni et al. 2017). Therefore, theory and practice must examine contextual preconditions with a focus on how to translate theoretical contributions into practical planning and sustained implementation (Huitema et al. 2009). In developing contexts, adaptive strategies must also deliver of co-benefits from development projects (Azhoni et al. 2017). Therefore, adaptive water governance scholars and practitioners must develop innovative ways to couple theory with practical applications by articulating clearly beneficial policy opportunities (Huitema et al. 2009). Not only does this improve the relevancy of theory, but it encourages and facilitates policy-makers to enact change.

Thus, this paper examines a case-specific water governance paradigm in order to analyze the dynamic interconnection between contextual conditions and adaptive water governance implementation. The objective in doing so is to articulate context-specific pathways toward adaptive governance implementation. These pathways can serve as practical policy opportunities that facilitate collaboration, coordination, stakeholder participation, and capacity-building. This paper does so by examining the polycentric water governance system in Lombok, Indonesia.

Lombok is undergoing rapid ecological, social, political, and economic change. Its markedly heterogeneous physical and social geographies present an opportunity to glean lessons about adaptive water governance in a wide variety of contexts. Lessons learned may be broadly applicable to contextually-similar social-ecological systems such as rural communities, island geographies, the Indonesian archipelago, tropical Asia-Pacific region, and or developing world more broadly. First, this paper details the theoretical framework and methods used to conceptualize Lombok's water governance paradigm. Second, the paradigm and systems are presented in detail with an eye toward eliciting adaptation pathways. Third and finally, this paper concludes with an analysis of this case study's implications for our understanding of the interconnection between context and adaptive water governance implementation.

2. Methods

2.1. Theoretical framework

To analyze the complex system dynamics of water governance in Lombok, this study follows a two-step approach informed by adaptive governance analysis and water management paradigm analysis. Specifically, this paper draws from the Management and Transition Framework first developed by Pahl-Wostl et al. (2007, 2010) and further developed by Halbe et al. (2013) and then blends it with elements of the adaptive governance evaluation framework developed by Trimble et al. (2015). In doing so, the study integrates dimensions of in-depth systems evaluation and participatory evaluation.

First, this study examines water management systems in Lombok to elicit and analyze the water governance paradigm by examining four components set forth by Trimble et al. (2015); (i) Setting (biophysical, social-ecological, institutional, external drivers); (ii) Process (participation, social relationships, social learning); (iii); Outcomes (social capital, decision-making, social learning and adaptation); (iv) Effects (ecological, social, social-ecological). The fourth component is presented throughout the discussion of the preceding three. Being explicit about paradigms reveal inconsistencies in management and government systems (Halbe et al. 2013). Data from document analyses and focus group discussions are utilized to do so. These initial methods allow for in-depth evaluation and increased validity through triangulation (Trimble et al. 2015).

Second, the governance paradigm elicited then serves as a basis for participatory envisioning and designing of pathways to adaptive water governance implementation. This is done through semi-structured interviews framed to facilitate a process in which multiple stakeholders define the challenges, strengths, goals, indicators, and evaluation methods of moving toward adaptive water

governance. Participatory approaches foster transfers of knowledge, social learning, informed decision-making, collaboration, and capacity development (Halbe et al., 2013). Furthermore, participatory evaluation allows for greater external validity, enhanced selection of indicators, organizational learning, and empowerment of disenfranchised stakeholder groups (Plottu and Plottu 2011, Trimble et al. 2015). The data collected from the interviews are triangulated to corroborate and test the validity of previous findings, and then inform the overall conceptualization of Lombok's water governance paradigm.

2.2. Data Collection

First, this paper extracted water-specific scholarly literature on adaptive governance in Lombok from a broader systematic literature review of adaptive governance theory and practice in the province of Nusa Tenggara Barat conducted by Laplaza et al. (2017). Concurrently, in March 2017, three field group discussions (FGDs) were held with water user associations in three villages in North, East, and South Lombok, during which local-level water users (i.e. villages, farmers) could express their perceptions of water governance settings, processes, outcomes, and effects. These perceptions of the 58 participants were audio-recorded, transcribed, and translated into English (see Appendix A of supplementary material). A document analysis of the water-specific scholarly literature and the FGD recordings were used as the basis for the preliminary conceptualization of the water governance paradigm in Lombok and identification of key stakeholders, institutions, and contextual components to be evaluated through interviews.

