Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems

by

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A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Doctor of Philosophy

in

Sustainability Management

Waterloo, Ontario, Canada, 2025

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of contributions

Md. Ruyel Miah was the sole author for Chapters One and Five, which were written under the supervision of Dr. Prateep Kumar Nayak and were not written for publication.

This thesis consists in part of three manuscripts (Chapters 2-4) written for publication. Exceptions to sole authorship of material are as follows:

Research presented in Chapter 2:

This research was conducted at the University of Waterloo by Md. Ruyel Miah under the supervision of Dr. Prateep Kumar Nayak. Md. Ruyel Miah, Dr. Prateep Kumar Nayak and Dr. Ratana Chuenpagdee contributed to conceptualizing the research, methodology, and reviewing the drafts. Md. Ruyel Miah wrote the draft manuscripts, on which all co-authors contributed intellectual input.

Citation:

Miah, M. R., Nayak, P. K., and Chuenpagdee, R. (Under Review). From vulnerability to viability for small-scale fisheries: a conceptual framework to facilitate the transitions. *Ocean and Coastal Management*.

Research Presented in Chapter 3:

This research was conducted at the University of Waterloo by Md. Ruyel Miah under the supervision of Dr. Prateep Kumar Nayak. Md. Ruyel Miah designed the study, collected and analyzed the data with consultations from Dr. Prateep Kumar Nayak. Dr. Jeremy Pittman, Dr. Simron J. Singh, and Dr. Ratana Chuenpagdee contributed to designing the study and reviewing the drafts. Md. Ruyel Miah drafted the manuscript, and each author provided intellectual input on the manuscript drafts.

Citation:

Miah, M. R., Nayak, P. K., Pittman, J., Singh, S. J., and Chuenpagdee, R. (Under Review). Assessing the status and challenges of vulnerability to viability transitions of small-scale fisheries in the transboundary Sundarbans mangrove forest. *npj Ocean Sustainability*.

Research Presented in Chapter 4:

This research was conducted at the University of Waterloo by Md. Ruyel Miah under the supervision of Dr. Prateep Kumar Nayak. Md. Ruyel Miah designed the study, collected data and completed the data analysis. Dr. Prateep Kumar Nayak, Dr. Jeremy Pittman and Dr. Ratana

Chuenpagdee contributed to designing the study. Md. Ruyel Miah drafted the manuscript, and each author provided intellectual input on the manuscript drafts.

Citation:

Miah, M. R., Nayak, P. K., Pittman, J., and Chuenpagdee, R. (Under Review). Governability analysis on vulnerability to viability transitions in transboundary small-scale fisheries of the Sundarbans. *Maritime Studies*.

Abstract

Globally, small-scale fisheries are known for their significant contribution to employment, food and nutritional security, livelihoods, poverty eradication, and community well-being. Despite their significant contribution, small-scale fisheries are underestimated, marginalized, and undervalued in the decision-making process, and often compete against large-scale fisheries and other industries for fishing space, resources and government attention. A transition toward viable and sustainable small-scale fisheries is crucial for the well-being of the small-scale fishers and the society at large.

A transition from vulnerability to viability for small-scale fisheries is complicated, with different stages and processes. This research argues that small-scale fisheries' vulnerabilities are 'wicked,' which have no easy fix, are not clear when they are solved, tend to reappear, and have no right or wrong solution to scientifically determine. The transboundary nature of small-scale fisheries in shared social-ecological systems further complicates the wickedness of small-scale fisheries vulnerability and so the transitions toward viability. Fisheries resources are highly diverse, mobile, and porous, and they are difficult to manage in a shared fisheries system. A gap exists theoretically and empirically in understanding the vulnerability to viability transitions at different scales and levels. This research employed case studies in the transboundary Sundarbans mangrove forest, a typical transboundary social-ecological system shared between Bangladesh and India along the coast of the Bay of Bengal. The forest supports millions of small-scale fishers, protects the communities from natural disasters, and faces common threats, such as resource decline, salinity intrusion, and climate change impacts on both sides of the forest. The purpose of this research is to develop a comprehensive understanding of small-scale fisheries' vulnerability to viability transitions and identify the key characteristics of governance arrangements that can help facilitate the transition in the Sundarbans transboundary small-scale fisheries. The research addresses three specific objectives: (i) to determine the key processes and mechanisms of vulnerability to viability transitions in small-scale fisheries; (ii) to explore the key vulnerabilities and the factors that hinder or facilitate transitions toward viability for small-scale fisheries in the transboundary Sundarbans; and (iii) to examine the governability of the governing system to facilitate vulnerability to viability transitions.

Using a scoping literature review, the study highlighted how conventional responses, such as migration, gear modifications, or top-down policies like fishing bans, often fail to address systemic vulnerabilities and may even worsen them. Based on the outcome of the literature review, the study developed a conceptual framework to systematically diagnose the challenges related to vulnerability to viability transitions. By employing a mixed-method approach, the study conducted interviews (N=32), household surveys (N=151), and focus group discussions (N=2) on the Bangladesh and India sides of the Sundarbans mangrove forest. The results revealed that the multi-dimensional vulnerabilities, such as poor housing conditions, marginalization of fishermen and women in decision-making, natural hazards like cyclones, floods, and tiger attacks, inequitable benefit-sharing, exploitation by middlemen, and restrictive fishing policies, pose a barrier to transitions toward viable small-scale fisheries.

The research found that both Bangladesh and India employ a mixed (hybrid) governance mode, with hierarchical governance dominating and co-governance initiatives in early stages. The study identified several governability challenges, for instance, diverse stakeholder images about the transboundary Sundarbans issues, which pose barriers to small-scale fisheries' vulnerability to viability transitions. The study suggested that effective governance requires decentralizing power, improving stakeholder coordination, and aligning conservation goals with community livelihoods. The study also urges a meaningful collaboration between Bangladesh and India, and genuine inclusion of fishing communities in decision-making to facilitate the transition from vulnerability to viability for small-scale fisheries. The study has made a significant contribution to the discussion of vulnerability to viability transitions as an emerging field. The empirical findings provide evidence of whether and how the transitions toward viability can be achieved for small-scale fisheries.

Acknowledgements

My doctoral journey has been a remarkable and life-changing adventure, though not without its difficulties. I am deeply thankful for the invaluable guidance and support I have received from so many individuals in various ways along the way.

I was incredibly lucky to have **Prof. Prateep Kumar Nayak** as my supervisor. Dr. Prateep, thank you for your expert guidance, mentorship, strategic advice, and kindness, without which I would not have achieved so much or met my program's timeline. Your steadfast support and dedication carried me through every challenge and inspired a lifelong commitment to learning and optimism. Working with you has been a true privilege.

My committee also provided invaluable support along the way. **Prof. Simron J. Singh,** I am deeply grateful for your insightful advice as I shaped my research direction, as well as your warmth and support. **Prof. Ratana Chuenpagdee,** thanking you is not enough given the contribution you have made to my life so far. I am just grateful for your guidance, thoughtful feedback, and constant encouragement. As always, your contributions elevated my work to new heights. **Prof. Jeremy Pittman**, I would like to offer a heartfelt thank you for your ideas, advice, and unwavering support throughout this journey.

No words can fully capture my deep gratitude to the communities in Khulna, Bangladesh, and West Bengal, India, who so generously shared their time, experiences, and wisdom despite their daily challenges. I hope to nurture the meaningful connections we built and find ways to give back in the future. I am also immensely thankful to my local research partners, the University of Liberal Arts Bangladesh (ULAB), the Indian Institute of Technology (IIT) Kharagpur, the V2V Global Partnership, and the Too Big To Ignore (TBTI) Global Research Network, for their unwavering support and invaluable contributions to my fieldwork. I am grateful to Dr. Samiya Ahmed Selim, Dr. Jenia Mukherjee, Dr. Mohammad Mahmudul Islam, and the students of ULAB and IIT Kharagpur for their extensive help during my fieldwork. A special thanks to the Sundarbans Tourism Services Cooperative Society and the Sundarbans Fisheries Cooperatives Societies for hosting me in India, as well as to all the individuals who assisted me in countless ways, especially helping with local recruitment. This work would not have been possible without you.

I felt very fortunate and privileged to have received funding from the Vulnerability to Viability Global Partnership, Mitacs Globalink Research Award, the David Johnston International Experience Award, the R. S. Dorney Memorial Fellowship, and Graduate Studies and Postdoctoral Affairs.

I am grateful for the friendship and support of my University of Waterloo academic community. I appreciate the love and support of my cohort, Navya Vikraman Nair, Nayadeth Arriagada

Oyarzun, Nilushika Gamage, Akash Kar, Sabrina Jannat Nyrit, Dipak Bishwakarma, and Maha Abdelbaset. I am also thankful to V2V graduate students and early career researchers, Bhabishya Khaniya, Natasha Serrao, Richard Nyiawung, Samuel Abalansa, Sisir Kantha Pradhan, Ella Kari-Muhl, Ana Carolina, Madu Galappaththi, Evan Andrews, and Murray Lister, for their encouragement and help at different stages of my doctoral journey. I am also grateful to Anastasiya Saparaliyeva, Jennifer Nicholson, and Cynthia Subramaniam for their wonderful administrative support from the School of Environment, Enterprise and Development (SEED).

To my wife and dearest friend, Tahmina Tarin, thank you for inspiring me to become the best version of myself and for your endless love, patience, and wisdom as I navigated the challenges of this PhD journey.

I also owe boundless gratitude to my parents, siblings, and in-laws, who, despite the distance, showered me with unwavering love and support. You are my strength and my anchor in life.

Finally, I want to acknowledge the many colleagues, friends, and kind souls who crossed my path and enriched this journey in countless ways. To all of you—thank you!

Dedication

To my parents, Md Isar Uddin and Mallika Khatun

and

my adorable niece, Tasfia Fairuz Ayat and nephew, Fahim Arefin Zayan,

who gave me the best time in life so far!

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List of Abbreviations

ACF	Assistant Conservator of Forest
BDO	Block Development Officer
BLC	Boat License Certificate
CMCs	Co-management Committees
CMEC	Co-Management Executive Committee
CMGC	Co-Management General Committee
CNRS	Centre for Natural Resource Studies
EDC	Eco-Development Committees
FAO	Food and Agriculture Organization of the United Nations
FPC	Forest Protection Committee
GI	Governing Interaction
GS	Governing System
JFMC	Joint Forest Management Committees
JMM	Joint Mangrove (forest) Management
MoEF	Ministry of Environment and Forest
MoU	Memorandum of Understanding
NTFP	Non-Timber Forest Products
PF	People's Forum
SDGs	Sustainable Development Goals
SESs	Social-Ecological Systems
SFD	State Forest Department
SG	System-to-be-governed
SOFIA	State of World Fisheries and Aquaculture
STR	Sundarbans Tiger Reserve
UNO	Upazila Nirbahi Officer
V2V	Vulnerability to Viability Transitions
VCFs	Village Conservation Forums

Chapter 1

Introduction

1.1 Research context and problem rationale

Globally, small-scale fisheries are known for their significant contribution to employment, food and nutritional security, livelihoods, poverty eradication, and community well-being (Basurto et al., 2025). These fisheries typically use low-tech and sustainable fishing methods using locally available materials made into gears such as handlines, small nets and traps. Small-scale fishers use small fishing vessels with a modest amount of capital and energy, usually make short fishing trips close to shore, and provide food and nutritional support mainly at the local communities (FAO, 2015a). According to the Food and Agriculture Organization of the United Nations (FAO), Duke University (DU), and WorldFish (2023) report (hereafter IHH 2023), around 492 million people around the world are directly or indirectly engaged in small-scale fisheries. Of them, 60 million are directly employed, 53 million are involved for subsistence income, and 379 million are involved for food and nutritional security (IHH, 2023). Small-scale fisheries contribute to more than 90% of the world's total fish production, and 90-95% of them are for human consumption (IHH, 2023).

Despite their significant contribution, small-scale fisheries are underestimated, marginalized, and undervalued in the decision-making process, and often compete against large-scale fisheries and other industries for fishing space, resources and government attention (Chuenpagdee and Jentoft, 2018). The numerous vulnerabilities, including overfishing, climate change, pollution and habitat destruction that small-scale fisheries face are multifaceted and multidimensional (Nayak, 2022). Islam and Chuenpagdee (2022) categorized the multifaceted vulnerabilities of small-scale fisheries into five key areas, (i) biophysical (climate change, habitat degradation, declining fish stocks), (ii) social (low education, gender bias, health risks, resource conflicts), (iii) economic (market instability, high fishing costs, poverty), (iv) technological (destructive gear, outdated equipment), and (v) governance (weak policies, exclusion from decision-making, corruption). They found that these vulnerabilities are further accelerated by external pressures, such as industrial competition, climate variability and unsustainable development. A report by the State of World Fisheries and Aquaculture (SOFIA) in 2016 stated that "declining fisheries resources; degraded aquatic habitats; other more-powerful sectors outcompeting small-scale fishing communities for access to land and water; unequal power relations; lack of access to services; and limited participation in decision-making, often leading to unfavorable policies and practices within and beyond the sector" (FAO, 2016, XX). Thus, considering the direct and potential contribution of small-scale fisheries, the vulnerabilities that small-scale fisheries face need to be addressed for the sake of fishers, the communities, and the society at large that benefits from the services of small-scale fishers. A transition toward viable and sustainable small-scale fisheries is crucial for the well-being of the small-scale fishers and the society at large.

A transition from vulnerability to viability for small-scale fisheries is complicated, with different stages and processes. The transition processes are often complex and non-linear, which involve changes in structure, culture, and practices at different levels and scales of a societal system (Patterson et al., 2016; Feola, 2015). The transition processes also cause a gradual and

continuous change in a society's structure, attitudes, and institutions (Rotmans et al., 2001; Todaro and Smith, 2012). In making small-scale fisheries sustainable, a transition indicates regime changes involving fundamental shifts in their social, economic, technological and institutional (Mathias et al., 2020; Nayak and Armitage, 2018; Haberl et al., 2011). Some of the processes of making a shift in the society's regime include innovation (e.g., social, economic, technological and institutional), collaboration, knowledge integration, and learning (Hölscher et al., 2018). In the past, regime shifts were observed in the development of the fisheries sector from traditional to industrial societies, starting mainly in the 18th century (Smith, 2000). As part of the traditional to industrial society movement in the 18th century, changes took place in the practice and culture of fisheries due to the large-scale development in their technological, social, economic, environmental and policy (Van Hoof et al., 2020). The fisheries sector, which used to be mainly traditional and small-scale, started adopting modern techniques and approaches, resulting in competition, conflicts, overexploitation, stock collapse, and eventually increased vulnerabilities of small-scale fisheries (see, for example, Bavinck, 2011).

Different initiatives are taken at different levels and scales for the sustainability and viability of fishing communities (Salomon et al., 2014; Visbeck et al., 2014; Quaas et al., 2018). For example, at the international level, in 2015, the member states of the Food and Agriculture Organization of the United Nations (FAO) endorsed a set of guidelines, i.e., Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). The aim of the SSF Guidelines is to encourage governing institutions, including state and civil society organizations, to take necessary steps to bring changes and improve the sustainability and viability of small-scale fisheries (FAO, 2015b). At the regional level, for instance, the Dutch took the initiative for a more nature-inclusive circular fisheries system (Österblom et al., 2011), which allows small-scale fisheries to benefit as well. At the national level, Costa Rica took initiatives to increase the participation of small-scale fisheries and considered their rights and voices in making policies to make Costa Rican small-scale fisheries ecologically and socially sustainable (Sabau, 2017). While the initiatives, such as international law, voluntary guidelines, bilateral agreements, and state/community institutions at different levels and scales, are encouraging, these institutions are fragmented in terms of their scale of operations and show qualitative differences in terms of what substances they have and how they process, when it comes to transboundary fisheries system (SESs) (Doria et al., 2020; Scholtens and Bavinck, 2014). Transboundary fisheries system refers to the fisheries resources of a shared ecosystem spanning across two or more countries' jurisdictions (Scholtens and Bavinck, 2014).

The vulnerabilities of small-scale fisheries are often considered as 'wicked,' which has no easy fix, is not clear when they are solved, tends to reappear, and has no right or wrong solution to scientifically determine (Nayak, 2022; Jentoft and Chuenpagdee, 2009; Rittel and Webber, 1973). The wickedness of small-scale fisheries vulnerability to viability transition is further complicated by the transboundary nature of small-scale fisheries in a shared fisheries system. Fisheries resources are highly diverse, mobile, and porous, and it becomes difficult to manage in shared social-ecological systems (Hossain et al., 2019; Nyikahadzoi et al., 2017). The target fish species move across political and jurisdictional borders, which may make fishers travel across boundaries in order to access the fish, resulting in competition and conflict between fisheries groups and governing stakeholders (Scholtens et al., 2019). Additionally, a number of

institutions at different scales and levels are involved in managing the dynamic transboundary fisheries resources (Doria et al., 2020). The stakeholders rely on transboundary fisheries resources representing different groups, ethnic backgrounds, and cultures. Therefore, another challenge related to the transboundary SES is the inclusiveness of the governance arrangement, for example, providing space for small-scale fisheries (Scholtens, 2015; Chuenpagdee et al., 2005). This recognizes that transboundary fishing is a tricky fisheries governance that demands an understanding of challenges related to different cultures, the socio-economic conditions of the communities, and scales and levels of operation and governance. Developing administrative goals in addressing the vulnerabilities of small-scale fisheries and moving toward viability in transboundary fisheries systems is thus wicked, especially related to scalar mismatch, power imbalances and linkages of one issue to other bigger issues, e.g., geopolitical disputes (Scholtens, 2015).

The governance for the viability of small-scale fisheries in a transboundary fisheries system often focuses on a particular boundary within national jurisdiction. Each jurisdiction has its own plans, policies and programs. On the contrary, the sustainability of such shared social-ecological systems faces common threats, such as climate change-induced salinity intrusion, resource depletion, sea-level rise, biodiversity loss, and seasonal natural disasters, for example, cyclones (Doria et al., 2020). These threats are likely to be beyond the capacity of a single jurisdiction. Therefore, the administrative focus of a single jurisdiction falls short of addressing the greater issues of the transboundary SES. The transitions toward the viability of small-scale fisheries in a transboundary fisheries system require a collective decision-making process across jurisdictions. In transboundary fisheries, transition processes require the involvement of all the relevant actors, their networks, ideas and perspectives across the scales and boundaries, which is often difficult and absent in practice to a great extent (Jentoft et al., 2010; Schlüter et al., 2021). It is likely to be difficult for different governing actors from different jurisdictions to agree on a common interest or goal, i.e., the viability of small-scale fisheries. The differences in priorities and interests of different countries are one of the main barriers to developing transboundary governance plans (Scholtens, 2015). Thus, the governance of transboundary small-scale fisheries is arguably a governability challenge (Bavinck et al., 2013). This means that vulnerability to viability transition in small-scale fisheries in a transboundary fisheries system depends both on the characteristics of the fisheries system and the structure and function of the governing systems (Jentoft and Chuenpagdee, 2015; Chuenpagdee and Jentoft, 2013).

While different concepts (e.g., ecological modernization) (Davidson and Frickel, 2004) and approaches (e.g., Sustainable Livelihood Approach) (DFID, 1999) across the disciplines explain vulnerability and viability separately, such concepts and approaches are rarely available to explain vulnerability to viability transitions. Only a few studies have touched base on vulnerability to viability transitions, for example, Nayak and Armitage (2018) and Nayak and Berkes (2019). However, no such research has explored the concept of vulnerability to viability transitions from the transboundary fisheries context. Therefore, a gap exists theoretically and empirically in understanding the vulnerability to viability transitions at different scales and levels. This research, therefore, emphasizes having a comprehensive understanding of the vulnerabilities of small-scale fisheries in the Sundarbans mangrove forest, a transboundary SES between Bangladesh and India in the Bay of Bengal. The research also focuses on the initiatives

that have been taken to move toward viability and the key challenges that administrative units face in facilitating the transition.

1.2 Research purpose, objectives, and key contributions

As explained, the literature relevant to vulnerability to viability (V2V) falls short of explaining this transition concept appropriately. Therefore, the purpose of this research is to develop a comprehensive understanding of small-scale fisheries' vulnerability to viability transitions and identify the key characteristics of governance arrangements that can help facilitate the transition in the Sundarbans transboundary small-scale fisheries. To achieve this purpose, this dissertation pursues three specific objectives.

1. To determine the key processes and mechanisms of vulnerability to viability transitions in small-scale fisheries.
2. To explore the key vulnerabilities and the factors that hinder or facilitate transitions toward viability for small-scale fisheries in the transboundary Sundarbans.
3. To examine the governability of the governing system to facilitate vulnerability to viability transitions.

The objectives of this are interconnected, and findings are presented in three manuscripts (Chapters 2-4) for peer-reviewed publications. The first manuscripts (Chapter 2) contribute to achieving the first objective. Drawing from a scoping review of the literature, the first manuscript assesses the patterns and sources of small-scale fisheries' vulnerabilities and the responses at the community, non-government and government levels to address them. Based on the scoping literature review findings, the chapter introduces a conceptual framework to help assess the governance of vulnerability to viability transition. Using this conceptual framework and based on empirical data, the second manuscript (Chapter 3) contributes to achieving objective two by assessing the vulnerabilities of small-scale fisheries in the Sundarbans' transboundary fisheries system. It also assesses the factors that hinder or facilitate vulnerability to viability transitions. The conceptual framework is used as theoretical and analytical framework for Chapter 4. Using empirical evidence, the third manuscript (Chapter 4) contributes to achieving objective three by assessing the governability of transboundary small-scale fisheries in the Sundarbans mangrove forest between Bangladesh and India. It examines the capacity and quality of the existing governing system.

The research through this dissertation makes a noble and original contribution to the advancement of knowledge in three main ways. Firstly, the research contributes to the understanding of the vulnerability to viability transitions in small-scale fisheries from their social-ecological systems and governability perspectives. This research draws on complex social-ecological systems in a transboundary fishery and examines the issues related to scales or boundaries and the capacity and quality of governing systems. Secondly, the research integrates knowledge from the relevant disciplines and develops a methodological framework to assess the vulnerability to viability transitions of small-scale fisheries. The framework is tested and validated through the empirical findings in this study. Therefore, this research makes a significant contribution to the theoretical development process of vulnerability to viability transitions. Finally, the research contributes to the sustainability literature areas, identifying the

processes and characteristics crucial for viable small-scale fisheries in a transboundary fisheries system. The core of sustainable small-scale fisheries is to manage human-nature relations and interactions (Salas et al., 2018; Glaser et al., 2010). This study finds the relevance of viability and sustainability to the transboundary fisheries system, the governance system, their mechanism and interactions. This research critically analyzes the connection between these areas and how they inform vulnerability to viability transitions and small-scale fisheries' sustainability.

This research also makes important applied and policy contributions. The outcome of this research indicates whether the existing policies and the governance structure fit into the vulnerabilities of small-scale fisheries. Through this research, the identified characteristics of how vulnerability to viability transition looks like help the governing actors to make relevant changes. Furthermore, the results show to what extent the capacity of the existing governing system can enable a viable transboundary fisheries system. It also indicates the areas that the governing system should (re-)consider improving the quality of its governance. Therefore, the immediate findings of this research help the respective departments of the Governments of Bangladesh and India make changes to the existing policies and formulate policies for future discourse in the context of vulnerability to viability transitions. These research findings advocate for the participation of small-scale fishers in the decision-making process. It also advocates safeguarding the rights (e.g., participation, equity and equality) and entitlements (e.g., food and nutritional security) of small-scale fishing communities. The research promotes the inclusiveness and diversity of small-scale fisheries within Bangladesh and India, as well as across borders in the decision-making process.

1.3 Literature review and conceptual framework

In accordance with research objectives, the dissertation integrates three groups of literature, i.e., development theories and approaches[1], social-ecological systems and governance. As presented in Figure 1.1, this research finds that these areas are interconnected and help explain the transitions from vulnerability to viability of a social-ecological system. The relevant development theories and approaches explain the developments and changes in social-ecological systems (Potter, 2014a; Singh, 2010). The development theories also help conceptualize small-scale fisheries' vulnerabilities and identify the processes crucial for viability. Given that the transition process is deeply political (Patterson et al., 2016), the analysis of development theories and approaches and social-ecological systems suggests the role of governance in facilitating the vulnerability to viability transitions.

[1] Here, this study defines the theory is a system of principles, assumptions and relationships established to explain a set of phenomena or facts. Evidence through empirical research shape the theory (Fisher et al., 2005). Theories are not perfect all the time as empirical evidence can either support it or show inadequacies. Approaches refers to methodology or perspectives. In short, theories explain how the different phenomena or facts are related to one another and approach is the obtaining those facts in the first place.

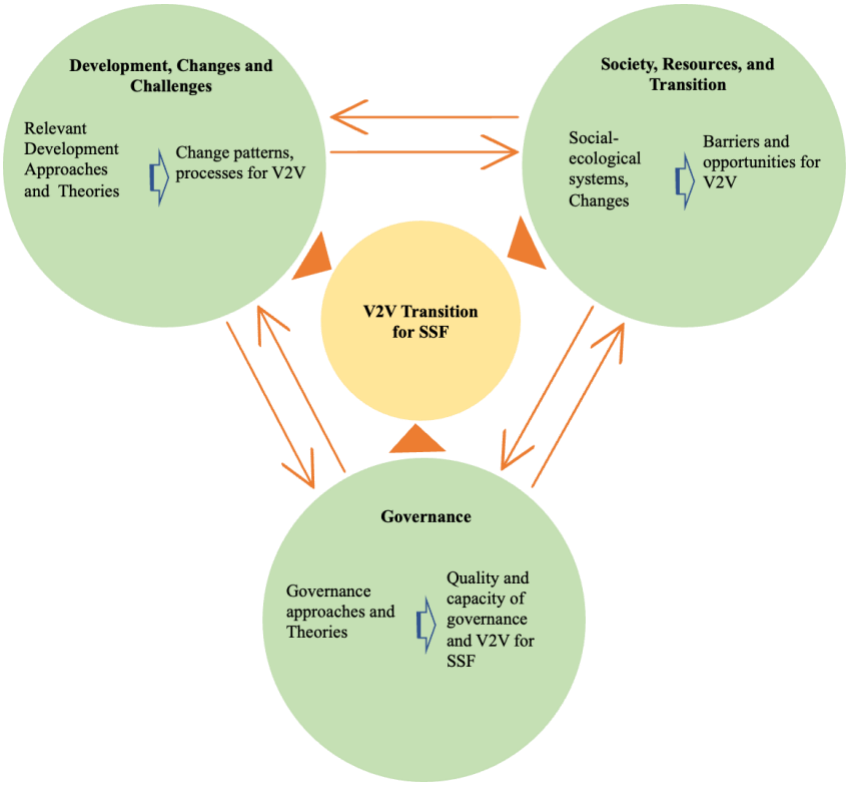

Figure 1.1 The conceptual framework in the context of vulnerability to viability transition for small-scale fisheries.

1.3.1 Development theories and approaches in understanding V2V transitions

The society we live in has come through a lot of changes and developments over time in its social, cultural, economic and political dimensions. According to Todaro and Smith (2012), "development" is a multi-dimensional process that involves major changes in the structure, attitudes, and institutions of a society. It also makes progress in achieving economic growth, reducing inequality, and eradicating poverty. The drivers and facts of societal development and changes are explained differently in different development theories. Development theory usually refers to the leading theories that explain the facts and changes over the course of human societal development (Potter, 2014b; Pieterse, 2010; Schuurman, 2007). An analysis of the major development theories and approaches related to fisheries below helps interpret development efforts carried out in developing countries. These theories and approaches show how the core ideas of these theories and approaches have motivated the advancement of fisheries.

1.3.1.1 Development Economics

Development economics studies developing countries' economic progress, performance, and economic transformation (Potter, 2014a; Ray, 1998). In the 1950s, it became a subdiscipline of economics when the policies started to focus on economic growth in developing countries. De Janvry and Sadoulet (2015) see development economics as a problem-solving approach to solve the underdevelopment problem, considering countries' own constraints, opportunities and

priorities. Many countries failed to address development-related vulnerabilities such as shocks, inequity/inequality, and unsustainable development (De Janvry and Sadoulet, 2015). These, along with instability, internal violence, less participatory governments, and unequal power distribution, increased the vulnerabilities of the societies (Wang et al., 2008). At the same time, some positive outcomes, including rapid income growth, reduction of extreme poverty, and satisfaction with basic needs, are also observed (De Janvry and Sadoulet, 2015). It indicates that the long-term practice of the positive outcomes of development can potentially contribute to making societies viable. For this, economic and technological innovations are crucial (Wang et al., 2008). The innovation of environmentally friendly technologies for harvesting fish widened the opportunities and income for fishers worldwide (Selgrath et al., 2018; Butcher, 2004). However, to a large extent, innovative economic initiatives (e.g., blue economy) and technology (e.g., trawl fishing) have created income and livelihood-related vulnerabilities for small-scale fisheries (Bavinck, 2001, 2011).

1.3.1.2 Modernization

Modernization theory emphasizes the strategies that speed up economic progress. The description of modernization, in most cases, starts with technological and economic changes, which result in changes in social structures, cultural values, and political institutions (Nolan and Lenski, 1999). Modernization theories suggest that traditional societies, which exist more in developing countries, need to adopt the features of modern societies and make changes accordingly in order to make economic progress (Inglehart and Welzel, 2007). Some scholars argue that modernization emphasizes economic growth, social progress, and broad participation in politics (Singh, 2018; Acemoglu et al., 2009). In the case of fisheries, social progress and broader participation, along with the diversification of income options and technological advancement, have the potential to make societies viable against the social and environmental stresses they face (White and Scheld, 2022; Beaudreau et al., 2019). However, Condorcet (1979) and Burke (1999) suggest that technological innovations and economic growth can inevitably change human moral values. The idea of modernization creates dependency and exploitation of developing countries, undermining the socio-cultural aspects of these countries (Schuurman, 2014; Wallerstein, 1974).

1.3.1.3 Dependency

Modernization theory is closely linked to dependency theory. The dependency theory emerged in the context of the development and underdevelopment of the international political economy (Potter, 2014a). It is believed that each country goes through an underdevelopment stage (Ziai, 2007; Rostow and Rostow, 1990). Developing countries depend on developed countries to pass their underdevelopment stage (Dos Santos, 2002). For example, the development of fishing technology started in Europe and North America, which was later followed by the newly independent countries in Asia after World War II (Bavinck, 2011). It helped governments of developing countries develop the fisheries sector and enhance their capacity to exploit fisheries resources. The dependencies are not always from developing to developed. For example, developed countries are also dependent on developing countries for fish. Particularly, European countries have increased their dependency on developing countries to fulfill their fish demand (Belhabib et al., 2018; Alder and Sumaila, 2004).

1.3.1.4 World System

The world system theory came as a direct critique of the dominant modernization theory in the mid-twentieth century (Singh, 2010, 2003). The world system as a world economy is integrated through markets, in which different regions are independent in terms of necessary goods and services, such as food, fuel, and protection, and two or more polities get involved in a competition for domination without the emergence of a single centre forever (Goldfrank, 2000; Wallerstein, 1974, 1976). The structure of the world system suggests a power hierarchy between the 'core' and 'periphery' societies (Singh and Eisenmenger, 2010; Martínez-Vela, 2001). The core societies (e.g., Western countries) largely shape the structure of the economic development of the periphery (e.g., developing coastal states) in terms of trade, infrastructure development, and exploitation of resources (Alder and Sumaila, 2004). Although the core societies enjoy the most technological and institutional benefits in practice, appropriate innovation of technology for accessing global development information and institutions can contribute to small-scale fisheries' vulnerability to viability transition (Ison and Straw, 2020; Hölscher et al., 2018). For example, countries can become pioneers through the innovation of technologies, get rid of destructive fishing practices, and ensure the sustainable utilization of fisheries' resources (Selgrath et al., 2018).

1.3.1.5 Globalization

Similar to the world systems theory, globalization emerges from the global mechanisms of greater integration, emphasizing economic transactions (Herod, 2014; Kaplan, 1993). Meyer (2007) sees globalization as an exchange and as cultural and institutional. The globalization theory helps us understand both the negative and positive outcomes for societies. For example, in many cases, the integration of small-scale fisheries into the global market mechanisms and structures and the globalization of fish and fisheries products resulted in vulnerabilities related to livelihoods, economy and ecology across the scales and levels (Crona et al., 2015). Further, the globalization of fisheries products negatively affects local social, economic and institutional aspects (Daly and Chuenpagdee, 2020). At the same time, the advancement of communication and access to global market information allows fishers to prepare their products to sell and make them popular in other countries (Bhuiyan et al., 2021). Small-scale fishers increase their income and establish a cross-cultural relationship between countries through the integration of markets (Advani, 2020).

1.3.1.6 Sustainable Livelihoods

The livelihood theory is people-centred and focuses on reducing poverty (Allison and Ellis, 2001). Chambers (1995, p. vi) defines livelihoods as "*the means of gaining a living.*" The term "sustainable livelihoods" has gained popularity in the last few decades. Some key elements of sustainable livelihoods include the creation of employment, well-being, livelihood adaptation and resilience, poverty reduction, and natural resource base sustainability (Scoones, 1998). The sustainable livelihoods approach suggests learning from the practices of societies about what facilitates or prevents societies from earning a viable livelihood. Learning is an important process that can shape the transition from vulnerability to viability (Hölscher et al., 2018). For example, the sustainable livelihood approach aims to reduce poverty and vulnerability of small-

scale fishing communities (Apine et al., 2019; Béné and Neiland, 2004). The importance of small-scale fisheries' sustainability is broadly recognized within fisheries management and policy (Allison, 2001; Pauly, 1997). However, the scope of sustainable livelihoods needs further explanation regarding setting priorities and what is important for people.

1.3.1.7 Well-being

The notion of well-being and the capability of people provides a wider scope to understand the livelihoods approach. The understanding of well-being is a broad-based outcome, including material goals (e.g., income and food supplies) and non-material aspects (e.g., safe work conditions) of the natural resources (ILO, 2011; Garcia and Cochrane, 2005). The multidimensional nature of well-being contrasts with a narrow, single-objective view in many cases. For instance, at the national/state level of economic development, the well-being of an individual, community or state is often narrowed down to monetary values (Elliot, 2014). Industrial fisheries, for example, have been given favour due to their economic efficiency and export earnings (Charles, 1988), which further increase vulnerability, for instance, conflicts among the fishers (Schuhbauer et al., 2017). Understanding well-being helps draw the attention of governing actors to the non-material benefits as well as fishing communities' social and economic dynamics (Coulthard et al., 2011; McGregor, 2008).

1.3.1.8 Freedom, Entitlements, Rights and Access

The well-being of people in a society is connected to freedom, entitlements, rights, and access. Freedom entails all forms of economic freedom, civil rights and political liberties (Chauffour, 2011). Economic freedom is the basic liberty that people have reason to value. Economic freedom and free markets satisfy human demand, technological progress, and overall economic growth (Chauffour, 2011; Friedman, 2005). The expected economic benefits are not possible if civil and political rights are violated (Sen, 1999).

Given the political circumstances, the state may require different activities to foster direct growth, promote development, and achieve various social objectives, such as reducing social inequalities and promoting social justice (Elliot, 2014; Chauffour, 2011). These activities typically involve different political solutions that entail an enlargement of the scope of the state and the creation of entitlements, such as food security, health, education, housing, work and adequate standards of living. Countries that favour free choices over entitlement rights are more likely to achieve sustainable economic growth (Sen, 1999), which is similar to small-scale fisheries' access to fisheries resources and markets (Jentoft et al., 2010).

According to Ribot and Peluso (2003, p. 153), 'access' is "*the ability to benefit from things—including material objects, persons, institutions, and symbols.*" Their interpretation of access is who and in what processes benefit from resources. For example, evidence suggests that only a few people and institutions control fisheries access (O'Neill and Crona, 2017; Rodrigues and Villasante, 2016). The understanding of access and its mechanisms can help analyze resource conflicts, for example, industrial vs small-scale fisheries and aquaculture vs capture fisheries, and how those conflicts can become a means of gaining or losing benefits from fisheries resources by different actors (Parlee et al., 2021). Therefore, the understanding of freedom,

entitlements, rights and access indicates the importance of institutional innovation (e.g., access mechanisms) and collaboration in order to facilitate small-scale fisheries' vulnerability to viability transition. The actions and initiatives of the governing institution are particularly important.

1.3.2 Transitions in Social-Ecological Systems

The dynamic social-ecological systems are changing/transitioning fast. The term "Transition" is used to analyze the thorough, non-linear, and structural changes in complex systems (Patterson et al., 2016). For sustainability transitions, researchers use "Transition" to indicate the fundamental, social, economic, technological and institutional changes from one regime to another (Mathias et al., 2020; Nayak and Armitage, 2018; Haberl et al., 2011; Rotmans et al., 2001). The analysis of transition focuses on the process and draws change patterns, and explains how the shift from one regime to another is facilitated or impeded (Hölscher et al., 2018). The processes include social, economic, technological and institutional innovation, collaboration, knowledge integration, and learning (Hölscher et al., 2018).

Over the last two million years, we have exploited almost the entire biosphere on Earth (Fischer-Kowalski et al., 2014; Haberl et al., 2011). This colonization of the biosphere has resulted in the creation of SESs, where socio-economic and ecological processes co-regulate the fundamental patterns and processes of SESs. Berkes and Folke (1998) define SESs as complex and integrated systems where humans are connected to nature as part of it. Ostrom (2009) suggests that all humanly used resources, including fisheries, lakes and forests, are embedded in complex SESs. The perspective on SESs focuses on mutual feedback between social and ecological sub-systems and the results of uncertainty, cross-scale feedback, and non-linearity (Nayak and Armitage, 2018). The changes in sub-systems affect the overall SESs. Haberl et al. (2011) characterize the evolution of the SESs as a stable configuration for a certain regime and denote them as "socio-metabolic regimes." They also divide and differentiate the transition of the regimes into three fundamental socio-metabolic regimes, i.e., hunter-gatherers, agrarian, and industrial societies. As Modernization theory suggests, following the global North, the majority of the current world's population is in transition from an agrarian to an industrial regime (Haberl et al., 2011), which is also observed in small-scale fisheries (Boonstra et al., 2019; Nayak and Armitage, 2018). One of the main drivers of this current regime transition is achieving economic growth (Potter, 2014b; Singh and Eisenmenger, 2010), resulting in the overexploitation of natural resources (Colloca et al., 2017) and disturbing fundamental socio-economic and ecological processes (Ison and Straw, 2020).

As the fisheries resources are mobile in nature and travel across national boundaries, the developments and transitions in transboundary fisheries SESs have increased concerns, such as ecological sustainability and social justice for small-scale fisheries (Scholtens, 2015). Transboundary fishing has a long history (Butcher, 2004), but only recently has it received attention from policymakers and fishery managers because of the overexploitation of migratory fish stocks, such as Salmon, Billfish, Shark and Tuna (White and Costello, 2014). Since migratory fish travel across borders, habitat quality and connectivity are important for the proper management of important fisheries resources and their stocks. Habitat connectivity between borders often poses a challenge for fishery managers (Hossain et al., 2019). The exploitation of

transboundary fisheries resources has increased tensions between neighbouring countries and led to the making of bilateral agreements, voluntary guidelines, and state and community institutions to deal with the transboundary issues (Russell and Vanderzwaag, 2010).

Industrial fishing practices have been leading the transboundary concerns and disputes between countries ever since the transition processes started to move toward large-scale modern fishing techniques, such as trawl fishing (Bavinck, 2001, 2011). This movement has notably marginalized and increased the vulnerabilities, such as a decline in fish catch, poor income, and competition with other industries for small-scale fisheries. The transition in fisheries has also led to the changes/formation of policies regarding transboundary fisheries resources, which, in most cases, further restrict small-scale fishers from accessing fisheries, for instance, a 65-day fishing ban on transboundary fishery (*Tenualosa ilisha*) in Bangladesh (Rahman et al., 2020). The negative consequences of the growth of industrial fisheries as part of the fisheries social-ecological transition on small-scale fisheries are irreversible and further contribute to the wickedness of the governance (Chuenpagdee and Jentoft, 2013). It is unlikely for the governance system to stop industrial fisheries and address the vulnerabilities of small-scale fisheries. The reasons include the past and ongoing capital investments in industrial fisheries, the strong connections among the industrial fishers, traders, and loans system, poor alternative livelihood options, political support, and the government's economic growth-based agendas (Scholtens, 2015). Therefore, it is essential to find ways to address the vulnerabilities of small-scale fisheries in transboundary SESs, analyzing the past and present factors and moving toward viability.

1.3.3 Governance

With large-scale changes in the social, economic, cultural, political, and natural environments, societies have become more diverse, complex, and dynamic (Kooiman, 2008). This has led to changes in the management approaches and the role of the governments (Chuenpagdee and Jentoft, 2018; Kooiman, 2008; Schuurman, 2007). A gradual transition has been observed from traditional management modes to new governance patterns involving state-society interactions (Chuenpagdee and Jentoft, 2018; Armitage et al., 2012; Dixon et al., 2003). The new patterns of governance aim to govern societies more comprehensively with broader participation, address limitations, and minimize the negative consequences of conventional management. Governance refers to the broader processes and involves different institutions through which different actors make collective decisions in dealing with social-ecological changes (Bundy et al., 2017; Oakerson, 1992). The current era of governance considers the importance of state-society interactions, the knowledge and experiences of relevant actors, and the complexities of the societies. The emerging governance theories and approaches, such as polycentric, adaptive, and interactive governance, acknowledge that the government is no longer the ultimate authority of decision-making in dealing with complex social-ecological and environmental changes and promote the importance of non-state actors' participation (Partelow et al., 2020; Armitage et al., 2012). This research analyzes the following relevant governance approaches, their structure, functions and mechanisms and examines their relevance to the vulnerability to viability transition of small-scale fisheries.

1.3.3.1 Polycentric governance

Vincent Ostrom introduced the Polycentric governance theory in the early 1960s (Ostrom et al., 1961), which consists of different autonomous units. Each unit accounts for the other by taking action and interacting with the processes of cooperation, conflicts, and competition (Ostrom, 1991; 2010). A polycentric governance system has a diverse array of decision-making capacities, making it capable of adapting to dynamic changes and modifying when required (Carlisle and Gruby, 2019). The multi-level configuration of the governing units enables the governing arrangements to keep a balance between centralized and decentralized governance (Lubell and Robbins, 2022; Imperial, 1999). However, the involvement of different stakeholders in decision-making with what roles are not explicit (Mudliar, 2021) often overlaps (Mudliar and O'Brien, 2021; McGinnis and Ostrom, 2011). This makes the actors fail to realize their potential and affects preparedness plans (Pittman et al., 2016).

1.3.3.2 Co-management

Collaborative management or co-management refers to the "*sharing of power and responsibility between the government and the local resource users*" (Berkes et al., 1991, p. 12). The basic idea behind co-management is that local resource users should have a say, especially if management decisions affect their livelihoods (Berkes, 2009). Co-management focuses on managing both the resources and relationships among the relevant actors (Alexander et al., 2015; Berkes, 2009). It can be recognized as good for allocating resources, exchanging resources, linking different organizations, reducing transaction costs, risk sharing, and conflict-sharing mechanisms (Alexander et al., 2015; Carlsson and Berkes, 2005). Co-management makes bridges between organizations and widens the opportunities to respond to social-ecological changes (Folke et al., 2005). One of the main drawbacks of co-management is that it is unlikely to capture the complexities, dynamicity and scale issues related to governing natural resources (Tilley et al., 2019; Plummer and FitzGibbon, 2004).

1.3.3.3 Adaptive governance

Adaptive governance is the process of testing and revising institutional arrangements and ecological knowledge through a dynamic, ongoing and self-learning process (Folke et al., 2002). The premise of the theory is to reduce uncertainty through interactive learning by doing (Chaffin et al., 2014). The hypothesis of adaptive governance theory is that a more adaptive governing system that can change and function within a societal system is more effective in achieving societal goals, such as sustainability. It recognizes the links and mechanisms between social and ecological processes across different levels (Partelow et al., 2020). Adaptive governance employs a polycentric institutional arrangement involving local to higher organizational levels and operates on multiple scales (McGinnis, 1999; Ostrom, 1996). The theory promotes broader stakeholder participation by sharing governing responsibilities, power, and rights.

1.3.3.4 Interactive governance

Given that no single actor holds the knowledge and resource capacity to tackle the problems unilaterally (Kooiman, 1993), the idea of governance came up as an interactive process. The decision-making process allows active interaction with different actors in terms of participation,

collaboration, knowledge integration, compliance or non-compliance, and management decisions (Kooiman et al., 2005). The interactive governance theory follows these processes in dealing with complex social issues, such as social justice, poverty, food security and food safety, and provides opportunities to solve them (Chuenpagdee et al., 2005). The interactive governance recognizes that fisheries are diverse, complex, dynamic and operative at various scales. These characteristics become fundamental building blocks of the governance structure and must be carefully studied in assessing the governance potential (Jentoft, 2007). From the interactive governance theory perspective, a fishery system consists of three sub-systems: the system-to-be-governed, the governing system, and the governing interaction. This systemic approach allows a thorough inspection of fisheries management-related complexities (Kooiman et al., 2005).

1.4 Empirical Context

This research was carried out in the Khulna region of Bangladesh and West Bengal in India since the Sundarbans stretched over those areas (Figure 1.2). The Sundarbans is the largest single continuous mangrove forest in the world, which lies in the deltas of the Ganga-Brahmaputra-Meghna rivers. The Sundarbans comprised numerous islands formed by the sediments deposited from the flow of three rivers. The forest has been shared between Bangladesh and India since 1947. The forest covers 10,017 km^2 over Bangladesh (60%) and India (40%) (FD, 2010).

The Sundarbans are known for supporting rich floral and faunal biodiversity, supplying potential goods and services for human societies, and playing critical ecological roles (Islam et al., 2018; Rahman et al., 2018; Islam and Hossain, 2017). On the Bangladesh side, around 334 species of trees, herbs, and shrubs are listed, and about 100 species are on the Indian side (Rezwan, 2019; Seidensticker and Hai, 1983). Among the faunal diversity in the Bay of Bengal, the Sundarbans provide suitable feeding, breeding and nursery ground for 177 species of fish and 315 birds in the Bangladesh Sundarbans and 165 species of fish and 300 birds in the Indian side, along with more than 600 mammals found on both sides (Gopal and Chauhan, 2018). Besides, the forest supports about 240 species of crustaceans, 200 sp. of insects, 143 sp. of molluscs, 41 sp. of platyhelminths, 68 sp. of nematodes and 70 sp. of polychaetes (Gopal and Chauhan, 2018). More than 12 million people live around the forest for their income and livelihood through paddy culture, shrimp farming, honey collecting, and fisheries-related activities (Raha et al., 2013). The Sundarbans provide ecosystem services, including provisioning (e.g., food and medicinal uses), cultural (e.g., ecotourism and recreation), regulatory (e.g., carbon sequestration), and supporting (e.g., pollination) (Islam et al., 2020).

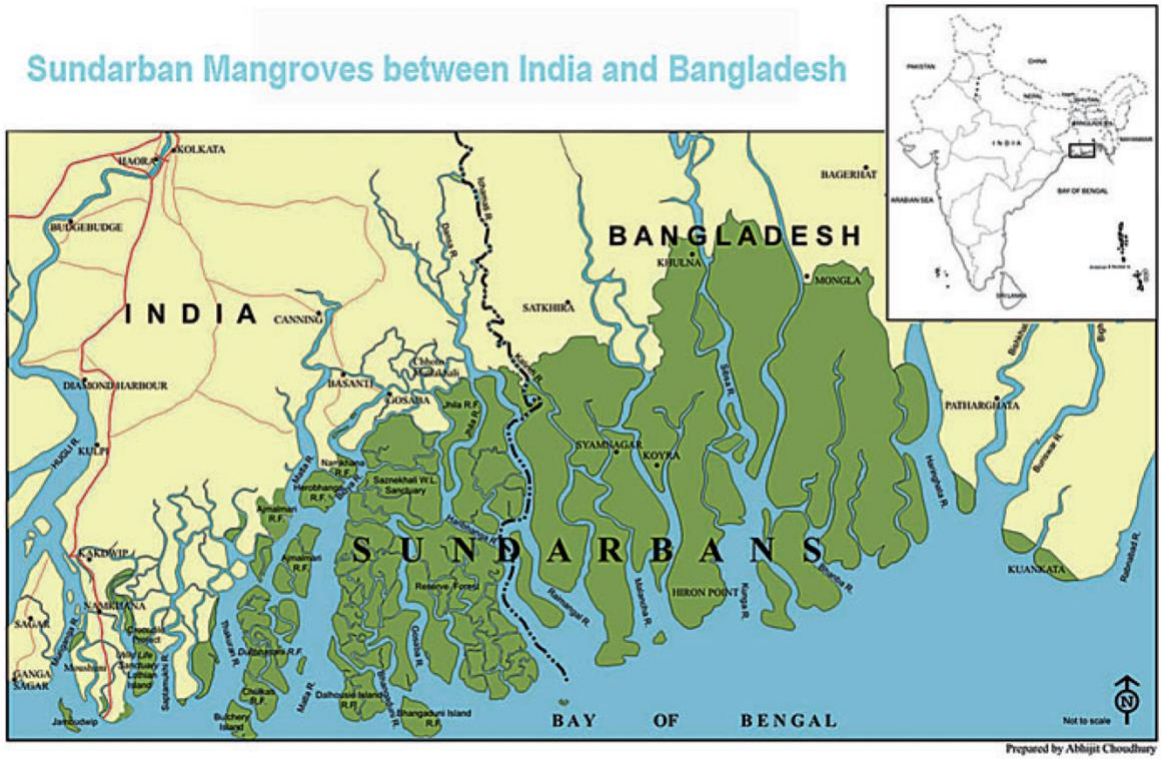

Figure 1.2 The map shows the geographical position of the Sundarbans mangrove forest between Bangladesh and India (Source: Gopal and Chauhan, 2018).

Historically, the Sundarbans have been exploited for timber, forest conversion into paddy and farming, and land reclamation for various other uses. It is estimated that about 428,000 ha of mangrove areas had been cleared out between 1776 and 1968 (Ghosh et al., 2015). The major threats to the ecological balance of the Sundarbans include the conversion of forests for agriculture and aquaculture (Seidensticker et al., 1987), alteration of hydrology through upstream irrigation and establishment of embankments (Chauhan and Gopal, 2014), sea level rise (Pethick and Orford, 2013), salinity intrusion, and pollution (Manna et al., 2010; Rahman et al., 2009). The sustainability of the resources of the Sundarbans mangrove forest thus largely relies on the ability of the governing system to govern efficiently to meet both human and environmental needs.

The governing system of small-scale fisheries in the Bay of Bengal is diverse, complex, and dynamic. For example, in the Bangladesh Sundarbans governing system, a diverse set of governing institutions exists at varying levels, such as fishing community organizations, traders' associations, boat owners' associations, transporters' associations, distributors' associations, exporters' associations, government organizations and other non-profit organizations. The position and interests of each governing institution do not necessarily complement each other (Islam et al., 2017), which characterizes the highly diverse nature of the governing system. Furthermore, the highly migratory nature of this fishery across borders makes it difficult to implement effective governance strategies (Merayo et al., 2020). The Government of Bangladesh passed a number of acts, ordinances, and rules to exploit, develop, manage and conserve the fisheries sector. These include the Protection and Conservation of Fish Act (1950), which was amended by the Protection and Conservation (Amendment) Ordinance (1982), and the Marine

Fisheries Ordinance (1983). The West Bengal (WB) government, India, has initiated a hilsa (*Tenualosa ilisha*) conservation plan, which includes restrictions on mesh size, juvenile capture, and periodic fishing bans (GOW, 2013). Recently, India's draft of the National Fisheries Policy 2020 focused on regional cooperation in managing and preserving common resources between countries.

