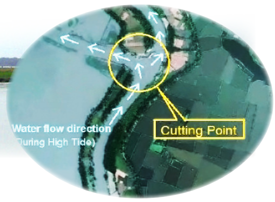
Turning the Tide?

The Role of Participation and Learning in Strengthening Tidal River Management in the Bangladesh Delta



Mahmuda Mutahara

PROPOSITIONS

1. For effective participation in delta management, learning partnerships will have to operate both horizontally and vertically within the stakeholder network.
   (this thesis)

2. The differentiation between 'politicised' and 'non-politicised' as used in the TWINS (transboundary water intensity nexus) model does not make sense in the case of Bangladesh where all social and institutional relations are highly politicized.
   (this thesis)

3. Responsive and responsible management in times of systemic global dysfunction, requires a paradigm shift towards a complex management trajectory.

4. A well-functioning multi-stakeholder process requires social cohesion, mutual trust and joint commitment, not just meeting and talking.

5. One can debate whether seemingly universal access to the Internet and digital media such as Skype, leads to a deepening of human interaction.

6. The Netherlands and Bangladesh both are Delta countries having to cope with rising sea levels but when looking at the capacities and options to respond the comparison quickly falls short.

7. It remains to be seen whether the enormous sacrifice of having to leave my two newly born children behind for many months in order to work on my PhD in Wageningen, is worth it in the end.

Propositions belong to a thesis, entitled:

"Turning the Tide?
The Role of Participation and Learning in Strengthening Tidal River Management in the Bangladesh Delta"

Mahmuda Mutahara,
Wageningen, 30 January 2018

Turning the Tide?

The Role of Participation and Learning in Strengthening Tidal River Management in the Bangladesh Delta

Mahmuda Mutahara

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Turning the Tide?

The Role of Participation and Learning in Strengthening Tidal River Management in the Bangladesh Delta

Mahmuda Mutahara

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Acronyms

ADB	Asian Development Bank
BAR	Basins at Risk (Scale)
BATNA	Best Alternative to a Negotiated Agreement
BWDB	Bangladesh Water Development Board
CEGIS	Center for Environmental and Geographic Information Services
CDP	Centre for Policy Dialogue
CEP	Coastal Embankment Project
CERP	Coastal Embankment Rehabilitation Project
COPDAB	Conflict and Peace Data Bank’s
CoP	Communities of Practice
CSO	Civil Society Organization
DoF	Department of Fisheries
DAE	Department of Agriculture Extension
EP-WAPDA	East Pakistan – Water and Power Development Authority
FAO	Food and Agriculture Organization
FCD	Flood Control and Drainage
FGD	Focus Group Discussion
GBM	Ganges Brahmaputra Meghna (delta)
GoB	Government of Bangladesh
GPS	The Global Positioning System
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
IWM	Institute of Water Modeling
IWRM	Integrated Water Resource Management
KCERP	Khulna Coastal Embankment Rehabilitation Project
KJDRP	Khulna Jessore Drainage Rehabilitation Project
LCCI	Local Conflict and Co-operation Intensity
LGED	Local Government Engineering Department
LGI	Local Government Institution
LSM	Local Stakeholder Meeting
NGO	Non- Government Organization

MoWR	Ministry of Water Resources
MSLP	Multi-stakeholder Learning Partnership
MSP	Multi-stakeholder Partnership
NWO	Netherlands Organization for Scientific Research
PC	Pani Committee
PCM	Public Consultation Meeting
PWD	Public Works Datum
RRA	Rapid Rural Appraisal
RWMA	Rapid Water Management Appraisal
SES	Socio-Ecological System
SETS	Socio-Eco-Technical System
SL	Social Learning
TBM	Tidal Basin Management
TRM	Tidal River Management
TWINS	Transboundary Water Interaction Nexus
UNO	Upazila Nirbahi Officer
WM	Water Management
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMG	Water Management Group

Chapter 1

Introduction

1.1. Introduction

When water management projects or interventions continued to fail to fulfil their expected long-term objectives in the south-western coastal delta in Bangladesh and, arguably, caused severe flooding (3-6 months a year) since the mid-1980s (Tutu, 2005; Kibria and Mahmud, 2010; Amir et al., 2013), management approaches had to be modified. The new direction emphasized high levels of participation and stakeholder involvement and a better use of community capacity (MoWR, 1994; Gupta et al., 2005). My thesis investigates whether this espoused shift in emphasis towards a centring of participation and learning is successful in enabling more sustainable delta management processes in the south-western coastal delta.

The south-western coastal delta is the poorest part of Bangladesh. Rural communities in this area are living with frequent natural hazards and are subject to extreme climate vulnerability (Brammer, 2014; Mutahara et al., 2013). A large portion of the area is frequently flooded, in part due to water logging and drainage congestion caused by the impact of large-scale structural engineering (e.g., the creation of embankments and polders) (Rahman, 2005; Dewan et al., 2014; Nowreen et al., 2014). In this situation the practice of Tidal River Management (TRM) was initiated by local communities without support from government authorities to remove waterlogging (Tutu, 2005; Kibria, 2011). While originating in indigenous (local) knowledge, it was accepted as a state management approach and finally formalized as a novel re-interpretation of the polder concept to relieve drainage congestion, restore the tidal nature of the delta and save the agro-ecological system (EGIS I, 2001; de Die, 2013, ; Amir et al., 2013).

My PhD thesis was developed under the WOTRO-IP *Dynamic Deltas* project (2012-2017). This project included integrated studies in deltas in Bangladesh and The Netherlands on strategies to reduce flood risk and vulnerabilities, with the aim to strengthen ‘institutions of resilience’ as well as ‘resilient communities’. It also considered the TRM approach as an adaptation strategy in managing the sediment loaded delta in Bangladesh (NWO, 2011). As one of four PhDs studies in this project, my research aimed to explore and understand changes in practices, scope of learning, and the role of participation in adaptive delta water management. It focused on socio-technical innovation and capacity development in delta management and flood risk reduction in the context of strengthening TRM in a dynamic delta like Bangladesh.

A basic assumption of my research is that learning is central in shaping the capacities and outcomes of resilience in risk reduction, adaptation, and sustainable management (IPCC, 2012). Learning as an iterative process of monitoring, research, evaluation, learning, and innovation, can reduce risk and uncertainties, and promote adaptive management in the context of complex natural resource systems (Biggs et al., 2015). In this context, knowledge accumulation and stakeholder participation may help to achieve resilience, especially when combine with capacity development anchored at the local level (Rahman et al., 2017). Furthermore, learning and capacity development towards sustainable management in the perspective of a local or regional socio-ecological system change can benefit from questioning assumptions and paradigms to encourage new patterns of management responses (IPCC, 2012).

From this point of view, sustainable water and land management research increasingly focuses on the use of participatory approaches at local and regional level. In addition, in developing countries, evolving and maintaining sustainable management systems remains a challenge (United Nations, 2012). Therefore, delta management and development research in countries like Bangladesh needs to focus on learning and participatory processes to deal with challenges and deep uncertainties in the management system (Berkes, 2009). In this thesis, I have focused on Social Learning (SL) and Multi-stakeholder Partnerships (MSPs) as promising mechanisms for capacity development and linking science, policy and governance (Boogard et al., 2013).

My thesis intends to contribute to an understanding of how learning and change processes have developed (or, as the case may be, failed to develop) in adapting a delta management system, and of how multi-stakeholder approaches are utilized. The overall objective of the thesis is:

To analyse the role of participation and learning in the creation of local water management knowledge and socio-technical systems, designed to deal with flood (waterlogging) risks in vulnerable rural delta communities.

While anthropological studies give us an idea of how communities cope with adverse challenges (Duyne, 1998; Schmuck, 1999), there is little knowledge about socio-technical systems resilience and local-central links. The interaction between communities and management groups in Bangladesh has often been tense, especially where local practices are seen by outsiders as ‘deviant’ and backward (Warner, 2010). So, the gaps in interaction and management co-ordination force local stakeholders to be self-reliant, but result in weak links with support systems, especially for the more vulnerable groups. My research was conducted on and in interaction with waterlogging affected rural communities and water management groups in the southwest delta.

1.2. Research Background

Delta and delta management systems in Bangladesh

Bangladesh is one of the world's most populated deltas and Asia's largest (Ericson et al., 2005), located in the north-eastern part of South Asia. Its major landmass (almost 80%) is extremely flat, built by delta-forming activities of three major rivers in the Indian sub-continent: the Ganges, the Brahmaputra and the Meghna (usually referred to as the GBM Delta) (Figure 1.1).

Figure 1.1: Location of the Bangladesh Delta (Banglapedia, 2012)

The south-western part of the Bangladeshi delta lies entirely along the coast, mainly comprised of the *Khulna, Jessore, Satkhira*, and *Bagerhat* districts (Islam, 2008). This part of the delta is an active delta region mostly bounded by mangrove forests, also referred to as the 'Sundarbans' in the south (Islam, 2004; Ahmed, 2006). This coastal delta is mostly covered by rich alluvial deposit from the Ganges-Brahmaputra river systems and carries the highest annual sediment load in the world (at least one billion tonnes per year). The delta is therefore characterized by a constantly changing geographic and geomorphologic processes such as river sedimentation and erosion (Goodbred, 2003; Sarker, 2004). A major part of the south-west delta is also low-lying flood plain and subject to regular inundation, even in ordinary tidal flow. Three basic environmental processes and events are governing the opportunities and vulnerabilities of the south-western part of Bangladesh delta: tidal fluctuation, salinization and sedimentation. In addition to the aforementioned hydro-morphological process, some anthropogenic events and also structural management activities have enhanced changes in this coastal system (Hossain et al., 2016). Intensification of shrimp culture is also a major change factor in this area.

The southwest delta is defined as a complex area with an ever-changing relationship between the bio-physical environment and its inhabitants (Chadwick and Datta, 2001; Islam, 2004). However the relationship between water and inhabitants has proven to be very volatile over the last couple of decades (Rahman, 2005; Kibria, 2011). As this delta is severely threatened by climate change and natural hazards: floods, salt-water intrusion, cyclonic storms, and tidal interaction, one-fourth of the population of the country suffers from these vulnerabilities ((Mutahara, 2013). In previous studies that provided some groundwork for this thesis (Annex-A: Published Journal Article), I have investigated the level of insecurity of the inhabitants in the south-west coastal delta (Mutahara et al., 2016). Although the cases of that research were more relevant to security against storm surge hazard, the scenarios describe the uncertainties in coastal life and livelihoods in this area. One of the main dynamics of this delta system are its river systems, ten of which including the Ganges and Brahmaputra share the border with India (Wikipedia, 2013). The withdrawal of upstream flow from Transboundary Rivers, especially from the Ganges system, has severely affected the south-west's river systems and influenced vulnerability in this area (Sarker, 2004). On the other hand, to prevent flooding and to reduce the poverty of rural people, several small and large water management projects like coastal embankment, flood-control drainage, and irrigation projects have been implemented in coastal Bangladesh since the 1960s by the national government as well as international donors (Kibria and Mahmud, 2010; Dewan et al., 2014). Nevertheless, most of these projects ceased functioning within a few years, and caused new flooding area and continued regular inundation in different river-basins in the region. So, where the monsoon-related floods in tidal flood-plains once brought benefits to local dwellers, nowadays they tend to create high-scale drainage congestion and waterlogging, and set back hard-won development gains (Brammer, 2010; Nowreen, 2014).

Waterlogging in the south-western coastal area of Bangladesh

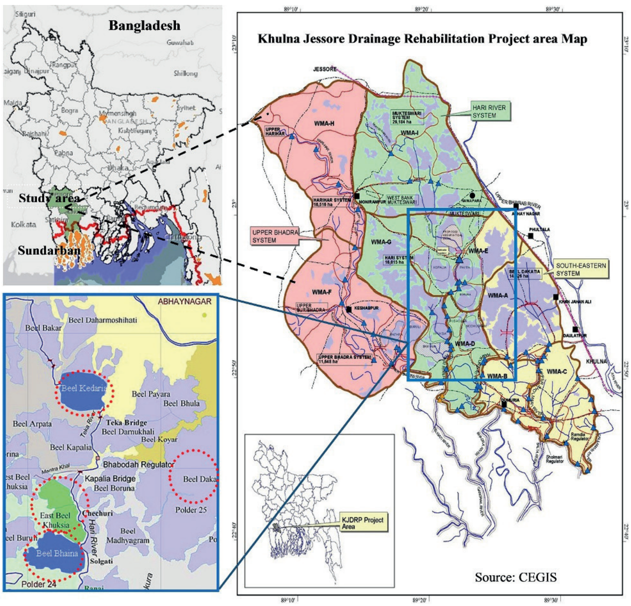
Historically, flooding in various forms (fluvial floods, rainfall floods, tidal floods or floods caused by cyclonic storm surges) has been a recurring phenomenon in most parts of the Bangladesh Delta (Brammer, 2010). Waterlogging and drainage congestion had been rare prior to the 1980s (Tutu, 2005; de Die, 2013), but since have become a severe problem in the south-west delta due to both natural and human interventions. In the early 1960s, when the Coastal Embankment Project (CEP) was launched to support agricultural development, several polders were established to protect the area from tidal flooding and rising salinity (CEGIS, 2003; Dewan et al., 2015). Such interventions disconnected the wetlands from the rivers, essentially preventing sedimentation of the flood-plains. Sediments could also not be pushed out into the Bay of Bengal due to a reduced flow from the Ganges and, as a result, were deposited on the river bed. Consequently, in many places, the river bed elevation became higher than the basin causing drainage congestion (Islam et al., 2004; Sarker, 2004) and increasing flooding. Further, vast tracts of land remained waterlogged for about six months in a year in the southern-most polders.

People in Khulna, Jessore, and Satkhira Districts are still suffering from these compounded impacts today, due to lack of sustainability in adaptive delta management (ADB, 2007; de Die, 2013, Mutahara et al., 2015). Waterlogging has sent their income into decline, sanitation conditions have worsened and livelihoods degraded, and access to their homes, agricultural lands, and infrastructure facilities has become problematic for many. Waterlogging also generated a strong competition for the rapidly diminishing resource base, thereby heightening tensions and creating a volatile social and political situation with respect to saline water use in agricultural land (Kibria, 2011). To mitigate constant flooding and improve drainage capacity in tidal rivers, the government had set up the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) (IWM, 2007 and CEGIS, 2008) in approximately 100,600 ha (25% of the CEP area) between the Khulna and Jessore districts (Figure 1.2). As an application of an Integrated Water Resource Management (IWRM) approach in Bangladesh, Tidal River Management (TRM) was formally introduced into the KJDRP area. Although the local community practiced it already on a smaller scale, TRM was planned to be used extensively as a new tool for reduce the extreme sedimentation in the delta river systems.

Community knowledge in delta management

Local knowledge, experience, and practices in coping with climate change in the past and present have much to contribute to the design of planned adaptation programmes (Kibria, 2011). People in the Bangladesh Delta have been adapting to the forces of nature (storm surges-salinity-flooding) for generations. For their traditional wisdom and practical experience, it would stand to reason that they have a right to say something about novel technical or semi-technical practices, introduced from the outside, that are profoundly linked to their physical and socio-economic living conditions (Tutu, 2005). Excluding the 'Sundarbans' mangrove ecosystem and the estuary, the larger part of the South-west Delta is characterized by an agro-ecological system with extensive tidal rivers, streams, and water-filled depressions (the local term is *Beel*) (Nowreen et al., 2014).

The river flows were naturally carried to the flood-plains during high tide, depositing large volumes of sediment when there was no permanent barrier (or polder/embankments) along the river banks. In that area, people traditionally used indigenous, sediment management practices, which included the construction of temporary, earthen embankments during the dry season to protect flooding and reduce salinity intrusion into crop lands (Amir et al., 2013). During the monsoon, natural river floods would sweep away these embankments and leave huge silt loads in the flood-plain, which made the land more fertile.



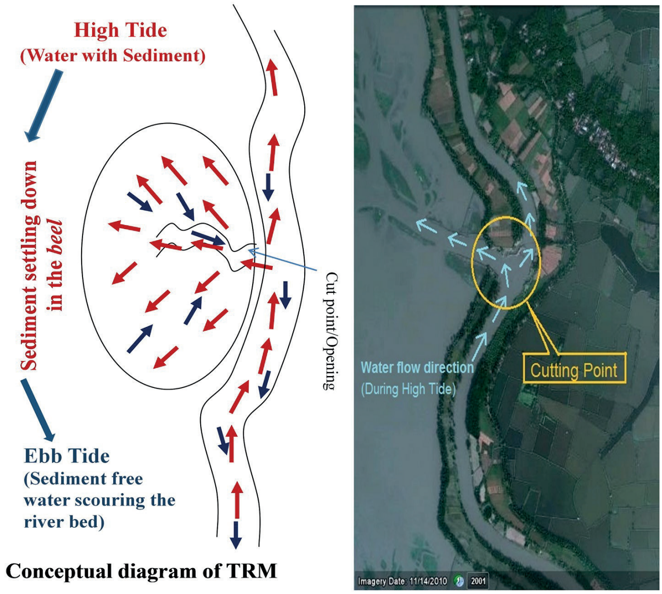


Figure 1.2: Tidal River Management practice in different beels (first) and process (second) in KJDRP area (Source: CEGIS, 2007; CEGIS, 2014)

The TRM process originates from such indigenous practices of delta management in the South-west region (Tutu, 2005). Technically, this process allows the natural movement of sediment-borne tidal water into an embanked tidal basin or *beel* during high tide. It keeps a huge deposition of sediment in the *beel* (Figure 1.2). During low tide the outgoing sediment-free water flow runs out, erodes the riverbed, and increases or restores its drainage capacity. TRM raises the level of *beel* land, which in turn becomes more productive (Shampa and Pramanik, 2012; Amir et al., 2013). The evolution and practices of TRM are studied here in the KJDRP area and in the Integrated Drainage Rehabilitation Project in the *Kobadak* River area (see Figure 1.3). They are the largest and latest drainage rehabilitation projects in the coastal districts of *Khulna*, *Jessore*, and *Satkhira*. The government-appointed Bangladesh Water Development Board proposed a community-based participatory water management approach in both projects, but the participation process did not function well (CEGIS, 2010; CEGIS, 2014). The effectiveness and sustainability of TRM has become uncertain within only a few decades, due to the adverse impact of multiple issues where the natural domains seem minor however the anthropological issues are major (Kibria and Mahmud, 2010).

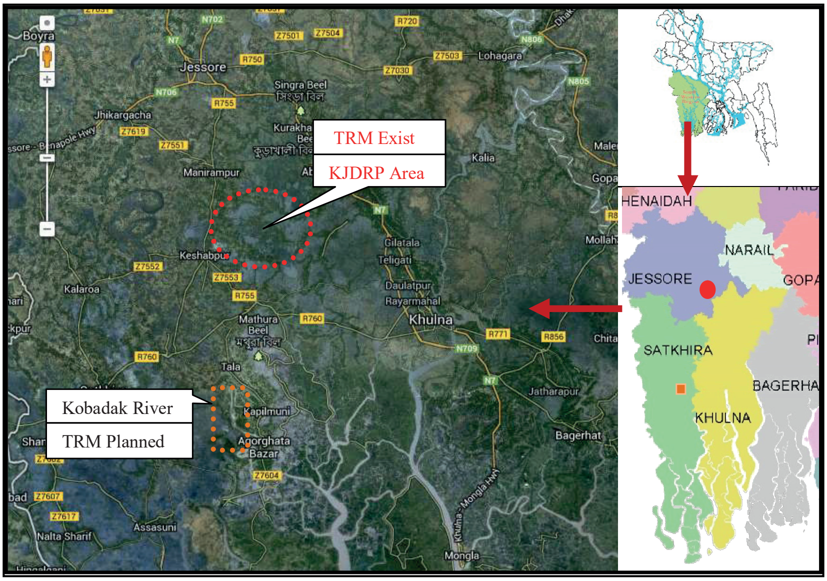


Figure 1.3: Study area in the Southwest Delta in Bangladesh (Google earth, December 2012)

Stakeholder participation in delta management

Participation of local stakeholders is a continuous process in the pursuit of sustainable development. To achieve effective natural resources management the different objectives and interests of stakeholders need to be accommodated and anticipated for long-term benefits (Röling, 2002; Leeuwis, 2004). Participatory approaches in environmental development and water management are the focus of attention in Bangladesh since the 1990s (Ahammed and Harvey, 2004). The National Water Policy (1999) highlights the importance of stakeholder participation in water management. However, participation of all stakeholders in delta water management still does not effective well, which becomes a major reason of limited effectiveness of the management interventions. Since TRM is originally a community initiated management process, local people have been actively involved in practicing it, 'informally' (EGIS I, 2001). While government authorities have taken the lead in implementing TRM, they stress the importance of multiple stakeholder participation (CEGIS, 2003). But that is basically on paper; in practice, such participation does not sustain and remains very much perplexing, particularly at community level (de Die, 2013; Haque et al., 2015). An exploratory research for the improvement of participatory practices therefore is necessary to revive the adaptation of delta management in Bangladesh.