Thirty-five in-depth semi-structured interviews were then conducted with the various key stakeholders. These included representatives of academic institutions (coded as AI), non-governmental organizations (NG), local government agencies (LG), regional government agencies (RG), and various local water users, typically irrigation farmers (WU) (see Table 1). Water users included upstream, midstream, and downstream water users within all four of distinct Lombok's distinct ecological topographies (North, South, East, Central) to reflect the marked heterogeneity of Lombok's physical and social geographies. The data collected from the document analyses and FGDs indicated local water users are often marginalized from the decision-making process despite being highly affected by the decisions made. Therefore, the semi-structured interviews allowed for increased representation of local water user perceptions relative to the other stakeholders.

Table 1. Composition of interview participants

Contextual Characteristic		AI	NG	RG	LG	WU	Total
Geographic Location	Mataram	5	2	5	-	-	**12**
	North	-	-	-	1	6	**7**
	East	-	-	-	1	4	**5**
	Central	-	-	-	1	4	**5**
	South	-	-	-	2	4	**6**
Location in Irrigation Area	Upstream	-	-	-	1	6	7
	Midstream	-	-	-	2	6	8
	Downstream	-	-	-	2	6	8

Total	**5**	**2**	**5**	**5**	**18**	**35**

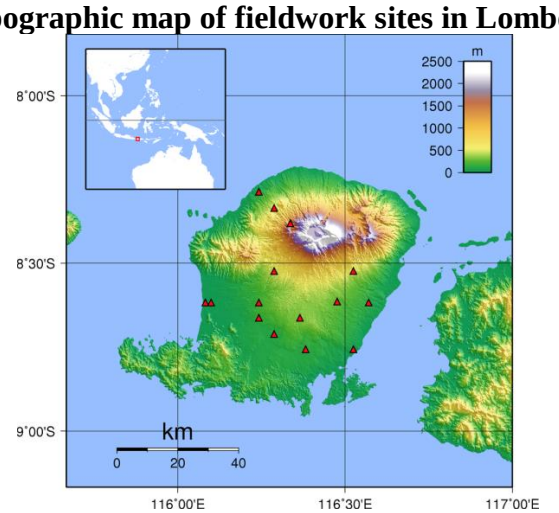
The semi-structured interviews were designed to encourage participatory evaluation of contextual challenges, systemic strengths, and adaptive pathways to overcome these challenges (see Appendix B of supplementary material). The objective in doing so was to facilitate stakeholder envisioning of translating strengths to overcome water-related challenges. The interviews were conducted in Bahasa Indonesia and Bahasa Sasak, audio recorded, then transcribed and translated into English. Once transcribed and translated, an interpretive approach to content analysis was applied to the data set. Informed by grounded theory, this approach elicits themes and subthemes in interview responses by inductively coding the verbatim transcripts (see Appendix C of supplementary material) (Glaser and Strauss 2012). The total number of times respective codes appeared in the transcripts, the total number of respondents' transcripts containing respective codes, and a breakdown of which stakeholder transcripts contained respective codes were than analyzed.

3. Results

3.1. Setting

Located in the island archipelago of eastern Indonesia, Lombok's tropical climate features a five-month monsoon season that contributes 80 percent of the island's precipitation (Klock 2007). It is affected by the El Niño Southern Oscillation (ENSO), which can generate drier and/or wetter than average periods. Rising temperatures due to climate change are likely to increase the frequency and intensity of droughts and decrease the predictability of rainfall patterns (Yasin et al. 2007). Rainfall patterns may become concentrated into fewer events (Butler et al. 2014). The orographic effects of the volcano Mt. Rinjani create steep climate gradients across the island. Combined with marked variation in soil types, these microclimates support diverse agricultural systems and livelihoods over a short distance (Yasin et al. 2007). Therefore, changes in rainfall patterns and impacts will vary widely across the island (Kirono et al. 2016).