Small-scale fisheries – targeting both fish and crab – in the transboundary Sundarbans face diverse vulnerabilities, including environmental, socio-economic, governance, geopolitical and health and safety concerns. Environmental vulnerabilities are primarily related to climate change and ecosystem degradation. Rising sea levels and increased salinity intrusion are altering fish breeding habitats, particularly for economically important species like hilsa and mud crabs (*Scylla sp.*) (Islam et al., 2020). Frequent cyclones (e.g., Amphan in 2020) destroy fishing gear and boats (Rahman et al., 2020). The socio-economic vulnerabilities are related to poverty, lack of alternatives, and exploitative market chains (Mozumder et al., 2018). The transboundary nature of the forest and differences in regulations in each country complicate the management of the forest. Fishers often suffer from the differences in governance actions (e.g., fishing ban) in terms of conflicts and competition, illegal crossing of the border, and harassment by the border security (Gopal and Chauhan, 2018). This sometimes results in long-term geopolitical disputes between Bangladesh and India. Besides, fishers often get exposed to life-threatening risks, including tiger attacks (*Panthera tigris*) and saltwater crocodile (*Crocodylus porosus*) encounters (Mozumder et al., 2018). Many fishers lack basic safety equipment, such as life jackets or communication devices, and emergency medical aid is scarce (Sarker et al., 2019). Therefore, addressing these vulnerabilities and moving toward viability is crucial for the livelihoods and well-being of the fishing communities living around the forest on both sides of the forest.

1.5 Research Design, Methodology and Methods

1.5.1 Study design, philosophical worldviews, and methodological approach

The transition from vulnerability to viability is a complex process that requires perspectives about social-ecological systems and interdisciplinary thinking. Understanding vulnerability and viability varies depending on context and disciplines, including economics, anthropology, psychology, and engineering. The vulnerabilities of small-scale fisheries are linked to both social and political dimensions. Therefore, I adopted the pragmatic worldview for this research as it allowed me to explore both the social and political dimensions related to small-scale fisheries. The pragmatic worldview provides freedom to choose methods, techniques, and research procedures that best meet the research objectives and goals (Cresswell and Creswell, 2018). Thus, it helps to develop an understanding of vulnerability to viability transition in the context of small-scale fisheries. The philosophical view of pragmatism arises from actions, situations and consequences. Under this worldview, researchers emphasize research problems rather than methods and employ all relevant approaches to understand the problem (Rossman and Wilson, 1985). Other scholars, such as Patton (1990), Morgan (2007) and Tashakkori and Teddlie (2010), also emphasize the importance of focusing on the research problem in social science research and employing all the relevant approaches to produce knowledge on the respective problems. Therefore, the pragmatic worldview ideally guided this research.

An inquiry of relevant disciplines, such as social science and political science, and systems, such as the social-ecological system, their governing system and interactions, is crucial to understanding the vulnerability to viability transition of small-scale fisheries. Similarly to this, pragmatism also does not rely on one particular system or reality. It applies a mixed method of research and draws liberally from both qualitative and quantitative assumptions when engaging in its research. For this research, I employed a mixed-method approach that offers more advantages in collecting data than using a single method. The mixed method allows capitalizing on the strengths of one method to counterbalance the weaknesses of another method. It may get the flexibility necessary to generate new insight into the object we study, for instance, people (Axinn and Pearce, 2006). The use of multiple methods can produce more comprehensive empirical results about a topic than either qualitative or quantitative alone and minimize the non-sampling error by providing unnecessary information from diverse sources (Creswell and Plano Clark, 2007). For data collection, I employed six methods, including a desk study, household surveys, semi-structured interviews, informal interviews with key informants, direct observation, and focus group discussions. The results from one method were fed into the other, which provided supplementary information and facilitated the interpretation of the research findings. For example, the results from the desk study and key informant interviews helped formulate context-specific and sensitive survey questions.

1.5.2 Selection of case study

This research employed case studies in the transboundary Sundarbans in Bangladesh and India. A case study is an in-depth analysis of a case undertaken over time, for example, policy, implementation process, participants, or an area of interest. This approach allows a researcher to choose a case that illustrates some features or processes in which the researcher is interested, according to some theories the research subscribes to (Silverman, 2005). The case study areas of this research were selected following the purposive sampling approach.

The research focused on the Sundarbans mangrove forest for the case studies, considering three factors, i.e., typical transboundary case, same language, and familiarity. The Sundarbans have rich biodiversity, support millions of small-scale fishers, protect the communities from natural disasters, and lie between two countries, i.e., Bangladesh and India. The forest represents a typical transboundary SESs on both sides. The small-scale fishers from both sides use Bengali as their first language, which gives me an extra advantage in understanding their input, the depth of knowledge, their feelings and emotions, as Bengali is my mother tongue too.

I have prior experience researching small-scale fisheries in the Sundarbans of Bangladesh for the last four years. In 2019, I studied different sustainability aspects (i.e., social, biological, and economic) of the small-scale mud crab fishery (*Scylla sp*.) in the Sundarbans. Again in 2020, I studied the same fishery, focusing on the access to markets for small-scale fisheries. Both studies made me realize that the fisheries' resources in the Sundarbans mangrove forest play a crucial role in terms of income and livelihoods for small-scale fishers as well as earning revenue for the country. At the same time, I found that small-scale fisheries are often marginalized and vulnerable to a number of challenges, such as natural disasters, poverty, social injustice, and lack of government attention. Those studies, in particular, made me more curious to know the situation on the other side of the forest, which is the Indian Sundarbans. Therefore, I considered

conducting this research in the Sundarbans and mapping the vulnerabilities and ways to viability for small-scale fisheries in the transboundary fisheries in the Sundarbans.

Further, I conducted extensive informal consultations with a couple of scholars using the Vulnerability to Viability (V2V) Global Partnership and Too Big To Ignore (TBTI) research network, of which I am also a member. Those scholars are experienced in small-scale fisheries research over there, which has favoured choosing the Sundarbans mangrove forest for the case studies. Furthermore, small-scale fishing villages around the Sundarbans mangrove forest are associated with poverty and low income, making them unable to bring positive changes. According to the criteria of theoretical sampling, small-scale fisheries in the Sundarbans area provide appropriate case studies. The insights or learnings from this study can likely be applicable to fisheries with a similar status. Also, an analysis of small-scale fisheries' vulnerability to viability in the Sundarbans may produce fresh knowledge of governing needs and capacities for both Bangladesh and India.

1.5.3 Sampling techniques

Data collection is a science, and careful planning is required to select the appropriate participants and data sources and analyze the data. There are two fundamental approaches for primary data collection: probability sampling and non-probability sampling. Probability sampling is used to generalize the characteristics of the research population based on the sample data, while non-probability sampling is used to explore the characteristics of the sample (Li and Zhang, 2022). This research used the non-probability sampling technique as it is often used in qualitative research to probe certain inquiries, for instance, small-scale fishers' or governors' behaviour or attitude, in detail, and the subjects are difficult to reach.

The common non-probability sampling techniques that researchers use include convenience, snowball, purposive, quota and key informant sampling. Among the common techniques, this research followed the snowball, purposive and key informant techniques. Snowball sampling techniques start with a certain number of research subjects/participants to gather data, and then get introduced to more research participants (Li and Zhang, 2022). The research started with selecting a certain number of research participants for the methods (e.g., survey questions or semi-structured questionnaire) for primary data collection, and then increased the sample size following the research participants' suggestions. Researchers use purposive sampling based on their judgment in accordance with the research purpose. I selected representatives from each actor in the small-scale fisheries supply chain, for instance, fishing community leaders, based on their roles, knowledge, ethnic background, and relevance to small-scale fisheries. Similarly, I did key participant sampling from the small-scale fisheries supply chain actors. These techniques were intended to include research participants who hold knowledge about the research questions and study area. I included the list of actors from whom I selected the key informant participants.

1.5.4 Research Methods

I used both secondary and primary data collection approaches for this research. Secondary data is the data that someone else collects and publishes in the form of journal articles, news portals, online blogs, documentaries, public talks, or reports. For secondary data collection, I conducted a desk study. Primary data is what a researcher finds, analyzes, and interprets from their field of work. For primary data collection, I used household surveys, semi-structured interviews with key

informants, informal discussions with key informants, direct observation and focus group discussions. This section describes the methods that were followed for the data collection and analysis. It includes sampling techniques the researcher followed and sources of data. It further discusses the methods the researcher followed to collect data from the data sources the researcher selected.

1.5.4.1 Desk Study

I conducted a desk study to analyze the resources available online, such as newspaper articles, legal documents, and bilateral agreements between Bangladesh and India related to the transboundary fishery in the Bay of Bengal and the Sundarbans. This helped enrich the background information in the study context and complemented the primary data. The term "Desk Study" refers to research that is carried out without physical investigations; thus, it can be done sitting in front of a computer at a desk (DBW, 2021). A desk study can be a preliminary study carried out before physical investigation, or it can be standalone research instead of physical investigation. This approach of study is less expensive and less time-consuming than physical investigation. A desk study can provide an initial understanding of the research topic, identify potential risks and inform the details, scope and subsequent actions to be taken.

The data I reviewed includes book chapters, journal articles, grey literature, government reports, proceedings of the regional symposium, and online news materials. Different strategies were used to collect the online materials, including Google search, direct search in fisheries-related organizations, and subscriptions to relevant websites and research networks, such as FAO, V2V Global Partnership, ICSF (International Collective in Support of Fisheries), and TBTI (Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research).

For Chapter 2, a scoping review of the literature was performed to examine the complex challenges small-scale fisheries face in transitioning from vulnerability to viability. The study followed a systematic approach, analyzing sources directly or indirectly related to vulnerabilities, responses to mitigate them, and the long-term sustainability of small-scale fisheries. The review aimed to (i) identify major vulnerability sources and corresponding mitigation strategies, and (ii) assess the effectiveness and durability of these responses in promoting viability. Relevant literature was sourced from databases such as Google Scholar and Scopus using targeted keywords and search parameters. Key search terms included "small-scale fisheries vulnerabilities," "artisanal fisheries vulnerabilities," "small-scale fisheries and viability," "sustainability in small-scale fisheries," "responses to small-scale fisheries challenges," "small-scale fisheries governance," "small-scale fisheries management," and "SESs sustainability," with a focus on peer-reviewed journal articles.

1.5.4.2 Household surveys

In Chapters 3 and 4, the data from household surveys were drawn. Surveys are known as the most common data collection method in social sciences. This method allows the researcher to set a range of questions for a large sample of participants. The participants usually provide responses to the survey questions on their own. There are two types of survey questions, i.e., open-ended and closed-ended questions. For open-ended questions, the choice of answers is not given, and the participants respond to the question based on their knowledge and experiences. On the other hand, the choice of answers is provided for the closed-ended questions so that the

research participants can choose from the given answers. In the closed-ended questions, the researcher uses "other" as the last option to choose in case the given answers are not something that participants wanted to respond to. I used both open-ended and closed-ended survey questions for this research. As Li and Zhang (2022) suggested, I followed the rules presented in Table 1.1 in structuring the survey questions.

Table 1.1 The rules to follow in structuring the survey questions (*Adopted from Li and Zhang, 2022*)

Rules
• Questionnaires should be spread out appropriately and uncluttered. • One question should be about one line. • Use contingency questions when necessary. • Format matrix questions to add readability of the questionnaire. • Place interesting items in the beginning (opposite to interviews). • Include instructions to the questions. • Include a disclaimer at the beginning of the questionnaire. • Offer to share the survey results with the respondents. • Pretest all or part of the questionnaire.

The survey was conducted using the snowball sampling method. The main criterion was the primary profession of small-scale fishing for the survey participants. Local community leaders' help was taken to select the research participants. This allowed me to collect their demographic information, socio-economic and cultural aspects, and the major transboundary issues they face. The desk study and scoping review helped prepare the questions. Once the questions were ready, I conducted in-person surveys. This allowed me to conduct a survey even if the participants are not literate. It also helped to see the actual feelings and emotions of fishers regarding their vulnerability to viability transition while they provide their input. The survey questions were designed in a way that doesn't take more than 40-60 minutes for each participant. In total, I conducted 151 household surveys, 99 of which were in Bangladesh and 52 in India. The results of the household surveys are presented in chapters 3 and 4 in different diagrams and charts.

1.5.4.3 Semi-structured interviews with key informants

In Chapter 3, the survey data were supplemented by the semi-structured interviews with key informants. In Chapter 4, the data were mainly obtained from the semi-structured interviews. Semi-structured interviews are one of the most used methods for data collection through conversation with one person at a time (Adams, 2015). This method allows for asking probing and follow-up questions, for instance, *why* or *how* and enables respondents to provide their perspectives, experiences, and reflections in their own words (Mason, 2004). This research employed semi-structured interviews that covered a wide range of topics related to small-scale fisheries' vulnerability to viability in the transboundary context. The interviews were carried out with key informants, including representatives from fishers, farmers, middlemen, local depot owners, exporters, early career researchers, academia and government officials from the Forest Department and Department of Fisheries. The participants were selected based on previous

research networks and suggestions made by the interviewed participants. Contacts were made over email initially. In case there was no response in a week, I followed up with another email and finally called them on their cell phone. Depending on the key informants' backgrounds, different themes, such as social-ecological systems, governance, vulnerability and viability, were focused on. The interview participants outlined their roles and relationships in the small-scale fisheries in the Sundarbans. I conducted a total of 32 semi-structured interviews, 18 in Bangladesh and 14 in the Indian side of the Sundarbans.

1.5.4.4 Informal discussion with key informants

Several informal discussions were carried out with key informants throughout the research. This provided qualitative contextual information for Chapters 3 and 4. This method is also useful in identifying the key processes and issues, interpreting data, and verifying interview results. The participants from both Bangladesh and India were selected based on previous research networks and expert suggestions.

1.5.4.5 Direct observation

The research partially relied on direct observation for qualitative data collection. This method helps complete the analysis and fill the information gap left by the above-mentioned study methods. Direct observation is an established research method that allows the researcher to participate in daily activities in the local community and learn about socio-cultural processes, patterns, relationships among people, and the organization of institutions (DeWalt and DeWalt 2002; Jorgensen 1989). The main activities as part of this direct observation include walking, participating in fishing activities, visiting fish markets, attending social events, and 'hanging out' with fishermen and village members.

1.5.4.6 Focus Group Discussions

Focus group discussions are commonly used methods to further solicit public input regarding public policies and projects (Greenbaum, 1993). Focus group discussions are effective methods for collecting primary data. Some of them are organized, while some are less organized. For this research, I conducted a couple of focus group discussions, each from Bangladesh and India, involving experts on small-scale fisheries in the Sundarbans mangrove forest and their vulnerability to viability transition. The participants consisted of representatives from academia, policymakers, extension departments, and non-government organizations relevant to transboundary Sundarbans governance. This allowed me to validate and cross-check the input from the small-scale fishing communities and other supply chain stakeholders, for example, traders and commission agents. The participants were limited to 15-20 for each focus group discussion in Bangladesh and India. The participants were selected based on their relevance to transboundary small-scale fisheries in the Sundarbans mangrove forest. The participants were asked to share their knowledge and experiences related to the vulnerability to viability transition of small-scale fisheries. Each session lasted for 90-120 minutes. The participants brainstormed to find out some of the possible drivers of vulnerability and opportunities to move toward viability for small-scale fisheries in the transboundary context. As the local communities hold the best knowledge, the focus group discussions thus allowed for some of the collective possible solutions for the transboundary issues and the viability of small-scale fisheries, and these are presented in Chapters 3 and 4.

1.6 Ethical considerations

The research complies with the University of Waterloo Statement on Human Research (2018) and was consistent with the Tri-Council Policy on research involving living human participants (TCPS 2, 2014). The core principles of this policy – respect for persons, concern for welfare, and justice- were maintained while the research was being conducted. The ethical standards of this research were confirmed during the review of this research by the University of Waterloo's Research Ethics Board prior to initiating research activities. As presented in Table 1.2, there are a number of ethical considerations were made due to the nature of this research.

Table 1.2. The ethical considerations of the research.

Ethical Considerations	**How will it be addressed?**
Informed and prior consent to participate	All the interview schedules and research protocols were translated into the regional language. The objectives, content and affiliations of the research were explained to the research participants. It informed that their rights and identity will be kept anonymous, and all the records of the interview will be destroyed upon any such request. Since the enquiry involves perspectives and involves many individuals without functional literacy, strategies like oral consent and field notes were followed.
Anonymity and confidentiality of respondent	All data were encrypted and stored in a secure location. Datasets were de-identified as much as possible and as soon as possible following data collection.
Research reporting and community benefits	Preliminary research results were disseminated among the research participants through stakeholder meetings and planned workshops. The possibility of developing policy documents with the active participation of research participants by reflecting on the final results were explored and completed.

1.7 Data coding and analysis

Content analysis was performed in analyzing the scoping review data. All the articles were documented in an Excel spreadsheet under different categories following the content analysis presented by Graneheim and Lundman (2004) and Erlingsson and Brysiewicz (2017). The content analysis began with the identification of meaning units (condensed), code, categories, and themes. Each condensed meaning unit consists of a few sentences talking about the key vulnerabilities, challenges, responses to address them, and the viability of small-scale fisheries from each article. When articles covered more than one key message, several meaning units were documented under each article. Codes were assigned to best describe each meaning unit, usually in a few words. The codes were further organized under categories based on similarities and dissimilarities. Finally, all the categories were grouped into three main themes related to the study, i.e., (i) social, (ii) natural and (iii) governance aspects to which small-scale fisheries are inherently linked.

The collected surveys were recorded using Microsoft Excel. The appropriate coding was used to convert the open-ended questions. Microsoft Excel is easy to operate and allows a number of different forms of data analysis. Different diagrams and charts are prepared using the recorded data. The interview data were analyzed thematically based on the categories outlined by the conceptual framework presented in Chapter 1. The gathered data was also complemented by an analysis of secondary data, including academic and grey literature (e.g., news articles, podcasts, and documentaries) to provide a social, cultural, economic and historical context to the interview data. Besides, the relevant policy documents by the government and institutions related to small-scale fisheries governance, the Sundarbans mangrove forest, and export trade were analyzed to identify potential opportunities and barriers for small-scale fisheries' vulnerability to viability transition.

1.8 Organization of Dissertation

The dissertation consists of five chapters, including an introduction, three independent manuscripts and a concluding chapter. The three manuscripts are prepared on the three objectives of this PhD research.

Chapter 1 introduces the research background, problem statement, rationale and research gaps. It also presents the research purpose and objectives. The main literature areas, i.e., development theories and approaches, social-ecological transitions, and governance that were reviewed to contextualize the research are presented in this chapter. This chapter also introduces the research study areas. The research designs, philosophical views, research approach and methods are introduced here as well.

Chapter 2 is the first independent manuscript for peer-reviewed journal publication. This chapter is on the first objective of the PhD research. The chapter develops a noble conceptual framework to assess the governability of vulnerability to viability transitions for small-scale fisheries. The framework is an outcome of the scoping literature review of the existing vulnerabilities of small-scale fisheries, and the responses are taken at the community, government and non-government levels. It presents why the where should be emphasized to help facilitate the vulnerability to viability transitions for small-scale fisheries. The manuscript is entitled “From vulnerability to viability for small-scale fisheries: a conceptual framework to facilitate the transitions.”

Chapter 3 is built on the framework developed in Chapter 2 and addresses the second objective of this research. The conceptual framework is applied and tested in the study areas. Drawing on the conceptual framework, this chapter assesses the social, natural, and governance aspects of the transboundary Sundarbans mangrove forest between Bangladesh and India. It identifies the key vulnerabilities that small-scale fisheries face on both sides of the forest. It also finds out the factors that hinder the vulnerability to viability transitions for small-scale fisheries in this transboundary context. The manuscript is entitled, “Assessing the status and challenges of vulnerability to viability transition of small-scale fisheries in the transboundary Sundarbans mangrove forest.” The manuscript is finalized, and yet to decide on the journal to which to submit it.

Chapter 4 addresses the third objective, drawing from the conceptual framework presented in Chapter 2. Based on the suggestions from Chapter 3, this chapter assesses the capacity and quality of the existing governing system to help facilitate the vulnerability to viability transitions

in the transboundary Sundarbans for small-scale fisheries. It assesses how the governance systems are structured, how they work and how they function. It also assesses whether the existing governing systems have the quality in terms of their overall performance and effectiveness to facilitate the vulnerability to viability transitions. The chapter is entitled, "Governability of vulnerability to viability transitions in transboundary small-scale fisheries: a study on the Sundarbans." This manuscript is also in good shape and is finalized for journal publication.

Chapter 5 summarizes the findings of each chapter and discusses the theoretical and empirical contribution this dissertation makes. It also presents the limitations of this research. The future research directions are also provided, especially with the use of the conceptual framework presented in Chapter 2.

At the end, a list of references to all the literature sources used in Chapters 1 and 5 of the dissertation is presented in alphabetical order. The appendices referred to within this introductory chapter are also included at the end of the dissertation as a series of appendices.

Chapter 2

From vulnerability to viability for small-scale fisheries: a conceptual framework to facilitate the processes

2.1 Chapter summary

Small-scale fisheries are vulnerable to every possible aspect of the societal system, including social, political, economic, natural and governance. The diverse, dynamic, and scale-dependent nature of small-scale fisheries makes it difficult to identify the sources of the vulnerabilities and determine when viability is reached. Small-scale fisheries communities and governing actors may respond differently to the challenge, but not all responses are effective. Inappropriate responses further intensify the ongoing vulnerabilities, making the transition toward viability for small-scale fisheries complicated. This indicates the wickedness of the small-scale fisheries' vulnerabilities. Through a systematic scoping review, this study aims to enhance understanding about vulnerabilities in small-scale fisheries by identifying and categorizing major sources and the appropriate responses at different levels. The findings reveal that small-scale fisheries' vulnerabilities come from multiple and multi-dimensional sources and that the existing responses are not effective in moving toward viability. For the most part, the responses are focused on technical fixes at the day-to-day level, leaving a gap in understanding the root causes and the role of the governing system in facilitating the vulnerability to viability transitions. Drawing from the interactive governance theory and the governability concept, the study proposes a conceptual framework that can help determine the quality and the capacity of the governing system needed to facilitate the transition from vulnerability to viability in small-scale fisheries, given their structure and function.

2.2 Introduction

According to the Food and Agriculture Organization (FAO) of the United Nations, Duke University and WorldFish (hereafter, IHH study) (2023), around 492 million people depend at least partially on small-scale fisheries. Among them, 60 million are directly employed in small-scale fisheries as part-time or full-time, 53 million are engaged in subsistence fishing, and 379 million additional household members rely on small-scale fisheries for their food and nutritional security. Small-scale fisheries are generally characterized as fishing using small vessels with a modest amount of capital and energy, making short trips close to shore and providing food for the family, local communities, and national consumption (FAO, 2015). Despite the significant contribution of small-scale fisheries, they are globally disadvantaged compared with their large-scale counterpart and other industries, including oil, gas, and aquaculture, in accessing space and resources, and in government attention (Chuenpagdee and Jentoft, 2018). A shift from vulnerability to viability for small-scale fisheries involves changes in social, ecological, economic, and governance systems, all of which are complex, diverse and dynamic.

The transition from vulnerability to the viability of a social-ecological system (SES) is a complex process. The term "transition" is used to indicate non-linear and structural changes in complex

adaptive systems (Patterson et al., 2016; Feola, 2015). In the context of sustainability, a "transition" involves fundamental social, economic, technological and institutional changes from one system to another (Mathias et al., 2020; Nayak and Armitage, 2018; Haberl et al., 2011; Rotmans et al., 2001). The analysis of transition focuses on the process and the dynamics, and draws patterns on changes to explain whether and how the shift from one state to another is facilitated or hindered (Hölscher et al., 2018). The process often includes social, economic, technological and institutional innovation, collaboration, knowledge integration, and learning (Hölscher et al., 2018).

Transition in fisheries began in the 18th century as part of the movement from traditional to industrial society (Smith, 2000). Since then, the changes have been prominent in the structure, practice and culture of the fishery as a result of developments in different aspects, such as technological, social, economic, environmental and policy (Van Hoof et al., 2020). The deployment of modern technology and powerful engines has led to competition over fisheries resources, overexploitation, and stock collapses in some cases, with social consequences such as stakeholder conflicts, social injustice, and marginalization of certain groups, including small-scale fisheries (see for example, Bavinck, 2010).

In the governance context, a gradual transition has been observed from traditional management approaches to new governance patterns emphasizing state-society interactions (Chuenpagdee and Jentoft, 2018; Armitage et al., 2012; Dixon et al., 2003). Studies show that traditional centralized management has failed to provide effective solutions to highly contextualized situations and also falls short of coordinating across scales and jurisdictional boundaries (Lozano and Heinen, 2016; Ho et al., 2016; Lemos and Agrawal, 2006). One of the reasons for the failure is a lack of acknowledgment of the importance of non-state actors (e.g., civil society) and the role of indigenous knowledge in decision-making (Dudayev et al., 2023; Kramer et al., 2016).

The new patterns of governance aim to broaden both stakeholder participation and the way problems are identified and addressed. While 'management' focuses on achieving short-term and specific outcomes, 'governance' refers to the broader processes that involve different institutions through which actors make collective decisions in dealing with social-ecological changes (Kooiman et al., 2005; Stoker, 1998; Oakerson, 1992). The emerging governance approaches, like polycentric governance, acknowledge that the government is no longer the ultimate authority of decision-making in dealing with complex social-ecological and environmental changes (Partelow et al., 2020; Armitage et al., 2012). The participatory and interactive decision-making process provides space for both state and non-state representatives to share their worldviews, ideas, and perspectives. Given proper structures, mechanisms, and functions, it can be argued that changes in small-scale fisheries governance can lead to ideal outcomes.

As the vulnerabilities of small-scale fisheries are often multidimensional and are considered a "wicked" problem that is difficult to solve (Nayak, 2022; Jentoft and Chuenpagdee, 2009), a governability lens (Bavinck et al., 2013) can be employed to help unpack the complexity and address the challenge. Through governability, the transition from vulnerability to viability is recognized as a process that depends not only on the structure, function and capability of the governing system but also on the nature and the characteristics of the small-scale fisheries that are being governed (Jentoft and Chuenpagdee, 2015; Chuenpagdee and Jentoft, 2013). The

governability framework further suggests that factors underlying small-scale fisheries' vulnerability and those fostering viability may be found in all three orders of governance. Specifically, the governing capacity needs to be built for the daily interactions (first order), for the design of institutions (second order) and for the articulation of principles, values and images (meta order) (Chuenpagdee and Jentoft, 2013). The governing quality, in turn, depends on the goodness of fit between the governing actions and the small-scale fisheries system, the ability of the governing mode to respond to the demand, and the overall performance of the governing system (Jentoft and Chuenpagdee, 2015).

Using a scoping literature review, this study examines the patterns and sources of small-scale fisheries' vulnerabilities and the responses at the community, non-government and government levels to address them. It then performs the governability analysis to determine whether the existing governing responses, both by the formal (e.g., governments and NGOs) and the informal (e.g., community) levels, foster or hinder the transition toward viability for small-scale fisheries. Based on the findings, the analysis aims to reveal key factors and considerations that can help facilitate the vulnerability to viability transition for small-scale fisheries, and offers a comprehensive and systems thinking about the transition.

The section below describes the theory and method of the study, introducing first the governability concept for small-scale fisheries' vulnerability to viability (V2V) transitions context. It also describes the systematic scoping review method employed for this study. The results section presents the wickedness of the vulnerability to viability transition by analyzing the sources of vulnerabilities and responses taken at different levels to address them. It describes the nature of small-scale fisheries vulnerabilities and the subsequent responses under four different typologies. The discussion section first critically reflects on the typology of vulnerability/response and indicates the gaps in understanding the governance of vulnerability to viability transitions. The second part of the discussion introduces a conceptual framework that can help assess the capability of the governing system to facilitate the vulnerability to viability transitions for small-scale fisheries. Finally, the study concludes with the lessons learned and suggests the future use of the study outcomes.

2.3 Theory and Methods

All societal systems can be assessed from a governability point of view (Kooiman, 2008). Analytically, the governability concept constitutes two complementary dimensions, i.e. the capacity to govern and the quality of the governing system (Chuenpagdee and Jentoft, 2015). Governability also depends on the nature and characteristics of the system that is being governed. In the case of small-scale fisheries, this system is highly diverse, complex and dynamic, making it difficult to govern. Under a capable governing system, the governability challenge may be low. Unfortunately, the governing system itself can also be diverse, complex and dynamic, and thus is not competent in dealing with the day-to-day problems facing small-scale fisheries (first order). The design of the governing system (second order), like the institutions and the legal frameworks, may not be appropriate in providing a timely response to the problems. Its performance is therefore limited, thus affecting its ability to govern. The governing mode employed also determines governability. When meta-order elements, like values, images and principles, are well articulated and properly integrated in the design of

governing institutions, the governing system can perform well at any mode, whether hierarchical, co- or self-governance. On the contrary, the co-governance mode, which seems to be the preferred arrangement (Chuenpagdee and Jentoft 2018), may not work so well without due consideration to the power imbalance between and among state and non-state actors. In effect, governability depends not on the choice of governing mode, but on how the governing system functions and performs. Therefore, in addressing challenges like small-scale fisheries' vulnerabilities, Bavinck and Kooiman (2013) suggest that the assessment of the governing system calls attention to goodness-of-fit, responsiveness and performance.

Drawing from the governability concept, this study begins with a scoping literature review that identifies the wickedness of small-scale fisheries' vulnerability to viability transitions by analyzing the sources and responses to vulnerabilities. The systematic scoping review of the literature provides a quick overview, focused synthesis that identifies gaps in the literature related to small-scale fisheries vulnerabilities and associated responses (Peterson et al., 2017; Arksey and O'Malley, 2005). It identifies whether the existing governing responses at different levels are capable of addressing the vulnerabilities of small-scale fisheries. Google Scholar and Scopus were used to find literature using specific keywords and search criteria. A combination of keywords, such as "small-scale fisheries vulnerabilities," "artisanal fisheries vulnerabilities," "small-scale fisheries and viability," "sustainability and small-scale fisheries," "responses to small-scale fisheries challenges" "small-scale fisheries governance," "small-scale fisheries management" and "SESs sustainability" was used by only considering peer-reviewed journal articles.

The screening of the literature was conducted in two stages. In the first stage, the abstracts of the articles were reviewed and selected based on their direct or indirect focus on small-scale fisheries' vulnerabilities, viability, governance or responses to the issues of small-scale fisheries. After the initial search, more than 150 articles published from 2005 to 2024 were selected, and a list was developed. In the second stage, the articles were read carefully, looking for relevance to the study context, especially those that have focused on both vulnerabilities of small-scale fisheries and have highlighted a few strategies, pathways or solutions to address the vulnerabilities. After the second screening, 86 articles were selected and organized in a Microsoft Excel Sheet.

All the articles were documented under different categories following a content analysis approach presented by Graneheim and Lundman (2004) and Erlingsson and Brysiewicz (2017). Codes of both vulnerabilities and responses were assigned to best describe the key messages, usually in a few words. The codes were further organized under categories based on similarities and dissimilarities. Finally, given the diverse and interconnected nature of the vulnerabilities and subsequent responses, categories are grouped under the following four typologies based on their relevance. Given that the vulnerabilities of small-scale fisheries are sourced from various sources, and similarly, the responses are also different depending on the level of institutions involved at what scales and levels, the Results section below depicts the complexity and wickedness of the vulnerabilities/responses.

i. ***Similar sources of vulnerability/similar responses:*** Small-scale fisheries face the same or similar sources of vulnerability and respond using similar responses or strategies.

ii. ***Similar sources of vulnerability/different responses:*** Small-scale fisheries face the same or similar sources of vulnerability, but respond in different ways.
iii. ***Different sources of vulnerability/different responses:*** Small-scale fisheries face different sources of vulnerability and respond in distinct ways tailored to their specific challenges.
iv. ***Different sources of vulnerability/similar responses:*** Small-scale fisheries face different sources of vulnerability but use similar responses because of their broad applicability.

2.4 Results

The complexity of the transitions from vulnerability to viability is due partly to the various understandings and treatments of wicked problems and governability concepts. Some assess vulnerability as the end point of appraisal, some as the focal point, and others as the starting point (Kelly and Adger, 2000). Vulnerability can be referred to as the negative effects of social, economic and institutional changes or physical events on a system at individual, household or community levels (Islam and Chuenpagdee, 2022; Füssel and Klein, 2006; Kelly and Adger, 2000). Similarly, some see viability as capabilities, some as the role of governance and rights, and others as processes and structures (Berardi et al., 2015). The differences in the understanding of vulnerability and viability suggest that the transition process is likely to be context-specific and place-based. The vulnerabilities of small-scale fisheries are multifaceted, multi-dimensional, and interlinked to diverse sources (Islam and Chuenpagdee, 2022; Nayak, 2022), and the inappropriate responses are likely to increase wickedness and lower governability. As presented in Figure 2.1, the sources or vulnerabilities and the responses to address them can be broadly categorized into four typologies.

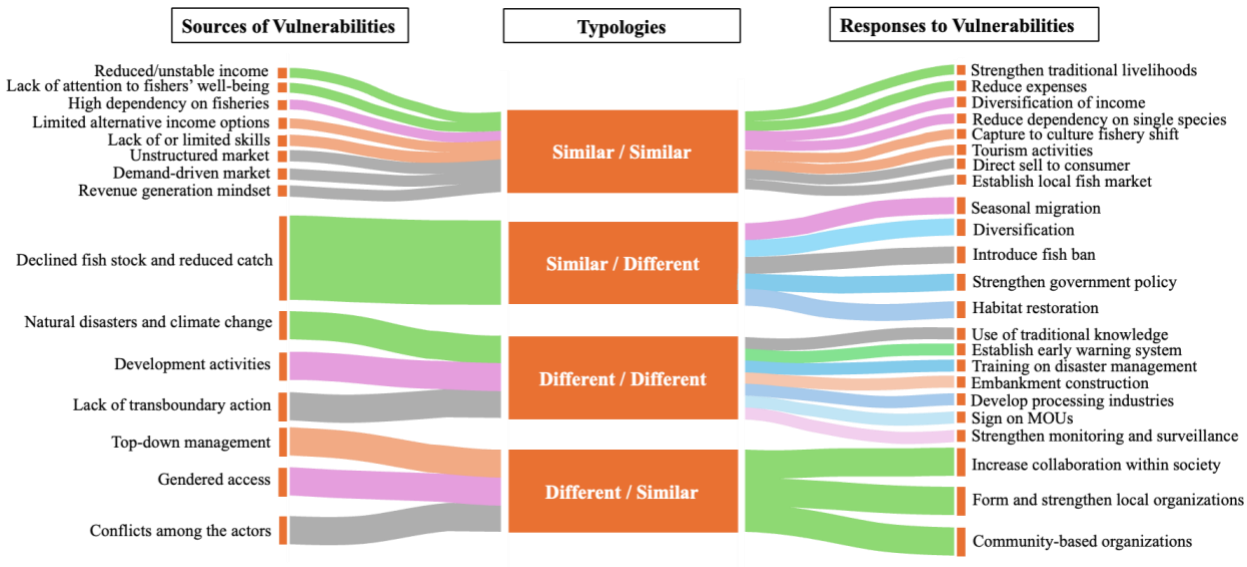

Figure 2.1. The typology of sources of vulnerabilities vs responses in small-scale fisheries (source: scoping literature review).

2.4.1 Type 1: Similar Sources of Vulnerability / Similar Responses

The findings suggest that responses are taken to address similar vulnerabilities in many cases. For example, the livelihoods and income of small-scale fisheries are also complicated by the unavailability of fish, seasonal migration, fewer jobs for women, poverty, and climate change (Yanda et al., 2019; Betcherman and Marschke, 2016). The livelihoods of small-scale fishers are also affected by inequity in accessing fisheries resources and sharing benefits (Yamazaki et al., 2018) and sidelining fishers in governance planning and development activities (Martins et al., 2019). The livelihoods and well-being of small-scale fisheries are also not considered in the development activities and policy action in many cases (Nayak, 2017). In response, small-scale fishers at the community level diversify their skills for different income options and help each other (Ritzman et al., 2018). They also engage children in income-generating activities, taking them away from their institutional education (Ratner et al., 2014). To some extent, fishers reduce their expenses on health, food, and education for children so that they can minimize their livelihood vulnerabilities (Villasante et al., 2022; Kapembwa et al., 2021).

Diversification is a crucial strategy for small-scale fishers to get rid of their dependency on fisheries-based livelihoods. Dependency in terms of target fish, fishing profession, fishing areas, credit support system, and limited individual skills is another important cause of small-scale fisheries vulnerabilities (Dancette, 2019; Panpeng and Ahmad, 2017). In response, they diversify their fishing strategy, change target fish species, look for alternative income options, and switch between capture to culture fisheries (March and Failler, 2022; Turner et al., 2007). The response related to culture fisheries raises further challenges, such as water quality deterioration due to large-scale aquaculture, competition among stakeholders, and social tensions (Kathijotes et al., 2015). Fishers also switched their focus to tourism-based income opportunities, such as handicraft making and selling, and also made savings so that they would not get trapped in debt in a crisis (Sereenonchai and Arunrat, 2019).

The market is an important social institution for the viable income and livelihoods of small-scale fishers. Unfortunately, in most cases, markets are not properly structured and are dominated by only a few actors (e.g., traders) (Pascual-Fernández et al., 2019; Crona et al., 2015). Price fluctuation, too often, is one of the outcomes of unstructured markets, which affects the fishers most (Bunce et al., 2009). Crona et al. (2015) identified that the globalization of fisheries products negatively affects the social, economic, and institutional aspects of local arrangements. The economic efficiency and growth strategies facilitated by the neoliberal policies have pushed the traditional fisheries system toward capitalistic production systems, which terminates low-capital-based enterprises eventually like small-scale fisheries (Said and MacMillan, 2020). In addressing the market-related vulnerabilities, responses include direct selling to consumers through bargaining (Be´ne´ et al., 2010), establishing local-level fish markets (Eriksson et al., 2017), and creating a diverse and stronger market portfolio (Galappaththi et al., 2019).

2.4.2 Type 2: Similar Sources of Vulnerability / Different Responses

Some of the vulnerabilities arise from a similar source, and the responses vary depending on the context. The decline in fish stock and subsequent reduction in fish catch is one of the main vulnerabilities for small-scale fisheries and has consequences on other factors such as income, livelihoods and well-being (Cánovas-Molina and García-Frapolli, 2022; Ankrah, 2018). The fisheries resources, including marine, coastal, and freshwater, are overexploited (Cánovas-Molina and García-Frapolli, 2021; Ferse et al., 2014). The drivers for fish catch reduction include an increase in the number of fishers, high fishing pressure, and increased illegal and destructive fishing (Yamazaki et al., 2018; Limuwa et al., 2018; Deb and Haque, 2011).

In response to fish stock decline and catch reduction, the common strategy at the fishing community level is migration to different fishing locations or cities for non-fishing jobs (Apine et al., 2019; Manach et al., 2012), which often makes fishers work in uncomfortable environments for lower wages and are exploited by employers (Apine et al., 2019; Ankrah, 2018). Similarly, fishing communities diversify their fishing activities, for instance, changing fishing locations, which creates pressure on fish stock in the new area and conflicts with other stakeholders (Limuwa et al., 2018; Gaillard et al., 2009). Some fishers expose themselves to extra workload and diseases when they spend extra time fishing, making use of good weather and longer fishing seasons (Apine et al., 2019; Fabinyi, 2010; Uy et al., 2011). In some cases, fishers replace their fishing gear with modern gear (e.g., explosive fishing) to increase fish catch, which often leads to resource degradation and biodiversity loss, resulting in intergenerational equity concerns (Lemos and Agrawal, 2006).

At the governing institutions level, the common governing actions to enhance fish stock include fishing bans or fisheries closure (Ritzman et al., 2018), declaring conservation areas (Mollick et al., 2023), protected areas (Chen and Lopez-Carr, 2015), and individual quota systems (Kraan and Hoefsloot, 2020). These results in limiting access to resources, and small-scale fishers are often against these policies as these are implemented at the cost of fishers' income and livelihoods without proper alternative arrangements (Nayak et al., 2014). In addressing the ecosystem's health concerns, both government and NGOs have taken initiatives to restore sand dunes, design rain gardens, rehabilitate mangroves, and plan relocation (Narayan et al., 2020). Overall, the responses, both at the community and government levels, mainly address the day-to-day problems of small-scale fisheries.

2.4.3 Type 3: Different Sources of Vulnerability / Different Responses

In many cases, different governing and community responses are taken for different vulnerabilities of small-scale fisheries. Natural disasters and climate change cause huge suffering for small-scale fisheries. The main sources of vulnerabilities related to disasters include coastal and river erosion, salinity intrusion, cyclones, drought and flood, temperature fluctuation, mass mortality of fish, and unfavourable weather conditions (Hoang et al., 2020; Karlsson and Mclean, 2020; Mozumder et al., 2018). At the local level, small-scale fishers use their traditional knowledge and take action to recover from disasters (Galappaththi et al., 2022; Villasante et al.,

2022). At the governing institution level, many countries are making progress in terms of establishing early warning systems and weather forecasts (Finnis et al., 2019) and providing incentives to disaster-affected communities (Bellquist et al., 2021). The result suggests that small-scale fisheries may become resilient against natural disasters through these initiatives, but transitions toward viability is unlikely due to a lack of governing capacity, comprehensive planning, action, and participation (Salik et al., 2015).

Disasters are not always natural; human interventions, especially development activities, also cause disasters for fisheries resources and fishing communities. Development activities, including mining (e.g., sand and coal) and mega projects (e.g., power plant and seaport) in the coastal areas, resulted in the displacement, dispossession and limited space for coastal small-scale fishing communities (Bhimji et al., 2023; Ganseforth, 2023; Bavinck et al., 2017). In response, climate change adaptation strategies such as embankment construction in coastal areas cause erosion and cause fishing communities to relocate in many cases (Huq and Azaz, 2024; Paprocki, 2018). Processing industries are growing for post-harvest fish processing, which also creates employment opportunities for men and women. However, the wages and working hours violate the rights of the people working in many processing industries (Roy et al., 2023). The outcome of development activities also indirectly affects small-scale fisheries and the fish stock. The pollutants discharged from the coastal industries, mining, ports and shipping cause massive pollution in the coastal waters (Owusu, 2019; Deason et al., 2014).

The sources of vulnerabilities, in some cases, go beyond country jurisdictions. Fish and fisheries resources sometimes become part of geopolitical disputes in transboundary regions (Doria et al., 2020). Common sources of vulnerabilities derived from transboundary issues include a lack of common governing policies and coordination between neighbouring countries in managing shared resources (Deb and Haque, 2011). In many cases, countries sign a memorandum of understanding (MOU) and join forces to monitor and surveillance (Zou and Wang, 2020). However, the progress of these initiatives relies on the interests and priorities of the countries.

2.4.4 Type 4: Different Sources of Vulnerability / Similar Responses

In most cases, the study found that small-scale fishers have limited access to the fisheries resources that they rely on. The governance structures are mostly top-down, weak and inappropriate in responding to climate/environmental/social stresses (Chuenpagdee and Jentoft, 2018; Jentoft and Chuenpagdee, 2017). Women are often marginalized and treated unfairly in terms of access to resources and markets (Galappaththi et al., 2022; Lentisco and Lee, 2015). The differences among the local communities in terms of who holds what power and position in society create social imbalances and hamper social institutions and harmony (Ferse et al., 2014; De Silva and Yamao, 2007). The common conflicts in small-scale fisheries are between fishers for space, fishers and law enforcement authorities, fishers and other resource stakeholders, and fishers and traders for price and wages (Leite et al., 2019; Limuwa et al., 2018).

At the community level, a few cases suggest that fishing communities have taken the initiative to minimize social conflicts, including collaboration within and between different stakeholders, strengthening social institutions at the local level, establishing cooperative societies by fishers, and increasing social cohesion (Lemahieu et al., 2018; Islam and Chuenpagdee, 2013).

Government, in many cases, provided training facilities on fisheries policies to educate communities (Madhanagopal and Pattanaik, 2019), helped form community-based organizations (Inaotombi and Mahanta, 2019) and women's self-help groups to enhance their capacity and skills (Khan et al., 2018; Lukić and Tonković, 2019; Eriksson et al., 2017). The complexities related to these initiatives are that small-scale fishers are located in remote areas, and they are large in number, and the initiatives that governing and community organizations take make it hard to reach all the fishers and bring them all under the support measures. The people are not included; they feel left out, and tension grows against government policies (Owusu, 2019). Also, in many cases, only a specific number of people in a community benefit, whether they are fishers or not, due to their connection and lobbying of corrupt governing actors (Martins et al., 2019).

2.5 Discussion

2.5.1 Governing vulnerability beyond technical fixes

The typology discussed above suggests that small-scale fisheries' vulnerability to viability transition is complex, wicked, and less governable under the current governing structure and functions. Figure 2.2 depicts the degree of wickedness and level of governability based on the analysis of the responses to address the vulnerabilities in four different typologies. This typology highlights the interlinkages, multi-dimensional, and multifaceted nature of the vulnerabilities that small-scale fisheries face. The findings also suggest that the current responses are mostly focused on day-to-day issues, reactive, and short-term. It seems these responses are intended to address the symptoms rather than the root causes of the vulnerabilities. As a result, small-scale fisheries are continuously exposed to multi-dimensional vulnerabilities, including social, natural and governance aspects (Islam and Chuenpagdee, 2022). To a large extent, the responses undermine the importance of building institutional capacity, both at the community and government levels, in making small-scale fisheries viable (Chuenpagdee and Jentoft, 2018). The responses also ignore maintaining the quality of the governing responses in terms of their performance, effectiveness and acceptance in small-scale fisheries (Doria et al., 2020; Nyikahadzoi et al., 2017).

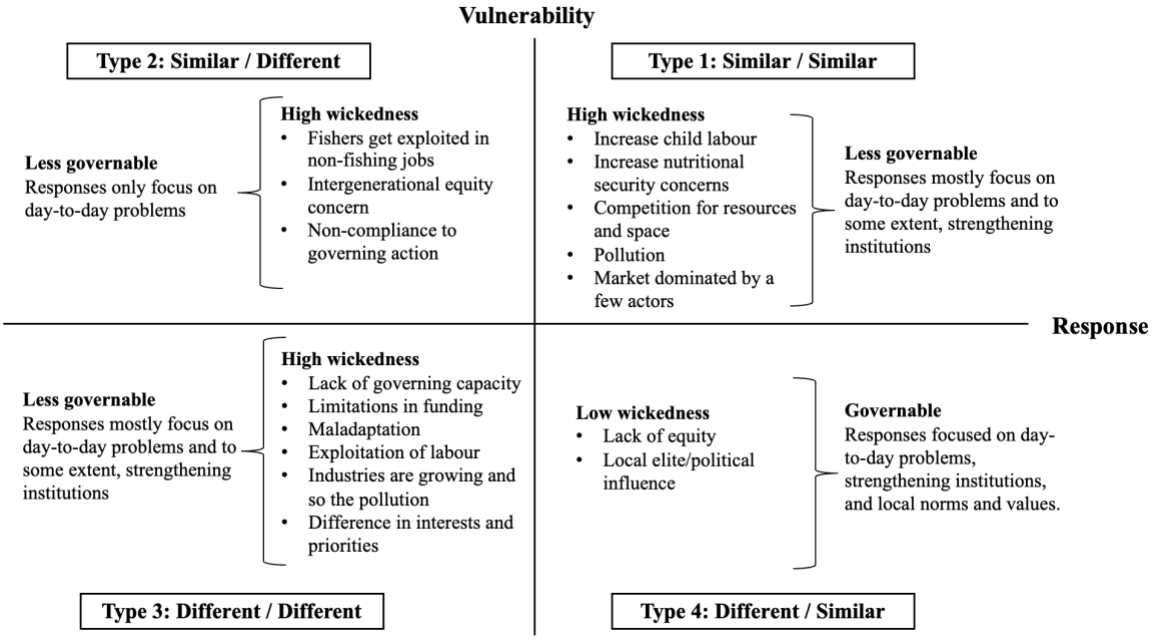

Figure 2.2 The wickedness and level of governability of existing sources of vulnerability vs responses (Source: Scoping literature review).

The study found that the short-term responses further intensify the wickedness of the issues in small-scale fisheries, such as resource depletion, social inequity, and institutional inefficiencies. This indicates that the vulnerability to viability transitions is fundamentally a governability challenge. The study suggests that successful governance of vulnerability to viability transitions for small-scale fisheries requires strategies that bridge scales, integrate knowledge from both traditional and scientific sources, balance immediate needs with long-term viability, and restore relationships among diverse stakeholders. A lack of studies on the governance of vulnerability to viability transitions results in gaps in understanding power imbalance navigation, institutional barriers, and the trade-offs required for the transitions toward viability for small-scale fisheries.

Given that the vulnerabilities of small-scale fisheries are unlikely to completely stop and reach an absolutely viable state (Nayak and Berkes, 2019), this study argues that vulnerabilities related to governance should be carefully assessed and understood before prescribing solutions. The transitions from vulnerability to viability for small-scale fisheries are not only social, ecological or technical but also linked to political and institutional factors. In dealing with such issues, governance structures must reform to embrace a decentralized, polycentric, adaptive and interactive approach that empowers local communities while also ensuring accountability and equity. In governing the processes of vulnerability to viability transitions, mediating conflicts among stakeholders, fostering adaptive learning, and ensuring policies are iterative and inclusive are the key (Hölscher et al., 2018). This raises pressing questions: What governance structures are most effective for enabling a just and sustainable vulnerability to viability transitions? Should they prioritize decentralized, community-led institutions or stronger cross-scale coordination mechanisms? Equally critical is the question of function: What governance functions, such as knowledge co-production, conflict resolution, and adaptive monitoring, are crucial to navigating

the wickedness of vulnerability to viability transitions? Drawing from the results, the study argues that the answers to these questions are likely to vary depending on the type of vulnerability/response.

In dealing with such a wicked issue of small-scale fisheries' vulnerability to viability transitions, a holistic framework is crucial to understanding and identifying the different attributes relevant to the governance of this transition. It can help assess the existing governing system's capacity and quality of facilitating small-scale fisheries' vulnerability to viability transitions. It can also find out if the governing system itself is vulnerable or not. The section below introduces a concept/framework that can help assess both the capacity and quality of the governance system in practice in the context of the study areas.

2.5.2 Conceptual framework for vulnerability to viability transitions

Drawing from the above findings, and informed by Interactive Governance (Kooiman et al., 2005) theory and governability lens (Bavinck et al., 2013), the conceptual framework presented in Figure 2.3 can help assess capacity and quality of the governing system and facilitate the vulnerability to viability transition for small-scale fisheries. The assessment involves looking at how the governing system is formed, followed by what goals/images, what institutions and stakeholder groups are involved, and the way daily issues are addressed. The interaction between fishing communities and the governing system, in terms of policy implementation, compliance/non-compliance, consultation, cooperation, and learning from each other, needs to be assessed to help strengthen the governing institution and decision-making process (Jentoft and Chuenpagdee, 2015).

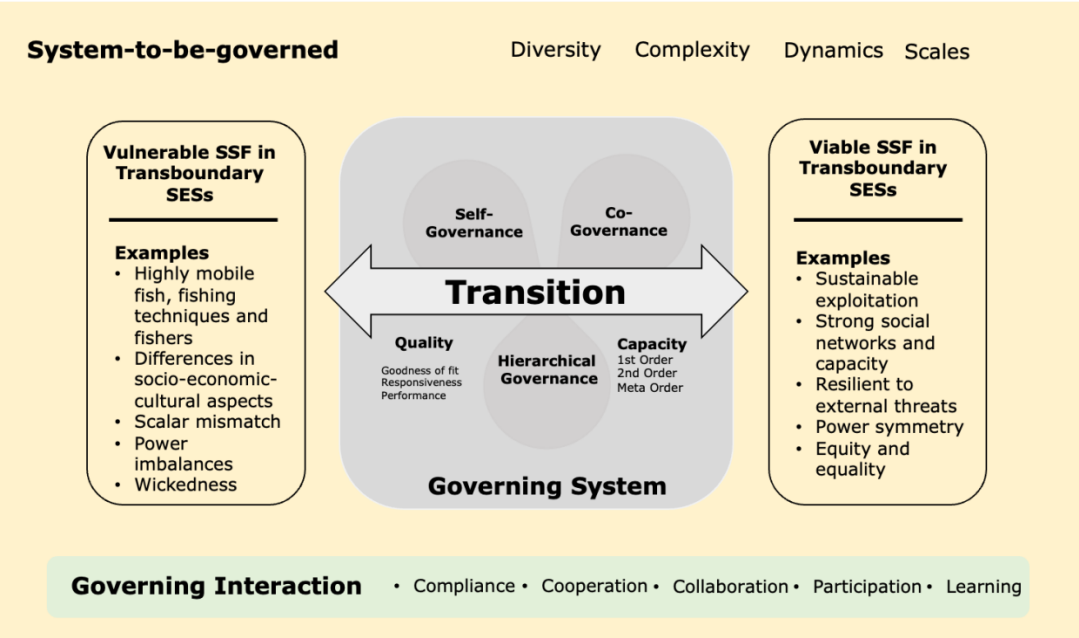

Figure 2.3 A conceptual framework for small-scale fisheries vulnerability to viability transition. The system-to-be-governed explains the nature and characterizes the vulnerabilities and viability of small-scale fisheries SESs; the governing system explains the role it plays in making the

transition from vulnerable system-to-be-governed to viable system-to-be-governed; and the governing interaction discusses the processes between system-to-be-governed and governing system through which the transition takes place.

