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OUTLOOK ARTICLE

Enabling incremental adaptation in disadvantaged communities: polycentric governance with a focus on non-financial capital

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ABSTRACT

Floods increasingly threaten disadvantaged communities around the globe. When limited financial resources are available, nature-based and community-based incremental adaptation that codifies existing actions and behaviours can help protect people and assets through risk reduction management. These adaptation measures mainly rely on non-financial capital that can be appropriate alternatives when financial resources are limited, especially within the context of disadvantaged communities. There are, however, challenges in implementing such adaptation measures, including differential power relationships that might lead to misallocation of benefits. We propose a polycentric governance framework that can enhance stakeholder engagement and mobilize various forms of non-financial capital to trigger a web of incremental adaptation measures through four support mechanisms: technological investment, institutional enhancement, knowledge production, and environmental protection. We further discuss how various facilitating factors, including (i) communication and transportation infrastructure, (ii) flexible laws/regulations, (iii) risk communication, and (iv) environmental restoration, can increase the likelihood of success in application of the framework. A successful application of the proposed framework also necessitates development of a research agenda around suitable non-financial metrics for monitoring and evaluating the performance of the proposed strategies. In addition, learning from new developments in general societal protection and resilience in communities with relatively large financial capital and experiences of practicing polycentric governance in disadvantaged communities may facilitate the implementation of polycentric governance-based disaster risk reduction globally.

Key policy insights:

- In communities with limited financial resources, nature-based and community-based incremental adaptation (IA) can help protect people and assets through risk reduction management.
- The proposed polycentric governance framework can enhance stakeholder engagement and mobilize various forms of non-financial capital to trigger a web of IA measures.
- Technological investment, institutional enhancement, knowledge production, and environmental protection are the foundational support mechanisms for a successful IA.
- Communication and transportation infrastructure, flexible legal and regulatory frameworks, risk communication, and environmental restoration are the four principal facilitating factors embedded in our proposed approach to enable IA.

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1. Introduction

In a warming climate, more intense and/or frequent extreme weather events such as flooding are expected (Jongman, 2018; Winsemius et al., 2015). If no protective measures are implemented, accelerating sea level rise will leave 340 million people exposed to annual coastal flood levels by 2050 (Dangendorf et al., 2019; Kulp & Strauss, 2019). Increased water vapour holding capacity of the atmosphere leads to more intense storms and changes in precipitation patterns (Hirabayashi et al., 2013). Hurricane Harvey, which made landfall in Texas in 2017, for example, would not have resulted in as much rain without human-induced climate change (Trenberth et al., 2018).

Tropical cyclone Idai hit Mozambique, Zimbabwe and Malawi in March 2019 and was the costliest and second-deadliest cyclone in the South-West Indian Ocean on record. Idai destroyed 90% of Beira, Mozambique's fourth largest city, affected 1.85 million people in Mozambique alone and left the region with billions of dollars of damaged infrastructure (OCHA, 2019; Onishi & Moyo, 2019). These immediate impacts were followed by a cascade of related incidents, including thousands of cholera and malaria cases across the region, and an estimated 1.5 million children in need of healthcare, nutrition and water assistance (UN News, 2019). Such events, with significant societal impacts that disproportionately affect vulnerable populations, are increasing globally due to climate change, aging infrastructure, population growth and concentrated human settlement in flood-prone areas (Jongman, 2018). Disadvantaged communities, in particular, are in pressing need of strategies to strengthen resilience to hazards in the face of such alarming trends to resist, absorb, accommodate, adapt to, transform and recover from the effects of these hazards in a timely and efficient manner (UNDRR, 2020).

