

Multilevel Governance of Climate Change Adaptation in Coastal Areas

Evidence from Bangladesh

by

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ABSTRACT

Climate change impacts are evident throughout the world, particularly in the low lying coastal areas. The multidimensional nature and cross-scale impacts of climate change require a concerted effort from different organizations operating at multiple levels of governance. The efficiency and effectiveness of the adaptation actions of these organizations rely on the problem framings, network structure, and power dynamics of the organizations and the challenges they encounter. Nevertheless, knowledge on how organizations within multi-level governance arrangements frame vulnerability, how the adaptation governance structure shapes their roles, how power dynamics affect the governance process, and how barriers emerge in adaptation governance as a result of multi-level interactions is limited. In this dissertation research, a multilevel governance perspective has been adopted to address these knowledge gaps through a case study of flood risk management in coastal Bangladesh. Key-informant interviews, systematic literature review, spatial multi-criteria decision analysis, social network analysis (SNA), and content analysis techniques have been used to collect and analyze data. This research finds that the organizations involved in adaptation governance generally have aligned framings of vulnerability, irrespective of the level at which they are operated, thus facilitating adaptation decision-making. However, this alignment raises concerns of a neglect of socio-economic aspects of vulnerability, potentially undermining adaptation initiatives. This study further finds that the adaptation governance process is elite-pluralistic in nature, but has a coexistence of top-down and bottom-up processes in different phases of adaptation actions. The analysis of power dynamics discloses the dominance of a few national level organizations in the adaptation governance process in

Bangladesh. Lastly, four mechanisms have been found that can explain how organizational culture, practices, and preferences dictate the emergence of barriers in the adaptation governance process. This dissertation research overall advances our understanding on the significance of multilevel governance approach in climate change adaptation governance.

DEDICATION

For my family- Shamim Akter Chowdhury, Sheikh Mofizul Islam, Tasnuba Jerin, Nazia Naoreen; without their support I would not be the person I am today.

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TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF FIGURES	vi
CHAPTER	
1 INTRODUCTION	1
1.1 Problem Statement.....	1
1.2 Conceptual Background	4
1.3 Study Area Context.....	11
1.4 Chapter Overview	16
1.5 Significance.....	18
2 EXAMINATION OF COASTAL VULNERABILITY FRAMINGS AT MULTIPLE LEVELS OF GOVERNANCE	22
2.1 Introduction.....	22
2.2 Study Area.....	28
2.3 Materials and Methods	29
2.4 Results	40
2.5 Discussion	54
2.6 Conclusion	58
3 MULTILEVEL GOVERNANCE IN CLIMATE CHANGE ADAPTATION: STRUCTURE, PROCESSES, AND POWER DYNAMICS.....	61
3.1 Introduction.....	61
3.2 Conceptual Background	62

CHAPTER	Page
3.3 Research Hypotheses	69
3.4 Methods.....	70
3.5 Results	76
3.6 Discussion	91
3.7 Conclusion	96
 4 MECHANISM-BASED ANALYSIS OF BARRIERS TO ADAPTATION	
GOVERNANCE	97
4.1 Introduction.....	97
4.2 Conceptual Background	99
4.3 Methods.....	104
4.4 Results	108
4.5 Discussion and Conclusion.....	117
 5 CONCLUSION	122
REFERENCES	126
 APPENDIX	
A ORGANIZATIONS INVOLVED IN VULNERABILITY MANAGEMENT ..	146
B LIST OF VULNERABILITY INDICATORS	149
C RESULTS OF SOCIAL NETWORK ANALYSIS	153
D SEARCH KEY WORDS FOR MECHANISM-BASED ANALYSIS	155

LIST OF TABLES

Table	Page
2.1 Scale of Relative Importance.....	36
2.2 Differences in Mean Value in Terms Of Infrastructural Criteria Weighting.....	44
2.3 Differences in Mean Value in Terms Of Agricultural Criteria Weighting	45
2.4 Differences in Mean Value in Terms Of Social Criteria Weighting.....	47
2.5 Differences in Mean Value in Terms Of Economic Criteria Weighting	49
2.6 Differences in Mean Value in Terms Of Natural Criteria Weighting.....	50
3.1 Conceptualization of Power.....	68
3.2 Selected Organizations and Their Acronyms.....	72
3.3 Social Network Measures and Their Relationships To Governance.....	74
3.4 Brokerage Types and Functions	75
3.5 Exploratory SNA at the National And Sub-National Level	78
4.1 Examples of Action-Formation Mechanisms Gathered From Literature.....	103
4.2 Inclusion and Exclusion Criteria.....	108
4.3 Summary Information on Barriers From The Finally Selected Articles	110

LIST OF FIGURES

Figure		Page
1.1	Location of yhe Study Area	12
1.2	Standard Embanked Polders	13
2.1	A Network Structure of Vulnerability Criteria.....	33
2.2	A General Form of Supermatrix	35
2.3	Workflow Diagram of Vulnerability Analysis.....	40
2.4	Vulnerability Framings by the Studied Organizations	51
2.5	Comparative Criteria Weighting by the Studied Organizations	52
2.6	Vulnerability Hotspots by the Studied Organizations	53
3.1	Brokerage Types in SNA	76
3.2	Influence of Organizations in Multilevel Adaptation Governance Network	79
3.3	Organization Type And Their Operation at Different Levels of Governance....	82
3.4	Power Dynamics in Adaptation Planning Process	86
3.5	Power Dynamics in Adaptation Implementation Process	88
3.6	Power Dynamics in Adaptation Monitoring And Evaluation Process	91
4.1	Conceptual Framework for Mechanism-Based Analysis.....	102

CHAPTER 1

INTRODUCTION

1.1. Problem statement

The latest Intergovernmental Panel on Climate Change (IPCC) report projected that the climate change impacts would be more intense than previously expected in the low-lying coastal areas (Wong et al. 2013). Global mean sea level has risen 0.19 m in the last 110 years, resulting into submergence, coastal erosion, and coastal flooding (Rhein et al. 2013, Wong et al. 2013). The vulnerability of coastal areas are increasing because of high population growth, more economic activities, and urbanization in coastal areas (IPCC 2014). Climate change vulnerability is particularly evident in the coastal part of Bangladesh. Multidimensional climate change impacts, such as increased frequency of natural extreme events, salt water intrusion, sea level rise make Bangladesh one of the 10 most climate affected countries in the world (Germanwatch 2019). Because of the potential for large scale damage as a result of climate change impacts, the management of coastal vulnerability requires participation of multiple organizations, in addition to small-scale societal efforts. Globally, many of these organizations operate at different levels of jurisdictional scale (i.e. national, province, municipality) with different corresponding spatial scales of influence (i.e. national, regional, local) (Cash et al. 2006, Termeer et al. 2010, Amundsen et al. 2010, Bauer et al. 2012). Through managing the adaptation actions that are designed to reduce vulnerability these organizations interact with each other, continuously or sporadically. Their understanding of vulnerability, the structure of governance arrangement, and nature of interactions can have significant impacts on the efficacy of adaptation. For instance, similar understandings of vulnerability has the

potential to increase the efficiency, effectiveness, equity, and legitimacy of adaptation management, but difference in understanding can cause economic wastage, resource misallocation, maladaptation, governance failures, and fragmented development (Wilbanks & Kates 1999, Gibson et al. 2000, O'Brien et al. 2004, Adger et al. 2005, Eakin & Luers 2006, Pahl-Wostl 2009, Engle 2011). Similarly, highly centralized governance arrangements may prohibit experimental learning, trust building, collaborative management and disregard local priorities and context sensitivities (Ostrom 2010, Jordan et al. 2015), on the other hand, it can facilitate better coordination and as a result prevent overlapping authorities, conflicting responsibilities, and duplicating functions (Termeer et al. 2010, Gillard et al. 2017).

Some attempts have been made to evaluate how the understanding of vulnerability varies across scales (e.g. O'Brien et al. 2004, Balica et al. 2009, Birkmann 2007, Antwi-Agyei et al. 2017) and how actors' governance structure and interactions influence adaptation governance process (e.g. Keskitalo 2010, Bates et al. 2013, Fidelman et al. 2013, Verkerk et al. 2015), and the resulting challenges that might appear in the governance process (e.g. Amundsen et al. 2010, Juhola 2016). Despite these commendable contributions to the field of adaptation governance, we have limited understanding of a) how the multilevel organizations, operating at multiple levels of governance, understand vulnerability and what might explain coherence or difference in their framing; b) how power dynamics among actors influence the adaptation governance process, particularly in the context of Global South; and c) how and why challenges or barriers emerge in the adaptation governance process.

In response to these limitations, this research attempts to address these issues from a multilevel adaptation governance perspective (see section 1.2 for a conceptual background). This dissertation research is designed as three independent manuscripts, presented in chapter two, three and four, together responding to a broad research question: *How does the understanding of climate change vulnerability by the different organizations involved in adaptation governance, and interactions among them to address that vulnerability through adaptation actions, ultimately affect the adaptation governance process?* This overall research question is addressed by three sub-questions, each addressed separately in subsequent chapters, and each with multiple sub-questions:

1. How do organizations, operating at different levels of governance and within different sectors of engagement, understand vulnerability to coastal flooding?
 - a. What elements do these organizations prioritize as vulnerability determinants?
 - b. What factors might explain any observed alignment or mismatch in their framings?
2. How do the multilevel structure of governance arrangements and organizational interactions influence the adaptation governance process?
 - a. How does the structure of the multilevel organizational network influence the adaptation governance process?
 - b. How do power dynamics affect the planning, implementation, and monitoring phases of adaptation actions across the multilevel organizational network?

3. How do barriers emerge in adaptation governance?

- a. What are the mechanisms that can explain the emergence of barriers in the adaptation governance process in Bangladesh?

I approach these questions pulling theories and concepts from multiple research areas, such as vulnerability, adaptation, and governance. I use different techniques that include key-informant interview, multi-criteria decision analysis, GIS, remote sensing, social network analysis, content analysis, to answer these research questions. The following section provides a brief overview of the theoretical and conceptual background I use in this dissertation research. For a detailed discussion on the use of these concepts and methods in answering the research questions, readers are requested to see chapter two through four.

1.2. Conceptual Background

1.2.1. Vulnerability

Vulnerability, in this study, is defined as the degree or extent to which a system is likely to be exposed and sensitive to a hazard, and the capacity of that system to adapt to the effects of climate impacts (Watts and Bohle 1993, Cutter 1996, Kasperson et al. 2005). Vulnerability has three subcomponents: exposure, sensitivity, and adaptive capacity. Exposure is the degree, duration, extent in which the system remains in contact with perturbations (Kasperson et al. 2005, Adger 2006). Sensitivity, on the other hand, is conceptualized variedly. Sensitivity is defined by Adger (2006) as ‘the extent to which a system can absorb impacts without suffering significant damage’, while Gallopin (2006) defined

sensitivity as the degree to which a system is modified or affected by internal or external disturbances. Accentuating the climate factor, IPCC (2014) defined sensitivity as ‘the degree to which a system is adversely or beneficially affected by climate-related stimuli’. Thus, the basic notion of sensitivity is the system’s responsiveness to the internal or external perturbations it encounters. High sensitivity indicates higher responsiveness towards perturbations; in other words, higher probability of being affected. Exposure and sensitivity are oftentimes argued as inseparable (i.e. Luers 2005; Smit and Wandel 2006). This is because sensitivity and exposure are entangled with each other in such a way that the latter is the precondition of the former. Adaptive capacity, on the other hand, is the ability of the system and its components to adjust to potential damage, to take advantages of opportunities, or to respond to consequences (IPCC 2014). Adaptive capacity modulates exposure and sensitivity through an inverse relationship. Higher adaptive capacity ensues lower exposure and sensitivity, and vice versa. Engle (2011) thinks that adaptive capacity is a desirable property or positive attribute of a system for reducing vulnerability. The resilience literature also depicts adaptive capacity as a desirable system property, but in somewhat different terminology (adaptability) (Engle 2011).

Vulnerability of an area can be understood differently by different actors because of relative prioritization of exposure, sensitivity, and adaptive capacity determinants. This relative prioritization of vulnerability determinants indicates how vulnerability is conceived and evaluated. Such understanding of vulnerability

is also known as diagnostic framing in which the stakeholders are involved in the attribution and identification of key factors of vulnerability.

In this dissertation research, we operationalize exposure, sensitivity, and adaptive capacity by selecting indicators from various secondary sources. While exposure indicators mostly represent the physical risk of the region, sensitivity indicators reflect the dependence of actors on hazard-sensitive activities and patterns of resource use. Adaptive capacity indicators measure the access to entitlements and resources that can be mobilized to cope with and adapt to climatic threats: health status, wealth, information access, resource stocks and access. Using these indicators I develop a composite index to analyze vulnerability framings by different actors.

1.2.2. Adaptation

The term ‘adaptation’ can be traced back to Darwin’s seminal work on evolutionary biology. It was later imported to human-environment studies with a little alteration in conceptual meaning. Currently, geographers perceive adaptation from social and ecological viewpoint with more emphasis on socio-economic, institutional, and organizational aspects. Adaptation definition in this research arena revolves around three questions posited by Smit et al. (2000): *Adaptation to what? Who or what adapts? How does adaptation occur?*. Answering these questions Smit & Wandel (2006, pp. 282) defined adaptation as the “process, action or outcome in a system in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity”. This

definition of adaptation has evolved from vulnerability perspective and is relatively broad in scope. On the other hand, with greater emphasis on future conditions, Nelson et al. (2007, pp. 397) defined adaptation as “the decision-making process and the set of actions undertaken to maintain the capacity to deal with future change or perturbations to a social-ecological system without undergoing significant changes in function, structural identity, or feedbacks of that system while maintaining the option to develop.” This definition comes from a resilience point of view where the system essentially tries to maintain or look forward to stability or less perturbations the system. In this study, I construed adaptations as continuous, forward-looking strategies that are taken to manage or adjust to current and future perturbations. This definition allows me to consider the processes, actions, outcomes as well as future changing conditions.

1.2.3. Multilevel governance

Multilevel governance is built upon the context in which the governance authorities are dispersed across multiple jurisdictions. The concept has evolved from the early 1990s to capture the transformed governance structure and mechanisms of the European integration process and the eventual formation of the European Union. With the signing of the Single European Act in 1986 and the Maastricht Treaty in 1991, the integration process disseminated the power and authority away from national governments to the supranational European Community (later formed as European Union or EU) and to other regional actors (Hooghe 1996, Tortola 2017). These transformations brought about changes in the

EU polity that no longer could be explained or captured by the dominant theories of political integration: neofunctionalism¹ and intergovernmentalism² (Marks 1992, 1993, Marks et al. 1996). Multilevel governance concept came into existence to capture this pluralistic and networked polity.

The fundamental notion of this concept is decision making in a pluralistic and highly dispersed policy-making milieu where multiple actors participate at various political levels from supranational to sub-national or local (Stephenson 2013). Multilevel governance directs threefold of authority displacement: upward to international actors, downward to local actors, and outward to private/civil actors (Pierre and Peters 2000). It implies that the actors are mutually dependent through intertwined cross-level decision making activities. Under a multilevel model, the increased competencies and the interconnectedness among the actors diminish, if not void, the ‘gate-keeper’ role of national government and allow the subnational and/or non-central actors to open, or even remove, the center-periphery gate (representativeness of peripheral actors in the central policy processes) and the domestic-foreign gate (representation of national or local interest in the international arena). The inclusions of NGOs, corporations, professional societies, and advocacy groups in the multi-actor network open up

¹ Developed in the late 1950s, the neofunctionalism theory primarily rests upon the ‘spillover’ notion, meaning that integration or cooperation in one area creates the conditions or incentives for integration in another policy area. Neofunctionalism theory hypothesized that regional integration will be dominated by common needs and interests.

² Characterized by state-centrism, intergovernmentalism postulates that national governments of the member states are the primary actors in the European integration process (Cini 2016). Establishment of a supranational body (i.e. EU) does not weaken the role of national governments rather it determines the national governments as the ultimate decision makers in the integration process.

the state-society gate (prioritization of societal demand as national interest) (Piattoni 2010).

Because of the involvement of different organizations in climate change adaptation in Bangladesh, in this study, I am using multilevel governance concept to examine the arrangement of organizations that are operating at multiple levels of governance and at different sectors of engagement. I am particularly focusing on government organizations and prominent non-government organizations. This concept enables me explain how power is distributed from national government to various levels of governance and how power differences are affecting the governance process.

1.2.4. Power

In this study, power is defined as the organizational and discursive capacity to achieve outcomes in social practices (Arts & Tatenhove 2004). Insights into the sources and dimensions of power can help evaluate the mechanisms of adaptation governance (Crona and Bodin 2010, Duit et al. 2010) and assess the performance of governance (Hayward & Lukes 2008). Understanding which actor is more powerful than others, and in what ways, can lead to improved policy and institutional design (Sherman & Ford 2014).

The concept of power is long debated and its theorization and operationalization are essentially contested (Lukes 1974, Baldwin 2002, Avelino & Rotmas 2011, Boonstra 2016). In this paper, we adopted the conceptualization of power developed by Arts & van Tatenhove (2004) as an effective way to

analyze the power dynamics in multilevel adaptation governance where power can be observed in the interactions among actors, in actors' capacities, and in the structure of the multi-actor network. Building from earlier theorizations (i.e. Weber 1978, Giddens 1984, Clegg 1989), Arts & van Tatenhove (2004) converge the dichotomy of actor-centered and structure-centered conceptualizations of power. Based on their conceptualization, we adopted two types of power: *dispositional* and *structural* to analyze our case. *Dispositional* power indicates actor's capacity to act using the resources it possesses and abiding by the institutional rules. This power can be invoked from material and ideational sources. Material sources primarily represent financial capacity and human resources, while ideational sources include knowledge, ideas, and information (Fuchs & Glaab 2011, Orsini 2013). *Structural* power is a macro-level phenomenon that shapes the nature and behavior of actors through order of significance, legitimization, legal means, and economic institutions, and can be characterized as authority. Authority can be defined as the perceived legitimized exercise of power by a certain actor to influence other actors or their interactions (Sikor & Lund 2009, Eriksen et al. 2015). For example, in a centralized regime, the structure of governance gives maximum authority to the central (i.e. national level) actors, enabling them to exercise power over other actors (Pahl-Wostl and Knieper 2014). Notably, dispositional and structural power can be intrinsically embroiled and, in an instance of interaction among actors, both of them can be wielded together.

1.3. Study area context

Founded by the sedimentation of Ganges-Brahmaputra-Meghna river system, the south-central coastal area of Bangladesh is less than 6 meter in elevation.

Administratively, this region is divided into five districts: Barisal, Patuakhali, Barguna, Jhalkathi, and Pirojpur. Each of these districts is further divided into 32 sub-districts (Fig. 1.1). With more than 8 million people, this 9000 km² area regularly encounters climate induced extreme natural events such as monsoon flood, tropical cyclone, high tidal variation. This region suffers some of the more severe impacts of climatic extremes given that, unlike southwest or southeast coast, the south-central coast is highly exposed and not protected by mangrove forest or hills. Along with cyclones, flooding is also a recurrent phenomenon in this region. Two types of flooding usually occur in this region: river floods and tidal floods. River flooding happens during the monsoon and post-monsoon period from river water overflowing, and the tidal flooding occurs when high tide or storm surge inundates large tracts of land. In order to protect the inhabitants of this region from cyclone and tidal inundation, in the 1960s-70s the government built 6000 km of embankments across the entire coastline. Inspired by the Dutch model of polders and with the support of multilateral development agencies, the coastal embankment project involved the construction of embankments along the river channels to enclose low-lying tracts of coast land. Among the 139 polders built across the coastline, 44 are located in this area. The establishment of the embankments brought a large tract of land, which was usually flooded during high tide, under agricultural activities (see Fig. 1.2). As a result, food production increased in the region and food security was enhanced to some extent.

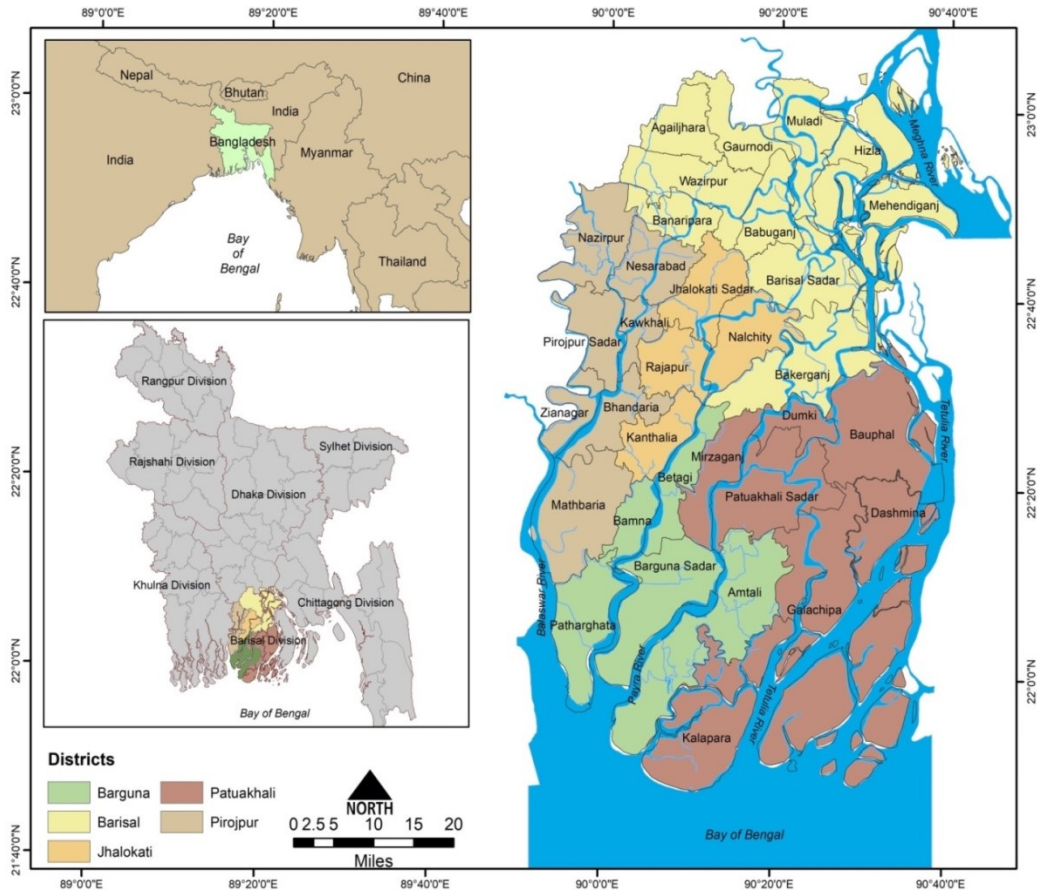


Figure 1.1: Location of the study area

Although the coastal embankments protected this area from some extreme events, it was still vulnerable to higher-intensity events. In 1991, the category-5 *Cyclone 02-B* caused 150,000 human deaths; a majority of them were from this region. The damage of this tropical cyclone convinced the government to invest in constructing cyclone shelters and developing an early-warning system. Currently, there are 2130 cyclone shelters along the entire coast and an effective early-warning system has been developed. While these efforts significantly reduced human death toll from subsequent events (Paul 2009), high vulnerability of the residents still persists. The empirical evidence suggest that the Bangladesh Meteorological Department cannot provide a reliable forecast beyond 12

hours, and that there is considerable mistrust of warning messages among residents (Roy et al. 2015). The efficacy of the evacuation system is further impeded by religious superstitions and other socio-cultural reasons (Alam & Collins 2010, Garai 2017). Furthermore, the IPCC projects that by 2100 the coastal areas of Bangladesh will encounter at least 0.5m rise in mean sea level, resulting into 15-20% rise in tidal surges (Church et al. 2013). Such trends of rising sea levels can further cause overtopping of all polders in this study region by 2050 (Dasgupta et al. 2014).