Figure 1. Topographic map of fieldwork sites in Lombok, Indonesia



The volcano Mt. Rinjani captures high-elevation rainfall and concentrates it in a 1,375,000m^3 lake. The water then funnels through the porous volcanic soil and forms hundreds of streams reaching across most the island. Ninety percent of the island's 33 rivers originate from Rinjani (Klock 2007). These rivers and streams are divided into 32 sub-basins for administrative purposes. However, sub-basin boundaries aren't clear as water is diverted out of water basins across the island. Whereas North and West Lombok generally received a surplus of water, Central, East, and South Lombok face chronic shortages. Many of the rivers and streams have been dammed or diverted to serve these areas facing water shortages. However, infrastructure degradation and illegal diversion upstream often lead to water shortages downstream. Furthermore, in the past two decades, over 400 springs have dried up due to illegal logging on the mountain (Klock and Sjah 2011). This deforestation results in chronic flooding during the wet season and chronic water scarcity during the dry season. Tension and conflict between water users are increasing as a result.

The population affected by these spatio-temporal hydrological changes is simultaneously facing rapid demographic changes. Although only 4,725km^2, Lombok's population of 3.1 million (2010) is expected to reach 4.5 million by 2050 (Fachry et al. 2011). The population is characterized as having low human development (0.651 HDI), reflecting low levels of life expectancy, literacy, education, and per capita income (BPS Indonesia 2015). Poverty has been greatly reduced over the past two decades but remains prevalent in rural areas where 58 percent of the population lives (BPS NTB 2016).

Livelihoods on the island are intimately tied to ecosystem goods and services. Freshwater is the primary input to five of the seven identified principal livelihood typologies (e.g. agriculture, aquaculture) (Rochester et al. 2016). Agriculture is dominated by water-intensive rice farming and comprises approximately 80 percent of the island's total water consumption. Industry, tourism, and households comprise the remaining 20 percent. Population growth is increasing demand across these sectors and straining the already contested water supply. This combination of climate and hydrological change, low human development, high water dependency, and rapid population growth leave Lombok highly vulnerable to change and uncertainty, but beset by low resilience and adaptive capacity.

A polycentric water governance system manages these challenges. Polycentric governance is defined as governance systems in which "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchal relationship to each other" (Skelcher 2005: 89). The 1997 Asian financial crisis catalyzed a process of broad political decentralization that distributed water management authority across government agencies (Bhat and Mollinga 2009). Rural water distribution is managed by the ministries of forestry, public works, and agriculture who assume interrelated roles in conserving, developing, and distributing water resources. Within these agencies, authorities are further distributed by scale. For example, the Ministry of Public Works (MPW), which is responsible for the development and maintenance of water infrastructure, delegates authority of irrigation areas larger than 3000ha to the national level, areas between 1000-3000ha to the provincial level, and areas smaller than 1000ha to the district level. Representatives of the three agencies together form Water Resource Council tasked with coordinating multi-level water management operations (Sjah and Baldwin 2014). Urban and drinking water distribution is managed by *Perusahaan Daerah Air Minum* (PDAM), a public-