1.3. Research Questions

The key practical purpose of this dissertation is to contribute to the creation of a functional, participatory, sustainable land-water management system in the Bangladesh delta. To understand the possibilities and gaps in adapting such management approach, I designed a pragmatic and exploratory form of research focusing on the evolution and practice of the promising delta management intervention that is called the Tidal River Management (TRM). My thesis is organized concerning four specific research questions:

- How does TRM frame management transition in the Bangladesh delta and what transformation, if any, does it enable in the south-west delta in particular?
- How does learning and participation occur in practicing TRM and how does it contribute to an adaptive delta management in the country?
- What is the role of conflict and co-operation in a multi-stakeholder participatory process and in adapting TRM as a regional delta management system?
- How does multi-stakeholder learning contribute to reframing the participatory process for sustainability in adaptive delta management?

1.4. Conceptual Overview of the Research

Most studies on TRM have looked at government project development and implementation (*i.e.,* studies under the BWDB and Ministry of Water Resources) (see SMEC, 2002; CEGIS, 2003; IWM, 2010). Only a few studies have examined aspects of learning, collaboration, conflict, and partnerships in TRM practices, and the capacities of stakeholders that need to be developed to improve TRM successfully. My study tried to do just that by considering both the technical aspects and the learning and social characteristics of TRM to enrich the practice as well as by assessing its potential for a sustainable delta management strategy.

System transformation and learning orientation

Knowledge and technology are key elements in relation to social and bio-material (or bio-physical) dynamics, and tend to become contextually integrated within society, technology, and nature in configurations with more and less desirable consequences (Leeuwis, 2013). In delta research, a delta system tends to be conceptualized as a unique socio-ecological system and water management system is defined as a socio-technical system (Wester and Bron, 1996). In my research, I conceptualize the delta system and delta management in a wider boundary context (Mollinga, 1997, revised by Wester, 2010) where ecology (i.e. water environment) and technology (i.e. management interventions) interact with society or social systems (see further Chapter 2). I have explored management transition theory (Geels and Schot, 2007) to define the complex trend in delta management approach and assumed the transformation of the delta system in this regards. I argue that the complexities, uncertainties, and conflicts associated with delta water management practices are transformed through concerted actions by multi-level actors and their institutions within a complex system relationship (Ison and Watson, 2007).

The key role of knowledge creation and learning is evident in an ever-changing delta system where imposed management interventions and human interference create more space for knowledge (co)creation, sharing, and a joint learning orientation within social networks (see Chapter 3). With this assumption, this thesis utilizes multi-stakeholder social learning as an overarching approach to the capacity of societies and communities to be more learning-orientated in the way they tackle major problems and sustainable development (Woodhill, 2004).

Learning and social learning for adaptive management

The theoretical background of this research builds on 'learning' and 'social learning' as they emerge in natural resource governance, environmental management, and sustainability education (Pahl-Wostl et al., 2007; Wals, 2007 and 2011), which includes multi-actor learning (Groot, 2002) in a complex nature and society relationship. From this perspective, a multi-stakeholder approach is a specific contribution to the broad idea of social learning (or participatory learning), covering a range of approaches operating at different levels such as the individual, organization, whole system and society (Pahl-Wostl et al., 2007; Rodella, 2011). Although much research has been carried out on the meaning and manifestations of social learning in the context of natural resource management all over the world (Pahl-Wostl, 2007; Sol et al., 2013), the concept has received little attention in environmental and social science studies in Bangladesh yet, specifically with respect to the dynamics, complexity, and context of adaptive delta management.

Adaptation may be reactive, concurrent, or anticipatory (Pelling and High, 2005), but always depends on the capacity of an affected system, region, or community to cope with the consequences or risks of system changes (Smit and Wandel, 2006). Key principles of building and enhancing adaptive capacity in a delta management system are learning to live with changes and exchanging knowledge (Tschakert and Dietrich, 2010). Adaptive capacity building implies explicit attention to learning from the past, present, and future of changing management and understanding the impacts or changes of community adaptation or lack of it. Multi-stakeholder (social) learning constitutes a multi-dimensional or multi-loop process seeking to improve a multiple-actor based management practice, which may eventually result in fundamental changes in practice and behaviour (Leeuwis and Pyburn, 2002; Keen et al., 2005; Brouwer et al., 2015).

In the conceptual framework, the learning process is assumed as lessons learned from the past, monitoring and analysis of trends of anticipated events, deliberate surprises, and anticipated change from known change, measures of further capacity, and design of decision-support tools for adaptive management (Tschakert and Dietrich, 2010). This learning process basically includes a cycle of discovery and renewal that keeps people and organizations thinking forward into a potential future. In a social learning perspective, the potentiality of information interpretation is considered high when there is a heterogeneity or diversity of stakeholders or actors (Wals, 2007).

Multiple-level stakeholder participation in land and water management systems sometimes is problematic due to the dominance of engineering mind-sets and technical control within a complex power structure (Wood, 1999; Warner, 2010) and conflicting state-society relationships. Consequently, my research also tries to understand the conflict-cooperation continuum, recognizing that conflict is an unavoidable event in this multi-stakeholder process. In fact, conflict may even represent an opportunity to develop co-operation capacity in a management system.

Conflict and co-operation in multi-stakeholder processes

Conflict and co-operation are both inevitable in a multiple stakeholder setting (see Chapter 4): among actors, and between established institutions and others who may cooperate in some instances and get involved, but will also resist at times, seeking to obstruct dialogue and negotiation processes (Warner and van Buuren, 2009). It is not simple to adopt an approach in framing conflicts, negotiations and inter-group interactions (Dewulf et al., 2009) in the perspective of managing a continuous system change. So, I have reviewed and integrated multiple theories of conflict and co-operation analysis in my study for exploring and learning the dynamics of conflict and co-operation to deal with effective interaction of multiple actors in a complex delta management system. In Bangladesh, competition and complexities in delta resources have increased significantly over the last few decades, not only between a diversity of interest groups, but also due to the establishment discourse of management interventions and role of management institutions (Murshed and Khan, 2011). This is happening because local and national water management institutions are weakly developed and little equipped to reconcile a diversity of interests and to provide sustainable management (Dewan et al., 2014). My research (Chapter 4) recognizes that proper knowledge of and information on dynamics of local and regional conflict and co-operation can provide important contributions to the formulation of new policies as well as to improved legal and institutional frameworks for water management (Funder et al., 2010).

Multi-stakeholder learning and partnerships for sustainable management

Integrated learning is a form of social learning that develops relational capacity between a community and social agents (Pahl-Wostl, Mostert, and Tàbara, 2008), which affects collaboration with other people and the overall responsive capacities of a socio-technical system. This kind of learning is perceived as a means to enable stakeholders to take advantage of the diversity in perspectives to generate more sustainable practices (Sol et al., 2013).

Stakeholders may have diverse levels of understanding and specific ideas, but together they can create new knowledge. On the other hand incomplete information is one of the main constraint in aiding decision-support to tackle risks in a management system (Bacic et al., 2006). So, multi-stakeholder participation and social learning have been recognized here as a useful research elements to complete an information system for developing collective interest and to improve capacity to enrich management adaptation. The final key concept in my thesis is "multi-actor participation" and ´learning integration´. That is to say, learning to co-ordinate action (Leeuwis, 2004) should be a process to improve any practice in which people could iteratively voice their own understandings, interpret other people's contributions, and share an understanding of learning tasks (Beers et al., 2009). Knowledge sharing within social networks - including scientists, government agencies, and other stakeholders - that occurs within an integrated process may develop generative participation and partnerships (Brouwer et al., 2015). The concept of 'partnership' in a participatory multi-stakeholder system refers to the way in which groups of people can make decisions and take action for the collective good, at local, regional, and national scales (Chapter 5).

In multi-stakeholder participation, different stakeholder groups come to a partnership with different levels of power related to their wealth, status, political connections, knowledge, and competence. Against the backdrop of my research, the multiple levels of stakeholders are interdependent, and multilevel change is assumed to proceed in an iterative and not necessarily sequential fashion. A learning partnership, too, is assumed to develop in an iterative fashion within a network (Pahl-Wostl et al., 2009) to evaluate a multi-stakeholder process.

1.5. Research Design and Methodology

To answer the research questions, an interdisciplinary research (Repko and Szostak, 2016) was designed using an integrated and participatory research methodology combining the natural science and social studies. The study area was identified on the basis of vulnerability to waterlogging and the dynamic history of TRM, which included both traditional community initiated practices and current formal practices. Field research was conducted in three districts in the south-west coastal delta in Bangladesh from 2012 to 2016. This section discusses the overall research approach; further details are provided later in individual chapters.

Participatory research approach

The major part of my research involved a participatory appraisal. This is a family of methods, which enable communities to share, develop, and analyse their knowledge of life and existing conditions (Chambers, 1981). By empowering local people to conduct their own modes of investigation, communities can plan and act on their own outcomes and develop more contextually grounded solutions (Campbell, 2001). To achieve this requires, researchers recognize the wealth and value of local knowledge and information through participatory approach. In my research, I have designed an intensive participatory method of investigation in which one of the key participant groups were rural community people in the Bangladesh delta.

Participatory learning and evaluation research in delta management takes place in the same way as the Rapid Water Management Appraisal (RWMA) method (Wester and Bron, 1996), which is in turn adapted from the Rapid Rural Appraisal (RRA) approach (Chambers, 1994). RWMA was especially developed for participatory research in Bangladesh with particular attention to existing water management issues and practices. The development of RWMA itself was done interactively by involving small teams of multi-level participants. The tools and techniques of this method were especially selected to enhance an understanding of local and regional conditions with special emphasis on tapping the knowledge of the local people (Wester and Bron, 1996). I have also conceptualized a common method of stakeholder analysis for defining the dynamic actor network (Hermans and Thissen, 2009) to deal with the complexities in delta water management. In my research, RWMA was used to investigate the delta system management, because it provides a better understanding of the interrelationships within and between TRM practices, stakeholders, and local governance. The methodological overview is shown in Figure 1.4.

Data collection and interpretation

To understand the TRM process better as well as the forms of participation and organization in delta water management in Bangladesh, different RWMA tools were used in different phases of the research:

a) Secondary data collection

- Study of international journal articles, published government and non-government policy reports, books, and discussion papers at global and national levels
- Bio-physical data - river system, wetland geography, water logging extent, and land use changes - were gathered in an institutional survey

b) Field research and primary data collection

Field research started in Bangladesh in November 2012. I conducted a national-level workshop conducted in Dhaka in December of that year to establish the research idea and to draw the background. During a preliminary field visit, I found that building trust in the communities (with local stakeholders) was the real challenge for a researcher intending to take a participatory approach in the study area. Coming a researcher from a university (rather than from the Water Board or any other government agency), I received maximum co-operation at community level. In January and February 2013, the field study was carried out for overall observation and conducting some informal public consultations (community meetings) in water-logging prone areas, particularly on the situation of TRM *beels* in KJDRP.

I started intensive field investigations using Rapid Water Management Appraisal (RWMA) in August 2013 and continued up to early December 2013. Individual interviews (semi-structured questionnaires) were conducted with the help of two research assistants under the NWO-WOTRO-IP Dynamic Delta Project. I continued field research on my own by facilitating public consultations and stakeholder meetings for collective evaluation. The fieldwork culminated in a regional workshop in February 2016 and the overall research concluded then with individual interviews with some national level stakeholders. In the

RWMA, I used the following tools and techniques of field investigation and primary data collection:

- Physical observations
- Informal discussion and non-structured interviews with key informants
- Informal community meetings and Focus Group Discussions in the TRM area
- Institutional survey at regional and national level (semi-structured interviews with local government, local BWDB officials, regional BWDB engineers and other professionals in government and non-government organizations)
- Random semi-structured interviews with community stakeholders

c) Synthesis of field research

I conducted three large local-stakeholder meetings (LSMs) and one regional workshop, both with multiple-level stakeholder groups, sub-groups and communities to enable social learning, dialogue and co-ordination of research findings.

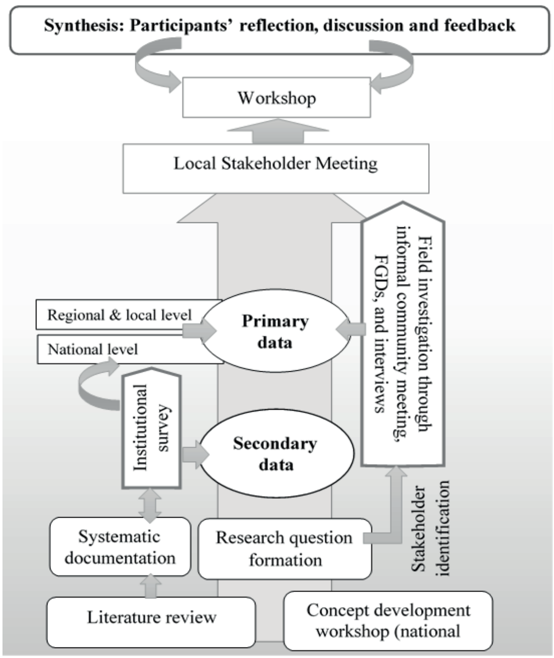


Figure 1.4: Overall methodological design of the research

1.6. Organization of the thesis

The thesis comprises six chapters. The introduction is followed by four chapters, which cover the key aspects of the research project. The text of each part was published earlier in, or submitted to, international journals as individual article.

Chapter 2 focuses on sustainable delta management transition: social, ecological and technological transformations in the south-western coastal area of Bangladesh. It explores the transition of delta management by following the history of the water-logging hazard and adaptation stimulated by Tidal River Management (TRM). A multi-dimensional system change is outlined that presents the integration of a socio-eco-technological approach in the entire management system applying TRM in a dynamic delta.

Chapter 3 describes social learning for adaptive delta management in the context of TRM practice in the Bangladesh Delta. It discusses the space of multi-level learning with respect to co-ordination and facilitation for stakeholders for a responsive and sustainable TRM in Bangladesh, particularly in times of increased flood (waterlogging) vulnerability.

Chapter 4 deals with conflict and learning to co-operate while adapting a local delta management system. It analyses the co-existence of conflict and co-operation in TRM in Bangladesh and its contribution to improve a multi-stakeholder process in local governance.

Chapter 5 is entitled 'Enabling Stakeholder Partnership for Sustainable Delta Management in Bangladesh'. It looks at problems and prospects of multi-stakeholder processes. Through participatory evaluation research critically analysed current problems and opportunities in organized participation and social learning. Results suggest multi-stakeholder learning partnerships to increase sustainability in delta management in Bangladesh.

The concluding **Chapter 6** revisits the initial research questions, summarizes and discusses the major findings, reflects on methods and methodology and formulates lessons and implications for policy and practice in adaptive and sustainable delta management.

Chapter 2

Sustainable Delta Management Transition: Social, Ecological and Technological Transformations in the Southwestern Coastal Area of Bangladesh

This chapter is under review for journal publication as:
Mutahra, M., Warner, J. And Khan, M. S. A. Sustainable delta management transitions: social, ecological, and technological transformations in the south-western coastal area of Bangladesh in *Journal of Regional Environmental Change.*

2.1. Introduction

Socio-economic development of Bangladesh is tightly linked with water and the water ecosystem because of its location within the largest delta of the world, encompassing the Ganges, Brahmaputra, and Meghna river systems (Jakobsen et al., 2005). Although flooding is a recurring phenomenon in this delta, waterlogging and drainage congestion had not been severe anywhere before the 1980s (Nowreen et al., 2014). Waterlogging is the result of long-term effect of large-scale structural interventions and polder construction in a continuous changing sediment loaded coastal delta (Tutu, 2005). This kind of slow flooding has become an ever-growing problem and caused severe socio-economic disruptions in the active delta region in Bangladesh like the south-west coastal delta.

Formal water resources management was introduced in the Bangladesh delta in the 1960s (that time called East-Pakistan), inspired by a global discourse on mega-structural engineering for flood protection and agricultural development particularly by following the Dutch dyke system (Dewan et al., 2015). The waterlogging problem became devastating first in the southwestern coastal districts like *Jessore* and *Khulna* due to long term effect of construction of embankments, dykes/polders and larger regulators on the tidal channels (Rahman, 2005; Kibria and Mahmud, 2010). De-touching the river channels from floodplains, constructed embankments/polders prevented silt from being spread out to the free catchment area. It caused huge load of sediment settled down in the bed of both tidal rivers and linked canals (locally called *Khals*) to the point that many silted up completely (Amir et al., 2013; Nowreen et al., 2014). The excessive sedimentation in the riverbeds raised water levels in the rivers higher than the polders and led to a permanent waterlogging problem in this area (Sarker, 2004). Consequently the state management authority had to change their mind to modify the delta management approach to resolve the waterlogging problems, re-store the tidal rivers, and develop further agricultural system in the south-west. Our present research tried to explore the trend of water management approach in the southwest delta in Bangladesh following the history of waterlogging and evolution of its possible solutions.

Our research focused on Tidal River Management (TRM) as an option in management technology which is currently practiced to prevent severe waterlogging and restore the tidal river system in a particular part of the south-west delta in Bangladesh. Although decision-makers had recognized gaps in the feasibility of constructing river and coastal embankments to provide effective management of this delta, they had not skipped structural management techniques yet (Brammer, 2010). In the meantime, TRM had introduced the concept of a local-knowledge based, 'soft', delta management technology highlighting multiple aspects of a delta resource system like environmental conservation (e.g., water and ecology), participatory interventions (e.g., institutions and technology), and agricultural development (e.g., water, land, and society). In this study, we assumed a unique system relationship between social, ecological, and technological resources to define the dynamics in the delta and delta management system. Our present research analysed the sifts in delta management approach and transformative changes in social, ecological, and technical contexts brought about by the evolution and formalization of TRM in the delta system where the main research questions were:

1) How does indigenous knowledge cause a transition of water management in Bangladesh?
2) How does social and ecological transformation occur in the delta system due to a change of management technology such as the application of TRM?

Although several technical research publications on TRM have appeared in the last five years, very few ex-post evaluations of TRM exist. While Dewan et al. (2015) examined the evolution of participatory water management in Bangladesh emphasizing policies and institutions, our research aims to step further to understand transitions in a multi-disciplinary system inter-relationship in a dynamic delta management process. The thesis attempts to shed light on the historical timeline in this regard and to provide a multi-dimensional system change analysis of TRM in the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) area in *Khulna* and *Jessore* Districts in south-west Bangladesh. In doing so, it will not discuss technical dimensions of TRM so much, but rather outline transformations in Socio-eco-technical system relationships stemming from TRM.

2.2. Conceptual framework

In our research, three major ideas and concepts related to a delta management system were studied:

a) transitions of management in a delta system
b) a delta is a socio-ecological system and delta management is a socio-technical system
c) transformation in a system trajectory includes changes in social, ecological, and technological relations.

2.2.1. Management transitions in a delta system

Theoretically, transitions refer to change in a dynamic equilibrium from one state of equilibrium to another. They are also referred to as a regime change (Smith et al., 2005), and are often seen as equivalent to or occurring with a paradigm change (Vanloqueren and Baret, 2009). Geels and Kemp 2007 distinguished between 'transformation' and 'transition'. Transformation in their view refers to a change in the direction of trajectories, related to an alteration in the rules that guide innovation. Transition refers to a shift to a new trajectory and system. It is widely assumed that science and technology should contribute to environmental management and policymaking (Bukowski, 2016). So, we argue that the use of a new technology or significant changes in an existing technology in a management system may trigger a transition of management.