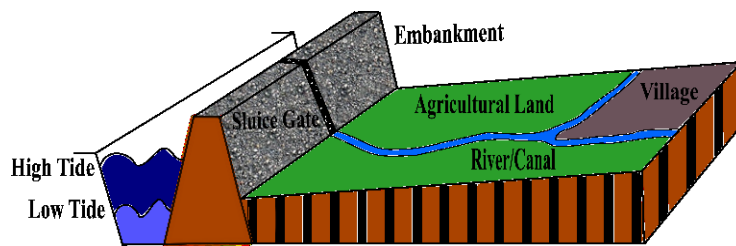


Figure 1.2: Standard embanked polders. The construction of polders brought large tracts of lands under agricultural production, and at the same time protected the residents from extreme natural events (source: author's sketch)

In order to combat climate change impacts, different adaptation strategies have been undertaken in the study region. Some strategies are efforts by households or communities, such as homestead gardening, rainwater harvesting, shifting cropping patterns, and rice/prawn farming (Alam and Collins 2010, Arfanuzzaman et al. 2016, Garai 2017). Other adaptation efforts are large-scale, requiring the participation of organizations operating at multiple levels of jurisdiction. For example, the Bangladesh Rice Research Institute introduced salt-tolerant and flood-tolerant rice varieties that can endure moderate to strong soil salinity and withstand several days of inundation. On the other hand, the Local Government Engineering Department (LGED) is responsible for

climate-resilient infrastructure projects and constructing multipurpose disaster shelters. Multiple organizations from different levels of jurisdictional scales are involved in these adaptation actions. International organizations like the World Bank and the Asian Development Bank are involved in adaptation decision-making process and in providing funds or loans, while national level organizations, such as the LGED or Ministry of Environment often act as the key adaptation implementation agencies. Adaptation implementation further includes involvement of district and/or more local level government or non-government organizations. Through collaboration and coordination, these organizations form a multilevel network of interactions.

The governance of adaptation actions in Bangladesh is similar to traditional governance of development activities. Through formulating National Adaptation Plan of Action (NAPA) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP), Bangladesh government was able to mainstream climate change adaptation into development. The organizations that are involved in adaptation actions are the same organizations that work on development activities. Rahman & Tosun (2018) reported that the governance process of these organizations is highly influenced by the historical administration system of this region. The administration system of Indian subcontinent, that includes Bangladesh, India, and Pakistan, has colonial inheritance and the colonial governance culture was characterized by a rigid, centralized, elite-centered, command-control bureaucratic system. With the end of British colonialism in 1947, Bangladesh became a part of Pakistan and continued to have a similar governance approach: elite-centered, top-down, and authoritarian. In an effort to promote a more democratic and socialist government system, Bangladesh fought for its independence and gained it in

1971. However, the first few years were turbulent, characterized by several military coups, and no government stabilized. Bangladesh started a process of distributing power from the national government in 1980s with the empowerment of sub-district administrations, yet the governance approach was still rigid and centralized. Devolution of power accelerated after the first democratically-elected government came into power in 1991. The government started to formulate plans to set up priorities, mobilize organizations focusing on different sectors, and facilitate involvement of civil societies in the governance process. Particularly, in climate change management, the Bangladesh government involved various stakeholders to design actions plans.

The involvement of multiple organizations in the management of adaptation actions makes Bangladesh an ideal case to examine my research questions. The climate change impacts that Bangladesh is facing are not novel; they can be found in any coastal area. Similarly, the way Bangladesh government mobilized its organizations in different sectors of engagement is also not uncommon. A sectoral focus of administration enables the government to emphasize specific aspects of society; thus governments from Global North and South seek to mobilize organizations in different sectors. Evidence across the world indicates that these organizations operate at multiple levels of governance, sometimes just two (i.e., national and local), and sometimes more than three (national, regional, state, and municipal). In this way, an analysis of multilevel adaptation governance in Bangladesh may help understand the process of adaptation governance not just in the region but in other parts of the world where there are strong traditions of administrative centralization and sectoralization of decision-making.

1.4. Chapter overview

This dissertation thesis is comprised of three chapters and a concluding chapter, in addition to this introduction chapter. These three chapters are written as individual research manuscripts with separate but related conceptual backgrounds and methods. They are framed in a way so that they can answer the three research questions that this dissertation seeks to answer. As a cohesive whole, these chapters provide us with insights on the framings of coastal vulnerability, management of adaptation actions, and governance barriers in a multilevel milieu.

In the second chapter, I argued that the multidimensional impacts of climate change necessitate participation of large scale organizations in the management of vulnerability to climate change. Operating at multiple levels of governance, these organizations help manage the deleterious effects of changing climate for different sectors of human-environment systems. How they frame vulnerability, what influences their framings, why are their framings aligned or misaligned: While these are critical questions for managing vulnerability, they are often overlooked in the literature. By ‘framing’ I meant how actors understand and evaluate key factors of vulnerability. I analyzed how vulnerability is framed by the leading organizations across five sectors and three levels of governance. Evidence suggests that similarity in vulnerability framings of these organizations has the potential to increase the efficiency, effectiveness, equity, and legitimacy of vulnerability management, while significant misalignment can cause economic wastage, resource misallocation, maladaptation, governance failures, and fragmented development (Wilbanks & Kates 1999, Gibson et al. 2000, O’Brien et al. 2004, Adger et al. 2005, Eakin & Luers 2006, Pahl-Wostl 2009, Engle 2011). Drawing

from key-informant interviews, I developed a spatial multi-criteria decision analysis (MCDA) approach and identified vulnerability hotspots. With few variations, this chapter reveals that the framings of vulnerability are mostly aligned across scale irrespective of the scale at which stakeholders are operating. Collectively, proximity to river/sea along with poverty, schooling, cropping intensity, soil salinity, and availability of multipurpose disaster shelters are identified as key determinants of vulnerability by all organizations. They prioritize infrastructural and agricultural development as basis for vulnerability management. I argued that similarity of understanding of vulnerability across scales would facilitate adaptation decision-making process. However, the analysis revealed lesser focus on socio-economic criteria, which can undermine the success of adaptation initiatives. While the findings of this study can assist the decision-makers of Bangladesh in coastal vulnerability management, the methodological approach should be useful to assess coastal vulnerability in other parts of the world as well.

The third chapter is built on the conceptual foundations of multilevel governance and power. I analyzed the structure and processes of and power dynamics in the multilevel governance of adaptation to flood. I adopted social network analysis approach and used the concept of power to examine the structure and processes of the multilevel adaptation governance network, and tested four hypotheses related to governance. The results revealed that the adaptation governance process is elite-pluralistic in nature, meaning that there is a coexistence of top-down and bottom-up processes in different phases of adaptation actions. I found that the organizations with highest influence over the governance process reside at the national level. I further identified five types of organizations based on the structural attributes of the governance network and their

functions. The analysis of power dynamics disclosed the dominance of a few organizations in the adaptation governance process in Bangladesh. I concluded with a discussion of the implications that might arise due to such relative centralization of power.

The fourth chapter argues that existing barriers to adaptation studies mostly have attempted to create an exhaustive list of barriers by focusing on ‘what’ question (what barriers exist?), while we continue to have a meager understanding on ‘how’ or ‘why’ barriers emerge in the governance process. In this chapter, I take an effort to explain the mechanisms that causes the emergence of barriers in the climate change governance process. I adopted key-informant interviews and evidence synthesis techniques to identify how the barriers emerge in the adaptation governance process in flood management sector. My analysis revealed that there are at least eight mechanisms that are involved in the emergence of barriers: frame polarization, lost in translation, power dynamics (enclosure/exclusion), power dynamics (boundary control), conflict infection, risk innovation, organizational inertia, and belief formation. This mechanism-based analysis of barriers will help to address and navigate through the barriers more effectively to ascertain successful adaptation. Chapter five discusses the key findings derived from this dissertation research and in what areas research can be furthered.

1.5. Significance

Climate change impacts affect the coastal low lying areas vigorously. These impacts do not just jeopardize the livelihood of coastal people; their very existence is under threat. To sustain secure livelihoods in the coastal vulnerable areas, concerted

efforts from different actors are indispensable. In these efforts to plan and manage adaptation actions, these actors interact with each other. The premise of my dissertation is that a better understanding of different issues entailed in these interactions will result into a better management of adaptation actions. In that regard, this dissertation research contributes to the existing adaptation governance research in at least three ways. First, it advances our understanding on the multiple perspectives of perceiving vulnerability by revealing how multilevel organizations frame vulnerability. Analysis of multiple perspective of vulnerability is important because a similarity in understanding of a problem may result into more effective and efficient management while divergence in understanding can cause conflict, tension, contestation among actors and thus impede the governance process. This research further contributes to the methodological aspect of vulnerability research by developing a composite vulnerability index based spatial multi-criteria decision analysis technique. Second, it enhances our knowledge on how power dynamics among these organizations influence the adaptation governance process. Studies on power dynamics are crucial in order to understand the governance approach and its effects on the outcome of interest – i.e., adaptation. It will assist us to realize which actors need to be more empowered to facilitate the governance process and how power relations among governing agencies can influence adaptation outcomes. To understand the influence of power dynamics in adaptation governance in Bangladesh, this research introduces a novel social network analysis approach to identify the influence of different organizations in the adaptation governance process based on their collaboration and cooperation networks. Third, this research enables us to look beyond the list of barriers to adaptation governance by identifying underlying social mechanisms of why

and how barriers emerge. Mechanism-based explanation of barriers is a relatively new approach of analysis in climate change adaptation. This approach assists us in capturing the processes through which barriers emerge in the governance process. Mechanism-based analysis is important because it allows us to address the causes of the problem (i.e. barriers).

This research draws theories from geography, disaster studies, political science, sociology, public administration, and sustainability science. In this way, it is an interdisciplinary research project and will be useful to all disciplines that are concerned of climate change research. Also, the methodological approach that has been used in this research can be replicated to identify the vulnerable hotspots, to examine the influence of organizations over adaptation governance, and to analyze the underlying mechanisms of barriers in other climate vulnerable areas. The findings of this research will be beneficial to the decision-makers of Bangladesh as they will be able to recognize the role of power dynamics in adaptation governance and the underlying mechanisms of governance barriers. Addressing the power dynamics and mechanisms of barriers, they can make the adaptation governance more efficient and effective. This research will further assist the international development aid agencies, such as USAID, World Bank, to formulate better adaptation plans for coastal vulnerable areas in Bangladesh.

Whether development and adaptation should be treated same or differently is arguable, but in Bangladesh adaptation and development are conceived in a similar vein. The only difference between these two is that in case of adaptation these organizations consider the impacts of long-term climate change. Because of the mainstreaming of

climate adaptation into development, adaptation becomes prone to be affected by the same governance challenges that a regular development initiative encounters.

CHAPTER 2

EXAMINATION OF COASTAL VULNERABILITY FRAMINGS AT MULTIPLE LEVELS OF GOVERNANCE

2.1. Introduction

Operating at different levels of governance (e.g. national, regional, local), governmental and non-governmental organizations manage vulnerability to climate change by undertaking or enabling adaptation actions (Pahl-Wostl 2009, Keskitalo 2010, Termeer et al. 2010). The different ways that such organizations frame vulnerability – in other words, how they understand and evaluate vulnerability – are likely to affect how they interact in their efforts to ensure successful management of vulnerability across scales (Adger et al. 2005, O’Brien et al. 2004). Similarity in vulnerability framings of these organizations has the potential to increase the efficiency, effectiveness, equity, and legitimacy of vulnerability management, while significant misalignment can cause economic wastage, resource misallocation, maladaptation, governance failures, and fragmented development (Wilbanks & Kates 1999, Gibson et al. 2000, O’Brien et al. 2004, Adger et al. 2005, Eakin & Luers 2006, Pahl-Wostl 2009, Engle 2011). Similarity in framing can also ensure that diverse agencies pinpoint the same vulnerable areas and thus facilitate coordinated management. Contrarily, a misalignment in framing may suggest there is no agreement in what constitutes vulnerable areas, baffling decision-makers. By analyzing vulnerability framings, researchers can shed light on which criteria have been prioritized by what agencies and why, and thus which sector of engagement needs particular attention in future adaptation policy making.

‘Vulnerability’, in this study, is defined as the degree or extent to which a system is likely to be exposed and sensitive to a hazard, and the capacity of that system to adapt to the effects of climate impacts (Watts and Bohle 1993, Cutter 1996, Kaspersen et al. 2005). By ‘organization,’ I refer to a set of actors and institutional arrangements with a common set of objectives, and who must interact across multiple action situations at different levels of activity (Polski & Ostrom 2015). Formally, I define ‘framing’ as how an actor or an organization understands the structure and boundary of a system and prioritizes its functions (Leach et al. 2010). Despite significant discussion on the importance of analyzing vulnerability framings at different levels of governance, little effort has been made to date to capture such framings by actors engaged in managing vulnerability (e.g. Reidsma et al. 2009, Fekete et al. 2010, Carmenta et al. 2017). In this paper, I present an analysis of how different organizations, at different levels of government, frame vulnerability in the context of coastal areas in Bangladesh. I adopted the diagnostic framing approach (Snow & Benford 1988) in which the stakeholders are involved in the identification and attribution of key factors of vulnerability.

Located only a few meters above mean sea level, the south-central coastal Bangladesh is experiencing the adverse impacts of climate change in the form of recurrent flooding, increased frequency of tropical cyclones, higher tidal surges, wider tidal fluctuations, and penetration of salt water inland. Downscaled analyses of climate impacts indicate that a large part of this area will likely to be flooded by next three decades due to the changing climate (Karim & Mimura 2008, Bhuiyan & Dutta 2012, Dasgupta et al. 2014). The potential negative consequences of flooding have persuaded the government of Bangladesh to adopt an inclusive approach in order to manage

vulnerabilities in the coastal systems. The government has distributed the responsibility for climate change response across multiple organizations with mandates of different scopes, and has fostered the participation of non-governmental organizations (NGOs) in reducing climate change vulnerability. These organizations operate at different levels of governance with variable authority. As such, the national government has taken a multilevel governance approach by ensuring participation of a range of organizations operating at different levels of jurisdictional and/or corresponding spatial scale in formulating and implementing activities to reduce vulnerability. Following Termeer et al. (2010), I define ‘multilevel governance’ as the decision-making and decision implementation that involves multiple actors at multiple levels of governance and that takes place across multiple jurisdictions and sectors. In this multilevel governance context, I would expect that if the organizations involved have similar framings of vulnerability, they would have similar priorities for action and make decisions in a synergistic and complementary fashion. However, this assumption may not always hold true.

Multilevel vulnerability management has primarily been analyzed in two ways: *multilevel interactions* and *multilevel assessment*. Studies of *multilevel interactions* are concerned with exploring the interactions among stakeholders operating at different levels of governance. Such interactions, often of two types- vertical and horizontal-- can subdue the consequences of scale mismatch, multiple interpretation, and vulnerability tradeoffs (Young 2002, Cash et al. 2006, Janssen & Anderies 2007). The empirical evidence suggests that multilevel interactions are highly contextualized in nature and influenced by the governance system. For instance, a centralized system in England

develops well-integrated and efficient vertical and horizontal interactions among the organizations involved in vulnerability management (Keskitalo 2010), while under a similar centralized system in Senegal, limited vertical coordination undermines the local level efforts to address vulnerability (Vedeld et al. 2016). On the other hand, *multilevel vulnerability assessments* are concerned with representing the differential manifestation of vulnerability across spatial scales. These assessments mostly focus on units of analysis at different levels of spatial scales. The determinants of vulnerability may be treated equally at all scales, or analyses may adopt expert judgment to weigh determinants differently according to different processes at play across various decision levels. O'Brien et al. (2004), Fekete et al. (2010) and Mclaughlin & Cooper (2010) argued that important local variations are masked by simplification at national scale and thus analyses need to be conducted at all possible levels before an adaptation decision is made. The selection of determinants is contentious; some scholars support using the same vulnerability determinants irrespective of scale it is being analyzed (e.g. O'Brien et al. 2004, Balica et al. 2009), while others found that the determinants vary across different levels with implications for investment and development (e.g. Birkmann 2007, Antwi-Agyei et al. 2017). Overall, these efforts explore the linkages among organizations and other stakeholders at multiple levels of governance and capture the vulnerability manifestation across spatial scale. Yet, the questions of how the multilevel organizations frame vulnerability and why there is a coherence or difference in their framing are still under-researched.

In order to address the climate change vulnerability more effectively, the government of Bangladesh formulated the National Adaptation Program of Action

(NAPA), Bangladesh Climate Change Strategy and Action Plan (BCCSAP), and National Plan for Disaster Management (NPDM). In their effort to implement the NAPA, the government focuses on six sectors of engagement: agriculture, forestry, water, livelihood, industry and infrastructure, and policy and institutions (NAPA 2009). Although around 40 ministries and their associated departments and autonomous organizations are working in these sectors to reduce climate induced vulnerability, there are only a few organizations and agencies with key roles in implementation of an action plan. For instance, in the hydrology or water resources sector, four organizations are actively engaged under the Ministry of Water Resources, and among them Bangladesh Water Development Board is the dominant organization in terms of resources, work scope, and influence (see Table 1). Furthermore, along with the government organizations, non-government organizations (NGOs) play active roles in vulnerability reduction efforts, particularly in socio-economic sectors (Khan & Rahman 2007, Islam & Walkerden 2015). These organizations are mostly hierarchical and follow jurisdictional scale (i.e. national, division, district, sub-district) in governance (Rahman & Tosun 2018). In the development of climate policies, plans, and actions they actively contribute through baseline information collection, vulnerability assessments, synthesis of information, and decision making (Shaw et al. 2013).

To date, there have been a few efforts to understand the role of organizations in climate vulnerability management in coastal Bangladesh (e.g. Matin & Taher 2001, Thomalla et al. 2005, Khan & Rahman 2007, Ikeda 2009, Islam & Walkerden 2015). Focusing mostly on NGOs, these studies indicated that NGOs play crucial roles in the reduction of natural disaster vulnerability through various social and economic activities

but often criticized for concentrating more on short-term emergency events for financial benefits and ignore long-term vulnerability reduction measures. Despite these studies, it is less-understood that how the government and non-government organizations frame vulnerability or what influences their framings. Alignment in framings would potentially limit the resource wastage, avoid episodic development initiatives, and assist in coordinating investment decisions, and adaptation planning; the misalignment would do otherwise.

This lacuna in the research leads us to ask the following questions: How do sectoral organizations operating at different levels of governance frame vulnerability? What elements do such organizations prioritize as vulnerability determinants? What factors might explain any observed alignment or mismatch in their framings? I tackle these questions by conducting a primary research on the major actors across sectors (i.e. hydrological, infrastructural, agricultural, forestry, socioeconomic) and levels of governance (i.e. national, district, sub-district). I select the leading government organizations in hydrology, infrastructure, agriculture, and forestry sector which are involved in the vulnerability management in the south-central coastal region of Bangladesh as major actors (see Appendix A). Because of their active participation in vulnerability management, I also included the leading NGOs, who primarily attend the socio-economic sectors. Most of these NGOs work at two levels: national and local. I identified ‘leading’ organizations on the basis of the scope of work, resources, funding, and reputation. I develop an indicator-based composite vulnerability index and identified vulnerability hotspots using a spatial multi-criteria decision analysis (MCDA) approach- an approach that is concerned with solving spatial decision and planning problems

involving multiple criteria, for each of the leading organizations at each level of governance. Because vulnerability hotspots are those areas where there is strong agreement over vulnerability, their identification can assist the decision makers in narrowing resource investment and preventing wastage. Lack of coincidence in the prioritization of vulnerable areas among the organizations would indicate a lack of underlying agreement on the determinants of vulnerability and potentially a need for further investigation on the source of such disagreement.

2.2. Study Area

The south-central coast of Bangladesh is home to more than eight million people. This 9000 km² area is divided into five contiguous districts and 32 sub-districts (Fig. 1.1). In this paper, I consider sub-district as unit of analysis because of the data availability at that scale, and to better capture dynamics of vulnerability. The area regularly encounters climate-induced events such as floods, tropical cyclones, and high tidal variation. Unlike southwest or southeast coastal plain, the south-central coast is not protected by mangrove forest or hills, and hence is exposed to extreme events. Two types of floods usually occur in this region: river floods and tidal floods. River floods occur during monsoon and post-monsoon period due to spilling of river waters. The tidal floods occur when high tide or surge inundates large tract of lands. Following the Dutch model of polders, the government built 44 polders (embanked low lying areas) during 1960s–1970s to protect the inhabitants from cyclone and tidal surge and to ensure food security by expanding agricultural lands. However, the system is still vulnerable to higher-intensity floods and cyclones due to embankment debility, and the population's mistrust in warning signs, fear

of household larceny (affecting their willingness to evacuate), and obliviousness to the impacts of previous events (Saari & Rahman 2003, Roy et al. 2015, Garai 2017, Ishtiaque et al. 2017). Dasgupta et al. (2014) found that under the changing climate this region will encounter approximately 27 cm rise in sea level per year and as a result all the polders will be overtopped by 2050 unless the government invests more than \$800 million to heighten the embankments. Furthermore, they estimated that the damage of the tropical cyclones would be more intense, potentially costing more than \$2 billion by 2050.

2.3. Materials and Methods

In order to examine the coastal vulnerability framings by the leading organizations operating at different sectors of engagement and levels of governance, I followed several steps. First, I developed an indicator-based composite vulnerability index by consulting with key-informants from the leading organizations and by putting relative weights to the indicators using MCDA approach (i.e. analytical network process). Second, I mapped the results of each organization's framing of vulnerability, and identified the vulnerability hotspots for each of the leading organizations and for each level of governance. Third, I analyzed the variation in the relative importance of specific vulnerability criteria across the leading organizations. This three step approach can be used to assess coastal vulnerability in any part of the world and thus serve as a generalizable approach to elicit the framings of distinct organizations that are involved in collaborative adaptation governance in a specific coastal area. It is important to note that this methodological approach requires a large set of proxy indicators for vulnerability, extensive interviews with decision-makers, and unbiased identification of vulnerable

areas. As such, availability of data, access to decision-makers, and caution for interviewer biasness would be imperative to adopt this approach.

2.3.1. Development of vulnerability index

2.3.1.1. Vulnerability indicators

Indicator-based vulnerability assessment requires the selection of proxy variables for biophysical and socio-economic components (Cutter et al. 2003) thought to represent the three core aspects of vulnerability of a system: exposure, sensitivity, and adaptive capacity (Eakin & Bojórquez-Tapia 2008). Exposure indicators mostly represent the physical risk of the region. Sensitivity indicators reflect the dependence of actors on hazard-sensitive activities and patterns of resource use. Adaptive capacity indicators measure the access to entitlements and resources that can be mobilized to cope with and adapt to climatic threats: health status, wealth, information access, resource stocks and access. Note that interpretations of these indicators are context specific. For instance, Gerlitz et al. (2017) found that indebtedness in Hindu-Kush Himalayan region increases the sensitivity through intensifying the financial tension during times of emergencies. Lemos et al. (2016), however, argued that access to loans in Northeast Brazil increases adaptive capacity. As such, the indicators need to be interpreted in the context of study area (in this case, coastal Bangladesh) and informed by prior research that associates system variables to vulnerability outcomes in the area.

Based on a literature review, I identified 27 indicators of vulnerability and categorized them under seven major dimensions. These indicators have been widely used in vulnerability research as proxy variables for determining vulnerability. They served as first-level criteria for structuring the vulnerability assessment: social, economic, natural, agriculture, land use, infrastructure, and household characteristics (see Appendix 1). Data for each sub-criterion (or indicator), collected from census reports and district statistics, was aggregated at the sub-district level.