There is growing interest in how governance affects resilience and the potential for Disaster Risk Reduction (DRR), a process through which we aim for "*preventing new and reducing existing disaster risk and managing residual risk all of which contribute to strengthening resilience and therefore to the achievement of sustainable development*" (UNDRR, 2020, 2015). There exists a sizeable literature on disaster governance, which "*consists of the interrelated sets of norms, organizational and institutional actors, and practices (spanning predisaster, transdisaster, and postdisaster periods) that are designed to reduce the impacts and losses associated with disasters*" (Tierney, 2012). However, there still exist some gaps in our knowledge about the approaches that can integrate processes at various scales and increase adaptive capacity of these systems. Previous works have studied the interlinkages between adaptive governance, resilience and DRR, and concluded that adaptive governance with the following characteristics may contribute to building resilience: (i) polycentric and multilayered institutions, (ii) participation and collaboration, (iii) self-organization and networks, and (iv) learning and innovation (Djalante et al., 2011). Djalante et al. (2013) further proposed a framework for adaptive and integrated disaster resilience that focuses on mechanisms to build adaptive capacity in the system and develop pathways to achieve resilience. Such proposals, with significant potential to improve upon existing policies, are mainly focused on institutional mechanisms. Also, while significant progress at regional, national and international level has been made, there is a paucity of studies on the interlinkage of governance and DRR at the local scale. In fact, successful implementation of DRR policies at the national scale requires strengthening local capacities and compatibility with the local context (UNISDR, 2014). Here, we propose to fill in the gaps mentioned above with a polycentric governance framework that can help mobilize various forms of non-financial capital to trigger a local web of incremental adaptation measures and increase the chance of success in flood DRR projects.

The current study focuses on flooding and its increased frequency and intensity due to climate change, with cascading impacts that can yield large scale disasters (AghaKouchak et al., 2020; Ruiter et al., 2020). Robust governance frameworks that help organizing institutions and communities, with specific data and responsibilities for effective flood DRR, are lacking (Morrison et al., 2018). In the case of flooding, for example, disaster risk assessment guidelines developed by most federal and state governments that are mainly based on univariate metrics (i.e. river discharge or coastal ocean water level) may result in mischaracterization and consequently misperception of disaster risk if applied to a freshwater-influenced coastal system exposed to compound flooding hazards with multiple interrelated flood drivers (Moftakhari et al., 2017). Despite some relevant initiatives, such as Local Governments for Sustainability (https://iclei.org/), there exists limited evidence (i.e. global

data or systematic reporting) to track the progress of local governments in DRR implementation (Djalante & Lassa, 2019). A key issue that emerges from local level DRR governance research is a lack of attention to local stakeholder capacity for adaptation, risk perception, and coordination (including with external actors) (Djalante & Lassa, 2019). This is particularly important for disadvantaged communities that are often left out of decision-making processes, and can facilitate the process of local capacity building in communities suffering from limited resources.

Adaptation, alongside greenhouse-gas mitigation, is an essential part of climate policy. Adaptation to natural hazards is defined as a set of strategies and actions that seek changes in socio-ecological systems with the aim of moderating harm or exploiting beneficial opportunities in response to the actual/expected impacts of natural hazards (Field et al., 2014; Moser & Ekstrom, 2010). Adaptation might occur through explicit and planned interventions, or spontaneously as a consequence of inherent flexibility (Schipper, 2009). There are two main types of adaptation: incremental adaptations (IA) and transformational adaptations (TA). IA intend to avoid sudden disruptions of systems at their current situations through extensions of familiar actions and behaviours that have been proven effective in reducing losses or enhancing benefits. TA are those with at least one of the following characteristics: (i) adopted at a much larger scale or intensity, (ii) truly novel to a particular region or resource system, (iii) re-organize the vulnerable system and/or transform places and shift locations (Chung Tiam Fook, 2017; Kates et al., 2012; Pelling et al., 2015).