As the deltas are a dynamic system, management technology could be changed based on the nature of hazards and their impacts. Researchers across the world have called for more emphasis on the role of societal actors in (re)shaping the earlier preferred use of engineer-based technologies in delta management. Further, social scientists dealing with technology have proved the significance of an approach that is integrated with scientists, policy-makers, users, and special-interest groups to the sustainable transition of management technology (Geels and Schot, 2007). As delta management transition is not a simple shifting of management technology or techniques, this concept needs to be supplemented by multiple criteria such as sustainability, socio-economic development, and environmental conservation (Benson and Clay, 2002). Similarly, delta management researchers are broadening their change analysis approaches as part of a shift towards a 'complexity paradigm' in environmental research (Manson, 2001; Manson and O'Sullivan, 2006). Therefore, we assumes that environmental management systems are increasingly complicated (due to the inclusion of social, economic and physical factors), complex and uncertain (due to the nonlinear relations between environment, society and technological domains), and as a result, increasingly contested (by a public less willingness to surrender power to traditional experts). There has also been widespread scope of interdisciplinary research on system transition in delta management by integrating natural and social sciences (Uyarra et al., 2017). In this study, we have tried to explore the delta management transitions based on history of water management practices and innovation in Bangladesh. In this context, we have argued that TRM is a new water management opportunity which caused systems change in delta management giving equal importance to natural conservation and social development.

2.2.2. *Deltas and delta management system in Bangladesh*

From a broader perspective of keen interaction between human actors and environmental processes, the largest deltas in the world are now being considered a socio-ecological system (referred to as delta-SES) (Berkes et al., 2002; Renaud et al., 2013; Van Staveren and van Tatenhove, 2016). In the Bangladesh delta, the SES concept has the following spatial characteristics:

1) an active tidal nature with terrestrial, mangrove, and brackish wetland ecosystems (Mutahara et al., 2016);
2) a natural resource-based socio-economic system; and
3) a coastal community that is mostly depending on an agro-ecological system; (Nawreen et al., 2014).

Most delta studies of Bangladesh were inspired by this SES concept and analysed it as a rural society with a floodplain eco-system that is vulnerable to tidal flooding, excessive salinity intrusion, and frequent cyclone and storm surge hazards (Islam and Gnauck, 2008). Water management is subject to technical intervention to modify the spatial or temporal process in a water system by managing natural hazards (Young et al., 2006). Delta water management may be defined as a socio-technical system (Wester and Bron, 1996) in which physical and social processes are closely connected to coastal hazards and risk reduction.

The concept of a management system is defined here based on the relationship between the environmental processes, societal activities, and management technology (or tools), which previously had been used in a socio-technical approach in irrigation system analyses (Kloezen and Mollinga, 1992; Vincent, 1997; Mollinga, 2003). In the last couple of decades, delta management research in Bangladesh has strongly argued that large-scale, structural interventions are not effective for delta management in the country. As it had already experienced a severe waterlogging problem in the South-west (Tutu, 2005; Brammer, 2010), a national discourse had evolved about using a delta management technology with equal emphasis on ecological conservation, agricultural development, and social participation (CEGIS, 2003).

In the case of south-west Bangladesh, Amir et al. (2013) argued that TRM is an eco-technological approach with the potential of solving this waterlogging problem and improving agro-ecological development. Identifying various combinations of social, ecological, and technological aspects in delta water management literature, our study suggests a combination of these three in a triangular (Δ) arrangement - a Socio-Eco-Technical (S-E-T) system- for better understanding of and learning about the dynamics of delta management transformation (Figure 2.1).

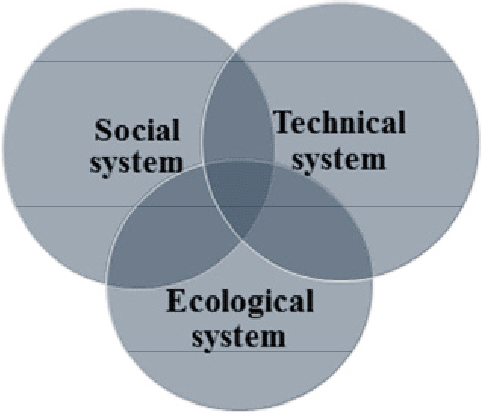


Figure 2.1: Triangular management approach: the delta Socio-Eco-Technical system

2.2.3. Transformations in a delta system: interrelations and changes

There are multiple perspectives on how to approach the dynamics and changes in socio-eco-technical systems in a management transition. In our approach, delta water management is embedded in multi-perspective changes in social structures. According to Waddell (2013), three types of changes may occur in a system: incremental, reformative, and transformative. Transformative (systemic) change is the most complex and challenging (Brouwer et al., 2015). Our research argues that systemic change or transformation took place (Waddell, 2013) in a delta system with the initiation of TRM, because this delta water management system was developed with complex and multiple perspectives. Therefore, management transitions in a dynamic system appear that the technology is mediating not only with the changes in people's actions to bio-physical domain, but also shaping or being shaped by a relationship between society, ecosystem, and management policy and technology (Van Staveren et al., 2017). Central to this theory is evolved here on how mutual interaction between the social system and the delta ecosystem takes shape and transforms as a result of changes in delta management technology over time (Geels and Kemp 2007). This concerns both historical timescales (how past practices influenced and have directed present practices) and a present timescale (how present practices affect the delta system and influence social processes).

In our study, transformation was investigated within a framework of three inter-relationships in a delta system (Figure 2.2). Such transformation was defined as bio-physical changes (e.g., delta management practice impacts the water system), socio-institutional changes (e.g., delta management practice involves social actors), and socio-economic changes (e.g. a delta social system depends on the water system). The outcome aims at contributing to a better understanding of the multiple system dynamics of a delta with complex management transitions (Fischer-Kowalski and Rotmans, 2009) in the South-west Bangladesh delta.

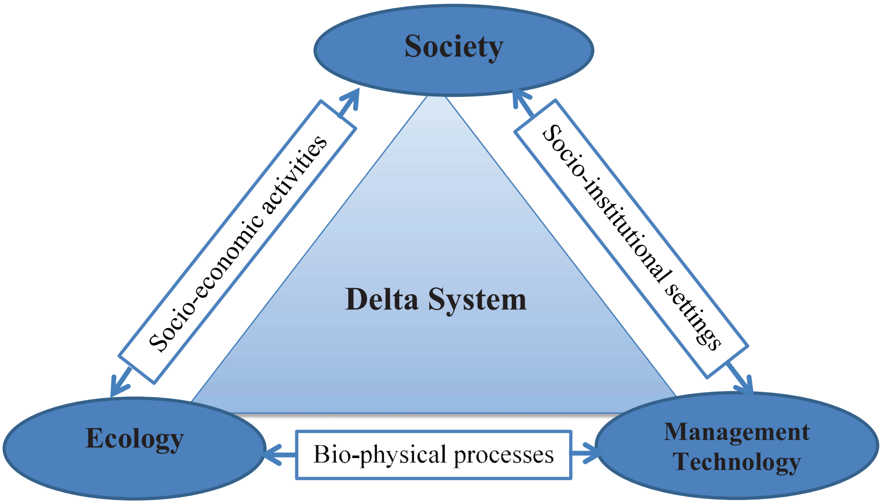


Figure 2.2: Transformations within the Socio-eco-technical system in a dynamic delta system

2.3. Research Area: Khulna-Jessore Drainage Rehabilitation Project

The *Khulna-Jessore* Drainage Rehabilitation Project (KJDRP) (Paul et al., 2013) is the latest and largest water management project in the South-west region of the Bangladesh delta. The Project covers an area of approximately 100,600 ha including 800,000 people in *Khulna* and *Jessore* Districts (Figure 2.3). It includes 27 *beels* (wetland/depressed landforms) within three main tidal river catchments - the *Upper Bhadra* system, *Mukteswari-Hari* system, and *South-eastern/Sholmari* system. For our study, the KJDRP area had been selected as research area, because, firstly, people of this area had already been suffering much due to waterlogging since the 1980s and, secondly, most of the informal (referred to as a 'public cut' in *beel Dakatia* and *beel Bhaina*) and formal (*beel Kedaria* and *beel Khuksia*) TRM practices have

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been taking place in that project area. The total KJDRP area was considered to analyse bio-physical and institutional perspectives, whereas specific villages within the catchment of the *Mukteswari-Hari* river system were selected for a participatory, social investigation. These study sites included *Keshabpur and Monirampur Upazilla* in *Jessore* District, and a part of *Dumuria Upazilla* in *Khulna* District.

2.4. Methodology

A mixed-method approach was used in which both qualitative and quantitative data were collected from secondary and primary sources in the KJDRP project. Preliminary investigation and literature reviews helped articulate the research background and develop the main hypothesis and concepts for analysis. A base map of the study area was taken from KJDRP project reports prepared by CEGIS (2007 and 2014) (See Figure3). The bio-physical change analysis was designed using hydro-morphological data, relevant images, and physical model data (historical and recent) from published reports and research findings in KJDRP project studies conducted by government and non-government organizations as also from research institutes.[1] The field study followed principles of Rapid Water Management Appraisal (RWMA) (Wester and Bron, 1996), which is an adaptation of Participatory Rural Appraisal (PRA) techniques [http://www.fao.org/docrep/006/w2352e/W2352E03.htm]

1 Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modelling (IWM), Bangladesh Water Development Board (BWDB), and Institute of Water and Flood management (IWFM). Demographic and other required information was found from the Bangladesh Bureau of Statistics (BBS), National Water Resource Database (NWRD), PDO-Integrated Coastal Zone Management office (WARPO), Asian Development Bank, Bangladesh University of Engineering and Technology (BUET), some local NGOs, and relevant websites.

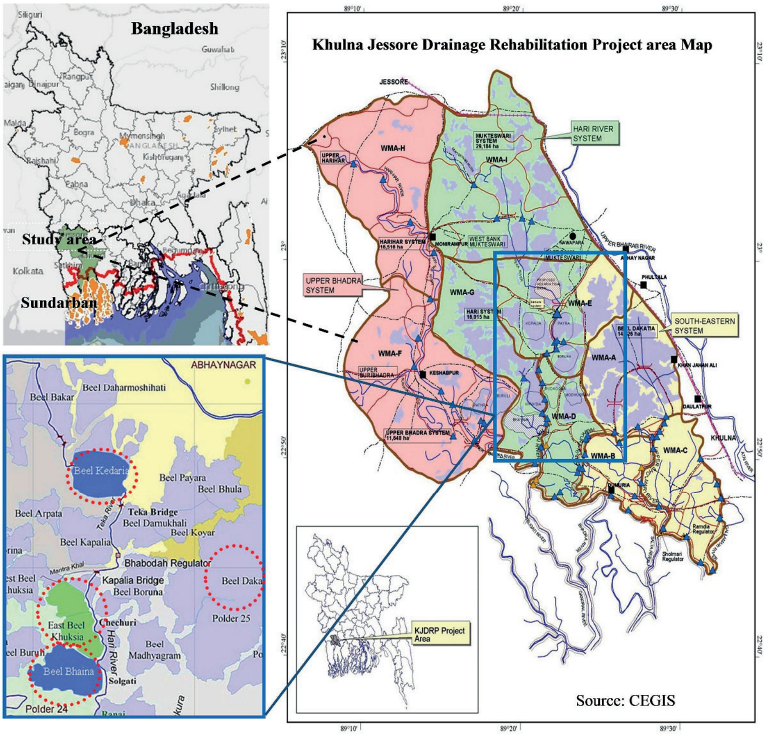

Figure 2.3: Study area in KJDRP under the South-west coastal districts Jessore and Khulna (Source: CEGIS 2003, 2014)

Formal and informal participatory tools were used in the study area during the field investigation from 2012 to 2015. In the beginning several informal community meetings and 15 Focus Group Discussions (FGDs) were conducted with local farmers and fisher groups as well as school teachers, business groups, and others. Elderly people were encouraged to talk about the history of water management in their areas including traditional and current practices. A timeline on current water management initiatives was drawn in the field (Figure 2.4) to express the transition of water management in local perception.

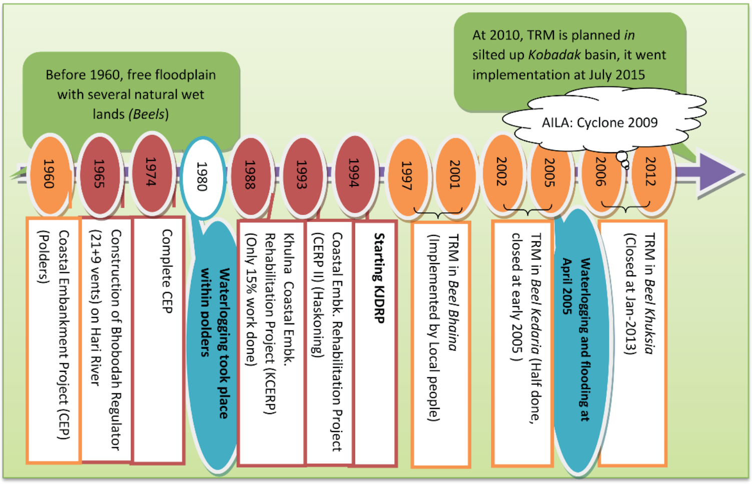

Figure 2.4: Timeframe of water management interventions in the South-west Delta in Bangladesh (Put together from participants' hand-drawings in FGDs)

For the socio-economic and socio-institutional change analysis, semi-structured interviews (SIs) were conducted during 2013-2014, mostly in *beel* surrounding villages. The sample villages were randomly selected observing their location in the periphery of *beels* with TRM and based on their maximum dependency on the *beel* system according to community perception. A GPS survey was conducted in *beel* surrounding areas in September 2013 to map the sample villages[2] in the Hari River catchment within the KJDRP area (in Figure 2.5, the black points show the selected villages for SIs and the location of FGDs). Respondents were mainly landowners, landless farmers, fisher folks, day labourers, shopkeepers, and housewives. Those interviews provided data on their agricultural systems, land use and productions, livelihoods, income changes, and the like.

[2] The sample villages were *Arua, Santala, Kismat Santala, Moynapur, Kalicharanpur, Agorhati, Bhorot Bhaina (Keshobpur Upazilla, Jessore), Kapalia, Manoharpur, Nehalpur, Balidaha, Pachakuri (Monirampur Upazilla, Jessore*)

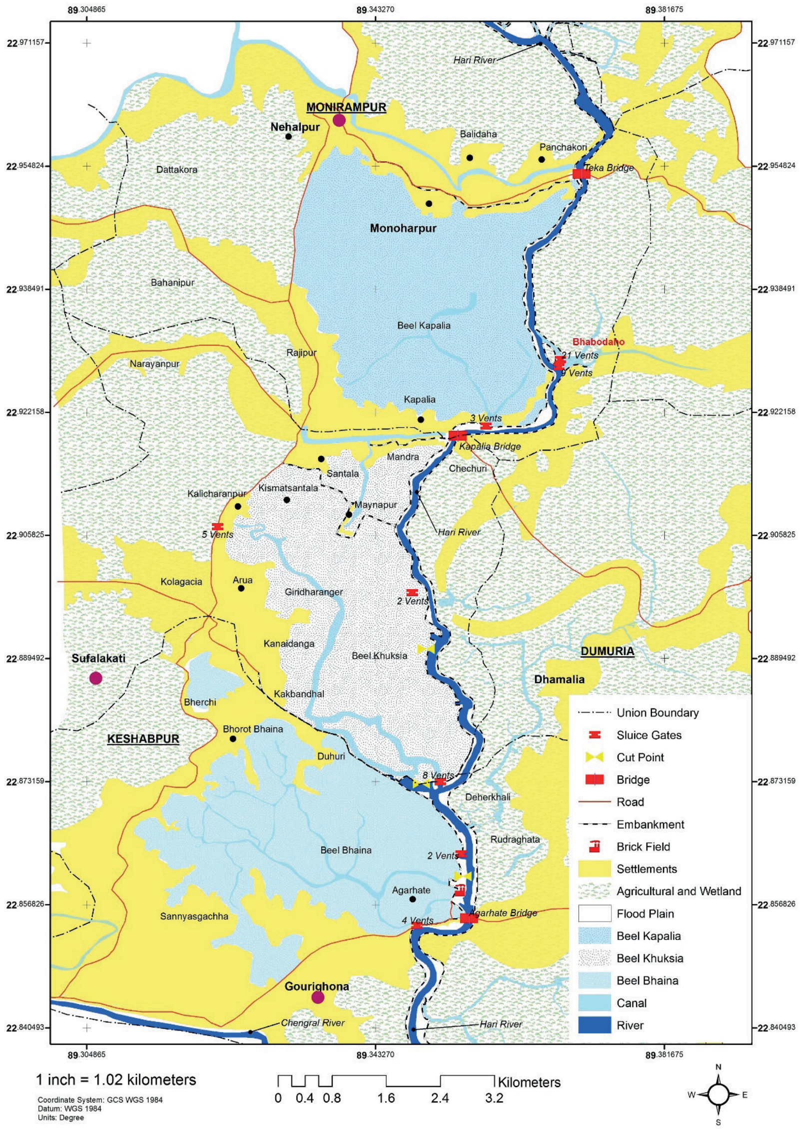

Figure 2.5: Sampling area surrounding the TRM beels in KJDRP (Small black points shows villages for interview and large pink points shows the locations of PCM)

Interviews were also conducted with teachers, social workers, and political and community leaders. Representatives of relevant government and non-government organizations such as

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Local Government Institutions (LGIs) and upazilla level offices of the BWDB, Department of Fisheries, and Department of agriculture were interviewed to cross-check and clarify synthesized results of the community-based investigation in the TRM areas of study.

To integrate and synthesize findings from the field research three large-scale Public Consultation Meetings (PCMs) were conducted in the study area during May to July 2015 with 30-35 participants from different local level stakeholder groups. We have defined those meeting as Local Stakeholder Meetings (LSMs). These meetings provided an opportunity to move away from a purely dialogue-based approach and encouraged stakeholder involvement to collective action and participatory evaluation (Wates, 2000; Chambers, 2002). In these sessions the Socio-eco-technical (S-E-T) approach for delta system analysis was defined and stakeholders' feedback on it was invited. The majority of stakeholders supported this analytical approach and contributed to the transformation assessment, which the authors had made with respect to system relationships and components of changes in a dynamic delta.

2.5. Results and Discussion

2.5.1. Transitions of management in the South-west delta

Our research found that the overall delta management approach in the South-west region of the Bangladesh Delta had moved away from traditional small-scale, temporary poldering to the current, formal TRM process. Figure 2.6 gives a systematic diagram of management transitions in that area.

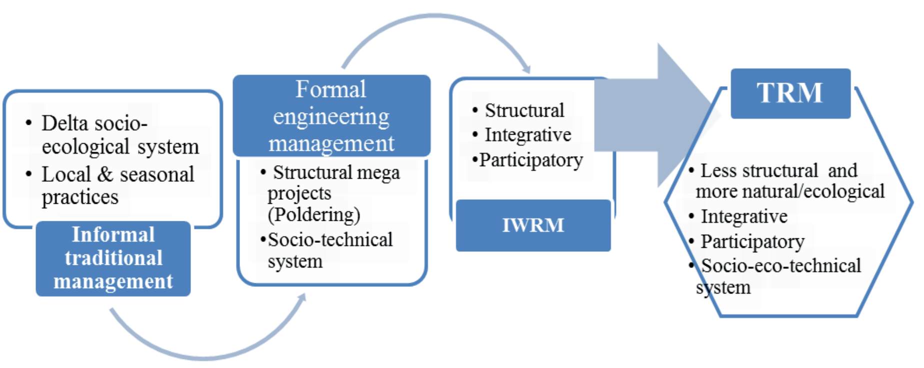


Figure 2.6: Changes in water management approach in the South-west delta in Bangladesh

a) From traditional management to formal structural management

In the Bangladesh Delta, historically people used to follow local-knowledge based, temporary delta management practices. In the South-western part of the coastal delta, people used a different approach to protect their agricultural lands from flooding and saline ingression. Construction of freshwater reservoirs (‘*Jwaradhars’*) or earthen embankments (‘*Bandhs’*) for the eight dry months of the year (November to mid-June) are good examples of it (Tutu, 2005). During the monsoon months, natural river floods would sweep away the temporary embankments, and floodplains gained silt, which would make their lands more fertile.