Further, this framework can be used to examine each mode of governance using some general and mode-specific indicators. Analytically, the framework uses two main variables, i.e., capacity and quality, to assess the governance of transition (Table 2.1). Under each mode of governance, the capacity analyzes the different orders and key features of the governing system, and quality examines the goodness-of-fit, responsiveness and performance of the governing system (Bavinck and Kooiman, 2013).

Table 2.1 The framework for assessing the governability of small-scale fisheries' vulnerability to viability transition.

Modes	Self-governance	Co-governance	Hierarchical governance	
First order	- day-to-day problems and activities of the governed	- day-to-day problems and activities within the governed	- day-to-day problems and activities of the governed	Capacity
Second order	- Structure of the community - Boundary of the community - Deciding on the community leader	- Arrangement of the governing units - Boundary of the units - Members' inclusion and exclusion criteria - Role of community and state	- Structure - Boundary - Connection of governing unit to SSF - Inclusion and exclusion criteria of relevant governing actors	
Meta order	- Community principles, values, and norms	- Principles, values, and norms of the communities and state	- Principles, values, and norms that the governing unit consider	
Goodness of fit	- Images/goals of the community - the goodness of the goal - Fitness of governing unit in the context of the community - Fitness of their action - Social, political and economic limitations of the community	- Images/goals of the governing units - Goodness and ethical choices of the units - Fitness of the arrangement and their action - Social, political and economic limitations of the communities and the state	- Images/goals of the state/governing unit - Goodness of their goal - Ethical choices need to make - Fitness of the governing body and their action - Social, political, and economic limitations	Quality
Responsiveness	Community/governing unit's responses - process - quickness - accuracy - consequences	Governing units' responses - process - quickness - accuracy - the satisfaction of the governed	State/governing unit's responses - criteria/process - quickness - accuracy - the satisfaction of the governed - consequences (if any)	
Performance	- Effectiveness of the governing body in terms of action and response - The logic of decision-making - External influence	- Effectiveness of the arrangement, their action and response - the process and rationale of decision-making - External influence - the balance between 1st and 2nd and meta orders	- Effectiveness of the body, their action and response - Process and rationale of decision-making - Factors that influence decision-making - the balance between 1st and 2nd orders - The principles set in meta order	

Under the first order, each of the modes first looks at the day-to-day problems and activities of the small-scale fishing community or the governing unit (e.g., Matera, 2016). Under the same order, co-governance looks into how the shared responsibilities of governing units deal with day-to-day problems, for example, by analyzing the co-governance in Tanzania (Katikiro et al., 2015). The hierarchical mode's day-to-day activities are also assessed against the problems of the communities and the governing unit itself.

Similarly, under the second order, the structure of the self-governed community/unit, to what extent they are able to address their vulnerabilities, and how they want to be led to overcome those vulnerabilities are assessed. The arrangement of the co-governance, the scales they operate, the criteria that they follow to include/exclude members from the co-governed units, and the roles of each unit are examined. The hierarchical mode of governance is examined by looking into their structure, their connection/interaction with the governed, and how they include/exclude communities in/from their radar.

The meta order looks into the principles, values and norms that each governing unit follows to govern small-scale fisheries. Under this order, the examination of each mode can show that the principles, values, and norms that a self-governed community/unit follows may not be the same for co- and hierarchical governance. The assessment of each mode will show how the different principles, values and norms influence their structural arrangements and day-to-day actions. This will also give a sense of how the priorities are distinct for each mode of governance in terms of underlying principles.

The goodness of fit of the governance is assessed through the images/goals, fitness and limitations. For example, the goals of the self-governed community/unit and how good it is, the fitness of the governing unit, and their action and response in the context of the community's vulnerabilities are assessed. Additionally, the social, political, and economic barriers that they face being a self-governed community are assessed. For co-governance, the fitness of the governing arrangements and whether they need to make any ethical choices are examined in addition to assessing their goals and limitations. A similar assessment can be done for hierarchical governance. However, the output of assessing each mode can be different, and this will indicate the overall goodness of fit for the respective governance mode. This will help inform the governors about their capacity and suitability in small-scale fisheries.

The responses that governors take in order to address the problems and their limitations also need to be examined. This includes the process or factors that they consider responding, how quickly they respond, and the accuracy of their responses given the time they take/have to respond. Once the responses are made, it is also important to check whether the governed are satisfied or not. The responses can be collective for self-governance, and the community members are more likely to accept the decisions. However, for co- and hierarchical governance, the acceptance may vary based on the interests of different groups and the voices heard. If the communities are not satisfied, the consequences that occur following the governing decisions also need to be analyzed. This will allow the governors to make more effective and satisfactory decisions. A comprehensive assessment of the responsiveness of each governing mode will help to analyze the performance of the governing modes as well.

A performance check is the ultimate step in assessing the governability of small-scale fisheries' vulnerability to viability. It is assessed by analyzing the effectiveness of their action, structure, and mechanisms in small-scale fisheries and the overall decision-making process. In doing so, how the decisions are made, what logic is followed, if there is any internal and external influence governors face, and how the balance between the first and second order of governance is maintained. Additionally, how the principles are set for the meta orders will be analyzed. It is important to see what principles governors take into account and based on what.

Once these indicators are assessed and compared, given the social, natural, and governance aspects of small-scale fisheries, it will indicate whether the current governance system has the capacity and quality to transition from vulnerability to viability. If the outcomes of the analysis are good against the majority of the components, it can indicate higher governability/viability. If the outcomes are poor, it can indicate that the mode is incapable of dealing with the vulnerabilities.

2.6 Conclusions

The transitions from vulnerability to viability for small-scale fisheries follow a complex process. The more diverse, complex or dynamic small-scale fisheries are, the more difficult it is to move toward an ideal outcome following the transition stages. The vulnerabilities or viability of small-scale fisheries are not absolute; they are very much context-specific, place-based and governance-related. The findings suggest that the responses taken to address the vulnerabilities are more focused on day-to-day problems, undermining the importance of the capacity and quality of the governing institutions. Therefore, the responses are taken at different levels, further intensifying the wickedness of the problems and complicating the transitions toward viability.

This study suggests that governance plays a fundamental role in guiding the transitions of small-scale fisheries toward viability. The outcome of the small-scale fisheries transitions largely relies on how governance guides the transition processes. A strong governance system for small-scale fisheries is likely to guide the transition outcome toward viability. Given that there is no panacea or single fix to the issues that small-scale fisheries are facing (Degnbol et al., 2006; Ostrom, 2007), the governance system requires a holistic approach to deal with the vulnerabilities. The study argues that the conceptual framework proposed here will help the governors assess their capacity and the quality of the governing system. The application of this framework in practical situations regarding the capability of small-scale fisheries' governing system can validate it and establish a methodological framework for the vulnerability to viability transitions of societal systems. Case studies can be performed to validate the use of this framework, which can also help develop this framework further. We argue that future research on small-scale fisheries' vulnerability to viability will largely benefit from using this framework, especially regarding the capacity and quality development of small-scale fisheries' governing systems.

2.7 References

Ankrah, J. (2018). Climate change impacts and coastal livelihoods; an analysis of fishers of coastal Winneba, Ghana. *Ocean & Coastal Management*, *161*, 141-146.

Apine, E., Turner, L. M., Rodwell, L. D., & Bhatta, R. (2019). The application of the sustainable livelihood approach to small scale-fisheries: The case of mud crab Scylla serrata in South west India. *Ocean & coastal management*, *170*, 17-28.

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International journal of social research methodology*, *8*(1), 19-32.

Armitage, D., De Loë, R., & Plummer, R. (2012). Environmental governance and its implications for conservation practice. *Conservation letters*, *5*(4), 245-255.

Bailey, M., Miller, A. M., Bush, S. R., van Zwieten, P. A., & Wiryawan, B. (2016). Closing the incentive gap: the role of public and private actors in governing Indonesia's tuna fisheries. *Journal of Environmental Policy & Planning*, *18*(2), 141-160. DOI: 10.1080/1523908X.2015.1063042

Bavinck, M. (2010). The megaengineering of ocean fisheries: A century of expansion and rapidly closing frontiers. In *Engineering earth: The impacts of megaengineering projects* (pp. 257-273). Dordrecht: Springer Netherlands.

Bavinck, M., & Kooiman, J. (2013). Applying the governability concept in fisheries–explorations from South Asia. In *Governability of fisheries and aquaculture* (pp. 131-153). Springer, Dordrecht.

Bavinck, M., Berkes, F., Charles, A., Dias, A. C. E., Doubleday, N., Nayak, P., & Sowman, M. (2017). The impact of coastal grabbing on community conservation–a global reconnaissance. *Maritime studies*, *16*, 1-17.

Bavinck, M., Chuenpadee, R., Jentoft, S., & Kooiman, J. (Eds.). (2013). Governability of fisheries and aquaculture: Theory and applications. Dordrecht: Springer.

Bellquist, L., Saccomanno, V., Semmens, B. X., Gleason, M., & Wilson, J. (2021). The rise in climate change-induced federal fishery disasters in the United States. *PeerJ*, *9*, e11186.

Béné, C., Lawton, R., & Allison, E. H. (2010). "Trade matters in the fight against poverty": narratives, perceptions, and (lack of) evidence in the case of fish trade in Africa. *World Development*, *38*(7), 933-954.

Berardi, A., J. Mistry, C. Tschirhart, E. Bignante, O. Davis, L. Haynes, R. Benjamin, G. Albert, R. Xavier, D. Jafferally, and G. De Ville. 2015. Applying the system viability framework for cross-scalar governance of nested social-ecological systems in the Guiana Shield, South America. *Ecology and Society 20*(3):42. http://dx.doi.org/10.5751/ES-07865-200342.

Betcherman, G., & Marschke, M. (2016). Coastal livelihoods in transition: How are Vietnamese households responding to changes in the fisheries and in the economy?. *Journal of Rural Studies*, *45*, 24-33.

Bhimji, F., Uwazuruike, A., & Ba, M. (2023). Displacement at seascapes: Senegalese fishermen in between state power and foreign fleets. *Identities*, *30*(4), 607-624.

Bunce, M., Rosendo, S., & Brown, K. (2010). Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environment, Development and Sustainability*, *12*, 407-440.

Cánovas-Molina, A., & García-Frapolli, E. (2022). A review of vulnerabilities in worldwide small-scale fisheries. *Fisheries Management and Ecology*, *29*(5), 491-501.

Chen, C., & Lopez-Carr, D. (2015). The importance of place: Unraveling the vulnerability of fisherman livelihoods to the impact of marine protected areas. *Applied Geography*, *59*, 88-97.

Chuenpagdee, R., & Jentoft, S. (2013). Assessing governability: What's next? In M. Bavinck, R. Chuenpagdee, S. Jentoft, & J. Kooiman (Eds.), Governability of fisheries and aquaculture: Theory and applications (pp. 335–350). Dordrecht: Springer.

Chuenpagdee, R., Jentoft, S., 2018. Transforming the governance of small-scale fisheries. *Mari. Stud*. https://doi.org/10.1007/s40152-018-0087-7.

Crona, B. I., Van Holt, T., Petersson, M., Daw, T. M., & Buchary, E. (2015). Using social–ecological syndromes to understand impacts of international seafood trade on small-scale fisheries. *Global Environmental Change*, *35*, 162-175.

Dancette, R. (2019). Growing vulnerability in the small-scale fishing communities of Maio, Cape Verde. *Maritime Studies*, *18*(2), 205-223.

De Silva, D. A. M., & Yamao, M. (2007). Effects of the tsunami on fisheries and coastal livelihood: a case study of tsunami-ravaged southern Sri Lanka. *Disasters*, *31*(4), 386-404.

Deason, G., Seekamp, E., & Barbieri, C. (2014). Perceived impacts of climate change, coastal development and policy on oyster harvesting in the Southeastern United States. *Marine Policy*, *50*, 142-150.

Deb, A. K., & Haque, C. E. (2011). 'Sufferings start from the mothers' womb': vulnerabilities and livelihood war of the small-scale fishers of Bangladesh. *Sustainability*, *3*(12), 2500-2527.

Degnbol, P., Gislason, H., Hanna, S., Jentoft, S., Nielsen, J. R., Sverdrup-Jensen, S., & Wilson, D. C. (2006). Painting the floor with a hammer: technical fixes in fisheries management. Marine Policy, 30(5), 534-543.

Dixon, J., Kouzmin, A. and Goodwin, D. 2003. Introduction to the Symposium: Comparative Sociopolitical Governance. Journal of Comparative Policy Analysis, 5: 101–105.

Doria, C. R., Athayde, S., Lima, H. M. D., Carvajal-Vallejos, F. M., & Dutka-Gianelli, J. (2020). Challenges for the governance of small-scale fisheries on the Brazil-Bolivia transboundary region. *Society & Natural Resources*, *33*(10), 1213-1231.

Dudayev, R., Hakim, L. L., & Rufiati, I. (2023). Participatory fisheries governance in Indonesia: Are octopus fisheries leading the way?. *Marine Policy*, *147*, 105338.

Eriksson, H., Albert, J., Albert, S., Warren, R., Pakoa, K., & Andrew, N. (2017). The role of fish and fisheries in recovering from natural hazards: Lessons learned from Vanuatu. *Environmental Science & Policy*, *76*, 50-58.

Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African journal of emergency medicine*, *7*(3), 93-99.

Fabinyi, M. (2024). Small-scale fisheries, large-scale fisheries and fisheries governance in the Philippines. *Journal of Environmental Policy & Planning*, *26*(2), 159-172. DOI: 10.1080/1523908X.2024.2314451

FAO, 2015. *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries. Volunt. Guidel. Secur. Sustain. Small-Scale Fish*. Context Food Secur. Poverty Erad.

FAO, Duke University & WorldFish. 2023. *Illuminating Hidden Harvests – The contributions of small-scale fisheries to sustainable development*. Rome. https://doi.org/10.4060/cc4576en

Feola, G. (2016, September). Translocal grassroots movements and the geography of sustainability transitions: the case of the Transition Towns Network. In *7th International*

Sustainability Transitions (IST) Conference 2016: Exploring Transition Research as Transformative Science. Wuppertal, Germany.
Ferse, S. C., Glaser, M., Neil, M., & Schwerdtner Máñez, K. (2014). To cope or to sustain? Eroding long-term sustainability in an Indonesian coral reef fishery. *Regional environmental change*, *14*, 2053-2065.
Finnis, J., Shewmake, J. W., Neis, B., & Telford, D. (2019). Marine forecasting and fishing safety: improving the fit between forecasts and harvester needs. *Journal of agromedicine*, *24*(4), 324-332.
Füssel, H. M., & Klein, R. J. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic change*, *75*(3), 301-329.
Gaillard, J. C., Maceda, E. A., Stasiak, E., Le Berre, I., & Espaldon, M. V. O. (2009). Sustainable livelihoods and people's vulnerability in the face of coastal hazards. *Journal of Coastal Conservation*, *13*, 119-129.
Galappaththi, E. K., Ford, J. D., Bennett, E. M., & Berkes, F. (2019). Climate change and community fisheries in the arctic: A case study from Pangnirtung, Canada. *Journal of environmental management*, *250*, 109534.
Galappaththi, E. K., Ford, J. D., Bennett, E. M., & Berkes, F. (2021). Adapting to climate change in small-scale fisheries: Insights from indigenous communities in the global north and south. *Environmental Science & Policy*, *116*, 160-170.
Galappaththi, M., Armitage, D., & Collins, A. M. (2022). Women's experiences in influencing and shaping small-scale fisheries governance. *Fish and Fisheries*, *23*(5), 1099-1120.
Ganseforth, S. (2023). Blue revitalization or dispossession? Reform of common resource management in Japanese small-scale fisheries. *The Geographical Journal*, *189*(2), 204-216.
Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse education today*, *24*(2), 105-112.
Haapasaari, P., Ignatius, S., Pihlajamäki, M., Sarkki, S., Tuomisto, J. T., & Delaney, A. (2019). How to improve governance of a complex social-ecological problem? Dioxins in Baltic salmon and herring. *Journal of Environmental Policy & Planning*, *21*(6), 649-661. DOI: 10.1080/1523908X.2019.1661236
Haberl, H., Fischer-Kowalski, M., Krausmann, F., Martinez-Alier, J., & Winiwarter, V. (2011). A socio-metabolic transition towards sustainability? Challenges for another Great Transformation. *Sustainable development, 19*(1), 1-14.
Ho, N. T. T., Ross, H., & Coutts, J. (2016). Evaluation of social and ecological outcomes of fisheries co-management in Tam Giang Lagoon, Vietnam. *Fisheries Research*, *174*, 151-159.
Hoang, H. D., Momtaz, S., & Schreider, M. (2020). Assessing the vulnerability of small-scale fishery communities in the estuarine areas of Central Vietnam in the context of increasing climate risks. *Ocean & Coastal Management*, *196*, 105302.
Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference?. *Environmental innovation and societal transitions*, *27*, 1-3.
Hovik, S., Sandström, C., & Zachrisson, A. (2010). Management of Protected Areas in Norway and Sweden: Challenges in Combining Central Governance and Local Participation. *Journal of Environmental Policy & Planning, 12*(2), 159–177. https://doi.org/10.1080/15239081003719219

Huq, E., & Azaz, M. (2024). The destructive work of restoration: Fishing communities facing territorialization in Turag river. *Environment and Planning E: Nature and Space*, 25148486241254922.

Inaotombi, S., & Mahanta, P. C. (2019). Pathways of socio-ecological resilience to climate change for fisheries through indigenous knowledge. *Human and Ecological Risk Assessment: An International Journal*.

Islam, M. M., & Chuenpagdee, R. (2013). Negotiating risk and poverty in mangrove fishing communities of the Bangladesh Sundarbans. *Maritime Studies*, *12*, 1-20.

Islam, M. M., & Chuenpagdee, R. (2022). Towards a classification of vulnerability of small-scale fisheries. Environmental Science & Policy, 134, 1-12.

Jentoft, S. (2017). Small-scale fisheries within maritime spatial planning: knowledge integration and power. *Journal of Environmental Policy & Planning*, *19*(3), 266-278. DOI: 10.1080/1523908X.2017.1304210

Jentoft, S., & Chuenpagdee, R. (2009). Fisheries and coastal governance as a wicked problem. Marine policy, 33(4), 553-560.

Jentoft, S., & Chuenpagdee, R. (2015). Assessing governability of small-scale fisheries. In Interactive governance for small-scale fisheries (pp. 17-35). Springer, Cham.

Jentoft, S., & Chuenpagdee, R. (2017). From poverty to wellbeing in small-scale fisheries: the governability challenge. In *Social wellbeing and the values of small-scale fisheries* (pp. 293-315). Cham: Springer International Publishing.

Kadfak, A., Hanh, T. T. H., & Widengård, M. (2025). The impact of state-led traceability on fisheries sustainability. *Journal of Environmental Policy & Planning*, *27*(2), 95-107. DOI: 10.1080/1523908X.2024.2422825

Kapembwa, S., Gardiner, A., & Pétursson, J. G. (2021). Small-scale fishing: Income, vulnerability and livelihood strategies at Lake Itezhi-Tezhi, Zambia. *Development Southern Africa*, *38*(3), 331-352.

Karlsson, M., & Mclean, E. L. (2020). Caribbean small-scale fishers' strategies for extreme weather events: lessons for adaptive capacity from the dominican republic and Belize. *Coastal Management*, *48*(5), 456-480.

Kathijotes, N., Alam, L., & Kontou, A. (2015). Aquaculture, coastal pollution and the environment. *Aquaculture Ecosystems: Adaptability and Sustainability*, 139-163.

Katikiro, R., Deepananda, K. A., & Macusi, E. (2015). Interplay between perceived changes in fishery and social structures in Tanzanian coastal fishing communities. *Fisheries Research*, *164*, 249-253.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and Facilitating adaptation. *Climatic change*, *47*(4), 325-352.

Khan, F. N., Collins, A. M., Nayak, P. K., & Armitage, D. (2018). Women's perspectives of small-scale fisheries and environmental change in Chilika lagoon, India. *Maritime Studies*, *17*(2), 145-154.

Kooiman, J. (2008). Exploring the concept of governability. Journal of Comparative Policy Analysis: *Research and Practice, 10*(2), 171-190.

Kooiman, J., Bavinck, M., Jentoft, S., & Pullin, R. (2005). *Fish for Life: Interactive Governance for Fisheries*. Amsterdam University Press. Retrieved from; https://www.jstor.org/stable/j.ctt46mzgb

Kraan, M., & Hoefsloot, F. (2020). Small-Scale Fisheries in the Netherlands: Fishing on the Margin. *Small-Scale Fisheries in Europe: Status, Resilience and Governance*, 395-415.

Kramer, D. B., Hallan, C., Stevens, K., & Axelrod, M. (2016). Getting Beyond Consumption Without Conscience and Production Without Prudence: The Governance of Globalizing Small-Scale Fisheries. *Journal of International Wildlife Law & Policy*, *19*(4), 348-364.

Lane-Miller, C. C., Wheeler, S., Bjornlund, H., & Connor, J. (2013). Acquiring water for the environment: lessons from natural resources management. *Journal of Environmental Policy & Planning*, *15*(4), 513-532. DOI: 10.1080/1523908X.2013.807210

Le Manach, F., Gough, C., Harris, A., Humber, F., Harper, S., & Zeller, D. (2012). Unreported fishing, hungry people and political turmoil: the recipe for a food security crisis in Madagascar?. *Marine policy*, *36*(1), 218-225.

Leite, M., Ross, H., & Berkes, F. (2019). Interactions between individual, household, and fishing community resilience in southeast Brazil. *Ecology and Society*, *24*(3).

Lemahieu, A., Scott, L., Malherbe, W. S., Mahatante, P. T., Randrianarimanana, J. V., & Aswani, S. (2018). Local perceptions of environmental changes in fishing communities of southwest Madagascar. *Ocean & coastal management*, *163*, 209-221.

Lemos, M. C., and A. Agrawal. 2006. Environmental governance. Annual Review of Environment and Resources 31:297-325. http://dx.doi.org/10.1146/annurev.energy.31.042605.135621

Lentisco, A., & Lee, R. U. (2015). A review of women's access to fish in small-scale fisheries. *FAO Fisheries and Aquaculture Circular*, (C1098), I.

Limuwa, M. M., Sitaula, B. K., Njaya, F., & Storebakken, T. (2018). Evaluation of small-scale fishers' perceptions on climate change and their coping strategies: Insights from Lake Malawi. *Climate*, *6*(2), 34.

Lozano, A. J. G., & Heinen, J. T. (2016). Property relations and the co-management of small-scale fisheries in Costa Rica: lessons from marine areas for responsible fishing in the Gulf of Nicoya. *Marine Policy*, *73*, 196-203.

Lukić, A., & Tonković, Ž. (2019). Fisheries-dependent community–Obstacle or opportunity for further development? A case study of Kali in Croatia. *Marine policy*, *100*, 116-121.

Madhanagopal, D., & Pattanaik, S. (2020). Exploring fishermen's local knowledge and perceptions in the face of climate change: the case of coastal Tamil Nadu, India. *Environment, Development and Sustainability*, *22*(4), 3461-3489.

March, A., & Failler, P. (2022). Small-scale fisheries development in Africa: Lessons learned and best practices for enhancing food security and livelihoods. *Marine Policy*, *136*, 104925.

Martins, I. M., Gammage, L. C., Jarre, A., & Gasalla, M. A. (2019). Different but similar? Exploring vulnerability to climate change in Brazilian and South African small-scale fishing communities. *Human Ecology*, *47*, 515-526.

Matera, J. (2016). Livelihood diversification and institutional (dis-) trust: Artisanal fishing communities under resource management programs in Providencia and Santa Catalina, Colombia. *Marine Policy*, *67*, 22-29.

Mathias, J. D., Anderies, J. M., Baggio, J., Hodbod, J., Huet, S., Janssen, M. A., ... & Schoon, M. (2020). Exploring non-linear transition pathways in social-ecological systems. *Scientific reports*, *10*(1), 1-12.

McAteer, B., & Flannery, W. (2025). Network governance and reflexivity in fisheries management: a case study of Northern Ireland. *Journal of Environmental Policy & Planning*, *27*(1), 21-33. DOI: 10.1080/1523908X.2024.2395860

Mollick, A. S., Ranon, R. J. K., Khan, M. N. I., & Nath, T. K. (2023). Evaluating social equity in protected areas co-management: evidence from the Sundarbans Mangrove Forests, Bangladesh. *Society & Natural Resources*, *36*(8), 970-990.

Mozumder, M. M. H., Shamsuzzaman, M. M., Rashed-Un-Nabi, M., & Karim, E. (2018). Social-ecological dynamics of the small scale fisheries in Sundarban Mangrove Forest, Bangladesh. *Aquaculture and Fisheries*, *3*(1), 38-49.

Naik, S., Pradhan, U., Karthikeyan, P., Begum, M., Panda, U. S., Mishra, P., & Murthy, M. R. (2024). Heavy metal pollution causes mass mortality of fish in a tropical estuary in the southwestern Bay of Bengal. *Marine Environmental Research*, *199*, 106595.

Narayan, S., Esteban, M., Albert, S., Jamero, M. L., Crichton, R., Heck, N., ... & Jupiter, S. (2020). Local adaptation responses to coastal hazards in small island communities: Insights from 4 Pacific nations. *Environmental Science & Policy*, *104*, 199-207.

Nayak, P. K. (2017). Fisher communities in transition: Understanding change from a livelihood perspective in Chilika Lagoon, India. *Maritime Studies*, *16*, 1-33.

Nayak, P. K. (2022). Making sense of multidimensional injustice for creating viable small-scale fisheries in chilika lagoon, bay of Bengal. In *Blue justice: small-scale fisheries in a sustainable ocean economy* (pp. 199-212). Cham: Springer International Publishing.

Nayak, P. K., & Armitage, D. (2018). Social-ecological regime shifts (SERS) in coastal systems. *Ocean & Coastal Management*, *161*, 84-95.

Nayak, P. K., & Berkes, F. (2019). Interplay between local and global: Change processes and small-scale fisheries. In *Transdisciplinarity for Small-Scale Fisheries Governance* (pp. 203-220). Springer, Cham.

Nayak, P. K., Oliveira, L. E., & Berkes, F. (2014). Resource degradation, marginalization, and poverty in small-scale fisheries: threats to social-ecological resilience in India and Brazil. *Ecology and Society*, *19*(2).

Nyikahadzoi, K., Mhlanga, W., Madzudzo, E., Tendaupenyu, I., & Silwimba, E. (2017). Dynamics of transboundary governance and management of small scale fisheries on Lake Kariba: Implications for sustainable use. *International Journal of Environmental Studies*, *74*(3), 458-470.

Oakerson, R.J. (1992). Analyzing the commons: a framework. In Bromley, D. (edit). *Making the commons work: theory, practice and policy*. ICS Press, San Fransisco. p. 41–59.

Ostrom, E., 2007. A diagnostic approach for going beyond panaceas. Proceedings of the National Academy of Sciences 104, 15181–15187.

Owusu, V. (2019). Impacts of the petroleum industry on the livelihoods of fisherfolk in Ghana: A case study of the Western Region. *The Extractive Industries and Society*, *6*(4), 1256-1264.

Panpeng, J., & Ahmad, M. M. (2017). Vulnerability of fishing communities from sea-level change: a study of laemsing district in chanthaburi province, Thailand. *Sustainability*, *9*(8), 1388.

Paprocki, K. (2018). Threatening dystopias: Development and adaptation regimes in Bangladesh. *Annals of the American Association of Geographers*, *108*(4), 955-973.

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., ... & Van Assche, K. (2020). Environmental governance theories: a review and application to coastal systems.

Pascual-Fernández, J. J., Pita, C., Josupeit, H., Said, A., & Garcia Rodrigues, J. (2019). Markets, distribution and value chains in small-scale fisheries: a special focus on

Europe. *Transdisciplinarity for small-scale fisheries governance: analysis and practice*, 141-162.
Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2016. Exploring the governance and politics of transformations towards sustainability. *Environ. Innov. Soc. Transit*. http://dx.doi.org/10.1016/j.eist.2016.09.001.
Peterson, J., Pearce, P. F., Ferguson, L. A., & Langford, C. A. (2017). Understanding scoping reviews: Definition, purpose, and process. *Journal of the American Association of Nurse Practitioners*, *29*(1), 12-16.
Ratner, B. D., Åsgård, B., & Allison, E. H. (2014). Fishing for justice: Human rights, development, and fisheries sector reform. *Global Environmental Change*, *27*, 120-130.
Ritzman, J., Brodbeck, A., Brostrom, S., McGrew, S., Dreyer, S., Klinger, T., & Moore, S. K. (2018). Economic and sociocultural impacts of fisheries closures in two fishing-dependent communities following the massive 2015 US West Coast harmful algal bloom. *Harmful Algae*, *80*, 35-45.
Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*.
Roy, A., Manna, R. K., Ghosh, S., Sahu, S. K., & Das, B. K. (2023). Assessment of women's contribution in small-scale fisheries in Indian Sundarbans: Issues, strategies, and way forward for sustainability. *Fisheries Management and Ecology*, *30*(4), 378-391.
Salik, K. M., Jahangir, S., & ul Hasson, S. (2015). Climate change vulnerability and adaptation options for the coastal communities of Pakistan. *Ocean & coastal management*, *112*, 61-73.
Smith, H. D. (2000). The industrialization of the world ocean. *Ocean & Coastal Management*, *43*, millenium essay, 11–28.
Stoker, G. (1998). Governance as theory: five propositions. *International social science journal, 50*(155), 17-28.
Tafon, R. V. (2019). Small-scale fishers as allies or opponents? Unlocking looming tensions and potential exclusions in Poland's marine spatial planning. *Journal of Environmental Policy & Planning*, *21*(6), 637-648. DOI: 10.1080/1523908X.2019.1661235
Turner, R. A., Cakacaka, A., Graham, N. A., Polunin, N. V., Pratchett, M. S., Stead, S. M., & Wilson, S. K. (2007). Declining reliance on marine resources in remote South Pacific societies: ecological versus socio-economic drivers. *Coral Reefs*, *26*, 997-1008.
Van Hoof, L., Steins, N. A., Smith, S., & Kraan, M. (2020). Change as a permanent condition: A history of transition processes in Dutch North Sea fisheries. *Marine Policy*, *122*, 104245.
Villasante, S., Macho, G., Silva, M. R., Lopes, P. F., Pita, P., Simón, A., ... & Calvo, N. (2022). Resilience and social adaptation to climate change impacts in small-scale fisheries. *Frontiers in Marine Science*, *9*, 802762.
Voyer, M., Quirk, G., McIlgorm, A., & Azmi, K. (2018). Shades of blue: what do competing interpretations of the Blue Economy mean for oceans governance? *Journal of Environmental Policy & Planning, 20*(5), 595–616. https://doi.org/10.1080/1523908X.2018.1473153
Yamazaki, S., Resosudarmo, B. P., Girsang, W., & Hoshino, E. (2018). Productivity, social capital and perceived environmental threats in small-island fisheries: insights from Indonesia. *Ecological Economics*, *152*, 62-75.

Yanda, P. Z., Mabhuye, E., Johnson, N., & Mwajombe, A. (2019). Nexus between coastal resources and community livelihoods in a changing climate. *Journal of Coastal Conservation*, *23*, 173-183.

Zou, K., & Wang, J. (2020). Transboundary fisheries management: China's practice. *The Korean Journal of International and Comparative Law*, *8*(2), 101-130.

Chapter 3

Assessing the status and challenges of vulnerability to viability transitions of small-scale fisheries in the transboundary Sundarbans mangrove forest

3.1 Chapter summary

Small-scale fisheries around the world are confronted with vulnerabilities related to social, natural, economic, institutional and political aspects. The vulnerabilities are even more intense when it comes to transboundary fisheries systems. This study aims to assess the vulnerabilities of small-scale fisheries and the challenges to facilitate the transitions from vulnerability to viability in a transboundary context. The study was carried out in the Transboundary Sundarbans mangrove forest between India and Bangladesh in the Bay of Bengal. Data were collected from several locations in India and Bangladesh using household surveys, key informant interviews and focus group discussions. The results reveal that small-scale fisheries face diverse vulnerabilities sourced from social (e.g., reduced income and increased social injustices), natural (e.g., decreased fish stock) and governance systems (e.g., increased restrictions and limited access) of the forest. The results also suggest that the current structure and function of the governing system fail to the greatest extent in addressing the vulnerabilities and moving toward viability. Several factors, including a lack of common governing action, differences in interests and values among the governing institutions, and mismatches of governance goals and implementation, cause barriers to transitions toward viability. The study suggests that increased participation of relevant stakeholders and their voices is crucial to make comprehensive governing actions from both sides of the forest and to facilitate the viability transitions. The study also suggests that respective governing institutions should establish a process to assess the vulnerabilities and their interconnectedness in the transboundary fisheries system in order to facilitate the transition toward the viability of the fisheries communities as well as the forest itself.

3.2 Introduction

Fisheries resources that span across political, social, and ecological boundaries significantly affect small-scale fisheries. In transboundary fisheries systems, i.e., shared social-ecological systems (SESs) between two or more countries, small-scale fisheries face multifaceted vulnerabilities, driven by social, political, economic, and cultural challenges. As Scholtens and Bavinck (2014) define it, transboundary fishing involves fishers harvesting marine resources across borders, which is not exclusively within national jurisdiction. This practice raises sustainability concerns, impacting both social justice and ecological health (Scholtens, 2015). Small-scale fishers in these regions often cross borders to follow fish movements (such as migratory or straddling stocks) or access nearby fishing grounds, sometimes leading to overfishing (Doria et al., 2020). Such border-crossing increases conflicts and competition between fishers from neighbouring areas (Song et al., 2017). Additionally, the mobile nature of small-scale fishing, whether intentional or unintentional, may lead the fishers to cross borders, whether for shelter during disasters or due to drifting in emergencies (Scholtens et al., 2019).

For many small-scale fishers, mobility or transnational migration is a livelihood pattern (see Adhuri and Visser, 2007), which is criminalized by state-biased contrasts in the context of mobile resource exploitation (Gupta and Sharma, 2008). Such a situation can entangle small-scale fishers in high-level geopolitical disputes between the countries (Song, 2015), and fishers can be used as a medium of bargaining between neighbouring countries to achieve their desired interests (Scholtens, 2016). For example, given that fisheries' products are globally traded, small-scale fishers can become victims of global trade in terms of tariff restrictions, forced trade rules, price fluctuation and importing food safety standards (Purcell et al., 2017). Additionally, in the transboundary regions, fishing people share their stories, interact, learn about fishing from each other, and exchange knowledge. A political boundary in a fisheries system makes fishers disconnected, affecting their cultural practices and community cohesion (Song et al., 2017).

The governance of transboundary fisheries resources is difficult for several reasons. The mobility of fish and fishers makes it difficult to control, monitor and implement regulations (Song et al., 2017; Schlager et al., 1994). In managing mobile resources, the structure and function of formal and informal organizations are unlikely to match within and across political boundaries (Nyikahadzoi et al., 2017; Mostert, 2003). The differences in jurisdictions, interests, and values in transboundary resources by different institutions make the governance complex (Maldonado et al., 2017). It is unlikely that the governments will pay equal attention throughout the transboundary regions due to the remoteness of fishing communities, poor transportation, and difficulties in communication (Ruffino, 2016).

Maintaining sustainable fish stocks depends on the combination of social, biological, and ecological factors, as well as user behaviour (Lorenzen, 2008) and governance structures (Aguilera, 2018; Burns and Stohr, 2011). The vulnerabilities of small-scale fisheries in the transboundary context are not nested in a particular jurisdiction, discipline or boundary; they are often connected to bigger problems (e.g., geopolitical disputes), making it hard to address them in isolation. Such problems are unlikely to be addressed through a one-size-fits-all approach. Instead, it is important to understand the characteristics of small-scale fisheries that are being governed and under the structure and functions of the governing system in facilitating a transition from vulnerability to viability for small-scale fisheries in the transboundary context.

This is the case for the transboundary Sundarbans mangrove forest between India and Bangladesh in the Bay of Bengal. The common resources, including fish, honey and crab, on which millions of small-scale fishers from both sides of the forest rely, are affected by transboundary complexities. Not only are the resources the same, but the language, culture, social norms and values are almost identical among the fishing communities living around the forest (Gopal and Chauhan, 2018). Despite the importance of small-scale fisheries as a source of income, employment, food and nutritional security for people from both sides of the forest (Islam et al., 2020; Raha et al., 2013), a lack of coordination in terms of policies and action between those countries for the shared fisheries resources governance is persistent (Merayo et al., 2020; Islam et al., 2017; Gopal and Chauhan, 2018).

While studies are conducted on transboundary fisheries and water resource governance around the world (Doria et al., 2020; Scholtens et al., 2019, 2015, Nyikahadzoi et al., 2017; Song et al., 2017; Paisley and Henshaw, 2013; Chen, 2008; Wolf, 2007; Sneddon and Fox, 2006; Sadoff and

Grey, 2005), the issue of transboundary fishing remains poorly studied in the Bay of Bengal (Dutta et al., 2021; Scholtens, 2015; Scholtens and Bavinck, 2014) and no such studies have been conducted on the Sundarbans mangrove forest. This study aims to assess the vulnerabilities of small-scale fisheries in the transboundary Sundarbans fisheries system by analyzing the characteristics of the social, ecological and governing systems. In doing so, the study will answer the following two questions: (i) What are the key vulnerabilities of small-scale fisheries in the Sundarbans transboundary fisheries system? (ii) What are the factors that hinder or facilitate the vulnerability to viability transition for small-scale fisheries in the transboundary context?

The following section first introduces the theoretical and analytical framework of the study. Then, it describes the methods, including the study areas, as well as the data collection and analysis for this study. The result section presents the main findings in terms of social, ecological and governing systems of the transboundary fisheries between India and Bangladesh. The next section discusses the key vulnerabilities and challenges to facilitate the transition from vulnerability to viability. Finally, the study concludes with the key research findings, recommendations for the governing bodies and public policies and future research direction.

3.3 Conceptual Framework

This study was drawn from the vulnerability to viability (V2V) transitions framework presented in Figure 3.1 below. The conceptual framework was developed drawing from the interactive governance (Kooiman et al., 2005) theory and the governability lens (Bavinck et al., 2013). This framework helps assess not only the social and natural characteristics of the fisheries system but also how they are governed on both horizontal and vertical institutional scales and through what channels of interaction between the governed and the governor.

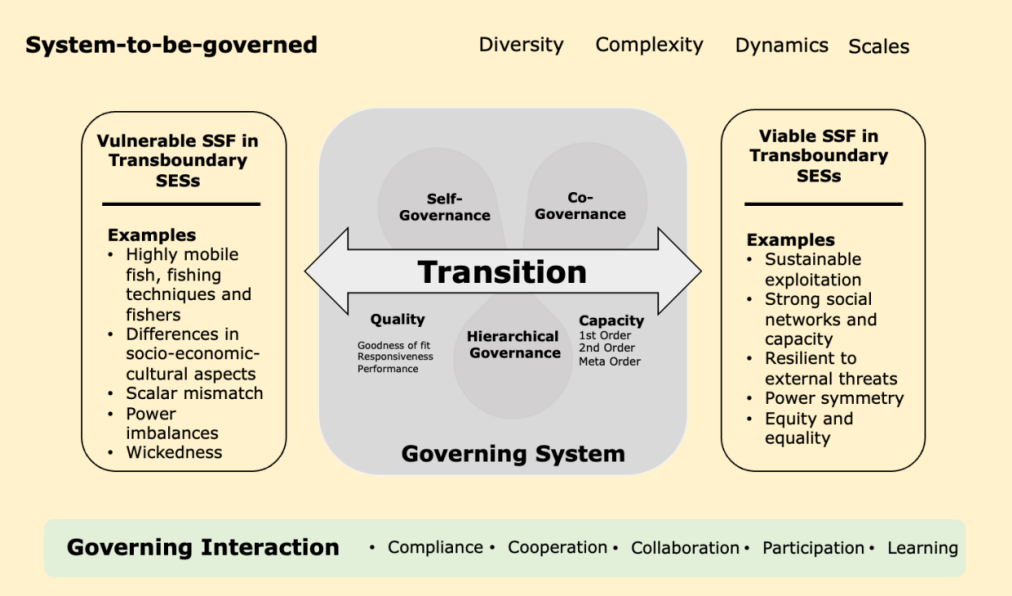

Figure 3.1 A conceptual framework to assess the characteristics of transboundary social-ecological systems (SESs), the governing system and the governing interaction.

As outlined in the conceptual framework, the fisheries system in the transboundary context can be comprised of diverse governance actors, including governing institutions from neighbouring countries, civil society institutions, non-government organizations, market institutions and international bodies. These actors and their actions are constrained by the structure of their institutions (Kooiman and Bavinck, 2013). The actors both within and across the political borders involved in the transboundary fisheries governance have diverse views, ideas, perspectives, interests and values. The differences are not straightforward and unequivocal (Kooiman et al., 2008). The differences can also be based on the culture and language of the actors.

This study contends that reconciling these differences while tackling the multifaceted vulnerabilities of small-scale transboundary fisheries presents a governability challenge. Governability refers to the "overall capacity for governance of any societal entity or system" (Kooiman et al., 2008, p. 3), grounded in the idea that societal systems consist of three interconnected elements: the *system-to-be-governed*, the *governing system*, and the *interactions* between the two. Governability is shaped by the attributes of both governors and the governed, as well as their dynamic relationship.

As presented in Figure 3.1, the light yellowish box is the system-to-be-governed (SG), representing the diversity, complexity, dynamics and scales characteristics of the transboundary SESs. The framework is used to assess the characteristics of the transboundary fisheries system. The boxes in SG provide some examples of vulnerable and viable transboundary fisheries systems. The light grayish box represents the governing system (GS), which shows that GS is crucial to facilitate the transition from vulnerability to viability. The three small bubbles inside the grayish box represent the common governing approaches, i.e., self-, co- or hierarchical, that may be in place in the transboundary fisheries system. This study defines self-governance as a governing arrangement where the state or central government has minimal to no intervention, such as a fishing community organization in their village. For co-governance, the responsibilities are shared between the governed and governors. Hierarchical governance is where the community (governed) has minimal to no input in decision-making. This framework is used to identify the governance approach on both sides of the forest. The major interaction channels between the SG and GS (long greenish rectangle box at the bottom) can be in the form of compliance or non-compliance with policies, cooperation, collaboration, participation, learning and beyond. Using this framework, this study examined the major channels of interaction between small-scale fisheries and the governing system. Thus, the V2V transitions framework analytically guided this research by assessing the characteristics of the transboundary small-scale fisheries SG, GS and GI to identify the key vulnerabilities and challenges to facilitate the vulnerability to viability transitions.

3.4 Methods

3.4.1 Study Areas

The study was conducted in the Sundarbans mangrove forests on the Bay of Bengal coast of Bangladesh and India (Figure 3.2). The Sundarbans, shared between India and Bangladesh, are the largest mangrove forests in the world. The total area of the forest is about 10,000 $km^{2,}$ where

60% of the forest is in Bangladesh jurisdiction and 40% in West Bengal, India (Islam and Hossain, 2017; Hussain and Karim, 1994). The forest was formed about 7000 years ago by the deposition of sediments from the foothills of the Himalayas, carried out by the Ganges River system (Aziz and Paul, 2015; Allison et al., 2003). The forest provides a rich biodiversity with diverse flora and faunal composition. About 50% of the world's mangrove species are found in the forest (Aziz and Paul, 2015; Hoque and Datta, 2005).

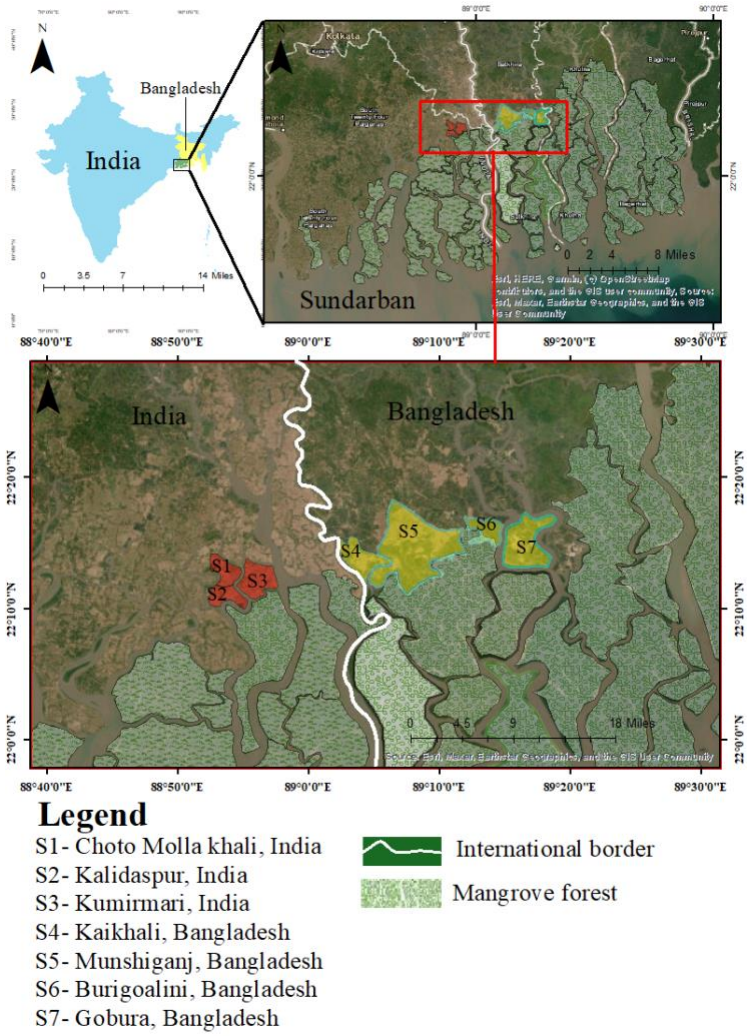

Figure 3.2 The map shows the geographical position of the Sundarbans mangrove forest between Bangladesh and India and the study areas.

The Sundarbans are also known for supplying potential goods and services to human societies and playing critical ecological roles (Islam and Hossain, 2017; Islam, 2018; Rahman et al., 2018). More than 12 million people live around the forest for their income and livelihood, and the majority of them are small-scale fishers (Raha et al., 2013). Small-scale fisheries make a significant contribution to food and nutritional security, employment and poverty reduction for the communities living around the forest (Mozumder et al., 2018). However, small-scale fisheries face a number of vulnerabilities in earning their livelihoods from the forest. The major

vulnerabilities include the conversion of forests for agriculture and aquaculture (Seidensticker et al., 1987), alteration of hydrology through upstream irrigation and establishment of embankments (Chauhan and Gopal, 2014), climate change-induced sea level rise (Pethick and Orford, 2013), salinity intrusion, and pollution (Rahman et al., 2009; Manna et al., 2010), overfishing, lack of alternative livelihood sources, poor health and safety conditions, large-scale aquaculture practices and weak governance arrangements (Islam et al., 2018; Gopal and Chauhan, 2018).

In addressing these challenges and making small-scale fisheries viable, the governance system both India and Bangladesh Sundarbans comprise of a diverse set of governing institutions, such as fishing community organizations, traders' associations, boat owners' associations, transporters' associations, distributors' associations, exporters' associations, government organizations and other non-profit organizations (Aziz and Paul 2015). The position and interests of each governing institution do not necessarily complement each other (Islam et al., 2017). Furthermore, the highly migratory nature of this fishery across borders makes it difficult to implement effective governance strategies (Merayo et al., 2020). The Government of Bangladesh passed a number of acts, ordinances, and rules to exploit, develop, manage and conserve the fisheries sector. These include the Protection and Conservation of Fish Act (1950), which was amended by the Protection and Conservation (Amendment) Ordinance (1982), and the Marine Fisheries Ordinance (1983). The West Bengal (WB) government, India, has initiated a hilsa (*Tenualosa ilisha*) conservation plan, which includes restrictions on mesh size, juvenile capture, and periodic fishing bans (GOW, 2013). Recently, India's draft of the National Fisheries Policy 2020 focused on regional cooperation in managing and preserving common resources between countries. Despite the similarities in resources, livelihood options, culture, and social norms and values across the borders, the governing policies and regulations are different for the Indian and Bangladesh sides of the forest, which put barriers to the viability of small-scale fisheries.

3.4.2 Data collection and analysis

This study was carried out in Satkhira, Khulna, Bangladesh and Gosaba Block, West Bengal, India, from September 2023 to April 2024. The researcher covered these areas by considering three factors: typical transboundary case, same language, and familiarity. The small-scale fishers from both sides use Bengali as their first language, which gave the researcher an extra advantage in understanding their input, the depth of knowledge, their feelings and emotions, as Bengali is their mother tongue too. The researcher spent less time in India compared to Bangladesh's study areas, as Bangladesh was the primary study site, with corresponding sites on the Indian side to develop a comparative view of vulnerabilities across the transboundary Sundarbans.

This research used a purposive sampling approach to select the research participants. The researcher has experienced researching small-scale fisheries in the Sundarbans of Bangladesh for the last four years and has established contacts with fishing communities. For India, extensive informal consultation was conducted with a couple of scholars from the Vulnerability to Viability (V2V) Global Partnership and Too Big To Ignore (TBTI) research network to choose the study areas. Besides, the Indian Institute of Technology (IIT), Kharagpur, in West Bengal, hosted the researcher during their research in India. A faculty member of IIT Kharagpur connected the researcher to the representative of a fisheries cooperatives society in Kurmimari

island, Gosaba Block in India. They helped select the research participants and took the researcher to the fishing villages.

As presented in Table 3.1, data were collected from eight villages from Kumirmari and Chuto Mollakhali in Gosaba Block, West Bengal, India. A total of 52 household surveys (N=52), 14 Key Informant Interviews and one focus group discussion were conducted in these villages in India. The participants were selected based on their fishing profession and legal age (i.e., not less than 18 years old). Key informant interviews were conducted with fishing community leaders and also other stakeholders, including traders, cooperative societies, government bodies, non-government organizations (NGOs), and academia. The focus group was conducted with representatives from fishers, NGOs, cooperative societies, women's groups and government bodies. A similar approach has been used on the Bangladesh side as well. Data were collected from ten villages in East Dhankhali, Gabura, Burigoalini, Munshiganj and Koikhali areas of Shyamnagar, Khulna. In most villages, the participants were selected by the local community leaders, who were known to me from previous research. A total of 99 household surveys (N=99), 18 key informant interviews, and one focus group discussion were conducted. Similar to India, the inclusion and exclusion criteria for selecting participants were followed.

Table 3.1 The study areas and the methods used to collect data.