2.3.1.2. Data Standardization

There are several ways for data standardization (see Yoon 2012, Nguyen et al. 2016). I used a *min-max rescaling transformation* to transform the diverse measurement scales and units of the sub-criteria into a uniform measurement scale with a range between zero and one (Cutter et al. 2010, Yoon 2012, Ahsan & Warner 2014). In this study, if the higher value of a sub-criterion represents higher vulnerability (e.g. poverty rate), the standardization was been done as following:

$$s_i = \begin{cases} 0 & \text{if } v_i = v_{min} \\ \frac{v_i - v_{min}}{v_{max} - v_{min}} & \text{if } v_{min} < v_i < v_{max} \\ 1 & \text{if } v_i = v_{max} \end{cases}$$

On the other hand, if the lower value of a sub-criterion represents higher vulnerability (e.g. elevation), it is standardized as follows:

$$s_i = \begin{cases} 0 & \text{if } v_i = v_{min} \\ \frac{v_{max} - v_i}{v_{max} - v_{min}} & \text{if } v_{min} < v_i < v_{max} \\ 1 & \text{if } v_i = v_{max} \end{cases}$$

2.3.1.3. Key-informant interviews

I conducted key-informant interviews in the three offices (i.e. national, district, and sub-district office) of each leading government organization and two offices (i.e. national, local) of two NGOs: BRAC and Sangram. I prepared a semi-structured questionnaire and interviewed 25 key informants who had substantial knowledge on that organization's activities and held enough authority to comment as a representative of that organization. Interviews lasted approximately an hour, in which the interviewees provided a detailed description of their organizational activities as well as evaluated specific vulnerability criteria as part of a process of eliciting their vulnerability framings. The relative importance of the pre-identified vulnerability criteria for the interviewee was interpreted as an indication of how they framed primary factors influencing on vulnerability in the region. Each interviewee was asked to create a network structure: a structure that related specific vulnerability criterion to other criterion within an overall structure that presented vulnerability as a product of a series of first-level criteria (i.e., social, economic, natural, agriculture, land use, infrastructure, and household characteristics) (Fig.

2.1). I made sure that the creation of network structure was not influenced by interviewer bias.

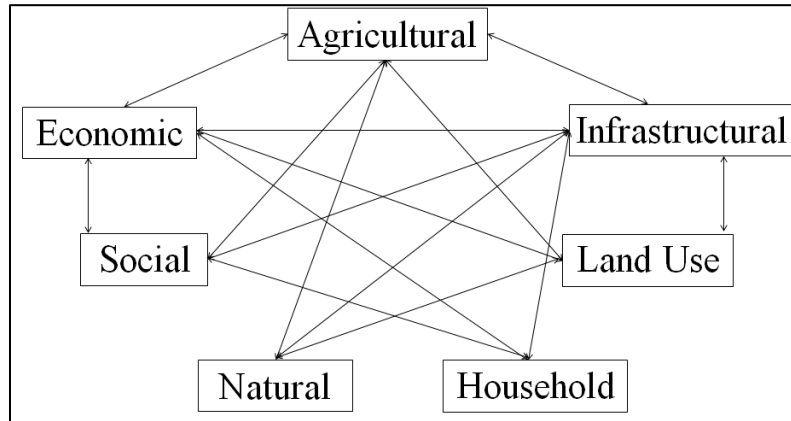


Figure 2.1: A network structure of vulnerability criteria created by the district level DAE official. Each interviewee created a separate network structure based on their prior knowledge and experience.

Later, the interviewees perform a pairwise comparison of first-level criteria using Saaty’s scale (Saaty 1987) (Table 2.1). This process involves each interviewee deciding which of two criteria (e.g., “social” vs. “economic”) is more important as a vulnerability determinant, and then *how much* more important. To reduce interviewee fatigue, I limited the pairwise comparisons to the first-level criteria, and instead asked them to ordinally rank the sub criteria within each first-level category (e.g., rank the sub criteria related to “social” and then the sub-criteria related to “natural” etc.). The sub-criteria ranking was done following an ascending order of significance in determining vulnerability (Bausch et al. 2014). Note that, the interview could be long and exhaustive for the interviewees

if they have to create the network structure or do the pairwise comparison alone. Interviewer should provide a succinct detail of how the network structure functions toward vulnerability and may guide the interviewee in the process of network structure creation and pairwise comparison, but at the same time the interviewer needs to ensure that the process is devoid of interviewer-biasness.

2.3.1.4. Analytical Network Process (ANP)

The criteria weighting for each office of the organizations was determined using the ANP process. Once the pairwise comparison was completed, the priority weight vector was computed using Superdecision software (Liu et al. 2003). To be acceptable, the weighting of all criteria needed to obtain a consistency ratio of less than 0.1 (Saaty 1990). The criteria were put into a supermatrix- a form of partitioned matrix comprising of several block matrices, to represent their interrelationships. Each block matrix contained the priority weight vectors of the elements and represents the influence (or importance) of the elements over one another. Later, this initial supermatrix was modified to a weighted supermatrix so that each of the columns sums to unity (Fig. 2.2).

		C_1				C_2				...	C_N			
		e_{11}	e_{12}	...	e_{1n1}	e_{21}	e_{22}	...	e_{2n2}		e_{N1}	e_{N2}	...	e_{NnN}
C_1	e_{11}	W_{11}				W_{12}				...	W_{1N}			
	e_{12}													
	...													
	e_{1n1}													
C_2	e_{21}	W_{21}				W_{22}				...	W_{2N}			
	e_{22}													
	...													
	e_{2n2}													
...							
C_N	e_{N1}	W_{N1}				W_{N2}				...	W_{NN}			
	e_{N2}													
	...													
	e_{NnN}													

Figure 2.2: A general form of supermatrix. Here, C represents components (or criteria), e represents element (or sub-criteria), and W represents relative weights obtained through pairwise comparison.

However, as all the criteria are part of a network, a criterion can indirectly influence a third criterion through a second criterion. To capture this transmission of influence along all possible paths of supermatrix, a limit matrix is required. The limit matrix was processed by raising the entire supermatrix to powers until convergence so that all columns are identical. The limit matrix provides the final weight to the criteria and the sum of all the criteria is one.

Table 2.1: Scale of relative importance (Saaty 1990)

<i>Intensity of importance</i>	<i>Definition</i>	<i>Explanation</i>
1	Equal importance	Two criteria contributes equally
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Extreme importance	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above

2.3.1.5. Sub-criteria weights

During the interview process the interviewees were asked to rank the sub-criteria based on their importance in evaluating vulnerability. The rank scale was in ascending order meaning 1 is the most important, 2 is the second most importance, and so on. However, this ordinal scale for sub-criteria weights cannot be directly compared to the criteria weights without transformation (Bausch et al. 2014). In this study, using *rank-order centroid* method the ordinal scale is transformed to weights (w_i) in a scale with ratio properties (Noh & Lee 2003):

$$w_i = \frac{1}{n} \sum_{k=i}^n \frac{1}{k} \quad (1)$$

where, i is the index variable, n is the number of variables, k is the rank of variable determined by the interviewee. After calculating the weights for

all sub-criteria, the weights were normalized with respect to the criteria weights. To illustrate, hydrological organization gave the weight of 0.225 to the agricultural criterion. The weights of the agricultural sub-criteria were then standardized, so that the sum of the sub-criteria weights equaled to the criteria weight (0.225).

2.3.2. Vulnerability mapping and hotspots

2.3.2.1 Vulnerability score and categories

Once the data were standardized and relative weights of sub-criteria were determined, the final vulnerability score for each location was calculated as:

$$V_i = \sum_{i=1}^n s_i w_i \quad (2)$$

where, V_i is the final vulnerability score, s_i is the standardized data score, and w_i is the sub-criteria weights. Based on the Equation 2 vulnerability ranges from 0 to 1, where 0 represents the least vulnerability and 1 denotes the most vulnerable. After calculating vulnerability for all sub-districts, a vulnerability map was produced for each organization and for each level. The final vulnerability index was divided into five categories: $\{VL$ (very low), L (low), M (moderate), H (high), VH (very high) $\}$ based on *Weber-Fechner Law* (Bojórquez-Tapia et al. 2009). The Weber-Fechner Law states that perception is proportional to increase of stimulus which is

noticeable only when it increases by a constant percentage, known as ‘just noticeable difference’ (For details, see Bojórquez-Tapia et al. 2009).

In this study, the category cuts, c_v , are computed with respect to the best state or the lowest vulnerability score, c^- :

$$c_v = c_0 (1 + r)^v + c^-$$

where, v is the category cut value as VL equals to 1, L equals to 2, and so on; c^- represents the best state of stimulus; $(1 + r)$ is the progression factor representing the relationship between the stimulus and perceived intensity; c_0 is the initial stimulus representing the smallest detectable level of a stimulus and can be calculated as follows:

$$c_0 = \frac{c_n}{(1 + r)^n}$$

where, n is the number of vulnerability categories; c_n is the difference between the best and worst state of the stimulus. For each category cut, I tested different progression factors ranging from 1 to 2, and found 1.25 progression factor as the most suitable for this analysis (For details, see Bojórquez-Tapia et al. 2009). I suggest trialing different progression factors and further consulting with the interviewees to obtain a specific progression factor. If multiple progression factors are selected by the interviewees, arithmetic mean could be considered for analysis.

2.3.2.2. Vulnerability hotspot identification

To analyze the vulnerability hotspots, both global and local clustering techniques were employed. I relied on two indices of spatial clustering. Global spatial autocorrelation was assessed using Moran's *I*. Ranging from -1 to +1, this index indicates spatial dispersion (-1) or aggregation (+1). On the other hand, the local clustering was identified using Getis-Ord G_i^* (Getis & Ord 1992) to determine local hotspot. The spatial weight was based on a queen case contiguity rule-based spatial weight matrix for both indices.

2.3.3. Analysis of variation in criteria weighting

In order to analyze the variation of criteria weightings among the organizations, determined using the information from the key-informant interview and ANP processes, I adopted one-way analysis of variance (ANOVA). ANOVA reveals statistically significant differences between the means of two or more independent groups or samples. I conducted the ANOVA test and associated post-hoc test for each organization type and level of governance.

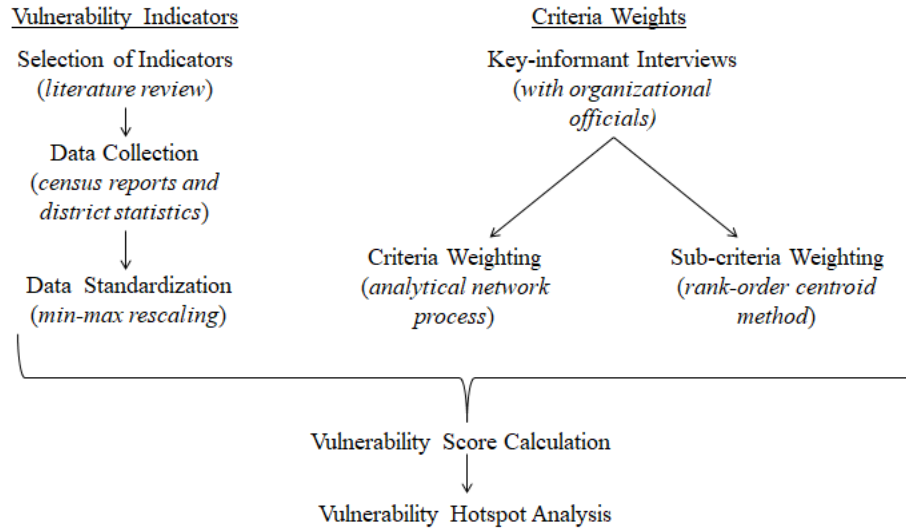


Figure 2.3: Workflow diagram of vulnerability analysis.

2.4. Results

The coastal vulnerability maps indicate significant homogeneity in the framings of vulnerability by the different organizations, though some variations can be observed (Fig. 4). It is the result of weighting of different criteria by the key respondents (Fig. 5). Collectively, the representatives of the different organizations concur that the eastern part of the study area is highly vulnerable while the central part is the least vulnerable (Fig. 6). According to our analysis, vulnerability of Muladi, Mehendiganj, Gaurnodi, Babuganj, Hizla, and Barisal Sadar sub-districts (under *Barisal* district), in the northeast part, is considered particularly high given their proximity to the *Meghna River (E)*, greater number of earthen houses (*S*), high poverty rate (*S*), low amount of net cultivated and vegetated area (*S*), lack of irrigation facilities (*AC*), and existence of fewer flood shelters (*AC*). Some organizations' framings also identified the southeastern sub-districts as highly vulnerable. In particular, Galachipa and Bauphal sub-districts (under *Patuakhali*)

are relatively more vulnerable because of their low elevation (*E*), adjacency to the *Tetulia River* and the *Bay of Bengal* (*E*), a high number of earthen houses with no electricity (*S, AC*), and less net cultivated area with high soil salinity (*S, AC*). In all of their framings, organization representatives designated the least vulnerable areas as the Betagi, Barguna Sadar (under *Barguna* districts), Kathalia (under *Jhalokati* districts), and Mirzaganj sub-districts (under *Patuakhali* districts). This designation resulted from relatively greater distance from major rivers and the sea (*E*), a low poverty rate (*S*), a greater number of schools and colleges (*AC*), high cropping intensity (*AC*), and low soil salinity (*AC*). Geographically, the entire western part of study area is classified as moderate to low vulnerable to flood as it is located away from large water bodies. However, Zianagar sub-district (under *Pirojpur*) depicts high vulnerability compared to its adjacent areas because of significantly low literacy rate (*AC*), few flood shelters and educational institutions (*AC*), lack of fertile soil and farming equipment (*S, AC*), and proximity to the *Balaswar River* (*E*). Overall, poverty, education, means of livelihoods, household structure, and proximity to rivers or sea are playing key roles in determining vulnerability in the framings of all the organizations consulted.

Although the vulnerability framings of the leading organizations are mostly aligned, they contain some variations. Particularly, the framing of NGOs differs significantly with most of the government organizations. In the following sections, I discuss how vulnerability framings vary across the levels of governance and sectors based on each criterion. Note that the differences in prioritization for each criterion do not explicitly represent discrepancies in the overall vulnerability framings of these

organizations, rather, it is the combinations of weighting of criteria and sub-criteria that determine the overall framing.

2.4.1. Determinants of Vulnerability

2.4.1.1. Infrastructure

The studied organizations acknowledge the significance of infrastructure in this hazard prone area and recommended that infrastructure should remain as one of the topmost priorities in future planning and policy formulation. They consider that both flood shelters and educational institutions are important during floods. Construction of schools and colleges in flood prone areas, while at first may seem counterintuitive and perhaps *maladaptive* (by increasing exposure of key services to flooding), in practice can serve two purposes: the provision of education (enhancing capacity over long-term) and supporting evacuees during emergency (reducing exposure at times of flood). While these institutions are customarily built by LGED, other organizations recognized the importance of such infrastructure in managing flood-induced vulnerability. The representative of the sub-district-level of DAE, for example, comments that without embankments agriculture would be nearly impossible in this region because of high soil salinity and tidal fluctuations, and thus weighted infrastructure higher than agriculture. As such, the ANOVA test did not find any significant differences between the infrastructural criteria weights by BWDB, LGED, DAE, and FD (Table 2.2).

However, the NGOs' prioritization differs significantly with several organizations, as they think disaster shelters are certainly required but that "social awareness" of disasters should also receive priority. They found that in many instances the local people are reluctant to take refuge in disaster shelters because of the mistrust in early warnings and notices, fear of theft of their belongings and loss of memory of the impacts of previous events (Garai 2017, Ishtiaque et al. 2017). For instance, in our study area, during cyclone *Mora*, Bangladesh Meteorological Department raised the warning signal to 8 (great danger) in fear of strong winds and storm surge, but the cyclone made landfall in south-eastern Bangladesh and part of Myanmar, leaving the study area unaffected. The NGOs said, the 'government wanted us to help evacuate the vulnerable people under the warning signal 8, but the local people laughed at and ignore the evacuation process indicating the clear and sunny sky.' This is further complicated by the narrative of the NGOs, who point that the study area already has a good number of educational institutions that can serve as disaster shelters and the emphasis should be on disaster awareness among local people. Overall, the organizations agreed that infrastructure is a key criterion for coastal vulnerability management but the NGOs additionally stressed on the inclusion of social aspects, capacity building, to infrastructural solutions.

Table 2.2: Differences in mean value between organizations in terms of infrastructural criteria weighting

Organizations	BWDB	LGED	DAE	FD	NGOs
BWDB		0.007	0.017	0.033	0.080**
LGED			0.010	0.027	0.073*
DAE				0.017	0.063*
FD					0.047
ANOVA Diagnostic	<i>F</i> -statistics: 6.554**				
Significance	<i>p</i> -value: ‘***’<0.001, ‘**’<0.01, ‘*’<0.05				

2.4.1.2. Agriculture

Agricultural criteria are also ranked high by most of the organizations, possibly reflecting the extreme vulnerability of net cultivated area, intensely cropped areas, and irrigation facilities to floods. Most of the organizations working in the rural area prioritize sustaining agriculture in their long-term planning as agriculture encompasses a major source of livelihoods. Historically, safeguarding and expanding the agricultural lands was one of the major objectives of BWDB and DAE. In all level of governance, these two organizations emphasized the importance of agriculture as source of livelihoods. Furthermore, despite their operational differences, the national and district level offices of LGED and FD acknowledged the importance of agricultural criteria. The LGED official commented, ‘you will find agricultural lands almost everywhere in this region. Before hitting the settlements, floods damage the agricultural lands, and destroy the economic base of the agricultural households, and thus make them vulnerable.’ However, the national and

sub-district level FD, sub-district level LGED, and the NGOs conceded that although rural economy mostly relies on agriculture, the overall economy should be prioritized. More than 55% of employed populations in this region are engaged in non-agriculture related work and the overall economy has started to shift from agriculture to service activities; around 40% people work in the service sector (LFS 2018). As such, unlike BWDB and DAE, other organizations are mostly in favor of prioritizing agriculture equal to or less than overall economy. Such differences in their prioritization feed into the differences in their overall vulnerability framings (Table 2.3). In sum, some organizations prioritize agricultural criteria because of their operational objectives, but other organizations put similar or lesser emphasis than economic criteria. Difference in vulnerability framing point us to the likelihoods that what may be perceived as climate change adaptation may actually be underpinned by different understanding and unspoken assumption held by the stakeholders involved.

Table 2.3: Differences in mean value between organizations in terms of agricultural criteria weighting

Organizations	BWDB	LGED	DAE	FD	NGOs
BWDB		0.043	-0.017	0.050	-0.087*
LGED			-0.060*	0.007	0.043
DAE				0.067*	0.103**
FD					0.037
ANOVA Diagnostic	<i>F</i> -statistics: 9.159**				
Significance	<i>p</i> -value: ‘***’<0.001, ‘**’<0.01, ‘*’<0.05				

2.4.1.3. Social

Social criteria are less emphasized by the leading government organizations. This is not surprising. For example, BWDB, LGED, and DAE emphasized social aspects less compared to other criteria. This is partly due to their operational objectives and long term planning goals, which do not address social criteria directly. Notably, LGED is actively involved in reducing the poverty rate and increasing the education rate by constructing market centers and multipurpose emergency shelters, and connecting remote areas through roadways. Also, DAE is engaged in poverty reduction by intensifying crop production, distributing climate resilient crop varieties, and educating farmers. Nevertheless, while these organizations think that social criteria are crucial for adaptive capacity development, they believe that focus should be given to strengthening infrastructures. For instance, the district level BWDB said: ‘certainly, social criteria are important, but if you don’t have infrastructural support or a good base of agriculture for your economy, it really doesn’t matter whether you have high education or low population density.’ While they might be true to some extent, such biasness towards infrastructure based understanding is not new in vulnerability literature.

Social criteria are ranked highly by FD and NGOs. The operational objectives of NGOs primarily include poverty reduction, increase of education, health and demographic development etc. In that respect, their prioritization of social criteria reflects their operational interest. Grounded

on social science knowledge, NGOs takes a distinctive perspective and give higher weightings of social criteria. For this reason, the district and sub-district level FD are rather interesting. Although FD primarily deals with suppressing the impacts of natural disturbances through afforestation/reforestation, it contributes to the socio-economic development of individuals through social forestry. As such, the ANOVA test does not indicate much difference except with NGOs (Table 2.4). Overall, social criteria receive less focus from the organizations unless it falls under their operational objectives.

Table 2.4: Differences in mean value between organizations in terms of social criteria weighting

Organizations	BWDB	LGED	DAE	FD	NGOs
BWDB		-0.057	-0.030	-0.070	-1.433**
LGED			0.027	-0.013	-0.087
DAE				-0.040	-0.113*
FD					-0.073
ANOVA Diagnostic	<i>F</i> -statistics: 6.611**				
Significance	<i>p</i> -value: ****<0.001, ***<0.01, **<0.05				

2.4.1.4. Economic

Economic criteria are ranked moderately by LGED, FD, and NGOs, while the remaining organizations ranked these as low. The local economy has been prioritized in the operational objectives of LGED and NGOs. These two organizations actively participate in building economic centers, reducing the poverty rate, providing micro-credit to the marginal farmers, and connecting remote areas with major markets. Although FD

does not directly engage with economic development, they think that widespread poverty make people more vulnerable, ‘this region is so low in elevation that a complete prohibition of flooding is nearly impossible. For this reason, an agriculture-based economy would not be helpful in diminishing poverty. We should focus more on economic development rather than only agriculture.’ However, BWDB and DAE think otherwise. According to them, agriculture determines economic prosperity of the region. Although they acknowledged that some other dominant non-agricultural occupations exist, they characterized the occupations as indirectly or directly dependent on agriculture. In the words of DAE, ‘the first victim of floods is usually the farmers. These farmers are dependent on agriculture and most often they do not have bank balance or any other financial support. Unless we can protect their economic means (aka agriculture), poverty cannot be eliminated from this region.’ Such discrepancies in weighting have partly been observed through the ANOVA test (Table 2.5). In short, the organizations had differing opinions on the prioritization of economic and agricultural criteria. While some put more emphasis on economy than agriculture, others did the opposite.

Table 2.5: Differences in mean value between organizations in terms of economic criteria weighting

Organizations	BWDB	LGED	DAE	FD	NGOs
BWDB		-0.057	0.000	-0.057	-0.105**
LGED			0.057	0.000	-0.048
DAE				-0.057	0.105**
FD					-0.048
ANOVA Diagnostic	<i>F</i> -statistics: 8.238**				
Significance	<i>p</i> -value: '***'<0.001, '**'<0.01, '*'<0.05				

2.4.1.5. Natural

Among studied organizations, BWDB ranked natural criteria high, and the rest put it on moderate weighting; however, only the FD and NGOs have a significant difference with BWDB in weighting (Table 2.6). BWDB is responsible for hydrological operations including river dredging and construction of embankment. As a result, they are at the forefront of dealing the tidal fluctuations, river bank erosion, sedimentation and other natural phenomenon. BWDB acknowledges that low elevation, proximity to rivers/sea, and less tree cover can make certain parts of the region more vulnerable than others and the protective infrastructures can reduce vulnerability to some extent. Because of the operational objectives, BWDB ranked natural criteria higher than the other organizations, yet the importance of natural criteria is recognized by all.

Table 2.6: Differences in mean value between organizations in terms of natural criteria weighting

Organizations	BWDB	LGED	DAE	FD	NGOs
BWDB		0.040	0.053*	0.063**	0.070**
LGED			0.013	0.023	0.030
DAE				0.010	0.017
FD					0.007
ANOVA Diagnostic	<i>F</i> -statistics: 9.058**				
Significance	<i>p</i> -value: ‘***’<0.001, ‘**’<0.01, ‘*’<0.05				

2.4.1.6. Land Use

Land use criteria are prioritized by BWDB and DAE as they are of primary concern by these organizations; however, there is no significant difference in prioritization by other organizations represented by the ANOVA test. BWDB aims to limit spread of soil salinity and maintain fertile lands, while DAE is concerned of expanding crop production area. Both of these organizations think that the region becomes more vulnerable when land use criteria are affected. Unlike district and sub-district level FD, the national level FD considers land use criteria as an important determinant and they think that greater forested or vegetated area ensures less vulnerability. Overall, all organizations put moderate to low weight on land use criteria depending on their operational objectives.