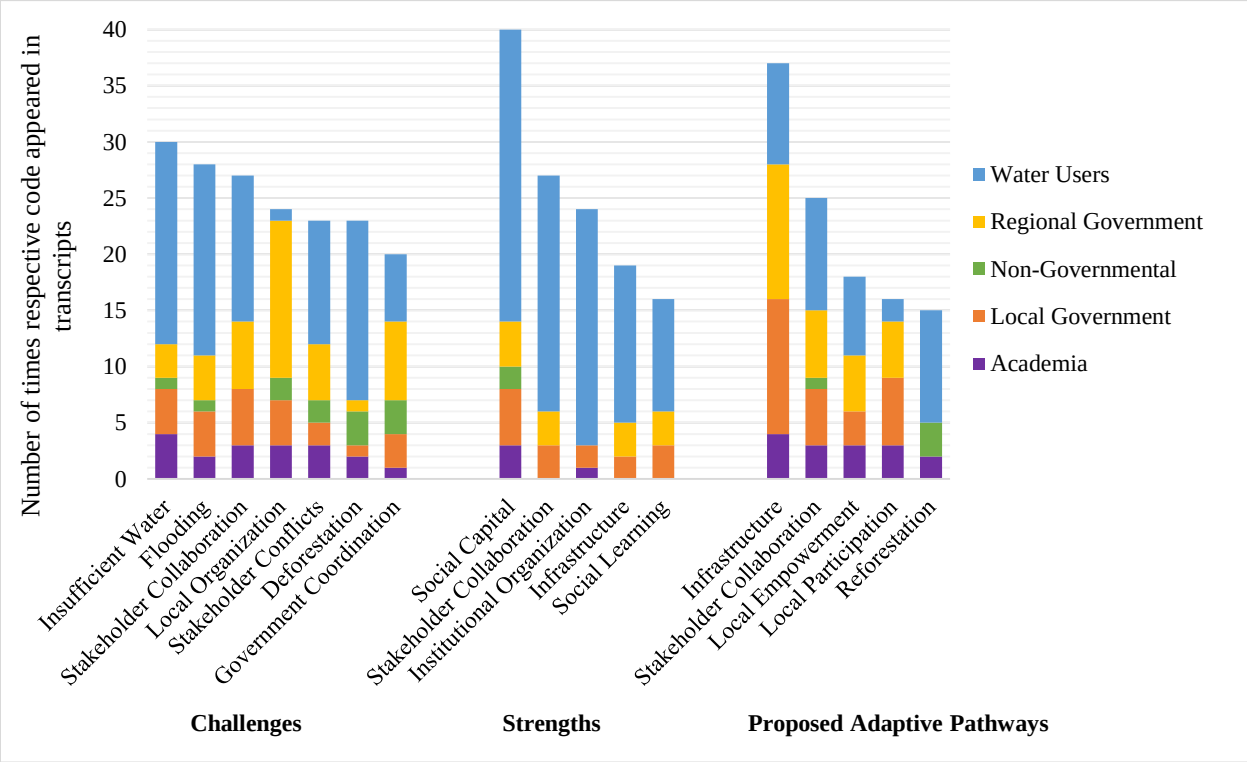
private utility that supplies households and tourism facilities with tap water for a fee. PDAM sources their water from natural springs, often diverting water from irrigation canals to do so.

External actors, including domestic and international academic institutions, non-governmental organizations, and development organizations provide technical and financial assistance to communities and government stakeholders. Notable programs include a water catchment project led by the UN World Food Programme, a watershed payment for ecosystems services scheme led by the World Wildlife Fund, and a water infrastructure development project led by the World Bank.

3.2. Process

National legislation requires government agencies to promote local water user participation in developing and managing irrigation systems (Sjah and Baldwin 2014). Local water users collectively manage tertiary irrigation networks through water user associations. WUAs range in size from 50 to 1000 members, averaging around 300 members (Sjah and Baldwin 2014). WUAs sharing the same water source collaborate through a WUA union as well as a broader umbrella group of various WUA unions. Government agencies facilitate institutional organization of local water users into WUAs. Once established, these agencies empower WUAs to collaborate on tertiary irrigation network management through training opportunities, technical expertise, and financial assistance.

Table 2. Interview responses on main water governance challenges, strengths, and proposed adaptive pathways



Stakeholders widely reported high levels of social capital that undergirded the institutional organization and operational capacity of WUAs (see Table 2; Appendix C of supplementary material). This is consistent with previous studies of water user associations in Lombok (Klock and Sjah 2011, Sjah and Baldwin 2014). Klock and Sjah (2011), for example, found a positive statistical correlation between the number of mosques in village (indicating social capital) and ability to cope with water shortages (indicating organizational capacity). Interviews further revealed how shared local practices foster collaboration between local stakeholders. Irrigation cooperation is underpinned by a traditional customary belief in collective action for community benefit known as *gotong royong*. Within villages, WUAs meet often to determine water-related decisions such as distribution schedules, fee payments, sanctions, and conflict resolution. The primary decision-making mechanism is a customary consensus-based deliberative process known as *musyawarah*. The process creates a forum in which all stakeholders can participate in decision-making and evaluation. Decisions are codified and recorded as customary laws known as *awiq-awiq*. These laws form the basis of member rights and responsibilities. *Awiq-awiq* are widely reported to be fair, respected, and enforced among water users. *Musyawarah* is also employed by WUA unions when determining equitable and timely water distribution between villages. The laws and decisions promulgated by WUAs and their unions are recognized as legitimate by the government.