Country	**Villages**	**Surveys**	**Key Informant Interviews**	**Focus Group Discussion**
India	Karmakarpara, Kumirmari	4	14	1
	Badanpara, Kumirmari	3		
	Miridapara, Budbar bazar, Kumirmari	11		
	Gayenpara, Kumirmari	8		
	7 No Hetalbari, Chuto Mollakhali	6		
	8 No Khalidaspara, Chuto Mollakhali	5		
	9 No Khalidaspara, Chuto Mollakhali	9		
	4 No Boiddopara, Chuto Mollakhali	6		
Bangladesh	Achra, Kalbari	6	18	1
	Dumuria, Gabura	10		
	East Dankhali, Munshiganj	11		
	Chuna, Burigoalini	9		
	Muthrapur, Munshiganj	10		
	Horishkhali, Gabura	14		
	Kalindapara, Koikhali	14		
	Datinakhali, Burigoalini	7		
	9 no Shora, Gabura	8		
	Holopara, E. Koikhali	10		
	Total	**151**	**32**	**2**

The household survey questions mostly comprised closed-ended questions regarding social, ecological, and governance information of the transboundary fisheries system. There were some open-ended questions as well to support the community responses in some cases, for example, whether people were happy with the governing system, and if not, the researcher asked follow-up questions to share reasons for not being happy. The surveys were mainly helpful in identifying the vulnerabilities of small-scale fisheries. The key informant interview questions were comprised of general information about transboundary fisheries, the major sources of vulnerability for small-scale fisheries, the governing systems, and suggestions for making small-scale fisheries viable. Key informant interviews were helpful in identifying the attributes crucial for vulnerability to viability transitions. The information collected from both methods complemented each other and helped in achieving the research objectives. A few specific discussion questions related to vulnerability to viability transitions in the transboundary fisheries system were listed and discussed in the focus group discussion, which were helpful in validating the information collected from surveys and interviews. The survey and interview questions were designed in a way that did not take more than 60 minutes for the participants. The FGD was carried out for 2 hours each.

The data collected using each method were compiled in a Microsoft Excel sheet. The household survey data were converted to numbers using 'yes=1' and 'no=0' against each response. For the majority of questions, the participants provided/chose multiple answers against each response. All the responses were analyzed in the Excel sheet and converted to percentages. The interview responses were analyzed using the content analysis method. The responses to each question were coded using a few words, and the codes were then sub-categorized into broader terms. The sub-categories were further categorized based on their similarities and dissimilarities. The categories are broadly related to three themes, i.e., transboundary social and natural systems, governance systems and governing interactions. The data were analyzed thematically based on the themes of the conceptual framework introduced above. The information gathered from FGDs was helpful in validating or cross-checking the survey and interview data.

3.5 Results

The results section first presents the small-scale fisheries system to be governed and the diversities, complexities and dynamics in the social and natural systems that small-scale fisheries are part of within and across the political boundaries. The governance approaches in the practice of the Sundarbans are explained, and the key vulnerabilities are associated with them. The common channels of interaction that take place between the governing systems and the governed are also presented.

3.5.1 Transboundary Sundarbans small-scale fisheries

3.5.1.1 Household information

The small-scale fishermen and women interviewed are dominated by men in both India (77%) and Bangladesh (87%) Sundarbans (Figure 3.3a). It is observed that women feel shy in many cases when talking to strangers and prefer that a man from their family participate in the interview if they are around. Such dynamics highlight how patriarchal structures invisibilize

women's labour in fisheries, despite their contributions to post-harvest activities or informal economies. Regarding religion, most of the small-scale fisheries in the Bangladesh side are Muslim (70%), while in India, Hindu people (87%) are more involved in fishing in the forest (Figure 3.3b). In Bangladesh, it used to be mostly Hindu people who were involved with small-scale mud (*Scylla sp.*) fishing in the Sundarbans; however, given less opportunity to work outside the forest and the high demand for crab in the international market, Muslim people increased their participation in fishing. This shift hints at how economic pressures can reshape traditional occupational divisions along religious lines. From the participants, the research suggests that younger generations perceive fishing as unsustainable or unviable, as around 90% of the participants from both India and Bangladesh are married (Figure 3.3c). The majority of the small-scale fishers who participated in the study, both from India (58%) and Bangladesh (60%) (Figure 3.3d), have no land, forcing reliance on tenuous housing arrangements (Figure 3.3e). Those who have some land are using it mainly for housing, cash crop cultivation, and livestock (e.g., poultry, duck, cow) rearing. The majority of the fisher respondents do not own the land on which they built their house. The availability of electricity in both India (98%) and Bangladesh (97%) is better (Figure 3.3f), while other necessities, including pure water, sanitation and fuel for cooking for small-scale fishing communities, are poor. More than 40% of fishing households in India and 29% in Bangladesh still do not have a private latrine (Figure 3.3g). They share a latrine among 3-5 neighbouring households. This results in significant health and safety concerns for fishing communities.

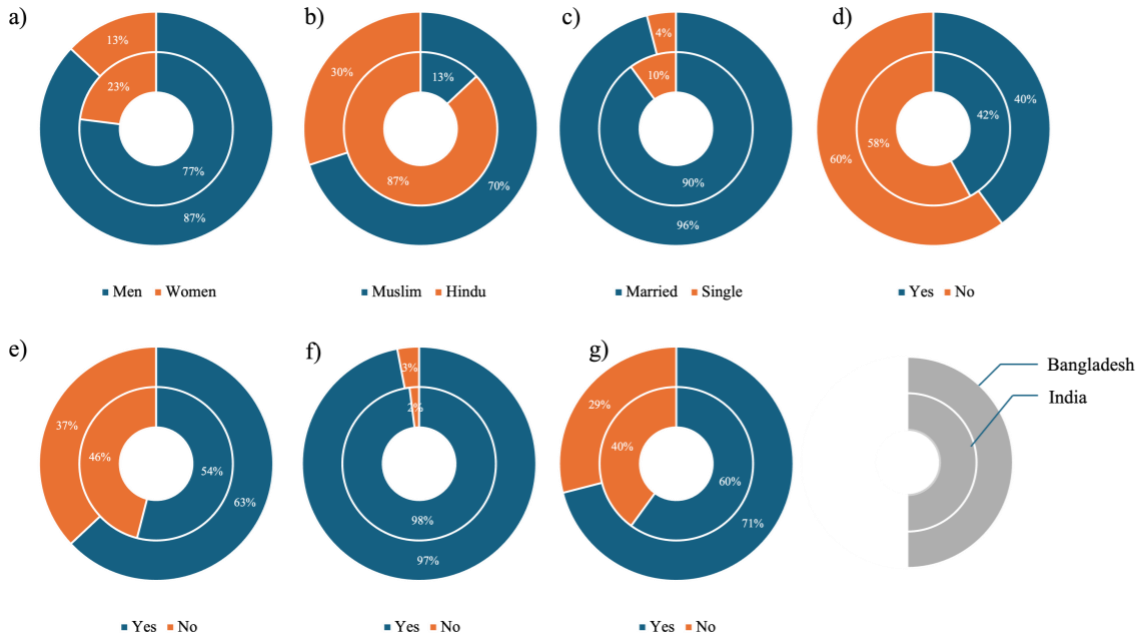

Figure 3.3 Demographic information of SSF communities in the Sundarbans: a) Gender, b) Religion, c) Family Status, d) Land ownership, e) House ownership, f) Electricity availability, g) Private latrine for each household.

The results show that the fishers involved in small-scale fisheries are mostly between 35 and 60 years old (Figure 3.4). This demographic trend raises concerns about the future sustainability of

small-scale fisheries, as younger generations appear disengaged from the profession. Regarding education, the majority of the small-scale fisher participants from India (52%) are illiterate, while in Bangladesh, the majority (37%) can sign only (Figure 3.5). More than 30% of fisher participants from Bangladesh have five years of schooling, which is 17% in India. The pervasive illiteracy and minimal education levels perpetuate cycles of poverty, limiting fishers' ability to adopt new technologies or sustainable practices, access alternative livelihoods, or advocate for their rights effectively.

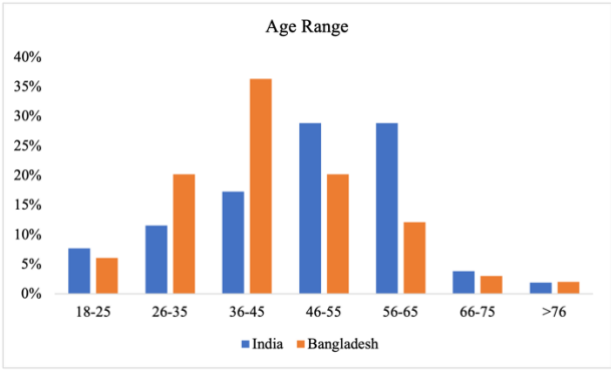

Figure 3.4 The age range of SSF participants.

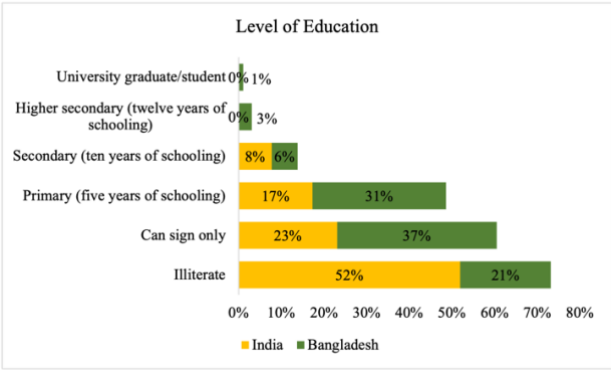

Figure 3.5 The level of education of SSF fishers.

High dependency on fisheries and a lack of or limited alternative income options pose barriers to small-scale fisheries' transitions to viability. Small-scale fishing is the main occupation for the majority of the fishers in Bangladesh (87%) and India (81%) (Figure 3.6), which reflects their high dependency on fisheries resources. Crab harvest is the main income source for the majority of small-scale fishers in India (85%), which is comparatively lower in Bangladesh (40%). A considerable number of fishers (27%) use honey collection as their main profession. As presented in Figure 3.7, small-scale fishers opt for day labour jobs as the main secondary income source in both India (69%) and Bangladesh (68%). Given the limited available alternative income options, fishers in India look to Agriculture (19%) or migrate to different cities and states (13%) to feed their family in the absence of forest income. In Bangladesh, some small-scale fishers still rely on crab harvest (18%) and honey collection (12%) from the forest or work in the agricultural field (12%) as a secondary income source. The absence of diversified livelihood options traps fishers in cycles of resource depletion and economic instability. The prevalence of informal labour (e.g., day work) as a secondary income underscores the inadequacy of current interventions.

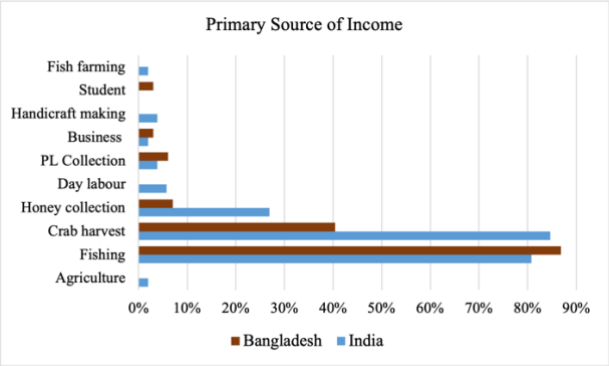

Figure 3.6 Primary sources of income for fishers.

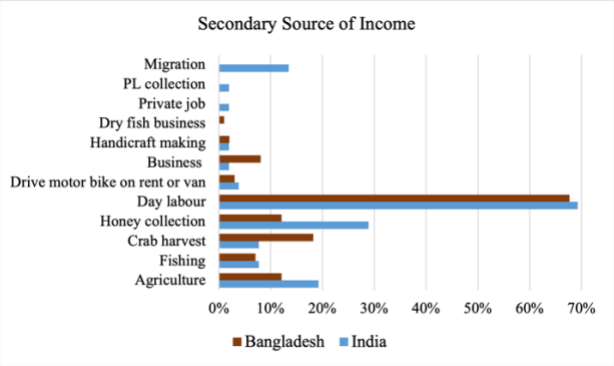

Figure 3.7 Secondary sources of income for fishers.

3.5.1.2 Food security and family well-being

The study reveals systemic vulnerabilities plaguing small-scale fishing communities, with alarming deficiencies in healthcare access, infrastructure, and food security. As presented in Table 3.2, about 83% of Indian and 77% of Bangladeshi fishers report inadequate medical services, which is a fundamental rights violation exacerbated by poor transportation networks. The data exposes particularly grim realities for maternal health, with pregnant women enduring dangerous journeys to distant clinics, sometimes requiring hours-long boat rides in India. Nutritional insecurity presents another crisis, with 73% of Indian and 51% of Bangladeshi parents struggling to feed their children adequately. While Bangladesh shows marginally better outcomes (45% can afford basic nutrition), the broader picture remains dire. Most households (75% in India, 85% in Bangladesh) lack subsistence capacity, relying entirely on purchased food. During financial shocks, over half of Indian (54%) and one-third of Bangladeshi (34%) families reduce meals from three to two daily, a clear indicator of precarity. While the educational enrollment rates (56% in India, 65% in Bangladesh) are hopeful, they may reflect desperation rather than opportunity, children sent to school as an escape from declining fisheries viability, not necessarily with adequate support to succeed.

Table 3.2 Food security and family well-being of small-scale fisheries in Sundarbans mangrove forest.

Variables	**India (%)** (N=52)	**Bangladesh (%)** (N=99)	**Variables**	**India (%)** (N=52)	**Bangladesh (%)** (N=99)
Health and medical facilities			***Food bought for household consumption***		
Poor	83	77	Everything	75	85
Good	8	10	More than half	25	15
Moderate	10	13	***Daily Meals***		
Enough good food for children			One	0	3
Yes	27	45	Two	0	9
No	73	51	Sometimes Two	54	34

Prefer not to mention	0	4	Three	100	92
			Sometimes three	0	4
Women express their needs to					
Husband	77	84	***Child Education***		
Family head	4	6	Yes	56	65
Self-dependent	19	10	No	44	32

Although more than 70% and 80% of fisherwomen in India and Bangladesh, respectively, depend on their husbands to fulfill their needs, 19% and 10% of fisherwomen are self-dependent in India and Bangladesh, respectively, because of their active contribution to family income (Table 3.2). This challenges stereotypical notions of passive dependence, highlighting women's often-overlooked economic roles. Women on the Indian and Bangladeshi sides of the Sundarbans mangrove forest make a significant contribution to family income and well-being. More than 80% of fisherwomen on both sides of the forest take care of their family members and maintain the household activities (Figure 3.8). The high percentage of women managing households reflects entrenched gendered divisions of labour, where domestic work remains uncounted in economic assessments. Additionally, they are actively involved in day labour jobs, crab harvesting, fishing, and shrimp post-larvae (PL) collection from the rivers to supplement their family income. Around 45% of fisherwomen in India are involved in day labour activities, and 14% in Bangladesh. Women are also involved in crab harvest in India (27%) and Bangladesh (18%), and in fishing, 25% and 9%, respectively.

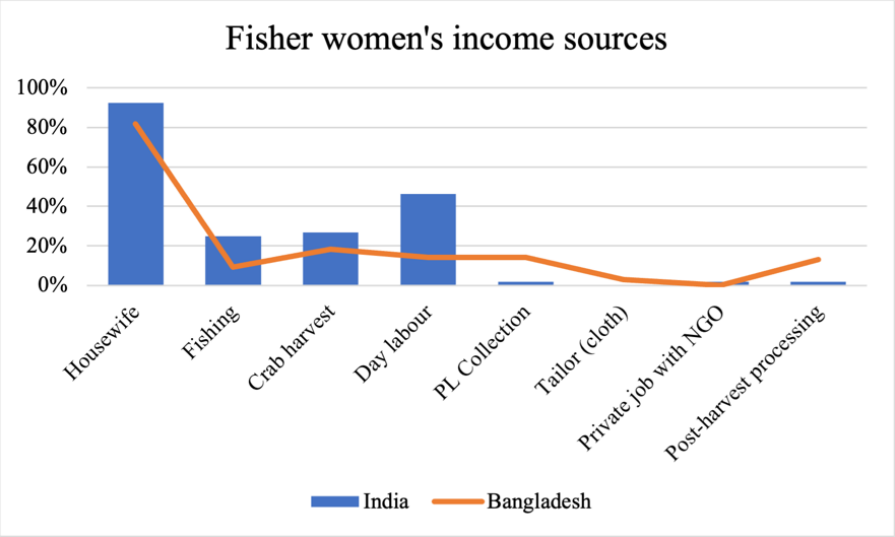

Figure 3.8 Fisherwomen's contribution to family income.

3.5.1.3 Natural Hazards

Natural disasters are one of the key vulnerabilities that small-scale fishing communities face on both sides of the forest, with 90% of fisher respondents from both sides of the forest reporting

frequent cyclones, floods and salinity intrusion (Table 3.3). Salinity intrusion is lower in Bangladesh (47%), mainly because their households are not inside the forest. In India, many fishing communities live in and around the islands of the forest. As a result, fishing communities in India suffer from river erosion (42%) more than in Bangladesh (4%). Emerging climate patterns compound these challenges. Around 40% of fisher respondents in India and 30% of respondents in Bangladesh agree that sea level rise and waterlogging are gradually increasing. In Bangladesh, more than 55% of fisher participants agree on increased erratic rainfall.

Table 3.3 Common natural hazards in the Sundarbans mangrove forest.

Natural Hazards	India	Bangladesh
Cyclone	96%	87%
Flood	96%	94%
Salinity	88%	47%
High tide and sea level rise	42%	29%
Water logging	42%	29%
River erosion	42%	4%
Erratic rainfall	15%	56%
Temperature rise	12%	42%
Change in seasonal patterns	4%	25%
Cold in winter	2%	0%
Drought	0%	7%

3.5.1.4 Transboundary Fishing

During fishing operations, the common vulnerabilities of small-scale fishers in the Sundarbans mangrove include dependency on middlemen for credit support, inequity in income and benefits sharing, lack of proper forest pass/license, and competition among the fishers for fishing space. Small-scale fishers go fishing in groups of 3-5 people, and those who are involved with crab harvest go in smaller groups of two or sometimes alone. The fishing group enters the forest for a week or two and takes the necessary food and other logistics with them for the whole trip. They go deep into the forest or sometimes even cross the country border. They are unlikely to have enough savings to buy logistics before the fishing trip starts. Therefore, they are bound to middlemen (locally known as *Dadon*) for credit support to buy necessary logistics or to borrow fishing gear, for instance, a boat. As presented in Figure 3.9a, more than 35% of fishers in India and around 25% of fishers in Bangladesh have a contractual informal agreement with middlemen or fishing gear owners. As part of this contract, they either need to sell their products to the respective middlemen from whom they take money or gear or share a major portion of the profit from the harvested products. This is one of the reasons that 54% of the fishers in India and 42% in Bangladesh are unable to get equitable benefits from their fishing trips (Figure 3.9c).

Furthermore, the Indian government has stopped renewing the Boat Licence Certificate (BLC) for the last few decades, which is the entry requirement for fishers to go into the forest and harvest fish. As a result, fishers borrow the BLC from those who have it or have it as a legacy

from their previous generation. Currently, the majority of the fishers do not have the BLC, and they borrow it by paying $800-1,000 USD/ year. Therefore, fishing is hardly profitable for those fishers. On the Bangladesh side, fishers in Bangladesh have an ongoing forest entry pass issuance system, and more than 55% of fishers are able to get equitable benefits from their harvest. Still, the lower prices in the markets and the middlemen-bound credit market system do not allow fishers to earn their desired benefits. Around 60% of fishers in India are unable to set their fishing gear in any place due to a lack of BLC and protected areas in the forest (Figure 3.9b). Similarly, almost half of the fishers in Bangladesh expressed that they are able to set their gears in any place they want during the fishing season with proper fishing permits.

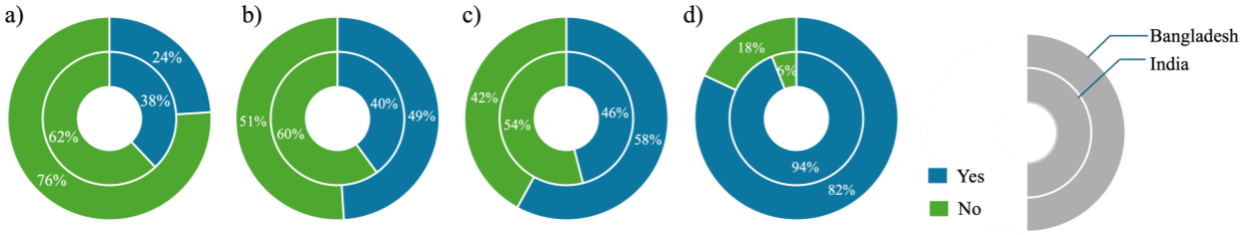

Figure 3.9 Characteristics of SSF in Transboundary Sundarbans: a) contractual agreement between fishers and money lenders, b) setting up fishing gears in any place in the river/forest, c) Equitable share of benefits from fish harvest, d) Fishers' ownership of fishing gears.

For fishing in the forest, more than 85% of fishers in India use different nets and traps, 98% and 25%, respectively, in Bangladesh (Table 3.4). They also use different types of sips or hooks for crab fishing, mainly on both sides of the forest. Among diverse fishing gears, *Dhon-dhori* (sip), *Fash jhal* (net), *Ber jhal*, fine net and *Khebla jhal* are more frequently used (Figure 3.10). In Bangladesh, *Fine Net, Dhon-Dhori, Keola Jhal, Pata Jhal*, and *Atol* are used more. In both countries, more than 80% of fishers have their own fishing gear (Figure 3.9d). A majority of them do not have fishing boats, which they borrow from *bepari* or *mohajan* with a contractual agreement. Thus, a significant number of people mentioned that their harvested products are sold to middlemen, locally known as *dadon* (see Table 3.4). This practice is more common in Bangladesh (56%) compared to India (35%). The main buyers of the fish in the markets are local traders in India (94%). Local traders (48%) and commission agents (46%) are also important fish buyers in Bangladesh. The income from fishing is declining gradually for a number of reasons, including the unstructured market that is controlled by middlemen groups and local traders. Another important reason that causes income vulnerability of small-scale fisheries is that around 80% of fishers agree that the status of fish has decreased significantly in the forest.

Table 3.4 The characteristics of transboundary fisheries in the Sundarbans mangrove forest.

Variables	**India (%)** (N=52)	**Bangladesh (%)** (N=99)
Fishing strategies		
Nets	87	98
Traps	88	25

Hook	27	47
Fish farming	2	0
Market Actors		
Middlemen (*dadon*)	35	56
Consumer	2	2
Local trader	94	48
Commission agent	17	46
Relatives or neighbour	12	1
Status of fish in the forest		
Increased	6	16
Decreased	81	80
No change	13	4

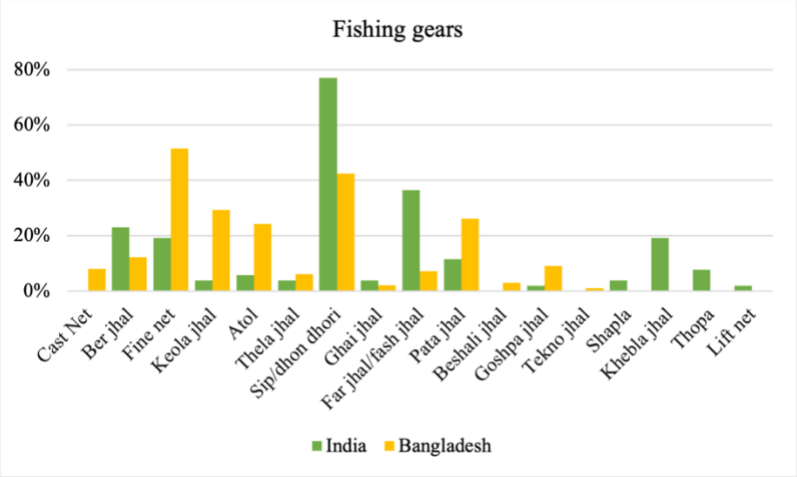

Figure 3.10 Common fishing gear used in the transboundary Sundarbans mangrove forest.

Small-scale fishers operating in the Sundarbans face multiple intersecting threats during fishing operations (Figure 3.11). An overwhelming 90% of small-scale fisher respondents identified storms and confrontations with law enforcement as pervasive challenges. These encounters often involve disputes over fish they harvest, permits, equipment, and territorial access, frequently exacerbated by corrupt practices. The frequent conflicts with authorities reveal deep governance failures. Additionally, fishers must contend with criminal elements (locally termed *dakhat*) and dangerous wildlife, including tigers, wild boars, snakes, and crocodiles. The human-tiger conflict emerges as particularly severe, with nearly all respondents reporting increasing attacks. Many fishers in India attribute this to government-led tiger reintroduction programs, while officials maintain the growing tiger population reflects successful conservation measures. While Bangladesh reports fewer attacks (68%), the threat remains significant. Spatial conflicts among fishers are intensifying as conservation zones expand while fisher populations grow, creating competition for dwindling fishing grounds. Border-related incidents affect 21% of Bangladeshi

and 12% of Indian fishers, with transboundary movement primarily driven by seasonal resource availability, honey collection for Bangladeshis and fishing during bans for Indians.

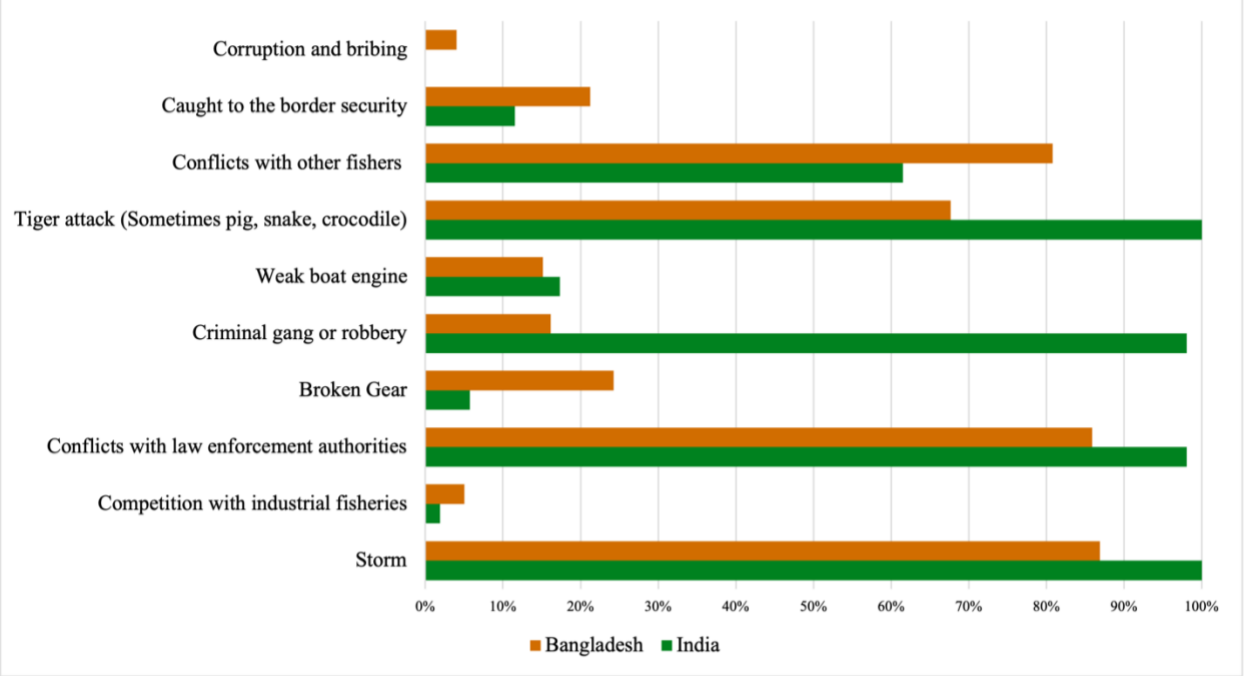

Figure 3.11 The vulnerabilities of SSF inside the transboundary Sundarbans mangrove forest.

3.5.2 Transboundary Governing System

The current governance systems in Bangladesh and India create significant barriers to the viability of small-scale fisheries in the Sundarbans, exacerbating vulnerabilities rather than enabling viable transitions. A fundamental issue is the lack of joint transboundary governance mechanisms, with both countries maintaining strictly national approaches to governance despite the shared ecosystem. This fragmented system fails to address ecological and livelihood challenges holistically. Furthermore, governance remains overwhelmingly hierarchical, with India's system being entirely top-down (as reported by all fisher respondents) and Bangladesh's predominantly so (71% of fisher respondents) (Figure 3.12). While Bangladesh has attempted to introduce co-management through its Co-Management Committees (CMCs) established under the Wildlife (Conservation and Security) Act, 2012 and the Protected Area Management Rules, 2017, implementation has been strikingly ineffective, as 78% of fishers remain unaware of these initiatives. A mere 22% of those who recognize some hybrid governance elements suggest that these efforts exist more on paper than in practice. This situation reveals a profound disconnect between policy intentions and ground realities, where traditional top-down approaches continue to exclude fishing communities from decision-making processes, despite their critical knowledge and stake in sustainable resource management.

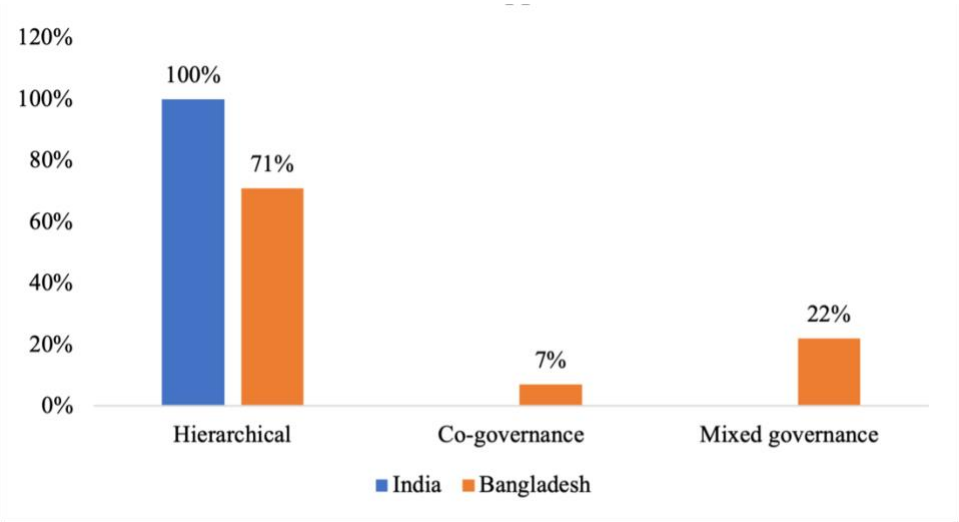

Figure 3.12 Governance approaches are in practice in the Transboundary Sundarbans.

It is true that there have been some changes in governance approaches, such as the co-management committee in Bangladesh and joint forest management in India. As presented in Figure 3.13, around 50% of fisher respondents agree that the governance approach has been transformed from hierarchical to co-governance, but almost the same percentage of people in India disagree with that. Fisheries in India are still hierarchically governed. However, the majority of the fisher respondents in India (52%) and Bangladesh (42%) disagree about their increased participation in governance (Figure 3.14). Despite the introduction of a co-governance approach on the Bangladesh side, the majority of the fishers are still not aware of or participate in the decision-making process. The persistence of such exclusionary governance structures not only undermines conservation efforts but also exacerbates the vulnerabilities of fishing communities who bear the brunt of environmental degradation while being denied meaningful participation in solutions.

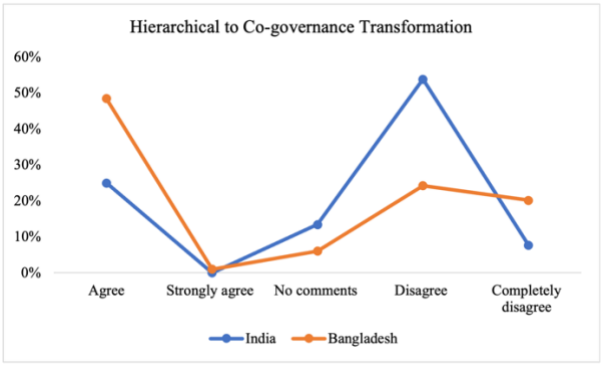

Figure 3.13 Governance transformation from hierarchical to co-governance.

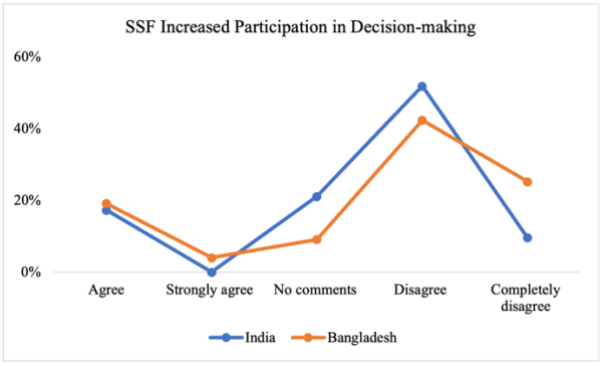

Figure 3.14 Increased participation in the decision-making for SSF.

A Memorandum of Understanding (MOU) was signed between Bangladesh and India in 2011. One of the key focuses of this MOU was to address the livelihood issues of communities living around the forest. However, since the agreement was signed, no such visible implementation is

in place. Despite the co-governance initiative in Bangladesh, more than 80% of the fisher respondents expressed that they have no opportunity to participate in the decision-making process (Figure 3.15a). Sometimes, they participate in the monthly meetings organized by the forest department to raise awareness among local communities, but it is unlikely that any suggestions will be taken from the communities. More than 60% of fisher respondents shared that they are not consulted in forming or implementing governing actions in both India and Bangladesh (Figure 3.15b). However, fishing communities are connected to some formal and informal organizations. In Bangladesh, the majority of the fishers are members of NGOs for different support, such as loans, relief, livestock farming, etc., which is much less so in India (Figure 3.15c). Women in Indian fishing communities form Self-Help Groups (SHGs) to get loans with the lowest interest rates.

Currently, there are no significant governance initiatives to address the vulnerabilities of small-scale fisheries in the transboundary forest. At each jurisdiction, there are some initiatives, but fishers have yet to benefit from them (Figure 3.15d). A couple of prominent initiatives in Bangladesh include getting rid of pirates (17%) inside the forest and the initiation of co-governance (22%) involving local communities (Table 3.5). On the other hand, many parts of the forest are fenced (25%) by the West Bengal Government in India to protect the communities from tiger attacks and prevent illegal access to the forest for resource harvest.

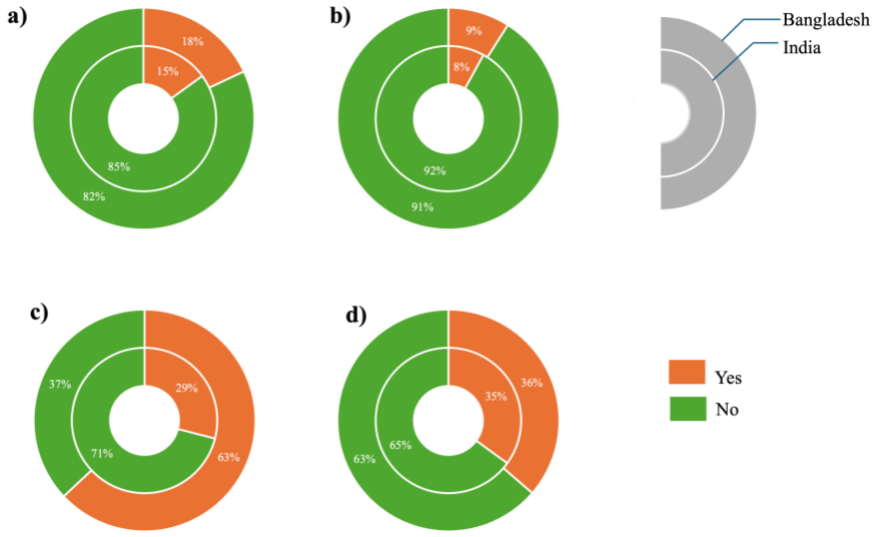

Figure 3.15 Governance aspects of transboundary Sundarbans governance: a) fishers' participation in the decision-making process; b) consultation with fishers; c) members of the informal organization; d) any innovative initiatives taken by the government in the transboundary forest.

Table 3.5 The strategies the governments have taken in the Transboundary Sundarbans to address the vulnerabilities of communities.

Major Initiatives	**India (%)** (N=52)	**Bangladesh (%)** (N=99)
Emerging co-management arrangements	0	22
Steps taken to get rid of robbery	4	17
Training on capacity development	0	3
Introduction of new legal forces	2	2
Reduced drugs business	0	1
Formed fishers cooperatives	2	2
Fencing the forest	25	0
Reduced tree cut	13	0
Provided good house	10	0

3.5.3 Transboundary Governing Interaction

The main channels of interaction between the government and small-scale fishers occur through policy implementation, informed decisions and non-compliance with the rules and regulations (Figure 3.16). This dynamic reflects a largely one-way communication model, where fishers are expected to follow regulations without meaningful engagement in the policymaking process. Rather than addressing the root causes of conflict, such as inadequate consultation, unrealistic restrictions, or lack of alternative livelihoods, the current system responds with punitive actions, including fines and imprisonment. This punitive cycle exacerbates tensions and fails to promote sustainable fisheries governance.

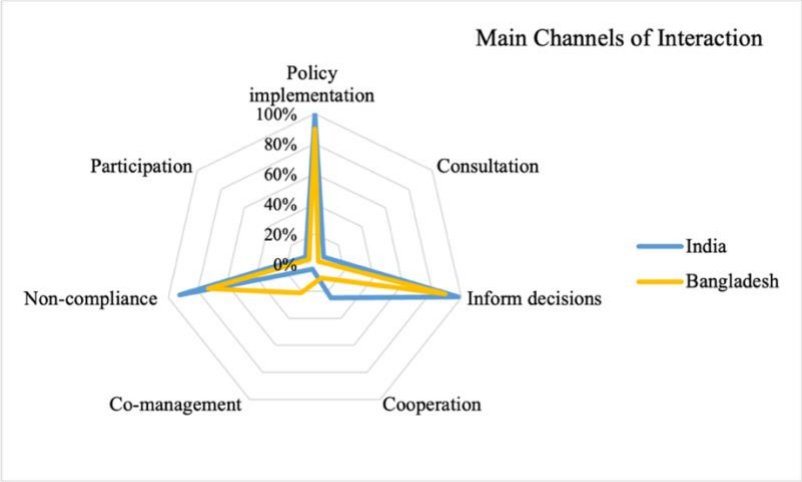

Figure 3.16 The common channels of interaction between fishers and the governing system in the transboundary Sundarbans.

The data presented in Figure 3.17 reveal significant dissatisfaction among fisher respondents in both countries, with over 70% expressing discontent with current governance approaches. Key grievances include harassment by forest and law enforcement authorities (>20%) and excessive restrictions on accessing forest resources (>20%). In Bangladesh, a notable 33% of fisher respondents directly accused forest guards of corruption, a claim that even some officials acknowledge as partially valid. While efforts are reportedly being made to address corruption with the cooperation of fishing communities, these findings highlight systemic governance failures that undermine trust between authorities and local resource users. Furthermore, the exclusion of communities from decision-making processes is particularly alarming; over 80% of fisher respondents stated they were never invited to participate, and 90% reported being excluded from consultations on forest-related decisions. This lack of inclusion not only perpetuates marginalization but also risks policy inefficacy, as decisions made without local input may fail to address on-the-ground realities.

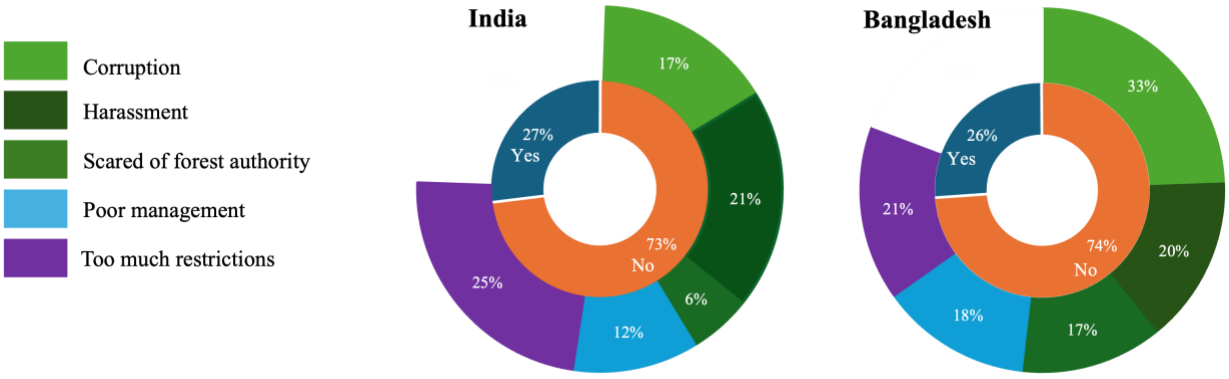

Figure 3.17 The figure shows the satisfaction of fishers with the current governing approach in the study areas. The inner circle indicates the percentage of people not happy, and the outer circle represents the common reasons for not being happy with the current governance approach.

3.6 Discussion

The results section shows the diverse sources of the vulnerabilities that small-scale fisheries face in the transboundary Sundarbans forest. It also indicates many factors that hinder the transitions toward viability. Drawing from the results, this section discusses the key vulnerabilities of small-scale fisheries and the barriers to viability, which are also summarized in Table 3.6 below.

Table 3.6 The key vulnerabilities of small-scale fisheries and the barriers to viability in the transboundary Sundarbans.

Attributes	Key Vulnerabilities	Barriers to Viability	Challenges
Access to basic entitlements	• Poor pure drinking water condition, health	• Remoteness and lack of attention by the government	• Capacity development

	and medical facilities, and sanitation		
Availability of Fish	• Fisheries stock declined • High dependency on fisheries • Increased number of fishers • Reduced income	• Destructive fishing practices to cope with the situation • Illegal migration across the borders	• Minimize the conflicts and competition
Safety and Security	• Natural disasters • Pirate attacks • Wild animal attacks • Unsafe fishing condition for women • Water related skin diseases	• Lack of safety measures • Unawareness of safety preparedness	• Adequate safety and security measures
Equity and benefits sharing	• Lack of credit support • Unfair prices for fishery products • Poor forest pass issue system	• Middlemen intervention • Lack of ability to benefit from resources	• Ensure better access to forest and resources
Governing structure and function	• Lack of attention to fishers • Marginalization of fishers in decision-making	• Top down interaction • Lack of joint governance initiative	• Provide space for fishers
Governing action	• Increased restrictions • Lack of incentives	• Poor governing action • Increased boundaries inside the forest	• Increase compliance with governing action
Involvement of youth	• Poor livelihood condition • Lack of physical asset • Uncertainty about income	• Reduced interest in fisheries as profession • Illiteracy among fishers • Gap in transferring indigenous knowledge	• Motivation for youth to enhance engagement in fisheries

3.6.1 Access to basic entitlements

Small-scale fishing communities in Bangladesh and India often face significant challenges in accessing basic necessities such as clean drinking water, healthcare, and proper sanitation (Roy et al., 2024; Bhunia and Ghosh, 2011). The persistent lack of safe water infrastructure exposes

many fishers to life-threatening waterborne diseases, including diarrhea, which remains a critical public health concern (Mozumder et al., 2018; Bhadra et al., 2018). The health facilities to go for treatment are also not good on both sides of the forest. This situation highlights systemic neglect, as governments have failed to prioritize the needs of marginalized coastal populations. Healthcare access is similarly inadequate, with many fishers depending on untrained local pharmacists due to the absence of proper medical facilities (Roy et al., 2024). The remoteness of these communities exacerbates the problem, as transportation barriers prevent timely access to hospitals, a particularly dire issue for pregnant women during emergencies.

The communities on the Indian side live on islands covered by rivers and rely on boats to travel to cities or for better medical facilities. It becomes even worse for pregnant women, especially during their labour pain. Because the boats are not easily available, and it takes more time to travel than other vehicles. The mothers who give birth at home face further complexities in registering their kids' names and getting the desired benefits. There is a policy in India that pregnant women need to be transferred to hospitals or under the supervision of registered nurses before their baby is born. While India has policies mandating hospital deliveries under professional supervision, implementation remains weak due to infrastructural and logistical constraints. This reflects a broader governance failure, where policy intentions are undermined by inadequate resource allocation and poor planning, leaving vulnerable communities in perpetual distress.

3.6.2 Availability of Fish

The decline in fish stocks and other forest-based resources, such as honey, has intensified income insecurity for small-scale fishers, particularly as the number of fishers continues to rise (Tzanatos et al., 2020). This reflects a global trend where dwindling fisheries resources struggle to meet escalating demand, leading to heightened competition (Crona et al., 2015). In dealing with such a crisis, some fishers use destructive fishing practices, such as poison fishing, which put a barrier to their viability in the long run (Cánovas-Molina and García-Frapolli, 2022; Mozumder et al., 2018). Additionally, some fishers are crossing the border illegally (Doria et al., 2020), with fishers from both India and Bangladesh accusing each other of encroachment. The tensions grow both within fishers from the two countries against each other and also at the administration levels from both jurisdictions, which complicates the sustainability of the resources and relationships (Scholtens et al., 2019; Nyikahadzoi et al., 2017). Such dynamics reveal a troubling cycle where resource scarcity drives unsustainable practices, which in turn deepen political and social divisions.

3.6.3 Safety and security

The governing institutions from both sides failed to a large extent to provide safety and security for fishers due to financial, manpower and political limitations (Roy et al., 2024; Mozumder et al., 2018). Fishers face year-round natural disasters, causing loss of lives and property. Although pirates in Bangladesh are not a big issue lately, fishers often die or get hurt by tiger, crocodile, or snake attacks. On the Indian side, pirates and wild animal attacks are both common vulnerabilities for small-scale fishers. Women are not safe inside the forest, and no such actions are in place (Roy et al., 2023). Moreover, women do not get their desired recognition, and the

decision-making process is still dominated by men (Roy et al., 2023; Lentisco and Lee, 2015). Both men and women fishers suffer from water-related skin diseases. Without enough safety cautions and measures, viable fishing communities are unlikely (Dias et al., 2023). Even though fishers know the risks of being a Sundarbans fisher, they still want to go fishing for income, food and nutritional security due to the unavailability of alternative income options (Islam et al., 2018; Mozumder et al., 2018). Given the generational involvement fishing communities have with the forest, it is unlikely that they will give up on fishing due to the safety and security concerns. This grim reality exposes the failure of governance structures to provide basic protections or viable economic alternatives, trapping fishers in a cycle of danger and deprivation.

3.6.4 Equity and benefits sharing

Small-scale fisheries in the transboundary forest are hardly able to benefit from the fisheries resources. The majority of the fishers are tied to informal agreements with either middlemen, local traders, boat owners, or BLC holders due to a lack of credit support. In most cases, fishers get exploited by the middlemen group, capitalizing on the social position and financial crisis of fishers (Thủy et al., 2019; Crona et al., 2010). At the market, unfair prices that fishers get from local traders undermine their rights and ability to benefit from their access to the forest (Kimani et al., 2020). Local markets have been informal and hierarchy-based for generations (Steenbergen et al., 2019). Issues exist in accessing forest resources and getting the forest pass. As a result, small-scale fishers lack the ability to benefit from access to the forest (Bennett et al., 2024). This indicates that as a country, both Bangladesh and India have made poor progress in achieving Sustainable Development Goals (SDGs) 14 target ‘b’, which is providing access to marine resources and markets for small-scale fisheries. A similar case was also observed by Said et al. (2020) in Europe in achieving SDG 14.b.

3.6.5 Youth involvement in fisheries

One of the key concerns is that the new generations are not much involved in small-scale fisheries due to various reasons, including poor livelihood conditions of fishers, lack of family physical assets, and uncertainty about income. The people who took fishing as their main profession are mostly illiterate, and they have carried this knowledge from their ancestors. The ongoing livelihood crises for small-scale fishers and the increased restrictions on fishing demotivated the new generations. Besides, the lack of house and land ownership for small-scale fishers and the remoteness of their villages, in many cases, near the forest and riverbanks, also encourage new generations to study and look for alternative professions. The fishing households, especially the parents, are also not in favour of involving their kids in this uncertain profession. A similar situation is also found by Espinoza-Tenorio et al. (2022) in Mexico and Power et al. (2014) in the case of Newfoundland and Labrador in Canada. Therefore, it is challenging for the governing actors to motivate youth to consider what innovation and ideas they can bring in for the sustainability of the fisheries resources and viability of fishing communities.

3.6.6 Governing structure and function

The current governance arrangements in both countries hardly match each other. Similar cases were reported by Doria et al. (2020) and Nyikahadzoi et al. (2017). The rules and responsibilities

of governing institutions in the country to govern Sundarbans mangrove forests sometimes overlap, sometimes conflict with each other, or result in undesired outcomes for other stakeholder groups (Islam et al., 2017). It is evident from the perspectives of the fishers that the government mostly focuses on their jurisdictions, and small-scale fisheries are not their priority. Within the country, the communication between fishers and governing bodies is mostly top-down and one-way. Instead of consulting fishers about what they want and how they envision the sustainability of the forest and livelihoods of communities at the same time, government bodies just impose their decision and make arrangements for fishers to obey the rules and regulations, whether they like it or not. Therefore, viable fishing communities are unlikely, especially undermining the rights and access of the local communities to decision-making regarding the resources that they have been enjoying for generations (Dias et al., 2023).

3.6.7 Governing action

The findings of this study suggest that governing actions in both countries are not appropriate to any great extent in dealing with the vulnerabilities of small-scale fisheries in a transboundary context. In spite of coming up with common policies, regulations, and action plans to sustain the forest and fishing communities, the countries are putting more boundaries in the forest in terms of core, buffer, protected, or restricted areas (Sarkar et al., 2019; Ghosh, 2015). More boundaries are likely to create more confusion and non-compliance with regulations and add to the vulnerabilities of small-scale fisheries (Song et al., 2017). In some cases, the government has a support plan for affected communities; for instance, Bangladesh has a compensation plan for the 65-day fishing ban in the country (Islam et al., 2021). However, the process of distributing these benefits or compensations is further complicated by power hierarchy or local political dynamics, for instance, the case of Ghana (Nyavor et al., 2023) and Bangladesh (Mozumder et al., 2020). The restrictions keep increasing in accessing the forest, which makes fishers unhappy and indirectly forces them to take illegal steps to survive. At the same time, the open access to forests or increased pass issuance to the forests can result in overexploitation of forest resources, threaten the sustainability of the forest and grow more tension in the borders (Scholtens et al., 2019; Nyikahadzoi et al., 2017).

3.7 Conclusions and Recommendations

The small-scale fisheries in the Transboundary Sundarbans between Bangladesh and India are confronted with vulnerabilities sourced from multiple dimensions, including social, natural, and governing systems. The major vulnerabilities related to social aspects include illiteracy, landless people, intergenerational discontinuity in fisheries, remoteness of fishing villages, poor water, health, and medical facilities, and high dependency on fisheries. Some of the vulnerabilities are historical, such as remoteness, exploitation of fishers by middlemen groups, and poor safety in the forest, and some are emerging, for example, limited access to the forest, limited areas for fishing, and increased income uncertainties. In addressing the vulnerabilities, diverse factors, such as illiteracy among fisheries communities, limited income opportunities, improper distribution of desired benefits, lack of women's recognition and acceptance in the wider society alongside men, and illegal encroachment of fishers from neighbouring countries, hinder the transitions from vulnerabilities to viability.

The status of natural resources, i.e., fish, honey, crab, etc., on which small-scale fisheries mostly rely, is not in good shape. The stock of fish declined significantly, and this study suggests it is expected to continue with the current exploitation rate. Despite the different initiatives (e.g., reduced access) from the governments of both Bangladesh and India, the sustainability of forest resources is on the verge of collapse. Reduced fish stock directly affects small-scale fisheries' income and livelihoods. The destructive fishing practices, for instance, poison fishing and the use of fine-meshed nets, largely drive resource overexploitation. The intervention into the wildlife, i.e., tigers, crocodiles, and snakes in the forest by small-scale fishers, exposes them to mild injuries or death. Furthermore, frequent natural disasters, including storms, cyclones, and floods, expose small-scale fishers to unbearable suffering. Because of the mobile nature of fishing in the forest, fishers suffer on the border in search of shelter during sudden storms. Not all the time, fishers can take shelter in the other part of the forest and convince the forest officers that their intention was to shelter only for crossing the border if needed. The sustainability of forest resources and the protected areas plan for both countries can be more effective with joint action and assessment of the interconnected natural causes of resource degradation and subsequent vulnerabilities of fishers.