Shifting from a traditional approach, formal water management was introduced in the Bangladesh delta with the large scale Coastal Embankment Project (CEP) proposed by the East Pakistan - Water and Power Development Authority (EP-WAPDA) after severe flooding in 1954 (Dewan et al., 2015). This hard-core, hydraulic engineering project was completed in 1975 covering over 400,000 hectares of area along the entire coast. Under the CEP, the largest structural interventions of 37 polders and 1566 kilometres of embankment were constructed in the *Khulna* Circle, the most south-western part of the delta (Leedshill, 1968; Nowreen et al., 2014). Positive outcomes from this initiative were found in the first 10-15 years but proved unsustainable. Within one decade after completion of the CEP, delta dwellers faced a major impact of the full flood-control project in a sediment loaded, dynamic delta system. Polders de-linked floodplains from rivers, and sediment had been deposited on river beds. After the *Farakka Barrage* (constructed in the Indian part of the Ganges in 1975) became operational, the upstream water flow was decreasing in the *Mathabhanga* and *Gorai,* and other main distributaries of the river Ganges, significantly in the Bangladesh part (Sarker, 2004). As there was far less water pressure from upstream, most rivers in the study area had begun silting up by trapping the huge sediment load coming downstream in the months of March, April, and May. In most cases, the elevation of the river bed became higher than the embanked floodplains, and caused severe waterlogging within the polder.

This study found that severe waterlogging had been taking place in *beel Dakatia* area in *Khulna* district since 1982 (Rahman, 1995). The Bangladesh Water Development Board initiated the first phase of the Coastal Embankment Rehabilitation Project (CERP-I) and the *Khulna* Coastal Embankment Rehabilitation Project (KCERP) in December 1986 (ADB, 2007). The CERP II started in 1989 as a larger project and continued up to 1994 in the *Khulna* region. When all coastal rehabilitation projects followed the previous structural approach, local people raised their voices against huge structural interventions. Afterward, a very large area in coastal polders in-between *Khulna* and *Jessore* Districts became waterlogged since 1990 due to rapid siltation of the *Solmari, Hamkura* and *Hari* river systems. Consequently, the connecting tidal channels (locally called '*Khals'*) became inoperative. As the Water Board failed to take effective management to remove stagnant water from the locality, lives and livelihoods became endangered.

b) From poldering to de-poldering: the current transition of delta management

In September 1990, the polder of *Dakatia beel* was breached (called 'public cut') by community people to remove stagnant water and allow free tidal movement into the *beel* (SMEC, 2002; de Die, 2013; van Minnen, 2013). With regular tidal actions and the accumulation of alluvium, the land formation process resumed in the *beel* area. Within two years, from 1990-1992, about 1000 hectares of high land (silted up) emerged from the *beel* area and rice was cultivated on new land in October 1992 (Tutu, 2005; Community meeting, 2012). Although the communities practiced the tidal management successfully without any government support, the management authorities did not change their approach. Worse, the BWDB asked the armour to stop the sedimentation practice in *Beel Dakatia* in 1994. So, while authorities had initiated the largest drainage rehabilitation programme, that is, the KJDRP, to solve this waterlogging problem, they did not change their hard-core, structure approach. However, they also proposed an Integrated Water Resource Management (IWRM) approach suggesting a more participatory process for sustainable delta management, which is the latest discourse on water management all over the world (Rouillard et al., 2014).

The KJDRP ran from 1994 to 2002 with financial and technical support from the ADB and the Dutch Government (EGIS I, 2001). In the initial phase, the Project emphasized structural solutions, but they failed to achieve the long-term project benefits (ADB, 2007). As destructive waterlogging became a regular issue in the *Hari-Mukteswari* and other two river basins, a heated debate sprung up again among the local community, NGOs, and government authorities about the feasibility of an 'inclusive', structural solution.

During this research, elderly people in the *Bhabodah* area shared about their experience with the huge rainfall in the monsoon of 1997, which had caused waterlogging in most of the *beels* in the *Teka-Hari-Mukteswari* catchments. People lost their crops and settlers in the *beels*' surroundings were suffering much. People then made two public cuts in the BWDB embankment of *beel Bhaina* along the *Hari* River in October 1997 (SMEC, 2002) to drain out stagnant water from the villages and the *beels*. Although the BWDB took legal steps against the community, they could not ignore the effectiveness of their tidal basin management. Afterward, due to strong interest from international donor agencies (ADB,

2007) and pressure from communities and civil society, the concerned authority asked for scientific studies on *beel Bhaina*. These government commissioned studies advocated looking at opportunities for an alternative, ‘soft’, system management technology, which would equally regard ecosystem conservation and socio-economic development in the country (CEGIS, 2003). This argument boosted the formalization of Tidal River Management (TRM) in the South-west delta management system in 2001, which also complies with regional, floodplain ecological insights (Haque, Chowdhury and Khatun, 2015). A schematic outline of water management initiatives and major changes in the management system in the South-west delta in Bangladesh are shown in Table 2.1, based on participatory mapping of an historical time scale (see Figure 2.4) in the field study (2012-2013) and an institutional survey (2012-2015).

Table 2.1: Historical timeframe of delta water management transition in the South-west area of Bangladesh

Historical time scale	**< 1954**	**1955-1964**	**1965-1974**	**1975-1984**	**1985-1994**	**1995-2004**	**2005-2014**	**2015 <**
Management strategy								
Informal / traditional								
Formal engineering/structural								
Integrated but structural								
Integrated considering soft measures								
Management practices								
Small-scale and short-term seasonal embankment								
Coastal polder and large structures, e.g., regulator and sluice								
Flood control, irrigation and drainage project								
Coastal embankment rehabilitation project, i.e., KCERP, CERP II								
Khulna- Jessore Drainage Rehabilitation Project KJDRP								
Tidal River Management (TRM)							x	x
Participation approach								
Local community								
Government authority								
Multi-stakeholder participation								
Delta management transition								
Socio-ecological system								
Socio-technical system								
Socio-eco-technical system								

Here, x = no current action in KJDRP area

Tidal River Management (TRM) is the latest innovative approach in dealing with basin-scale management in tidal river catchment in Bangladesh (Amir, 2013). The evolution and process of TRM is shown in Figure 2.7a and 2.7b relatively. TRM, from a physical perspective, means the opening of an embanked *beel* to allow regular tide, so that it becomes a tidal basin. Enormous amounts of sediment coming with high tides are deposited in the basin and then sediment-free water flows back to the downstream, thereby naturally dredging the river (Shampa and Pramanik, 2012). This process keeps the river capacity high enough for proper drainage of the embanked *beels* and the catchment. In addition, the land level in the tidal basin rises and can be used for agriculture at the end of a TRM intervention (EGIS I, 2001; IWM, 2005; van Minnen, 2013). TRM is, therefore, a natural water management process and requires assistance from small-scale, structural interventions like pipe sluices and 2-3 vent regulators. At the same time, it needs a strong community participation and effective action along with commitment and sacrifice by local stakeholders during a TRM period.

After formalization of TRM, the BWDB was planning a one-shot, temporary intervention in *Kedaria beel* in the North-western part of the KJDRP area by opening the *Bhabodah regulator* in January 2002 (CEGIS, 2007; de Die, 2013;). However, the *Beel Kedaria* tidal management had to be suspended in March 2005 at the instigation of landowners. As severe sedimentation was taking place in about 17 kilometres downstream from the regulator in the *Hari* river system from April to November 2005 (IWM, 2010; van Minnen, 2013;), the BWDB realized the importance of continuing tidal basin management in that area. After that they planned a similar approach in *Beel Khuksia* in April 2006. This time, the basin management system was officially introduced as Tidal River Management (TRM). While this TRM opened in November 2006 with a four-year plan (IWM, 2007), it was continued until early 2013.

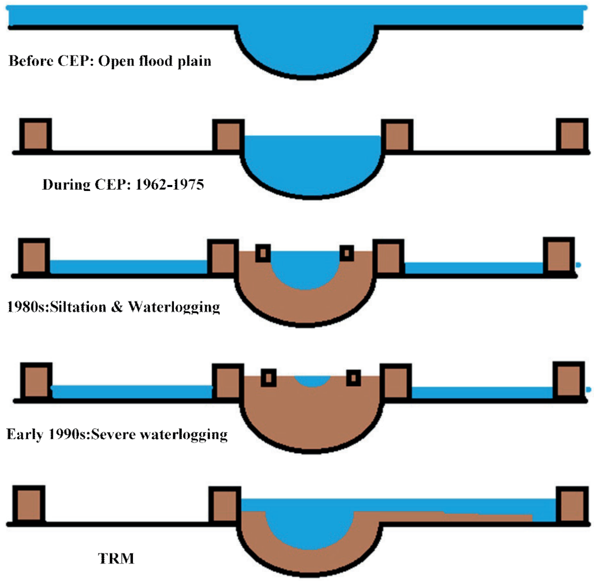


Figure 2.7a: Evolution of TRM in delta management in the South-west of the Bangladesh delta (Redrawing from van Minnen, 2014)

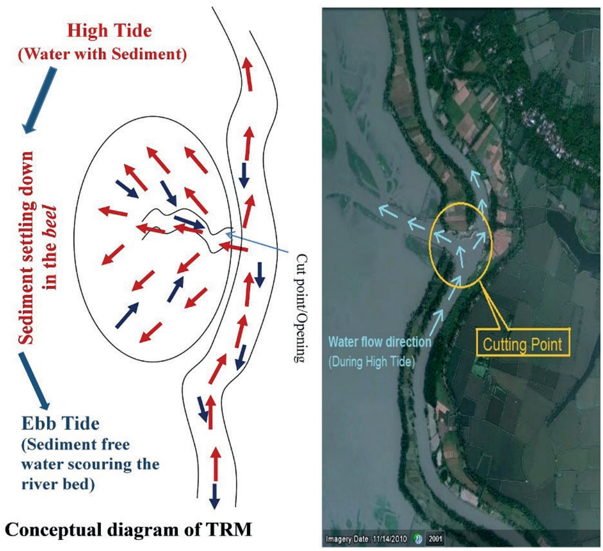


Figure 2.7b: Process and practice of TRM in delta management in the south-west delta (CEGIS, 2007; Paul et al., 2013)

2

2.5.2. Transformations in a delta system occurred due to TRM

In view of (assumed) indestructible inter-relationships in a delta Socio-eco-technical system, transformations happen with changes in bio-physical processes, socio-economic activities, and socio-institutional settings. A participatory analysis of significant changes and consequences was developed, both qualitatively and quantitatively, in the context of social, ecological, and technical system relationships in the southwest delta using TRM based timeframe (Table 2.2).

Table 2.2: Time scale for analysing delta system transformation in KJDRP area

Time Scale	Management practice
Before TRM (Up to 1996)	Following objective of CEP: construction of polders, permanent embankments, regulators and sluices, and drainage; excavation and dredging.
	KJDRP started
During TRM (1997- 2013)	*Bhaina* TRM (1997-2001)
	Kedaria TRM (2002-2005)
	Khuksia TRM (2006-2013)
	Kapalia TRM (postponed)
After TRM (2014 - now)	No TRM again

a. Change in bio-physical processes

Use of management technology, either hydraulic engineering or any other interventions, may change the environmental (and ecological) processes in a dynamic delta in a positive or negative manner. In the KJDRP area, transition of management by implementation of TRM has changed bio-physical processes as outlined below.

Tidal river system

An historical review showed that CEP had caused major barriers to tidal river systems in the South-west, in particular, construction of a large 21-vent regulator in *Bhabodah* (done in 1964-1965) had been obstructing the *Teka-Hari-Mukteswari* river flow since the late 1980s. Sedimentation in the river bed became extensive and waterlogging had taken place regular during the late monsoon since 1996.

Our study found a scenario of changes in the *Teka-Hari* river system over the last two decades according to data collected from modelling studies of the BWDB conducted by the Institute of Water Modeling (IWM, 2007; IWM, 2014). The result shows that regular tidal influence was insignificant in most of the river systems in the KJDRP area up to 1996. The tidal volume in the *Hari* River was found to have increased in September 1996, though, on account of some major river excavation as part of rehabilitation activities. As can be seen in Figure 2.8, a significant change in tidal flow was found after informal and formal TRM implementations in *Beel Bhaina* and *Beel Kedaria* (after 2005).

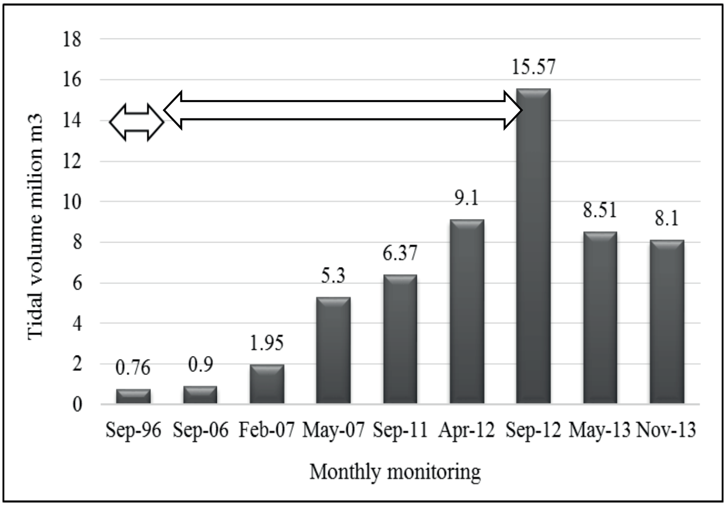


Figure 2.8: Tidal volume before, during, and after TRM in Hari River (at Ranai point) (Source: data from IWM, 2007 and 2014)

During TRM in *Beel Khuksia,* the tidal volume of the *Hari River* was over 5 million cubic metres in May 2007, which was 6 times more than pre-TRM. This tidal volume has become even 17 times higher (from less than 1 to almost 16 million cubic metres) after TRM started in *Beel Khuksia* in 2012. The river cross-section at *Ranai* point (measurement station of the Teka-Hari system in the Project) significantly improved between 2007 and 2011, which is shown in Figure 2.9. The river cross-section at the same point was calculated as -9.25 metres PWD in January 2013, just before closing the *beel Khuksia* TRM (last monitoring report of IWM was in 2014). During our field study, within eight months after the closing of the TRM in September 2013, a 5.5 metres deep siltation was measured downstream of the *Bhabodah* regulator in the *Hari* system (field observation, 2013; IWM, 2014). This shows that the conveyance capacity of the river had begun to reduce again after the closure of the TRM in the KJDRP area.

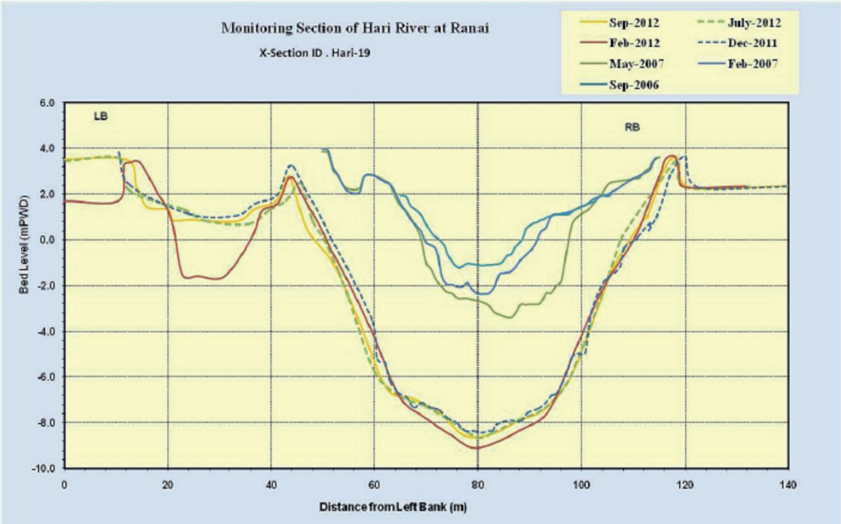


Figure 2.9: River cross-section at Ranai of Hari River from 2006 to 2012 (Source: IWM, 2014)

Waterlogging extent in KJDRP

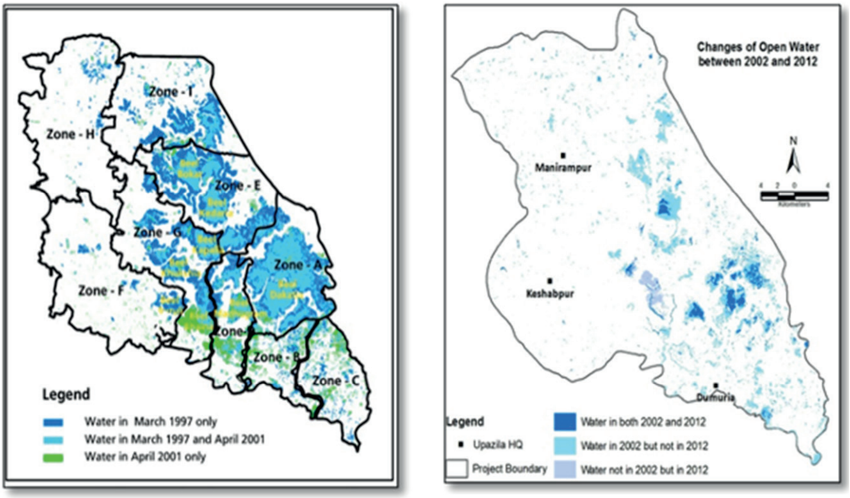
Public consultations and some investigation at local NGOs gave a statistical view of waterlogging in different river catchment areas in the South-west. Table 2.3 shows the historical waterlogging extent in the *Hari* system.

Table 2.3: Participatory analysis of waterlogging extent in KDRP area

Waterlogging area in hectares	Year					
	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2009
Hari river	3100	7300	1200	No	No	No

(Sources: Institutional survey, 2013; Public consultation, 2015)

In community views, after implementation of informal TRM in *Beel Bhaina* (1997-2001) waterlogging was significantly reduced in the *Hari* catchment and also from total KJDRP area. It was validated by institutional data as a change in open water area (extent of waterlogging) within the KJDRP as shown in Figure 2.10 based on image data collected from CEGIS (2007 and 2014). In Figure 2.10a, waterlogging in the KJDRP in early 1997 (deep blue colour) was significant. Most of the light-blue areas represent a mixture of very shallow, swampy water with aquatic grass (not yet ready for paddy cultivation) and some moist soils at the time of imaging during *Bhaina* TRM in 2001. Interestingly, in early 2001 the waterlogging was insignificant (green colour). The extent was reduced by almost 7 % in the total KJDRP area from 2002 to 2012. In the image of 2012 (Figure2.10b), some new open water was identified inside the *Khuksia beel area* because of a tidal influence within the TRM that had been in operation since end 2012.



(a) **(b)**

Figure 2.10: Change of water logging and open water area (Source: CEGIS 2007, 2014)

Changes in land cover

The implementation of TRM caused major changes in land use in the South-west delta. The change of land cover in the KJDRP area is shown in Table 2.4 and Figure 2.11 based on data collected from CEGIS (CEGIS, 2007 and 2014). According to numerical data, open water areas have significantly decreased from 1997 to 2012 and, as a result, these areas are replaced by increasing agricultural land and settlement. Agriculture land has increased by about 24% from 1997 to 2012 in the total KJDRP area.

Table 2.4: Land use changes in KJDRP area

	Area in Hectares (Ha)		
Land Use	Before TRM (1996-1997)	During TRM (2001-2002)	Just after TRM (2012-13)
Open water	26,156	8,558	2,556
Agriculture – land (Production area)	47,282	68,187	71,543
Settlement	27,162	30,464	33,111

Source: CEGIS, 2003; CEGIS, 2014.

Figure 2.11 shows similar changes in land coverage in 2002 till the end of 2012. Although apparently agricultural land has increased significantly, in fact, crops and fish are cultivated by rotation in most of this type of land. As a case in point, after implementation of the *Beel Khuksia* TRM (2013-2015), most of the land in this *beel* was used mainly for shrimp culture.