Despite this emphasis on local participation, decentralization has offered little opportunity to transition away from agency-dominated water governance (Helmi 2000, Brun 2001). Lombok's water governance system is more polycentric in theory than in practice. Authority across scales remains centralized among government agencies. Interviews with these agencies suggest a degree of paternalism. Water management decisions are frequently made without wide consultation with affected stakeholders (Sjah and Baldwin 2014). This dynamic is best exemplified by the relationship between PDAM and local water users. PDAM often sources its water from natural springs used for irrigation purposes without consulting nor notifying the affected local communities. Many downstream users directly attribute water shortages to PDAM siphoning. PDAM then charges the same users for the provision of drinking water. These fees contribute to the WWF-administered payment for ecosystem services (PES) scheme aimed at reforesting upstream areas to conserve surface water. However, downstream users are unaware of the scheme because of the lack of consultation and correspondence. This significantly erodes trust, produces tension and conflict, and undermines effective collaboration between government and local water users.

3.3. Outcomes

The centralization of authority between multiple overlapping agencies often results in inter-agency bureaucratic turf wars (Klock, 2007). Rather than promote resilience through system redundancy, this fragmentation produces a high degree of institutional flux and system complexity that now results in poor coordination and even contradictory planning and development (Butler et al. 2016). The concomitant distribution of government revenue leads to a lock-in of this status quo. Agencies are resistant to integration because they perceive it to be a streamlining of their authority and revenue flows. Such institutional inertia significantly impedes effective coordination, collaboration, and integration across and between stakeholders.

Furthermore, although political decentralization did emphasize a shift from an exclusively technical perspective to a socio-technical perspective, authorities retained a technocratic focus on infrastructure development as a management strategy (Helmi 2000). Regional and local government respondents' diagnosis of water challenges recognized social dimensions such as poor local institutional organization. However, social and political considerations did not readily translate into envisioned adaptive pathways. Local and regional government respondents instead prioritized further water infrastructure development (see Table 2). Wise et al. (2015) also found that adaptation planning in the province prioritizes incremental strategies aimed at addressing proximate challenges rather than transformative strategies aimed at systemic challenges.

This technocentric approach suggests a reluctance to facilitate systemic institutional changes. Entrenched norms, behaviors, and vested interests have led to an ossification of the status quo. An example of this is PDAM's aversion to wider stakeholder consultation because of the financial benefits from selling drinking water. Government agencies perceive the transactions costs of decentralizing decision-making and increasing stakeholder participation to be quite high, specifically due to the difficulty of reaching collective agreements. Increased coordination could remedy such complexity, however coordination across sectors and scales is already fraught, with difficulty (Huitema et al. 2009, Butler et al. 2016). Poor WUA institutional organization and weak operational capacity further increase transaction costs. In some villages, WUAs are incompetent, inactive, or inexistent. In villages with functioning WUAs, technical and financial capacities for self-management remains low. This results in government reluctance to promote self-management projects which itself creates a self-fulfilling dynamic. In the absence of learning and capacity-building opportunities through management projects, WUA operational capacities further deteriorate when faced with pervasive social and ecological change, thereby increasing government reluctance for self-management.

Notably however, half of WUA representatives interviewed reported robust institutional organization (see Table 2; Appendix C of supplementary material). These same representatives all reported effective collaboration with the Ministry of Public Works (MPW) and credited it with improvements in water management and distribution. WUAs initiate the process by deliberating among themselves and proposing context-specific projects (i.e. small dams, irrigation canals, water catchment facilities) to address spatio-temporal water distribution challenges. Importantly, these proposals include an assumption of partial responsibility on behalf of the WUAs with regards to the planning, construction, operation, and maintenance of the proposed projects. MPW provides the primary inputs (i.e. technical, financial) required to carry out the projects, but also empowers WUAs to meet their responsibilities through training opportunities.

In these arrangements, infrastructure acts as a fulcrum on which processes of multi-scale participation, stakeholder collaboration, relationship building, experimentation, and social learning begin. This arrangement is community (bottom-up) initiated and government (top-down) led. Rather than radically shift the government's technocratic perspective in pursuit of these adaptive pathways, it leverages it thereby maintaining transaction costs low and government willingness high. By providing context-specific knowledge inputs based off intimate understanding of the social-ecological systems in which the projects will be carried out, WUAs actively participate in water governance decision-making. The government then provides the

technical expertise and financial resources needed to effectively carry out the project. Such multi-stakeholder cooperation increases the quality of technical decisions (i.e. social and environmental benefits) and decreases the potential for maladaptation and lock-ins (Pahl-Wostl et al. 2007, Huitema et al. 2016). Such effective collaboration fosters trust, relationship building, and capacity-building among and between stakeholders. As social capital between the multiple levels of stakeholders grows, transaction costs and paternalistic reluctance for self-management decrease. Additionally, such arrangements also serve as a form of experimentation and social learning through management. The combination of increased WUA participation, trust between stakeholders, and multi-level collaboration creates a reflective framework in which stakeholders can identify outcomes of management strategies and systematically learn from them.