When abundant financial resources are available, TA measures can be implemented once behavioural and social barriers are overcome (Aerts et al., 2018). Motivated by the aftermath of Hurricane Sandy, New York City committed to invest $20 billion in flood defense and adaptation measures (Nelson & Wilson, 2014). Similarly, the Netherlands has made substantial investments to protect its population and assets against 10,000-year floods (Aerts, 2009). Such TA measures alone, however, are not universally successful due to inherent uncertainties, their perceived costs, and the suite of institutional/behavioural inertia that tends to maintain existing systems/policies. In other words, while IA seeks to maintain an internal state of resilience within a stability domain, TA addresses the capacity to cross thresholds into new development trajectories (Folke et al., 2010). Crossing thresholds can result in widespread system disruption, which can render it challenging to manage the interrupted system and minimize vulnerability through legitimate and democratic deliberation about such radical futures (Adger & Barnett, 2009). History provides us with some examples. Despite major investments (i.e. transformational adaptation, including the construction of levees) in response to the Great Mississippi Flood of 1927 and Hurricane Betsy in 1965, the 'levee effects'[1] (Kates et al., 2006) indeed exacerbated flooding impacts during Hurricane Katrina in the US in 2005 by exposing sub-population groups displaying much higher social vulnerability than others.

2. Proposed framework

In this article, we propose an IA framework that is derived from a polycentric governance perspective, built upon the strength of local knowledge, resources and capital, which can complement existing systems. Previous literature often regards IA as insufficient to cope with abrupt environmental disruptions (Kates et al., 2012; Termeer et al., 2017). Despite IA's limitations, we argue that it can provide a path toward resilience for disadvantaged communities and build capacities on a local scale if utilized efficiently in conjunction with local inherent resilience. Complementary to feasible TA measures, from our understanding, IA is an approach that emphasizes coordinated implementation of a portfolio of interventions rooted in local, culturally specific knowledge and drawing on diverse, local forms of capital (Mercer et al., 2010). IA codifies existing actions and behaviours, that are primarily nature-based and community-based, and aims to protect people through DRR. Generally, a combination of TA and IA is required for effective risk reduction, and such a scheme will be successful only if involved stakeholders believe that the process eventually yields effective and affordable protection against threatening hazards (Aerts et al., 2018). Most importantly, IA relies mainly on non-financial resources (or capital) that can be an appropriate alternative when financial resources are limited, especially within the context of disadvantaged communities. The four principal forms of non-financial capital (NAS, 2019) that enable and sustain IA are shown in Figure 1 and include:

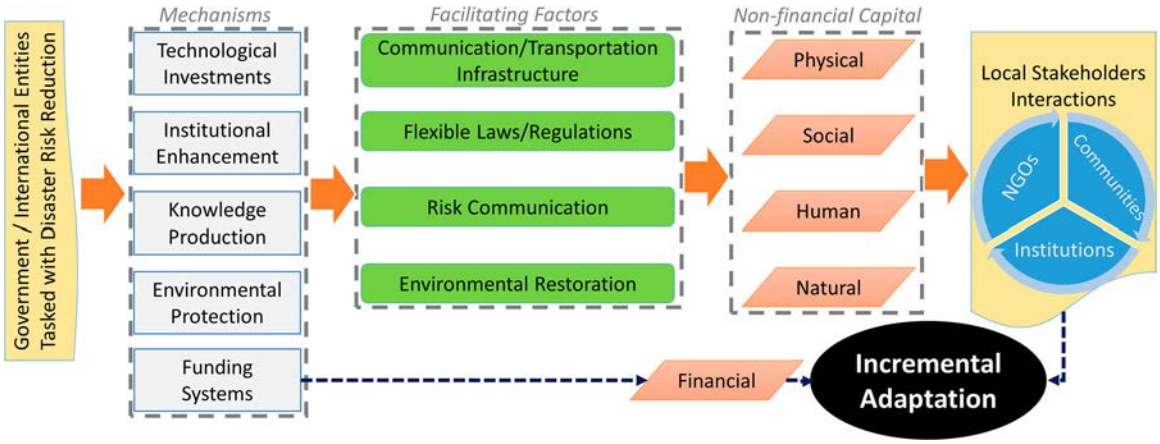

Figure 1. The proposed polycentric governance framework for incremental adaptation for disaster risk reduction.