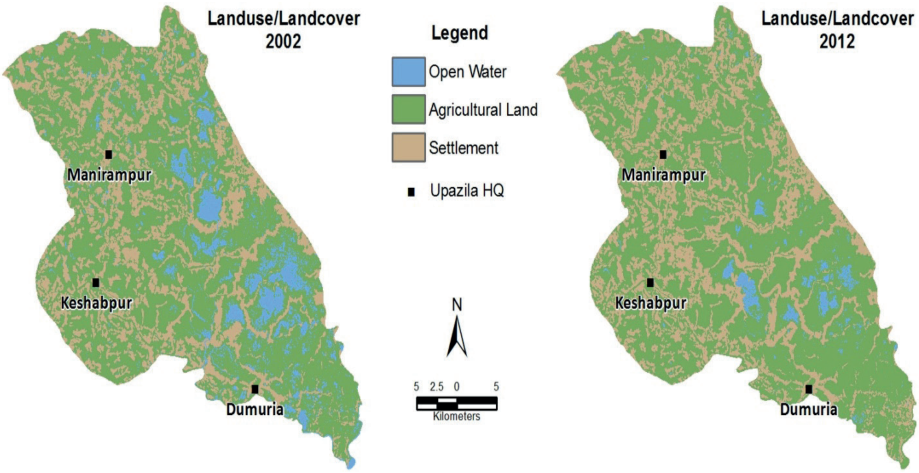


Figure 2.11: Changes in land cover in the KJDRP area as result of TRM (Source: CEGIS, 2007 and 2014)

Salinity level

The changes in tidal flow have brought about a change in the salinity level of surface water, which is one of the major indicators of an ecological transformation. Most of the KJDRP area experienced regular tidal action twice a day. Due to severe siltation of the local river systems this action became irregular, before the KJDRP was implemented.

Due to TRM in *Beel Bhaina*, tidal action was restored in the Teka-Hari-Mukteshwari system, while in the dry season (March-April) the salinity level in the river and surrounding *beel* area was at an average of 10-15 ppt in 2000-2001(EGIS I, 2001). After that TRM was being implemented in 2002-2013 in *Beel Kedaria* and *Beel Khuksia* with some time gap. The salinity level became higher in the TRM beel areas, while it was lower by an average of 2-5 ppt in the rest of the area. In contrast, during 2012-2012 the salinity level in river and beel area was within 3-8 ppt (CEGIS, 2014). The main cause of salinity fluctuation in *beel* water is caused by a huge practice of salt water shrimp culture. Although one of the major goals of implementing TRM was to increase rice production, this shrimp production has become dominant in recent years in this area. It is not exactly environment friendly in a dynamic delta system.

b. Changes in socio-economic activities

In a rural coastal area of Bangladesh like the KJDRP area, society as well as life and livelihoods are mainly dependent on land use practices, specifically agriculture and production. Transformation was analysed here in the context of socio-economic changes in areas surrounding TRM *beels* in the KJDRP area in a participatory approach. Some secondary data were taken from institutional studies in LGIs, the Agricultural and Fisheries Departments, and CEGIS.

Changes in production pattern

Historically, the production system in this area indicates agricultural crop production. There are two distinct cropping seasons in a year. One is the *Kharif season*: *Kharif*-1 (March-June) and *Kharif*-II (July-October), mainly represented by the production of *Aus* rice and *Aman* rice. The other is the *Rabi* season (November - February), in which dry-season rice, vegetable, and pulses are grown. In our study area one-third of the *beel* grew only Aman rice due to low land-level and long-term waterlogging. Community perceptions and records of LGIs show a new dimension in the cropping pattern in the study area on account of shrimp farming since 1990s. It was not significant in the KJDRP area in 1996; now, apparently, the intensity of shrimp culture (both saline and fresh water) is increasing. After the introduction of formal TRM, a new agro-fishery mixed production pattern is showing up in the study area.

Figure 2.12 shows the present production pattern (on a 100 % scale) in the relevant *beels*.

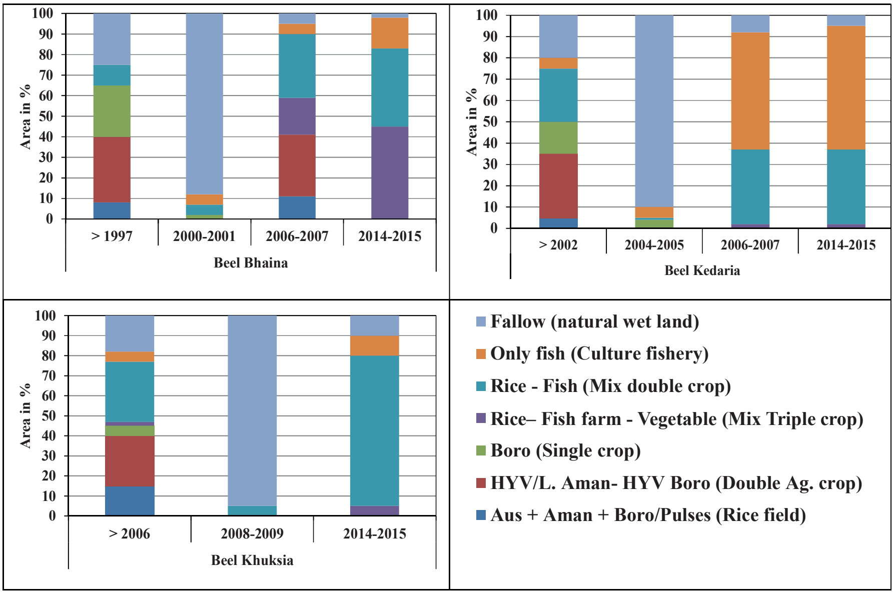


Figure 2.12: Changing pattern of production in the study area (Field survey, 2013-2015)

In current analysis, an agriculture and fisheries mixed (double and triple) cropping pattern is found in the *beels* of the study area. In *beel Bhaina*, an incredible growth of vegetable production appeared with a mixed culture of rice and fisheries. The recently developed land area in *beel Khuksia* has been used mostly for rice and shrimp culture. Such changes in cropping pattern and intensity have influenced livelihoods and income generation in these localities.

Major changes in livelihood system in KJDRP area

The livelihood system in the KJDRP area had been dominated by local *beel* resources with limited external sources of income. Before implementation of the TRM, income generation was mainly driven by crop cultivation and capturing fish in the *beel* area. While coastal shrimp culture had been prominently extended since the 1990s, it was not practiced extensively in the KJDRP area. Now, after TRM implementation, people in the *beels* have taken up more fish culture than agriculture. Our research identified a significant change in livelihood within the last one and half decade, after the introduction of TRM in the area.

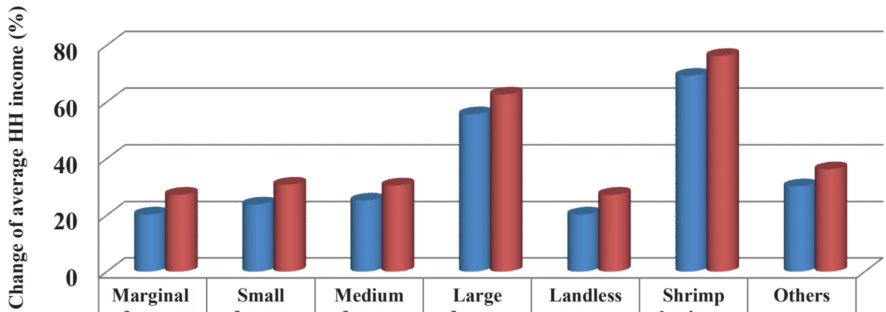
Figure 2.13 shows changes in livelihood systems with water management situations in areas surrounding the *beels*.

Figure 2.13: Livelihood system changes in Hari river catchment area in KJDRP (Field survey, 2013-2015)

In each case, a loss of major livelihood was noticed in surrounding villages during running TRM in the beel. Community people observed that small farmers and day labourers were suffering most. Small and medium farmers had fewer working opportunities and needed to seek alternatives. Small farmers in some cases worked as day labourers or turned to fishing in *beels* and rivers. Women from farmer families had to go also for daily labour and fishing in the *beel.* Particularly those who had no land and were dependent on wages from agricultural work in the *beels* had completely lost their sources of income. However, after TRM, a big shift was found in livelihoods. Most of the farmer community had turned to crop farming-cum-fish culture. Large shrimp businesses were started with external investment. Some people became involved in small businesses related to fried shrimp supply and fish-feed industry. Another new market opportunity was developed thanks to an increasing production of vegetables in the *beel* area.

Changes in income situations

TRM also resulted in changes in living standards, triggering a generation of more income opportunities on account of new production systems in the area, thus opening up ways to better livelihoods and income as well as secure food for today and tomorrow. Household incomes and food security levels in the area have undergone sea changes from 1995 to 2015. At present, farmers grow more than one crop every year. Single-crop lands occupy around 4-14% of the entire study area, whereas double-crop and triple-crop lands occupy about 50-98% in the three main TRM *beels* (Field survey, 2013-2015). Based on landownership, production system, and new livelihood opportunities, a participatory assessment was conducted in the study area to find the trend of household income levels for 2007-08 and 2014-15 considering the base year of 1995-96 (Figure 2.14).



	Marginal farmer	Small farmer	Medium farmer	Large farmer	Landless	Shrimp business	Others
2005-2006	20.28	23.83	25.23	55.66	20.28	69.28	30.24
2014-2015	27.28	30.83	30.53	62.66	27.28	76.28	36.24

Figure 2.14: Trend of average household income in the study area (base year 1995-96) (Sources: Field survey, 2013-2015)

The identified trend reflects that the income level has been increasing for most groups after TRM in the study area. Local people explained their higher incomes because of using alternative varieties of products like high-yielding varieties of rice and vegetables as also fish farming, especially brackish/salt water shrimp. They thought that the food security level in the study area had also increased, this too, because of change in income and increase the rate of production. The income of marginal and medium farmers has been increasing and 60% of them now have scope to use their lands for rice cultivation at least once a year.

c. Changes in socio-institutional arrangement

Management transition is closely linked with actors and their actions. Community acceptance is one of the crucial variables in the use of management techniques and technology that may change or introduce formal and informal institutions in the delta system.

Participation and development of formal community organizations

TRM is originally a community oriented management practice, which was formalized as a concept of multi-stakeholder participation and development of community organization in water management. As a participatory approach had been officially intended from the beginning in KJDRP, government and some non-government as well as donor organizations ran a number of community consultation programmes in the area during the TRM intervention in 2000-2001. Afterward, local, community-based, water management organizations (WMOs) were developed in nine zonal (zone A - zone I) areas in KJDRP. TRM is mostly in zone G.

Following an IWRM approach, several Water Management Groups (WMGs) including Water Management Committees (WMCs), Fisher Folk Group (FFGs), Land-Less Groups (LLGs), etc. were established by the BWDB in each zone of KJDRP. A Water Management Association (zonal level) and Water Management Federation (KJDRP area) were also formed to have a proper communication with management authorities. However, it was not sustainably functional and during our field study (2012-2016) I did not find any formal WMO in action. This would indicate that a lack of social awareness, insignificant interaction and monitoring of the BWDB, and limited financial support were the main reasons for the failure of action of formal community institutions in the KJDRP area.

During our research (2012-2016), most people put forward that TRM has the potential to prevent waterlogging and protect the tidal river in their localities. At the same time, the practical view was that marginal people or directly affected people would need financial and institutional support first. Due to a lack of compensation and social management initiatives there were mixed impressions and conflicts in perception within the community; this was also explored recently (after about two decades of TRM intervention). See Figure 2.15.

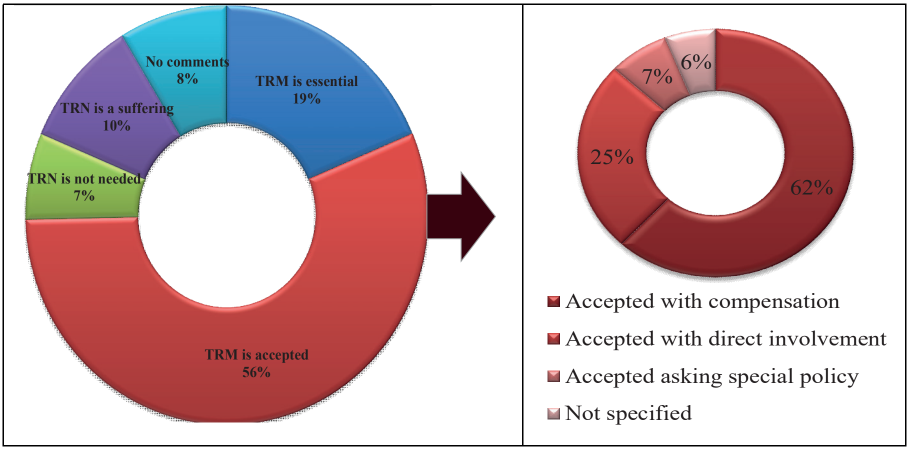


Figure 2.15: Level of acceptance of TRM in the KJDRP area (Field survey, 2012-2013)

Figure 2.15 shows that about 10% of the population, who were mostly landless and small land-owners, thought TRM a disaster, because they lost their source of income during TRM. Some 19% were strong proponents of TRM. While 56% were interested, they were concerned about a proper timeframe and compensation. Local knowledge groups (including teachers, journalists, NGO researchers, and social activists) also asked for a special policy and even a new water law for sustainable TRM in the coastal area.

Compensation and project affected people

During informal TRM, landowners allowed their land to be taken losing crop yields in the bargain. They were sacrificing their production for the broader benefit of their locality. Other, more dependent people had also gone along with this practice, that too, spontaneously, because they had been suffering much due to long-term waterlogging. However, when TRM was formalized as a government and donor funded project, landowners and project-affected people were, logically, expecting compensation. Then, the BWDB had to change their way of land acquisition for infrastructure construction and formed a new land requisition strategy for the TRM intervention period. That meant, acquisition meant a permanent hand-over of land with full payment for loss (= land + crop/trees + house/any constructed structures), and land requisition was no longer defined as temporarily acquired land for a TRM period with payment only for a yearly production loss (CEGIS, 2008). The government authority took a long time to fix a compensation mechanism for this area. The Water Board declared crop compensation for landowners during the *beel Khuksia* TRM intervention at the end of 2007.They proposed it for two years, even though a TRM intervention was running for about seven years in such a *beel.*

In the case of TRM in *beel Kapalia* (proposed in 2012), the compensation programme was started before implementation of TRM and had gone well enough as compared to *beel Khuksia*. But TRM in *beel Kapalia* has not started yet due to a lack of strategic co-ordination between authority and the community. Table 2.5 gives an overview of compensation activities.

Table 2.5: Compensation activities for TRM in KJDRP area

TRM practice	Compensation scenarios		
	Running TRM (Years)	Proposed compensation (for Years)	Received compensation (% of Land owner)
Beel Bhaina	>4 (1997-2001)	N/A	N/A
Beel Kedaria	3 (2002-2005)	N/A	N/A
Beel Khuksia	>6 (2007-2013)	2 (2008-09)	30-40
Beel Kapalia	Postponed	4 (2012-15)	More than 50 (for first year)

As the application procedure and the payment process had not been clearly defined at community level, the majority had been struggling to apply for compensation due to their limited knowledge about legal papers, unclear land recording system, and other bureaucratic issues. Especially marginal landowners (<0.26 ha) and small landowners (0.26-0.80 ha) were also not capable enough to go to district level and communicate with the payment authority there (District Commissioner's Office) without assistance. Also, marginal farmers did not have money to get support from middlemen, who were (anyway) illegally active between landowner and authority. There were no initiatives for socio-economic support to the landless, who were actually most affected. Our research showed that, although the gap in the compensation mechanism is a major barrier in a further application of TRM, it is not the only cause of uncertainty for a sustainable adaptation of the practice.

2

Conflicts in water management

Stakeholder conflicts in water management had taken place first in the south-west delta in Bangladesh as a reflection of long-term suffering from CEP by locals and of other structural interventions before 1990s between authorities (the BWDB) and local communities. Since a formal community participation was not followed in water management in this area, local people has limited scope to share their knowledge, ideas, and experiences to deal with management problems. In 1990 a conflict erupted because of a *beel Dakatia* embankment cut by community people in protest against the activities of the authority. It was the first recorded attempt of TRM in KJDRP area which caused conflict between communities and BWDB again. In the meantime, shrimp culture was entered in the southwest area and new conflicts between agro-farmer and shrimp farmer (mainly shrimp business holder) took place regarding the use of saline water in crop fields.

In 1997, conflict between the management authority and community became extreme and turned to a socio-political violence when the *beel Bhaina* TRM was constructed by the community people. Conflict also arose between the authority and landowners regarding the TRM implementation strategy (controlled by the *Bhabodah* regulator) and compensation issue during the *beel Kedaria* TRM. Although in *beel Khuksia* TRM, the BWDB had proposed crop compensation to landowners for a certain period during TRM, conflict was still there about the rate and period of compensation and the mechanism of payment. Another conflict, between the BWDB and a local government authority, became visible recent period over the issues related to tendering and the use of money in embankment construction.

While the *Khuksia* TRM continued for about seven years, local people and BWDB have been at loggerheads since 2012 around the issue of closing the TRM intervention. The most severe conflict happened in June 2012. A very violent situation was taking place in *Kapalia* village: community people, social activists, and political groups fought with the police, when BWDB tried to initiate a TRM in *beel Kapalia*. More than 50 persons were injured, BWDB's and parliament members' cars burned, and thousands of community people arrested. The event caused tremendous social and economic harassment for the local community. Based on field data, two major categories of conflict are identified such as community vs authority and within the community. The extent of stakeholders' conflicts regarding delta water management is reflected in Table 2.6.

Table 2.6: Extent of stakeholder conflicts in KJDRP area

	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014
Conflicts					
Community vs management authority					
Farmer vs fisher (shrimp farmer)					
Landowner vs management authority					
Landowner vs *Gher* (Shrimp farm) owner					

In this study we tried to assess the severity of observed conflicts in the KJDRP area over time, based on stakeholders' perceptions. In a field survey, a five-point (0-4) ordinal ‚severity scale was used with a ranking of 'most severe', 'severe', 'moderately severe', 'not severe', and 'nothing', based on socio-economic sufferings of local people in conflicting situations (Figure 2.16). From a *Bhabodah* incident (in 1986) to the *Beel Kapalia* fight, local people, whether directly involved in the conflict or neutral, faced legal harassment every time. The BWDB has taken several legal steps to indict community people as suspected, whether as a group or individually. People have lost money as well as social dignity. These conflicts have created a durable, adverse impact on the community's livelihood system.

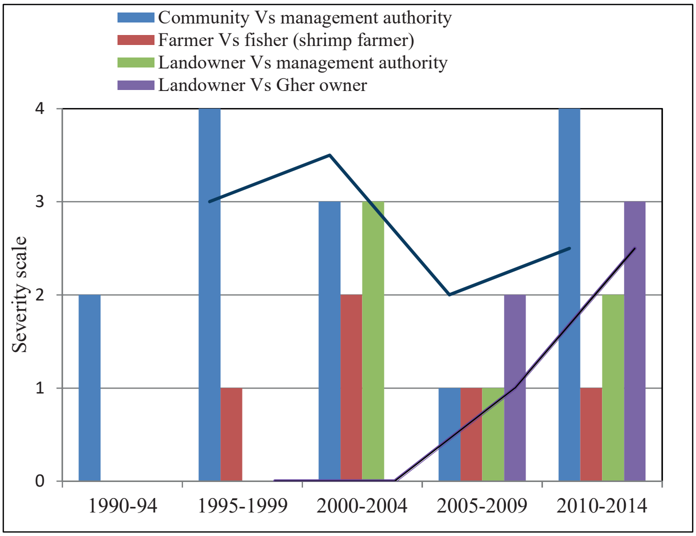


Figure 2.16: Severity of conflicts in terms of socio-economic sufferings of community.

Migration during and after TRM

In the study area two types of migration related to water management practices were observed closely. In the 1990s migration took place because of severe waterlogging in the South-west. Particularly lower-income people migrated, when the area adjacent to *beel Dakatia* was waterlogged for a long time. After 2000, people migrated internally during the *beel Bhaina* TRM because of tidal over-flow in adjacent villages. Besides, the right bank of the *Hari* downstream became eroded during TRM in this *beel* forcing landless people who were living on the river bank, to migrate. In our study, respondents could identify only a few out-migrated families in the *beel Khuksia* area with an average of five to eight (5-8) per year in 2008-2011. From 2013, labour out-migration increased due to the less labour-intensive shrimp farming activities and use of technology in agriculture like tractor, pump, and crop harvesting instruments.

2.6 Conclusion

Transitions in delta management in Bangladesh have been identified with time-line changes in management approaches and practices. Shifts could be noted: 1) from government management to a community participatory approach; 2) from an individual water-control goal to an integrated management goal; and finally 3) from a hard-core, hydraulic engineering to a local-knowledge based, combined (less structural-more natural) management system. I have found that tidal river management is a process causing a transition in current delta management systems in Bangladesh, which emphasizes ecological conservation equitably with physical and social processes. Our research assumed a new systems approach, that of a Socio-eco-technical system, to define a dynamic delta system properly, when it is integrated into a TRM-based system. This may be considered a conceptual shifting in systems research in a complex environment.