The governing system is the most important system in the sustainability of the transboundary Sundarbans. Our study suggests that the majority of the vulnerabilities that small-scale fisheries face are linked to governance failure in terms of ensuring capacity and quality. Both countries should think of establishing a common forest pass entry system for small-scale fishing from both sides to maintain a steady and continuous resource harvest. In this process, it is important to consider the voices of small-scale fishers and what they think would be ideal. The law enforcement authorities should be more friendly and helpful towards fishers. Both the decision-making and enforcement systems should be decentralized with more participation from fisheries communities and other relevant stakeholder groups. The interaction between fishers and governing authorities should be two-way. The local culture, norms, and values of fishing communities should be respected and reflected in new policies. The overlapping rules of different governing institutions should be minimized. Moreover, both countries should look at the Sundarbans mangrove forest as one social-ecological system instead of focusing only on their jurisdictions and making plans accordingly and jointly. It is important for the governing authorities to understand the diversities, complexities, and interconnectedness of the societal issues to address them. A process should be in place to assess the vulnerabilities and their implications more systematically. Using the conceptual framework of this study, future research can make a systematic and structured diagnosis of the governing capacity and the quality of the transboundary Sundarbans governing system, which can help identify the challenges and opportunities to facilitate the vulnerability to viability transitions.

3.8 References

Adhuri, D. S., & Visser, L. E. (2007). *Fishing in, fishing out: Transboundary issues and the territorialization of blue space*. Asia-Pacific Forum, 36, 112–145.

Aguilera, S. E. 2018. Measuring squid fishery governance efficacy: A social-ecological system analysis. *International Journal of the Commons 12* (2):21. doi:10.18352/ijc.821.

Allison, M. A., Khan, S. R., Goodbred, S. L. and Kuehl, S. A. (2003). Stratigraphic evolution of the late Holocene Ganges-Brahmaputra lower delta plain. *Sedimentary Geology, 155* (3-4) pp. 317-342.

Aziz, A., & Paul, A. R. (2015). Bangladesh Sundarbans: present status of the environment and biota. *Diversity*, *7*(3), 242-269.

Bavinck, M., Chuenpadee, R., Jentoft, S., & Kooiman, J. (Eds.). (2013). Governability of fisheries and aquaculture: Theory and applications. Dordrecht: Springer.

Bennett, N. J., Calò, A., Guidetti, P., Milazzo, M., Prato, G., Lamine, E. B., ... & Di Franco, A. (2024). Access and well-being in small-scale fisheries. *Marine Policy*, *169*, 106328.

Bhadra, T., Das, S., Hazra, S., & Barman, B. C. (2018). Assessing the demand, availability and accessibility of potable water in Indian Sundarban biosphere reserve area. *Int J Recent Sci Res*, *9*(3), 25437-25.

Bhunia, R., & Ghosh, S. (2011). Waterborne cholera outbreak following cyclone Aila in Sundarban area of West Bengal, India, 2009. *Transactions of the royal society of tropical medicine and hygiene*, *105*(4), 214-219.

Burns, T. R., and C. Stohr. 2011. Power, knowledge, and conflict in the shaping of commons governance. The case of EU Baltic fisheries. *International Journal of the Commons 5*(2):233–58.doi:10.18352/ijc.260.

Cánovas-Molina, A., & García-Frapolli, E. (2022). A review of vulnerabilities in worldwide small-scale fisheries. *Fisheries Management and Ecology*, *29*(5), 491-501.

Chauhan, M., & Gopal, B. (2014). Sundarban mangroves: impact of water management in the Ganga river basin. *Our National River Ganga: Lifeline of Millions*, 143-167.

Chen, S. 2008. From community-based management to transboundary watershed governance. *Development 51*(1):83–8. doi:10.1057/palgrave.development.1100445.

Crona, B. I., Van Holt, T., Petersson, M., Daw, T. M., & Buchary, E. (2015). Using social–ecological syndromes to understand impacts of international seafood trade on small-scale fisheries. *Global Environmental Change*, *35*, 162-175.

Crona, B., Nyström, M., Folke, C., & Jiddawi, N. (2010). Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Marine policy*, *34*(4), 761-771.

Dias, A. C. E., Armitage, D., Nayak, P. K., Akintola, S. L., Arizi, E. K., Chuenpagdee, R., ... & Singh, S. (2023). From vulnerability to viability: A situational analysis of small-scale fisheries in Asia and Africa. *Marine Policy*, *155*, 105731.

Doria, C. R., Athayde, S., Lima, H. M. D., Carvajal-Vallejos, F. M., & Dutka-Gianelli, J. (2020). Challenges for the governance of small-scale fisheries on the Brazil-Bolivia transboundary region. *Society & Natural Resources*, *33*(10), 1213-1231.

Dutta, S., Al-Abri, I., & Paul, S. (2021). Bio-economic trends of Hilsa (Tenualosa ilisha) fishery: Perspectives of transboundary management between India and Bangladesh. *Marine Policy*, *128*, 104483.

Espinoza-Tenorio, A., Ehuan-Noh, R. G., Cuevas-Gómez, G. A., Narchi, N. E., Ramos-Muñoz, D. E., Fernández-Rivera Melo, F. J., ... & Torre, J. (2022). Between uncertainty and

hope: Young leaders as agents of change in sustainable small-scale fisheries. *Ambio*, *51*(5), 1287-1301.
Ghosh, P. (2015). Conservation and conflicts in the Sundarban biosphere reserve, India. *Geographical Review*, *105*(4), 429-440.
Gopal, B., & Chauhan, M. (2018). The transboundary Sundarbans mangroves (India and Bangladesh). *The Wetland Book: II: Distribution, Description, and Conservation*, 1733-42.
GOW, Gazette Notification No. 718 and 719, Govt. of West Bengal, (2013). The Gazette notifications of amendments on hilsa fishery, April, 2014. Fisheries Department, Government of West Bengal, 2013.
Gupta, C., & Sharma, M. (2008). *Contested coastlines: Fisherfolk, nations and borders in South Asi*a. New Delhi: Routledge.
Hoque, A. F., & Datta, D. K. (2005). The mangroves of Bangladesh. *International Journal of Ecology and Environmental Sciences*, *31*(3), 245-253.
Hussain, Z., Karim, A., 1994. Introduction. In: Hussain, Z., Acharya, G. (Eds.), Mangroves of the Sundarban, vol. 2. IUCN, Bangkok, TH, pp. 1–10. Bangladesh.
Islam, M. M., and M. M. Hossain. 2017. Community Dependency on the Ecosystem Services from the Sundarbans Mangrove Wetland in Bangladesh. In *Wetland Science* (pp. 301-316). Springer India.
Islam, M. M., Begum, A., Rahman, S. M. A., & Ullah, H. (2021). Seasonal fishery closure in the northern bay of Bengal causes immediate but contrasting ecological and socioeconomic impacts. *Frontiers in Marine Science*, *8*, 704056.
Islam, M. M., Pal, S., Hossain, M. M., Mozumder, M. M. H., & Schneider, P. (2020). Coastal ecosystem services, social equity, and blue growth: A case study from south-eastern Bangladesh. *Journal of marine science and engineering*, *8*(10), 815.
Islam, M. M., Shamsuzzaman, M. M., Mozumder, M. M. H., Xiangmin, X., Ming, Y., Jewel, M. A. S. (2017). Exploitation and conservation of coastal and marine fisheries in Bangladesh: do the fishery laws matter? Mar. Pol. 76, 43–151. http://dx.doi.org/10. 1016/j.marpol.2016.11.026.
Islam, M. M., Sunny, A. R., Hossain, M. M., & Friess, D. A. (2018). Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. *Singapore Journal of tropical geography*, *39*(2), 244-265.
Islam, M. S. 2018. Mass Engagement of the Local Communities in Mud Crab Culture in the Sundarban Area, Bangladesh : A Potential Livelihood under Threats of Climate Change. *Progress in Aqua Farming and Marine Biology*, 1(1), 1–5.
Kimani, P., Wamukota, A., Manyala, J. O., & Mlewa, C. M. (2020). Analysis of constraints and opportunities in marine small-scale fisheries value chain: A multi-criteria decision approach. *Ocean & Coastal Management*, *189*, 105151.
Kooiman, J. (2008). Exploring the concept of governability. Journal of Comparative Policy Analysis: *Research and Practice, 10*(2), 171-190.
Kooiman, J., & Bavinck, M. (2013). Theorizing governability–The interactive governance perspective. *Governability of fisheries and aquaculture: Theory and applications*, 9-30.
Kooiman, J., Bavinck, M., Chuenpagdee, R., Mahon, R., & Pullin, R. (2008). Interactive governance and governability: an introduction. *The journal of transdisciplinary environmental studies*, *7*(1), 1-11.

Kooiman, J., Bavinck, M., Jentoft, S., & Pullin, R. (2005). *Fish for Life: Interactive Governance for Fisheries*. Amsterdam University Press.
Lentisco, A., & Lee, R. U. (2015). A review of women's access to fish in small-scale fisheries. *FAO Fisheries and Aquaculture Circular*, (C1098), I.
Lorenzen, K. 2008. Understanding and managing enhancement fisheries systems. *Reviews in Fisheries Science 16* (1–3):10–23. doi:10.1080/10641260701790291.
Maldonado, A. G., P. F. M. Lopes, C. A. R. Fern andez, C. A. L. Alcala, and U. R. Sumalia. 2017. Transboundary fisheries management in the Amazon: Assessing current policies for the management of the ornamental silver arawana (Osteoglossum bicirrhosum). *Marine Policy 76* (76): 192–9. doi:10.1016/j.marpol.2016.11.021.
Manna, S., Chaudhuri, K., Bhattacharyya, S., & Bhattacharyya, M. (2010). Dynamics of Sundarban estuarine ecosystem: eutrophication induced threat to mangroves. *Saline systems*, *6*, 1-16.
Merayo, E., Myint, K. T., Ei, T., Khine, M., Aye, P. T., Thwe, T. L., Leemans, K., Soe, K. M., Akester, M., Bladon, A., and Mohammed, E. Y. (2020). Migratory patterns of Hilsa shad in the Myanmar Ayeyarwady delta: lessons for fisheries management. IIED Working Paper, IIED, London.
Mostert, E. 2003. Conflict and co-operation in international freshwater management: A global review. *International Journal of River Basin Management 1* (3):267–78. doi:10.1080/15715124.2003.9635212.
Mozumder, M. M. H., Pyhälä, A., Wahab, M. A., Sarkki, S., Schneider, P., & Islam, M. M. (2020). Governance and power dynamics in a small-scale hilsa shad (Tenualosa ilisha) fishery: A case study from Bangladesh. *Sustainability*, *12*(14), 5738.
Mozumder, M. M. H., Shamsuzzaman, M. M., Rashed-Un-Nabi, M., & Karim, E. (2018). Social-ecological dynamics of the small scale fisheries in Sundarban Mangrove Forest, Bangladesh. *Aquaculture and Fisheries*, *3*(1), 38-49.
Nyavor, S., Amposah, S., Owusu, V., & Boateng, K. J. (2023). Compensation payment for fisherfolk during closed-season fishing: Lessons from small-scale fisherfolk in Ghana. *Cogent Social Sciences*, *9*(2), 2282502.
Nyikahadzoi, K., Mhlanga, W., Madzudzo, E., Tendaupenyu, I., & Silwimba, E. (2017). Dynamics of transboundary governance and management of small scale fisheries on Lake Kariba: Implications for sustainable use. *International Journal of Environmental Studies*, *74*(3), 458-470.
Paisley, K. R., and T. W. Henshaw. 2013. Transboundary governance of the Nile River Basin: Past, present and future. *Environmental Development* 7:59–71. doi:10.1016/j.envdev.2013.05.003.
Pethick, J., & Orford, J. D. (2013). Rapid rise in effective sea-level in southwest Bangladesh: Its causes and contemporary rates. *Global and Planetary Change*, *111*, 237-245.
Power, N. G., Norman, M. E., & Dupré, K. (2014). “The fishery went away” The impacts of long-term fishery closures on young people's experience and perception of fisheries employment in Newfoundland coastal communities. *Ecology and Society*, *19*(3).
Purcell, S. W., Crona, B. I., Lalavanua, W., & Eriksson, H. (2017). Distribution of economic returns in small-scale fisheries for international markets: A value-chain analysis. *Marine Policy*, 86, 9-16.

Raha, A. K., Zaman, S., Sengupta, K., Bhattacharyya, S. B., Raha, S., Banerjee, K., & Mitra, A. (2013). Climate change and sustainable livelihoood programme: a case study from Indian Sundarbans. *J Ecol*, *107*(335348), 64.

Rahman, M. M., Chongling, Y., Islam, K. S., & Haoliang, L. (2009). A brief review on pollution and ecotoxicologic effects on Sundarbans mangrove ecosystem in Bangladesh. *International Journal of Environmental Engineering*, *1*(4), 369-383.

Rahman, M., S. M. Haque, A. Wahab, H. Egna, and C. Brown. 2018. Soft-Shell Crab Production in Coastal Bangladesh: Prospects, Challenges and Sustainability. *World Aquaculture*, 43–47(September).

Roy, A., De, A., Aftabuddin, M., Bera, A. K., Bayen, S., Ghosh, A., & Das, B. K. (2024). Analysis of Health Ailments and Associated Risk Factors in Small-Scale Fisherfolk Community of Indian Sundarbans: A Cross-Sectional Study. *Indian Journal of Community Medicine*, *49*(2), 360-366.

Roy, A., Manna, R. K., Ghosh, S., Sahu, S. K., & Das, B. K. (2023). Assessment of women's contribution in small-scale fisheries in Indian Sundarbans: Issues, strategies, and way forward for sustainability. *Fisheries Management and Ecology*, *30*(4), 378-391.

Ruffino, M. L. 2016. A gestao dos recursos pesqueiros no Brasil. In *Repensando a gestao Ambiental no Brasil: Contribuicao ao debate de reconstrucao nacional*, edited by M. A. R. Araujo. Belo Horizonte: Kindle ed.

Sadoff, C. W., and D. Grey. 2005. Cooperation on international rivers: A continuum for securing and sharing benefits. *Water International 30* (4):420–7. doi:10.1080/02508060508691886.

Said, A., Pascual-Fernández, J., Amorim, V. I., Autzen, M. H., Hegland, T. J., Pita, C., ... & Penca, J. (2020). Small-scale fisheries access to fishing opportunities in the European Union: Is the Common Fisheries Policy the right step to SDG14b?. *Marine Policy*, *118*, 104009.

Sarker, S., Rahman, M. M., Yadav, A. K., & Islam, M. M. (2019). Zoning of marine protected areas for biodiversity conservation in Bangladesh through socio-spatial data. *Ocean & Coastal Management*, *173*, 114-122.

Schlager, E., W. Blomquist, and S. Y. Tang. 1994. Mobile flows, storage, and self-organized institutions for governing common-pool resources. *Land Economics 70* (3):294. doi:10.2307/3146531.

Scholtens J, Bavinck M (2014). Lessons for legal pluralism: investigating the challenges of transboundary fisheries governance. *Curr Opin Environ Sustain* 11:10–18. https://doi.org/10.1016/j.cosust.2014.09.017

Scholtens, J. (2015). Limits to the governability of transboundary fisheries: Implications for small-scale fishers in northern Sri Lanka and beyond. *Interactive governance for small-scale fisheries: Global reflections*, 515-536.

Scholtens, J. (2016). *Fishing in the margins. North Sri Lankan fisher's struggle for access in transboundary waters*. Dissertation, University of Amsterdam.

Scholtens, J., Song, A. M., Stephen, J., Chavez, C. G., Bavinck, M., & Sowman, M. (2019). Transdisciplinary engagement to address transboundary challenges for small-scale fishers. *Transdisciplinarity for small-scale fisheries governance: Analysis and practice*, 321-340.

Seidensticker, J., Kurin, R., & Townsend, A. K. (1987, November). The commons in South Asia: societal pressures and environmental integrity in the Sundarbans of Bangladesh. In *Proceedings from a workshop held November* (pp. 20-21).

Sneddon, C., and C. Fox. 2006. Rethinking transboundary waters: A critical hydropolitics of the Mekong basin. *Political Geography 25*(2):181–202. doi:10.1016/j.polgeo.2005.11.002.

Song, A. M., J. Scholtens, J. Stephen, M. Bavinck, and R. Chuenpagdee. 2017. Transboundary research in fisheries. *Marine Policy 76*:8–18. doi:10.1016/j.marpol.2016.10.023.

Song, A.M. (2015). Pawns, pirates or peacemakers: fishing boats in the inter-Korean maritime boundary dispute and ambivalent governmentality. *Pol Geogr 48*:60–71.

Steenbergen, D. J., Fabinyi, M., Barclay, K., Song, A. M., Cohen, P. J., Eriksson, H., & Mills, D. J. (2019). Governance interactions in small-scale fisheries market chains: Examples from the Asia-Pacific. *Fish and Fisheries*, *20*(4), 697-714.

Thủy, P. T. T., Flaaten, O., & Skonhoft, A. (2019). Middlemen: good for resources and fishermen?. *Environment and Development Economics*, *24*(5), 437-456.

Tzanatos, E., Georgiadis, M., & Peristeraki, P. (2020). Small-scale fisheries in Greece: status, problems, and management. *Small-Scale Fisheries in Europe: Status, Resilience and Governance*, 125-150.

Wolf, A. T. 2007. Shared waters: Conflict and cooperation. *Annual Review of Environment and Resources 32* (1):241–69. doi:10.1146/annurev.energy.32.041006.101434.

Chapter 4

Governability of vulnerability to viability transitions in transboundary small-scale fisheries: a study on the Sundarbans

4.1 Chapter summary

Despite their significant contribution, small-scale fishers find themselves marginalized, ignored, underrepresented, undervalued, and in disadvantaged positions. The vulnerabilities of small-scale fisheries are further intensified in the transboundary fisheries system due to the mobile nature of fisheries resources and fishing operations across national jurisdictions. This study argues that addressing the vulnerabilities of small-scale fisheries in a transboundary context and making a transition toward viability is a governability issue. The study aims to analyze the governability of transboundary fisheries governance in the Sundarbans mangrove forest and see whether the existing governing systems have the capacity and quality to facilitate the vulnerability to viability transitions. Data were collected using household surveys, key informant interviews, and focus group discussions on both the Bangladesh and Indian sides of the forest. The results reveal that the governing system lacks the proper capacity (e.g., structure, arrangements, and interactions) and quality (e.g., the effectiveness of the governing arrangements and the performance) to address the vulnerabilities and move toward viability. The governing system is entangled with a number of governability challenges, including differences in images of governance, lack of coordination across the governing institutions/jurisdictions, decentralization of power, and geopolitical disputes and debates. These challenges pose barriers to small-scale fisheries' vulnerability to viability transitions. The study suggests taking common transboundary governing actions and policies for transboundary forest governance. The governing system should be strengthened with the participation of local fisheries communities, counting on their knowledge and worldviews.

4.2 Introduction

Small-scale fisheries around the world are known for their contribution to employment, food and nutrition security, poverty reduction, livelihoods and the well-being of millions of people (IHH, 2023). Small-scale fishers possess a deep cultural heritage and strong identity, and the continuation of small-scale fishing plays a vital role in maintaining the cultural identity and traditions of fishing communities globally (Bennett et al., 2024; Nayak and Berkes, 2019). Despite their significant contribution, small-scale fishers find themselves marginalized, ignored, underrepresented, undervalued, and in disadvantaged positions in competing against large-scale fisheries, oil and gas industries and aquaculture for fishing space, resources and government attention (Islam and Chuenpagdee, 2022; Chuenpagdee and Jentoft, 2018; Nayak, 2017). The existing key vulnerabilities of small-scale fisheries include poverty, high dependence on fisheries, uncertainty and environmental changes, lack of access to information and technology, limited capacity to adapt to changed conditions, and weak governance (Islam and Chuenpagdee, 2022; Cánovas-Molina and García-Frapolli, 2022; Nayak and Berkes, 2019).

The existing vulnerabilities get further intensified in the transboundary fisheries system due to mismatches in governing actions and priorities between neighbouring countries (Doria et al., 2020; Song et al., 2017). Transboundary fisheries system refers to the fisheries resources of a shared ecosystem spanning across two or more countries' jurisdictions (Scholtens and Bavinck, 2014). In a transboundary context, the fisheries communities are socially (e.g., depend on the same fisheries stock for their livelihoods), culturally (e.g., traditional knowledge and practice), and ecologically (e.g., benefit from the same shared rivers, lakes or forests) interconnected and interdependent (Doria et al., 2020; Nyikahadzoi et al., 2017). The mobile and porous nature of fish in a transboundary fisheries system tempts fishers to operate across borders and jurisdictions following the fish movement, resulting in conflicts with fishers of other jurisdictions (Scholtens et al., 2019; Song et al., 2017). Additionally, small-scale fisheries in the transboundary region suffer due to a lack of coordinated management across borders, socioeconomic and political inequalities, and competition between the fishers of different countries or communities of shared ecosystems (Doria et al., 2020; Nyikahadzoi et al., 2017; Lopes et al., 2013). Often led by state governments in a hierarchical mode, fail to provide effective solutions to address the transboundary vulnerabilities of small-scale fisheries and help make the fisheries communities viable (Scholtens et al., 2019).

Jentoft and Chuenpagdee (2009) identify the issues of small-scale fisheries governance as "wicked," the concept introduced by Rittel and Webber (1973). The sources of wicked problems are often unknown, and there is no consensus on how they occur and how to address them. This means there are no easy and straightforward solutions to the vulnerabilities of small-scale fisheries. Similar to what Rittel and Webber (1973) suggested, this study argues that the transboundary fisheries governance is wicked as the issues are hard to define from a single disciplinary/actor perspective, have no stopping rule, and are connected to bigger issues within and across national borders (Song et al., 2017; Scholtens, 2015). In practice, the governing responses to address the transboundary vulnerabilities of small-scale fisheries mostly focus on providing technical and routine solutions for day-to-day issues, such as conflicts among fishers (Doria et al., 2020; Song et al., 2017). This shows a narrow vision of the governance approach, which hardly questions the fundamental issues and perspectives that are required for a legitimate and effective governance approach (Jentoft and Chuenpagdee, 2015). This study argues that addressing the vulnerabilities of small-scale fisheries in a transboundary context and making a transition toward viability is a governability issue. This means that, in addition to day-to-day operations, the design of governing institutions and the principles that governing actors follow are important in addressing the transboundary vulnerabilities of small-scale fisheries and moving toward viability.

The governability concept emphasizes not only day-to-day issues but also institutional designs, principles, values, and images that the governing system follows in addressing the problems and challenges in transboundary fisheries (Scholtens, 2015). Governability is a composite concept both in terms of capacity and quality of governance (Jentoft and Chuenpagdee, 2015). In the case of transboundary fisheries, the capacity emphasizes what the governing system can possibly do, given the social and natural properties of the transboundary fisheries system (Jentoft and Chuenpagdee, 2015). The quality of the governing system depends on how it performs and functions to deliver the desired goals under its political, economic, and legal constraints (Chuenpagdee and Jentoft, 2013). A governability analysis can suggest whether the governance

approaches are, in practice, capable enough to deal with the existing vulnerabilities of small-scale fisheries in a transboundary context and move toward viability.

Studies have been conducted on different aspects of transboundary small-scale fisheries' governance (see Doria et al., 2020; Cohen et al., 2019; Berkes and Nayak, 2018; Song et al., 2017; Scholtens, 2016); however, only a few studies have a focus on governability aspects (Song et al., 2017; Scholtens, 2015; Bavinck and Gupta, 2014). There is no such study available on the role of governability in facilitating the transitions from vulnerability to viability for small-scale fisheries.

Inspired by Jentoft and Chuenpagdee (2015), this study aims to assess the governability of transboundary small-scale fisheries in the Sundarbans mangrove forest between Bangladesh and India. The Sundarbans mangrove forest is an ideal transboundary fisheries system as it is known for providing employment, food and nutrition, shelter from natural disasters, livelihoods and income sources for more than 12 million people from Bangladesh and India (Gopal and Chauhan, 2018; Raha et al., 2013). The study will answer the following two questions: (i) What is the status of governability in the transboundary Sundarbans fisheries system, and (ii) Are the existing governing systems in the Sundarbans capable of making small-scale fisheries' vulnerability to viability transition? The section below introduces the conceptual framework of the study and defines the terms used. The next section presents the methods, first describing the study areas in the Sundarbans mangrove forest, followed by a description of the data collection and analysis. The results section presents the status of capacity and quality of the existing governing systems in the transboundary Sundarbans. The next section discusses the key implications of the results and the governability challenges to facilitate the vulnerability to viability transitions in a transboundary context. The final section concludes the research findings and provides the way forward.

4.3 Conceptual and analytical framework

Drawing from the Interactive governance (Kooiman et al., 2005) theory, this study focuses on the notion of governability in the context of transboundary social-ecological systems (SESs). Inspired by Jentoft and Chuenpagdee (2015), as presented in Figure 4.1, the study uses the Vulnerability to Viability (V2V) transitions conceptual framework to analyze the governability of the transboundary SESs. This framework emphasizes understanding the issues of small-scale fisheries and assessing the characteristics of the transboundary fisheries governing system, including the structure, functions, interactions, and enforcement mechanisms of the governing action for the transitions from vulnerability to viability. The wicked nature of vulnerabilities in terms of difficulty in defining absolute vulnerability, interconnection of issues, and re-appearance of the issues when solved, makes it challenging to facilitate the V2V transition (Dias et al., 2023; Kolding et al., 2014; Jentoft and Chuenpagdee, 2009).

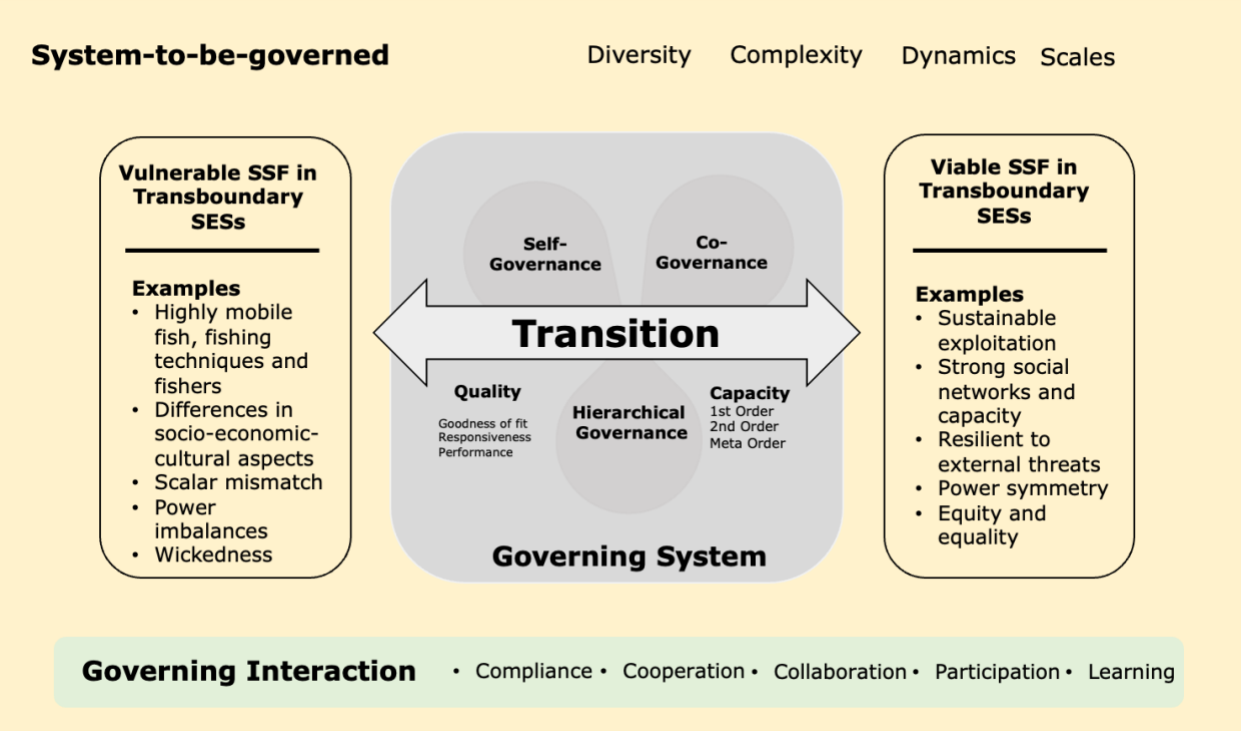

Figure 4.1 The V2V transition framework for small-scale fisheries in the transboundary fisheries context.

The transition from vulnerability to the viability of a SES involves fundamental changes to its social, economic, technological and institutional aspects (Mathias et al., 2020; Haberl et al., 2011; Rotmans et al., 2001). The processes of the changes are often complex, non-linear, and radical (Patterson et al., 2016). In an ideal system, the processes of change involve interaction between the governed and the governors. The forms of governing interaction can be innovation, cooperation, collaboration, learning, compliance, and participation (Hölscher et al., 2018). Here, the V2V transition framework suggests that the assessment of the capacity and the quality of the transboundary governance system is crucial to facilitating the transition processes in transboundary SESs. Therefore, this study used this conceptual framework to first examine the capacity (i.e. institutional designs and structures) and the quality (i.e., effectiveness and performance) of the existing governance approaches in the study areas and determine the governability status. Second, the framework is used to analyze the capability of the governing approaches to facilitate the transition process through the desired changes in the transboundary fisheries' social, economic, technological and institutional aspects. In doing so, the conceptual framework assessed different variables and indicators regarding the quality and capacity aspects of the governing system.

As presented in Table 4.1, the capacity and the quality of the governing systems were analyzed using different variables and indicators for the modes of governance in practice. As suggested by Kooiman (2008), the modes of governing systems of the transboundary fisheries can be self-, co-, or hierarchical. The intervention of the government is minimal to none in self-governance. The government and the communities share responsibilities in the co-governance approach. In hierarchical governance, the intervention of the communities is to a minimum. The variables of

the capacity and quality of the V2V transition framework were drawn from the governability literature, especially related to properties, i.e., diversity, complexity, dynamics and scale of the system-to-be-governed, its governing system and the governing interaction (for example, Jentoft and Chuenpagdee, 2015; Bavinck et al., 2013; Chuenpagdee and Jentoft, 2013). The capacity of the governance approach – self-, co-, or hierarchical – was assessed under first, second and meta orders of governance (Table 4.1). As explained by Kooiman (2008), the first order is the day-to-day operations of the governance system, the second order is the institutional structures and policies of the governance system, and the meta order is the principles, values and norms that governors follow. In other words, meta-order goals, principles, norms, and values shape the structural arrangements of the governing institutions in the second order, which operate and implement in the first order to achieve the desired goal. The V2V transition framework helped assess each order of governance with the indicators listed. For example, under self-governance, the framework helped analyze the day-to-day problems and activities small-scale fisheries face in the transboundary fisheries system. In dealing with day-to-day problems, the framework assessed what structure of governance they follow within their area of focus and what principles, norms and values they count. It also helped explain the inclusion and exclusion of members within their governing unit, the selection of community leaders and the way of interaction. Eventually, the findings against each indicator helped determine the capacity of the governance approach in practice in the study areas.

Table 4.1 The variables and indicators of the governability assessment of the transboundary fisheries system.

Modes	**Self-governance**	**Co-governance**	**Hierarchical governance**	
First order	- day-to-day problems and activities of the governed	- day-to-day problems and activities within the governed	- day-to-day problems and activities of the governed	Capacity
Second order	- Structure of the community - Boundary of the community - Deciding on the community leader	- Arrangement of the governing units - Boundary of the units - Members' inclusion and exclusion criteria - Role of community and state	- Structure - Boundary - Connection of governing unit to SSF - Inclusion and exclusion criteria of relevant governing actors	
Meta order	- Community principles, values, and norms	- Principles, values, and norms of the communities and state	- Principles, values, and norms that the governing unit consider	
Goodness of fit	- Images/goals of the community - the goodness of the goal - Fitness of governing unit in the context of the community - Fitness of their action - Social, political and economic limitations of the community	- Images/goals of the governing units - Goodness and ethical choices of the units - Fitness of the arrangement and their action - Social, political and economic limitations of the communities and the state	- Images/goals of the state/governing unit - Goodness of their goal - Ethical choices need to make - Fitness of the governing body and their action - Social, political, and economic limitations	Quality

Responsiveness	Community/governing unit's responses - process - quickness - accuracy - consequences	Governing units' responses - process - quickness - accuracy - the satisfaction of the governed	State/governing unit's responses - criteria/process - quickness - accuracy - the satisfaction of the governed - consequences (if any)	
Performance	- Effectiveness of the governing body in terms of action and response - The logic of decision-making - External influence	- Effectiveness of the arrangement, their action and response - the process and rationale of decision-making - External influence - the balance between 1st and 2nd orders Meta order	- Effectiveness of the body, their action and response - Process and rationale of decision-making - Factors that influence decision-making - the balance between 1st and 2nd orders - The principles set in meta order	

Similar to capacity, the quality of the governance approach in the study areas was assessed using the indicators listed in Table 4.1 under goodness of fit, responsiveness, and performance. The goodness of fit was analyzed for the mode of governance in practice. For example, it helped assess the goals or images of the governing unit, the goodness of their goal against the problems that communities face, whether the existing governance arrangements and their actions fit into the community context, and how they operate given their social, political and economic limitations. The responsiveness of the governance system was assessed by explaining the processes the governing system follows in making decisions, how quickly the decisions are made, the accuracy of the decisions from both governed and governing perspectives, and what consequences follow. The performance of each governing unit was analyzed by explaining the effectiveness of the governing action, the logic/rationale of the decisions, and the balance they keep among the three orders of governance and under the given external influences, for example, local political pressure. Overall, the findings of both capacity and quality indicators presented the governability status of vulnerability to viability transitions.

4.4 Methods

4.4.1 Study areas

The Sundarbans is the largest continuous mangrove forest in the world. It comprises 10,000 $km^{2,}$ covering both Bangladesh and India. The forest lies between 21°32′ and 22°40′N ′ N and 88°05′ and 89°51′E ′ E, where 60% is under Bangladesh jurisdiction and 40% is in Indian jurisdiction. The silt carried by these river systems provides a unique food and nutritional source for diverse flora and fauna (Rezwan, 2019; Mitra et al., 2016; Khan, 2013). The forest provides income sources for millions of people, mostly small-scale fishers, from both sides of the forest (Raha et al., 2013). Among the commercially important fisheries, Mud crab (*Scylla serrata*), Hilsa (*Tenualosa ilisha* Hamilton, 1822), Black tiger shrimp (*Penaeus monodon*), and prawn (*Marobrachium rosenbergii*) have high demand in domestic and international markets (Habib et al., 2020). The rich fisheries' resources attract not only the local communities but also people who migrate from different parts of the country to the Sundarbans area for fishing.

Forests face different natural and anthropogenic threats, such as the impact of climate change and forest conversion for development. The change in climate conditions alters the local weather parameters, including temperature, rainfall, and salinity (Islam et al., 2018). These changes affect the biological cycles and habitat conditions of forest flora and fauna (Uddin et al., 2013). The exploitation of fisheries resources has increased (Islam et al., 2018). The number of fishers and the tendency to use destructive fishing practices, such as poison fishing and the use of fine-meshed nets, have increased (Siddique et al., 2023; Mozumder et al., 2018). The increase in fishers' dependency on the forest is also caused by the large-scale aquaculture farms outside the forest, converting mangroves and paddy fields into farms (Giri et al., 2022a,b; Ghosh et al., 2015). This resulted in limited day labour job opportunities for local people since the farms do not require a lot of labour to operate them (Basu et al., 2021; Sundaray et al., 2019).

While the threats are common to the whole forest, the governing responses remained scattered within each country's jurisdictions. The common governing response from both sides of the forest is to reduce access for small-scale fishers to the forest through the declaration of protected areas and fishing bans (Siddique et al., 2023; Rahman, 2022). To a large extent, the fisheries communities do not comply with the rules and regulations, resulting in conflicts between fishers and governing actors (Mollick et al., 2022). A lack of common policies for the whole forest is missing, which eventually victimizes small-scale fishers when they cross the border by following fish movement.

The study was conducted from September 2023 to April 2024 in 8 villages from Chuto Mullakhali, Kalidaspur, and Kumirmari in West Bengal, India, and 10 villages from Kaikhali, Munshiganj, Burigoalini, and Gabura in Shyamnagar, Satkhira in Bangladesh (See figure 4.2). The study sites were selected based on four criteria: transboundary nature, closeness to the border between Bangladesh and India, language, and familiarity. The areas are around the transboundary Sundarbans, and the communities rely on the forest for their income and livelihoods. These areas are close to the border between Bangladesh and India, and small-scale fishers of this region often fish near or cross the border. The communities of both sides speak Bengali as their mother tongue, which gives the researcher an advantage in understanding the true feelings, emotions, and perspectives of the local communities, as Bengali is the researcher's mother tongue too. The researcher is familiar with community-based research in the Bangladesh side of the Sundarbans. The study areas in Bangladesh were chosen based on previous research experiences. For the sites in India, suggestions and help of experts were taken using the network of vulnerability to viability (V2V) global partnership network at the Indian Institute of Technology (IIT), Kharagpur, India.

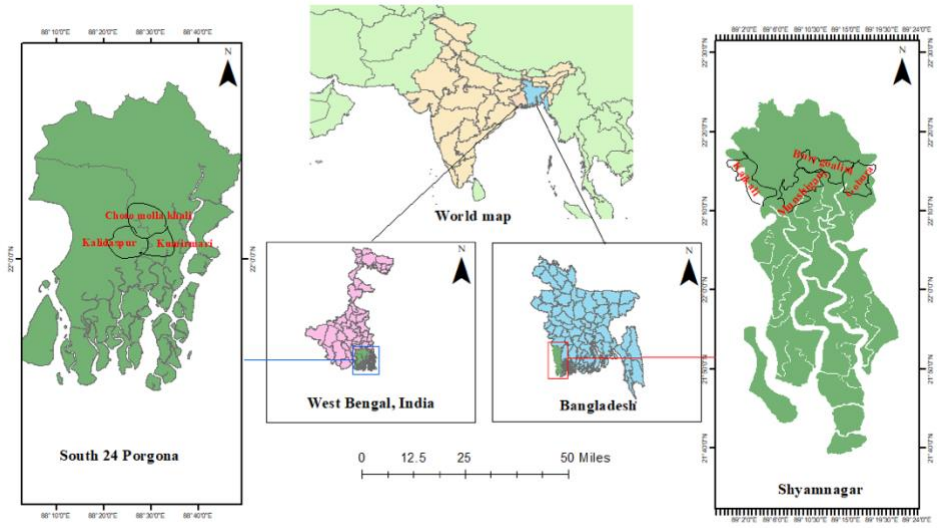

Figure 4.2 The map shows the study areas in Bangladesh and India sides of the Sundarbans forest.

4.4.2 Data collection and analysis

The study used a purposive sampling approach to select the research participants. The researcher has already developed a network and contacts with the local communities and their leaders from the previous research experience. The researcher made contact with the established networks and selected more participants following the suggestion of the interviewed participants. In India, the researcher used the V2V Global partnership network, especially the Academia of Indian Institute of Technology (IIT) Kharagpur, to select the study areas and the participants. The expert from IIT Kharagpur connected the researcher to a cooperative society in the study areas. The cooperative society is comprised of all the relevant stakeholders, including small-scale fishers living adjacent to the forest. The members of the cooperative society took the researcher to communities and helped select the research participants.

The data were collected using three methods, including household surveys, key informant interviews and focus group discussions. As presented in Table 4.2, a total of 52 surveys in India and 99 surveys in Bangladesh were conducted. Drawing from the framework presented above, the survey questions asked mostly closed-ended questions, supplemented by a few open-ended questions under different themes. The questions are asked regarding the demographic information of households, the properties of the transboundary fisheries system, the governance system of the fisheries resources, and how the governors interact with the local fisheries communities. The surveys are mostly conducted with household heads of the family, and in many households, women participated in the study and talked about their families. Some villages are small, and some are bigger than others. More interviews were conducted in the larger villages following the community leaders' suggestions. The number of surveys in each village was decided based on the saturation point of the information shared.

Table 4.2 Study areas and the methods employed for data collection.

Country	Villages	Surveys	Key Informant Interviews	Focus Group Discussion
India	Karmakarpara, Kumirmari	4	14	1
	Badanpara, Kumirmari	3		
	Miridapara, Budbar bazar, Kumirmari	11		
	Gayenpara, Kumirmari	8		
	7 No Hetalbari, Chuto Mollakhali	6		
	8 No Khalidaspara, Chuto Mollakhali	5		
	9 No Khalidaspara, Chuto Mollakhali	9		
	4 No Boiddopara, Chuto Mollakhali	6		
Bangladesh	Achra, Kalbari	6	18	1
	Dumuria, Gabura	10		
	East Dankhali, Munshiganj	11		
	Chuna, Burigoalini	9		
	Muthrapur, Munshiganj	10		
	Horishkhali, Gabura	14		
	Kalindapara, Koikhali	14		
	Datinakhali, Burigoalini	7		
	9 no Shora, Gabura	8		
	Holopara, E. Koikhali	10		
	Total	**151**	**32**	**2**

Key informant interviews are conducted using a semi-structured questionnaire to validate/supplement the findings of household surveys. A total of 14 and 18 key informant interviews were conducted in India and Bangladesh. The participants of key informant interviews are researchers, NGO representatives, local government representatives, forest department representatives, law enforcement authorities, co-management actors, small-scale fishers, community leaders, and representatives of cooperative societies. Depending on the role of the research participant, questions were asked that were relevant to their role. For example, questions related to forest governance were asked of the representatives of the forest and local government.

One focus group discussion was held on each side of the forest. The researcher invited representatives of different governing actors and fisheries resource users based on the suggestions of local leaders for a focus group discussion. The researcher also invited some of the participants of the survey and key informant interviews to focus group discussions because of their depth of knowledge and understanding of transboundary fisheries. A few open-ended questions were developed about the transboundary fisheries and the governance system to guide the discussion. The questions were picked to engage all the participants in brainstorming and to respond accordingly.

The data were analyzed thematically based on the themes of the V2V transition framework (Figure 4.1). The data collected using each method were compiled in a Microsoft Excel sheet. The household survey data were converted to numbers using 'yes=1' and 'no=0' against each response. For the majority of questions, the participants provided/chose multiple answers against each response. All the responses were analyzed in the Excel sheet and converted to percentages. The interview responses were analyzed using the content analysis method. The responses to each question were coded using a few words under the indicators presented in Table 4.1 above. The codes are further categorized under the main variables of the analytical framework. The information gathered from the focus group discussion was helpful in validating or cross-checking the survey and interview data.

4.5 Results: Governability of transboundary small-scale fisheries governance

The Sundarbans mangrove fisheries system has ecological, social, economic, political and geographical significance for Bangladesh and India. However, the governance of the forest fisheries resources is under each country's jurisdiction. This section presents the capacity in terms of the structure and mechanisms of the existing governance system in both countries. It also presents the quality in terms of goodness of fit, responsiveness, and overall performance of the fisheries' system governance.

4.5.1 Capacity of the governance system

The findings suggest that the modes of governance of the Sundarbans fisheries resources in both Bangladesh and India are mixed. Hierarchical governance is the dominant mode of governance, while co-governance is in the process of implementation. In practice, the fisheries resources in the forest are still managed hierarchically. The summary of the capacity of the existing mixed governance is presented in Table 4.3 and explained below.

Table 4.3 The indicator and status of governing capacity in the transboundary Sundarbans (Source: key informant interviews and household surveys).

Orders	Indicators	Status	
		Bangladesh	**India**
1st order	- day-to-day problems and activities of the governed	• Increased tiger and wild animal attacks • Complicated daily access to fisheries resources • Harassment inside the forest • Illegal border crossing • Fishers caught while crossing the border • Confusion about policies and implementations	• Increased tiger and wild animal attacks • Frequent pirate attack • Complicated regular access to fisheries resources • Illegal border crossing • Harassment inside the forest • Fishers caught while crossing the border • Confusion about policies and implementations

2nd order	Governing units involved and their arrangements	• *Union Parishad* • Co-management committees • Centre for Natural Resource Studies • Ministry of Environment and Forests • Ministry of Fisheries and Livestock • Bangladesh Forest Department • Department of Fisheries • Bangladesh Fisheries Research Institute • Bangladesh Fisheries Development Corporation	• *Panchayet* • Local Cooperative Societies • Department of Sundarban Affairs, Government of West Bengal • Sundarbans Development Board • State Forest Department • The Sundarban Tiger Reserve • Joint Forest Management Committee • Ministry of Environment & Forests
	Legal Policies	• Wildlife (Conservation and Security) Act, 2012 • Protected Area Management Rules, 2017 • Coastal Zone Policy (2005) – co-management establishment • The Protection and Conservation of Fish Act (1950)- conservation, sanctuary establishment, fishing bans, and prevent illegal fishing • Marine Fisheries Act (2020)- define artisanal fisheries • National Fisheries Policy (1998)- management, safety and well-being • Fishermen Registration and Issue of Identity Card Guidelines (2019)- fishers' ID issuance	• National Forest Policy, 1988 – Formation of JFMC • Forest Rights Act 2006- rights of local indigenous communities • Forest Act 1920 – management and protection of forest • Indian Forest Conservation Act, 1980- mangrove as protected area • The Wildlife (Protection) Act, 1972- mangrove as protected areas • Environmental Protection Act,1986- declaration of coastal regulation zone • Coastal Aquaculture Authority Act, 2005- Protection of mangroves
	Boundary of the units	• Co-management committee: fisheries resources inside the Sundarbans • Hierarchical: Inland, coastal and marine fisheries including Sundarbans	• Joint Forest Management Committee: Fisheries resources inside the Sundarbans • Hierarchical: Inland, coastal and marine fisheries including Sundarbans
Meta order	Principles, values, and norms that different governing units consider	• Increase participation • Increase fish production • Sustainability of the forest ecosystem • International treaty and UN commitment • Increase governance efficiency	• Realization of that people cannot be taken away from the forest • Protect the forest and its biodiversity • Reduction of Man-Animal conflict • SDGs commitment

4.5.1.1 First order

The vulnerabilities that small-scale fisheries face on a day-to-day basis are more or less similar in Bangladesh and India. According to the study participants, the common daily issues include tiger attacks, pirate attacks, unequal and complicated access to forests, and illegal fishing across borders. In India, pirates are very active inside the forest, which is one of the main problems that fishers face. Women are especially vulnerable to pirate attacks when they enter the forest. Many areas of the Indian forest are fenced, and fishers follow a particular point in the forest to enter. There is no such fencing in the Bangladesh Sundarbans, and fishers can access the forest from the areas that they prefer with proper forest passes. Having limited forest areas for fishing, fishers often follow the movement and availability of fish and intentionally or unintentionally cross within and across jurisdictional borders. Consequently, they get caught by the forest guards

and border patrol officers and face additional legal and policy-related vulnerabilities. In many cases, fishers commit or violate rules unintentionally, not being aware of the policies. There are a number of policies active in the Sundarbans, and they are confusing to fishers (Table 4.3). Sometimes, small-scale fishers blame researchers for the emerging policies and actions. A fisherman from Bangladesh stated that,

> *"There are so many rules and regulations in place now in the forest. I think researchers are responsible for this. We see researchers come and talk to us about the forest and our problems. Then we see new restrictions or bans are coming up."*

4.5.1.2 Second order

A number of governing institutions are involved in governing the Sundarbans mangrove forest. In Bangladesh, at the local level, *Union Parishad* (the smallest unit of local governments) member-chairman, Upazila Nirbahi Officer (UNO), Assistant Conservator of Forest (ACF), and Co-management Committees (CMCs) are active. The CMCs are the new additions to forest governance from 2010 to decentralized governance (See Figure 4.3). Under the CMCs, local forest resource users form Village Conservation Forums (VCFs). The main role of the VCF is to assist with the annual work plan and raise awareness among the local communities. There are 76 VCFs formed in the Bangladesh study areas, and one female and one male from each VCF form People's Forum (PF). Some of the VCF's representatives join the Community Patrol Group (CPG) to assist with forest monitoring and surveillance. The CPG members get paid for their assistance. The PF ensures the participation of local communities in planning activities, encourages fishers to comply with the rules and regulations, assists VCF in generating alternative income and cooperates with the forest department.

The total PFs are 152, and they form an executive committee through a voting process. The executive committee consists of a chairman, a vice-chairman, a general secretary and general members. The representatives of PF and other relevant actors, including forest, agriculture, fisheries, civil society, law enforcement authorities, and the Centre for Natural Resource Studies (CNRS) as an NGO representative, form a co-management general committee (CMGC) or council and a co-management executive committee (CMEC). Civil society representatives are part of the general committee, not the executive committee. Those committees are responsible for overall governance and implementation of action in the Sundarbans protected area. At the central level, different ministries, research, and development institutions are involved in the governance of the Bangladesh Sundarbans (Table 4.3). These institutions mainly approve and finalize the plans for local-level policy implementation, which is mostly done through a top-down process.

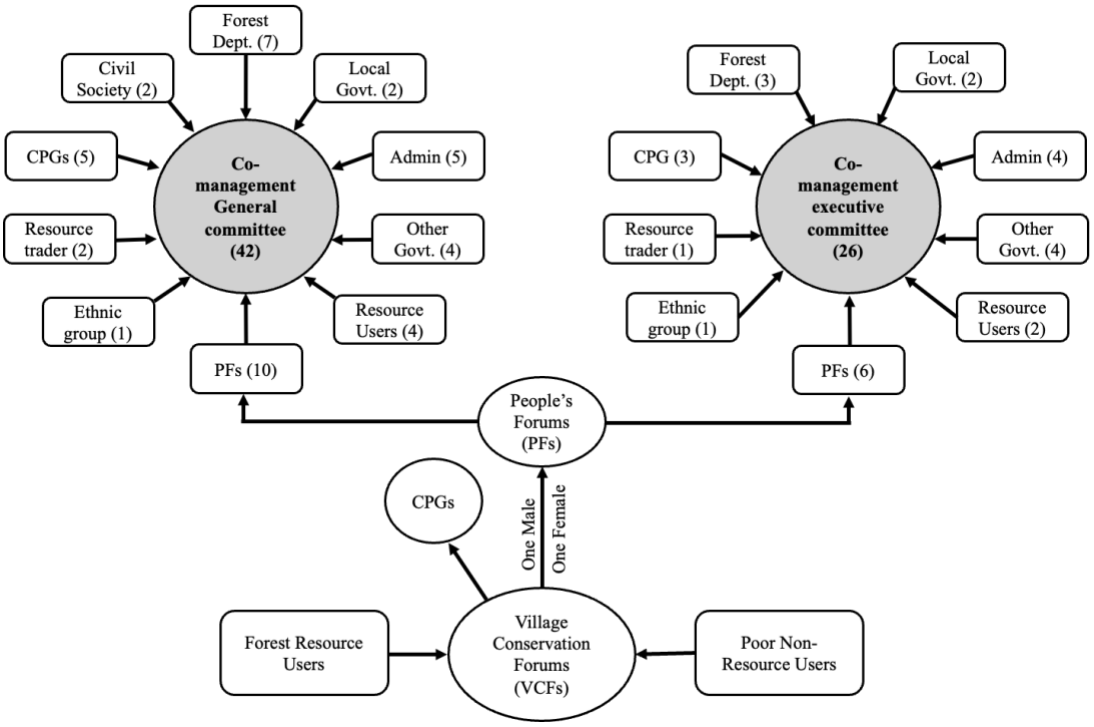

Figure 4.3 Schematic diagram of co-management committees (CMCs) in Bangladesh Sundarbans and the number of representatives of each stakeholder group (Source: Bangladesh Gazette, MoEF, 2017).