2.4.1.7. Household Characteristics

Household characteristics are ranked the lowest criteria by all the organizations. They admitted that the household characteristics are

important for flood vulnerability; however, in their view, considering the biophysical and socio-economic criteria, household characteristics should get the least priority in vulnerability determination. As such, the ANOVA test shows that there are no significant differences among organizations in weighting household criteria. I think such weighting might have resulted from the fact that addressing household characteristics directly are beyond the scope of any organization’s working domain.

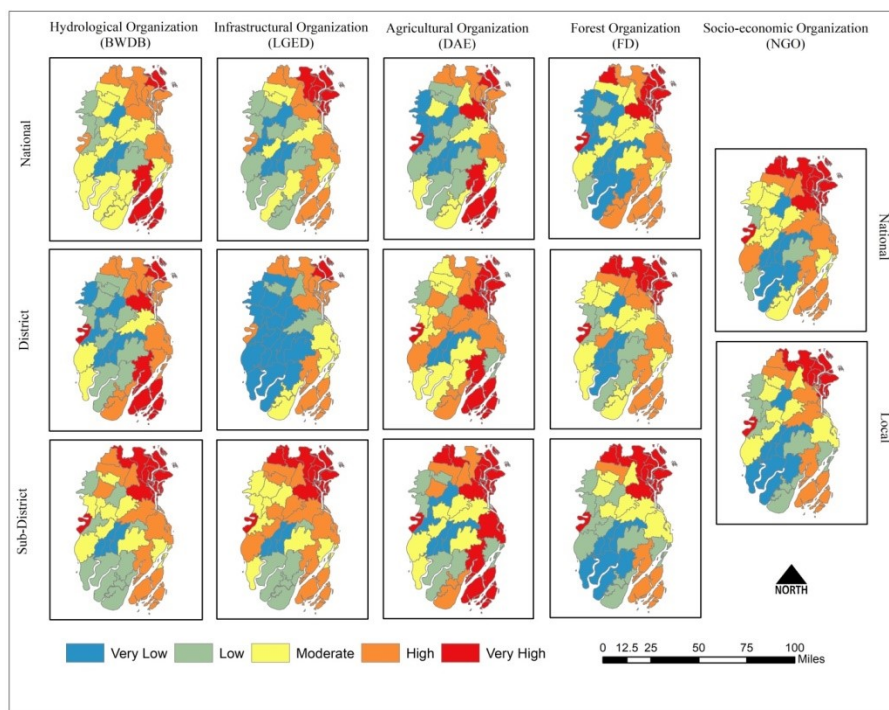


Figure 2.4: Vulnerability framings by the studied organizations at each sector and level.

As a whole, in the criteria weighting I observed no significant difference across levels of governance, but significant mean differences were found among organizations. The following figure shows a comparative average weighting of

the criteria by the organizations (Fig. 2.5). Notably, mean weight values of different levels for each organization were considered. It is evident from Fig 4 that the infrastructural and agricultural criteria received higher weight than other criteria by most of the organizations, while household characteristics received less attention. Clearly, infrastructure and agricultural are widely deemed important to reduce vulnerability to environmental stressors in the region. As an exception, the NGOs put relatively more weight in social and economic criteria, reflecting their working domain. The largest variances in weighting were particularly observed in the case of social, economic, and agricultural criteria.

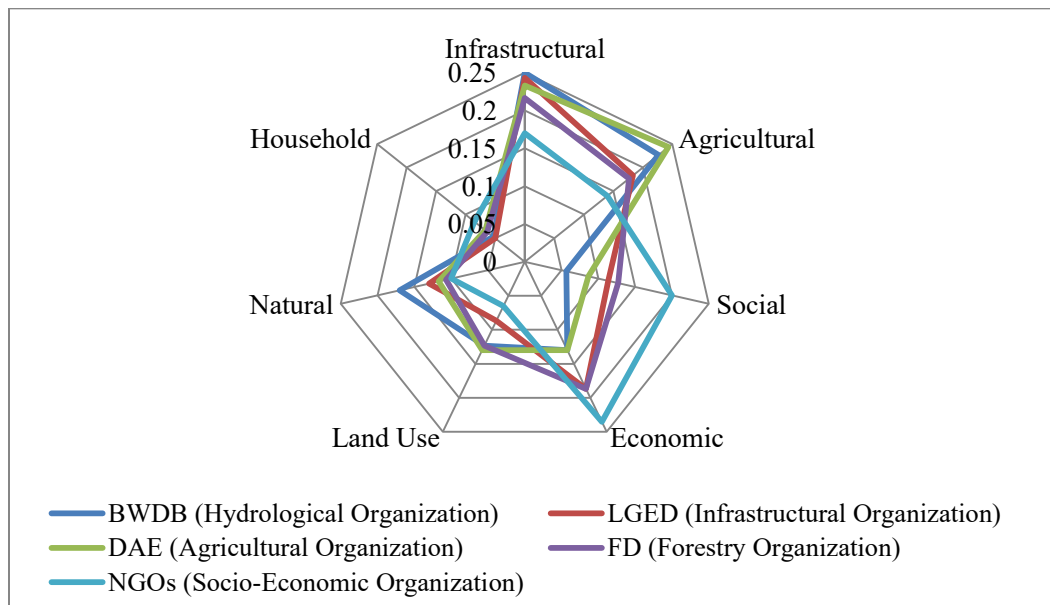


Figure 2.5: Comparative criteria weighting by the studied organizations

2.4.2. Vulnerability Hotspots

Global spatial autocorrelation (Moran's *I*) indicates that the vulnerability is not random, instead it is clustered over specific spatial scale, as one would

expect. The hotspot analysis reveals that hot and cold spots are similar according to the framings of all organizations across all levels (Fig. 2.6). Based on their framings, Hizla, Muladi, and Mehendiganj sub-district in the northeastern part are vulnerability hotspots. These areas are characterized by high poverty, located very close to the *Meghna River*, and with few concrete-built houses and flood shelters. On the other hand, Betagi, Bamna, Kanthalia, Mirzaganj, and Rajapur in the south-central zone are vulnerability cold spots, because of greater distance from major rivers and sea, low poverty rate, greater number of shelters, and high literacy rate.

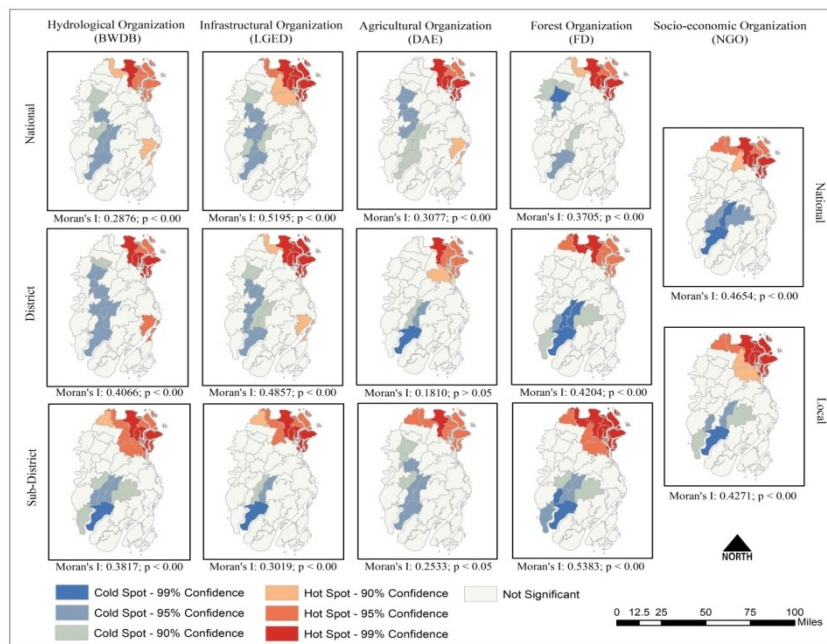


Figure 2.6: Vulnerability hotspots identified by organizations at each sector and level

2.5. Discussion

Bangladesh's efforts in climate change mainstreaming have likely had an influence on the homogeneity in vulnerability framings. Nevertheless, discrepancies in the framings are noticeable in a few instances (Fig. 5, 6). I suspect that such discrepancies are exhibited predominantly because of the sectoral policies and operational objectives of the organizations interviewed. For instance, operational objectives of DAE include ensuring food security through the provision of agricultural services. As such, DAE prioritizes agriculture over other criteria. Again, the sectoral policies of LGED and BWDB emphasize infrastructure related issues, and for this reason, these two organizations prioritize infrastructure while put less emphasis on social criteria. Similarly, NGOs have different agendas that are more specific to a particular issue (e.g. health, education) or constituencies (e.g. poor, vulnerable).

The ways in which organizational mandates affect framings and understanding of vulnerability is not surprising. Indeed, some scholars of geospatial analysis have posited that connotative features of landscape attributes should be considered explicitly in policy making. Bibby and Shepard (2005) to have three ontological dimensions: the constitutive – the objective condition and state of landscape features (e.g., elevation, water depth etc.), the agentive – referring to *how* actors interact with the landscape (e.g., deforestation), and the telic dimension – referring to the function of specific attributes in light of the organizational mandate and intention of a specific actor (see also discussion in Bojórquez et al. 2011). Here I see evidence that the telic dimension of landscape features comes into play in differentiating the ways that the different sector organizations frame vulnerability, to some extent.

Discrepancies in vulnerability framings are sometimes considered to be of concern, as perhaps indicative of conflict or a potential for inefficiencies in management. In this case, I think that the discrepancy in vulnerability framings between NGOs and other organizations is not a matter of concern, but rather indicates how a diversity of agendas and sectoral roles can be complementary in adaptation. In particular, it appears that NGOs are filling the gaps in vulnerability management where government organizations are deficient (Batley & Rose 2011). This complementary relationship with the government is represented through an active participation of NGOs in the socio-economic sector, specifically in education, health, and sanitation (Nair 2011, Rose 2011). Sansom (2011), for example, noted that limited resources of government organizations created an institutional space for NGOs in sanitation sector in Bangladesh and soon NGOs became a leading player in this sector. However, many NGOs are relatively narrow and limited in functionality. As such NGOs are playing vital roles in covering distinct foci not emphasized by the government in socio-economic sectors, some gaps might still persist.

Socio-politically, response to large scale environmental problems affect and are affected by multilevel governance, and homogeneity in understanding of the problem by stakeholders spanning across scale is desirable to addressing issue more effectively (Lemos & Agrawal 2006). In our case, cross-level interactions among multilevel organizations played a critical role in the homogeneity of vulnerability framings. Cross-level interactions of information and knowledge flow are important as they offer insights on how to deal with multisectoral issues (Cash et al. 2006, Young 2006, Termeer et al. 2010). Vertical (across different levels) and horizontal (across same level) linkages

among organizations determine the information and knowledge flow among them (Young 2002). In Bangladesh, vertical networks among sectoral organizations are well established in terms of information and knowledge flow. In this study, similar framings of vulnerability across sectors and levels of governance indicates greater information and knowledge flow which can potentially reduce the cross-scalar conflicts in managing limited resources (Adger et al. 2005, 2006). The reciprocity of the flow is maintained to some extent in this network; however, vertical relationship does not exist across sectors. To illustrate, the local level FD will not generally interact with higher level BWDB. On the other hand, the sub-national level horizontal interactions are quite frequent, but national level horizontal interaction is limited. At the sub-national level, the district and sub-district administrations hold a meeting in every 2 – 4 months regarding the actions undertaken in different sectors such as, agriculture, forest etc. This meeting is attended by all major organizations engaged in vulnerability management. In this meeting, these organizations share their action updates and requirements from other organizations. This meeting also aims to resolve confusions, conflicts, and misunderstandings among organizations, if any. Furthermore, these organizations are also connected with each other through need-based informal interactions. In case of any immediate requirement at the sub-national level, an organization can contact the another directly and resolve minor issues. For example, if the sub-national level FD encounters problems in tree plantation over the embankments, they contact the same level BWDB officials to discuss and resolve their concerns. Again, if the BWDB faces difficulties in constructing embankments because of local political dynamics, they can seek law and order assistance from district or sub-district administrations. This structure of strong sectoral vertical

linkages and moderately-strong horizontal cross-sector linkages may represent a particularly robust configuration for adaptation governance. It provides consistency in sectoral policy, and allows generic principles regarding adaptation to permeate from the national level to local level actors. The strong horizontal linkages provide a capacity for refinement, precision and coordination necessary in the operationalization of such generic principles in specific social and environmental contexts. Due to these frequent interactions, they often have a good understanding of each other's understanding of vulnerability. Furthermore, our interviews with the organization officials reveals that the government promotes discussion on climate change impacts at different levels of governance, provides documentation and training to the officials, and appreciates the inclusion of climate change in the short-term and medium-term projects. Also, the government encourages NGOs to play active roles in enhancing local adaptive capacity, and thus channels 10% of the \$170 million Bangladesh Climate Change Resilience Fund to them (GED 2015). I suspect that such promotion of cross-level interactions contributes to the alignment of the vulnerability framings of these organizations.

While similar understanding of vulnerability offers insights on dealing with complex multisectoral issues, it can also raise some concerns such as what has been called the 'coordination dilemma' and 'work scope overlapping' (Termeer et al. 2010). Coordination dilemma occurs when coordinating among a large number of stakeholders demands significant time and resources, and overlapping happens when two or more organizations address the same issue similarly. Such overlapping becomes evident in coastal Bangladesh when LGED, in one instance, planted trees in their project areas whereas it was supposed to be done by FD with a lower expenditure.

Overall, the alignment in vulnerability framing indicates that the leading organizations working in different sectors understand vulnerability in similar homogeneous way. Such similar understanding is important for avoiding fragmented development initiatives and undertaking vulnerability reduction measures for those who need it the most. I found that the locations of adaptation projects by the leading organizations correspond to their vulnerability framings. I obtained the details of currently running projects from their websites and found that the sub-districts of *Barisal* and *Patuakhali* districts have higher climate adaptation related projects running now than other districts. In *Barisal*, each sub-district has around 12 running projects on an average, and in *Patuakhali*, the number is 15. Relatively less vulnerable *Pirojpur* and *Barguna* districts have 10 running projects in each sub-district, and the sub-districts under *Jhalkathi* district have only four projects. I think that the vulnerability framing might not directly contribute in developing these projects, but it might influence these undertakings circuitously. In this way, on one hand, homogeneity in framings assists the decision makers to undertake investment decisions and effective adaptation actions, and on the other hand, diversity in the framing of FD and NGO represent emphasis on different sectors.

2.6. Conclusion

As discussed in this paper, vulnerability framing has been described as a process by which stakeholders construct meaning to understanding the consequences of particular event or occurrence. Although vulnerability to climate change is intuitively framed one way or another, it plays an important role in research, policy development and policy

implementation. Framing allows certain questions to be asked repeatedly and with emphasis at the cost of other equally important ones. Our study contributes to multilevel vulnerability research through an analysis of vulnerability framings at different sectors and levels of governance. I developed a spatial MCDA approach by creating a key-informant led composite vulnerability index and identifying vulnerability hotspots. Overall, the study found a significant alignment in the vulnerability framings of leading organizations operating at the forefront of climate vulnerability management in coastal Bangladesh. However, the NGOs I consulted showed a significant difference in framing, primarily because of the difference in their working domain, mandates and sectoral priority. In essence, for NGO, framing is truly social process that relates to the way individual (or household) interact in social groups. Since vulnerability framing, especially from social science perspective, is embedded in, and part of, social, cultural and political processes, it has the potential to determine certain pathways to climate vulnerability and its response. For this reason, stakeholders engaged in managing vulnerability are able to reflect on preconceived framing and engaged in the development of shared framing of vulnerability.

Most of the organizations, irrespective of sectors or levels, acknowledge the importance of infrastructure and agriculture in reducing vulnerability in the region. Such similar understanding of the organizations would minimize resistance in decision making, actuate information and resource flow, and thus be facilitative to efficient adaptation governance across coastal areas. I also observed some minor misalignments across the sectors. These mismatches in framing are likely the result of different operational objectives which indicate diversity in understanding and, ultimately, a more complete

governance of adaptation and vulnerability in the region. However, while similar understanding of vulnerability indicate a priority on infrastructural and agricultural criteria, it is probable that other criteria are less emphasized, if not ignored, potentially to the detriment of addressing vulnerability effectively. The implications of such neglect could be demonstrated as a reduction of exposure with no substantial impact on adaptive capacity or sensitivity. The research presented here indicates that it is not enough to have vulnerability assessments and adaptation plans in place; it is also important to evaluate the assumptions about the determinants of vulnerability held by different agencies, and how these assumptions manifest in spatial understanding of vulnerability and adaptation investments. Vulnerability has both subjective and objective dimensions; by making the subjective dimensions explicit, the governance of vulnerability can be made more effective. By investigating the framing of vulnerability across scale, this paper reveals theories, concepts, and approaches as well as their proliferation through professional training and sectoral approaches.

CHAPTER 3

MULTILEVEL GOVERNANCE IN CLIMATE CHANGE ADAPTATION: STRUCTURE, PROCESSES, AND POWER DYNAMICS

3.1. Introduction

Climate change impacts do not maintain territorial jurisdictions and can be observed at multiple levels: global, regional, or local (Wilbanks & Kates 1999, Cash & Moser 2000, Cash et al. 2006, Termeer et al. 2010). Effective and efficient climate response requires engagement of multiple actors in different sectors and at different levels of governance (Adger et al. 2005, Amundsen et al. 2010, Eakin & Patt 2011, Bauer et al. 2012). While the national governments play key roles in country-specific climate adaptation policy and practices, increased participations of local government, civil societies, and NGOs have fostered local level adaptation (Keskitalo 2010, Juhola & Westerhoff 2011, Haque et al. 2015). The constellation of diverse actors and their interactions should facilitate climate change governance but their structure of arrangement and power dynamics can have variable effects on adaptation process (Bulkeley & Moser 2007, Keskitalo 2010, Bauer et al. 2012).

Limited attempts have been made using the concept of multilevel governance (MLG) to understand the influence of actors' structure and interactions in adaptation governance (see Keskitalo 2010, Bates et al. 2013, Fidelman et al. 2013, Verkerk et al. 2015), yet we still have limited evidence on how power dynamics among actors influence the adaptation governance process, particularly in the context of Global South (but see Bisaro et al. 2010, Di Gregorio et al. 2019). Furthermore, there has been a limited

emphasis in MLG research on how interactions among actors affect the structure of the adaptation governance. With a particular focus on adaptation to coastal flooding in Bangladesh, this study aims to address these limitations by analyzing the structure of organizational network in adaptation governance and the interactions through which power dynamics unfold and affect the adaptation governance processes.

This research contributes to the existing literature of climate adaptation in at least three ways. First, it uses a novel social network analysis approach to identify the influence of different organizations in the adaptation governance process based on their collaboration and cooperation networks. Second, it explores the nature of organizational interactions in large-scale adaptation actions in Bangladesh. Third, by analyzing the power relations, it examines how organizational power dynamics affect the adaptation governance process. In the next section, I first provide a background of the two concepts I am operationalizing for analysis- MLG and power (section 2). I then present our hypotheses on which I conduct our analysis (section 3). Next I discuss our research methods in section 4. I report our results on the structure and processes of adaptation governance in the following section. I conclude with a discussion on the policy implications and suggestions.

3.2. Conceptual Background

3.2.1. Multilevel governance

3.2.1.1. Conceptual clarification

I define MLG as a decision-making arrangement that involves a multiplicity of interdependent public and private actors operating at

multiple territorial or political levels in which decision-making power is dispersed along the vertical and horizontal interactions of actors (Marks 1993). The fundamental notion of MLG is that decision making takes place in a pluralistic and highly dispersed policy-making milieu, where multiple actors participate at various political levels from supranational to sub-national or local (Stephenson 2013). MLG describes different roles of actors operating at different political and/or jurisdictional levels (Peters & Pierre 2001). Globalization and associated social mobilization have enabled participation of multiple actors in governance and enhanced inter-sectoral cooperation throughout the world (Alcantara et al. 2015). For this reason, despite its conception in the European milieu, MLG concept has been used to analyze the institutional and policy dynamics of multi-actor governance arrangements in other parts of the world as well. However, before directly applying the MLG concept to any multi-actor governance context, three critiques of MLG must be addressed pertaining to the a) inclusion/exclusion of specific actors in MLG, b) lack of attention to process in MLG, and c) boundaries of MLG.

As the MLG was first conceptualized in a context where a supranational actor, the EU, was dominant, it was implicit that the presence of a supranational actor would be required to analyze MLG. However, more recent conceptual applications relaxed the supranational requirement and applied the MLG concept to settings as diverse as federations, international cooperation, and unitary states (Tortola 2017).

On the other hand, the role of non-state actors has been treated as equal or subordinate to state actors (Bruszt 2008, Piattoni 2010). Furthermore, it has been argued that the MLG concept puts too much focus on the structure of the multi-actor network and little attention towards the interrelationships and power relations (Bache 2008). There are some studies that address both structures and processes of MLG networks (Tortola 2017) but the analysis of power relations has been limited. However, determining the boundary of governance is tricky because there is a difference between engagement and influence, between a seat at the table and a real voice in crafting policy (Bache 2008, Norman and Bakker 2009). MLG takes an inclusive approach in defining governance by incorporating multi-level actors that interact across and around formal structures of representative government in decision making processes (Klijn and Skelcher 2007). Notably, decision making processes comprise not only of policy formulation or coordination processes, but also implementation, monitoring, and evaluation processes. As such, MLG doesn't have to involve a full and sustained relationship among all actors throughout the decision making process, the interrelationships can be active or latent at different stages of decision making process (Alcantara et al. 2015).

The interactions of actors in a MLG structure can be dictated by the nature of the multi-actor network. Empirical evidence suggests that a closed nature of the network, in which the interactions are mostly limited

among certain actors, facilitates cooperation and collaboration, while an open nature, in which interactions take place among all or most of the actors in a network, indicates knowledge and resource sharing (Berardo & Scholz 2010, Lubell et al. 2014). For instance, Hileman & Lubell (2018) found that the multilevel water governance network in Central America balances the local level collaboration represented by closed network with regional level knowledge sharing represented by open network. The nature of the network does not relate to particular type of MLG, rather they can be embedded in any type.

3.2.1.2. MLG in climate adaptation

Climate adaptation studies have used the MLG concept to explain and examine the structure and processes of the multi-actor networks involved in adaptation management. Although Betsill and Bulkeley (2006), Bulkeley and Betsill (2005), and Lee and Koski (2015) used MLG concept in climate change governance to explore the roles of sub-national actors in climate policy response processes, the use of MLG concept specifically focusing on climate adaptation began with the work of Keskitalo (2010). Keskitalo (2010) showed that MLG can be embedded in the existing governance structure, be it centralized or decentralized. More recently, Verkerk et al. (2015) argued that MLG in climate adaptation is characterized by a discontinuous chain of actions, and it is strengthened by instances of synchronization among multiple actors. However, Fidelman et

al. (2013) found that episodic and task-specific ideas about MLG are not sufficient to govern a response to a complex, multi-sectoral issue like climate adaptation. Instead, more stable, continuous, and inclusive interactions among the actors can provide more effective outcomes. In general, these studies have found that non-government and private actors also play significant roles in adaptation management, but the governmental organizations are at the vanguard. While these studies demonstrate how organizations are embedded in MLG networks, they lack analysis of power dynamics in the network and their implications for decision making. Also, more evidence on MLG in different political and social contexts is needed (Blom-Hansen 2005, Di Gregorio 2019); in general, the existing set of MLG-related climate adaptation studies lack evidence from climate-vulnerable Global South, where institutional arrangements can also be fragmented or fragile depending on the economic and political context. In this study, focusing on a case from Global South I used the MLG concept to understand the structure and processes of adaptation governance.

3.2.2. Power

In this study, power is defined as the organizational and discursive capacity to achieve outcomes in social practices (Arts & Tatenhove 2004). Insights into the sources and dimensions of power can help evaluate the mechanisms of adaptation governance (Crona and Bodin 2010, Duit et al. 2010)

and assess the performance of governance (Hayward & Lukes 2008).