Evolution and formalization of Tidal River Management (TRM) has provided the recent technological change discourse about regional and local delta management to remove waterlogging and keep tidal rivers functional as well as agricultural development in a very rural, coastal area. Transformation in delta management has been triggered by TRM, improving river capacity, reducing waterlogging, and increasing agricultural land. Developed landforms in the *beels* have brought about great changes in the socio-ecological system. The production system has changed drastically by the introduction of a large-scale, agro-fisheries mixed cultivation in most of the *beel* areas. Vegetable production has now

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been added to the main agricultural production system, which was only a small-scale practice of home gardening a decade before. Although farmers are now adapting with shrimp culture using both saline and fresh water in *beel* areas for more benefit, increased salinity may cause environmental degradation and ecological imbalance in this sensitive area.

The change in land-use pattern and agricultural system has brought major changes in the delta livelihoods system. Although the landless and small farmers suffered much during TRM in adjacent areas, they received multiple options like labours in agriculture and shrimp field, small business, vegetable supplier and so on after TRM. Yet, marginal people still have to deal with socio-economic discrimination in the locality, because defective compensation mechanisms did not help them for want of institutional support. On the other hand, the overall living standard is getting higher in the area, because income levels are anyhow increasing at each level. Double and triple cropping has improved average incomes. Intensive shrimp cultivation and ancillary businesses have increased income opportunities. The livelihoods of marginal farmers and wage labourers have become threatened, though, and sometimes they have to migrate (temporarily).

Our study did not find migration a massive problem, but institutional limitations and stakeholder conflicts are highlighted as major complexities in current delta management transition processes. Socio-economic uncertainties during the implementation period of a TRM like short-term livelihood loss, long-term production loss, and limited compensation access were found in our fieldwork. These need to be addressed properly. Government authorities should be alert to promote sustainable institutional and social management. Simplification of the compensation procedure and a more active, community-based, institutional support are required for sustainable TRM. TRM has introduced a multi-stakeholder participatory approach instead of a top-down, imposed practice in water management in rural coastal areas. This transition of delta management has created not only possibilities but also some space for problem management in a dynamic delta system. Multi-relational, transformative, system analysis following a Socio-eco-technical (S-E-T) system approach has identified some major causes of uncertainties in adapting participatory management in the ecologically and socially dynamic Bangladesh delta. The concept of transition identification and transformation assessment will influence and improve future interdisciplinary delta management research in Bangladesh.

The findings specifically indicate certain obligations in a management system to understand and learn the scope of institutional development, conflict management, and functional participation in adaptive delta management. Our research further aims at contributing to learning about opportunities and uncertainties with respect to integrated and participatory management, not only in ecologically dynamic but also in socio-economically sensitive deltas.

Chapter 3

Social Learning for Adaptive Delta Management: Tidal River Management in the Bangladesh Delta

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3

3.1. Introduction

Creating and maintaining a sustainable natural resource management in developing countries remains a challenge (United Nations, 2012). This is partly because successful practice and adaptive management require the effective participation of multi-level actors, who often have diverse interests and perspectives (Pahl-Wostl, 2006; Sriskandarajah et al., 2010). Worldwide, natural resource management is increasingly making use of participatory processes that utilises learning-based approaches to deal with challenges and uncertainties, and to help make the management system more sustainable (Berkes, 2009).

The Bangladesh delta is a highly dynamic entity (Nowreen et al., 2014), with a high exposure to natural hazards and climate vulnerabilities (Rouillard et al., 2014). Management system in this delta is complex and very uncertain, because it is hard to predict how the ecological system responds to human interventions (Pethick and Orford, 2013). To enhance the adaptive capacity and sustainability of a delta management system, the role of social learning is important. An understanding of the process how social learning occurs may contribute to managing contextual changes in the delta socio-ecological system (Pahl-Wostl et al., 2007). This article focused on learning in multiple contexts and with multiple actors in a delta management system like Tidal River Management (TRM) in the Southwest coastal region of Bangladesh. This research may useful to link social learning with adaptive delta management to address deep uncertainties in a complex management system.

Historically, community people used indigenous practices to save their crops from flooding: the most common hazard in the delta of Bangladesh (Brammer, 2010). However, inspired by the Dutch dyke system, the government (at that time: Government of East Pakistan) started in the 1960s the large structural Coastal Embankment Project (CEP) along the coast of Bangladesh to control tidal flooding and salinity intrusion with the aim to strengthen agricultural development (Dewan et al., 2015; Nowreen et al., 2014). In the Southwest region, hydraulic infrastructure was constructed between 1960 and 1975 consisting of 1566 kilometres of embankments and polders and 282 sluices (FAO, 1985). These had a long-term effect by preventing silt from the rivers being deposited on to the flood plains. Sediments could also not be pushed out into the Bay of Bengal due to a reduced upstream flow from the Ganges and were instead deposited on the riverbed (Sarker, 2004). As a result, in many places the riverbed elevation rose higher than the polders and caused drainage congestion and severe waterlogging in the Southwest region from the 1980s onwards.

Inhabitants began raising their voices against infrastructural coastal engineering only in the 1990s (Khadim et al., 2013). As the problem became severe, the government of Bangladesh officially incorporated a local knowledge-based practice called Tidal River Management (TRM) to reduce waterlogging and to restore the tidal river systems (Shampa and Pramanik, 2012; van Staveren et al., 2017). The concerned authority, the Bangladesh Water Development Board (BWDB), formally took up large-scale TRM practices in 2001 under the Khulna Jessore Drainage Rehabilitation Project (KJDRP) in Southwest Bangladesh (Figure 3.1) using a participatory approach (Amir et al., 2013). TRM was already being practiced informally in this area by the local community since the early 1990s to drain stagnant water from the polders. It was noticed that this gradually led to internal sedimentation and rising of the land level within the embanked areas (Khadim et al., 2013). This unforeseen secondary benefit created an opportunity for increased crop production and habitation on higher flood-free lands (Nowreen et al., 2014). Also it, in turn, encouraged the government authority to formalize TRM. Over time it has evolved to become: 1) a less structural, more ecological friendly water management option and 2) a more integrated approach to increasing community involvement in delta management in Bangladesh.

Water management in the Bangladesh Delta has shifted away from a purely technical management system to a 'soft' participatory management system (Wesselink et al., 2015) through the official introduction of the TRM process. Our research on social learning in TRM placed the focus on the existing management system to explore the process of managing changes in the delta socio-ecological system. Although TRM theoretically represents an integrated delta management approach (CEGIS, 2003), its sustainable benefit continues to be hampered due to technical system complexities and social system unrest. Therefore, the situation demands an understanding of systemic changes in TRM process for further implementation and adapting management interventions more effectively.

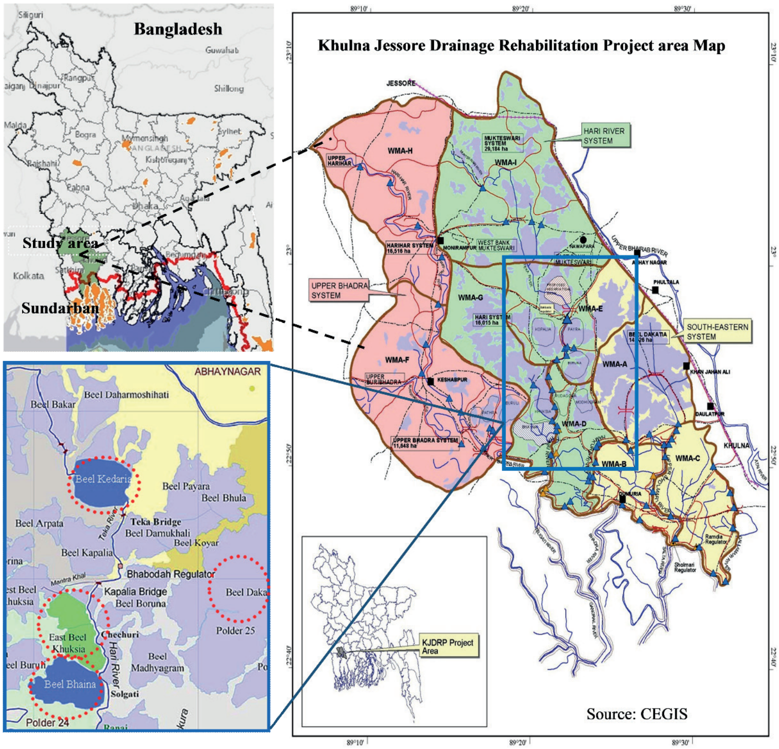

Figure 3.1: TRM practices under KJDRP in the Southwest coast area in the Bangladesh delta

At the same time, a resilience perspective (Apgar et al., 2015) calls for collective action and a learning integration between multiple contexts and stakeholders to allow for sustainable adaptation (Blackmore et al., 2007). This article argues that the observed changes in TRM process and their effectiveness may contribute to understanding the course of learning and increase management interactions within and between communities and other actors. In sum, this research has set out to assess how learning occurs in practicing TRM, with the aim to improve its effectiveness and sustainability in the Bangladesh delta management system.

3.2. TRM: A regional delta management system

Geographically, about 80% of Bangladesh is part of the Ganges Delta. Excluding the 'Sundarbans' mangrove ecosystem and the estuary (Figure 3.1), the larger part of the Southwest Delta is characterized by an agro-ecological system with extensive tidal rivers, streams, and water-filled depressions (the local term is *Beel*) (Nowreen et al., 2014). The tidal river flows were naturally carried onto the floodplains during high tides, depositing large volumes of sediment when there was no permanent barrier (or polder/embankments) along the river banks. In that area, people historically used indigenous sediment management practices, like '*Jowaradhar*'. This refers to the construction of temporary, earthen embankments during the dry season to preserve freshwater and reduce salinity intrusion onto crop lands (Amir et al., 2013). During the monsoon, natural river floods would sweep away the embankments, and deposit large silt loads on the flood plain, which made the land more fertile. Conceptually, the TRM process originates from these indigenous practices of delta management in the Southwest region (Tutu, 2005).

Technically, the TRM process allows for the natural movement of sediment-borne tidal water into an embanked tidal basin or *beel* during high tide. This leads to the deposition of sediment in the *beel* (Figure 3.2). During low tide the outgoing sediment-free water flow runs out, erodes the riverbed, and increases or restores the drainage capacity of tidal rivers. After the land of the used *beel* has been raised sufficiently, generally after 4 to 5 years, the embankment is closed again and another *beel* is opened for TRM (Shampa and Pramanik, 2012; Amir et al., 2013).

The evolution and practices of TRM are located in the KJDRP area, which is the largest and latest drainage rehabilitation project within two coastal districts - Khulna and Jessore (CEGIS, 2014). Before the KJDRP had started, the local community had initiated informal TRM in *beel Dakatia* in the *Hamkura* river catchment (1990). After the KJDRP had started, one informal TRM was identified in *beel Bhaina* (1997) in the *Hari-Mukteswari* river system (EGIS I, 2001). A background study found that government agencies had implemented two formal TRM in *beel Kedaria* and *beel Khuksia* in the same *Hari* river system (IWM, 2014) (Figure 3.1 shows all four *beels* in study area). However, no new TRM is being run in the study area since 2012, because the government agency had failed to convince all groups of stakeholders about the effectiveness of a formal TRM (Field investigation, 2012). As the sustainability of this process has come under pressure after formalization by the government for both technical and social reasons, the present research aims to investigate those reasons by assessing the changes the informal and formal implementation of TRM and their impacts.

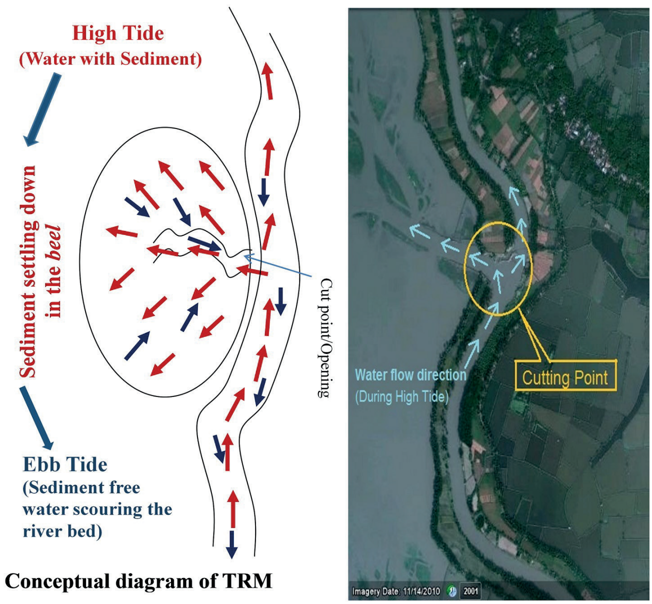

Figure. 3.2a: Conceptual view of the TRM process

Figure 3.2b: Practical view of TRM in beel Khuksia in KJDRP

3.3. Conceptual framework

3.3.1. Learning in natural resource management

Learning may be defined as an active process of selection and integration and/or reintegration of new contextual, methodological, theoretical or epistemic knowledge, skills and attitudes into one's existing knowledge (Leeuwis and Pyburn, 2002; Wals, 2007). At individual level, learning is a process by which a person's knowledge, skills, beliefs, or behaviour is changed as a result of experience (Diduck et al., 2012). Leeuwis (2004) argues that whether or not learning occurs, may depend on several conditions such as the urgency of problems, historical views and experiences, the social and organizational space for learning, and the interdependence felt between actors. In a social process, learning could occur during a participatory activity in which individuals are involved and their learning outcomes become distributed as well as collected mutually (Röling, 2002). However, learning at the organizational level does not occur, until individuals or groups embed what they have learned in organizational memory and structure (Diduck, 2010). An organizational learning process may include knowledge acquisition, information distribution, information interpretation, and organizational memory (Hubar, 1991).

In the field of natural resources management, learning-based approaches have been proposed as a way to deal with environmental as well as social uncertainties. Natural systems, specifically delta ecological systems, are complex and dynamic. This highlights the importance of creating adequate opportunities for a flexible, open, and participatory management (Rodela, 2011). This perspective increases the interest in a social-learning based approach in delta management. The current research conceptualizes the social learning approach by integrating the theory of Communities of Practice (Lave and Wenger, 1990) and the process of managing changes (Medema et al., 2014), and advocates the empirical use of the processes of organizational learning (Hubar, 1991). The delta management process under scrutiny will be analysed as a socio-technical system (Wester and Bron, 1996) in which knowledge oscillates between action and reflection, through conflict and co-operation as well as between stability and disruption (Hurst, 1995). Figure 3. 3 shows the knowledge acquisition and evaluation in one TRM practice and the reflection of changes in further practice. All individual groups of actors and organizations are considered to be tracking their experiences, actions, and performances, either in all practices or with changes between community practices to practices of government agencies (Figure 3.3).

Both individual and organizational level participation and feedback are considered crucial mechanisms in this learning and adapting process.

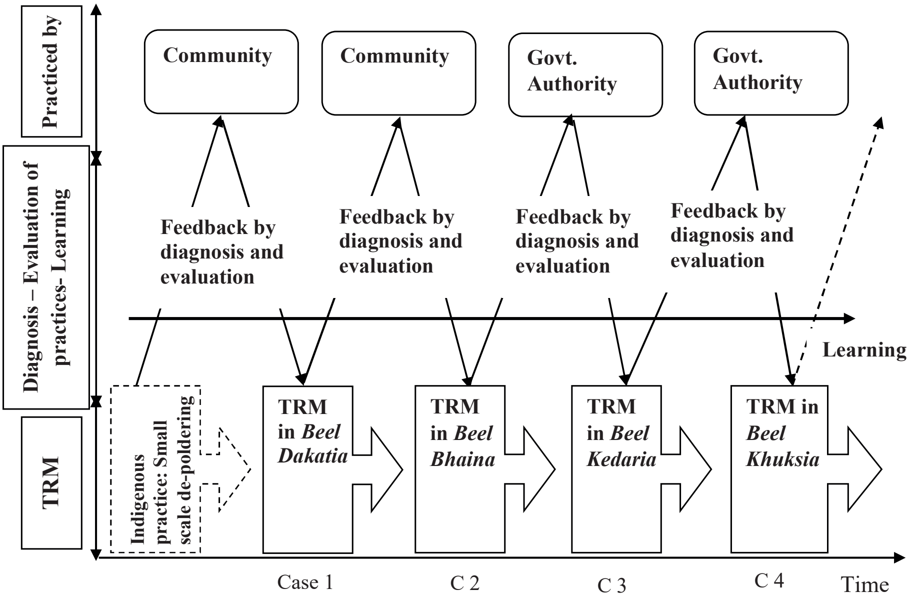

Figure 3.3: Ideal-typical evolution and evaluation of learning in TRM practice

3.3.2. From learning to social learning for improved water management

Social learning is conceptualized in many different ways (Muro and Jeffrey 2008) and may operate at different levels (individual, organization or whole system) (Rodella, 2011). Although there are different interpretations of social learning (Pahl-Wostl and Hare, 2004), there appears to be a core understanding suggesting that it is the social interactions between actors within social networks that create a change (Reed et al., 2010). For the current research, social learning is focused on an effective understanding of managing changes in the water management system in which knowledge is obtained from actors (both individual groups and organizations) (Ison and Watson 2007; Medema et al., 2014) who may distribute information to each other.

In a social learning perspective, the potentiality of information interpretation is considered high when there is a heterogeneity or diversity between stakeholders or actors (Wals, 2007). Put simply, people who have different ideas can learn more from one another than people who think alike (Sol et al., 2013). For example, social learning would be manifest if, after attending a delta management workshop, people with seemingly divergent interests such as farmers would favour the restoration of tidal rivers and drainage of wetlands for economic reasons, an environmentalist dedicated to conserving wetlands would protect ecological values, and an engineer mandated to pursue a system of dikes and detention basins, would have gained insight into other professional views and develop a shared interest in sustainable adaptation (Diduck et al, 2012). Building on Habermas's theory of 'communicative action', Webler et al. (1995) consider social learning as a 'cooperative discourse', when communities of people with both diverse and common interests can reach agreement on collective action to solve a shared problem.

However, in a complex and dynamic social system, bringing together people with different backgrounds, perspectives, values and so on, does not automatically lead to social learning. That requires the cultivation of commitment and trust between all involved. Medema et al. (2014) define social learning as a multi-layered process of examining actions, assumptions, values, and learning processes within the memory of the society. That is to say, learning may constitute a multi-dimensional or multi-loop process in improving a multiple-actor based management practice. This is defined in Figure 3.4 as single-, double-, or triple-loop learning, which may eventually result in fundamental changes in practice and behaviour (Leeuwis and Pyburn, 2002; Keen et al., 2005; Brouwer et al., 2015).

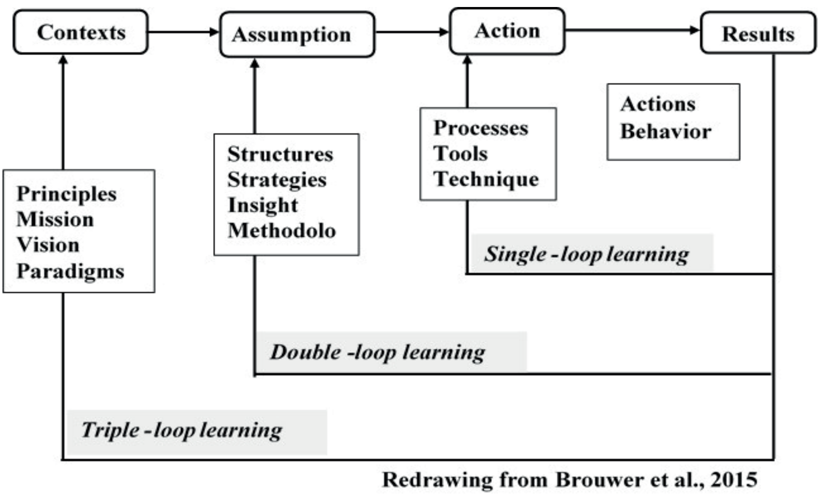

Figure 3.4: Conceptual social learning process in a management system

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Following Argyris and Schön (1996), the literature distinguishes between single- and double-loop learning. Single-loop learning focuses on actions and results, which are necessary for a group or organization to change behaviour or 'change management' in the context of adapting resource management. Single-loop learning is generated by 'how' questions such as: how to improve performance and how to avoid failure (Medema et al., 2014; Brouwer et al., 2015). When a mismatch between action and outcome is detected, future actions are altered accordingly to prevent similar mistakes. In contrast, double-loop learning occurs when serious problems are detected and actors' norms and values are changed as a consequence (Brouwer et al., 2015). The learning is qualified as double-loop, when the integrated information leads to changes in underlying assumptions, theories, and goals (Argyris and Schön, 1976). Later the notion of triple-loop learning was introduced as a change in assumptions and actions from a normative, moral, or ethical sense, and also evolutionary or experiential learning (Kransdorff, 2006). This kind of learning may lead to a redesigning of existing governance norms, protocols, and structures (i.e. transformational learning) (Medema et al., 2014).