The Indian side of the Sundarbans is divided into a core and a buffer zone. Fishing and other activities are completely prohibited in the core zone, while limited activities, such as fishing and honey collection, are allowed in the buffer zone with a permit, i.e., Boat License Certificate (BLC). Similar to Bangladesh, at the local level, the *Panchayet* is the main governing unit on the Indian side of the forest. Panchayet consists of 14 members from the adjacent villages of a particular geographical area. The members are elected through community voting. They also vote for a *Pradhan*, who is the head of each *Panchayet*. Local communities express their daily issues, for instance, forest guard harassment for money in the forest, to the panchayet via the members of their booth. Local booth members take it to the *Panchayet* and discuss how to address the issue. If they are unable to solve it, they take it to the Block Development Officer (BDO) or higher-level governing units. Besides, cooperative societies, such as the Sundarbans Tourism Services Cooperative Society and the Sundarbans Fisheries Cooperatives Societies, are also formed at the local level. These cooperative societies are formed involving fishers and other forest resource users. They use these societies to provide tourism services and introduce and sell fisheries and other forest products to tourists.

Under the Ministry of Environment and Forest (MoEF), the State Forest Department (SFD) and Sundarbans Tiger Reserve (STR) are mainly responsible for the management of the Indian Sundarbans. The SFD mainly looks at the Sundarbans buffer zone. The STR is actively managing the core zone and part of the buffer zone for tiger conservation. The Department of Sundarbans Affairs under the Government of West Bengal implements the development activities in the Sundarbans areas through the Sundarbans Development Board. Community-

based mangrove management was adopted in 1993 after the notification of Joint Forest Management (JFM). The Forest Department forms the Joint Forest Management Committees (JFMCs) at the village level with communities. Each JFMC is further divided into two committees, i.e., Forest Protection Committees (FPCs) and Eco-Development Committees (EDCs). The main role of the FPC is to protect the forest adjacent to the members' village, while EDC mainly focuses on revitalizing the degraded biodiversity. Through this governance practice, local communities, including fishers, get the right to utilize the non-timber forest products (NTFPs) and fish adjacent to their village. Under the JFM currently, there are 65 JFMCs, 14 EDCs, and 51 FPCs involving more than 35,000 local villagers responsible for the protection and conservation of the Sundarbans. The JFM also includes representatives from NGOs (e.g., the World Wide Fund for Nature) and scientific/academic institutions (Figure 4.4).

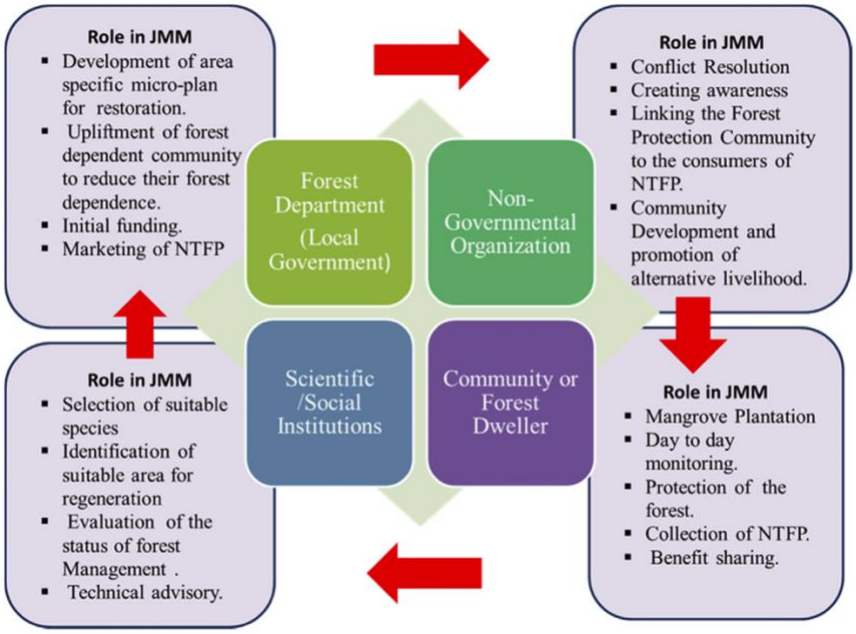

Figure 4.4 Schematic diagram of Joint Mangrove (forest) Management (JMM) in India (Source: DasGupta and Shaw, 2013).

As presented in Table 4.3 under second order, a number of legal policies and laws guide the formation of different governing units at the local and national levels in both countries. For example, the CMCs in Bangladesh were formed following the provisions of the Wildlife (Conservation and Security) Act, 2012 and the Forest Management Rules, 2017. The CMCs in Bangladesh and JFMCs in India operate and apply to their designated areas of the Sundarbans. The fisheries resources, i.e., river, sea, and floodplain outside of the forest, are still under formal hierarchical management. Fisheries resources, such as fish that migrate in and outside of the forest and fishers' movement following fish, are, thus, subjected to both co-management and hierarchical management decisions.

4.5.1.3 Meta order

Both countries have common goals and images behind the arrangements and operation of the current hybrid governance approach in the Sundarbans mangrove forest. Hardly the goals and images that they have, drive to formulate and implement a common policy applicable to both sides of the forest and help facilitate the V2V transition. However, a good thing is that the top-down management of both sides realized the importance of local communities' participation in the decision-making process. Initiatives are taken to decentralize the governance system through co-management in Bangladesh and Joint Forest Management in India. Both the modified governance structure acknowledges the local norms and values in the changed governance system. For example, despite most parts of the Indian forest being fenced and restricted access for small-scale fishers, the worship temples, e.g., *bonobiwi* and *gazi* are kept outside of the fencing. The governments see that if the local communities are aware of the long-term consequences of overexploitation and destruction of the forest, the successful implementation of the governance policies is possible. The governments want to revitalize the depleted fisheries stock, minimize the conflicts between wildlife and forest-dependent communities, and protect local villages from natural disasters. The government aim to offer sustainable alternative livelihood options for the fishing communities whose livelihoods are affected by the governing actions.

The governments of Bangladesh and India try to implement/achieve international treaties or milestones, such as Sustainable Development Goals (SDGs), Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines), Gender Equality, and 30 by 30. Achieving such goals requires changes or modifications governing policies and actions, which in most cases go against the local community's interests and result in non-compliance. Therefore, the governments want to increase the efficiency of governance by bringing the community into the governance system.

4.5.2 Quality of the governance system

This section presents whether the governance system functions the way it is structured in terms of its goodness of fit, responsiveness, and overall performance to facilitate the V2V transition for small-scale fisheries. The status of the governing quality indicators on the Bangladesh and Indian sides of the forest is more or less the same. The key findings of each indicator are combined and presented in Table 4.4 below.

Table 4.4 The status of governing quality in the transboundary Sundarbans (Source: key informant interviews and household surveys).

Variables	Indicators	Status
Goodness of fit	Goodness of the goals	• Forest conservation is the main goal • Lack of transboundary initiatives to address the ongoing transboundary vulnerabilities of fishers • Lack of decentralization of governance

	Ethical choices	• The conservation goal comes at the cost of community livelihoods • Fishers are hardly treated as indigenous people in the Indian Sundarbans • Fencing the forest for tiger conservation, limiting fisher's access
	Fitness of the arrangements and actions	• Co-management do not have the authority to make transboundary decisions • Lack of community interests in the decision-making • Lack of incorporating local knowledge, culture, and values in the governing action
	Limitations	• Lack of safety measures inside the forest • Inadequate incentives for affected communities • Lack of manpower for monitoring and maintenance • Lack of adequate funding sources • Lack of coordination among different govt. authorities • Conflict between governing institutions
Responsiveness	Governing bodies' process of decision-making	• Forest department is the main authority to make decisions • Limited involvement of local communities in governance • Limited capacity development training • Awareness building meetings and workshops • Mostly, government inform decisions • Border guards/force flag meeting about transboundary issues
	Satisfaction of the governed	• Lack of awareness among fisheries communities about the governance policies and actions • Tensions growing against government actions and policies • Fishers follow the rules mostly because of punishment fear
	Consequences	• Increased non-compliance • Lack of cooperation between different stakeholders • Forest authority destroy ceased fishing gears, impose penalty/imprisonment • Sometimes community protests
Performance	Effectiveness	• The current system hinder fishers' access to forest • Poor forest pass issuance • Corruption among governing actors • Lack of common policy for fisheries from both sides • Fishers bribe forest guards for illegal fishing
	Process of logic they follow for decision-making	• Local communities are hardly consulted under the co-management structure • Awareness raising meetings with communities are mostly to inform the policies
	Factors that influence decision-making	• Lack of common goal among governing actors • Political influence • Vote bank policy
	The balance between governing orders	• The changes in governance approaches are followed by good principles • The structure of governing institutions are following the principles • The practice and implementation are rarely keeping a balance with second and meta orders

4.5.2.1 Goodness of fit

Small-scale fishers expressed their opinion on whether the current governance actions, such as the fishing ban and expansion of protected areas, fit into the problems that small-scale fisheries face. Around 90% of fisher respondents in both countries disagree with government planning, and they see these actions as adding to their vulnerabilities (Figure 4.5). According to the 47% in Bangladesh and 35% in India of the fisher respondents, attention to small-scale fisheries is given

less, while forest conservation is the main priority for the governing system in both countries (Figure 4.5). About 42% of the fisher respondents in Bangladesh and 13% in India agree that the differences in the policies and governing arrangements in neighbouring countries affected small-scale fisheries the most, for instance, long imprisonment and bureaucratic processes if caught at the border. This suggests that the existing governing actions are unlikely to facilitate the V2V transition for small-scale fisheries.

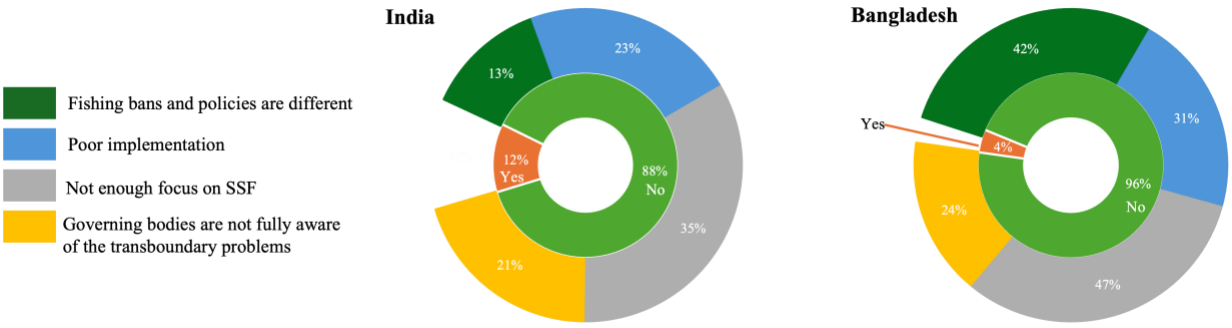

Figure 4.5 The figure shows the perspectives of fishers about the goodness of fit of the current governing action. The inner circle is about whether the action fits the problems, and the outer part is about the reasons.

Except for tiger conservation, a common transboundary Sundarbans governance policy between Bangladesh and India is still missing. There are transboundary initiatives at the NGO level; for example, Caritas is working on preventing illegal human trafficking through the Sundarbans. Also, there are transboundary research projects; for example, ENGAGE4Sundarbans looks at the issues of small-scale fisheries. The aim of the existing governance approaches to increase participation and decentralize the governance system is not visible on any side of the forest. The local communities are not consulted before making policies, and a practice of learning from each other is missing. An academic from India mentioned that,

> *"The community-based approach is ideal for dealing with the issues in the Sundarbans, and the structure is there. However, the intention of the government to decentralize the power among rural communities is not yet there."*

The ethical choices of governing actors are more in favour of forest conservation and less in favour of community well-being. For small-scale fishers, fishing is their main profession, and any restriction on accessing forest fisheries resources puts them in a vulnerable situation in terms of income, food and nutritional security. According to some key informants from Academia and NGO, the majority of the small-scale fishers who live around the Indian forest are treated as immigrants from Bangladesh and not indigenous. Therefore, they do not receive any benefits that governments provide for the affected forest-dependent communities due to forest conservation action. The major part of the Indian forest is fenced to protect local communities from tiger attacks. This caused limited access areas for small-scale fishers. Government representatives opine that the structure of the current governance arrangements and their actions to increase participation, decentralize, and sustain the forest fail to a large extent in the Sundarbans. Co-

governance arrangements are introduced in both Bangladesh and India to improve participation and governance success. However, the study finds that a lack of willingness to incorporate community interests in the decision-making failed to motivate communities' participation and interests in co-governance.

The existing governance approaches of both countries have a number of social, economic and political limitations, which directly affect the V2V transition for small-scale fisheries. The governments of both countries have limitations in supporting small-scale fishing inside the forest with adequate safety measures. According to some government key informants, sometimes the governments are unable to support all the fishers affected by governing actions, such as fishing bans, due to financial limitations. The surveillance and monitoring in the forest are poor due to inadequate manpower. A lack of adequate funding support affects the successful implementation of co-governance initiatives. Additionally, a lack of coordination and cooperation among the respective governing institutions for the Sundarbans eventually adds to the vulnerabilities of small-scale fishers. For example, the conflicts between the state and federal governments in India limit the government benefits that local communities receive. The current state and federal governments in India belong to two different political groups. Therefore, the initiation and application of any support measure for the Sundarbans dependent communities come through the vote bank policy, as noted by the fishers and experts.

4.5.2.2 Responsiveness

The study finds that the forest department is the main authority controlling, observing, and monitoring forest management in the Sundarbans. At the local administrative level, UNO and ACF in Bangladesh and BDO and the Forest Department in India play a major role in decision-making. The majority of the fishers respondents in Bangladesh opine that UNO and ACF pick the local community representatives for the different roles in the co-management committees. Sometimes, they take suggestions from members of the *Union Parishad*. The true representatives of local communities, including fishers, are still absent in the co-governance. According to 85% of fisher respondents in India and 82% of fishers in Bangladesh, the participation of small-scale fishers has not increased through the co-governance approach (Figure 4.6).

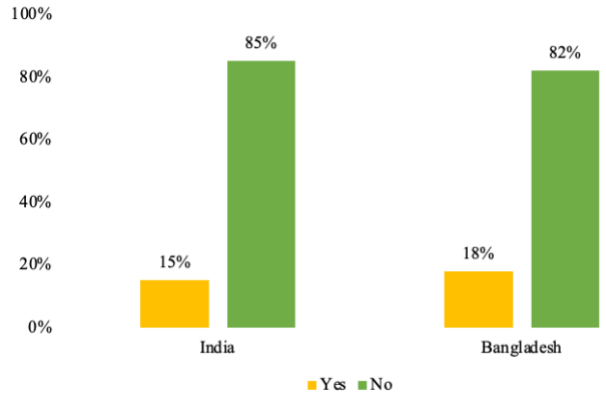

Figure 4.6 Participation of fishing communities in the decision-making, according to fishers participants.

Local communities are involved to a limited extent in governance. For example, fishing communities on the Bangladesh side help the forest department track poison fishing, deer hunting, and destructive fishing practices in the forest. They also take part in the awareness-raising meetings organized by the local forest department office. They help spread the importance of forest sustainability among fishing communities. Similarly, fishing communities in India contribute to the JFMCs by collecting non-timber forest products, monitoring illegal fishing, and protecting forests to the best of their capacity. However, the contribution of the local communities to forest sustainability is less emphasized. A key informant fisher from Bangladesh stated that,

> *"They help the forest department to track illegal activities – often by politically powered – in the forest. Instead of being rewarded for this help, sometimes corrupt forest officers disclose the identities of the fishers who have reported illegal activities. Then the fishers become socially and politically vulnerable to those politically and socially elite people."*

The governments in both countries sometimes organize workshops to increase the capacity of the fishing communities and help improve their condition. The government organize training on alternative income-generating activities, such as livestock farming, honey cultivation, fish farming, etc., but to a great extent, local communities find these options unsustainable. The study finds, to a great extent, small-scale fishers are only informed about the decisions, despite the presence of the co-governance approach on both sides of the forest. The interaction between the communities and the governments is one-way, i.e., top-down. In addressing the transboundary issues, such as fishers caught while crossing the border, the Border Guard Bangladesh (BGB) and the Border Security Force (BSF) of India call for a flag meeting to resolve the issue.

Small-scale fishers (>90% of respondents) are not happy with the processes, quickness and accuracy of the current governance approaches (Figure 4.7). A significant number of fisher respondents feel that some of the fishing bans in the forest are inappropriate; for instance, there is a crab fishing ban every year from January to February in Bangladesh. Fishers in Bangladesh (45%) comparatively suffer more from the fishing ban year-round. They also argue that the government is slow and lacks good judgment in responding to communities' needs, such as credit support and distribution of fishing ban compensation. More than 25 % of fisher respondents on both sides of the forest opine that, in most cases, the governing action goes against them because of a lack of fishers' representatives in the decision-making. Consequently, non-compliance with the regulations increased. Sometimes, the fisheries community protests against government policies. For example, fishers raise their voices against fishing bans in Bangladesh. In India, fishers have been able to prevent the complete restriction on accessing forest resources through their strong protests.

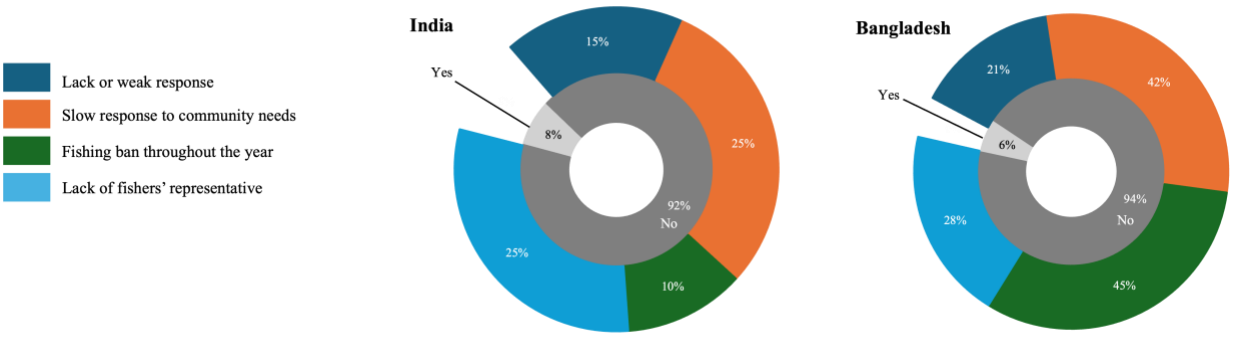

Figure 4.7 The figure shows the satisfaction of the small-scale fishers with the current governing processes, as well as quickness and accuracy. The inner circle represents whether communities are satisfied, and if not, the outer part comprises major reasons.

4.5.2.3 Performance

The study finds that the existing governance system aims to increase fishers' participation in the governance and ensure the sustainability of forests through conservation efforts. In practice, the local communities agree with the goal (e.g., the long-term sustainability of the forest) that the governing actors aim to achieve. However, the communities are against the governing instruments (e.g., declaration of protected areas and actions (e.g., reduced access to forest), which often put barriers to their viability. The community's perspectives on the problems and potential solutions are never heard. A platform for learning from each other is absent at the implementation level of the governing system. A cooperative society member from India noted that,

> *"The fisheries communities also want to see that the forest is sustainable for generations. However, the government should not just inform us of the governing action and affect us with the outcome."*

Around 80% of fisher respondents in India and 95% in Bangladesh argue that the current governing system is unlikely to address the vulnerabilities of transboundary small-scale fisheries (Figure 4.8). They added further reasons to support this argument, i.e., the government has a lack of capacity, improper policies, inadequate manpower, less focus on small-scale fisheries, and only country-focused policies.

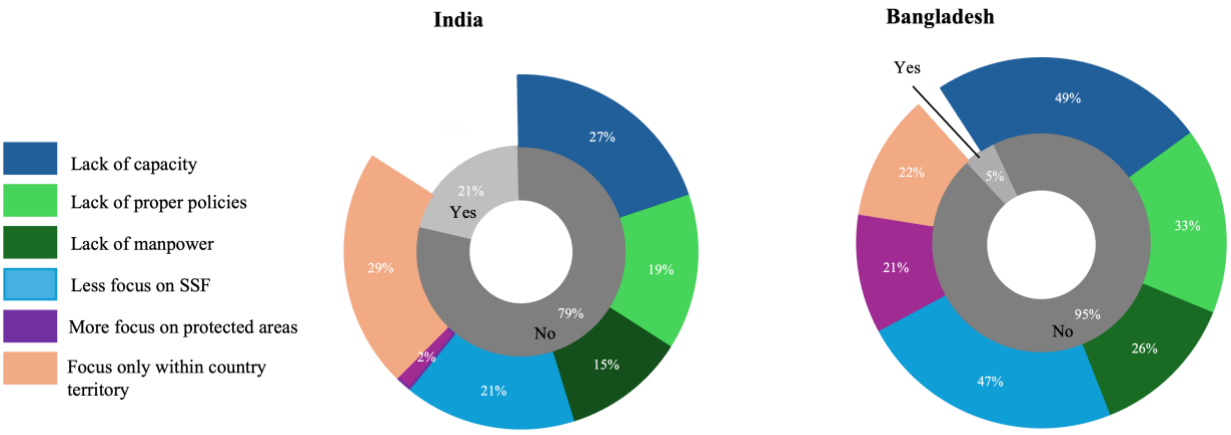

Figure 4.8 The figure shows the small-scale fisher respondents' expression of whether the current governing approach can address the vulnerabilities of SSF (the inner circle) and the reasons (outer circle) why the governing approach is not able to.

The fishing communities see that the ongoing governing actions are only to limit poor fishers' access to the forest. Many fisher respondents opine that those people are linked to the politically powerful and local elite; they can still access the forest and benefit from the resources. In India, the fisheries communities are not aware of the actual reason for the forest pass issuance shutdown and when it is expected to reopen. On the one hand, the respective governments of both sides of the forest want to increase the governance efficiency and success of their action. On the other hand, the corruption among the governing actors is increasing day by day, including those representatives who are picked for co-governance from local communities. The fisheries communities on both sides of the forest agree that a transboundary governance policy is likely to bring more success for forest conservation as well as contribute to the communities' viability. The differences in governing action and planning create confusion and tempt small-scale fishers to violate the rules for more income, resulting in failure to achieve the desired goal. For example, the differences in the duration of the fishing bans in the two countries especially provoke fishers to follow the fish movement and violate the rules.

The existing governance system argues that the co-governance approach is there to facilitate interaction between the governed and the governors, and facilitate learning from each other. However, in practice, such strategies are hardly followed. For example, the community meetings that the forest department holds in Bangladesh are mostly to raise awareness. The suggestions/knowledge that the communities share are unlikely to be implemented. On the Indian side, fishing communities are mostly not aware that there is a co-governance approach where they can provide their suggestions and input for better governance. A key informant in India mentioned that,

> *"There is a joint forest management committee for tiger conservation. I am not sure if there is a management structure that can allow local communities to participate actively. Even if the government calls for communities' input, they always call the people they know."*

Regardless of what the governance approaches are in practice, the study finds three factors that directly affect the decision-making and the V2V transition for small-scale fisheries. First, the goals of the multiple governing actors involved are hardly the same. The differences in visions and interests of each governing actor affect the implementation of the co-governance approach. Second, the governing actors are politically biased toward some parties or groups. The members of each group back each other either ethically or unethically. For example, if someone is caught poison fishing inside the forest, they somehow escape with the help of their political influence or lobbying. Third, the vote bank policy indirectly controls the governance mechanisms. In India, the conflicts between the state and central government inhibit the development of projects and the support for local fishing communities.

Overall, the motivation for changing governance approaches from hierarchical to co-governance is encouraging in both countries. The principles that they follow in structuring the governing institutions and their roles are great, but only on paper. When it comes to implementation at the community level, the practice remains hierarchical. Therefore, a balance between the three orders of governance is missing when governing the Sundarbans fisheries resources.

The findings against each indicator suggest that the capacity of the governing system in both countries is in good shape, but only on paper and at the institutional level. Yet, the practice of the governing approaches and the way they are designed is not there. This is further proven by the findings against indicators of the goodness of fit, responsiveness and performance. The results suggest that the transboundary small-scale fisheries in the Sundarbans are less governable under the given capacity and quality status of the governing systems. Therefore, the transition from vulnerability to viability is unlikely for the transboundary Sundarbans, which is complicated by the governability challenges, as discussed in the section below.

4.6 Discussion

The vulnerability to viability transition for small-scale fisheries is complex and further complicated by the nature of the fisheries system, especially if it spans across national jurisdictions. The existing transboundary fisheries system requires holistic changes in all aspects, i.e., social, natural and governance, related to forest fisheries to facilitate the V2V transition process. The transition processes, such as learning, cooperation, collaboration and learning from each other to make desired changes related to transboundary Sundarbans, are hard to follow for the governability challenges discussed below. The challenges and their implications for V2V transition are summarized in Table 4.5.

Table 4.5 The governability challenges of the transboundary Sundarbans in facilitating the V2V transition for SSF.

Attributes	Governability Challenges	Implications for V2V Transitions
Wickedness of transboundary vulnerabilities	• Difficult to define the problem, interconnected and embedded in bigger issues • No easy and straightforward fix	• Unlikely to completely stop the vulnerabilities and move toward viability

		• Absent of comprehensive solutions is a barrier to V2V transition
Images of the transboundary fisheries system	• Differences in views, problems, and priorities • Lack of common governing goals	• Lack of motivation for diverse stakeholder groups toward common goal
Coordination between governing institutions	• Involvement of many governing institutions with overlapping rules and responsibilities • Inappropriate governing institutions • Inadequate understanding of the problems	• Lack of cooperation, collaboration, learning from each other is a barrier to V2V transition
Common governance policy across the jurisdictions	• Lack of common governance policies • Less priority on fisheries as part of international collaboration	• The changes in policies against community's interest result in failure to achieve viability
Decentralization of power	• Power is state-centred • Lack of fishers' participation in decision-making	• Power imbalances is a barrier to V2V transition for SSF
Geopolitical debates/disputes	• SSF become the victim of geopolitical negotiations • The intention of SSF crossing borders hardly reflects in policies and action	• Unlikely to facilitate V2V transition making SSF the victim of geopolitical disputes

4.6.1 Wickedness of transboundary vulnerabilities

As suggested by Rittel and Webber (1973) and applied in fisheries by Jentoft and Chuenpagdee (2009), Figure 4.9 shows that the key vulnerabilities of transboundary small-scale fisheries are difficult to define and delineate from each other, interconnected and embedded in bigger issues, and there is no complete stopping rule. The vulnerabilities of small-scale fisheries in the transboundary fisheries system are not standalone; they are connected to each other (Dias et al., 2023). For example, high dependence on forest fisheries resources is the result of inadequate alternative livelihood options for small-scale fisheries, which is a failure of the governance system (Abdullah et al., 2016). An easy solution, such as a fishing ban for a particular period, is likely to bring consequences that may become irreversible, for instance, illegal poison fishing and the destruction of forest ecosystems (Mollick et al., 2023, 2022). This suggests that the vulnerabilities of small-scale fisheries have no complete stop rule. The issues of small-scale fisheries in the Sundarbans are interlinked to bigger issues (Jentoft and Chuenpagdee, 2009). For example, Bangladesh and India agreed on an MOU in 2011 to work together to contribute to the well-being of the forest-dependent communities. However, the implementation of the MOU has not progressed so far. Implementation of such a common agreement also relies on other national and international interests. Some of the issues are part of bigger dialogues between neighbouring

countries that create barriers to small-scale fisheries' transition toward viability in the transboundary context.

Figure 4.9 The wickedness of the vulnerabilities of small-scale fisheries in the Transboundary Sundarbans fisheries system.

4.6.2 Images of the transboundary fisheries system

The diverse views about the transboundary problems and differences in governing priorities of the transboundary Sundarbans make it challenging for the governing system to help facilitate the V2V transition for small-scale fisheries. Forest resources, including fisheries, have declined significantly, and governments want to reduce access to revitalize the depleted fisheries resources (Karim et al., 2025). On the other hand, the fishing communities see the restriction on fisheries' access as one of the main barriers to their viability (Dias et al., 2023). Ujjaman et al. (2025) and Siddique et al. (2023) suggest reducing the number of restrictions on accessing fisheries resources to make small-scale fisheries viable in the Bangladesh Sundarbans. They also suggest arranging sustainable alternative income opportunities for fishers. Aquaculture farms outside the forest supplement the national protein demand and also contribute to the national economy through foreign export (Giri et al., 2022a). Governing actors are in favour of supporting large-scale aquaculture, but the fisheries communities see the expansion of aquaculture industries reducing their alternative livelihood options outside of the forest. Some evidence shows that extensive aquaculture causes the conversion of mangrove forests and, eventually, the destruction of forests, for example, Chakaria Sundarbans in Bangladesh (Hasan et al., 2024; Giri et al., 2022b). Therefore, motivating each stakeholder group and addressing the vulnerabilities caused by the priorities of other stakeholders raises the governability challenge. This puts a barrier to the viability of the governing system if it fails to gain the trust of small-scale fisheries.

4.6.3 Coordination between governing institutions

The findings show that there are many governing institutions responsible for the Sundarbans management within and across the countries, and the relationships between them are largely

derived from their interests and areas of concern. The issues of small-scale fisheries are mainly related to the fisheries resources, while the forest departments in both countries are mainly responsible for managing the forest, and the involvement of the fisheries department is often not enough (Khan et al., 2024; Vivekanandan, 2021). Therefore, it is unlikely for the forest department to properly understand the issues of small-scale fishers and their well-being concerns. The findings suggest that cooperation, collaboration, learning from each other, and participation of local communities across the national jurisdictions are missing from the governing institutions (Vivekanandan, 2021), which is a barrier to the viability of small-scale fisheries. Although the current co-governance arrangements provide the opportunity for small-scale fisheries communities to participate in the decision-making process and share their concerns, the functioning and delivery of structured goals of the governing system are still missing (Begum et al., 2023; Mollick et al., 2022). This raises concerns about the poor quality of the governing system, and motivating the governing institutions across the national jurisdictions to coordinate and cooperate in making small-scale fisheries viable is a long way from being achieved. It is crucial to include local communities in developing governing infrastructure to better understand community perspectives and help make them viable.

4.6.4 Common governance policy across the jurisdictions

The vulnerabilities of forest small-scale fisheries and the threats to forest sustainability in both countries are similar, but the governing initiatives are different. The countries have transboundary agreements in other areas, such as river and tiger conservation. A lack of implementation of transboundary agreements on fisheries resources indicates the countries' lack of interest (Vivekanandan, 2021). This results in small-scale fishers being the victims of differences in governance priorities and actions in neighbouring countries (Doria et al., 2020). One common action that both countries have taken is restricting access to the forests through the declaration of protected areas, which is often against the community's interests. In such a situation, it is important to provide proper incentives/compensation for fishing bans and restrictions on accessing fisheries resources for the viability of the fisheries communities. Governing actors can take the initiative to prevent illegal and destructive fishing, stop poison fishing (especially in Bangladesh), implement the same fishing ban in both countries and enforce common policies, ensuring equal opportunities for all the relevant stakeholders. However, it is often a governability challenge to motivate the neighbouring countries to develop a common transboundary policy for the viability of small-scale fisheries (Doria et al., 2020; Scholtens et al., 2019).

4.6.5 Decentralization of power

The level of interaction between the governed and the governors can be enabled/restricted by power (Jentoft, 2007). Both Bangladesh and India have taken the initiative and developed a co-management approach for the governance of the Sundarbans. However, the findings of this study suggest that the government still holds the power of decision-making, and similar findings were suggested by Siddique et al. (2023) and Mollick et al. (2022). The co-governance arrangements in India started several decades ago, but in practice, most fishers are not aware of what this is about and how it performs (DasGupta and Shaw, 2017). Without distributing the power to relevant governing actors, the success of co-governance is unlikely. The intention of the

government to distribute power is not visible through their actions and activities in both countries. The power imbalance is an important governability problem which can bring the entire governing process to a halt (Chuenpagdee and Jentoft, 2013). The livelihoods and well-being concerns of small-scale fishers remain misrepresented, which challenges the governability in terms of governance legitimacy and effectiveness. Under the current governance structure and mechanism, the study suggests it is unlikely to improve accountability and transparency among the governing actors and help make small-scale fisheries viable.

4.6.6 Geopolitical debates/disputes

The fisheries' resources in a shared boundary can be a source of bigger issues than we see. Fisheries operations in the transboundary regions are tied to countries' sovereignty, security and defence (Scholtens et al., 2019). In the transboundary Sundarbans region, fishers often get caught at the border during the hilsa fishing ban every year, which raises tensions between countries (Mozumder et al., 2020). This way, fishers become a medium of calculation between countries, which is beyond fisheries issues. Small-scale fisheries get entangled in national, regional or international political processes (Scholtens et al., 2019). Small-scale fisheries are used as a medium of negotiation between higher levels of geopolitical processes (Dupont and Baker, 2014; Mitchell, 1976). The true intention of small-scale fishers crossing the borders or migrating to different areas is largely ignored by the governing policies and actions. The findings suggest that it is unlikely for the governing actors of both countries to consider the well-being and livelihoods of small-scale fishers over national or international geopolitical interests. Similar evidences are provided by Scholtens and Bavinck (2014) for transboundary fisheries between India and Sri Lanka, Roszko (2015) for transboundary fisheries between China and Vietnam, and Song (2015) in the case of the South Korean fisheries. Thus, governance of small-scale fisheries in the transboundary Sundarbans challenges local and regional governability due to diverse geopolitical disputes and puts barriers to the viability of small-scale fisheries.

4.7 Conclusions and recommendations

The findings of this study suggest that vulnerability to viability transition for small-scale fisheries in the transboundary fisheries system is a governability issue. The transition toward the viability of small-scale fisheries is complicated by the wickedness of the transboundary vulnerabilities, inadequate capacity and poor quality of the governing system. The vulnerabilities of small-scale fisheries in the transboundary fisheries system are multi-dimensional, hard to distinguish and identify the absolute sources, and are often connected to one another. In some cases, the vulnerabilities are beyond the capacity of the governing system to address.

The governance system of the study areas is found to be inadequate in dealing with the transboundary problems. There are no transboundary agreements in practice between the neighbouring countries related to managing fisheries resources. As a result, the fishing communities suffer from the legal frameworks of both countries because of the nature of their fishing operation. Within the country, the governance institutions are clustered and often overlap in roles and responsibilities. The initiation of the co-governance approach aims to facilitate community participation, which is encouraging, but the practice remains hierarchical. The utmost power is still held by the state or national government and their local representatives. The

community's trust in forest governance is poor due to inadequate participation of local communities and corruption among the governing actors. The local norms and self-governance practices are hardly considered in forest fisheries-related decision-making. As a result, the likelihood of non-compliance with the rules and regulations is high among the communities.

The weak governance capacity and poor quality of the governing system pose governability challenges for V2V transition. However, the vulnerabilities are not absolute; there is a way out toward viability or minimizing the intensity of the issues. As communities suggested, the governing system should arrange sustainable alternative income options, for example, the expansion of paddy fields, for the fisheries communities, before imposing restrictions on fishing. The communication between the communities and governing actors should be transparent to make the communities better aware of the forest fisheries stock and the governing goals. The communities should not be informed about the decisions; they should be part of it. Illegal fishing practices inside the forest should be completely stopped, regardless of the background of the person who violates the rules inside the forest. The policies and opportunities should be equal for all. The fishing bans and restrictions on fishing inside the forest should be implemented at the same time for both sides of the forest through a transboundary policy initiative.

In improving the capacity and enhancing the quality of the governing system, fisheries representatives should be brought in at all stages of the decision-making process, including the transboundary agreement-making discussion. Small-scale fishers should be provided access to a proper pass system. The monitoring and surveillance system should be strengthened with more involvement of the communities. Those involved with forest monitoring and surveillance systems should be provided with proper compensation and support. The corruption among the governing actors should be stopped by tracking the activities of those involved in forest guards and the issuance of passes. Such arrangements are likely to help facilitate the transition toward viability for small-scale fisheries.

4.8 References

Abdullah, A. N. M., Stacey, N., Garnett, S. T., & Myers, B. (2016). Economic dependence on mangrove forest resources for livelihoods in the Sundarbans, Bangladesh. *Forest Policy and Economics*, *64*, 15-24.

Basu, A., Nandy, G., & Kar, N. S. (2021). Evaluating the viability of shrimp aquaculture to impede climate change in the Sundarbans: Experiences from Bangladesh. In *South Asia and Climate Change* (pp. 156-188). Routledge India.

Bavinck, M., & Gupta, J. (2014). Legal pluralism in aquatic regimes: a challenge for governance. *Current Opinion in Environmental Sustainability*, *11*, 78-85.

Bavinck, M., Chuenpadee, R., Jentoft, S., & Kooiman, J. (Eds.). (2013). Governability of fisheries and aquaculture: Theory and applications. Dordrecht: Springer.

Begum, F., de Bruyn, L. L., Kristiansen, P., & Islam, M. A. (2023). Development pathways for co-management in the Sundarban mangrove forest: A multiple stakeholder perspective. *Forest Policy and Economics*, *148*, 102918.

Bennett, N. J., Calò, A., Guidetti, P., Milazzo, M., Prato, G., Lamine, E. B., ... & Di Franco, A. (2024). Access and well-being in small-scale fisheries. *Marine Policy*, *169*, 106328.

Berkes, F., & Nayak, P. K. (2018). Role of communities in fisheries management:"one would first need to imagine it". *Maritime studies*, *17*(3), 241-251.

Cánovas-Molina, A., & García-Frapolli, E. (2022). A review of vulnerabilities in worldwide small-scale fisheries. *Fisheries Management and Ecology*, *29*(5), 491-501.

Chuenpagdee, R., & Jentoft, S. (2013). Assessing governability: What's next? In M. Bavinck, R. Chuenpagdee, S. Jentoft, & J. Kooiman (Eds.), *Governability of fisheries and aquaculture: Theory and applications* (MARE publication series 7, pp. 335–349). Dordrecht: Springer.

Chuenpagdee, R., & Jentoft, S. (2018). Transforming the governance of small-scale fisheries. *Maritime studies*, *17*(1), 101-115.

Cohen, P. J., Allison, E. H., Andrew, N. L., Cinner, J., Evans, L. S., Fabinyi, M., ... & Ratner, B. D. (2019). Securing a just space for small-scale fisheries in the blue economy. *Frontiers in Marine Science*, *6*, 171.

DasGupta, R., & Shaw, R. (2013). Changing perspectives of mangrove management in India–an analytical overview. *Ocean & coastal management*, *80*, 107-118.

DasGupta, R., & Shaw, R. (2017). Retrofitting Joint Forest Management (JFM) in Protected Areas of Indian Sundarbans: How Sustainable It Is?. *Participatory Mangrove Management in a Changing Climate: Perspectives from the Asia-Pacific*, 59-71.

Dias, A. C. E., Armitage, D., Nayak, P. K., Akintola, S. L., Arizi, E. K., Chuenpagdee, R., ... & Singh, S. (2023). From vulnerability to viability: A situational analysis of small-scale fisheries in Asia and Africa. *Marine Policy*, *155*, 105731.

Doria, C. R., Athayde, S., Lima, H. M. D., Carvajal-Vallejos, F. M., & Dutka-Gianelli, J. (2020). Challenges for the governance of small-scale fisheries on the Brazil-Bolivia transboundary region. *Society & Natural Resources*, *33*(10), 1213-1231.

Dupont, A., & Baker, C. G. (2014). East Asia's maritime disputes: Fishing in troubled waters. *The Washington Quarterly*, *37*(1), 79-98.

FAO, Duke University & WorldFish. 2023. *Illuminating Hidden Harvests (IHH): The contributions of small-scale fisheries to sustainable development – Executive summary*. Rome.

Ghosh, A., Schmidt, S., Fickert, T., & Nüsser, M. (2015). The Indian Sundarban mangrove forests: history, utilization, conservation strategies and local perception. *Diversity*, *7*(2), 149-169.

Giri, S., Daw, T. M., Hazra, S., Troell, M., Samanta, S., Basu, O., ... & Chanda, A. (2022b). Economic incentives drive the conversion of agriculture to aquaculture in the Indian Sundarbans: L

Giri, S., Samanta, S., Mondal, P. P., Basu, O., Khorat, S., Chanda, A., & Hazra, S. (2022a). A geospatial assessment of growth pattern of aquaculture in the Indian Sundarbans Biosphere Reserve. *Environment, Development and Sustainability*, *24*(3), 4203-4225.

Gopal, B., & Chauhan, M. (2018). The transboundary sundarbans mangroves (India and Bangladesh). *The Wetland Book: II: Distribution, Description, and Conservation*, 1733-42.

Haberl, H., Fischer-Kowalski, M., Krausmann, F., Martinez-Alier, J., & Winiwarter, V. (2011). A socio-metabolic transition towards sustainability? Challenges for another Great Transformation. *Sustainable development, 19*(1), 1-14.

Habib, K. A., Neogi, A. K., Nahar, N., Oh, J., Lee, Y. H., & Kim, C. G. (2020). An overview of fishes of the Sundarbans, Bangladesh and their present conservation status. *Journal of Threatened Taxa*, *12*(1), 15154-15172.

Hasan, M., Hassan, L., Abdullah Al, M., Kamal, A. H. M., Idris, M. H., Hoque, M. Z., ... & Ali, A. (2024). Human intervention caused massive destruction of the second largest mangrove forest, Chakaria Sundarbans, Bangladesh. *Environmental Science and Pollution Research*, *31*(17), 25329-25341.

Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference?. *Environmental innovation and societal transitions*, *27*, 1-3.

Islam, M. M., & Chuenpagdee, R. (2022). Towards a classification of vulnerability of small-scale fisheries. *Environmental Science & Policy*, *134*, 1-12.

Islam, M. M., Sunny, A. R., Hossain, M. M., & Friess, D. A. (2018). Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. *Singapore Journal of tropical geography*, *39*(2), 244-265.

Jentoft, S. (2007). In the power of power: The understated aspect of fisheries and coastal management. *Human Organization, 66* (4).

Jentoft, S., & Chuenpagdee, R. (2009). Fisheries and coastal governance as a wicked problem. *Marine policy*, *33*(4), 553-560.

Jentoft, S., & Chuenpagdee, R. (2015). Assessing governability of small-scale fisheries. *Interactive governance for small-scale fisheries: Global reflections*, 17-35.

Karim, M. R., Ahasan, S. N., & Ashik Ur Rahman, M. (2025). Social-Ecological Dynamics of Sustainable Small-Scale Fisheries Management in the Sundarbans Mangrove Forest Region, Bangladesh. *Fisheries Management and Ecology*, e12798.

Khan, M. F. A. K., Rahman, M. S., Maryudi, A., Schusser, C., & Giessen, L. (2024). Revealing the Multilevel Actors Power Network in Mangrove Forest Governance-Insights from the Sundarbans, Bangladesh. *Forest and Society*, *8*(2), 372-401.

Khan, R. (2013). Wildlife of the Sundarban. *Sundarban: Rediscovering Sundarban, The Mangrove Beauty of Bangladesh. Reza K (ed.). Nymphea Publication, Dhaka–1000, Bangladesh*, 36-73.

Kolding, J., Béné, C., & Bavinck, M. (2014). Small-scale fisheries: Importance, vulnerability and deficient knowledge. *Governance of marine fisheries and biodiversity conservation: Interaction and coevolution*, 317-331.

Kooiman, J. (2008). Exploring the concept of governability. Journal of Comparative Policy Analysis: *Research and Practice, 10*(2), 171-190.

Kooiman, J., Bavinck, M., Jentoft, S., & Pullin, R. (2005). *Fish for Life: Interactive Governance for Fisheries*. Amsterdam University Press.

Lopes, P. F., Silvano, R. A., Nora, V. A., & Begossi, A. (2013). Transboundary socio-ecological effects of a marine protected area in the Southwest Atlantic. *Ambio*, *42*, 963-974.

Mathias, J. D., Anderies, J. M., Baggio, J., Hodbod, J., Huet, S., Janssen, M. A., ... & Schoon, M. (2020). Exploring non-linear transition pathways in social-ecological systems. *Scientific reports*, *10*(1), 1-12.

Mitchell, B. (1976). Politics, fish, and international resource management: The British-Icelandic cod war. *Geographical Review*, 127-138.

Mitra, B., Biswas, O., Roy, S., Chakraborti, U., & Panja, B. (2016). Insect faunal diversity of the Sunderban biosphere reserve, West Bengal, India. *International Journal of Current Research and Academic Review*, *4*(9), 87-98.

Mollick, A. S., Ranon, R. J. K., Khan, M. N. I., & Nath, T. K. (2023). Evaluating social equity in protected areas co-management: evidence from the Sundarbans Mangrove Forests, Bangladesh. *Society & Natural Resources*, *36*(8), 970-990.

Mollick, A. S., Roy, M., Khan, N. I., Islam, W., Sadath, N., & Nath, T. K. (2022). Assessing good governance in protected areas (PA) Co-management: a case study of the Sundarbans Mangrove Forests of Bangladesh. *Journal of Sustainable Forestry*, *41*(3-5), 277-301.

Mozumder, M. M. H., Pyhälä, A., Wahab, M. A., Sarkki, S., Schneider, P., & Islam, M. M. (2020). Governance and power dynamics in a small-scale hilsa shad (Tenualosa ilisha) fishery: A case study from Bangladesh. *Sustainability*, *12*(14), 5738.

Mozumder, M. M. H., Shamsuzzaman, M. M., Rashed-Un-Nabi, M., & Karim, E. (2018). Social-ecological dynamics of the small scale fisheries in Sundarban Mangrove Forest, Bangladesh. *Aquaculture and Fisheries*, *3*(1), 38-49.

Nayak, P. K. (2017). Fisher communities in transition: Understanding change from a livelihood perspective in Chilika Lagoon, India. *Maritime Studies*, *16*, 1-33.

Nayak, P. K., & Berkes, F. (2019). Interplay between local and global: Change processes and small-scale fisheries. *Transdisciplinarity for small-scale fisheries governance: Analysis and practice*, 203-220.

Nyikahadzoi, K., Mhlanga, W., Madzudzo, E., Tendaupenyu, I., & Silwimba, E. (2017). Dynamics of transboundary governance and management of small scale fisheries on Lake Kariba: Implications for sustainable use. *International Journal of Environmental Studies*, *74*(3), 458-470.

Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2016. Exploring the governance and politics of transformations towards sustainability. *Environ. Innov. Soc. Transit*. http://dx.doi.org/10.1016/j.eist.2016.09.001.

Raha, A. K., Zaman, S., Sengupta, K., Bhattacharyya, S. B., Raha, S., Banerjee, K., & Mitra, A. (2013). Climate change and sustainable livelihoood programme: a case study from Indian Sundarbans. *J Ecol*, *107*(335348), 64.

Rahman, M. M. (2022). Is co-management a double-edged sword in the protected areas of Sundarbans mangrove?. *Biology & Philosophy*, *37*(1), 4.
Rezwan, (2019). 1/6/2021 ‘Conservation or community rights’? Bangladesh bans fishing for 65 days. Global Voices, May 26, 2019.
Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4* , 155–169.
Roszko, E. (2015). Maritime territorialisation as performance of sovereignty and nationhood in the South China S ea. *Nations and Nationalism*, *21*(2), 230-249.
Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*.
Scholtens J (2016) *Fishing in the margins. North Sri Lankan fisher's struggle for access in transboundary waters*. Dissertation, University of Amsterdam.
Scholtens, J. (2015). Limits to the governability of transboundary fisheries: Implications for small-scale fishers in northern Sri Lanka and beyond. *Interactive governance for small-scale fisheries: Global reflections*, 515-536.
Scholtens, J., & Bavinck, M. (2014). Lessons for legal pluralism: investigating the challenges of transboundary fisheries governance. *Current Opinion in Environmental Sustainability*, *11*, 10-18.
Scholtens, J., Song, A. M., Stephen, J., Chavez, C. G., Bavinck, M., & Sowman, M. (2019). Transdisciplinary engagement to address transboundary challenges for small-scale fishers. *Transdisciplinarity for small-scale fisheries governance: Analysis and practice*, 321-340.
Siddique, M. R. H., Hossain, M., & Rashid, A. M. (2023). The dilemma of prioritizing conservation over livelihoods: Assessing the impact of fishing restriction to the fishermen of the Sundarbans. *Trees, Forests and People*, *11*, 100366.
Song, A. M. (2015). Pawns, pirates or peacemakers: Fishing boats in the inter-Korean maritime boundary dispute and ambivalent governmentality. *Political geography*, *48*, 60-71.
Song, A. M., Scholtens, J., Stephen, J., Bavinck, M., & Chuenpagdee, R. (2017). Transboundary research in fisheries. *Marine Policy*, *76*, 8-18.
Sundaray, J. K., Chakrabarti, P. P., Mohapatra, B. C., Das, A., Hussan, A., Ghosh, A., & Hoque, F. (2019). Freshwater aquaculture in sundarbans india. *The Sundarbans: A Disaster-Prone Eco-Region: Increasing Livelihood Security*, 295-319.
Uddin, M. S., Shah, M. A. R., Khanom, S., & Nesha, M. K. (2013). Climate change impacts on the Sundarbans mangrove ecosystem services and dependent livelihoods in Bangladesh. *Asian Journal of Conservation Biology*, *2*(2), 152-156.
Ujjaman, R., Mozumder, M. M. H., Emon, M. A. M., & Islam, M. M. (2025). Why do alternative livelihood interventions succeed or fail? a case study of the Sundarbans mangrove fishing communities of Bangladesh. *Maritime Studies*, *24*(1), 10.
Vivekanandan, J. (2021). Scratches on our sovereignty?: Analyzing conservation politics in the Sundarbans. *Regions and Cohesion*, *11*(1), 1-20.

Chapter 5

Conclusion

5.1 Chapter outline

The aim of this concluding chapter is to synthesize the significant and original knowledge contributions and outcomes from this research. The chapter begins by revisiting the study's purpose and objectives. The summary of the key findings from three manuscripts (Chapters Two to Four) is then presented. The chapter synthesizes theoretical, empirical, and applied contributions to the advancement of knowledge. The chapter also reviews the study limitations, explores future research directions, and presents personal reflections on the overall experience in undertaking this dissertation research.

5.2 Research purpose and objectives

The purpose of this research was to develop a comprehensive understanding of small-scale fisheries' vulnerability to viability transitions and identify the key characteristics of governance arrangements that can help facilitate the transition in the Sundarbans transboundary small-scale fisheries. In other words, the research was to assess whether governing systems are well equipped to help facilitate the vulnerability to viability transitions given the nature and characteristics of small-scale fisheries in the transboundary Sundarbans. In doing so, the research followed the following three objectives.

1. To determine the key processes and mechanisms of vulnerability to viability transition in small-scale fisheries.
2. To explore the key vulnerabilities and the factors that hinder or facilitate transitions toward viability for small-scale fisheries in the transboundary Sundarbans.
3. To examine the capacity and quality of the governing system to facilitate vulnerability to viability transitions.

The dissertation achieved these objectives through the development of a conceptual framework and an empirical investigation grounded on cases in Bangladesh and India, all of which collectively advanced the knowledge gaps highlighted in the introductory chapter. Each chapter addresses a specific objective of the research. Using a scoping literature review, Chapter 2 identified the key processes and mechanisms of vulnerability to viability transitions for small-scale fisheries (Objective 1). The literature review was conducted regarding the key vulnerabilities that small-scale fisheries face, and the subsequent responses are taken at different levels to address them. The outcome of the review suggested why the existing responses are not sufficient to address the vulnerabilities and move toward viability. The chapter also identified areas that need further work, especially those related to governance. It found that if a governing system is not strong enough with the required capacity and quality, the transition toward viability is unlikely. Therefore, the chapter introduced a conceptual framework that can help assess the capacity and quality of the governing system to facilitate the vulnerability to viability transitions.

The conceptual framework developed in Chapter 2 guides the empirical case studies in Bangladesh and the Indian side of the Sundarbans. Using the conceptual framework, Chapter 3 assesses the socio-economic, natural and governance aspects of the small-scale fisheries in the transboundary Sundarbans. It identifies the key vulnerabilities of small-scale fisheries and the factors that hinder the transition from vulnerability to viability in the transboundary Sundarbans (objective 2). The findings in Chapter 3 suggest assessing the capacity and quality of the governing system to facilitate the vulnerability to viability transitions, considering the characteristics and nature of vulnerabilities presented. Thus, it leads to Chapter 4, where this research looked at the governing system of the transboundary fisheries system in terms of its structure and overall performance (objective 3). This chapter is also guided by the conceptual framework presented in Chapter 2.