4. Discussion

The case study of Lombok's water governance paradigm reveals three interconnected points of discussion for adaptive governance literature and practice. First, the collaborative model between MPW and WUAs exposes shortcomings within the prevailing narrative concerning the technological dimensions of adaptive water governance. Adaptive water governance correctly identifies that technology is embedded into a broader context of social behavior and institutional structures (Pahl-Wostl et al. 2005). Much discussion has been given to how these social and institutional factors can or should inform technical outcomes of water management (Pahl-Wostl et al. 2005, Huitema et al. 2009, Lejano and Ingram 2009, Allan et al. 2013, Ananda and Proctor 2013, Halbe et al. 2013, Azhoni et al. 2017). However, scant discussion has been given to the converse direction of this complex dynamic. How technical factors can or should inform social and institutional outcomes is less understood. Examining this dynamic is pertinent given the challenge of rigid structures and contextual constraints that prevent shifts from technocratic water governance to adaptive and integrative governance.

Scholars and practitioners struggle to strike an adequate balance between technical and socially determined framings of water (Allan et al. 2013). The traditional water governance paradigm narrowly defines water management in exclusively technical terms (Pahl-Wostl 2007). This paradigm confines decision-making and authority to technical experts within state institutions that design large-scale command-and-control systems without consideration of broader social and institutional contexts (Pahl-Wostl et al. 2005, Pahl-Wostl 2007). When implemented into these contexts, the systems ossify due to lock-ins related to sunk investments, self-perpetuating organizational behavior, and perceived panaceas (Huitema et al. 2016). The conceptual pillars of adaptive water governance – polycentrism, flexibility, and reflexivity – mark a stark departure from this traditional approach. It argues for a more holistic governance approach that integrates environmental, social, and technological dimensions as well as their interdependence (Pahl-Wostl et al. 2005). This wide conceptual paradigmatic dichotomy leads to a reframing of water management by adaptive governance that often overlooks technological interdependence. In other words, in moving water management from an exclusively technical framing to a more multi-dimensional approach, adaptive water governance often neglects the importance of technological dimensions.

Advocating for more in-depth evaluation of technological dimensions neither supports the technocratic approach of traditional water management nor contradicts the integrative multi-

dimensional approach of adaptive water management. Rather, it points to the need for more comprehensive integration of the many complex dimensions of water governance. The process by which WUAs leverage infrastructure development to initiate a process of multi-scale participation, stakeholder collaboration, relationship building, experimentation, and social learning, demonstrates the need for a more integrated reframing of water governance's dimensions.

Second, this case study suggests a decentralized socio-technical approach can lead to pathways for adaptive water governance implementation by striking a balance between top-down and bottom-up strategies. This fits well within the arguments of Allan et al. (2013) and Meijerink and Huitema (2010) that adaptive water governance requires context-specific balancing between top-down and bottom-up strategies. Technology and technical decision-making need not be exclusively large scale command-and-control systems as it has traditionally been, but can be decentralized and bottom-up. Importantly though, although decentralized technology and technical decision-making can act as a fulcrum for adaptive water governance implementation, it does not do so in a vacuum. In this case study, social and institutional dynamics underpinned effective collaboration on the bottom-up initiated infrastructure projects. Only WUAs that reported robust institutional organization also reported effective collaboration. These respondents identified high levels of social capital as the determinant of successful local organization. Intuitively then, it would seem effective collaboration requires high levels of social capital at the community level. However, high levels of social capital were widely reported among WUAs, yet successful local organization was not. Many WUAs remained incompetent, inactive, or inexistent. This paradox implies effective collaboration between WUAs and MPW did not necessitate robust institutional organization underpinned by social capital.