The current study argues that single, double and triple-loop learning are all required to develop an effective management process. But multi-loop learning is often more efficient, as it is conducive to deep and sustainable changes and can help break out of stubborn, unsustainable routines (Jiggins et al., 2007). For a participatory water management, increased social cohesion and trust as well as joint commitment among all actors involved can lead to more creative solutions to complex problems (Sol et al., 2013). That is to say, learning in this study is seen as tending to comprise of multiple (double or triple) loop learning, as participants engage in collective action and reflection seeking to improve the management of human and environmental interrelations (Keen et al., 2005).

3.4. Research methodology

The research methodology was designed as a participatory study. This is known as a 'Rapid Water Management Appraisal' (RWMA) (Wester and Bron, 1996), which is adapted from the Rapid Rural Appraisal (RRA) approach (Chambers, 1994). The first author conducted the field research in the Southwestern Bangladesh delta from 2012 to 2016. We had identified a study area on the basis of the dynamic history of TRM, which included both community initiated practices and current formal practices. A literature review and preliminary investigation resulted in the selection of TRM cases for the informal in 1) *Beel*

Dakatia and 2) *Beel Bhaina,* and for the formal in 3) *Beel Kedaria* and 4) *Beel Khuksia* (see in Fig. 1). These all are in the KJDRP area and are highlighted and reported (CEGIS, 2014; IWM, 2014) as a transition in the regional water management system and national water governance over the last 25 years (Nowreen et al., 2013).

The research was conducted in two stages:

- In the participatory evaluation and knowledge acquisition stage (Rossman, 2000) we gathered information and explored knowledge generation regarding the transformation of TRM practices and changes in technical, social, and institutional contexts of TRM as well as their impacts and effectiveness. We did so through Focus Group Discussions (FGDs) (2012-2013), 250 semi-structured interviews (2013-2014) in community and organizations, i.e. the BWDB, Local Government Institutes (LGIs), NGOs, the Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modelling (IWM) and the like.

- The learning and social learning process was examined through a collective integrated assessment based on experience, negotiation, and bonding among participants as well as the knowledge of experts. We held three large Local Stakeholder Meeting (LSM) (group discussion involving on average 35 participants from both the community and organizations) in the study area and one regional learning workshop in Central Jessore District.

The learning assessment was conducted through four questions (Fabricius and Cundill, 2014):

- What has been learnt in the course of the TRM practices?
- Who has learnt?
- How have they learnt?
- What type or category of learning occurred?

What was learnt?

Knowledge and information are obtained from practice to practice over time through devices for understanding the management system, human-environment interactions, and the problems at stake. Here the 'what' question was evaluated explicitly discussing individual and organizational experiences with TRM practices, impacts, and challenges.

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Who has learnt?

Participation in the learning process was examined in particular by asking the ‘who’ question to understand the level of stakeholders in the management system from local to national levels.

How do they learn?

This includes categories to assess the modality of learning such as experience and sharing information (Biggs et al., 2011), dialogue and oral transfer (Berkes et al., 2000), and experimentation and reflection (Lee, 1999, Moore et al., 2011) within the participation process and interaction.

What type of learning occurred?

This aspects includes the nature of learning aimed at capturing broader learning processes according to social learning theory which consists single, double, or triple-loop learning (Brouwer et al., 2015).

Possible variables for these four questions in the learning assessment are listed in Table 3.1.

Table 3.1: Learning assessment question and variables for adaptive WM

Assessment Questions	**Variables**
What has been learnt?	• Participation: actors/ stakeholders in practice • Strategy and actions in WM ➢ Planning ➢ Timing ➢ Interventions • Institutional governance ➢ Community organization ➢ Integration and interaction ➢ Communication and social network ➢ Social capacity • Achievement/effectiveness based on: ➢ Sustainability to solve the water problem ➢ Land development ➢ Ecosystem conservation ➢ Socio-economic development
Who has learnt?	Actors and level in learning process • Individual or groups in community • LGIs • External stakeholders: NGOs, Civil society organizations (CSOs), researchers • Decision makers: Ministry, authority, Donors etc.
How do they learn?	Process of learning: ➢ Experience or observation ➢ Experimentation, information sharing ➢ Reflection, advocacy campaign ➢ Dialogue /oral transfer and negotiation (meetings, workshops, etc.)
Mode/type of learning	Mode of learning: ➢ Change in action and behaviour to improve existing practice (single-loop) ➢ Reflection and strategic innovation (double-loop) ➢ Learning about learning (triple-loop)

Source: Learning assessment tool developed in field investigation 2012-2013

The final synthesis of this systematically collected information was presented and discussed in a regional workshop with about 50 representatives from the main stakeholder groups and *assessed* by (regional and national) professionals and academic experts. The overall participatory research design and list of activities are shown in Table 3.2.

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Table 3.2: Methodological design for researching learning within TRM in Bangladesh

Investigation		RWMA Tools	Activities	Participants
Participatory evaluation of TRM practices (Changes and impacts)	2012-2013	FGDs	Idea sharing and identifying learning issues Preparing questionnaire and evaluation checklist Information gathering	Local stakeholders (Farmers, fishermen, landless labourers, businessmen, women)
		Desk work	Framing the learning questions and variables	Researcher and authors
	2013-2014	Organizational survey	Knowledge acquisition	LGIs, NGOs, BWDB, IWM, CEGIS, Ministry of Water resources (MoWR)
	2014 -2015	Interviews : Individuals	Experience sharing and information cross checking	Professionals, Teachers, Students, Local Police, Journalists, etc.
Learning assessment	2015	Local Stakeholder Meetings (LSMs)	Group interaction, information, interpretation	Community groups, LGIs, NGOs, BWDB officials
	2016	Workshop	Synthesize learning, representing results and collecting feedback	All stakeholder groups

3.5. Evaluation of TRM cases from learning perspective

3.5.1. Evolution of TRM: Changes in process

To get relief from severe waterlogging in the Khulna and Jessore district in the early 1990s local people reverted to a traditional practice. They made '**public (embankment) cuts**' in *beel Dakatia,* which was not approved by the BWDB at that time (Rahman, 1995). Then the BWDB started the KJDRP in 1994, covering an area of approximately 100,600 hectares (25% of the total coastal embankment area) including management infrastructures like regulators and new embankments. (EGIS I, 2001). However, within two years, waterlogging took place again in most parts of the KJDRP (CEGIS, 2003). Local people again breached the embankment in *beel Bhaina* in 1997 to remove stagnant water from their crop fields and villages.

Influenced by donor organizations, the BWDB conducted a feasibility study of the sediment management process based on the experience in *beel Bhaina* (Amir et al, 2013). The feasibility study recommended the practice as an option for water management in the Southwest area and termed it **Tidal Basin Management (TBM)** (CEGIS, 2003; IWM, 2010). The government started TBM in *beel Kedaria* in the upstream part of the *Hari* river catchment from 2002 to early 2005. The river bed silted up again clogging the drainage system from April 2005 onward (IWM, 2010; de Die, 2013). The BWDB realized the necessity for continuing this management process in a tidal river system and planned large-scale, rotational basin management in 17 (seventeen) selected *beels* in three major river systems under KJDRP (CEGIS, 2008; Amir et al., 2013). They officially renamed it **Tidal River Management (TRM)** in *beel Khuksia* at the end of 2006.

3.5.2 Actors in TRM: Change in participation

One important change process explored here was based on the dynamics of actors and their participation in TRM. *Beel Dakatia* and *Beel Bhaina* TRM was rather informal, where only local people were involved, to protect their lives and livelihoods from severe waterlogging. Some social activists and NGOs supported them at this local level. However, with their formal TRM, BWDB spearheaded a multi-actor participatory approach, including the community. The participation of stakeholders in different cases of TRM is shown in

Table 3.3.

The *beel Kedaria* and *beel Khuksia* TRM was implemented by the BWDB with financial assistance from the Asian Development Bank, World Bank, and the Dutch government. The Ministry of Water Resources (MoWR) was also involved in the decision-making. Community stakeholders included landowners and landless people who were fully or partially dependent on *beel* resources. Farmers (agro-farmers and shrimp farmers), fisher folk, daily-wage labourers as well as NGOs and Civil Society Organizations (CSOs) were also among the local stakeholders. LGIs, Union Parishad, Upazilla, and District administrative authorities, and research organizations - IWM and CEGIS were also major stakeholders (see Table 3.3).

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Table 3.3: Dynamics of stakeholder participation in TRM practices

Case of TRM		Local community: target groups	Social and political activists	NGOs, Civil Society Organizations (CSOs)	Local Government Institutions; Administrative authority	Research organizations (CEGIS,	WM authority Authority (BWDB)	Decision makers and donors (MoWR, ADB, WB, Dutch Govt.)
		Participation						
Informal	*Beel Dakatia*	√	√	√				
	Beel Bhaina	√	√	√				
Formal	*Beel Kedaria*	√	√	√	√	√	√	√
	Beel Khuksia	√	√	√	√	√	√	√

Source: Field data, 2012-2013

Although the Integrated Water Resource Management (IWRM) approach was promoted in this formal TRM, the benefits of multi-actor participation were much less than expected. On the contrary, conflicts and complexities increased due to their different individual or collective interests.

3.5.3 Institutional changes in TRM practice

In Bangladesh, BWDB is the government agency responsible for implementing all medium and large-scale WM programmes (Rouillard et al., 2015). Before the 1980s a highly top-down approach was followed, without considering any community institutions (CEGIS, 2003). During informal TRM in *beel Dakatia* no formal institutional body was developed at the local level.

However**,** in 1996, the *Beel Dakatia* Water Management Association (WMA) was formed as a pilot community Water Management Organization (WMO) in the Southwest area. The informal TRM in *beel Bhaina* (1997) caught the attention of the government and donor agencies. Pushed by them, the BWDB arranged several public consultations involving CEGIS to know the environmental soundness and social acceptance of TRM. At the same time, to fulfil the criteria of IWRM, a community level institution building process was initiated in KJDRP following a three-tier structure of WMOs (Gupta et al., 2005; CEGIS, 2003) (see Figure 3.5).

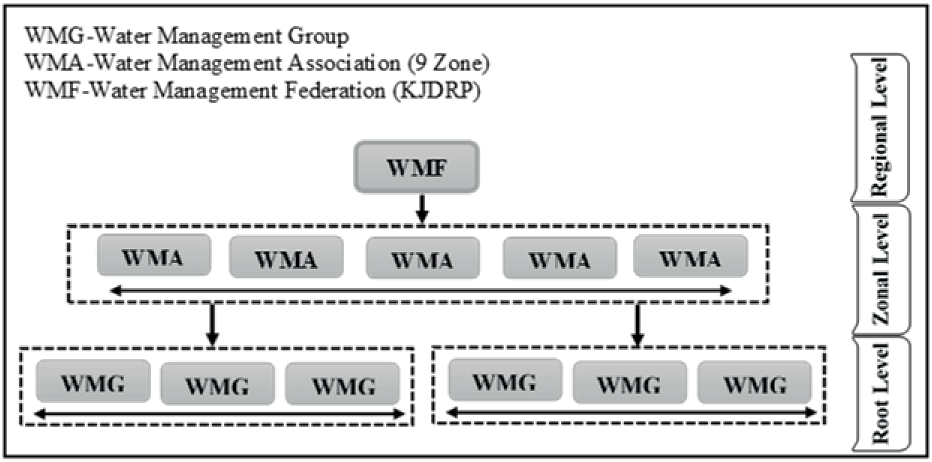

Figure 3.5: The three-tier structure of WM Organizations in KJDRP

Since the late 1990s, nine WM Associations (WMA), 507 Management Groups (WMG), 48 Fisher Folk Groups, 58 Landless Groups, 58 WM Committees (WMC), and one Federation (WMF) have been formed across the KJDRP area (CEGIS 2003). The field research data (Organizational survey, 2013) show that 31% households were enrolled in this institutional network in 2003. All WMAs and WMGs had been registered under the rules of national cooperatives. So, a community institution had been formally interlinked with other organizations at local, regional, and national level. Although such institutions had been developed during the *beel Bhaina* case, they did not play an interactive role in reality (Organizational survey, 2013). In *beel Kedaria*, they failed to negotiate for change in technical plan and crop compensation as community stakeholders had expected. Also, even during an extra-long time TRM practice in *beel Khuksia*, the institutions were ineffective. During this research in 2013 and 2014 community institutions were not found as active in the KJDRP area, since established community WMOs had already lost their official registration.

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3.5.4. Technical contexts and impacts of TRM

Our research found that *Beel Dakatia* was an ‘open’ TRM that followed a traditional process. The embankment had been breached at four places by inhabitants in September 1990 to remove waterlogging and allow free tidal flow into the *beel* (total area 11,609 hectares) without any peripheral embankment (de Die, 2013; Field data, 2012-13). This had led to an immediate removal of waterlogging in the *Hamkura* and *Solmari-Salta* river catchment areas. Additionally, about 1000 hectares of high land had been gained in the *beel* area, which was suitable for rice production within two years (Field survey, 2012).

However, since there had been no technical study, the embankment opening cuts had failed to work properly. This had caused permanent waterlogging and a salinity problem in the northern periphery of the *Dakatia beel*. There were reports of temporary out-migration here, particularly of marginal farmer and fisher folk families. Since neither the BWDB nor other government organizations (like LGIs) had been involved in this case, the embankment cuts had been recorded as a violation of the law (Tutu, 2005; Field survey, 2012). Then a major conflict between inhabitants and the BWDB erupted, as the agency had taken legal steps against hundreds of community people and social activists. This TRM was stopped in 1994 by the Bangladesh Army (Community meeting, 2012).

Local people opened the embankment in *beel Bhaina* in November 1997 (Field survey, 2013; de Die, 2013). This event took place in about 900 hectares of a low-lying *beel,* without peripheral embankment. Although the BWDB had then taken legal action against 300 villagers, people were determined to continue the process with the support of local NGOs and CSOs (Field survey, 2013). Within two years the average depth of the *Hari* river had increased by about 10 metres, while the width had become three times larger (IWM, 2010). This way, water from other upstream *beels* (26 in all) had drained out easily through the regulator at *Bhabodah* and the surrounding villages had become free of waterlogging.

According to a regional report by Fakir (2008), the magnitude of sedimentation had been higher at the entrance of the *Bhaina beel* near the cut point and gradually diminished to the far end. Participants in the field survey (2013) had said that the BWDB had not responded to use a mini excavator to deepen internal *khals* (channels) to ensure even sedimentation. BWDB stopped operating *beel Bhaina* in December 2001. Within next four years, about 572 hectares of land had become higher than before the TRM, on an average by two meters. The apparent successful implementation in *beel Bhaina*, at least in the perception of stakeholders, prompted the BWDB and the government to promote TRM as a key strategy for WM in the Southwest Delta.

Beel Kedaria was the first formal TRM (that time called TBM) with prior technical and social studies (CEGIS, 2014). In a feasibility study the BWDB had proposed a time-bound (6 months per year) implementation, during which tidal water would flow into the *Kedaria beel* through the 21-vent *Bhabodah* regulator in a controlled way to avoid embankment cuts (IWM, 2010). While the local community had expected an open cut in the embankment, the proposed TBM was in operation with BWDB planning in early 2002.

According to a participatory evaluation, the net silt deposition in *beel Kedaria* tidal basin since its operation from 2002 to 2004 had been 0.5 million cubic metres over an area of 500 hectares (IWM, 2010). Although the river had been restored within a year, the land level of the *beel* had not risen significantly. Since the *beel Kedaria* was a donor-funded project that affected people negatively, landowners within the *beel* area claimed crop compensation for the project period. Since the BWDB had no budget to compensate them, local people had doubts about the security of their lands and livelihoods. They stopped this TRM by closing the *Bhabadah* regulator in March 2005.

As the river *Hari* silted very fast after stopping *beel Kedaria* (IWM, 2010), the BWDB quickly prepared the east section of *beel Khuksia* (781 hectares) for TRM (Community meeting, 2013). It scheduled to open this *beel* in April 2006. Due to a conflict regarding the location of the embankment opening, inhabitants closed it within three months. It was finally opened in November 2006 and planned to be closed in December 2010 (IWM, 2014). However, land owners did not allow their land inside the *beel* to be used for the construction of an embankment, because they had been inadequately informed about government land requisition (temporarily for TRM) or acquisition (permanently for embankment) policies. Due to a lack of communication about the exact area to be brought under TRM, the peripheral embankment could not be constructed according to plan.

The location of the embankment opening was changed (in July 2007, during the monsoon) to allow the tidal flow to reach the northern section of the *beel* and distribute sediment deposition more equally in the entire *beel*. The current study shows that sedimentation was still not uniform in the northern part by the end of the project. In a participatory assessment, people indicated that the BWDB had not implemented internal management activities by integrating the maintenance of the existing channels and regulators during the TRM. In the *beel Khuksia* TRM, a BWDB proposed crop

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compensation did not materialize. There only 30-40% land owners had received compensation, while small farmers and landless people have become more endangered in the course of this management implementation. This TRM was stopped by local people in January 2013, because an extended long-term implementation (7 instead of 4 years) had brought vulnerability to both the environment and social systems (Field investigation, 2013).

The assessment of changes between informal and formal TRMs is summarized in Table 3.4.

Table 3.4: Changes in technical and strategical contexts of TRM practices over time

Technical context	*TRM Practices*			
	Informal		Formal	
	***Beel Dakatia* (1990-1994)**	***Beel Bhaina* (1997-2001)**	***Beel Kedaria* (2002-2005)**	***Beel Khuksia* (2006-2012)**
Operational strategy	Certain action	No technical planning	Planned and approved by BWDB	Planned and approved by BWDB
Proposed time frame	Not defined	Not defined	4 years	4 years
Operating time frame	4 years	4 years	3 years (Stop earlier by force of landowners)	> 6 years
Form of TRM (Opening and action)	Public cut	Public cut, (Open and continuous action)	No breaching of the embankment, operated through *Bhabodah* Regulator (temporary: 6 months per year)	Formal TRM Opening embankment and continuous operation
Internal sediment management	Not measured exactly	> 60% uniformly silted	Siltation in-significant	About 50% uniformly filled
	No initiatives	Existing internal water channels (*Khal*) were used automatically	Existing internal *Khals* were selected without any operation and maintenance	Existing internal *Khals* were selected without any operation and maintenance

Technical context	*TRM Practices*			
	Informal		Formal	
	Beel Dakatia (1990-1994)	***Beel Bhaina (1997-2001)***	***Beel Kedaria (2002-2005)***	***Beel Khuksia (2006-2012)***
Infrastructural support	Existing regulator was not in operation	2 BWDB operated regulators were in operation	*Bhabodah* regulator was in operation	2 BWDB operated regulators were in operation
Village protection	No	No	Yes	Yes
Area for ecological conservation	Open water area exists	Not significant	Engaged total *beel*	Engaged total *beel*
Compensation	No	No	No	Yes (not easy to get)

Sources: Field data, 2012-2015

3.5.5. Participatory assessment of the effectiveness of TRM

From a contextual assessment it may be said that the success of TRM largely depends on strong technical measures and a proper planning strategy as well as an active institutional contribution. Although there is a discrepancy between perceived and actual effectiveness of TRM as a delta management option, the effectiveness perceived by the community would be critical because it influences the likelihood of their supporting TRM.

We tried to assess stakeholder perceptions of TRM's effectiveness. A simple three-point ordinary scale for assessing the perceived effectiveness was used, where respondents could choose between 'effective', 'partially effective', and 'ineffective'. The assessment was based on stakeholders' opinions of the extent to which they thought key TRM outcomes were achieved. A participatory assessment was done based on above discussed technical and socio-economic impacts of TRM. Participants responded from their own experience on how each and every goal was achieved or not achieved in the four *beel* case studies. Our research analysed participants' responses by averaging their perceived effectiveness responses on TRM outcomes and mapping them on a perceived effectiveness scale. The synthesized result of this participatory performance assessment of TRM practices is shown in Figure 3.6.