- Physical or manufactured capital (e.g. locally available tools, equipment and infrastructure);
- Social capital (e.g. relationships, social networks and social institutions);
- Human capital (e.g. local knowledge, skills and labour); and
- Natural capital (e.g. natural resources and ecosystem services).

All these forms of capital are interrelated and interact. Though categorized as non-financial, however, it should be noted that enhancing these forms of capital still requires some amounts of financial capital. The focus here is to identify mechanisms that help redistribute resources and more efficiently allocate the limited financial capital with the aim of DRR, not to totally do without financial capital.

Interactions among diverse and representative stakeholders (including communities, NGOs, and institutions), and the human and social capital they represent, are essential to IA. This makes polycentric governance a critical dimension of IA based on the potential to transcend technical dimensions of adaptation and effectively account for the concerns and perceptions of those affected (Pelling & Garschagen, 2019) especially in a way that is inclusive (Ostrom, 2010). Community engagement is a slow process due to the complexities of engaging the most vulnerable community members, developing a shared understanding of risks, and securing broad support for action plans. Such processes can strain existing power relationships by challenging policymakers who often operate on different temporal and spatial scales as well as under different resource and political pressures.

Differential power relationships (both between local populations and policymakers, and amongst the local population itself) can be a threat to IA due to the potential to foster systemic misallocation of benefits (or disbenefits). However, recent developments in research on local governance demonstrate that local communities can indeed self-organize to effectively protect common resources without relying on interventions from central government or succumbing to privatization pressures (Ostrom, 2010). Hence, there is considerable promise that a polycentric governance approach to DRR can catalyze IA by leveraging non-financial capital.

As such, we propose an IA approach to DRR based on polycentric governance. The proposed approach, set out in Figure 1, focuses government and international entities responsible for DRR on cultivating non-financial capital through cooperation and communication among stakeholders at the local level – deliberations that can lead to a suite of IA measures. With this approach, there remains a need for financial capital, but it is distributed across interventions in much smaller amounts than with a TA approach. Moreover, support mechanisms are needed to identify and enable stakeholders through a 'bottom-up' approach of developing IA measures that reflect the myriad of needs and perspectives among at-risk constituents. IA leverages the four forms of non-financial capital through four support mechanisms: technological investment, institutional enhancement, knowledge production, and environmental protection (cf. Figure 1). Although funding mechanisms are still crucial components of the system, they are needed to a lesser extent than under TA, which is why we do not discuss their components in detail here.

Technological investments enhance physical capital. For example, improved transportation and communication networks foster more resilient infrastructure. Of similar importance, however, such physical capital empowers social networks and can facilitate social learning necessary for robust social capital (Pahl-Wostl et al., 2007). Technological investment can also enhance early warning systems that significantly contribute to reduced vulnerability. A recent study suggests that an increase in cell phone usage can substantially reduce disaster fatalities, with an even more significant impact on marginalized communities (Olugbenga & Owolabi, 2014; Toya & Skidmore, 2018).

Institutional enhancement is crucial to cultivating and maintaining the social capital necessary to resist social vulnerability pressures in low resource communities, especially within the context of flooding (NAS, 2019). In fact, in many cases, the institutional context of adaptation (i.e. responsible entities that facilitate adaptation for vulnerable groups, or the contribution of formal/informal rules, norms or policies governing social organization in building adaptive capacity) is not clear (Eakin & Lemos, 2010). For example, the disproportionate impacts among disadvantaged communities during Hurricane Katrina exposed decades of structural environmental injustices resulting from institutional failures at local and regional levels (e.g. poorly maintained infrastructure, long-term poverty, remnants of historical segregation and systemic racism in the US south) (Cutter, 2006). In order to prevent such situations, physical capital needs to be developed and maintained to foster social capital. This can be achieved through a collaborative process enabling stakeholders at different levels to engage in face-to-face communication and interaction for planning and decision-making, rather than imposing a top-down monocentric solution. Throughout this process, the main goals are increasing the flow of local knowledge, decentralizing adaptation planning and implementation, and improving accountability of local decision makers to their constituents (Agarwal et al., 2012; Tennekes et al., 2014).