Understanding which actor is more powerful than others, and in what ways, can lead to improved policy and institutional design (Sherman & Ford 2014).

The concept of power is long debated and its theorization and operationalization are essentially contested (Lukes 1974, Baldwin 2002, Avelino & Rotmas 2011, Boonstra 2016). In this paper, I adopted the conceptualization of power developed by Arts & van Tatenhove (2004) as an effective way to analyze the power dynamics in multilevel adaptation governance where power can be observed in the interactions among actors, in actors' capacities, and in the structure of the multi-actor network. Building from earlier theorizations (i.e. Weber 1978, Giddens 1984, Clegg 1989), Arts & van Tatenhove (2004) converge the dichotomy of actor-centered and structure-centered conceptualizations of power. Based on their conceptualization, I adopted two types of power: *dispositional* and *structural* to analyze our case (Table 1). *Dispositional* power indicates actor's capacity to act using the resources it possesses and abiding by the institutional rules. This power can be invoked from material and ideational sources. Material sources primarily represent financial capacity and human resources, while ideational sources include knowledge, ideas, and information (Fuchs & Glaab 2011, Orsini 2013). For instance, in Nepal, the non-state actors used their material resources to arrange a converging space (i.e. meeting) for all stakeholders in preparation of the local adaptation plan of actions (Vij et al. 2018), however, experts and consultants often used ideational sources (i.e. knowledge) to dominate the policy processes and demoted the affected citizens

(Ojha et al. 2016, Vij et al. 2018). *Structural* power is a macro-level phenomenon that shapes the nature and behavior of actors through order of significance, legitimization, legal means, and economic institutions, and can be characterized as authority. Authority can be defined as the perceived legitimized exercise of power by a certain actor to influence other actors or their interactions (Sikor & Lund 2009, Eriksen et al. 2015). For example, in a centralized regime, the structure of governance gives maximum authority to the central (i.e. national level) actors, enabling them to exercise power over other actors (Pahl-Wostl and Knieper 2014). Notably, dispositional and structural power can be intrinsically embroiled and, in an instance of interaction among actors, both of them can be wielded together (see Table 3.1).

Table 3.1: Conceptualization of power in this study.

Type of power	Representative form	Example
Dispositional	Material	A uses its financial or infrastructural capacity to influence the decision-making process that involves B.
	Ideational	A uses its knowledge or information to influence the decision-making process that involves B.
Structural	Authority	A uses legally/legitimately acquired/given power to influence B or the decision-making process that involves B.

3.3. Research Hypotheses

To analyze the adaptation governance in Bangladesh, I formulated the following four hypotheses to test. In Bangladesh, the public sector's administrative structure is broadly divided into three levels: national, district, and sub-district. The sub-district (local name: *upazilla*) level is considered as the local level and together with district level, they

are treated as subnational level. Our first two hypotheses are based on the nature of the governance network: closed network helps facilitate cooperation, while open network may help knowledge sharing and resource distribution (Berardo & Scholz 2010, Lubell et al. 2014, Hileman & Lubell 2018).

H1: The subnational level adaptation governance is driven by cooperation and collaboration, and thus will show higher clustering.

H2: The national level adaptation governance is dominated by knowledge and resource sharing, and thus will show higher degree and between centralities.

The third hypothesis is informed by empirical evidence from natural resource governance: a densely interlinked and highly central actor will likely have higher influence over the network than actors who are peripheral or less densely linked (Yamaki 2017, Blanc et al. 2018). The last hypothesis is based on the classic MLG theory (Hooghe & Marks 2001, 2003).

H3: The national level organizations have higher influence than the subnational level organizations over the adaptation governance, as evidenced by the centrality measures and core/periphery analysis.

H4: The adaptation governance is dominated by top-down governance as evidenced by the distribution of authority top to down in few levels of governance.

3.4. Methods

3.4.1. Selection of organizations and data collection

I identified the organizations associated with adaptation governance process through an online search and snowball sampling. Our network context was coastal areas and our network boundary was initially open so that I could include as many organizations as possible. I began our selection process by identifying the government organizations from the websites of sectoral ministries (e.g. agriculture, water resource). After reviewing the functions and activities of the organizations, I selected only those organizations whose mandates include adaptation to flood in coastal areas. From the websites of each of these organizations I identified their partners and thus expanded our network. In order to obtain the directionality of partnership I reviewed the websites of those partner organizations as well. At this stage I identified 19 organizations. I used snowball sampling to expand this initial sample. This step was important, because I found that none of the non-governmental organizations' websites contained any information on their partnerships with other organizations. I also recognized that the government organizations' websites might exclude some organizations with whom they work in practice.

I prepared a semi-structured questionnaire and interviewed the key informants in the initial list of organizations with substantial knowledge on that organization's activities and who held enough authority to comment as a representative of that organization. I specifically asked them about their partners

in the adaptation processes: “With which organization/s do you work to plan and implement adaptation actions?” I also asked for the frequency of inter-organization interactions and the main purpose of each interaction. I found that tens of national/local NGOs were working independently in the livelihood sector of adaptation governance without significant partnerships. In the adaptation governance network, they are represented either as isolates (no ties) or pendants (a single tie). These NGOs can have variable influences, but I am concerned about the structure of the governance network which is composed of collaboration and coordination network. For this reason, I removed the isolates from the network and considered all other NGOs as a single node (or organization). Also, I excluded disaster management related organizations as they focus on disaster preparedness and recover, not on adaptation.

Through this process I identified a total of 37 organizations that are involved in the adaptation governance process (Table 3.2). Notably, the subnational level offices of some organizations (i.e. DAE, BWDB, LGED) were considered as separate organizations because these offices had independent decision-making and implementation power. Similarly, for NGOs, I considered their head office, at the national level, and the field office, most often at the sub-district level, as separate nodes due to their independent decision implementation power. To draw the boundary of the governance network, I considered those organizations that are in regular collaboration with each other, and thus disregarded rare collaborations with university departments or short-term committees.

In order to analyze the adaptation governance process, I continued asking the key-informants about the governance measures they undertake.

Table 3.2: Selected organizations and their acronyms

Organization	Acronym	Organization	Acronym
Ministry of Water Resources	MOWR	Ministry of Agriculture	MOA
Ministry of Environment, Forest and Climate Change	MOEFCC	Ministry of Social Welfare	MSW
Ministry of Local Government	LGD	Ministry of Planning	MOP
Bangladesh Water Development Board- National level	BWDB_N	Development Aid Agencies	DAAs
Bangladesh Water Development Board- District level	BWDB_D	Department of Environment	DOE
Bangladesh Water Development Board- Sub-district level	BWDB_SD	River Research Institute	RRI
Local Government Engineering Department- National level	LGED_N	Water Resources Planning Organization	WARPO
Local Government Engineering Department- District level	LGED_D	Bangladesh Agricultural Development Corporation- National level	BADC_N
Local Government Engineering Department- Sub-district level	LGED_SD	Bangladesh Agricultural Development Corporation- District level	BADC_D
Department of Agricultural Extension- National level	DAE_N	Bangladesh Agricultural Research Council	BARC
Department of Agricultural Extension- District level	DAE_D	Bangladesh Agricultural Research Institute	BARI
Department of Agricultural Extension- Sub-district level	DAE_SD	Bangladesh Rice Research Institute	BRRRI
Forest Department- National level	FD_N	Bangladesh Institute of Nuclear Agriculture	BINA
Forest Department- District level	FD_D	Seed Certification Agency	SCA
Forest Department- Sub-district level	FD_SD	Soil Resource Development Institute	SRDI
Institute of Water Modeling	IWM	Center for Environmental and Geographic Information Services	CEGIS
District Administration	DA	Sub-district Administration	SDA
NGOs- National level	NGO_N	International NGOs	INGO
NGOs- Sub-district level	NGO_L	Ministry of Finance	MOF

3.4.2. Social Network Analysis

I used social network analysis (SNA) to analyze the characteristics of the multi-actor governance network. SNA enables the analysis of the interrelationships and interactions among the actors, which they establish through collaboration, coordination, and cooperation. The structural characteristics of the network can provide information about knowledge transfer, resource mobilization, stakeholder diversity, and power asymmetry (Adger 2003, Borgatti & Foster 2003, Bodin et al. 2006).

To address our hypotheses, I used a series of network measures at two levels of governance (national and sub-national): density, mean degree centrality, degree centralization, mean betweenness centrality, and local clustering coefficient (Table 3.3). I used the ‘sna’ and ‘statnet’ package in the R programming environment to undertake the analysis. These measures help us to compare the organizational network at different levels of governance and identify the influential organizations across the network. However, centrality scores are node-based measurements, while the influence of an organization additionally depends on its overall position in the governance structure in addition to its centrality. As such, I conducted a core-periphery analysis and brokerage analysis to complement the centrality analysis.

Table 3.3: Social network measures and their relationships to governance

Network structure measure	Definition	Relationship to governance
Density	Overall connectivity of the network and is measured as the ratio of observed ties to the maximum possible ties.	Higher density facilitates collaboration and builds trust (Ostrom 1990, Burt 2003) but may cause homogenization of knowledge and experience as well (Crona & Bodin 2006).
Degree Centrality	A node-level measure of connection.	Higher degree centrality represents significance of the actor in the governance process through mobilizing resources to action and diffusing information to other stakeholders. A highly central actor must mobilize a lot of energy to maintain connections, as a result, whether the actor can significantly influence others is arguable (Prell et al. 2009).
Degree Centralization	A measure of the extent to which a network is dominated by one or more high-degree nodes.	Higher degree centralization indicates the dominance of few actors in the governance process (Hileman & Lubell 2018). High degree centralization might represent an efficient information transfer and decision making system, but at the same time it can create a centralized governance structure and prohibits innovation and learning (Bodin et al. 2009).
Betweenness Centrality	A node-level measure of the extent to which a node lies in path of other nodes.	Higher betweenness centrality indicates higher bridging capacity. The actor with a high betweenness centrality can have greater influence over the network by controlling the flow of information and resources and facilitating communication (Bodin & Crona 2006, Baggio et al. 2015).
Clustering Coefficient	A network-level measure of the degree to which nodes in a network tend to cluster together.	Higher clustering coefficient indicates high level of cooperation and collaboration in the governance process (Hileman & Lubell 2018).
Eigenvector Centrality	A node-level measure of the degree of influence a node has based on its connections and the number of links those connections have.	Higher eigenvector centrality indicates that the actor is connected to other stakeholders who further have good connections in the governance network. As a result, an actor with high eigenvector centrality has higher reach and influence in the governance process (Barnes-Mauthe et al. 2015).

Core-periphery analysis explores the core and periphery of the network. I conceived the core-periphery structure based on the one-group intuitive conception by Borgatti & Everett (2000). The idea assumes that all the actors in the network largely belong to one group: in our case, the adaptation governance process. The core and periphery of the network is determined by the connection of the actors. A core comprises of densely interlinked actors, which is located at the center of the network, while the peripheral actors have relatively loose connection with the center (Yamaki 2017). I used UCINET software to undertake the core-periphery analysis. I further performed brokerage analysis to understand how these organizations act as ‘middleman’ and control and influence the information flow, knowledge transfer, collaboration opportunities in the network (Burt 2005). The brokers can be categorized into five types based on the position of the broker and the information or resource flow in the network (Gould & Fernandez 1989): liaison, itinerant, coordinator, gatekeeper, and representative (see Table 3.4 and Figure 3.1). I used ‘sna’ package in R to conduct the brokerage analysis.

Table 3.4: Brokerage types and functions

Type of Broker	Function
Liaison	A liaison broker acts as a channel for communication for two different groups to which it does not belong.
Itinerant	An itinerant broker plays more of a consultant role and connects two or more actors who belong to the same group but do not have connections between/among them.
Coordinator	A coordinator broker belongs to the same group to which other actors it connects belong.
Gatekeeper	A gatekeeper broker controls the information or resource flow towards its group from outside group.
Representative	A representative broker is positioned in the network similarly as a gatekeeper, but the representative broker channels the information or resource of its own group to actors outside its group.

Based on the centrality scores and core-periphery analysis, I categorized the influences of the organizations into high, medium, and low. Organizations that have all three centrality scores (i.e. degree, betweenness, eigenvector) greater than the first quartile, act as broker, and belong to the core of the network have high influence over the adaptation governance process. On the other hand, organizations that have all three centrality scores less than the fourth quartile, do not have any brokerage role, and belong to the periphery of the network have low influence. The rest of the organizations have medium influence.

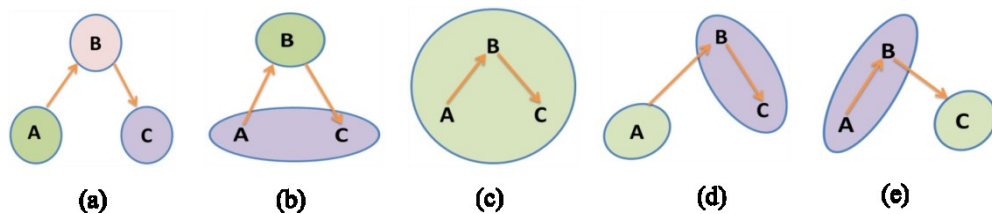


Figure 3.1: Brokerage types in SNA. The node B represents the broker in the network as (a) liaison, (b) itinerant, (c) coordinator, (d) gatekeeper, (e) representative. (Adapted from Gould & Fernandez 1989)

3.5. Results

3.5.1. Structural characteristics of multilevel adaptation governance network

The structural characteristics of multilevel adaptation governance network in Bangladesh comprise of horizontal and vertical interactions among the actors (Fig. 3.2). The SNA led us to reject our first hypothesis (Table 3.5). I found a higher clustering at the national level which indicates a relatively more closed network characterized by greater cooperation and collaboration among the organizations. The SNA supported the second hypothesis (Table 3.5). The mean

degree and betweenness centralities at the national level are greater than the subnational level, indicating a dominance of knowledge and resource sharing at the national level. At the national level, most of the organizations are well connected to each other and interact regularly for planning, implementing, monitoring, and evaluating adaptation actions. However, unless their functions overlap, these interactions are project-specific. I found that these interactions are more formal in nature and follow procedural protocols, while at the sub-national level the interactions are relatively less formal. The sub-national level organization officials sometimes interact informally and cooperate/collaborate without a protocol or paperwork. This discontinuous chain of actions (Verkerk et al. 2015) particularly takes place in case of minor confusions or instances of assistance. For example, in an adaptation project, sub-district level water development and forestry organizations had overlapping jurisdictions and conflict began when they started working at the same time. They finally resolved the conflict through informal interactions. I think such informal interactions among the organizations facilitate the sub-national level governance process rather than restrict it. In addition to the formal exchanges of information, these informal interactions could strengthen the relationship of trust and respect among them. However, other than these instances of ad-hoc informal cooperation, the collaboration among the subnational level organizations are often dictated by the national level organizations.

Table 3.5: Exploratory SNA at the national and sub-national level

Level	Density	Mean Degree Centrality	Mean Betweenness Centrality	Global Clustering Coefficient	Degree centralization
National	0.120	8.39	35.53	0.386	0.206
Sub-national	0.150	5.11	9.39	0.299	0.228
Multilevel	0.140	10.37	56.79	0.362	0.166

The SNA analysis further found that all organizations that have high influence over adaptation governance belong to the national level, and thus supports the third hypothesis (Fig. 3.2). These organizations are in the core part of the network and have varying roles of brokerage (see Appendix 2). The ministries are primarily responsible for coordinating with their associated organizations as well as other organizations outside their sectors. Thus, they act as various types of brokers in different instances. For example, they act as a gatekeeper or representative broker when they connect their associated organizations with other ministries. Again, they act as a coordinator broker when they connect two or more of their associated organizations that would not interact otherwise. Some organizations (e.g. LGED, DAE) under these ministries are responsible for leading the adaptation actions and they act as brokers as well. For example, national level water development organization acts as a liaison broker by connecting a research organization with a development aid agency. Alternatively, it can act as an itinerant broker by transferring information from its subnational level subsidiary to another subnational level organization of a different sector. With high influence over the adaptation governance, these organizations are capable of significantly impacting decision making by exerting authority and

allowing/restricting information, knowledge, and resource flow. Interestingly, the MOEFCC has been treated as a focal ministry for climate change, while I found it has medium influence because of its relatively weaker collaborations and coordination with other organizations. This was also reflected in the adaptation project budget of Bangladesh (2009-15) in which the MOEFCC received less than 0.20 percent of total budget amount (Rahman & Tosun 2018).

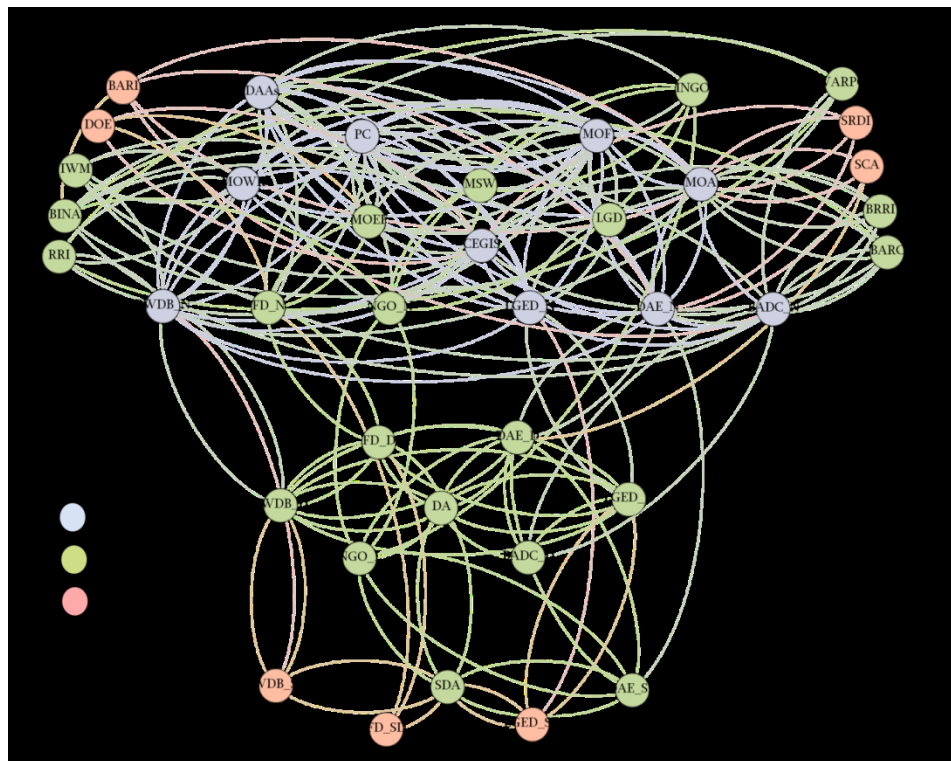


Figure 3.2: Influence of organizations in multilevel adaptation governance network.

The district level organizations have medium influence over the adaptation governance processes. They can affect the governance processes by controlling information or knowledge exchange between national and sub-district levels. The bureaucratic structure of governance allows them to exercise authority over their

sub-district subsidiaries. The sub-district level organizations have medium to low influence over the adaptation governance. Although these organizations remain at the forefront of adaptation management, their actions are often directed and controlled by the district level organizations. Yet, they contain the power to influence the information flow between local level and higher levels of governance, as they deal with the local beneficiaries.

3.5.2. Multilevel adaptation governance processes

In the multi-actor networked polity of adaptation governance in Bangladesh, I identified five types of organizations based on their influence, functions, and roles: key, funding, bridging, supporting, and frontier organization (Fig. 3.3). *Key organizations* play a lead role in managing the adaptation actions: from conceiving the plan to implementing to monitoring and evaluating, and are often termed as ‘implementing organizations’. They are generally associated with a ministry and can operate at national and/or subnational level/s of governance. *Frontier organizations* operate at the subnational level and often act as the representative of national level organizations to the local stakeholders. In most cases, they are the local subsidiaries of the key organizations. *Supporting organizations* contribute to the adaptation management through providing information, knowledge, or other forms of resources. They mostly operate at the national level of governance and aid in the adaptation project by conducting impact assessments, modeling human/environment system, and carrying out

research. For instance, BIRRI conducts research on flood tolerant rice varieties and assists DAE in agricultural adaptation projects. *Bridging organizations* primarily act as coordination platforms. Operating at national or subnational levels of governance, these organizations create a converging space where all involved organizations interact together. The Planning Commission under the MOP, as an example, arranges project evaluation meetings during adaptation planning where all involved organizations meet together and discuss the strengths and weaknesses of a project. *Funding organizations* are responsible for evaluating the adaptation budget, allocating the funding sources, and managing the financial aspects of the project. They usually operate at the highest level of governance. For example, the MOF and the ECNEC (Executive Committee of the National Economic Council, the country's highest economic policy making body headed by the Prime Minister) take the final decision on all government funded adaptation projects. Notably, some organizations can belong to two or more types depending on adaptation phases or projects. For instance, FD_N can act as both key organization and frontier organization at different stages of adaptation project. In the following sub-sections, I will portray how power dynamics emerges through the interactions of these five types of organizations in three phases of adaptation, drawing from how the organizations described their activities and relationships in adaptation governance. I classify the phases of adaptation as planning, implementation, and monitoring and evaluation (Moser & Ekstrom 2010).

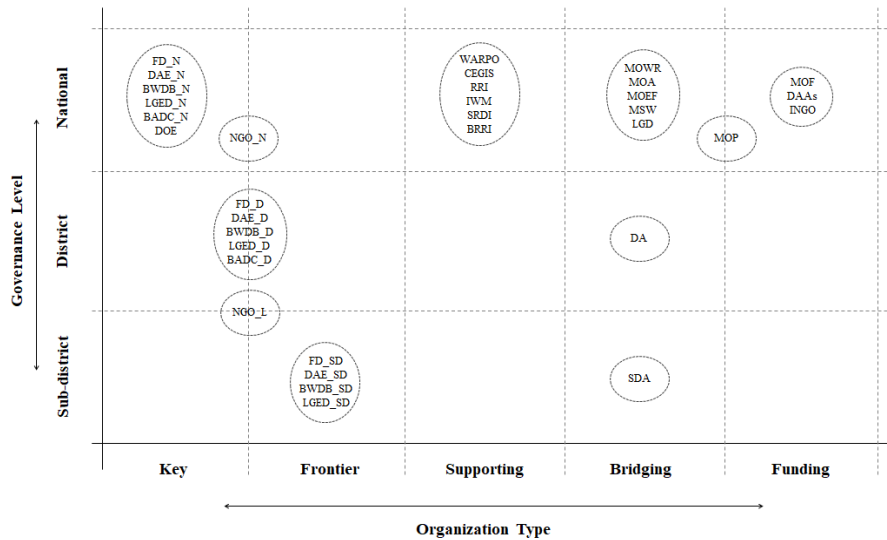


Figure 3.3: Organization type and their operation at different levels of governance (see Table 3.2 for acronyms)

3.5.2.1. Adaptation Planning

The climate adaptation planning process begins with the conception of an adaptation project usually by a national level key organization. Using material resources (i.e. funding) and authority, a key organization exercises power over frontier organizations to collect data on local priorities. The frontier organizations utilize their ideational resources (i.e. information/ knowledge) to shape the objectives of the adaptation project. As an illustration, the local level engineering department assists the national level offices in preparing an adaptation plan by obtaining information on potential significance and locations of disaster shelters. However, the exercise of power by frontier organizations is at times

influenced by elite perceptions and local politics. A respondent from a frontier organization commented: *'the sub-district administration is like a king here and the king knows better what is good for their subjects (i.e. local people) than the subject themselves'*. With such elite perceptions, these frontier organizations may not always choose to consult with local beneficiaries, instead select convenient information to transfer to key organizations. Furthermore, local politicians and elite people often successfully lobby for selecting their ruling areas for adaptation projects. Saha (2017), for instance, found that in the island areas participation of vulnerable populations in adaptation planning is curtailed by the close connection between local elites/ larger peasant farmers and frontier organization officials.