5.3 Major findings

This research found that small-scale fisheries face a complex "wicked problem" in transitioning from vulnerability to viability, shaped by interconnected social, economic, and governance challenges. Conventional short-term fixes over systemic governance reforms often fail to facilitate the transitions from vulnerability to viability. In the context of vulnerability to viability transition, the conceptual framework developed (Chapter 2) through this research was applied in the case of transboundary small-scale fisheries to test and validate it. The application of the framework found that in the transboundary Sundarbans (India-Bangladesh), fishers endure poverty, exploitation, and climate threats. It identified the key governability challenges that hinder the vulnerability to viability transitions for small-scale fisheries. Findings from this research were presented in Chapters 2-4 in this dissertation. These chapters were developed as three standalone yet interdependent manuscripts.

Using the scoping literature review, chapter 2 examined the transition from vulnerability to viability in small-scale fisheries, characterizing it as a "wicked problem" due to its complexity, dynamic nature, and dependence on contextual factors. The literature review found that the vulnerability arises from interconnected social, economic, and governance challenges, such as declining fish stocks, income instability, climate change, and weak governance structures. In contrast, viability is the fisheries' long-term capacity to thrive under changing conditions (Berardi et al., 2015; Simpson and Weiner, 1989). Based on the findings of the scoping review, the conventional responses (e.g., migration, top-down policies like fishing bans, or gear modification) often fail to capture the systematic vulnerabilities, which are also reported by Islam and Cheunpagdee (2022), Kapembwa et al. (2021) and Cheunpagdee and Jentoft (2018). These solutions focus more on short-term fixes than on a structured governance system. This may lead to multiple unintended consequences such as ecological degradation, social inequality, and low-level resilience (see Kathijotes et al., 2015; Ratner et al., 2014; Lemos and Agarwar, 2006). The chapter also highlighted that vulnerabilities are exacerbated by fragmented governance systems that often lack coordination, local participation, and adaptive strategies.

The chapter categorized the responses (at government, community and/or non-government levels) to address the vulnerabilities into four typologies, each of which identifies gaps in current governance approaches. In cases where similar vulnerabilities (e.g., reduced fish stocks) trigger different responses (e.g., migration or destructive fishing), outcomes often include exploitation

or environmental harm. Conversely, similar responses (e.g., livelihood diversification) to common challenges (e.g., poverty) may introduce new risks, such as child labour or market competition (see Said and MacMillan, 2020; Ratner et al., 2014). Disasters and development-related disruptions elicit context-specific actions, but governance limitations, such as weak enforcement, hinder long-term viability, similar findings are also reported by Mozumder et al., (2018) and Salik et al. (2015). The chapter found that the inadequacy of hierarchical governance models frequently marginalizes fishing communities, leading to conflicts and mistrust. The chapter emphasized that effective solutions require recognizing the interplay between ecological, social, and institutional factors and the need for inclusive, adaptive governance that integrates local knowledge and priorities (See also, Nayak and Berkes, 2019).

To address these challenges, the chapter proposed a conceptual framework in Chapter 3 based on Interactive Governance Theory (Kooiman et al., 2005), which evaluates governance capacity and quality across multiple dimensions. The framework incorporates three governance modes, i.e., self-, co- and hierarchical governance, and assesses them through three orders of governance: day-to-day operations (first order), institutional designs and structure (second order), and underlying norms and values (meta or third order). The framework also assesses goodness of fit (e.g., the goodness of the goal), responsiveness (e.g., decision-making speed and community satisfaction) and performance (e.g., effectiveness and equity in policy implementation) for each governance mode. It also aimed to identify gaps in terms of governance and opportunities for vulnerability to viability transitions. This research focused on systematic reforms that strengthen communities and institutional coordination with short-term alignment actions in addition to long-term sustainability goals. Ultimately, the chapter argued that viability is influenced by functional governance systems that are equitable, adaptive, and deeply engaged with the communities. This led to chapter three, which assessed the different characteristics of the governing system and the transboundary small-scale fishing communities that they govern, as well as the interaction among them.

Chapter 3 examined fishing communities' socio-economic and governance struggles in the transboundary Sundarbans mangrove forest, shared by India and Bangladesh. Demographic data revealed that most fishers are middle-aged, illiterate or minimally educated, and lack land ownership, with housing conditions often substandard (also found by Sarker et al., 2019; Islam et al., 2018; Mozumder et al., 2018; Gopal and Chauhan, 2018). Women, though contributing significantly to family income through fishing and other labour jobs, remain marginalized in decision-making. Natural hazards like cyclones, floods, and tiger attacks further contribute to their poor livelihood conditions. Additionally, inequitable benefit-sharing, exploitation by middlemen, and restrictive fishing policies deepen their vulnerabilities, hindering any transition toward viable and sustainable fisheries.

Chapter 3 found that the governing systems in both countries are hierarchical and ineffective, with minimal community participation in decision-making. While Bangladesh has introduced co-management initiatives, awareness and engagement among fishers remain low, which also found by Mollick et al. (2022) and Rahman (2022). India's governance is still top-down, with policies like the Boat Licence Certificate (BLC) system creating barriers for fishers to benefit from the forest fisheries resources. Transboundary cooperation is lacking, leading to conflicts over resource access and illegal fishing across borders. Small-scale fishing communities expressed

dissatisfaction with governance due to corruption, slow response to their needs, and inappropriate policies such as fishing bans that ignore local realities. The absence of joint governance frameworks and inadequate representation of fishers in policy-making further undermines efforts to promote viability, also suggested by Vivekanandan (2021) and Hassan et al. (2019).

The other argument of chapter 3 is the urgent need for inclusive, transboundary governance that prioritizes the rights and needs of the transboundary small-scale fisheries communities. In addition, it also recommended developing access to basic entitlements, creating alternative livelihoods, and fostering equitable benefit-sharing mechanisms among the stakeholders of the forest and small-scale fishing communities. The chapter also suggested that addressing safety concerns, such as pirate and wildlife attacks, and involving youth in fisheries through education and incentives are also critical. The findings of the chapter also recommend collaborative, adaptive governance that balances conservation goals with livelihood security, ensuring the long-term viability of both the Sundarbans ecosystem and its dependent fishing communities. Without such measures, the cycle of poverty, resource depletion, and marginalization will persist, jeopardizing the transitions towards viability of small-scale fisheries in the transboundary region (Doria et al., 2020; Nyikahadzoi et al., 2017). The chapter also emphasized assessing whether the existing governing system is capable of addressing the transboundary challenges of small-scale fisheries and facilitating the transition processes for viability.

Chapter 4 assessed the governability challenges faced by small-scale fisheries in the transboundary Sundarbans region. The chapter analyzed the governing systems in Bangladesh and India in terms of their capacity and quality. The study revealed that both countries implement a mixed governance system: First, hierarchical governance dominates, and second, early-stage co-governance initiatives. In Bangladesh, co-management committees aim to decentralize governance, while India's Joint Forest Management Committees involve communities in forest protection and eco-development. Despite these influencing structures, power plays a centralized role here, excluding local communities from participating in decision-making processes (also found by Begum et al., 2024). On the other hand, the governance quality was assessed under these three indicators: Goodness of fit, responsiveness, and performance. Chapter 4 also revealed that governance objectives often prioritize forest conservation over community livelihoods, leading to ethical dilemmas and conflicts. For example, fencing parts of the Indian Sundarbans to protect tigers restricts fishers' access, increasing their hardships. Governance is further determined by corruption, inadequate funding, and poor coordination (Khan et al., 2024).

Chapter 4 identified several governability challenges that pose barriers to small-scale fisheries' vulnerability to viability transitions in the transboundary region. First, the wickedness of transboundary vulnerabilities: small-scale fisheries' vulnerabilities are complex, interconnected, and lack clear solutions. For example, fishing bans intended to conserve resources may indirectly tempt fishers toward illegal practices like poison fishing. The transboundary nature of the issues complicates efforts, as solutions require cooperation between Bangladesh and India, which is often lacking. Second, diverse stakeholder images about the transboundary Sundarbans issues. Governing actors prioritize forest conservation, while fishers emphasize livelihood security. This misalignment leads to policies that fail to address community needs, such as inadequate

compensation for fishing restrictions. Third, poor coordination among relevant governing institutions. Multiple governing bodies with overlapping roles and responsibilities are involved in the transboundary Sundarbans governance, which creates confusion and inefficiencies (also found by Vivekanandan, 2021; Islam et al., 2018). For instance, forest departments focus on conservation, while fisheries departments are sidelined, resulting in poorly informed policies. Fourth, there is a lack of common transboundary policies between Bangladesh and India. Despite shared resources and common threats to the forest, Bangladesh and India lack joint fisheries policies. Differences in fishing ban durations or policies tempt fishers to violate regulations, undermining conservation efforts. Fifth, holding power at the central level in a hierarchical governance mode pose a barrier to small-scale fisheries' viability (also suggested by Dias et al., 2023; Siddique et al., 2023; Chuenpagdee and Jentoft, 2013). Although co-governance structures exist, decision-making remains top-down. Local communities are rarely consulted, and their knowledge is ignored. Finally, geopolitical disputes between neighbouring countries. Broader geopolitical tensions often overshadow the vulnerabilities of small-scale fisheries (Mozumder et al., 2020; Scholtens et al., 2019). Fishers caught crossing borders during bans become pawns in larger political negotiations, with their well-being overlooked (Dupont and Baker, 2014; Mitchell, 1976).

The chapter found that fishers in both countries are dissatisfied with the current governance system, pointing to the lack of transparency, corruption, and insufficient support. They propose solutions including suitable alternative livelihoods, reduced forest access restrictions, and equal compensation for conservation efforts. Many supported open-access fisheries along with stricter enforcement against illegal activities. They call for better community involvement in policy-making decisions and stronger accountability among governing actors. The chapter recommended that a better governance system, such as improving stakeholder coordination and aligning conservation goals with community livelihoods, can be utilized by decentralizing the power dynamics. On the contrary, the chapter also revealed that the wicked nature of these challenges, along with geopolitical complexities, makes progress difficult. Without meaningful collaborations between India and Bangladesh, and meaningful inclusion of fishers in governance, the transitions from vulnerability to viability for small-scale fisheries remain unlikely.

5.4 Novel and significant contributions

The study addressed the research gaps identified in the introductory section with novel contributions to theoretical, sustainability discourse and empirical and applied perspectives. The study has made a significant contribution to the discussion of vulnerability to viability transitions as an emerging field. The empirical findings provide evidence of whether and how the transitions toward viability can be achieved for small-scale fisheries. The overall contributions are discussed in the following three areas.

5.4.1 Theoretical contributions

This research made significant theoretical contributions by advancing the understanding of small-scale fisheries governance through the lens of "wicked problems" and "governability" (Jentoft and Chuenpagdee, 2009; Kooiman and Bavinck, 2013; Rittel and Webber, 1973) In Chapter 2, the research conceptualized the transition from vulnerability to viability as a wicked

problem, rather than a linear problem with straightforward solutions. The study critiqued conventional short-term fixes, such as fishing bans. It demonstrated how these technical fixes often intensify existing vulnerabilities by ignoring issues, such as power imbalances, fragmented governance, and transboundary conflicts (Jentoft, 2017; Crona & Bodin, 2010; McClanahan et al., 2009; Degnbol et al., 2006). By analyzing the major sources of vulnerabilities for small-scale fisheries globally and the main typologies of vulnerability/response, the study revealed the importance of assessing the governing institutions from the capacity and quality perspectives in the vulnerability to viability transitions discourse (Jentoft and Chuenpagdee, 2024; Nayak and Berkes, 2019; Chuenpagdee and Jentoft, 2018).

The development and application of a novel conceptual framework, i.e., the V2V transitions in Chapter 2, drawn from interactive governance theory (Kooiman et al., 2005) and the governability concept (Kooiman and Bavinck, 2013), is another key theoretical contribution. Using this V2V transition framework, this research in Chapters 3 and 4 evaluated governance modes (i.e., hierarchical, co-, and self-governance) and three analytical orders (i.e., day-to-day operations, institutional structures, and meta-level norms), while also assessing governance quality through criteria like goodness of fit, responsiveness, and performance (Jentoft and Chuenpagdee, 2015; Chuenpagdee and Jentoft, 2013; Kooiman and Bavinck, 2013). One of the key contributions of the use of this framework was that it found the application of "hybrid" governance in practice, which was also discussed by Chuenpagdee and Jentoft (2013). This hybrid governance, though not formally acknowledged, acts as a pragmatic fourth mode of governance, after self-, co- and hierarchical governance modes, adapting to the complex socio-political realities of the region. As the findings suggested, the persistence of hierarchical governance, even within co-governance frameworks, reflects deeper institutional inertia and power asymmetries. The study observed that a "mixed" governance approach is practiced among the communities and lower-level actors still exercise informal agency, whether through resistance, negotiation, or adaptive practices like illegal fishing during mismatched ban periods. As modified, the conceptual framework in Figure 5.1, recognizing this fourth mode, can reframe governance scholarship, moving beyond idealized models to engage with the complex, diverse, dynamic and scalable cases of social-ecological systems governance. Using this framework, future research can explore how to institutionalize hybrid governance in cases where hierarchical, co-, or self-governance alone cannot achieve.

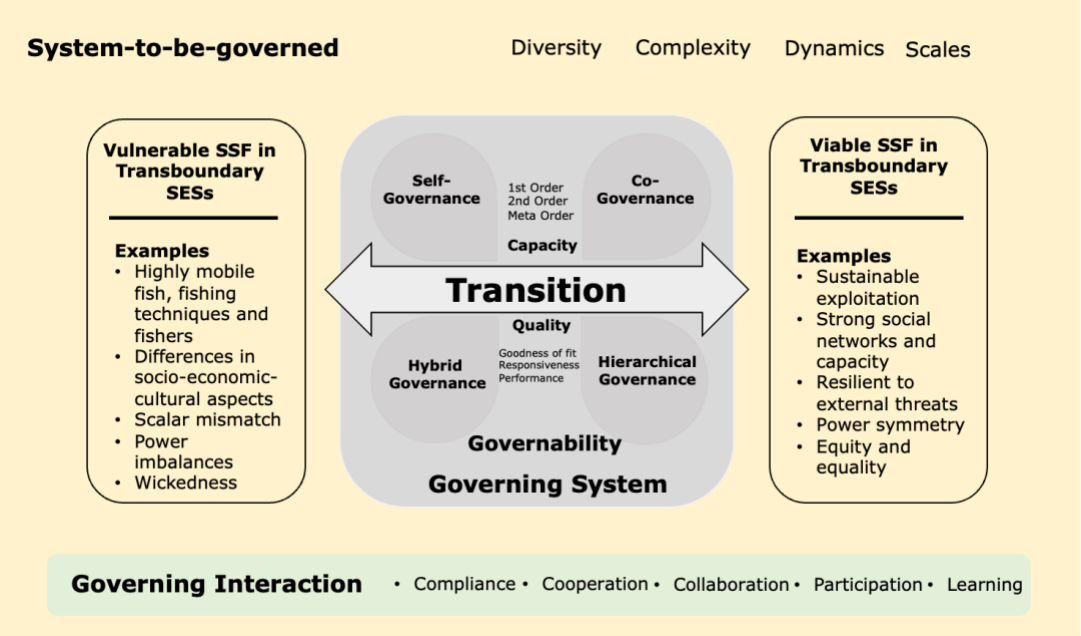

Figure 5.1 The revised V2V transitions framework.

Additionally, the research extended governance theory by highlighting the role of transboundary governance gaps in addressing small-scale fisheries vulnerabilities. It revealed how geopolitical tensions, centralized decision-making, and a lack of coordination between respective governing institutions in neighbouring countries can undermine viability transitions (Ahn and Pomeroy, 2024; Doria et al., 2020; Toonen and van Tatenhove, 2020). By empirically validating the V2V transitions framework in Chapters 3 and 4 in a real-world transboundary case, the research not only advances governance theory but also offers a pathway for future research to explore similar dynamics in other shared socio-ecological systems.

5.4.2 Contributions to sustainability discourse

Through questioning conventional approaches to governance for small-scale fisheries, this study aimed to contribute significantly to the discussions of sustainability. It highlighted the limitations of the existing temporary solutions (e.g., gear restrictions) in tackling the vulnerabilities that are related to social, economic, and ecological factors. The findings highlighted the need for structured governance that connects conservation and livelihood goals, specifically in the transboundary context of Sundarbans, where fragmented policies and tensions in terms of geopolitics further heighten the existing vulnerabilities. The research emphasized that environmental sustainability cannot be achieved without addressing equity, participation, and power imbalances in governance (Phelan et al., 2023; Aguión et al., 2022; Chuenpagdee et al., 2018; Kosamu, 2015).

A key contribution to sustainability discourse is the application of the V2V transitions framework, inspired by the governability framework (Kooiman and Bavinck, 2013). The use of the framework provided a structured way to diagnose and address capacity and quality issues of the governing system in complex socio-ecological systems. The framework revealed how an

inappropriate governance approach often marginalizes fishing communities, leading to policies that are ecologically ineffective and socially unjust (Reis-Filho et al., 2024; Schreiber et al., 2022; Lam and Pitcher, 2012). By contrast, the research demonstrated that interactive governance, which enhances interaction among the governed and governors, decentralizes decision-making, integrates local knowledge, and fosters multi-actor collaboration, can better support long-term viability (Jentoft and Chuenpagdee, 2022; Jentoft, 2017). This aligns with the transformative sustainability science, an emerging paradigm, which calls for systemic, context-sensitive solutions to global environmental challenges (Horlings et al., 2020; Shrivastava et al., 2020; König, 2015).

This research further enriches sustainability discourse by revealing the trade-offs and contradictions in current governance practice for small-scale fisheries (Crona et al., 2019; Said and Cheunpagdee, 2019; Smith and Basurto, 2019). For instance, conservation policies motivated by ecological objectives (e.g., declaring protected areas), often undermine the livelihoods and food security of small-scale fishing communities (Wade and Biedenweg, 2024; Weeratunge et al., 2014). The study emphasized that sustainability interventions focus highly on procedural justice (e.g. fair participation) and distributive justice (e.g. equitable access to resources) to prevent further marginalization. The research findings called for a reimagined sustainability agenda that centers the voices of transboundary small-scale fishing communities and shifts governance from a narrow technical solution to a more inclusive, integrated, and transboundary approach that supports both ecological resilience and human well-being. This will have broader implications for global sustainability efforts, particularly in contested ecosystems where environmental and social crises intersect.

5.4.3 Empirical and applied contributions

This research offers critical empirical insights by analyzing the real-world challenges faced by small-scale fisheries in the transboundary Sundarbans. Using a mixed-methods approach with scoping reviews, case study analysis, and governance assessments, this research provided evidence of how inappropriate governance systems fail to address vulnerabilities of small-scale fisheries in a transboundary context. The empirical data revealed that the fishers in the Sundarbans face systemic exploitation, climate threats, and exclusion from decision-making. The applied contributions of this research lie in its actionable framework for improving small-scale fisheries governance. The research developed and validated the V2V transition framework in a transboundary context, which provided policymakers and practitioners with a tool to diagnose governance limitations and gaps. The framework can help assess not just institutional performance but also equity, adaptability, and community engagement. The research made specific recommendations, including the practice of co-governance with decentralizing power, strengthening cross-border cooperation between neighbouring countries, and designing alternative livelihood programs that align with local needs. For instance, the research emphasized the proposed solutions of the fishers (e.g., equitable compensation for conservation-related actions) can help reduce conflicts and enhance compliance. These insights are highly applicable to regional agencies such as Sundarbans Joint Management Committees, NGOs, and international organizations (e.g., FAO) that are working on small-scale fisheries and mangrove conservation.

Moreover, the research emphasized the urgency of transboundary governance innovations, for example, joint or harmonized fishing regulations and joint crisis response systems, to address shared risks like cyclones and illegal fishing. The empirical findings of the research on the failures of top-down conservation measures (e.g., tiger-protection fencing that restricts fisher access) serve as a cautionary tale for global sustainability projects, advocating for policies that balance ecological and human well-being. This research equips stakeholders with evidence-based strategies by bridging theory and practice to foster resilient, equitable, and viable small-scale fisheries worldwide.

Both Bangladesh and India are signatory members of the United Nations' different initiatives and planning, for example, the SSF Guidelines and the Sustainable Development Goals (SDGs). The findings can be used by those countries first to check the status of implementation of the SSF Guidelines within the national jurisdiction and transboundary context. The thirteen principles of SSF Guidelines advocate safeguarding the rights, equity, participation, fair and equitable market access and preventing gender discrimination, among others (FAO, 2015b). This research suggested ways to improve in these areas for both countries. The findings of this research can be used to report the progress of the SSF Guidelines in the meeting to celebrate the SSF Guidelines' first decade in 2024.

5.5 Study limitations and future research directions

This section presents the limitations of this dissertation and explores the opportunities for future research. The chapters 2-4 had a specific objective, theoretical grounding, methods, results and limitations. First, a scoping review was conducted in Chapter 2 about the wickedness of vulnerability to viability transitions. Given the limited literature on vulnerability to viability transitions, a scoping review was conducted, and information was extracted from peer-reviewed articles to fulfill the purpose of the chapter. The review lacks information from gray literature, such as NGO reports and government documents, which may miss critical insights on the ground. Therefore, this research acknowledges that a scoping review may not critically analyze the findings (Tricco et al., 2016; Pham et al., 2014), which may lead to superficial insights on the complex viability transitions for small-scale fisheries. Further research can be conducted using a systematic literature review and a critical evaluation of the findings related to the concept of vulnerability to viability transitions.

Second, the literature picked for the review was not directly about the transitions but the relevant concepts, such as vulnerability, viability, social-ecological transitions, and responses to internal and external stressors that small-scale fisheries face. The information extracted from the selected literature was, to some extent, biased toward governance-related topics. The vulnerabilities of small-scale fisheries are diverse, and the responses are too (Islam and Chuenpagdee, 2022). Therefore, the research may miss the nuanced drivers, such as socio-cultural factors, power dynamics, fishers' behaviour and psychology, of vulnerabilities and motivations behind responses, which require in-depth analysis (Cánovas-Molina and García-Frapolli, 2022; Kawarazuka et al., 2017; Kolding et al., 2016). Future research can be conducted on exploring each dimensional aspect of small-scale fisheries' vulnerability to viability transitions with an in-depth analysis of empirical findings.

Third, the conceptual framework presented in Chapter 2 needs further empirical case studies to support the framework. The use of this framework for Chapters 3 and 4 in the context of the transboundary fisheries system proved the usefulness of the framework in diagnosing the capability of the governing system in facilitating the vulnerability to viability transitions. However, more case studies in different contexts need to be conducted to strengthen and further validate the framework (Van der Waldt, 2020; Pennel et al., 2016; Ngulube et al., 2015). Future studies can find out the missing areas or perspectives related to the governing system in assessing its capacity and quality. Given the dynamic nature of small-scale fisheries, new forms of vulnerabilities can emerge that need to be counted and tested against the capability of the governing system (Dias et al., 2023). The framework can be used to diagnose such circumstances. Fourth, the participation of fisherwomen was comparatively less in this study. The findings presented in Chapters 3 and 4 thus lack the in-depth perspectives of fisherwomen regarding the study context.

It is also crucial to consider the perspectives and views of fisherwomen to understand vulnerabilities in small-scale fishing deeply. While they do not directly participate in fishing activities in the transboundary study, they play an important role as stakeholders through their homemaking responsibilities and harvesting mud crab (*Scylla* sp.) (Roy et al., 2023; Bhuiyan et al., 2021). Women make up the major workforce in the post-harvest fisheries supply chain (Lekshmi et al., 2022; Harper et al., 2020; Frangoudes and Gerrard, 2018). The issues, for example, lower wages than males, that female fishers face are unique and these are linked to other socio-cultural aspects of the society (Frangoudes and Gerrard, 2019; Lentisco and Lee, 2015). Further research can be conducted on the role of gender in shaping the governing system to facilitate the vulnerability to viability transitions for small-scale fisheries.

Finally, biases in selecting study areas and participants. The study areas in Bangladesh were selected based on previous research experience and using already established contacts. The other areas of the forest need to be explored in future research, especially in the Bagerhat area, where small-scale fishers fish both in the forest and the sea. Similarly, the other areas of the Indian Sundarbans where fishers are more dependent on dry fish can be explored. The perspectives and experiences of transboundary fishing can vary in other areas of the Sundarbans. The data on social, ecological, governance and transboundary fisheries may vary depending on the geographical area and communities. Therefore, further research can be conducted in other areas of the forest to produce general knowledge about the vulnerabilities of small-scale fisheries, what capacity and quality are important to have in the governing institution to facilitate the transition from vulnerability to viability.

5.6 Personal reflections

As I grew up in Bangladesh, I have always questioned the multidimensional vulnerabilities faced by the small-scale fishing communities, especially those who rely on fishing as their primary source of livelihood. I have had the opportunity to witness the struggles of these communities, despite Bangladesh's rich fishing resources. My curiosity inspired me to pursue a deeper knowledge of the aspect of fisheries during my undergraduate – Bachelor of Science - followed by my first Master's degree in small-scale fisheries. My second master's was on governance issues in the small-scale fisheries supply chain, further deepening my interest that shaped my

doctoral research on fisheries governance. Before pursuing my PhD, my research was specifically focused on the Bangladeshi side of the Sundarbans. However, after having a thorough discussion about potential study areas with my supervisor, I came to the conclusion to enhance my research scope by including the Indian side of the Sundarbans. The idea was to focus on the transboundary aspect, specifically the governance gap in fisheries systems. My longstanding engagement with these communities has continually motivated me to uncover their vulnerabilities and work toward meaningful, viable improvements in their lives.

Conducting fieldwork on the Indian side of the Sundarbans was a new experience for me, and the enthusiastic participation of local communities struck me. Many recognized the significance of this transboundary fisheries governance study, a topic long overlooked by both policymakers and academics. Communities on both sides of the border suffer from the absence of common governance policies and decision-making systems for the mangrove forest. Because of having ancestral ties with Bangladesh, some participants from the Indian side expressed joy in engaging with a Bangladeshi researcher, reinforcing the study's transboundary relevance. Apart from focusing specifically on my research and findings, this fieldwork facilitated valuable collaboration and connection with faculty members and researchers from the Indian Institute of Technology, Kharagpur. This resulted in an increase in my professional network, as I had the opportunity to connect with diverse minds from the Indian side, such as scholars and NGOs. Cooperative societies and local communities lay the groundwork for future engagement.

I have gathered mixed perspectives from participants from both countries on the potential impacts of this research. While some worried it may lead to more restricted access to the firsts, others hoped it would influence decision-makers to prioritize community welfare. As mentioned in Chapters 3 and 4, conservation measures have limited forest access over time. Many fishers feared that the data collected could justify further government-imposed restrictions, reinforcing their marginalization. However, I clarified that research does not always threaten livelihoods—some studies advocate for community interests. Much of the information shared by participants criticized powerful actors, including local elites, moneylenders, intermediaries, and corrupt forest officials. This tension was evident in some participants' expressions, as they feared social consequences if identified. To address these concerns, I assured them that all data would remain anonymous in my dissertation and any published work, protecting their identities.

From local communities and institutional partners to colleagues and mentors, I have had the opportunity to collaborate with diverse minds that have deepened my own knowledge as a researcher. I have had the opportunity to work alongside expert individuals who have benefited my academic knowledge. I am also thankful to my supervisor, who has thoroughly guided me to shape my research with this expert knowledge on small-scale fishing communities. I would also like to extend my gratitude to the committee members, faculty of environment, and the School of Environment, Enterprise, and Development (SEED) members for their constant support throughout the process. I was also careful about my reflexivity as a researcher and tried my best not to incorporate my biased perspectives and maintained an equal relationship with the participants. My aim has always been to maintain relationships built on respect. Being committed to my values, I remained dedicated to give back to the communities involved in this study in meaning ways.

References

Acemoglu, D., Johnson, S., Robinson, J. A., & Yared, P. (2009). Reevaluating the modernization hypothesis. *Journal of monetary economics*, *56*(8), 1043-1058.

Adams, C. W. (2015). Conducting Semi-Structured Interviews. In: Newcomer, K. E., Hatry, H. P., & Wholey, J. S. *Handbook of practical program evaluation*, 492.

Advani, S. (2020). *How commoditization and cross-cultural values influence the sustainability of small-scale fisheries in the Andaman and Nicobar Islands, India* (Doctoral dissertation, University of British Columbia).

Aguión, A., Ojea, E., García-Flórez, L., Cruz, T., Garmendia, J. M., Davoult, D., ... & Macho, G. (2022). Establishing a governance threshold in small-scale fisheries to achieve sustainability. *Ambio*, *51*(3), 652-665.

Ahn, S., & Pomeroy, R. (2024). Evaluating the economic impact of distant water fleet activities on small-scale fishers in the South China Sea. *Marine Policy*, *168*, 106324.

Alder, J., & Sumaila, U. R. (2004). Western Africa: a fish basket of Europe past and present. *The Journal of Environment & Development, 13*(2), 156-178.

Alexander, S. M., Armitage, D., & Charles, A. (2015). Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries. *Global Environmental Change*, *35*, 213-225.

Allison, E. H. (2001). Big laws, small catches: global ocean governance and the fisheries crisis. *Journal of International Development, 13*(7), 933-950.

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine policy, 25*(5), 377-388.

Apine, E., Turner, L. M., Rodwell, L. D., & Bhatta, R. (2019). The application of the sustainable livelihood approach to small scale-fisheries: The case of mud crab Scylla serrata in South west India. *Ocean & coastal management, 170*, 17-28.

Armitage, D., De Loë, R., & Plummer, R. (2012). Environmental governance and its implications for conservation practice. *Conservation letters, 5*(4), 245-255.

Axinn, W. G., & Pearce, L. D. (2006). *Mixed method data collection strategies*. Cambridge University Press.

Basurto, X., Gutierrez, N. L., Franz, N., Mancha-Cisneros, M. D. M., Gorelli, G., Aguión, A., ... & H. Thilsted, S. (2025). Illuminating the multidimensional contributions of small-scale fisheries. *Nature*, 1-10.

Bavinck, M. (2001). *Marine resource management: Conflict and regulation in the fisheries of the Coromandel Coast*. New Delhi: Sage.

Bavinck, M. (2011). The megaengineering of ocean fisheries: A century of expansion and rapidly closing frontiers. In *Engineering earth* (pp. 257-273). Springer, Dordrecht.

Bavinck, M., Chuenpadee, R., Jentoft, S., & Kooiman, J. (Eds.). (2013). *Governability of fisheries and aquaculture: Theory and applications*. Dordrecht: Springer.

Beaudreau, A. H., Ward, E. J., Brenner, R. E., Shelton, A. O., Watson, J. T., Womack, J. C., ... & Williams, B. C. (2019). Thirty years of change and the future of Alaskan fisheries: Shifts in fishing participation and diversification in response to environmental, regulatory and economic pressures. *Fish and Fisheries*, *20*(4), 601-619.

Begum, F., Lobry de Bruyn, L., Kristiansen, P., & Islam, M. A. (2024). What factors influence women's participation in co-management? A case study of Sundarban mangrove forest management in Bangladesh. *Journal of Environmental Planning and Management*, 1-26.

Belhabib, D., Greer, K., & Pauly, D. (2018). Trends in industrial and artisanal catch per effort in West African fisheries. *Conservation Letters, 11*(1), e12360.

Béné, C., Neiland, A.E., 2004. Empowerment reform, yes. but empowerment of whom? Fisheries decentralization reforms in developing countries: a critical assessment with specific reference to poverty reduction. *Aquatic Resources, Culture and Development 1*, 35–49.

Berardi, A., J. Mistry, C. Tschirhart, E. Bignante, O. Davis, L. Haynes, R. Benjamin, G. Albert, R. Xavier, D. Jafferally, and G. De Ville. 2015. Applying the system viability framework for cross-scalar governance of nested social-ecological systems in the Guiana Shield, South America. *Ecology and Society 20*(3):42. http://dx.doi.org/10.5751/ES-07865-200342.

Berkes, F. (2009). Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of environmental management, 90*(5), 1692-1702.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. *Linking social and ecological systems: management practices and social mechanisms for building resilience*, *1*(4), 4.

Berkes, F., George, P., Preston, R., 1991. Co-management: the evolution of the theory and practice of joint administration of living resources. *Alternatives 18* (2), 12–18.

Bhuiyan, M. S., Shamsuzzaman, M. M., Hossain, M. M., Mitu, S. J., & Mozumder, M. M. H. (2021). Mud crab (Scylla serrata Forsskal 1775) value chain analysis in the Khulna region of Bangladesh. *Aquaculture and Fisheries*, *6*(3), 330-336.

Boonstra, W. J., Björkvik, E., Joosse, S., & Hanh, T. T. H. (2019). From Anthrome to Refugium? A short history of small-scale fisheries in the Anthropocene. *I Encyclopedia of the WorldTs Biomes. Reference Module in Earth Systems and Environmental Sciences*.

Bundy, A., Chuenpagdee, R., Boldt, J. L., de Fatima Borges, M., Camara, M. L., Coll, M., ... & Shin, Y. J. (2017). Strong fisheries management and governance positively impact ecosystem status. *Fish and Fisheries*, *18*(3), 412-439.

Burke, E. (1999 [1790]). *Reflections on the Revolution in Fra*nce. Oxford University Press, Oxford.

Butcher, J. G. (2004). *The closing of the frontier: A history of the marine fisheries of Southeast Asia, c. 1850-2000* (No. 8). Institute of Southeast Asian Studies.

Cánovas-Molina, A., & García-Frapolli, E. (2022). A review of vulnerabilities in worldwide small-scale fisheries. *Fisheries Management and Ecology*, *29*(5), 491-501.

Carlisle, K., and R. L. Gruby. 2019. Polycentric systems of governance: a theoretical model for the commons. *Policy Studies Journal 47*(4):927-952. https://doi.org/10.1111/psj.12212

Carlsson, L., & Berkes, F. (2005). Co-management: concepts and methodological implications. *Journal of environmental management, 75*(1), 65-76.

Chaffin, B. C., Gosnell, H., & Cosens, B. A. (2014). A decade of adaptive governance scholarship: synthesis and future directions. *Ecology and society, 19*(3).

Chambers, R. 1995. Poverty and livelihoods: whose reality counts?. *ID discussion paper,* 347. Brighton: IDS.

Charles, A. (1988). Fishery socioeconomics: a survey. *Land Economics 64*, 276–295.

Chauffour, J. P. (2011). What Matters for Development—Freedom or Entitlement?. *Economic freedom of the world, Annual Report*, 167-178.

Chauhan, M., & Gopal, B. (2014). Sundarban mangroves: impact of water management in the Ganga river basin. *Our National River Ganga: Lifeline of Millions*, 143-167.
Chuenpagdee, R., & Jentoft, S. (2013). Assessing governability: What's next? In M. Bavinck, R. Chuenpagdee, S. Jentoft, & J. Kooiman (Eds.), Governability of fisheries and aquaculture: Theory and applications (pp. 335–350). Dordrecht: Springer.
Chuenpagdee, R., Degnbol, P., Bavinck, M., Jentoft, S., Johnson, D., Pullin, R., & Williams, S. (2005). Challenges and concerns in capture fisheries and aquaculture. In *Fish for life: interactive governance for fisheries*. Amsterdam University Press, Amsterdam, The Netherlands, 25-40.
Chuenpagdee, R., Jentoft, S., 2018. Transforming the governance of small-scale fisheries. *Mari. Stud*. https://doi.org/10.1007/s40152-018-0087-7.
Chuenpagdee, R., Salas, S., & Barragán-Paladines, M. J. (2018). Big questions about sustainability and viability in small-scale fisheries. In *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean* (pp. 3-13). Cham: Springer International Publishing.
Colloca, F., Scarcella, G., & Libralato, S. (2017). Recent trends and impacts of fisheries exploitation on Mediterranean stocks and ecosystems. *Frontiers in Marine Science, 4*, 244.
Condorcet, J.-A.-N. de Caritat (1979 [1795]). *Sketch for a Historical Picture of the Progress of Human Mind*. Hyperion Press,Westport, CT.
Coulthard, S., Johnson, D. and McGregor, A. (2011) Poverty, sustainability and human wellbeing: a social wellbeing approach to the global fisheries crisis. *Global Environmental Change 21*, 453–463.
Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
Creswell, J.W. and Piano Clark, V.L. (2007) *Designing and Conducting Mixed Methods Research.* Sage Publications, Thousand Oaks, California.
Crona, B. I., Van Holt, T., Petersson, M., Daw, T. M., & Buchary, E. (2015). Using social–ecological syndromes to understand impacts of international seafood trade on small-scale fisheries. *Global Environmental Change*, *35*, 162-175.
Crona, B., & Bodin, Ö. (2010). Power asymmetries in small-scale fisheries: a barrier to governance transformability?. *Ecology and society*, *15*(4).
Crona, B., Käll, S., & Van Holt, T. (2019). Fishery Improvement Projects as a governance tool for fisheries sustainability: A global comparative analysis. *PLoS One*, *14*(10), e0223054.
Crona, B., Nyström, M., Folke, C., & Jiddawi, N. (2010). Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Marine policy, 34*(4), 761-771.
Daly, J., & Chuenpagdee, R. (2020). Facing an uncertain future: A prospective analysis of trade policy on coastal communities in northwest Newfoundland. *Marine Policy, 117*, 103890.
DasGupta, R., & Shaw, R. (2013). Changing perspectives of mangrove management in India–an analytical overview. *Ocean & coastal management*, *80*, 107-118.
Davidson, D. J., & Frickel, S. (2004). Understanding environmental governance: a critical review. *Organization & Environment*, *17*(4), 471-492.
DBW. (2021). Desktop study. Designing Building Wiki. Retrieved from: https://www.designingbuildings.co.uk/wiki/Desktop_study
De Janvry, A., & Sadoulet, E. (2015). *Development economics: Theory and practice*. Routledge.

Degnbol, P., Gislason, H., Hanna, S., Jentoft, S., Nielsen, J. R., Sverdrup-Jensen, S., & Wilson, D. C. (2006). Painting the floor with a hammer: technical fixes in fisheries management. *Marine Policy*, *30*(5), 534-543.

DeWalt, K.M. and DeWalt, B.R. (2002). *Participant Observation: A Guide for Fieldworkers*. Altamira Press, Walnut Creek, California.

DFID, U. K. (1999). Sustainable livelihoods guidance sheets. *London: DFID*, *445*.

Dias, A. C. E., Armitage, D., Nayak, P. K., Akintola, S. L., Arizi, E. K., Chuenpagdee, R., ... & Singh, S. (2023). From vulnerability to viability: A situational analysis of small-scale fisheries in Asia and Africa. *Marine Policy*, *155*, 105731.

Dixon, J., Kouzmin, A. and Goodwin, D. 2003. Introduction to the Symposium: Comparative Sociopolitical Governance. *Journal of Comparative Policy Analysis, 5*: 101–105.

Doria, C. R., Athayde, S., Lima, H. M. D., Carvajal-Vallejos, F. M., & Dutka-Gianelli, J. (2020). Challenges for the governance of small-scale fisheries on the Brazil-Bolivia transboundary region. *Society & Natural Resources*, *33*(10), 1213-1231.

Dos Santos, T. (2002). The Structure of Dependence', American Economic Review, 60 (2), May, 231-6. *INTERNATIONAL LIBRARY OF CRITICAL WRITINGS IN ECONOMICS*, 140, 238-243.

Dupont, A., & Baker, C. G. (2014). East Asia's maritime disputes: Fishing in troubled waters. *The Washington Quarterly*, *37*(1), 79-98

Elliott, J. A. (2014). Development and social welfare/human rights. *D. Vandana & P. Robert B.(Eds.), The Companion to Development Studies. Routledge*.

Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African journal of emergency medicine*, *7*(3), 93-99.

FAO (Food and Agriculture Organization) (2015b) Voluntary guidelines for securing sustainable small-scale fisheries. United Nations, Rome.

FAO, Duke University & WorldFish. (2023). *Illuminating Hidden Harvests – The contributions of small-scale fisheries to sustainable development*. Rome. https://doi.org/10.4060/cc4576en

FAO. (2015a). Artisanal fisheries. The Fish Project. Available at: http://thefishproject.weebly.com/artisanal-fisheries.html

FAO. 2016. *The state of world fisheries and aquaculture 2016*. Food and Agriculture Organization of the United Nations, Rome, Italy.

FD (Forest Department). 2010. Integrated resources management plan for Sundarbans (2010–2020). Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

Feola, G. (2016, September). Translocal grassroots movements and the geography of sustainability transitions: the case of the Transition Towns Network. In *7th International Sustainability Transitions (IST) Conference 2016: Exploring Transition Research as Transformative Science*. Wuppertal, Germany.

Fischer-Kowalski, M., Krausmann, F., & Pallua, I. (2014). A sociometabolic reading of the Anthropocene: Modes of subsistence, population size and human impact on Earth. *The Anthropocene Review, 1*(1), 8-33.

Fisher, K. E., Erdelez, S., & McKechnie, L. (Eds.). (2005). *Theories of information behavior*. Information Today, Inc..

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. AMBIO: *A journal of the human environment, 31*(5), 437-440.

Folke, C., Hahn, T., Olsson, P., Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources 30*, 441–473.
Frangoudes, K., & Gerrard, S. (2018). (En) Gendering change in small-scale fisheries and fishing communities in a globalized world. *Maritime Studies*, *17*(2), 117-124.
Frangoudes, K., & Gerrard, S. (2019). Gender perspective in fisheries: examples from the South and the North. *Transdisciplinarity for small-scale fisheries governance: Analysis and practice*, 119-140.
Friedman, B. M. (2005). *The Moral Consequences of Economic Growth*. Knopf.
Galappaththi, M., Armitage, D., & Collins, A. M. (2022). Women's experiences in influencing and shaping small-scale fisheries governance. *Fish and Fisheries*, *23*(5), 1099-1120.
Garcia, S.M. and Cochrane, K.L. (2005). Ecosystem approach to fisheries: a review of implementation guidelines. *ICES Journal of Marine Science 62*, 311–318.
Ghosh, A., Schmidt, S., Fickert, T., & Nüsser, M. (2015). The Indian Sundarban mangrove forests: history, utilization, conservation strategies and local perception. *Diversity*, *7*(2), 149-169.
Glaser, M., Krause, G., Oliveira, R. S., & Fontalvo-Herazo, M. (2010). Mangroves and people: A social-ecological system. In *Mangrove dynamics and management in North Brazil* (pp. 307-351). Springer, Berlin, Heidelberg.
Goldfrank, W. L. (2000). Paradigm Regained? The Rules Of Wallerstein? s World-System Method. *Journal of world-systems research*, 150-195.
Gopal, B., & Chauhan, M. (2018). The transboundary Sundarbans mangroves (India and Bangladesh). *The Wetland Book: II: Distribution, Description, and Conservation*, 1733-42.
GOW, Gazette Notification No. 718 and 719, Govt. of West Bengal, (2013). The Gazette notifications of amendments on hilsa fishery, April, 2014. Fisheries Department, Government of West Bengal, 2013.
Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse education today*, *24*(2), 105-112.
Greenbaum, T. L. (1993). *The handbook of focus group research*. Lexington Books.
Haberl, H., Fischer-Kowalski, M., Krausmann, F., Martinez-Alier, J., & Winiwarter, V. (2011). A socio-metabolic transition towards sustainability? Challenges for another Great Transformation. *Sustainable development, 19*(1), 1-14.
Harper, S., Adshade, M., Lam, V. W., Pauly, D., & Sumaila, U. R. (2020). Valuing invisible catches: Estimating the global contribution by women to small-scale marine capture fisheries production. *PLoS One*, *15*(3), e0228912.
Hassan, K., Higham, J., Wooliscroft, B., & Hopkins, D. (2019). Climate change and world heritage: A cross-border analysis of the Sundarbans (Bangladesh–India). *Journal of Policy Research in Tourism, Leisure and Events*, *11*(2), 196-219.
Herod, A. (2014). 1 Globalisation: An overview. *The companion to development studies*, 183-187.
Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference?. *Environmental innovation and societal transitions*, *27*, 1-3.
Horlings, L. G., Nieto-Romero, M., Pisters, S., & Soini, K. (2020). Operationalising transformative sustainability science through place-based research: the role of researchers. *Sustainability Science*, *15*, 467-484.

Hossain, M. S., Sharifuzzaman, S. M., Rouf, M. A., Pomeroy, R. S., Hossain, M. D., Chowdhury, S. R., & Uddin, S. A. (2019). Tropical hilsa shad (*Tenualosa ilisha*): Biology, fishery and management. *Fish and Fisheries, 20*(1), 44-65.

ILO (2011) *Sustainable Fishing: Decent Working Conditions, Safety and Social Protection*. Rural Policy Brief, International Labour Organization, Geneva, 4 pp.

Imperial, M. T. (1999). Institutional analysis and ecosystem-based management: the institutional analysis and development framework. *Environmental Management, 24*(4), 449-465.

Inglehart, R., & Welzel, C. (2007). Modernization. *The Blackwell encyclopedia of sociology*.

Islam, M. M., & Chuenpagdee, R. (2022). Towards a classification of vulnerability of small-scale fisheries. *Environmental Science & Policy*, *134*, 1-12.

Islam, M. M., and M. M. Hossain. 2017. Community Dependency on the Ecosystem Services from the Sundarbans Mangrove Wetland in Bangladesh. In *Wetland Science* (pp. 301-316). Springer India.

Islam, M. M., Pal, S., Hossain, M. M., Mozumder, M. M. H., & Schneider, P. (2020). Coastal ecosystem services, social equity, and blue growth: A case study from south-eastern Bangladesh. *Journal of marine science and engineering*, *8*(10), 815.

Islam, M. M., Rahman, M. A., Paul, B., & Khan, M. I. (2020). Barriers to climate change adaptation: insights from the Sundarbans mangrove-based fisheries of Bangladesh. *Asian Fisheries Science*, *33*(2), 175-186.

Islam, M. M., Shamsuzzaman, M. M., Mozumder, M. M. H., Xiangmin, X., Ming, Y., Jewel, M. A. S. (2017). Exploitation and conservation of coastal and marine fisheries in Bangladesh: do the fishery laws matter? Mar. Pol. 76, 43–151. http://dx.doi.org/10. 1016/j.marpol.2016.11.026.

Islam, M. M., Sunny, A. R., Hossain, M. M., & Friess, D. A. (2018). Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. *Singapore Journal of tropical geography*, *39*(2), 244-265.

Ison, R., & Straw, E. (2020). *The hidden power of systems thinking: Governance in a climate emergency*. Routledge.

Jentoft, S. (2017). Small-scale fisheries within maritime spatial planning: knowledge integration and power. *Journal of Environmental Policy & Planning*, *19*(3), 266-278.

Jentoft, S., & Chuenpagdee, R. (2009). Fisheries and coastal governance as a wicked problem. *Marine policy, 33*(4), 553-560.

Jentoft, S., & Chuenpagdee, R. (2015). Assessing governability of small-scale fisheries. In Interactive governance for small-scale fisheries (pp. 17-35). Springer, Cham.

Jentoft, S., & Chuenpagdee, R. (2015). Interactive governance for small-scale fisheries. *Global Reflections. Dordrecht, MA: Springer*.

Jentoft, S., & Chuenpagdee, R. (2022). Interactive learning and governance transformation for securing blue justice for small-scale fisheries. *Administration & Society*, *54*(7), 1255-1282.

Jentoft, S., & Chuenpagdee, R. (2024). Roles of Institutions for the Governability of Small-Scale Fisheries. In *Implementation of the Small-Scale Fisheries Guidelines: A Legal and Policy Scan* (pp. 13-28). Cham: Springer Nature Switzerland.

Jentoft, S., Onyango, P., & Islam, M. M. (2010). Freedom and poverty in the fishery commons. *International Journal of the Commons, 4*(1).

Jorgensen, D.L. (1989). *Participant Observation: A Methodology for Human Studies*. Applied Social Research Methods Series, Volume 15. Sage Publications, London.

Kapembwa, S., Gardiner, A., & Pétursson, J. G. (2021). Small-scale fishing: Income, vulnerability and livelihood strategies at Lake Itezhi-Tezhi, Zambia. *Development Southern Africa*, *38*(3), 331-352.
Kaplan, B. (1993). *Social Change in the Capitalist World*. Beverly Hills, California: SAGE.
Kathijotes, N., Alam, L., & Kontou, A. (2015). Aquaculture, coastal pollution and the environment. *Aquaculture Ecosystems: Adaptability and Sustainability*, 139-163.
Kawarazuka, N., Locke, C., McDougall, C., Kantor, P., & Morgan, M. (2017). Bringing analysis of gender and social–ecological resilience together in small-scale fisheries research: Challenges and opportunities. *Ambio*, *46*(2), 201-213.
Khan, M. F. A. K., Rahman, M. S., Maryudi, A., Schusser, C., & Giessen, L. (2024). Revealing the Multilevel Actors Power Network in Mangrove Forest Governance-Insights from the Sundarbans, Bangladesh. *Forest and Society*, *8*(2), 372-401.
Kolding, J., Béné, C., & Bavinck, M. (2014). Small-scale fisheries: Importance, vulnerability and deficient knowledge. *Governance of marine fisheries and biodiversity conservation: Interaction and coevolution*, 317-331.
König, A. (2015). Changing requisites to universities in the 21st century: organizing for transformative sustainability science for systemic change. *Current Opinion in Environmental Sustainability*, *16*, 105-111.
Kooiman, J. (1993). *Modern governance: New government–society interactions*. London, UK: Sage Publications.
Kooiman, J. (2008). Exploring the concept of governability. Journal of Comparative Policy Analysis: *Research and Practice, 10*(2), 171-190.
Kooiman, J., & Bavinck, M. (2013). Theorizing governability–The interactive governance perspective. *Governability of fisheries and aquaculture: Theory and applications*, 9-30.
Kooiman, J., Bavinck, M., Jentoft, S., & Pullin, R. (2005). *Fish for Life: Interactive Governance for Fisheries*. Amsterdam University Press.
Kosamu, I. B. (2015). Conditions for sustainability of small-scale fisheries in developing countries. *Fisheries Research*, *161*, 365-373.
Lam, M. E., & Pitcher, T. J. (2012). The ethical dimensions of fisheries. *Current Opinion in Environmental Sustainability*, *4*(3), 364-373.
Lekshmi, P. S., Radhakrishnan, K., Narayanakumar, R., Vipinkumar, V. P., Parappurathu, S., Salim, S. S., ... & Pattnaik, P. (2022). Gender and small-scale fisheries: Contribution to livelihood and local economies. *Marine Policy*, *136*, 104913.
Lemos, M. C., and A. Agrawal. 2006. Environmental governance. Annual Review of Environment and Resources 31:297-325. http:// dx.doi.org/10.1146/annurev.energy.31.042605.135621
Lentisco, A., & Lee, R. U. (2015). A review of women's access to fish in small-scale fisheries. *FAO Fisheries and Aquaculture Circular*, (C1098), I.
Li, Y., & Zhang, S. (2022). *Applied Research Methods in Urban and Regional Planning*. Springer.
Lubell, M., & Robbins, M. (2022). Adapting to Sea-Level Rise: Centralization or Decentralization in Polycentric Governance Systems?. *Policy Studies Journal, 50*(1), 143-175.
Manna, S., Chaudhuri, K., Bhattacharyya, S., & Bhattacharyya, M. (2010). Dynamics of Sundarban estuarine ecosystem: eutrophication induced threat to mangroves. *Saline systems*, *6*, 1-16.