Further unpacking reveals that the identification of social learning opportunities paralleled the identification of effective collaboration. Rather than robust institutional organization producing effective collaboration, robust institutional organization was produced by the social learning opportunities that emerged from effective collaboration. More simply, the presence of collaborative opportunities catalyzed improved institutional organization through social learning. The collective policy entrepreneurship in the form of bottom-up infrastructure project proposals stimulated top-down involvement and relationship-building between scales. This demonstrates how balancing bottom-up and top-down approaches can lead to adaptive strategies. This also supports the findings of Meijerink and Huitema (2010) that collective policy entrepreneurship can be an important transformative strategy by forging links across various scales.

Third, this case study also suggests transformative strategies, such as the collective policy entrepreneurship discussed above, need not exclusively challenge the status quo, but can transform governance from within it. The WUAs strategy to exploit the government's technocratic perspective not only recognizes contextual constraints, but leverages them to advance policy objectives. Doing so avoids the need to radically alter institutional arrangements and counter path dependencies thereby keeping transaction costs low and increasingly the likelihood of achieving policy goals. This strategy can potentially lead to a productive balancing of incremental and transformative strategies. In the case of WUA-MPW collaboration, tackling proximate drivers of vulnerability through the incremental strategy of infrastructure opened

pathways to tackle systemic drivers of vulnerability by creating residual opportunities for social learning, collaboration, and integration.

However, as demonstrated by this case study, without the collective policy entrepreneurship from local stakeholders, government agencies would continue to prioritize incremental strategies. If bottom-up participation isn't present or is present without adaptive objectives, it risks the traditional challenges of technocracy (i.e., narrow framing, path dependencies, etc.). Despite this, it is still important to exploit the policy opportunity presented, particularly in developing contexts where adaptation strategies must also deliver development benefits (Lee 1999, Huitema 2009, Butler et al. 2014, Wise et al. 2014, Azhoni et al. 2017). Therefore, context-specific balancing of top-down and bottom-up strategies is required to balance incremental and transformative strategies.

Conclusion

This paper broadens the understanding of the dynamic interconnection between contextual conditions and adaptive water governance. The objective in doing so was to expound how to better translate theoretical prescriptions of adaptive water governance into practical planning and sustained implementation. To do so, a case-specific water governance paradigm in Lombok, Indonesia was examined through document analysis, field group discussions, and in-depth semi-structured interviews. These interviews encouraged stakeholder participatory evaluation of contextual challenges, systemic strengths, and adaptive pathways thereby fostering greater external validity, enhanced selection of indicators, organizational learning, and participation of underrepresented stakeholders. The paradigm elicited was then unpacked and analyzed to articulate adaptive pathways and strategies to facilitate adaptive governance implementation.

Lombok's water governance system exhibited both a need for adaptive governance and inflexible contextual constraints that hamper a transition toward it. Despite this, it revealed an innovative pathway toward adaptive water governance. A decentralized approach to technical decision-making can act as a fulcrum on which adaptive water governance strategies are successfully implemented. In Lombok, local water user associations applied this strategy by recognizing contextual constraints and leveraging them to produce policy opportunities for local participation, stakeholder collaboration, social learning, and capacity-building. These findings underscore shortcomings in the prevailing narrative concerning the interconnection between technological and social dimensions of water governance. The wide conceptual dichotomy between traditional and adaptive paradigms of water governance lead to an unbalanced framing of water. As a result, adaptive water governance correctly examines how social and institutional factors can or should affect technical outcomes of water management, but insufficiently discusses the converse dynamic. This points to the need for further research to understanding of how technical factors and processes can affect social and institutional governance outcomes.

This case study begins to do so by unpacking the decentralized socio-technical approach presented. It suggests this approach can serve as a context-tailored transformative strategy that balances top-down and bottom-up approaches. Rather than radically counter contextual constraints and path dependencies, this strategy exploits them as policy opportunities to achieve governance objectives. Doing so is more likely to overcome the traditional challenges of

entrenched interests, high transaction costs, and institutional inertia. Exploiting the prioritization of incremental strategies to achieve adaptive policy objectives produced a balance of proximate development benefits and residual transformative opportunities. In developing contexts such as Lombok, striking such a balance is essential to concerted and sustained adaptive governance implementation.

Acknowledgements
This work was supported by the U.S. Fulbright Program and the Millennium Challenge Account Indonesia.

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