To buttress this local-level needs assessment, the supporting organizations use their ideational resources such as downscaled climate projections or impact analysis. In this process, the key organization can use structural power and material resources to mobilize the supporting organizations. To illustrate, the national level water organization can seek a downscaled climate projection from a research organization (i.e. RRI) in an adaptation plan on embankments. With these ideational supports from the frontier and supporting organizations, the key organizations formulate adaptation project proposals. However, in certain instances, by providing material resources the funding organizations exert authority over supporting organizations, requesting the development of ideational

resources through research and innovations. Later, supporting organizations can exercise structural power over key organizations to formulate new adaptation plans based on their research findings or innovations. For instance, Bangladesh's national-level agriculture organization formulates new plans to distribute BRRI's newly invented flood-tolerant seed varieties to coastal farmers.

The national-level bridging organizations use their structural power to evaluate the project proposals. Line ministries, for example, evaluate a study proposal to examine whether it is aligned with Bangladesh's Five Year Plan or other long-term plans, and hold the authority to recommend a revision or rejection. Also, the Planning Commission under the MOP looks into possible redundancies of a project, such as overlapping functions or geographical coverage, as well as project feasibility, and budgetary requirements. Furthermore, by arranging meetings, the bridging organizations create a converging space of interactions for all involved organizations. However, these bridging organizations often fail to exert enough authority to bring all involved stakeholders together, as evidenced by a respondent's comment: '*... even many important organizations, such as Ministry of Finance, do not attend many project evaluation meetings*'. In practice, these bridging organizations also do not always exercise their power of approval. For example, the Planning Commission does not reject even one percent of the proposals they receive because the key and funding organizations

informally reach an understanding beforehand. In this way, as a result of the power exercised by key and financial organizations, bridging organizations are left with little power to wield and often no effective means to coordinate among all involved organizations take place.

In sum, the adaptation planning process in Bangladesh is inclusive in nature and ensures participation of all types of organizations, yet the contribution of the supporting and bridging organizations are subordinate (Fig. 3.4). The key and frontier organizations take leadership by exerting their dispositional and structural power. Although the funding organizations operate at the highest level of governance, their participation in the overall planning process has not been observed much. The fusion of top-down process, influenced by authority and material resources, and bottom-up process, dominated by authority and ideational resources, seems to exemplify a well-crafted adaptation planning, but the minimal exercise of power by the bridging and supporting organizations and elite perception of frontier organizations are concerning. As a result of the subordinate roles of these organizations, their efforts to communicate local needs could be undermined and important local knowledge could be overlooked in the planning process.

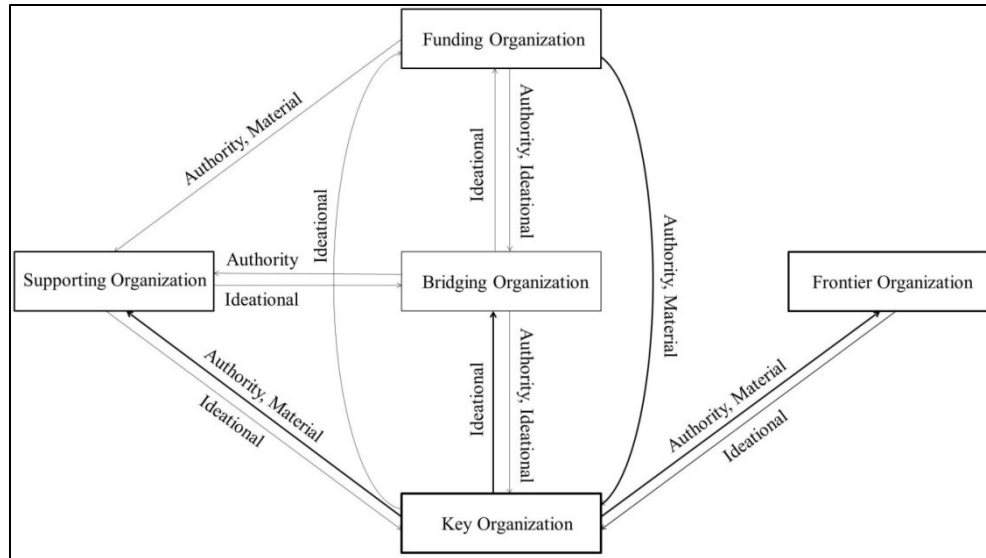


Figure 3.4: Power dynamics in adaptation planning process.

3.5.2.2. Adaptation Implementation

In the adaptation implementation processes in Bangladesh the key organizations mobilize the frontier organizations through exerting structural power and providing material support. Both of these organizations connect to local stakeholders by arranging workshops, trainings, demonstration in an adaptation project. For instance, in agricultural sector, Department of Agriculture Extension arranges demonstration and training programs to provide newly invented flood-tolerant seed varieties to the farmers. In contrast, in the water resource or infrastructure sector, involvement with local beneficiaries is minimal. In this sector, project implementation is outsourced through online bidding and the key and frontier organizations are responsible only for supervision and monitoring. However, interviewees reported that key and frontier

organizations often fail to conduct background checks and involved in corruption with the contractors. As such, many contractors take multiple projects in overlapping time periods and fail to complete any project in time. For example, in 2017, more than 160 thousands of hectares of cropland in northeast Bangladesh were inundated by flash floods due to incompleteness and corruption in an embankment project.

These key and frontier organizations can wield structural power over the bridging organizations to meet various needs. For example, water development board can ask the district administration or the Ministry of Land to acquire lands for the purpose of a project. However, the bridging organizations can also exert structural powers over key and frontier organizations by creating coordination platforms and acting as adjudicators. For instance, the district and sub-district administrations arrange a bi-monthly coordination meeting which serves as the only formal sub-national platform to coordinate among the adaptation implementing organizations. This meeting allows the discussion of what other organizations require from an organization in implementation and is used to resolve confusions, conflicts, misunderstandings among organizations, if any.

Overall, the key organizations hold relatively more dispositional and structural power, which makes them the most significant actor in the adaptation implementation process. These key organizations mostly operate at the national level and the asymmetry denotes a centralized top-

down governance process, although this might not be readily observable. This subtle polarization of power impairs the implementation process as the frontier organizations cannot take independent decisions in case of emergencies, or if the implementation process requires sudden alteration. As an illustration, in an event of embankment breach, the subnational level organizations cannot repair the embankment without getting permission from national level organizations. While such rigidity facilitates the implementation process, the crisis management capacities of these organizations remain low. This overall power dynamics is represented in Fig. 3.5.

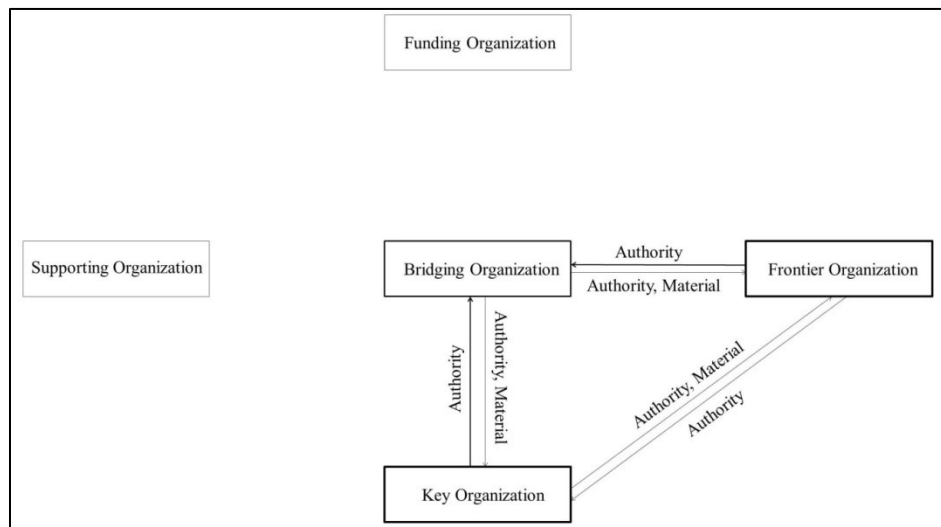


Figure 3.5: Power dynamics in adaptation implementation process

3.5.2.3. Adaptation Monitoring and Evaluation

The monitoring and evaluation (M&E) of adaptation progress in Bangladesh is conducted at multiple levels of governance primarily with

two approaches: onsite and offsite. The onsite approach is a direct form of M&E: the organization sends its team to the field site. In contrast, the offsite approach follows a hierarchical bureaucratic system of M&E: the national level organization collects information from subnational level organizations. Through the offsite M&E system, the key organizations provide material resources and wield structural power over frontier organizations for monitoring and evaluation. As such, by generating weekly or bi-weekly progress report, frontier organizations can only use ideational resources to exercise power in the process. For instance, the sub-district level organizations provide the district level organizations with weekly updates on the implementation progress. As unsatisfactory progress can lead to financial restrictions and authoritative pressure from higher level organizations, it is probable that the frontier organizations can cherry-pick the positive information. Notably, whether an adaptation project progress is ‘satisfactory’ is determined primarily by frontier organizations or district level key organizations. As such, by allowing or restricting progress information they conserve more power than others. Their report hierarchically goes upward to funding organizations. Because the offsite M&E follows a bureaucratic bottom-up process, the higher level organizations always hold the structural power to penalize the hierarchically subordinate organizations, if adaptation progress is unsatisfactory. For instance, if the progress is not satisfactory, the Implementation Monitoring and Evaluation Division (IMED), under the

MOP, takes various steps ranging from notifying the key organizations to restricting the fund disbursement for the next financial year.

Under the onsite M&E system, key and funding organizations use their material resources (i.e. inspection teams) to obtain progress information. In addition, they sometimes use citizen science to collect information. The World Bank, for example, gives away \$100 phones to the highly respected community people in the adaptation project areas as a part of the M&E process so that these people can contribute in monitoring by sending pictures and short messages. However, the key and funding organizations cannot take an onsite M&E approach for all projects because of human resource constraints. For instance, IMED randomly selects 10 projects in a financial year to conduct onsite M&E and for the rest they rely on offsite M&E. Such overreliance on the offsite approach provides the frontier organizations with more power to wield in the M&E process.

Overall, the exercise of power in the adaptation M&E process in Bangladesh is dominated by the use of ideational sources of power and the exercise of authority (Fig. 3.6). Although the combination of both onsite and offsite approaches appears to enhance the efficiency of the adaptation M&E process, the offsite approach remains dominant in the M&E process. Because of the reliance on offsite M&E approach, the participation of local stakeholders is limited and ensured mostly through the frontier organizations. Furthermore, the supporting organizations are kept outside the M&E process. As these organizations conduct research on climate

change impacts, without their participation in the M&E process the information on effectiveness of adaptation actions may remain incomplete. I think that such exclusion of local stakeholders and supporting organizations may mar the success of adaptation.

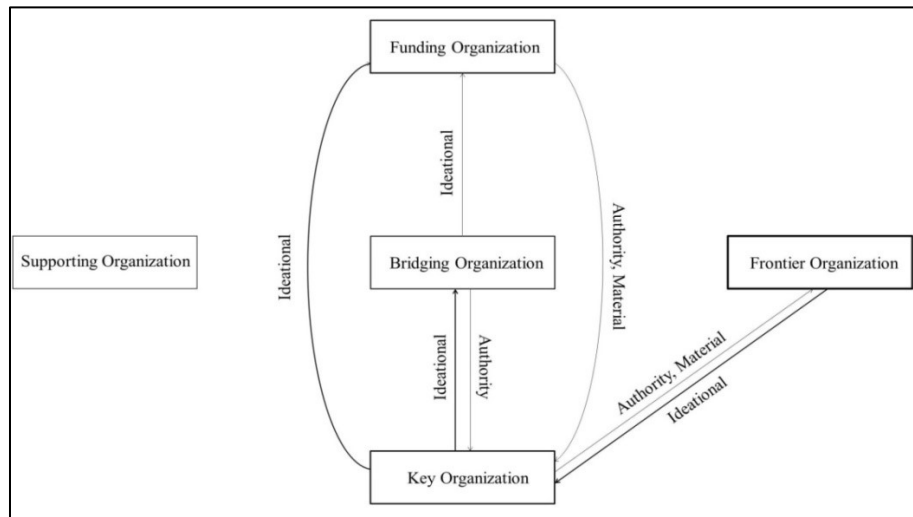


Figure 3.6: Power dynamics in adaptation monitoring and evaluation process

3.6. Discussion

All adaptation takes place in political context where actors struggle, contest, and negotiate to meet their interests (Eriksen et al. 2015). The first step of addressing the power dynamics in adaptation governance processes is to understanding how power is being unfolded through the interactions among the actors (Bulkeley 2012, Nightingale 2017). Power asymmetries will always exist among actors in governance; while complete parity in participation and decision-making influence is unlikely and perhaps undesirable,

it is important to make visible the nature of inequality and evaluate how it affects decision processes and outcomes. Attention to power, authority and decision-making is particularly important in adaptation given that the outcomes of adaptation governance are unlikely to be sustainable if they do not address the needs of the most vulnerable (Eriksen et al. 2011). The wide range of power inequalities in multilevel adaptation governance in Bangladesh lie within the bureaucratic structure of governance (Rahman & Tosun 2018).

The adaptation governance structure and processes in Bangladesh indicate a relatively centralized governance system and thus support *H4*. The power of decision-making is variably dispersed at multiple levels of governance, but a small number of national level actors are dominant in the adaptation process. The governance includes both top-down and bottom-up processes at different phases of adaptation, yet the key decision-making power rests with the some national level actors. Evidence across the world suggests that such relative centralization of adaptation governance is *Janus-faced*. On one hand, it can facilitate better coordination and as a result prevent overlapping authorities, conflicting responsibilities, and duplicating functions (Termeer et al. 2010, Gillard et al. 2017). For example, in England, national government-driven top-down structure of adaptation governance mobilized actors at different levels without any significant duplicity or conflict in adaptation actions (Tompkins et al. 2010). On the other hand, it might prohibit experimental learning, trust building, collaborative management and disregards local priorities and context sensitivities (Ostrom 2010, Jordan et al. 2015). For instance, a centralized adaptation planning system in Western Norway limits stakeholder collaboration and fails to make adaptation a salient issue at local level (Dannevig & Aall 2015). Empirical and experimental evidence support that the

disadvantages of such centralization outweigh its advantages (i.e. Cole 2015, Ojha et al. 2015, Nightingale 2017, Sova et al. 2017). I found similar scenario in Bangladesh as well.

The structure of multilevel adaptation governance in Bangladesh gives abundant authority to the national level key organizations in all phases of adaptation process. The bridging and supporting organizations, on the other hand, wield relatively little power. Despite actively participating in different phases of adaptation, the frontier organizations mostly follow orders or instructions and have few opportunities to initiate new ventures. This relative centralization of power falls between the *elite-centered* and *pluralistic* orientations. In an elite-centered structure, a small subset of actors holds most power and exerts disproportionate influence on governance (Mills 1956, Dahl 1958), while in a pluralistic structure, power is distributed among various groups in the society with some groups have more influence than others on certain issues. While in the Global South, climate adaptation governance is often elite-centered (i.e. Ojha et al. 2015, Vedeld et al. 2016, Sova et al. 2017), I think in Bangladesh, climate adaptation governance is similar to *elite pluralism*- in which power is dispersed among several actors, yet a few actors contain more power than others (Dahl 1982). In an elite pluralistic governance milieu, as demonstrated in Indonesia (Di Gregorio et al. 2019), Lesotho (Bisaro et al. 2010), and in our case, power is variably distributed among multiple levels of governance but some national level organizations, in most cases the sectoral leading organizations, influence the overall adaptation governance process the most.

The elite pluralistic nature of adaptation governance in Bangladesh can have serious implications. First, due to the powering of key organizations and elite-perceptions

of frontier organizations, sufficient participation of community people in determining local vulnerabilities and prioritizing adaptation actions might not be ensured and the adaptive capacity of local communities may remain unaddressed in national interventions (Khan & Rahman 2007). Second, integration of local or indigenous knowledge in adaptation planning is likely to be limited because of insignificant participation of local people through the frontier organizations (Haque et al. 2015). In the recent past, a disregard of indigenous knowledge (i.e. Tidal River Management) in flood management brought disastrous impacts in southwest Bangladesh. Flood prevention measures (i.e. sluice gate, embankment) ultimately created long-term water logging in many regions (see Islam & Kibria 2006, Ishtiaque et al. 2017). Third, the emergency management capacity of frontier organizations is also likely to be low because of the relative centralization of power. For instance, I found that in an event of embankment breached flooding, it takes at least two weeks to repair the embankment because frontier organizations lack power to act independently of central organizations. Similarly, in central Mexico, centralization of water resource management impedes proactive decision-making by municipal actors to release dam water to prevent flooding (Eakin et al. 2010). Fourth, it is likely that the success of any adaptation will not be disseminated because the supporting organizations participate only in adaptation planning. The evaluation of success requires more than mere information on physical progress of the adaptation actions but rather consideration of how adaptations are addressing the local socio-ecological complexities, feedbacks, and future changes (Adger et al. 2005, Eriksen et al. 2011, Fazey et al. 2016). This form of assessment may be best conducted by supporting organizations with research capacities. Lastly, the bridging organizations may not play an

effective role as adjudicators or evaluators. For example, the district administration often fails to resolve the conflict between engineering department and water board over overlapping jurisdictions, and line ministries of respective organizations need to intervene. In the case of the Planning Commission, adaptation project evaluation becomes a mere formality. Less than one percent of planning proposals submitted to them are rejected.

To alter the elite-pluralistic nature of adaptation governance and build a more collaborative, pluralistic environment, Bangladesh government has to address at least two issues: power dispersion to certain organizations and creation of an operating space for collaboration and coordination. The frontier organizations should be given more dispositional and structural power to manage emergency situations and the supporting organizations should have the power to independently evaluate the adaptation progress and outcome. The capacities of these organizations need to be enhanced as well to wield the given power. Also, the government needs to create an operating space where stakeholders can continuously interact. Unlike a coordination platform, interactions in the operating space will not require existence of a bridging organization instead the stakeholders can directly communicate with each other. In this way, an operating space for collaboration and coordination would facilitate trust building among stakeholders and prevent elite-capture. For example, elite-capture by the local influential people and frontier organizations in an aquaculture system in Bangladesh, the funding organization mobilized the key and frontier organizations and local stakeholders to increase representation and accountability, and thus effectively stopped elite-capture (Ratner et al. 2013).

3.7. Conclusion

This research analyzes the structure and processes of the multilevel adaptation governance network in Bangladesh. I adopted social network analysis approach to understand the structural characteristics and the concept of power to analyze the power dynamics among the organizations in the MLG processes. I identified that a few national level organizations have higher influence over the governance process than the sub-national level organizations. I further found that adaptation governance in Bangladesh is elite pluralistic in nature, as demonstrated as a relative centralization of power at the national level. The relative centralization of power may cause persistence of organizational conflicts, low local level organizational capacity, and disconnect with local beneficiaries. I think a more equitable redistribution of power and emphasis on coordination/collaboration will have a positive effect on the adaptation governance process, but at the same time we need more evidential research on the effect of power dynamics on adaptation outcomes.

CHAPTER 4

MECHANISM-BASED ANALYSIS OF BARRIERS TO ADAPTATION

GOVERNANCE

4.1. Introduction

The multidimensional nature and cross-scale impacts of climate change require a concerted effort from different actors operating at multiple levels of governance to adapt to changes (Gibson 2000, Cash & Moser 2000, Cash et al. 2006, Termeer et al. 2010). Through continuous or instance-based interactions, these actors often form a multilevel network of governance to manage the adaptation actions (Bulkeley & Moser 2007, Keskitalo 2010, Bauer et al. 2012). Multilevel governance to adaptation to climate change is characterized by the ambitions, preferences, responsibilities, and resources of the actors (Ford et al. 2013, Termeer et al. 2013, Vink et al. 2013) and, because of discrepancies in these attributes among actors, numerous challenges may surface in the process of interactions, impairing the adaptation governance process (Amundsen et al. 2010, Juhola 2016). These challenges are popularly known as *barriers to adaptation*. Synonymously termed as ‘hindrances’ or ‘constraints’ or ‘impasses’ in the literature, barriers can generally be defined as obstacles or challenges that can impede the governance process of planning, implementing, and monitoring the adaptation actions (Moser & Ekstrom 2010, Jones & Boyd 2011, Eisenack et al. 2014).

Research on barriers in adaptation literature is quite new but already prevalent (for a detailed list of literature, see Moser & Ekstrom 2010, Biesbroek et al. 2013, Eisenack et al. 2014). Collectively, the objectives of this body of research has tended to emphasize a need to inventory the range of barriers at play, with broad, if not vague,

suggestions on how to overcome them (Biesbroek et al. 2014). Although these studies are useful as starting points in documenting what type of barriers might emerge at different phases of the adaptation process, they are often not useful enough to understand how or why they emerge in the first place. Without an understanding of the processes that cause the emergence of the barriers, a mere listing of barriers reduces complex and highly dynamic decision making into simplified, static, and metaphorical statements about why current outcomes are ‘incorrect’ (Biesbroek et al. 2015). Furthermore, unless what causes the barriers to emerge in the governance process is known, addressing or overcoming the barriers may become hard. As such, several researchers encouraged to abandon the so called ‘barrier approach’ and instead examine the underlying mechanisms that are involved in the emergence of barriers in the adaptation governance process (Biesbroek et al. 2014, 2015, Wellstead et al. 2018).

Mechanism-based explanation is not uncommon in social science disciplines (Norkus 2005, Hedström & Ylikoski 2010). Scholars used this approach to understand what processes are involved that produce a certain outcome of interest. For instance, if X (variable/factor) produces Y (outcome), a mechanism-based analysis would go beyond investigating the correlation and examine the causation instead: how or why X produces Y. Introducing this approach of analysis in barriers to adaptation research, Biesbroek et al. (2014) identified three mechanisms that caused barriers in an adaptation project in the Netherlands. In a similar venture, Sieber et al. (2018) explained six mechanisms in five ecosystem-based adaptation cases in Thailand and the Netherlands. While these mechanism-based analyses help us to understand why, and under what context, these barriers come into play, more evidence from different adaptation contexts are required to

have a better understanding on the variety of mechanisms and to devise adaptation strategies considering those mechanisms (Biesbroek et al. 2014, Sieber et al. 2018).

In this study, we seek to analyze the underlying mechanisms that cause the barriers to emerge in the adaptation governance process in Bangladesh by asking the following question: *What are the mechanisms that can explain the emergence of barriers in the adaptation governance process in Bangladesh?* Because of increased risk of flooding due to climate change, we limit ourselves only to the barriers to adaptation in flood management sector. We drew from key-informant interview data, and utilized systematic literature review and content analysis techniques to conduct this research. By analyzing the mechanisms involved in barriers to adaptation governance in Bangladesh, this research aims to contribute to understanding of adaptation governance barriers in two ways. First, it intends to provide mechanism-based evidence for adaptation to flood context which will be useful not only to the decision-makers in Bangladesh but also to others interested in Global South or flood hazard contexts. Second, this research adopts an approach to analysis that is novel in barriers to adaptation literature. This approach of analysis will help in considering multiple cases together and to provide a more general statement about the mechanisms.