Knowledge production in this context involves mobilizing appropriate expertise and proficiency through inclusive processes that are trusted and yield outputs – forms of understanding, models, problem statements, solutions – that are useful and contextually sensitive (Djenontin & Meadow, 2018; Naess, 2013).

Environmental protection refers to practices, informed by scientific and local knowledge, to conserve and restore natural resources and ecosystem services. Government can work with stakeholders, with the help of enhanced human capital, on environmental restoration to foster more resilient natural capital. Given the complexity and geographic specificity of many environmental systems, nature-based solutions have gained increasing popularity in ecosystem services restoration (Keesstra et al., 2018). Benefits of nature-based solutions versus hard-engineered measures in building resilience have been extensively discussed in the literature (Morris et al., 2018), though further research is needed on the return on investment in these projects (Aerts, 2018). In Bangladesh, for example, community engagement in environmental restoration involving local communities, NGOs and local administrations, built resilience through nature-based adaptation (Mustafa Saroar et al., 2019).

Several facilitating factors (cf. Figure 1) are embedded in the proposed approach to enable IA. Improved communication and transportation infrastructure helps link social and physical capital and so builds a sense of ownership and leads to a higher willingness to reach an agreement and stronger commitment to outcomes (Pahl-Wostl et al., 2007), while also lowering the cost of behavioural monitoring, compliance, and management (Dietz, 2003). This means factors affecting household behaviour, social structure, recovery processes and the ability to learn can facilitate IA in disadvantaged communities (Surtiari et al., 2017).

Flexible laws/regulations also facilitate compliance with a set of rules on which diverse stakeholders can agree (Dietz, 2003). Polycentric governance often leads to increased responsibility for citizens rather than government, which will be unsuccessful if citizens lack the power to act and without proportional adjustments in laws/regulations (Wesselink, 2016). Findings from community-based flood mitigation practices in Bangladesh suggest that the legal status of community-based initiatives is a key factor through which activities are linked with the local government (Shaw, 2006). An analysis after typhoon Morakot in Taiwan revealed how inflexibility of laws and inappropriate/unclear distribution of responsibility posed challenges to disaster management (Yung-hua, 2018).

Meanwhile, the development and maintenance of social capital can itself pose risks. Strong social capital as reflected in firm solidarity among community members may to some extent prevent the flow of new information and ideas into the community (Adler & Kwon, 2002). This may create inertia and stall progress towards DRR solutions. Government should be mindful of this side of social capital and attempt to build

trust with communities, especially the most vulnerable and marginalized. Building such trust, while key to successful DRR, can be a daunting task due to constraints including competing values, knowledge gaps, and limited community engagement (Davenport et al., 2007; Richey & Ikeda, 2009). Building trust between government and communities can be helped by regular public outreach and engagement meetings. Such meetings, for example, were conducted to inform the public of the science behind Louisiana's Coastal Master Plan (Committee on Long-Term Coastal Zone Dynamics et al., 2018).

Human capital in DRR is essential to identifying and conveying both opportunities and risks facing stakeholders and requires a constituency informed through educational outreach and data sharing activities. In the U.S., current flood risk mapping is of limited value for risk communication and has even had the unintended consequence of incentivizing development in high risk areas (Christin & Kline, 2017; Silvis, 2018). A new generation of highly accurate and interactive flood risk maps is needed to more effectively communicate to stakeholders through visualization of flooding dynamics and expected consequences (Luke et al., 2018; NAS, 2019; Sanders et al., 2019). Moreover, to bridge the knowledge gap between the scientific community and stakeholders, participatory research, where scientists and interested stakeholders can exchange ideas and knowledge, can be useful; such an initiative has been proposed and implemented in Houston (Hendricks et al., 2018).