Martínez-Vela, C. A. (2001). *World systems theory. Engineering system division*, 83, 1-5.
Mason, J. (2004). Semi-Structured Interview. In M. S. Lewis-Beck, A. Bryman, & T. M. Liao (Eds.). *The SAGE Encyclopedia of Social Science Research Methods*, Volume 3 (pp. 1020–1022). doi:10.4135/9781412950589
Mathias, J. D., Anderies, J. M., Baggio, J., Hodbod, J., Huet, S., Janssen, M. A., ... & Schoon, M. (2020). Exploring non-linear transition pathways in social-ecological systems. *Scientific reports*, *10*(1), 1-12.
McClanahan, T. R., Castilla, J. C., White, A. T., & Defeo, O. (2009). Healing small-scale fisheries by facilitating complex socio-ecological systems. *Reviews in Fish Biology and Fisheries*, *19*, 33-47.
McGinnis, M. D. (1999). *Polycentric governance and development: Readings from the workshop in political theory and policy analysis*. University of Michigan Press.
McGinnis, M. D., and Ostrom, E. (2011). Reflections on Vincent Ostrom, Public Administration, and Polycentricity. *Public Administration Review 72* (1): 15–25.
McGregor, A. (2008). *Well-Being, Poverty and Conflict*. Briefing Paper 1/08, ESRC Research Group on Wellbeing in Developing Countries, University of Bath, Bath, UK.
Merayo, E., Myint, K. T., Ei, T., Khine, M., Aye, P. T., Thwe, T. L., Leemans, K., Soe, K. M., Akester, M., Bladon, A., and Mohammed, E. Y. (2020). Migratory patterns of Hilsa shad in the Myanmar Ayeyarwady delta: lessons for fisheries management. IIED Working Paper, IIED, London.
Meyer, J. W. (2007). Globalization: Theory and trends. *International Journal of Comparative Sociology*, *48*(4), 261-273.
Mitchell, B. (1976). Politics, fish, and international resource management: The British-Icelandic cod war. *Geographical Review*, 127-138.
Mollick, A. S., Roy, M., Khan, N. I., Islam, W., Sadath, N., & Nath, T. K. (2022). Assessing good governance in protected areas (PA) co-management: a case study of the Sundarbans Mangrove Forests of Bangladesh. *Journal of Sustainable Forestry*, *41*(3-5), 277-301.
Morgan, D. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research, 1*(1), 48-76.
Mozumder, M. M. H., Pyhälä, A., Wahab, M. A., Sarkki, S., Schneider, P., & Islam, M. M. (2020). Governance and power dynamics in a small-scale hilsa shad (Tenualosa ilisha) fishery: A case study from Bangladesh. *Sustainability*, *12*(14), 5738.
Mozumder, M. M. H., Shamsuzzaman, M. M., Rashed-Un-Nabi, M., & Karim, E. (2018). Social-ecological dynamics of the small scale fisheries in Sundarban Mangrove Forest, Bangladesh. *Aquaculture and Fisheries*, *3*(1), 38-49.
Mudliar, P. (2021). Polycentric to monocentric governance: Power dynamics in Lake Victoria's fisheries. *Environmental Policy and Governance, 31*(4), 302-315.
Mudliar, P., & O'Brien, L. (2021). Crowding-out lower-level authorities: Interactions and transformations of higher and lower-level authorities in Kenya's polycentric fisheries. *Environmental Science & Policy, 118*, 27-35.
Nayak, P. K. (2022). Making sense of multidimensional injustice for creating viable small-scale fisheries in chilika lagoon, bay of Bengal. In *Blue justice: small-scale fisheries in a sustainable ocean economy* (pp. 199-212). Cham: Springer International Publishing.
Nayak, P. K., & Armitage, D. (2018). Social-ecological regime shifts (SERS) in coastal systems. *Ocean & Coastal Management*, *161*, 84-95.

Nayak, P. K., & Berkes, F. (2019). Interplay between local and global: Change processes and small-scale fisheries. In *Transdisciplinarity for Small-Scale Fisheries Governance* (pp. 203-220). Springer, Cham.

Ngulube, P., Mathipa, E. R., & Gumbo, M. T. (2015). Theoretical and conceptual frameworks in the social and management sciences. *Addressing research challenges: Making headway in developing researchers*, *2015*, 43-66.

Nolan, P. & Lenski, G. (1999). *Human Societies: An Introduction to Macrosociology*, 8th edn. McGraw-Hill, New York.

Nyikahadzoi, K., Mhlanga, W., Madzudzo, E., Tendaupenyu, I., & Silwimba, E. (2017). Dynamics of transboundary governance and management of small scale fisheries on Lake Kariba: Implications for sustainable use. *International Journal of Environmental Studies*, *74*(3), 458-470.

O'Neill, E. D., & Crona, B. (2017). Assistance networks in seafood trade–a means to assess benefit distribution in small-scale fisheries. *Marine Policy*, *78*, 196-205.

Oakerson, R.J. (1992) Analyzing the commons: a framework. In Bromley, D. (edit). *Making the commons work: theory, practice and policy*. ICS Press, San Fransisco. p. 41–59.

Österblom, H., Sissenwine, M., Symes, D., Kadin, M., Daw, T., & Folke, C. (2011). Incentives, social–ecological feedbacks and European fisheries. *Marine Policy*, *35*(5), 568-574.

Ostrom E. 1996. Crossing the great divide: coproduction, synergy, and development. *World Dev. 24*(6):1073–87.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, 325*(5939), 419-422.

Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *American economic review*, *100*(3), 641-72.

Ostrom, V. 1991. *The Meaning of American Federalism*. San Francisco: Institute for Contemporary Studies Press.

Owusu, V. (2019). Impacts of the petroleum industry on the livelihoods of fisherfolk in Ghana: A case study of the Western Region. *The Extractive Industries and Society*, *6*(4), 1256-1264.

Parlee, C. E., Foley, P., Gomez, M. A. L., Miah, M. R., Mather, C., & Stephenson, R. L. (2021). Full spectrum sustainability and a theory of access: Integrating social benefits into fisheries governance. *Marine Policy*, 134, 104764.

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., ... & Van Assche, K. (2020). Environmental governance theories: a review and application to coastal systems.

Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2016. Exploring the governance and politics of transformations towards sustainability. *Environ. Innov. Soc. Transit*. http://dx.doi.org/10.1016/j.eist.2016.09.001.

Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.

Pauly, D. (1997). Small-scale fisheries in the tropics: marginality, marginalization, and some implications for fisheries management. *Global trends: fisheries management*, 20, 40-49.

Pennell, C. P., Hirst, A. D., Campbell, W. B., Sood, A., Agha, R. A., Barkun, J. S. T., & McCulloch, P. (2016). Practical guide to the idea, development and exploration stages of

the IDEAL framework and recommendations. *Journal of British Surgery*, *103*(5), 607-615.
Pethick, J., & Orford, J. D. (2013). Rapid rise in effective sea-level in southwest Bangladesh: Its causes and contemporary rates. *Global and Planetary Change*, *111*, 237-245.
Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Research synthesis methods*, *5*(4), 371-385.
Phelan, A., Ross, H., Adhuri, D. S., & Richards, R. (2023). Equity in a sea of debt: how better understanding of small-scale fisheries can help reel in sustainable seafood. *ICES Journal of Marine Science*, *80*(8), 2222-2232.
Pieterse, J. N. (2010). *Development theory*. Sage.
Pittman, J., Hurlbert, M., Hadarits, M. and Corkal, D. (2016). Bridging knowledge systems for drought preparedness: Case study from the Swift Current Creek Watershed (Canada). In Diaz, H., Warren, J. and Hurlbert, M. (Eds.) *Vulnerability and Adaptation to Drought on the Canadian Prairies*. Calgary: University of Calgary Press.
Plummer, R., & Fitzgibbon, J. (2004). Co-management of natural resources: a proposed framework. *Environmental management, 33*(6), 876-885.
Potter, R. B. (2014a). 3 The nature of development studies. *The companion to development studies*, 38-42.
Potter, R. B. (2014b). 1 Theories, strategies and ideologies of development: An overview. *The companion to development studies*, 105-109.
Quaas, M. F., Stoeven, M. T., Klauer, B., Petersen, T., & Schiller, J. (2018). Windows of opportunity for sustainable fisheries management: the case of Eastern Baltic cod. *Environmental and Resource Economics*, *70*, 323-341.
Raha, A. K., Zaman, S., Sengupta, K., Bhattacharyya, S. B., Raha, S., Banerjee, K., & Mitra, A. (2013). Climate change and sustainable livelihoood programme: a case study from Indian Sundarbans. *J Ecol*, *107*(335348), 64.
Rahman, M. J., Wahab, M. A., Nahiduzzaman, M., Haque, A. B. M. M., & Cohen, P. (2020). Hilsa fishery management in Bangladesh. *In IOP Conference Series: Earth and Environmental Science* (Vol. 414, No. 1, p. 012018). IOP Publishing.
Rahman, M. M. (2022). Is co-management a double-edged sword in the protected areas of Sundarbans mangrove?. *Biology & Philosophy*, *37*(1), 4.
Rahman, M. M., Chongling, Y., Islam, K. S., & Haoliang, L. (2009). A brief review on pollution and ecotoxicologic effects on Sundarbans mangrove ecosystem in Bangladesh. *International Journal of Environmental Engineering*, *1*(4), 369-383.
Rahman, M., Hossain, M. R., & Islam, M. N. (2021). Climate Change Impact on Sundarbans: Challenges for Mitigation Strategies. *Climate Change in Bangladesh: A Cross-Disciplinary Framework*, 47-64.
Rahman, M., S. M. Haque, A. Wahab, H. Egna, and C. Brown. 2018. Soft-Shell Crab Production in Coastal Bangladesh: Prospects, Challenges and Sustainability. *World Aquaculture*, 43–47(September).
Ratner, B. D., Åsgård, B., & Allison, E. H. (2014). Fishing for justice: Human rights, development, and fisheries sector reform. *Global Environmental Change*, *27*, 120-130.
Ray, D. (1998). *Development economics*. Princeton, NJ: Princeton University Press.

Reis-Filho, J. A., Hatje, V., & Barros, F. (2024). Navigating blue justice: Policy gaps and conflicts in coastal development from small-scale fisher perspectives. *One Earth*, *7*(10), 1786-1802.

Rezwan, (2019). 1/6/2021 'Conservation or community rights'? Bangladesh bans fishing for 65 days. Global Voices, May 26, 2019.

Ribot, J. C., & Peluso, N. L. (2003). A theory of access. *Rural sociology, 68*(2), 153-181.

Rittel, H.W.J., & Webber, M.M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155–169.

Rodrigues, J. G., & Villasante, S. (2016). Disentangling seafood value chains: Tourism and the local market driving small-scale fisheries. *Marine Policy*, 74, 33-42.

Rossman, G. B. and Wilson, B. L. (1985). Number and Words: Combining quantitative and qualitative methods in a single large-scale evolution study. *Evaluation Review, 9*(5) 627-643.

Rostow, W. W., & Rostow, W. W. (1990). *The stages of economic growth: A non-communist manifesto*. Cambridge university press.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*.

Roy, A., Manna, R. K., Ghosh, S., Sahu, S. K., & Das, B. K. (2023). Assessment of women's contribution in small-scale fisheries in Indian Sundarbans: Issues, strategies, and way forward for sustainability. *Fisheries Management and Ecology*, *30*(4), 378-391.

Russell, D. A., & VanderZwaag, D. L. (Eds.). (2010). *Recasting transboundary fisheries management arrangements in light of sustainability principles: Canadian and international perspectives* (Vol. 8). Brill.

Sabau, G. (2017). Costa Rica: a champion of the small-scale fisheries guidelines. *The Small-Scale Fisheries Guidelines: Global Implementation*, 355-378.

Said, A., & Chuenpagdee, R. (2019). Aligning the sustainable development goals to the small-scale fisheries guidelines: A case for EU fisheries governance. *Marine Policy*, *107*, 103599.

Said, A., & MacMillan, D. (2020). 'Re-grabbing' marine resources: a blue degrowth agenda for the resurgence of small-scale fisheries in Malta. *Sustainability Science*, *15*(1), 91-102.

Salas, S., Barragán-Paladines, M. J., & Chuenpagdee, R. (Eds.). (2018). *Viability and sustainability of small-scale fisheries in Latin America and the Caribbean* (Vol. 19). Springer.

Salik, K. M., Jahangir, S., & ul Hasson, S. (2015). Climate change vulnerability and adaptation options for the coastal communities of Pakistan. *Ocean & coastal management*, *112*, 61-73.

Salomon, M., Markus, T., & Dross, M. (2014). Masterstroke or paper tiger–The reform of the EU′ s Common Fisheries Policy. *Marine Policy*, *47*, 76-84.

Sarker, S. K., Reeve, R., Paul, N. K., & Matthiopoulos, J. (2019). Modelling spatial biodiversity in the world's largest mangrove ecosystem—The Bangladesh Sundarbans: A baseline for conservation. *Diversity and Distributions*, *25*(5), 729-742.

Schlüter, M., Lindkvist, E., & Basurto, X. (2021). The interplay between top-down interventions and bottom-up self-organization shapes opportunities for transforming self-governance in small-scale fisheries. *Marine Policy*, *128*, 104485.

Scholtens, J. (2015). Limits to the governability of transboundary fisheries: implications for small-scale fishers in northern Sri Lanka and beyond. *Interactive governance for small-scale fisheries: Global reflections*, 515-536.
Scholtens, J., & Bavinck, M. (2014). Lessons for legal pluralism: Investigating the challenges of transboundary fi sheries governance. *Current Opinion in Environmental Sustainability, 11*, 10–18.
Scholtens, J., Song, A. M., Stephen, J., Chavez, C. G., Bavinck, M., & Sowman, M. (2019). Transdisciplinary engagement to address transboundary challenges for small-scale fishers. In *Transdisciplinarity for Small-Scale Fisheries Governance* (pp. 321-340). Springer, Cham.
Schreiber, M. A., Chuenpagdee, R., & Jentoft, S. (2022). Blue Justice and the co-production of hermeneutical resources for small-scale fisheries. *Marine Policy*, *137*, 104959.
Schuhbauer, A., Chuenpagdee, R., Cheung, W. W., Greer, K., & Sumaila, U. R. (2017). How subsidies affect the economic viability of small-scale fisheries. *Marine Policy*, *82*, 114-121.
Schuurman, F. J. (2007). *Development studies: Work in progress*.
Schuurman, F. J. (2014). 4 The impasse in development studies. In *The companion to development studies* (pp. 43-46). Routledge.
Scoones, I. 1998. *Sustainable rural livelihoods: a framework for analysis*. IDS working paper, 72. Brighton: IDS.
Seidensticker, J., & Hai, M. A. (1983). The Sundarbans wildlife management plan: conservation in the Bangladesh coastal zone. Gland: IUCN; 1983. p. 120.
Seidensticker, J., Kurin, R., & Townsend, A. K. (1987, November). The commons in South Asia: societal pressures and environmental integrity in the Sundarbans of Bangladesh. In *Proceedings from a workshop held November* (pp. 20-21).
Selgrath, J. C., Gergel, S. E., & Vincent, A. C. (2018). Shifting gears: Diversification, intensification, and effort increases in small-scale fisheries (1950-2010). *PLoS One*, *13*(3), e0190232.
Sen, A.K. (1999). *Development as Freedom*. Oxford, Oxford University Press.
Shrivastava, P., Smith, M. S., O'Brien, K., & Zsolnai, L. (2020). Transforming sustainability science to generate positive social and environmental change globally. *One Earth*, *2*(4), 329-340.
Siddique, M. R., Hossain, M., Rashid, A. M., Khan, N. A., Shuvo, S. N., & Hassan, M. Z. (2024). Evaluating co-management in the Sundarbans mangrove forest of Bangladesh: success and limitations from local forest users' perspectives. *Ecology and Society*, *29*(2).
Silverman, D. (2005) *Doing Qualitative Research,* 2nd edn. Sage Publications, London.
Simpson, J. A. and Weiner, E.S.C. 1989. *The Oxford English Dictionary*. 2nd ed. Volume 2. Oxford, UK: Clarendon Press.
Singh, S. (2003). *In the Sea of Influence: A World System Perspective of the Nicobar Islands* (Doctoral dissertation, Lund University).
Singh, S. J. (2010). Introduction: The 'Nature' of Development Studies. *Journal für Entwicklungspolitik*, *26*(4), 4-13.
Singh, S., & Eisenmenger, N. (2010). How unequal is international trade? An ecological perspective using material flow accounting (MFA). *J. Entwickl*, *26*, 57-88.
Singh, Y. (2018). *Modernization of Indian tradition*. Rawat Publications.

Smith, H. D. (2000). The industrialization of the world ocean. *Ocean & Coastal Management*, *43*, millenium essay, 11–28.
Smith, H., & Basurto, X. (2019). Defining small-scale fisheries and examining the role of science in shaping perceptions of who and what counts: a systematic review. *Frontiers in Marine Science*, *6*, 236.
Song, A. M., Scholtens, J., Stephen, J., Bavinck, M., & Chuenpagdee, R. (2017). Transboundary research in fisheries. *Marine Policy*, *76*, 8-18.
Tashakkori, A. and Teddlie, C. (Eds.) (2010). *SAGE handbook of mixed methods in social and behavioral research* (2nd ed.) Thousand Oak, CA: Sage.
Thủy, P. T. T., Flaaten, O., & Skonhoft, A. (2019). Middlemen: good for resources and fishermen?. *Environment and Development Economics*, *24*(5), 437-456.
Tilley, A., Hunnam, K. J., Mills, D. J., Steenbergen, D. J., Govan, H., Alonso-Poblacion, E., ... & Cohen, P. J. (2019). Evaluating the fit of co-management for small-scale fisheries governance in Timor-Leste. *Frontiers in Marine Science*, *6*, 392.
Todaro, M., & Smith, S. (2012). What Do We Mean by Development?. *Economic development*, 14-25.
Toonen, H. M., & van Tatenhove, J. P. (2020). Uncharted territories in tropical seas? Marine scaping and the interplay of reflexivity and information. *Maritime Studies*, *19*, 359-374.
Tricco, A. C., Lillie, E., Zarin, W., O'brien, K., Colquhoun, H., Kastner, M., ... & Straus, S. E. (2016). A scoping review on the conduct and reporting of scoping reviews. *BMC medical research methodology*, *16*, 1-10.
Van der Waldt, G. (2020). Constructing conceptual frameworks in social science research. *TD: The Journal for Transdisciplinary Research in Southern Africa*, *16*(1), 1-9.
Van Hoof, L., Steins, N. A., Smith, S., & Kraan, M. (2020). Change as a permanent condition: A history of transition processes in Dutch North Sea fisheries. *Marine Policy*, *122*, 104245.
Visbeck, M., Kronfeld-Goharani, U., Neumann, B., Rickels, W., Schmidt, J., Van Doorn, E., ... & Quaas, M. F. (2014). Securing blue wealth: The need for a special sustainable development goal for the ocean and coasts. *Marine Policy*, *48*, 184-191.
Vivekanandan, J. (2021). Scratches on our sovereignty?: Analyzing conservation politics in the Sundarbans. *Regions and Cohesion*, *11*(1), 1-20.
Wade, E., & Biedenweg, K. (2024). Trade-offs in fishing strategy decisions and conservation implications for small-scale fisheries. *Environmental Conservation*, *51*(3), 179-187.
Wallerstein, I. (1974). *The modern World System I: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. New York: Academic Press.
Wallerstein, I. (1976). *The modern world-system I: Capitalist agriculture and the origins of the European world-economy in the sixteenth century* (Vol. 1). Univ of California Press. Chirot, D., & Hall, T. D. (1982). World-system theory. *Annual Review of sociology*, 81-106.
Wang, G. G., Korte, R. F., & Sun, J. Y. (2008). Development economics: A foundation for HRD policy studies in developing countries. *Advances in Developing Human Resources, 10*(6), 848-862.
Weeratunge, N., Béné, C., Siriwardane, R., Charles, A., Johnson, D., Allison, E. H., ... & Badjeck, M. C. (2014). Small-scale fisheries through the wellbeing lens. *Fish and Fisheries*, *15*(2), 255-279.
White, C., and Costello, C. (2014). Close the high seas to fishing?. *PLoS Biol, 12*(3), e1001826.

White, S. B., & Scheld, A. M. (2022). Characterizing Changes in Participation and Diversification in Small-Scale Fisheries of Virginia, USA. *Coastal Management*, *50*(1), 3-28.

Ziai, A. (2007). The Meaning of Development': A Critical Poststructuralist Perspective. *Journal Fur Entwicklungspolitik*, *23*(2), 64.

Appendices

A.1 Information letter

Information Letter: Household Survey

Date: _____

Study Title: Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems

Supervisor: Dr. Prateep Nayak, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Office EV3 4231. [redacted]

Student Researcher: Md. Ruyel Miah, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Email: [redacted]

Dear Resident:

This letter explains what the study is about, possible risks and benefits, and your rights as a research participant. You may print/save a copy for your records. If you do not understand something in the letter, please ask the researcher before consenting to participate.

My name is Md. Ruyel Miah, and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development, University of Waterloo, Canada. As part of my doctoral dissertation, I am conducting research under the supervision of Dr. Prateep Nayak. This study is not a work/employer or government requirement.

I am inviting you to voluntarily participate in an in-person survey and answer some questions about your demographic information, the vulnerabilities of small-scale fisheries, the governance system, and the institutions involved in the transboundary Sundarbans social-ecological systems. This study intends to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability.

Completion of the survey should take no more than 60 minutes. Your participation in this project is entirely voluntary, and your identity will be confidential. You are free to withdraw your participation from the study for up to one month after the survey. There will be no negative consequences for withdrawing your participation from the study. You can skip any questions that you do not wish to answer, or that may identify you, with no need to clarify why you will skip the question to the researcher. You can stop/end the survey session at any time; any data collected from you up until that point will be deleted and destroyed. If you choose to withdraw

within one month after data collection has ended, the data collected from you will be removed from the study. After one month, the data can no longer be removed, and as a result, your anonymized transcripts will be included for analysis. The data collected from this survey will be kept in my supervisor's office/lab at the University of Waterloo for a period of at least seven years. Only me and my supervisor will have access to the data.

When results are reported, it is possible that others may be able to ascertain your identity as the community in transboundary small-scale fisheries is small. You may decline to answer any questions you feel you do not wish to answer and may decline to contribute to the survey in other ways if you so wish. Your identity will be confidential. Your name will not be identified with the input you give to this survey. Further, you will not be identified by name in the report that is produced for this survey. Some of the questions may be sensitive as questions ask about their vulnerabilities, gender, and income status. If any participant feels upset during the survey process, I will skip the relevant questions.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions, or if you would like additional information to help you make a decision about participation, please feel free to raise them now.

If you would like to receive a summary of the findings from this study, please provide your contact information, which will be kept confidential, to me or contact my supervisor, Professor Prateep Nayak, at [redacted].

Yours Sincerely,

Md. Ruyel Miah

PhD Candidate,
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo, Canada.

Information Letter: Interviews

Date: _____

Study Title: Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems

Supervisor: Dr. Prateep Nayak, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Office EV3 4231. Email: [redacted]

Student Researcher: Md. Ruyel Miah, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Email: [redacted]

This letter explains what the study is about, what participation involves, possible risks and benefits, and your rights as a research participant. You may print/save a copy for your records. If you do not understand something in the letter, please ask one of the investigators before consenting to participate.

My name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems" for my doctoral degree under the supervision of Dr. Prateep Nayak. The study intends to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability.

Therefore, I would like to include you as one of several interview participants in my study. I believe that because you are actively involved in the transboundary Sundarbans social-ecological system with your current role, you are best suited to speak to the various issues, such as vulnerabilities of small-scale fisheries, the governance system, and the institutions involved in the transboundary Sundarbans social-ecological systems.

Participation in this study is voluntary. It will involve an interview of approximately 60 minutes in length to take place in a mutually agreed upon location. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. If you wish to withdraw your study data after participating, please contact the researchers. You can request your data be removed from the study up until a month after the interview, as it is not possible to withdraw your data once papers and publications have been submitted to publishers. Also, please note that this research offers 500 BDT ($6.5 CAD) cash for small-scale fisher participants as an appreciation of their time for the interview **[**Only for fisher participants**]**.

With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. Data collected during this study will be kept in my supervisor's office/lab at the University of Waterloo for a period of at least seven years, to which only researchers associated with this project will have access.

When results are reported, it is possible that others may be able to ascertain your identity as the community in transboundary small-scale fisheries is small. You may decline to answer any questions you feel you do not wish to answer and may decline to contribute to the interview in other ways if you so wish. Your identity will be confidential. Your name will not appear in any dissertation or report resulting from this study, however, with your permission, anonymous quotations may be used. Some of the questions may be sensitive as questions ask about their vulnerabilities, gender, and income status. If any participant feels upset during the interview process, I will skip the relevant questions.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions or if you would like additional information to assist you in reaching a decision about participation, please contact me by email at mrmiah@uwaterloo.ca. You can also contact my supervisor, Professor Prateep Nayak, at [redacted].

I hope that the results of my study will be of benefit to those directly involved in the study, others not directly involved in the study, as well as to the broader research community.

I very much look forward to speaking with you, and thank you in advance for your assistance in this project.

Yours Sincerely,

Md. Ruyel Miah

PhD Candidate,
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo, Canada.

Information Letter: Focus group discussion

Date: _____

Study Title: Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems

Supervisor: Dr. Prateep Nayak, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Office EV3 4231. Email: [redacted]

Student Researcher: Md. Ruyel Miah, School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Canada. Email: [redacted]

This letter explains what the study is about, possible risks and benefits, and your rights as a research participant. You may print/save a copy for your records. If you do not understand something in the letter, please ask one of the investigators before consenting to participate.

You are invited to participate in a focus group discussion session with other participants, including representatives from fishing communities, government officials, non-government officials, local traders, community leaders, and law enforcement agencies. The duration of the focus group discussion session will not be more than 90 minutes.

The participants will discuss developing a good understanding of the vulnerabilities that small-scale fisheries face and finding out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. The participants will also discuss and analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. Participation in this session is voluntary and involves discussing the issues associated with the role of governance in facilitating small-scale fisheries' vulnerability to viability transition. The session will be facilitated by Md. Ruyel Miah, Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada.

When results are reported, it is possible that others may be able to ascertain your identity as the community in transboundary small-scale fisheries is small. Some of the questions may be sensitive as questions ask about their vulnerabilities, gender, and income status. If any participant feels upset during the focus group discussion, I will skip the relevant questions. During the focus group discussion, the sensitive nature of the questions may sometimes cause short-term anxiety to some participants. In that case, I will follow up with the participants and will connect them with the appropriate mental health department if required. Please note that I will not be able to guarantee that focus group participants will keep what was said in the focus group confidential.

You may decline answering any questions you feel you do not wish to answer and may decline contributing to the session in other ways if you so wish. Your identity will be confidential. Your name will not be identified with the input you give to this session. Further, you will not be

identified by name in the report that is produced for this session. The information collected from this session will be kept in my supervisor's office/lab at the University of Waterloo for a period of at least seven years.

If you wish to withdraw your study data after participating, please contact the researchers. You can request your data be removed from the study up until one month after the session is held, as it is not possible to withdraw your data once papers and publications have been submitted to publishers.

Given the group format of this session, the researcher will ask you to keep in confidence information that identifies or could potentially identify a participant and/or their comments. If you have any questions about participation in this session, please feel free to discuss these with the facilitator or later by contacting Professor Prateep Nayak at [redacted]. If you are interested in receiving a copy of the executive summary of the session outcomes, please contact the researcher or Professor Prateep Nayak**.**

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions contact the researcher, Md. Ruyel Miah by email at mrmiah@uwaterloo.ca.

In appreciation of your time given to this session, this research offers 500 BDT ($6.5 CAD) cash for all the participants.

Yours sincerely,

Md. Ruyel Miah

PhD Candidate,
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo, Canada.

A.2 Recruitment form

Recruitment Script

My name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems" for my doctoral degree under the supervision of Dr. Prateep Nayak. The purpose of this study is to develop a comprehensive understanding of small-scale fisheries' vulnerability to viability (V2V) transition and identify the key characteristics of governance arrangements that can help facilitate the transition in the Sundarbans transboundary small-scale fisheries social-ecological systems (SESs). This study is not a work/employer or government requirement.

I am contacting you to invite you to participate in an interview or survey, or focus group discussions and discuss some general questions about the vulnerabilities of small-scale fisheries, the governance system, the institutions involved, and governability in the transboundary Sundarbans social-ecological systems. The interview or survey, or focus group discussions will last about one and a half an hour.

The target participants are people with experience, knowledge and familiarity with small-scale fisheries-related activities in the Sundarbans. These include people involved directly or indirectly in fishing, fisheries policy, fish processing, fish buying, fish selling and marketing, management of the markets, and certification and traceability initiatives. There is no restriction to participate except that participants must be of legal age (i.e. older than 19).

Your participation in this project is entirely voluntary, and your responses will be kept anonymous and confidential. You will not be identified by your name in any written report or publication resulting from this research. You are free to withdraw your participation from the study for up to one month after the interview or surveys or focus group discussion. There will be no negative consequences for withdrawing your participation from the study. You can skip any questions that you do not wish to answer, or that may identify you, with no need to clarify why you will skip the question to the researcher.

If you are interested in participating in this study, please reply to this message, and I will arrange a time that is convenient for you to conduct the interview or surveys or focus group discussions in person.

If you have any questions about me or my project, please contact me by email at [redacted] or by phone at [redacted].

Thank you in advance for considering my request,

Md. Ruyel Miah

PhD Candidate,
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Committee (ORE# 45657). If you have questions for the Committee, contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

Verbal Recruitment Script: Surveys

P = Potential Participant; I = Interviewer

I – Hello, my name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "*Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems*" for my doctoral degree under the supervision of Dr. Prateep Nayak. The purpose of this study is to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. This study is not a work/employer or government requirement. I would appreciate the opportunity to speak with you about your experience on this topic. Is this a convenient time to give you further information about the survey?

P – No, could we talk about this later today or another day? [In that case, a follow-up communication will be made]

OR

P – Yes, could you provide me with some more information regarding the survey you will be conducting?

I – I plan to conduct a survey on _____ (date) between the hours of **[**… pm/am and … pm/am**]** and expect to be in your village on that day. However, I would be happy to arrange another time if you prefer. Your involvement in this survey is entirely voluntary, and there are no known or anticipated risks to participation in this study. If you agree to participate, the survey should not take more than about 60 minutes. The questions are quite general (for example, what are the fishing strategies you follow to fish in the Sundarbans? what are the problems you face during fishing in the Sundarbans? how is the governance structure of transboundary Sundarbans? etc.). You may decline to answer any questions you feel you do not wish to answer. Your identity will be confidential and will be grouped with responses from other participants. Further, you will not be identified by name in any dissertation, report or publication resulting from this study. The data collected will be kept for at least seven years.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions, or if you would like additional information to assist you in reaching a decision about participation, please feel free to contact me at +[redacted] or by email at [redacted]

With your permission, I would like to give you an information letter which has all these details along with contact names and numbers to help assist you in deciding about your participation in this study.

P – No, thank you.

OR

P - Sure, please give me a copy of the information letter.

I – Here you go. Thank you so much for your time and interest in this project.

P – Good-bye.

I – Bye for now.

Verbal Recruitment Script: Interviews

P = Potential Participant; I = Interviewer
I – hello, my name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "*Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems*" for my doctoral degree under the supervision of Dr. Prateep Nayak. The purpose of this study is to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. This study is not a work/employer or government requirement. I would appreciate the opportunity to speak with you about your experience on this topic. Is this a convenient time to give you further information about the interview?

P – No, could we talk about this later today or another day? [In that case, a follow-up communication will be made].

OR

P – Yes, could you provide me with some more information regarding the interview you will be conducting?

I – I plan to conduct interviews on _____ (date) between the hours of **[**… pm/am and … pm/am**]** and expect to be in your village on that day. However, I would be happy to arrange another time if you prefer. Your involvement in this interview is entirely voluntary, and there are no known or anticipated risks to participation in this study. If you agree to participate, the interview should not take more than about 60 minutes. The questions are quite general (for example, what are the fishing strategies you follow to fish in the Sundarbans? what are the problems you face during fishing in the Sundarbans? how is the governance structure of transboundary Sundarbans? etc.). You may decline to answer any questions you feel you do not wish to answer. Your identity will be confidential and will be grouped with responses from other participants. Further, you will not be identified by name in any dissertation, report or publication resulting from this study. The data collected will be kept for at least seven years. Also, please note that this research offers 500 BDT ($6.5 CAD) cash for small-scale fisher participants as an appreciation of their time for the interview **[**Only for fisher participants**]**.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions, or if you would like additional information to assist you in reaching a decision about participation, please feel free to contact me at [redacted] or by email at [redacted]

With your permission, I would like to give you an information letter which has all these details along with contact names and numbers to help assist you in deciding about your participation in this study.

P – No, thank you.

OR

P – Sure, please give me a copy of the information letter.

I – Here you go. Thank you so much for your time and interest in this project.

P – Good-bye.

I – Bye for now.

Verbal Recruitment Script: Focus group discussion

P = Potential Participant; I = Interviewer
I – Hello, my name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "*Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems*" for my doctoral degree under the supervision of Dr. Prateep Nayak. The purpose of this study is to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. This study is not a work/employer or government requirement. I would appreciate the opportunity to hear about your experience and perspectives on this topic in a focus group discussion.

P – No, could we talk about this later today or another day? [In that case, a follow-up communication will be made]

OR

P – Yes, could you provide me with some more information regarding the focus group discussion you will be conducting?

I – I plan to conduct a focus group discussion on _____ (date) between the hours of **[**… pm/am and … pm/am**]** in your village. Your involvement in this focus group discussion is entirely voluntary, and there are no known or anticipated risks to participation in this study. If you agree to participate, the focus group should not take more than about 90 minutes. Some of the questions are quite general (for example, what are the problems you face during fishing in the Sundarbans?), and some require brainstorming (for instance, in your opinion, what governance arrangements can help facilitate the transition toward small-scale fisheries' viability). You may decline to answer any questions you feel you do not wish to answer. Your identity will be confidential and will be grouped with responses from other participants. Further, you will not be identified by name in any dissertation, report or publication resulting from this study. The data collected will be kept for at least seven years. Please note that for focus group discussion, an honorarium of 500 BDT ($6.5 CAD) cash will be provided to all the participants as an appreciation of their time.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions, or if you would like additional information to assist you in reaching a decision about participation, please feel free to contact me at [redacted] or by email at [redacted].

With your permission, I would like to give you an information letter which has all these details along with contact names and numbers to help assist you in deciding about your participation in this study.

P – No, thank you.

OR

P - Sure, please give me a copy of the information letter.

I – Here you go. Thank you so much for your time and interest in this project.

P – Good-bye.

I – Bye for now.

Recruitment: Email

Hello,

My name is Md. Ruyel Miah and I am a Ph.D. Candidate in the School of Environment, Enterprise and Development at the University of Waterloo, Canada. I am conducting a research project called "Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems" for my doctoral degree under the supervision of Dr. Prateep Nayak. The study intends to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. This study is not a work/employer or government requirement. I am currently inviting people to participate in this study.

I am contacting you to invite you to participate in a [interview/in-person survey/focus group discussions] and discuss some general questions about the vulnerabilities of small-scale fisheries, the governance system, the institutions involved, and governability in the transboundary Sundarbans social-ecological systems. The [interview/in-person survey/focus group discussions] will last approximately [60/60/90] minutes.

The target participants are people with experience, knowledge and familiarity with small-scale fisheries-related activities in the Sundarbans. These include people involved directly or indirectly in fishing, fisheries policy, fish processing, fish trading and marketing, management of the markets, and certification and traceability initiatives. There is no restriction to participate except that participants must be of legal age (i.e. older than 19).

Your participation in this project is entirely voluntary, and your identity will be confidential. You will not be identified by your name in any written report or publication resulting from this research. You are free to withdraw your participation from the study for up to one month after the [interview/in-person survey/focus group discussions]. There will be no negative consequences for withdrawing your participation from the study. You can skip any questions that you do not wish to answer, or that may identify you, with no need to clarify why you will skip the question to the researcher.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

If you are interested in participating in this study, please reply to this message, and I will arrange a time that is convenient for you to conduct the [interview/in-person survey/focus group discussions]. If you have any questions about me or my project, please contact me at [redacted]

Thank you in advance for considering my request.

Sincerely,

Md. Ruyel Miah

PhD Candidate,
School of Environment, Enterprise and Development
Faculty of Environment, University of Waterloo, Canada.

A.3 Research instruments

Household Survey

Research title: Governance for Vulnerability to Viability Transitions in the Transboundary Sundarbans Social-Ecological Systems

Date: _____ Survey ID:

In the next three sections, I would like to ask about your demographic information, including household, housing, food security and family well-being. This will help me to more accurately describe the study participants and put the results in the context of my study. Moreover, it will help me to draw an accurate picture of local small-scale fishers' socio-economic profile, their vulnerabilities and their potential to move toward viability.

1. Respondent and household information

1. Location: _____
2. Age range:

   1=18-25 | 2=26-35 | 3=36-45 | 4=46-55 | 5=56-65 | 6=66-75 | 7=>70 | 8=prefer not to mention

3. Gender: 1=Man | 2=Women | 3=Non-Binary | 4=Prefer to self-describe _____
4. Religion: M=Muslim | H=Hindu | C=Christianity | B=Buddhism | O=Other, please specify (if prefer to) _____
5. Family status: M=Married | S=Single | D=Divorced | W=Widowed | O=Other
6. Education level:

   1=Illiterate | 2=Can sign only | 3=Primary (five years of schooling) | 4=Secondary (ten years of schooling) | 5=Higher secondary (twelve years of schooling) | 6=University graduate/student

7. Primary source of family income

   1=Agriculture | 2=Fishing | 3=Crab harvest | 4=Honey collection | 5=Day labour | 6=Trawler operation | 7=Business | 8=Handicraft making | 9=Others, please specify (if prefer to)
   _____

8. Secondary source of family income

   1= Agriculture | 2=Fishing | 3=Crab harvest | 4=Honey collection | 5=Day labour | 6=Trawler operation | 7=Business | 8=Handicraft making | 9=Others, please specify (if prefer to)
   _____

2. Housing and other assets

11. Do you (or does your household) 'own' land? 1=Yes | 2=No

    a. If yes, for what do you use your land (multiple options)? 1=House | 2=Crop cultivation | 3=Livestock raising | 4=Renting out | 5=Fallowing | 6=Nothing | 7=Other, specify _____
    b. If yes, please estimate the total land size? _____ (Decimal)

12. Do you own the house you live in? 1=Yes | 2=No

13. Please indicate the building materials of the house you live in:

    a. Roof (multiple options): 1=Roofing tiles | 2=Iron sheets | 3=Concrete | 4=Natural materials, e.g. thatch or earth | 5=Other, specify_____
    b. Walls (multiple options): 1=Cement blocks/concrete| 2=Baked bricks | 3=Sun-dried bricks | 4=Wood | 5= Iron sheets | 6=Other natural materials, specify_____ 6=Other, specify _____
    c. Floor (multiple options): 1=Cement | 2=Earth | 3=Wood | 4=Other, specify _____

14. Does your house have electricity? 1=Yes | 2=No

15. What are the sources of fuel for cooking?

    1=Buy firewood | 2=Dry leaf | 3=Firewood from forest | 4=Charcoal | 5=Husk | 6= Cow-dung | 7=Propane | 8=Electricity | 9=Other, please specify _____

16. What is the source of your drinking water (multiple options)?

    1=Surface water | 2=Well | 3=Borehole/Pump | 4=Pond | 5=Other, specify _____

17. Does your house have a private latrine? 1=Yes | 2=No

3. Food security and family wellbeing

18. How many meals does your household eat on a 'regular day'? _____

    1=One | 2=Two | 3=Sometimes two | 4=Three

19. How much of the food your household consumes is bought (i.e. not produced by household itself)?

    1=Everything | 2=More than half | 3=Approximately half | 4=Less than half | 5=Hardly anything | 6=Nothing

20. Do you think your children get enough good food? 1=Yes | 2=No, if no, why? _____

21. Do your children go to school? 1=Yes | 2=No, if no, why? _____

22. What activities do women involve?

1=Housewife | 2=Fishing | 3=Crab harvest | 4=Day labour | 5=Other, please specify _____

23. What places do women go for their needs?

1=Husband | 2=Family head | 3=Self-dependent | 4=Other, please specify _____

24. How are the health and medical facilities? 1=Poor | 2=Good | 3=Moderate | 4=Excellent

25. What are the natural hazards you face?

1= Temperature rise | 2=Erratic rain fall | 3= Change in seasonal patterns | 4=Salinity | 5=High tide and SLR | 6=Water logging | 7=Cyclone and tidal surge | 8=Drought | 9=Flood | 10=Fog | 11=Cold wave | 12=Other, please specify

4. Transboundary Fisheries

26. If you work as a labour in the boat, do you have any contractual agreement with the owner?

1=Yes | 2=No

27. Can you set your gear in any place on the river? 1=Yes | 2=No, If no, then why? _____

28. Do you get an equitable share of fishing benefits? 1=Yes | 2=No, If no, then why? _____

29. What are the fishing strategies you follow to fish in the Sundarbans? Please specify _____

30. What fishing gear do you use? Please specify _____

31. Do you have your own fishing gear? 1=Yes | 2=No, If no, then how do manage one? _____

32. What is the current status of fish in the mangrove forest? 1=Increased | 2=Decreased | 3=No change

33. What are the problems you face during fishing in the Sundarbans?

1=Storm
2=Competition with industrial fisheries
3=Conflicts with law enforcement authorities
4=Broken gear
5=Criminal gang or robbery

6=Weak boat engine
7=Tiger attack
8=Conflicts with other fishers in terms of space
9=Caught to the border security authority
9=Other, please specify _____

34. Where do you sell your harvested fish?

1=Middlemen | 2=Consumer | 3=Local trader | 4=Commission agent | 5=Relatives or neighbour | 6=Other, please specify _____

5. Transboundary Sundarbans Governance

35. What is the governance structure of transboundary Sundarbans?

1=Hierarchical | 2=Co-governance | 3=Self=Governance | 4=Mixed governance, please specify _____

36. Are you happy with the current governance arrangement?

1=Yes | 2=No, If no, then why? _____

37. Do you participate in any transboundary fisheries management-related meetings?

1=Yes | 2=No, If no, then why? _____

39. Does the government consult with small-scale fishers before making policies?

1=Yes | 2=No, If no, then why? _____

40. Are you a member of any informal institution?

1=Yes | 2=No, If yes, please specify the name, their purpose and your role

_____

41. Do you think the action (e.g., fishing ban) of the current governance arrangement fits into

the transboundary small-scale fisheries problems?

1=Yes | 2=No, If not, why _____

42. Are you happy with the process, quickness, and accuracy of the responses of the current governance system to transboundary issues? 1=Yes | 2=No, If not, why _____

43. Do you think the current governance system is able to address the vulnerabilities of small-scale fisheries?

1=Yes | 2=No, If not, why _____

44. The governance system has been transformed from hierarchical to co-governance/self-governance in the last 30 years.

1=Agree | 2=Strongly agree | 3=No comments | 4=Disagree | 5=Completely disagree

45. The participation of small-scale fishers has increased in decision-making.

1=Agree | 2=Strongly agree | 3=No comments | 4=Disagree | 5=Completely disagree

46. The ways governing bodies interact with small-scale fisheries?

1=Policy implementation | 2=Consultation | 3=Inform decisions | 4=Cooperation | 5=Co-management | 6=Non-compliance | 7=Participation | 8=Other, please specify _____

47. In your opinion, what initiatives the governing bodies should take for small-scale fisheries viability?

Please specify _____

48. In your opinion, what initiatives should governing bodies take for the sustainability of

transboundary fisheries resources?

49. Do you see any innovative governance strategy in addressing transboundary small-scale fisheries?

1=Yes | 2=No, if yes, please specify _____

Interviews

Questionnaire ID # Date of interview: _ _ / _ _ / _ _

In the first section, I would like to ask a few questions about your demographic information, including personal information, place of stay, your role in the fisheries sector, and some opinions. This will help me to more accurately describe the study participants and put the results in the context of my study. Moreover, it will help me to draw an accurate picture of local small-scale fishers' socio-economic profile, their vulnerabilities and their potential to move toward viability.

Part 1: General Information

1. Age/age range: _____
2. Gender: _____
3. Area/region: _____ Country:_____
4. How long have lived/worked in the area/region? _____
5. What is your role in the small-scale fisheries, e.g. harvester, processor, trader, researcher, government/NGO representative?
    - How long have you been in this role? _____
6. In your opinion, what are two or three transboundary-related vulnerabilities facing the small-scale fisheries in this area/region?
7. What are the impacts of transboundary governance on small-scale fisheries in accessing resources?

Part 2: SSF in Transboundary Social-ecological Systems

8. How do small-scale fisheries operate in transboundary Sundarbans areas?
9. What are the common transboundary resources small-scale fishers harvest?
10. What are the fishing strategies small-scale fishers follow to harvest fish? Are they environmentally friendly and legal?
11. What changes have you seen in terms of resource availability and fishing techniques in the last 30 years in Transboundary Sundarbans?
12. Do small-scale fishers cross country borders to harvest fish? If so, what resources make small-scale fishers cross the borders?
13. In what capacity women involve in transboundary small-scale fisheries?
14. What are the problems faced by women in the supply chain of the fishery? Do the local and national governments take into consideration the issues and concerns affecting women? Are there venues for women to express their perspectives?
15. What are the alternative income activities of small-scale fishers in the Transboundary Sundarbans?
16. What are the direct and indirect challenges faced by small-scale fisheries in accessing transboundary resources?

Part 3: Governance of SSF in Transboundary Sundarbans

1. How are small-scale fisheries governed in the Transboundary Sundarbans? By what mode, e.g., self-governance, co-governance, or hierarchical governance? How effective is the governance mode?
2. Can you explain the structure and arrangements governing small-scale fisheries in the Transboundary Sundarbans?
3. Who are key actors/organizations involved with what roles in the transboundary small-scale fisheries?
4. Do the local and national governments have any specific regulations or policies to guide transboundary small-scale fisheries? If so, how do these regulations/policies enable or hinder access to resources for small-scale fisheries?
5. Can you explain whether small-scale fishers are consulted in formulating or changing market-related rules and regulations?
6. Are you a member of any formal or informal governing institution? If so, what is it for and how it functions?
7. How does the existing governance deal with the daily operation and issues of small-scale fisheries in the transboundary Sundarbans? Are small-scale fishers happy with the existing governance structure? If not, why?
8. Has the governance system been transformed or changed in the last 30 years? If so, what are the main types of governance transition/transformation (e.g., enhanced participation, rearranging institutions) that are in place in Bangladesh/India?
9. What are the key drivers that motivated the governing actors to change the policies/institutional structure and mechanisms in the last 30 years pertinent to transboundary small-scale fisheries?
10. What are the initiatives governing bodies have taken to address SSF vulnerabilities in the Bangladesh/India Sundarbans?
11. What are the challenges governing bodies face in governing Transboundary SSF?
12. What are the limitations (political, social and economic) of the current governance system?

Part 4: Interaction of SSF and Governance System in the Transboundary Sundarbans

13. How do the governing bodies interact with small-scale fisheries in transboundary Sundarbans? Through what mechanisms and channels? What factors drive these interactions?
14. What are the interactions that take place at the structural level of the relevant institutions, e.g., self-governance, co-governance, and hierarchical governance, and why? How would you characterize these interactions between transboundary governance systems (e.g., compliance, collaboration, cooperation, participation, learning) and small-scale fishers?
15. Do the small-scale fishers comply with the existing governance structure? If not, why? What are the likely consequences if they do not follow the national jurisdiction and local policies?
16. Does the transboundary governance system enable or hinder small-scale fisheries' access to fisheries resources? If so, how?
17. Do you think there have been changes in the way small-scale fisheries interact with transboundary governance mechanisms?

18. Are you aware of if there are any transboundary governance initiatives or plans between India and Bangladesh?

19. **Is there anything else you would like to add regarding the topics covered?**

Thank you for your responses!

Focus Group Discussion Instrument

FGD ID # Date: _ _ / _ _ / _ _

Location: _____

Phases	**Questions/topic**	**Approximate time spent**
Introduction	Thank you, everyone, for joining the focus group discussion. Again, my name is Md. Ruyel Miah, and I am a PhD Candidate at the University of Waterloo, Canada. Today, I will facilitate this focus group discussion. As mentioned in the recruitment and information letter, I am conducting a research project called "*Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems*" for my doctoral degree under the supervision of Dr. Prateep Nayak. The purpose of this study is to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. This study is not a work/employer or government requirement. Just to remind you, during the focus group discussion, we will discuss developing a good understanding of the vulnerabilities that small-scale fisheries face and finding out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. We will also discuss and analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. When results are reported, it is possible that others may be able to ascertain your identity as the community in transboundary small-scale fisheries is small. Some of the questions may be sensitive as questions ask about their vulnerabilities, gender, and income status. If any participant feels upset during the focus group discussion, I will skip the relevant questions. During the focus group discussion, the sensitive nature of the questions may sometimes cause short-term anxiety to some participants. In that case, I will follow up with the participants and will connect them with the appropriate mental health department if required. Please note that I will not be able to guarantee that focus group participants will keep what was said in the focus group confidential. You may decline answering any questions you feel you do not wish to answer and may decline contributing to the session in other	5 minutes

	ways if you so wish. Your identity will be confidential. Your name will not be identified with the input you give to this session. Further, you will not be identified by name in the report that is produced for this session. The information collected from this session will be kept in my supervisor's office/lab at the University of Waterloo for a period of at least seven years. If you wish to withdraw your study data after participating, please contact the researchers. You can request your data be removed from the study up until one month after the session is held, as it is not possible to withdraw your data once papers and publications have been submitted to publishers. Given the group format of this session, I will ask you to keep in confidence information that identifies or could potentially identify a participant and/or their comments. If you have any questions about participation in this session, please feel free to discuss these with the me or later by contacting Professor Prateep Nayak at [redacted] If you are interested in receiving a copy of the executive summary of the session outcomes, please contact the me or Professor Prateep Nayak.	
General questions	17. What are the common transboundary resources small-scale fishers harvest? 18. In your opinion, what are two or three transboundary-related vulnerabilities facing the small-scale fisheries in this area/region?	15 minutes
Deep understanding	1. What changes have you seen in terms of resource availability and fishing techniques in the last 30 years in Transboundary Sundarbans? 2. What are the direct and indirect challenges faced by small-scale fisheries in accessing transboundary resources? 3. Can you explain the structure and arrangements governing small-scale fisheries in the Transboundary Sundarbans? 4. Has the governance system been transformed or changed in the last 30 years? If so, what are the main types of governance transition/transformation (e.g., enhanced participation, rearranging institutions) that are in place in Bangladesh/India?	25 minutes
Brainstorming	1. What are the key drivers that motivated the governing actors to change the policies/institutional structure and mechanisms in the last 30 years pertinent to transboundary small-scale fisheries? 2. What are the limitations (political, social and economic) of the current governance system?	25 minutes

	3. In your opinion, what are some of the strategies that could help small-scale fisheries to be viable in this region?	
Seeking solution	1. What is your suggestion to improve the current governance structure, function and effectiveness in the transboundary Sundarbans? 2. What role would you be able to play to make a transition toward viability from your social and political position?	15 minutes
Closure	1. Is there anything else anybody wants to share regarding small-scale fisheries' vulnerability and viability in this region? 2. Thanking all for the participation!	5 minutes

A.4 Participant Feedback and Appreciation Letter

University of Waterloo, Canada

Date:

Dear _____,

I would like to thank you for your participation in this study entitled "Governance for vulnerability to viability transitions in the Transboundary Sundarbans Social-Ecological Systems." As a reminder, this study intends to develop a good understanding of the vulnerabilities that small-scale fisheries face and find out possible ways to move toward viability in the shared Sundarbans social-ecological systems between Bangladesh and India. It also aims to analyze the role of governing institutions both from Bangladesh and India side to facilitate the transition toward viability. The study will broaden our understanding of small-scale fishing communities in the transboundary Sundarbans and examine how a shared social-ecological system affects them. The data collected during the study procedures (e.g., interviews, surveys, focus groups, etc.) will contribute to a better understanding of change processes crucial for vulnerability to viability transition for small-scale fisheries.

Please remember that any data pertaining to you as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study or would like a summary of the results, please provide your email or postal address, and when the study is completed, I will send you the information. In the meantime, if you have any questions about the study, please do not hesitate to contact me by email or telephone or postal mail as noted below.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45657). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

For all other questions, contact

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