4.2. Conceptual background

The definition of ‘mechanism’ is heavily debated by social scientists. A list of definitions assembled by Mahoney (2001) represented 24 different definitions of mechanisms by 21 authors. With these definitions the ‘mechanism’ term could be applied to explicate a variety of phenomena ranging from cognitive processes, such as rational

choice, to societal change processes, such as French Revolution (Mayntz 2004). Some of these definitions view a mechanism as a variable(s) that explains why a correlation exists between two other variables (i.e. Hedström & Swedberg 1998), while some view it as a mid-level theory that is recurrent and easily recognizable (i.e. Elster 1998). However, these definitions fail to go beyond assumptions of correlation and typically do not take isolated or unobserved phenomena that could come into play in causal effects into account (Mahoney 2001). For instance, by defining mechanisms as ‘*frequently occurring and easily recognizable* causal patterns that are triggered under generally unknown conditions or with indeterminate consequences’, Elster (1998) asserted the correlational assumptions. Going beyond this correlational approach, in our study, mechanisms are defined as unobserved but empirically traceable processes that act as causes in generating the outcome of interest and explain how and/or why one thing leads to another (Mahoney 2001, Anderson et al. 2006, Biesbroek et al. 2017). As per this definition, mechanisms are posited relations or processes that when they operate, they produce an outcome of interest. This definition indicates that mechanism can exist in dormancy, but in favorable context it can be triggered and generate an outcome of interest (Mahoney 2001).

Although it is arguable, many suggest that mechanism-based analysis requires consideration of initial context (Hedström & Swedberg 1998, Pawson 2000, Mahoney 2001, Falleti & Lynch 2009). Contexts or initial conditions are important as they allow us to understand under which conditions some mechanisms are initiated and produce certain outcomes (Pawson 2013). Conceiving a mechanism as a *link* between cause (or input) and effect (or outcome), Hedström & Swedberg (1996) introduced the *I–M–O* model. The mechanism *M* explains the processes that leads the initial conditions *I* to produce the

observable outcome *O*. This model explains how mechanisms can cause (un)intended outcomes, but lacks the diagnosis of mechanism itself.

A variety of frameworks have been developed to analyze mechanisms. In this study, we used the widely adopted macro-micro-micro model, or popularly known as the ‘bathtub’ model, to diagnose mechanisms involved in adaptation governance. This model frames mechanisms as nested, multilevel phenomena. Developed by Coleman (1990) this model stipulates that mechanism must be understood by investigating how macro level phenomena (i.e. social norms) influence micro level phenomena (i.e. individual behavior) that generate another micro level phenomena (i.e. individual action) and ultimately affect the macro level phenomena (i.e. structure of social network). Hedström & Swedberg (1998) classified these macro-micro, micro-micro, and micro-macro linkages into three types: situational, action-formation, and transformational mechanisms. Situational mechanisms explain the influence of macro forces on more micro level phenomena. For instance, cultural norms, governance structure, practices influence the policy, perception, opportunities of organizations. Action-formation mechanisms operate solely at micro level and link cognition to behavior. For instance, the policy and perception of organizations may dictate how they will interact or act. Transformational mechanisms specify how micro level factors affect macro level. For example, the interactions among organizations may lead to unintended outcomes like barriers. The macro-micro-micro model can be nested within the mechanism part of the I-M-O model, but at the same time, the I-M-O model can be applied separately to all three mechanisms of the macro-micro-micro model (Mayntz 2004). In this study, we conceptualized the macro-micro-micro model nested within the mechanism part of I-M-O model (see Fig. 4.1).

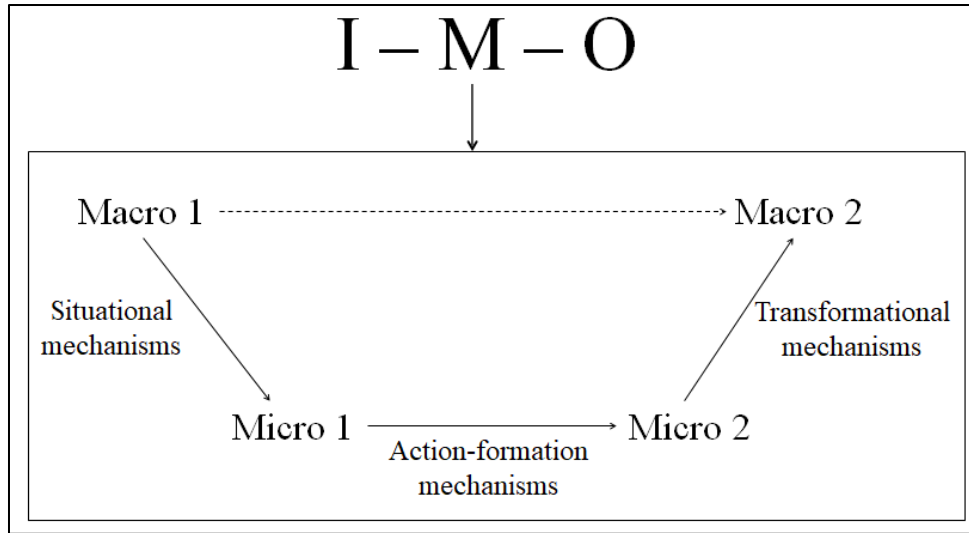


Figure 4.1: Conceptual framework for mechanism-based analysis. I-M-O model represents initial condition or context (I), mechanism (M), and outcome (O). The so-called bathtub model is nested within mechanism (M).

Examining all these three types of mechanisms of macro-micro-micro model in a single study is exhausting and may prevent in-depth analysis (Anderson et al. 2006). As such, in this study, we will examine action-formation mechanisms only. We are interested in analyzing action-formation mechanisms because they elucidate why organizations (inter)act the way they (inter)act. In this mechanism framework, our context or initial condition (*I*) is defined by organizational interactions in the governance of adaptation, and the outcome (*O*) we analyze is the barrier to such interactions. We thus examine the action-formation mechanisms: the mechanisms that form organizational actions that then cause the emergence of barriers. Notably, the purpose of this research is not to invent or define new mechanisms, but instead to explain the emergence of barriers by associating this emergence with mechanisms that have already been identified in the

literature. A thorough review of literature from sociology, political science, and climate change adaptation identified these action-formation mechanisms (Table 4.1).

Table 4.1: Examples of action-formation mechanisms gathered from literature

Mechanisms	Definition
Belief-formation	It states that the numbers of individuals who perform a certain act signal to others the likely value or necessity of the act, and this signal will influence other individuals' choice of action (Hedstrom & Swedberg 1996).
Organizational inertia	It is the tendency of a mature organization to continue on its current trajectory (Gilbert 2005). This inertia can be described as being made up of two elements -- resource rigidity and routine rigidity. Resource rigidity stems from an unwillingness to invest, while routine rigidity stems from an inability to change the patterns and logic that underlie those investments. Resource rigidity relates to the motivation to respond, routine rigidity to the structure of that response.
Power dynamics (boundary control)	It takes place when some actors want to keep its resources, abilities, or conflicts localized and strictly limit access to these (Gibson 2005). Boundary control mechanism can be observed in an authoritarian system or in a milieu where trust is lacking (Felleti & Lynch 2009).
Power dynamics (enclosure/exclusion)	Enclosure and exclusion mechanisms are representations of power dynamics among the actors. Enclosure means capturing resources and authority and exclusion indicates marginalizing stakeholders (Sovacool et al. 2015). Enclosure happens when authority and/or resources are transferred to a few influential private actors. Exclusion takes place in tandem with enclosure and it dismisses the participation of particular groups of stakeholders in the adaptation process.
Frame Polarization	It is an interactive process through which the distance between the perspectives of two or more opposing groups increases over time due to repeated reaffirmation of the same point by the actors involved (Dewulf and Bouwen 2012).
Veto player	It is the influence of one actor in this case resembles the veto player theory. Veto players can block decision-making processes based on powerful resources that they own and for reasons not always made transparently clear (Klijn 2003).

4.3. Methods

4.3.1. Study context

In this study, we selected Bangladesh as a case study area because Bangladesh is historically involved in adaptation to flooding. Due to climate change, the risk of flooding increased in recent years (Mirza et al. 2003, Karim & Mimura 2008). As the country lies in the intersection of Ganges-Brahmaputra-Meghna river system, one of highest discharged rivers in the world, flooding is a recurrent phenomenon here. Floods in Bangladesh can be categorized into four types: flash, riverine, rainwater, and coastal flood. Although Bangladesh encounters flooding every other year, climate change will increase the frequency and intensity of flooding in coming years (Mohammed et al. 2018). In order to deal with the risk, the government of Bangladesh mobilized a number of organizations in different sectors of engagement (i.e. infrastructure, water resource, forestry, socio-economy). These organizations work in a variety of ways, such as the water development board constructs embankments, the forest department creates green belts, or department of public health provides sanitation facilities. These organizations interact with each other as well as with local and national stakeholders to manage adaptation actions (Ishtiaque et al. 2019).

Several barriers have emerged through the interactions of the stakeholders in the governance process (Bhuiyan 2015, Ahmed et al. 2015, Zevenbergen et al. 2018). For example, lack of participation of local stakeholders has been identified as a barrier by many (Sovacool et al. 2012, Stott & Huq 2014, Bhuiyan 2015). As with the broader literature on barriers in adaptation, the barrier-related research in

Bangladesh has largely focused on assessing which barriers are present; how or why these barriers emerge remains largely unexplored. Nevertheless, to address barriers appropriately, the underlying factors that give rise to them need to be addressed.

4.3.2. Key- informant interviews

Through an online search and snowball sampling procedure, we identified the organizations associated with adaptation governance process and selected lead organizations in five key sectors of engagement: water resource, infrastructure, socio-economy, forestry, and agriculture. The lead organizations were selected based on their work scope and reputation. In total, we selected 17 organizations that included both government and non-government entities. These organizations operate at national, district, and sub-district levels of governance. We prepared a semi-structured questionnaire that included questions designed to elicit respondents' ideas about the challenges that impair the adaptation governance process: how these challenges become important in the process, why these challenges keep occurring, and how they impair the governance process. Each interview lasted approximately for an hour. These key-informant interviews enabled us to examine the emergence of barriers in the interactions among the actors directly involved in the adaptation governance process. The interview questionnaire was approved by the Institutional Review Board of Arizona State University. These interviews were later transcribed and coded according to the categories of mechanisms reported in the literature.

4.3.3. Evidence synthesis

The key-informant interviews were regionally limited to central coastal Bangladesh because of time and resource constraints; however, risk of flooding exists in other parts of the country as well. As such, we relied on published empirical studies to collect data on barrier emergence. This approach would allow us to consider existing studies on barriers to adaptation, most of which took a barrier approach. We argue that without completely abandoning this rich breadth of knowledge as suggested by Biesbroek et al. (2017), we can sort out the useful ones. For this reason, in order to obtain further information on the mechanisms associated with the emergence of barriers in the interactions among organizations and local stakeholders in Bangladesh, we conducted a systematic literature review (SLR). We adopted the ROSES (RepOrting standards for Systematic Evidence Synthesis in environmental research) protocol in the SLR process. We included only peer-reviewed journal articles in English that were published in the period of 1990-2019, and, given the large amount of literature on adaptation in Bangladesh, we limited our regional focus to Bangladesh.

Climate change adaptation is relatively a new policy paradigm in Bangladesh. Vij et al. (2018) found that Bangladesh has implemented climate policy in four periods since the mid-1990s: i) natural disaster vulnerability and disaster response (1997-present); ii) disaster risk reduction (2003- present); iii) climate change adaptation (2008-present); and iv) mainstreaming climate change adaptation (2011-present). Considering the changes in climate policy over this time span, we did not limit ourselves just to “climate adaptation” as the

organizing concept of the systematic review process. Instead, we included the disaster risk reduction and disaster vulnerability-related key words in the search process as well, assuming that the same mechanisms that would impede adaptation might be present in other phases of the country's approach to vulnerability and risk in flooding. This inclusion of search key-words would also allow us to sample from a larger set of literature. We began our search process using different combinations of keywords, such as climate change, adaptation, barriers, challenges, governance etc., in the Web of Science platform (see Appendix D). These keywords were selected based on the authors' prior knowledge and experience. The initial search retrieved 424 articles. We reviewed these articles based on exclusion and inclusion criteria (Table 4.2). These criteria were established to ultimately ensure the selection of articles which provide contexts and examples in addition to discussion on barriers. With this three-step review process we selected eight articles for final analysis (Table 4.3). We analyzed these articles and coded them to identify the barriers and their immediate causes (mechanisms) of occurrence. These articles were coded same as interview data.

Table 4.2: Inclusion and exclusion criteria

Process	Inclusion Criteria	Exclusion Criteria	Accepted	Rejected
Step 1: Title & Abstract Screening	Title or Abstract of the article must include topic related to adaptation/ disaster management/ vulnerability/ resilience in flood management sector. Abstract further includes discussion of adaptation governance or barriers or challenges or constraints.	Title or abstract of the article include topic related to climate adaptation, disaster management, vulnerability or resilience but the abstract does not contain any discussion of adaptation governance or barriers or challenges or constraints.	38	386
Step 2: Article Screening (Full text review)	Article identifies barriers or challenges of adaptation governance or management and explains the barriers with examples or attempts to provide causes.*	Article may list out the barriers but fails to provide examples or causes and does not make an attempt to explain in details.	21	17
Step 3: Article Screening (Critical appraisal & synthesis)	Article attempts addresses the causal mechanisms of the emergence of barriers through a detailed discussion on how barriers are emerging.	Article might explain the barriers with examples but does not analyze the underlying causes or article that is not methodologically robust.	08	13

**These articles will be considered for identifying the barriers but will not be further taken for analysis.*

4.4. Results

4.4.1. Barriers in adaptation governance process

Out of 424 initially selected articles, we found that only 21 articles (~5% of total articles) discussed the barriers with some examples of how they hinder the governance process. Of these 21 articles, only eight articles (~2% of total article) attempted to analyze how these barriers emerged through interactions among the actors. Notably, not all of these eight articles examined the causal mechanisms to a great extent. However, none of these articles adopted a mechanism-based

approach; instead, they took a barrier approach, which entailed identifying some barriers with detailed examples of how these barriers emerge. With these examples and descriptions, these articles were able to provide enough details from which we could derive instances of interactions, and the challenges that appeared and hindered the governance process.

We first coded for the immediate causes that generate the barriers. Later, using the list of mechanism that we identified from literature (see Table 4.1), we analyzed which mechanisms could explain the identified barriers and associated causes. For instance, Islam & Welkarden (2017) identified ‘limited participation of local people’ as a barrier in adaptation governance. From their examples, we identified the potential cause as ‘elite capture of governance process’ and, by inference, we found that ‘power dynamics (enclosure/exclusion)’ mechanism best explained the emergence of this specific instance of a barrier. Notably, some barriers can have multiple mechanisms involved. For instance, ‘corruption’ was identified by several studies as a barrier, but, as we describe in detail below, the associated mechanism depended on the context in which this barrier was observed. The following table summarizes the core information we gather from these articles (Table 4.3). Note that in addition to the mechanisms identified in the conceptual literature, we identified another mechanism from our interview analysis: organizational inertia. The mechanisms are detailed in the following subsection.

Table 4.3: Summary information on barriers from the finally selected articles

Reference	Identified barriers	Mechanisms*
Stott & Huq (2014)	<ul style="list-style-type: none"> - Access to information - Personal network based communication - Poor coordination at local level 	<ul style="list-style-type: none"> - Belief formation - Power dynamics (enclosure/exclusion) - Power dynamics (boundary control)
Bhuiyan (2015)	<ul style="list-style-type: none"> - Limited participation of local people - Corruption 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion) - Belief formation
Chowdhury & Haque (2016)	<ul style="list-style-type: none"> - Dominance of rural elites - Corruption 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion)
Haque et al. (2017)	<ul style="list-style-type: none"> - Limited participation of local people 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion)
Rahman & Giessen (2017)	<ul style="list-style-type: none"> - Personal network based communication 	<ul style="list-style-type: none"> - Belief formation
Islam & Welkarden (2017)	<ul style="list-style-type: none"> - Limited participation of local people - Poor coordination at local level - Corruption 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion)
Rahman & Tosun (2018)	<ul style="list-style-type: none"> - Struggle for authority among organizations - Corruption 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion)
Rahman (2018)	<ul style="list-style-type: none"> - Corruption 	<ul style="list-style-type: none"> - Power dynamics (enclosure/exclusion)

**These mechanisms have been identified by the researchers of this study. The explanations of these mechanisms are available in the next subsection.*

4.4.2. Mechanisms of the emergence of barriers to adaptation

4.4.2.1. Belief formation

Belief formation mechanism enables actors to positively value the judgment of others and thus induces trust building and concerted efforts.

This mechanism is at the core of building rapport and as a mechanism itself it has its benefits and disadvantages. In case of Bangladesh, belief

formation mechanism is responsible for causing emergence of several barriers. This mechanism assists us in explaining the barriers ‘personal network based communication’ and ‘corruption’ identified by three of the eight articles. Existing literature suggests that the success of adaptation efforts in Bangladesh largely depends on the personal network of the organizational high officials (Rahman & Giessen 2017). These adaptation projects often involve multiple stakeholders that require good management and collaboration skills of the project directors as well as of the high officials from other organizations. The nature and frequency of their interactions often relies on the trust among these officials. While the belief formation mechanism helps to build trust among organizations, it can also lead to inefficiency in organizational abilities. Our interview analysis reveals that the transfer or quitting of an organization’s high official can cut off or weaken the ties with other organizations that he or she established during his/her tenure. For instance, we found that in a climate resilient infrastructure project, the collaboration between local government engineering department (LGED) and water development board (BWDB) weakened significantly when the district level head of BWDB was transferred. The new head lacked cooperative mindset and did not act fast enough to prevent delays in collaborative efforts. The interviewee said: “We had great collaborations with BWDB when Mr. X was the project director. After he was transferred, our collaboration stopped as the new director was not welcoming to collaborative efforts.” From this example,

we posit that the belief formation mechanism (M), during the interactions among organizations (I), leads to personal network based communication (O) and that this form of communication can then lead to administrative delays in the governance process (O).

Belief formation is also critical for non-government organizations (NGOs) in order to acquire funding, information, and other support for their organizations (Stott & Huq 2014). Through investing resources, these NGOs attempt to build trust and rapport with officials from funding organizations or with decision-makers and politicians. However, building trust for collaboration should not be considered a barrier unless it leads to corruption. Transparency International Bangladesh (2013) found that due to political rapport, the ruling Awami League government appointed PKSF NGO, an organization that has no experience in climate change adaptation related works, to make decisions on climate change funding distribution. Furthermore, a number of NGOs that have no prior experience in climate change related works were funded with Bangladesh Climate Change Trust Fund money allegedly because the owners or executive directors of those NGOs had well-established connections with the ruling party (Bhuiyan 2015). In this way, belief formation mechanism, which individually has no negative normative connotations, can lead to the emergence of barriers in adaptation governance.

4.4.2.2. Power dynamics (enclosure & exclusion)

The enclosure mechanism represents how power and resources are grasped only by a few entities in a governance process, while the exclusion mechanism indicates how powering of certain actors dismisses the participation of others in the governance process. Our SLR review reveals that five out of eight selected articles identified barriers that could be explained by these mechanisms, such as limited participation, dominance of elites, and poor coordination. In the adaptation efforts in Bangladesh, enclosure and exclusion most often take place together. From our interview analysis we found that the social elites are often successful in lobbying to locate the disaster shelters close to their residences and utilize the public sluice gates, constructed for irrigation purposes, for their personal gains. These elites use their power of influence and political connections to have control over the governance process. Also, the organization officials demonstrate elite perceptions that induce enclosure and exclusion. For instance, in our interview, the sub-administration told: “The sub-district administration is like a king here and the king knows better what is good for their subjects (i.e. local people) than the subject themselves”. The empirical literature also demonstrated similar instances of power dynamics. Islam & Walkerden (2017) and Rahman & Tosun (2018) found that local organization officials often act as accomplices of

social elites to appropriate resources and marginalize the vulnerable groups.

Our interviews also found that through the exclusion mechanism the organizations and social elites limit the participation of local people in adaptation governance. As such, voice of marginalized vulnerable people can come only through public protests (Nowreen et al. 2014). For example, the river embankments in northeastern part of Bangladesh addressed flooding issue to some extent but met with public protest as its implications included displacement of local communities, increased river erosion, negative impacts on local fisheries, waterlogging in certain areas (Haque et al. 2017). Furthermore, our interview reveals that earthen embankments in the coastal areas are often constructed without sufficient consultation with local beneficiaries and as such cannot make them a part of the adaptation process. Feeling their demands have not been met, some villagers cut hole into the embankments to supply irrigation water or steal soil to elevate their homestead lands. Indeed, these local people need to be aware about the significance of embankments, but the exclusion mechanism prohibits social awareness. Exclusion mechanism is triggered even at national level policy making. The policy formulation process often disregards the participation of vulnerable or marginalized groups for whom the adaptation actions are planned. For instance, with the assistance from national level experts, the Bangladesh Climate Change Strategy and Action Plan was developed and instituted within just six months but

without sufficient consideration of local complexities (Raihan et al. 2010). In this way, power dynamics (enclosure & exclusion) mechanism becomes an important action-formation mechanism that leads to barriers related to inequality and discrimination.

4.4.2.3. Power dynamics (boundary control)

The boundary control mechanism, which entails organizations limiting access to specific resources that they control, explains another form of power dynamics among the organizations. Of the eight selected articles, one article identified ‘limited access to information’ or ‘downscaled information unavailability’ as barrier that can be explained by this mechanism. Through our interview analysis and literature review we found that downscaled knowledge development is nationally centralized and exclusive. It is conceived as an asset or a product by some research organizations and is not widely shared (Zevenbergen et al. 2018). Local stakeholders as well as NGOs rarely can obtain downscaled information that has been produced by national level government-funded or owned organizations (Stott & Huq 2014). By holding information and limiting access to it, these research organizations wield power over other actors and impair the adaptation governance process.

The boundary control mechanism is also observable in the interactions among government organizations. Our interview analysis reveals that some organizations are dominant in the adaptation governance

process and instead of collaborating with other relevant organizations they attempt to operate in every aspect of the adaptation action. For instance, in one project, Local Government Engineering Department (LGED) was responsible for constructing climate resilient infrastructures and the Forest Department was supposed to afforest the remaining project lands. However, instead of taking assistance from the Forest Department, the LGED afforested the lands by themselves and with a higher cost. Through boundary control mechanism, LGED attempts to be an independent organization, a one stop solution in order to gather foreign funds. In this way, some organizations use the boundary control mechanism to limit information access and curtail collaborative efforts, and thus impair adaptation actions.

4.4.2.4. Organizational inertia

Organizational inertia indicates how organizations demonstrate unwillingness to invest in new ventures or to change patterns of work. Our interview analysis found that several organizations in Bangladesh do not have any contingency plan or emergency preparedness for adaptation. For instance, in an event of embankment breach, Bangladesh Water Development Board (BWDB) takes at least 2-3 weeks to start repairing because of not having an emergency preparedness plan. Although embankment breach is a common phenomenon, due to organizational inertia BWDB is disinclined to invest resources for emergency

management. To make the situation worse, they do not even allow other organizations to assist in repairing the embankments. During the interview, the sub-district administration representative expressed frustration that, despite having resources, the administration cannot repair the breached part of the embankment and their support is limited only to providing emergency relief to the affected people. We also observed that the organizational inertia mechanism prohibits the Forest Department to come up with novel ideas to lease or own coastal lands for afforestation. Traditionally this organization afforests the newly formed islands in the coastal areas and due to organizational inertia they cannot act coherently with the government's plan of establishing a contiguous green belt along the coastal mainland.

4.5. Discussion & Conclusion

To date, the climate change adaptation researchers mostly have endeavored to identify the barriers without addressing how they emerge as such. It is certainly interesting to recognize the challenges that impair the adaptation governance processes, but this does not identify the root of the problem. In order to address these barriers we need a better understanding on how these barriers emerge. The emergence of barriers involves different mechanisms operating between different or same levels (i.e. macro-micro, micro-micro). In this study, we focused on the micro-micro or action-formation mechanisms as this focus allows us to understand how or why the belief, perception, and governance nature of the organizations cause the barriers to emerge in the governance

process. Our objective here was not to come up with new mechanisms but rather distill which mechanisms already identified in the conceptual literature best explain the barriers that have been observed in the adaptation governance process in Bangladesh. To that end, we identified barriers that appear in the interactions among organizations and analyzed the underlying action-formation mechanisms. We found that at least four mechanisms of those that have been discussed conceptually are involved in the emergence of barriers in Bangladesh: belief formation, power dynamics (enclosure/exclusion), power dynamics (boundary control), and organizational inertia.