3. Discussion

Adaptation tracking, a process of developing standards, methodologies, indicators and baselines to assess progress towards adaptation goals is of paramount importance and still a difficult task even at aggregate levels (national to international) (Berrang-Ford et al., 2019; Ford et al., 2015). When polycentric governance is implemented with the objective of flood DRR, robust metrics should be devised to monitor system resilience, especially in the context of developing countries with their own specific challenges (Conway & Mustelin, 2014). Previous studies suggest that these metrics should combine qualitative, quantitative and binary indicators, with specific baselines and combined information from national and subnational levels to improve understanding of progress (Lamhauge et al., 2013; Leiter, 2015). Unemployment rates, income levels, housing affordability, financial coping capacity (i.e. taking loans and selling assets), along with community risk perceptions, perceived adaptive capacity, and behavioural changes are among the useful socio-economic-behavioural metrics necessary to evaluate the effectiveness of proposed governance in a disadvantaged community (Parvin et al., 2016). Meanwhile, lessons learned from past experiences in communities with relatively large financial capital inputs (Pahl-Wostl et al., 2013), such as the Norwegian 'samfunnssikkerhet' concept (DSB, 2017), may be applicable in disadvantaged communities. When non-financial capital is in focus, however, relevant metrics must be developed and updated to monitor and evaluate the performance of non-financial adaptation strategies. Aggregated and disaggregated health indicators such as morbidity and mortality, water and vector borne infectious disease incidence and prevalence, crop yields, nutritional status and access to health care services, may also be essential monitoring indicators. Previous studies suggest that such metrics should utilize data at the population level and the health systems level (including clinical care and public health) and take the complexities of adaptation into consideration, including institutional learning and knowledge management to inform iterative risk management (Ebi et al., 2018). In Bangladesh, for example, people report improved livelihoods in some 80% of the locations where community-based organizations are active and involved in the adaptive learning process (Sultana & Thompson, 2017).

Meanwhile, we acknowledge the challenges and risks associated with the polycentric approach of IA. In the proposed framework, we place emphasis on aligning and creating complementary actions to leverage existing local resources and capital. Inevitably, conflicts may arise in DRR. Frequent communication among different groups of stakeholders with different sets of values, interests, and agendas are expected to help reduce frictions among them. The consensus-building effort is often effort-intensive and time-consuming, but achievable, if stakeholders join forces.

Numerous questions remain regarding the potential for successful application of polycentric governance to flood DRR. Therefore, a research agenda should be explored to address questions such as: What are effective strategies for facilitating collaboration around the identification and implementation of IA measures involving non-financial capital? What non-financial metrics are suited for monitoring and evaluating the performance of

polycentric governance strategies? What technologies, resources and process tools are needed to make the implementation of polycentric governance for IA more effective? What regions stand to benefit the most from its use? Additionally, what can be learned from new developments in general societal protection and resilience in communities with relatively large financial capital to implement polycentric governance based DRR globally?

4. Conclusion

The polycentric governance framework proposed here aims to enhance stakeholder engagement through mobilization of non-financial capital and to create a web of incremental adaptation measures through four support mechanisms: technological investment, institutional enhancement, knowledge production, and environmental protection. While the main emphasis here is on non-financial forms of capital, financial capital is still required to support various components of the proposed framework. However, these financial needs are less than under TA, and are based on existing resources to achieve more efficient allocation of limited financial capital among communication and transportation infrastructure development, risk communication, and environmental restoration projects supportive of DRR measures. The strength of such a framework lies in its ability to leverage existing resources in a manner less demanding of and reliant on financial capital than more conventional transformational adaptation approaches.

For successful application of the proposed framework, we need to consider the challenges and opportunities that more flexible laws/regulations and enhanced social capital might pose to policy makers. Development of suitable non-financial metrics for monitoring and evaluating the performance of the proposed strategies can help identify the strengths and weaknesses of such measures in different communities and promote development of context-sensitive, place-based solutions.

Note

1. Levee effects relate to risk perception and, specifically, the danger that overconfidence in the ability of levees to avert flooding might allow development in high risk areas.

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No potential conflict of interest was reported by the author(s).

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