By combining qualitative primary data and observations reported in the empirical literature, our approach of analysis enables us to consider multiple cases of adaptation and provides a more comprehensive view of mechanisms. Biesbroek et al. (2017), Wellstead et al. (2018) encouraged to abandon the barrier-approach research and produce more evidence-based research on mechanism-based explanation of barriers in order to have a more general understanding on mechanisms. We argue that our approach of analysis can act as a bridge between traditional barrier studies and mechanism-based explanation of barriers. Instead of totally abandoning all studies that took a barrier approach to identify the barriers, our approach would filter out the studies that took a barrier approach but provided insights into mechanisms as well. Our analysis reveals that not all barrier studies are useful. In order to consider a traditional barrier research, we have to make sure that the research describes or analyzes the context, interactions, and causes. A mere list of barriers will not be helpful in our approach of analysis.

Our mechanism-based analysis reveals that how organizations consciously or unintentionally interact with other organizations in a way that impair the governance

process. The mechanisms we identified are the output of situational or macro-micro mechanisms. Cultural practices or institutional norms often dictate the actions of the organizations. For instance, officials from the water development board individually acknowledged the significance of emergency management funding to us, yet collectively they did not take any action to establish the fund. The identification of the mechanism (i.e. organizational inertia) explains this lack of action: because of resource or routine rigidity. An upper level analysis of situational mechanisms would further reveal that why organizational inertia takes place, while a lower level analysis on transformational mechanisms would allow us to know how the inertia affect the interactions. In order to have a more complete diagnosis of how barriers are unfolding from macro level phenomenon to micro level impacts, we have to take all three mechanisms into account. While this study attempts to capture a part of the larger picture, future research can be directed to understand particularly situational mechanisms.

The mechanism-based analysis provides insights on the adaptation governance in Bangladesh. The National Adaptation Plan of Action indicates that the government ensured participation of variety of actors in the plan formulation process. Also, through our interviews we found that local stakeholders were involved in the adaptation planning process. Despite these efforts, our mechanism-based analysis showed that the power dynamics (enclosure/exclusion) mechanism is active, and serves to exclude some vulnerable groups from the adaptation governance process. Similarly, we found that organizational inertia prohibits organizations from being adaptive to climate change impacts. In this way, the mechanism-based analysis helps in going beyond a description

of engagement and participation to reveal the more complicated social processes that impair the adaptation governance process.

How does mechanism-based explanation help us to overcome or at least navigate through barriers that emerge in the interactions among actors? To answer this question, attention is required on how mechanisms are into influencing the governance process and how it shapes the actors' roles and activities. Note that the actors are not the center of our attention, but rather the mechanisms driving their actions. Once the roles of the actors, as influenced by mechanisms, in the emergence of barriers are understood, the decision makers would be in a better position to modulate the roles by addressing the mechanisms. These mechanisms can be addressed through continuous interactions or mutually changing the institutional rules or norms. For example, Dewulf & Bouwen (2012) found that creation of a coordinating space for mutual interactions and understanding each other's framings could work against triggering the power dynamics (enclosure & exclusion) mechanism. In most cases these mechanisms will exist to some extent but the objective should be to make these mechanisms dormant or diminish their influences so that they cannot trigger barriers. However, a complete eradication of one particular mechanism may require transformative changes (i.e. cultural shift, complete alteration of governance approach). For example, to remove organizational inertia once and for all, organizations need to be flexible, adaptive, and inclusive, requiring a fundamental change in the approach of organizational governance. Furthermore, addressing these mechanisms needs to be done carefully as short sighted interventions in one mechanism can trigger new mechanisms (Biesbroek et al. 2014). For instance, if the decision makers want to remove organizational inertia, they have to be cautious so that the same information has

been treated differently by different actors within the same organization. For this reason, a clear and critical understanding of all the involved mechanisms in the emergence of barriers to adaptation is essential. At the same time mapping out how these mechanisms are interrelated is critical as well.

Overall, our research shows that mechanism-based explanation of barriers can provide novel insights by allowing us to understand why and how barriers emerge. Mechanism-based thinking would enable the actors to address the barriers and navigate through them more effectively (Biesbroek et al. 2014, 2017, Wellstead et al. 2018). In this study, we attempted to provide an overall view of mechanisms by combining interview data with literature review data. However, our study is regionally contextualized in Bangladesh.

We need more evidence from other regions on the mechanism of barriers to ensure more effective adaptation governance process. Understanding and addressing these mechanisms would enable to us to plan adaptation actions more effectively and efficiently.

CHAPTER 5

CONCLUSION

This dissertation research sought to examine how understanding of multilevel organizations, their structure of governance network, and power dynamics among them influence the adaptation governance process in Bangladesh. This research found significant similarities in understanding of vulnerability among the organizations that are operating at different levels of governance. Similarity in understanding of the problem has the potential to increase the efficiency, effectiveness, equity, and legitimacy of climate adaptation (O'Brien et al. 2004, Adger et al. 2005). However, similarity in understanding can also indicate narrow vision and limited understanding of the problem. Particularly, if the governance arrangement is elite-centered, representing a dominance of few actors in the governance processes, similarity in understanding of the problem may not result into the desired outcome. In the second chapter, I found that the adaptation governance in Bangladesh is elite-pluralistic in nature and despite containing top-down and bottom-up processes, a few actors at the national level of governance are observed dominant. Under this elite-pluralistic governance arrangement, similarity in understanding of the problem can actually indicate a narrow framing of the problem. This narrow framing can happen because the organizations with high influence can dictate the perception of understanding of other organizations. A narrow framing of understanding can prohibit appreciating other perspectives and can lead to resource misallocation and fragmented development (Pahl-Wostl 2009). This is evident through the comparative criteria weighting by the organizations in my analysis. Less focus on social and economic aspects can negate the significance of infrastructural solutions.

Climate change adaptation is a ‘part and parcel’ of social and political processes (Eriksen et al. 2015). As such, the adaptation governance process is influenced by the existing cultural and historical processes. Similar to the administrative system in Bangladesh which is historically centralized and top-down in nature (Zafarullah 2016, Rahman & Tosun 2018), this research also found a relative centralization of power in adaptation governance. I further observed that representing the centralized nature of the governance, organizational cultures and perceptions are also top-down in approach. Under this approach, organizations attempt to push their understanding over hierarchically lower organizations. While doing so, they are not receptive to the understanding of the problem developed at lower levels of governance. At the same time, because of centralization of power, these organizations cannot facilitate local stakeholder participation enough. Such lack of participation and a failure in knowledge co-production can lead to unsustainable adaptation outcomes (Eriksen et al. 2011, Manuel-Navarette 2013). However, whether centralization of power or top-down approach contributes to unsustainable outcomes is arguable. In case of Bangladesh, I found that a relative centralization of power may contribute to unsustainable adaptation outcome but in England, national government-driven top-down structure of adaptation governance mobilized actors at different levels without any significant duplicity or conflict in adaptation actions and thus facilitates better coordination (Tompkins et al. 2010). Similarly, in the Netherlands, relative centralization of power does not impair the adaptation success (Hegger & Dieperink 2014). This dual nature of governance demonstrates that the importance of context. As adaptation is influenced by social and

political processes, how history and culture shapes the organizational behavior and governance process are important in adaptation studies.

It has been argued that addressing contextual vulnerability, ensuring local level participations, and understanding feedbacks between global and local processes are imperative for sustainable adaptation (Adger et al. 2009, Ribot 2010, Eriksen et al. 2011). However, I argue that only addressing these issues will not be enough in Bangladesh. The governance process in Bangladesh still retains the colonial mindset of administration in which the organizations conceive themselves superior than the local stakeholders. As such, even if local participation is ensured to some extent, because of this mindset local participation may remain ineffective. This is concerning because the power dynamics analysis of this study showed that local level needs assessment data are collected by frontier organizations and as frontier organizations hold such mindset, local requirements may remain unaddressed.

To ensure effective adaptation outcomes in Bangladesh, we need coproduction of policies and processes but at the same time we need to focus on changing the elite perception of the organizations. Unless the superior tendencies of these organizations are addressed, ensuring participation will not be sufficient. Furthermore, to devolve power from the national level, the frontier organizations should be given more opportunities to exercise power so that they can manage emergency situations. Also, the supporting organizations should have the power to independently evaluate the adaptation progress and outcome. The capacities of these organizations need to be enhanced as well to wield the given power. My mechanism based analysis suggests that focus should be given on the underlying mechanisms that cause the emergence of the barriers.

Overall, this research advances our knowledge on the significance of multilevel governance network in climate change adaptation governance by examining how multilevel organizations understand or frame the problem, how their interactions and power dynamics affect the governance process, and how barriers emerge in their interactions. While this research contributes to enhancing our broad understanding on the structure and interactions of multilevel organizations, more research on this issue is urgently required. The efficiency and effectiveness of adaptation largely depends on how these organizations are structured and interact to manage climate adaptation actions. More particularly, research is needed to examine the interactions between government and non-government organizations, the two largest actors in adaptation governance. A potential research question could be: How do power dynamics influence the competition, contestation, and collaboration between government and non-government organizations? Further research is needed to examine how the attributes of the organizations influence the nature and type of interactions. This research used social network analysis to examine the collaboration and coordination networks and determine the influence of organizations over governance process, but future research can extend this approach by considering organizational attributes and resources as well. More research on the interactions among organizations will enhance our understanding on how the adaptation actions can be made more efficient and effective.

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APPENDIX A

ORGANIZATIONS INVOLVED IN VULNERABILITY MANAGEMENT

Sectoral (government) organizations involved in managing vulnerability to climate change management in coastal areas of Bangladesh.

Sector	Key Ministry	Associated Organizations	Leading Organization	Key Actions
Agriculture	Ministry of Agriculture	I. Department of Agricultural Extension II. Bangladesh Agricultural Development Corporation III. Bangladesh Agricultural Research Council IV. Bangladesh Agricultural Research Institute V. Bangladesh Rice Research Institute VI. Bangladesh Jute Research Institute VII. Bangladesh Institute of Nuclear Agriculture VIII. Agricultural Information Services IX. Seed Certification Agency X. Soil Resource Development Institute	Department of Agricultural Extension (DAE)	<ul style="list-style-type: none"> - Providing need based extension services to farmers. - Enabling farmers to optimize resources to promote sustainable agricultural practices and socio-economic growth. - Assisting the farmers to increase agricultural productivity and adopt new technology.
Hydrology	Ministry of Water Resources	I. Bangladesh Water Development Board II. River Research Institute III. Directorate of Bangladesh Haor and Wetland Development IV. Water Resources Planning Organization	Bangladesh Water Development Board (BWDB)	<ul style="list-style-type: none"> - Development and management water resource projects through embankments, levees, and sluice gates. - Management and mitigation of river bank erosion. - Promoting food production through surface water irrigation. - Ensuring stakeholder participation in environment friendly development initiatives.
Infrastructures	Ministry of Local Government, Rural Development & Cooperatives	I. Local Government Engineering Department II. City Corporations III. National Institute of Local Government IV. Department of Public Health Engineering	Local Government Engineering Department (LGED)	<ul style="list-style-type: none"> - Improving accessibility of rural growth centers. - Construction of embankments. - Construction of disaster shelters, tree plantation on embankments. - Urban infrastructure development. - Providing technical support to district, sub-district, and union administrations.
Forestry	Ministry of Environment, Forests, and Climate Change	I. Bangladesh Forest Department II. Department of Environment III. Bangladesh Forest Research Institute IV. Bangladesh Forest Development Corporation	Bangladesh Forest Department (FD)	<ul style="list-style-type: none"> - Conservation and sustainable management of forest, wildlife, and biodiversity. - Increasing land stability and climate resiliency of ecosystem. - Expanding social forestry and ensuring stakeholder participation. - Increasing forest cover

				through afforestation and reforestation.
Socio-economy	Ministry of: Social Welfare, Disaster Management and Relief, Finance, Health & Family Welfare	I. Local Non-Government Organizations (NGOs) II. International NGOs III. Other relevant government organizations	Local NGOs	<ul style="list-style-type: none"> - Microfinance - Disaster management - Education provision - Community empowerment - Human rights and justice - Eliminating poverty - Health and nutrition

APPENDIX B

LIST OF VULNERABILITY INDICATORS

List of vulnerability indicators. The explanations, uses, and sources have been provided.

Each indicator has further been identified as an indicator of exposure (*E*), sensitivity (*S*), and adaptive capacity (*AC*): the three components of vulnerability.

Major Criteria	Sub-Criteria	Explanation & Use	Source
Social	Literacy rate	Percent of population aged 07 or over who can read and write. Higher literacy rate indicates higher ability to receive and process information and technology, and as such denotes lower vulnerability (Asfaw & Admassie 2004). <i>AC</i>	Population Census (2011)
	Dependency ratio	Ratio of population aged below 15 and over 65 to the population aged between 15 and 64. Higher dependency ratio indicates higher number of economically dependent member, less convenience in emergency evacuation dependent people, and as a result, higher vulnerability. <i>S</i>	Population Census (2011)
	Population density	Number of population per square kilometer. Higher population density represents higher economic activity, higher risk of population getting affected, and thus higher vulnerability. <i>S</i>	Population Census (2011)
	Size of the household	Average number of persons in a household. In Bangladesh, majority families are nuclear in nature with few earning members. As such, larger household size indicates more dependent people and higher chance of getting affected by disasters. <i>S</i>	Population Census (2011)
	Number of health center	Number of health centers per 100,000 populations. Health centers support hazard affected people during and after natural hazards. Higher number of health centers represents lower vulnerability. <i>AC</i>	Population Census (2011), District Statistics (2011), Directorate General of Health Services (http://www.dghs.gov.bd)
	Sanitation	Percent of population with sanitation facility. Absence of sanitation facility induces more vulnerability through spread of diseases in the hazard affected areas (WHO 2015). <i>S</i>	Population Census (2011)
Economic	Poverty rate	Poverty headcount ratio in percent or percent of population with an earning less than \$1.90 a day. Higher poverty causes higher vulnerability. <i>S</i>	Bangladesh Poverty Map (2010)
	Natural resource dependent population	Percent of population depend on agriculture and related activities. The agricultural sector is highly prone to natural hazards, and thus, higher ratio of natural resource dependent population in a system indicates higher vulnerability (Ahsan & Warner 2014). <i>S</i>	Agricultural Census (2008)
	Marginal land holders	Percent of farm holdings with ≤ 1.5 acres of cultivated land. Note, farm holding is defined as an agricultural production unit that has at least 0.05 acres cultivated lands. Marginal land holders are particularly vulnerable due to their minimum resources and lack of economic capacities. <i>S</i>	Agricultural Census (2008)
	Percent of agricultural holdings took loan	Percent of farm holdings took loan from banks or other institutions. In the rural areas of Bangladesh, the agricultural loans are often short term with high interest rate. At time of hazard and in the absence of any crop insurance, loans often become liabilities for these farm holdings and	Agricultural Census (2008)

		makes the holdings more vulnerable (Gerlitz et al. 2017). <i>S</i>	
Agricultural	Cropping intensity	Percentage of temporary gross crop area in comparison with temporary net crop area. Higher cropping intensity represents more frequent production of crop varieties, and a system with higher cropping intensity is less vulnerable. <i>AC</i>	Agricultural Census (2008)
	Irrigation facility	Percent of net cultivated area under irrigation facility. Irrigation facility can reduce vulnerability substantially by providing freshwater during dry season and by washing out the salt layer formed on land after major floods. <i>AC</i>	Agricultural Census (2008)
	Cattles	Percent of farm holdings reporting cattle. Holdings with cattle are less vulnerable than other farm holdings with no cattle as people can sell or live off cattle during disasters. <i>S</i>	Agricultural Census (2008)
	Farming equipment	Number of agricultural equipment per farm holding. In Bangladesh, higher number of farming equipment denotes lower vulnerability as farmers with equipment can do more production as well as can use them as asset to recover from disaster damage more quickly. <i>AC</i>	Agricultural Census (2008)
	Net cultivated area	Percent of net cultivated area in total area. Net cultivated area is defined as land area that is cropped in any given time in a census year. This includes land areas under permanent crops, temporary crops, and current fallow. As the economy of this area is largely agriculture dominated, higher net cultivated area represents less vulnerability. However, higher net cultivated area can produce high vulnerability through exposure, but it also provides higher agricultural outputs and assist affected people to recover fast. <i>S</i>	Agricultural Census (2008)
Land use	Forested area	Percent of land area under forest area. This forest area includes reserve forest and social forestry. Reserve forests can protect people from tidal floods and cyclonic storms, while the social forests can act as shield during cyclonic events. As such, higher forested area represents less vulnerability. <i>S</i> In this analysis, Landsat 8 OLI surface reflectance level-2 (image date: 01/17/2017) data product has been used. Unsupervised classification using ISODATA algorithm has been conducted.	USGS (https://earthexplorer.usgs.gov/)
	Area under fruit crop	Percent of land area under fruit crop. Fruit crops are mostly tall and strong trees and less affected by flood or cyclone hazards. <i>S</i>	Agricultural Census (2008)
	Area under Doash (fertile) soil	Percent of land area under Doash soil. Larger area indicates potentially highly productive areas. Higher production leads to lower vulnerability. Economic loss during disaster might be higher; however, the potential to compensate the damage after disaster will also be higher. <i>S</i>	District Statistics (2011) (District Statistics report contains sub-district level data)
	Area under saline soil	Percent of land area under saline soil (more than 8.0 dS/m). Larger saline area represents low productivity and less arable land. Increase of saline area will increase vulnerability of an area. <i>S</i>	Soil Resources Development Institute (2010)
Natural	Elevation	Elevation for each study unit has obtained from ASTER Global Digital Elevation Model at 30m spatial resolution. Higher elevation indicates lower vulnerability. <i>E</i>	USGS (https://earthexplorer.usgs.gov/)
	Tree cover	Tree cover includes forests as well as homestead trees. Trees can protect people and their houses during cyclones by reducing the wind speed. Also, people can sell matured trees during the times of emergencies. So, higher tree cover represents lower vulnerability. <i>E</i> Tree cover data was obtained from the Percent Tree Cover (PTC) 250m image layer in the MODIS Vegetation Continuous Fields product (MOD44B, v006).	LP DAAC (https://lpdaac.usgs.gov/)

	Distance from the sea/river	The distance from major river or the <i>Bay of Bengal</i> . Closer distance indicates higher vulnerability. <i>E</i>	Google Earth, ArcGIS Base Map
Infrastructural	Flood/cyclone shelter	Number of flood and cyclone shelters per 100,000 people. The government and the international development agencies establish multi-purpose shelters which can serve both as primary schools and shelters. Higher number of shelters ensures less vulnerability. <i>AC</i>	District Statistics (2011)
	High schools and colleges	Number of high schools and colleges per 100,000 people. High schools and colleges predominantly serve two purposes: education and shelter house during disasters. <i>AC</i>	District Statistics (2011)
Household structural characteristics	Non-brick built household	Percent of non-brick built households. This includes semi-built, mud houses, and shabby houses. Higher number of non-brick built houses represents higher vulnerability to flood and cyclone hazards. <i>S</i>	Population Census (2011)
	Households with no electricity	Percent of households with no electricity. Lack of electricity connection deters the dissemination of warning message and evacuation endeavors. <i>AC</i>	Population Census (2011)
	Unsafe drinking water source	Percent of households with unsafe drinking water source, such as river water, pond water. Despite water purification approaches, unsafe drinking water source can cause severe health issues at the time of hazards (WHO & UNICEF 2017). <i>S</i>	Population Census (2011)

APPENDIX C
RESULTS OF SOCIAL NETWORK ANALYSIS

Results of social network analysis for each organization.

Organization Name	Level of Governance	Degree Centrality	Betweenness Centrality	Eigenvector Centrality	Core/ Periphery	Influence over Governance	Brokerage Role
Ministry of Agriculture	National	20	229.980	0.227	Core	High	Representative / Coordinator/ Gatekeeper
Ministry of Planning	National	22	129.761	0.353	Core	High	Itinerant/ Representative / Gatekeeper
Ministry of Finance (Economic Relations Division)	National	22	129.761	0.354	Core	High	Itinerant/ Gatekeeper/ Liaison
Ministry of Water Resources	National	15	109.366	0.201	Core	High	Itinerant
Donor Agency	National	21	147.584	0.209	Core	High	Representative
LGED-N	National	16	155.061	0.260	Core	High	Representative
BWDB-N	National	18	158.236	0.220	Core	High	Itinerant/ Liaison
DAE-N	National	19	184.914	0.234	Core	High	Itinerant/ Representative / Gatekeeper/ Liaison
BADC-N	National	15	82.752	0.245	Core	High	Liaison
CEGIS	National	17	152.781	0.257	Core	High	Itinerant/ Liaison
Ministry of Social Welfare	National	9	10.133	0.138	Periphery	Medium	N/A
INGO	National	7	6.014	0.100	Periphery	Medium	N/A
WARPO	National	6	3.410	0.074	Periphery	Medium	N/A
RRI	National	6	1.452	0.074	Periphery	Medium	N/A
Ministry of Environment & Forest	National	9	4.736	0.122	Periphery	Medium	N/A
Ministry of Local Government	National	7	0	0.142	Periphery	Medium	N/A
BRRRI	National	6	29.834	0.103	Periphery	Medium	N/A
BARC	National	8	41.043	0.141	Periphery	Medium	N/A
IWM	National	6	1.577	0.100	Periphery	Medium	N/A
BINA	National	8	21.342	0.153	Periphery	Medium	N/A
NGO-N	National	10	58.680	0.133	Periphery	Medium	N/A
FD-N	National	12	68.123	0.127	Periphery	Medium	N/A
LGED-D	District	11	71.515	0.060	Periphery	Medium	Liaison
BWDB-D	District	12	78.941	0.062	Periphery	Medium	Liaison
BADC-D	District	5	6.860	0.058	Periphery	Medium	N/A
District Administration	District	12	41.515	0.034	Periphery	Medium	N/A
FD-D	District	9	25.600	0.042	Periphery	Medium	N/A
DAE-D	District	11	81.253	0.051	Periphery	Medium	N/A
DAE-SD	Sub-district	7	28.204	0.014	Periphery	Medium	N/A
Sub-district Administration	Sub-district	10	28.867	0.015	Periphery	Medium	N/A
NGO-L	Sub-district	8	41.591	0.029	Periphery	Medium	N/A
SRDI	National	4	2.930	0.067	Periphery	Low	N/A
BARI	National	5	0	0.075	Periphery	Low	N/A
SCA	National	4	1.200	0.074	Periphery	Low	N/A
DOE	National	4	1.095	0.084	Periphery	Low	N/A
LGED-SD	Sub-district	5	9.935	0.011	Periphery	Low	N/A
BWDB-SD	Sub-district	5	12.029	0.011	Periphery	Low	N/A
FD-SD	Sub-district	3	0	0	Periphery	Low	N/A

APPENDIX D

SEARCH KEY WORDS FOR MECHANISM-BASED ANALYSIS

Search key words for mechanism-based analysis (as of January 2019)

Platform	Search key words	Article found
Web of Science	TS = (climate change OR *adapt* OR climat* adapt*) AND TS = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	269
Web of Science	TS = (natural dis* OR disaster* OR disaster manage* OR disaster risk reduction) AND TS = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	122
Web of Science	TS = (disaster vulnerability OR vulnerab* OR resilien*) AND TS = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	199
Web of Science	TS = (govern* OR bureaucra* OR institution*) AND TS = (climate change OR climate adaptation) AND TS = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	62
Web of Science	TS = (climate change OR *adapt* OR climat* adapt*) AND TI = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	28
Web of Science	TS = (govern* OR bureaucra* OR institution*) AND TS = (climate) AND TI = (challenge* OR barrier* OR obstacl* OR constrain*) AND TS = (Bangladesh)	10
Total		690
Duplicates		266
Total articles for screening		424