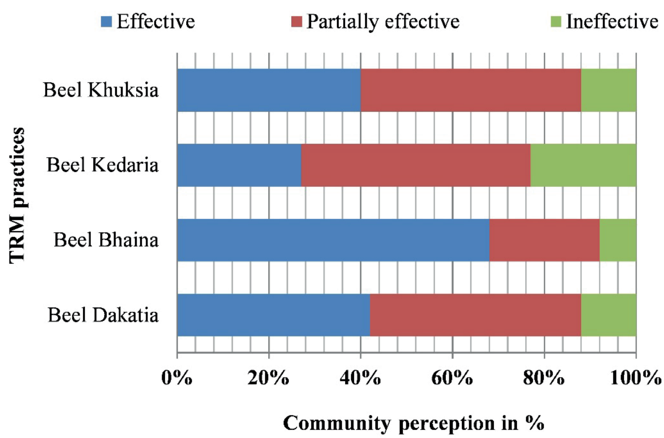

Figure 3.6: Performance evaluation of four TRM practices in KJDRP

According to Figure 3.6, the majority of participants considered the *beel Bhaina* TRM highly effective, whereas all others were denoted as partially effective. The participatory response indicated that the formal and official TRM is not implemented to its full potential and expectation yet, and still seems less effective than the community practiced informal TRM.

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3.6. Social learning for TRM practice in the Bangladesh delta

In this study learning has been explored by a historical reconstruction and through knowledge acquisition while assessing TRM practices. Individual and group actors and organizations took part in integrated participatory sessions (LSMs in 2015) and contributed to significant learning outcomes, which were listed and put up for all participants' feedback and validation.

In Box 1 we have summarized participants' learning as well as recommendations for adapting and improving TRM practices for a sustainable delta management in Bangladesh.

Box 1: Recommendations : Learning Summary

1. Sustainable adaptation of TRM or other management forms is very unlikely in the southwest area because of detachment from indigenous knowledge and without the active participation of local people. (BWDB; researcher)

2. Interim management options (like sediment management for uniform deposition, partial free wetland for bio-diversity conservation, social management like compensation, etc.) are required to improve formal TRM practices in sustainable delta management. (*Community and NGOs, CSOs*)

3. A series of TRM events should be implemented with sequential planning in different *beels* in a river catchment for long-term effectiveness, to keep the river alive and reduce waterlogging. (*Community stakeholder; researchers*)

4. Structural intervention and natural system based intervention (TRM) should not be conflicting in delta management. Although an embankment along the coast must be required (Battacharyya et al., 2013), sediment management is also essential for sustainability. (*BWDB)*

5. Be open, transparent and inclusive in the planning, implementation, and compensation process: community stakeholders are confident about the potential of TRM in delta management but do not trust yet the actions of government agencies and decision-makers. (*Community stakeholder*)

6. Social networks have already developed with an interest in TRM. However, good facilitation is needed in the networks to develop trust and joint commitment. (*Researcher*)

7. Strong motivation and advocacy are required in the society to recognize common and priority interests while implementing TRM. NGOs and civil society organizations need to be involved to deal with conflicts and social uncertainties. (*NGOs and LGIs*)

8. Regional and national platforms are required to facilitate and understand the contribution of TRM in WM in general and of tidal river basin issues and learning in particular. (*Community stakeholders; researchers)*

9. Real change and learning happens at local level. The national level is the platform for negotiation and policy making, but action and challenges are taken locally. (*LGIs and researcher*)

10. Out-migration is not significant during formal TRM. But community groups have experienced major changes in their livelihood systems. Alternative livelihood opportunities should be arranged for marginal farmers and landless stakeholders (Community stakeholders)

Sources: Field research, 2015 and 2016

The reflective discussion at the end revealed that community-level participants indeed gained a sense of co-operation, but that not all participants could participate equally and on equal terms. Many stakeholders also pointed out there was insufficient trust between stakeholders to allow for a fruitful and open learning process.

Table 3.5 shows the results of the final assessment of the learning process that took place within TRM practices in the Southwest Delta of Bangladesh.

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Table 3.5: Assessment of social learning in practices of TRM in Southwest coastal area

Learning Recommendation (What has been learnt?)	Who has learnt?	How do they learn?	Mode of learning
1	Researchers and BWDB	Knowledge sharing and interpretation	Double loop
2	Community; NGOs, CSOs	Experience, information sharing and monitoring	Single loop
3	Community ; researcher	Monitoring and information sharing	Single loop
4	BWDB	Experience and experiment	Single loop
5	Community	Experience	Single loop
6	Researcher	Monitoring and information gathering	Single loop
7	NGOs and LGIs	Experience and experiment	Single loop
8	Community and researchers	Experience and Information sharing	Single loop
9	LGIs and researcher	Monitoring and Information sharing	Single loop
10	Community and LGIs	Local dialogue and information sharing	Single loop

Source: Research findings, 2016

3.7. Conclusions

The effectiveness of TRM practices and its sustainable adaptation in a rural delta setting is uncertain due to divergence in common interests, lack of space for learning, and limited stakeholder interaction. This is not to say that no learning has taken place. Learning has occurred through changes of practice and knowledge has been obtained through a participatory assessment of changes in informal to formal practices of TRM. This assessment shows that the technical changes in practice have brought certain benefits in river system restoration and land development. Yet the learning was limited in dealing with social issues like realizing proper compensation and developing alternative livelihood systems, and coping with socio-ecological matters. So, the effectiveness of a formal TRM has not matched the expectation of a majority of stakeholders. Conflicts and lack of cooperation between stakeholders and government agencies have been documented as reasons for this uncertainty. But TRM is still a promising measure for immediate stakeholders because they have very closely experienced the positive and negative impacts of this management option in such a sediment carrying active delta system.

Since information distribution and interpretation is difficult in a rural society like that of the delta inhabitants in the Southwest Delta of Bangladesh, social learning is required to understand the multiple contexts of TRM. In this article social learning has been examined through an integrated participatory assessment based on individual and organizational learning outputs regarding the adaptation of TRM. The findings show that individuals and groups of community stakeholders have gained and shared knowledge through their experiences and efforts. Although government agencies and other involved organizations have some space for experimenting and monitoring, they rarely practice knowledge sharing and exchange with others due to their entanglement in a complex bureaucratic system. So, management interaction gaps between local people, external researchers, NGOs, organizational groups, and responsible government organizations are obvious here. This appears to be a major constraint to a participatory approach and sustainability of a socio-technical system in a vulnerable delta. Local government institutions can interact with local stakeholders, but they do not engage in a deeper reflection on the learning processes. The BWDB and administrative authorities revealed that their learning remained very theoretical and was dominated by technical and financial management dialogues without considering the social system or a knowledge interpretation from earlier or on-going TRM process.

Focusing on the learning perspective to improve TRM practice, this research explored the quality of learning and existence of social learning in delta management in Bangladesh. Following social learning theory (Brouwer et al, 2015) the learning processes in a multi-stakeholder system that seem to dominate, represent single-loop learning, that is, learning to improve existing practices. Only a few instances of double-loop learning were found: instances when reflection led to an alternative innovation and a rethinking of assumptions and strategies to change the process were rare. Since most learning is found at the individual level, multi-loop learning is rarely found in participatory TRM. It was found hard to ascertain double or triple-loop learning particularly, because of stakeholders' fixation on towards instrument and pre-determined TRM goals, leaving little room for deeper reflection.

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To deepen and broaden the learning to encompass both multi-loop and multi-level learning, coordination, facilitation, and support of multi-stakeholder engagement in TRM is essential. This requires a re-knowing, rethinking, and recalibrating of roles as well as the development of new capacities (e.g., system thinking and design, conflict management, reflexive monitoring and evaluation of all groups involved: the local community, workers associations, landowners, local government, civic society organizations, and government organizations. Only then it will be possible to achieve successful, responsible and responsive delta management practices in a rural coastal area. As the concept of adaptive delta management has been formally incorporated in Bangladesh Delta Plan 2100 (GoB, 2014) this recommendation might help incorporate social learning in adaptive delta management research and collaboration in Bangladesh delta.

Chapter 4

Analysing the Co-existence of Conflict and Co-operation in a Regional Delta Management System: Tidal River Management (TRM) in the Bangladesh Delta

This chapter is under review for journal publication as:
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4

4.1. Introduction

'Conflict resolution through more effective dialogue between all stakeholders' (Huntjens et al., 2015) can improve the integrated management of water resources and community participation in various countries. Conflict itself is an inevitable part of any multi-stakeholder process in natural resource management (Warner, 2007; Brouwer et al., 2015). In a global context, the 'From Potential Conflict to Cooperation Potential' (PC-CP) initiative of the UNESCO and Green Cross International (2004) examined and fostered the potential for international water resources to become a catalyst for peace and development through dialogue, co-operation, and the participatory management of natural resources (Mostert, 2003).

Mostert (2003) argued that in water resource management, both conflict and co-operation are part of a cyclical process, where the potential for conflict or co-operation is determined by hydrological, socio-economic, institutional, or political, cultural, and policy contexts. We speak of conflict when parties or individuals have genuinely different interests and struggle over them, and are, or appear to be, unable to resolve or transcend them. Mirumachi and Allan (2007) argued that assessing conflict and co-operation in their interrelatedness is the way to understand progress (or the absence of it) in a river or catchment management system. Our research likewise aimed to explore the co-existence of conflict and co-operation in a delta management system to achieve effective participation in local (and regional) water governance (Warner and Santbergen, 2007).

To date, much attention in water management has focused on the risk of and resolution to transboundary water conflicts (Funder et al., 2010). Conflicts in regional or local water management have received much less attention and analysis (Ravnborg et al., 2012). The extent of stakeholders' co-operation, such as the particular role of marginal communities, is seldom highlighted in the planning and design of water management systems (Tutu, 2005). In this article we go through Funder et al.'s assertion that: 'A better understanding of local water conflict and cooperation can provide important contributions towards the formulation of new policy, legal, and institutional frameworks for water governance and management that is currently taking place in many developing countries' (2010: 758). Therefore, we aim to analyse the existence, extent and role of conflict and co-operation in local and regional water management systems in the Bangladesh delta to contribute for effective multi-stakeholder participation. In this coastal delta, peoples' lives and livelihoods are mostly dependent on a land and water resource interface, where ownership as well as access to delta resources is strategically essential to the local inhabitants (Mutahara et al., 2016). Competition over resources and complexities in managing delta resources have increased significantly over the last few decades, not only because of the diversity of interest groups but also because of the debate on the feasibility of management interventions and the role of management institutions (Murshed and Khan, 2011).

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In Bangladesh, local and national water management institutions are weakly developed and practically not equipped to reconcile diverse interests and provide sustainable management (Dewan et al., 2014). Governmental agencies largely overlook ecological conservation and natural resource-based livelihoods (Vörösmarty et al., 2010), and frequent conflicts have taken place in water management systems. Diverging social, economic and cultural values make decision-making difficult in water resource management (Smith and Porter, 2010). The government promotes Integrated Water Resource Management (IWRM) for delta management (Amir et al., 2013), but multi-stakeholder participation in IWRM is still new in the country. Like elsewhere, it faces immense challenges to deal with diverse issues and complexities (Dewan et al., 2014). Apart from competing claims among multiple stakeholders, controversy often arises when directive management decisions are formulated without the consent of or concern for all community stakeholder groups.

We conducted our research to learn and increase understanding of the manifestations of conflict and co-operation in delta water management in Bangladesh and to get a better sense of their essential contribution to adapting and sustaining a multi-stakeholder system such as Tidal River Management.

4.2. TRM: A Regional Delta Management System

Tidal River Management (TRM) is a popular delta water management system in the South-west coastal region of Bangladesh (Nowreen et al., 2014) to resolve the severity of waterlogging problems since the 1990s. TRM emerged from indigenous knowledge of water and sediment management practices. It was officially adopted and adapted in 2001 by a government agency: the Bangladesh Water Development Board (BWDB). They considered it one of the formal management options in coastal delta management with a fundamental principle of integrated and participatory management (Khadim et al., 2013). TRM was introduced after a conflict arose between government and community stakeholders regarding the use of structural interventions such as embankments in a physically and socially sensitive delta (Mutahar et al., 2017). TRM was intended as a more natural and less structural delta management intervention in tidal river basins (*beels*) to reduce siltation in the riverbed and to prevent waterlogging (Shampa and Pramanik, 2014). Conflicts erupted when local people opened the *beel* embankments to relieve waterlogging inside the polders. Technically, TRM would allow the natural movement of sediment-borne tidal water into an embanked tidal basin at high tide and allow the deposition of sediment inside the *beel*. At ebb tide the outgoing silt-free water would scour the riverbed at high velocity and increase its drainage capacity (Amir et al., 2013; Paul et al., 2013) (Figure4.1).

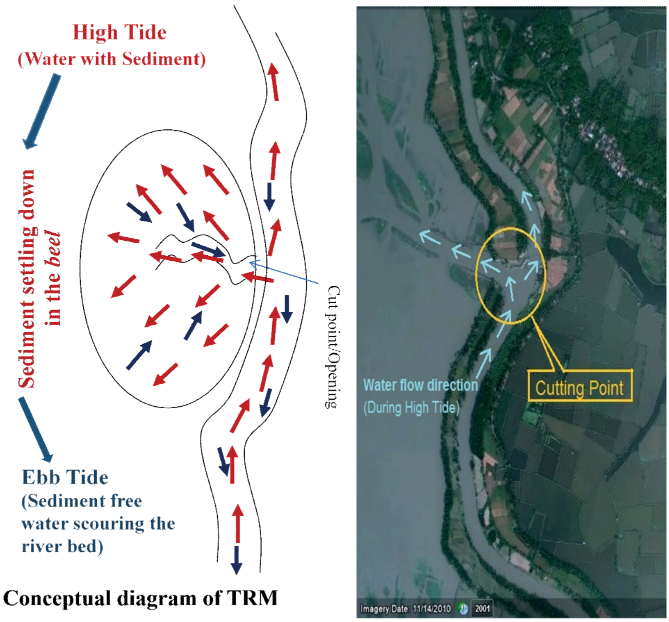

Figure 4.1: Strategic process of TRM

(Source: Drawing from CEGIS, 2007; Paul et al., 2013)

During TRM the concerned *beel* was exposed to free tidal movement for a certain number of years. This eventually led to sedimentation and raising of the land level within the embanked *beel* area. In addition to relieving water-logging, TRM created an opportunity for increased crop production and habitation on higher flood-free lands (Nowreen et al., 2014). These benefits prompted the BWDB to formalize TRM and take up large-scale projects under the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) in the South-west delta (Amir et al., 2013).

Community-initiated informal TRMs were implemented in *beel Dakatia* in the *Hamkura* river and *beel Bhaina* in the *Hari-Mukteswari* river catchments in 1990-2001. Formal TRM was practiced in *beel Kedaria* and *beel Khuksia* in the *Hari-Mukteshwari* river catchment from 2002 to early 2013 (Amir et al., 2013; CEGIS, 2014). Previous research highlighted that TRM has not been implemented yet in *beel Kapalia*, which was supposed to start in 2012-2013 (Mutahara et al., 2017). BWDB is now implementing TRM in *beel Pakhimara* in the *Kobadak* river catchment, another major tidal system in the South-west region. After nearly 20 years of implementation, tensions and uncertainties on implementation and continuation of TRM persist between communities and BWDB. Our research intends to contribute to more effective, participatory learning, with a more sophisticated approach to handling conflicts and cooperation and to improve collaboration with respect to local delta water governance in Bangladesh.

4.3. Conceptual Framework

Conflict and co-operation are most likely to occur in a multiple-actor system: among actors, and between established institutions and others, who may cooperate and get involved in some instances but resist at other moments, seeking to obstruct the negotiation process (Warner and van Buuren, 2009). In water management processes, conflict and co-operation is usually expressed as action and reaction of stakeholders, i.e. how different parties react to management interventions or how one party responds to the actions of one or more other parties. The incidences of conflict and cooperation may be considered 'events' in a water management regime (Ravnborg et al., 2008). An event may be defined in general as an action or set of actions to secure one or more parties' access or contribution to a water management system by challenging other parties' actions; confirming one's own or other parties' actions; or collaborating with other parties to secure action and contribution (Funder et al., 2010).

A water management event is identified as 'conflictive', when stakeholders are proponents or opponents on issues or events, which increases tensions and/or complexities hindering achievement of the management goal. In 'cooperative' events one or more parties engage in jointly coordinated actions with other actors to adapt or improve a water management system or to acknowledge other parties' access to contribute to water management. This may range from verbally acknowledging the rights of others to establishing integrated water management mechanisms (Mirumachi and Allan, 2007; Ravnborg et al. 2012). In a multi-level stakeholder management process in delta water management conflict may be identified based on stakeholder behaviour and factual controversies. Co-operation may also be determined as stakeholders seek to develop and maintain a good relation (Mostert, 2003) to get a positive and coherent output.

We set out to understand the existence and intensity of water events, not only regarding the evolution and practice of TRM, but also the participation of multiple levels of stakeholders in delta management in Bangladesh.

4.3.1. Conflict and co-operation intensity

To analyse the intensity of conflict and co-operation events in water management in a delta system we modified the Basins at Risk (BAR) Scale for intensity of water events. This scale originated from Edward Azar's Conflict and Peace Data Bank's (COPDAB) International Cooperation and Conflict Scale, which categorizes events in terms of the nature and intensity of conflict or cooperation (Yoffe and Larson, 2002). To make the COPDAB scale more intuitive, Yoffe and Larson (2002) converted it to BAR scale ranging from –7 to +7, with –7 denoting the most conflictive events, 0 denoting neutral events, and +7 denoting the most cooperative events. Mweemba et al. (2010) and Ravnborg et al. (2008) translated the BAR conflict-intensity scale to local level, while Wolf and his colleagues (2003) developed a version to characterize the intensity of water events in transboundary water basins (Wolf et al., 2003; Yoffe et al., 2003).

Therefore, inspired by those landmarks we further revised the scale (Table 4.1) to make it more suitable to the nature of water management events in a rural coastal delta area in Bangladesh. Here the changes made to Ravnborg et al.'s (2012) scale include regional and local delta water management terms and situations (3rd column in Table 4.1), and exclude some categories which are specially in the co-operation scale concerning the existing pattern of management co-operation in Bangladesh cases (CEGIS, 2003; 2008; and 2014).

Table 4.1: Local Conflict and Co-operation Intensity (LCCI) Scale in delta water management

Ravnborg et al.'s intensity scale (2012)	Intensity	Modified Intensity Scale for local water events (during current research)
Merge formerly individual access rights	7	Written agreement /act by government for local scheme
Joint decision-making authority and/or rules development	6	Regular facilitation and motivation programme for communities
Establish joint organizational forum	5	Occasional motivation and consultation activities
Written or verbal agreements sanctioned by third party	4	Development of formal community organizations
Written or verbal agreements not sanctioned by third party	3	Non-strategic social and scientific supportive activities
Sporadic/occasional joint activities	2	Minor official exchange or formal scope of open discussion on goal, values and adaptation
Casual verbal recognition of each other's access rights	1	Casual/informal verbal recognition of practice/plan
Neutral or insignificant act/action	0	Neutral or insignificant act/action
Informal verbal dispute/expression of discontent	-1	Mild verbal and informal expression of discontent
Sporadic/small scale violation or sabotage of other's access rights	-2	Strong verbal expression-hostility in interaction
Denounce authorities and/or third party	-3	Denounce authorities and/or other third party
Public protests/demonstrations	-4	Public protests/demonstrations
Large-scale violation of other party's access rights	-5	Collective scale violation of law / other access rights
Unplanned collective violence, riots	-6	Unplanned /sudden incidence of violence
Organized collective violence/warfare	-7	Plan/organized violence

Source: Reframed from the Water Event Intensity Scale (Yoffe et al., 2003; Ravnborg et al., 2012)

4.3.2. Co-existence of conflict and co-operation

To clarify the co-existence of conflict and co-operation in a multi-stakeholder process within a delta water management system and to assess the dynamics of conflict and co-operation in TRM-based water management systems in the Bangladesh delta, we theoretically followed Mirumachi and Allan (2007)'s analytical Transboundary Water Interaction Nexus (TWINS) model. According to them, both conflict and cooperation are key to understanding progress or lack thereof in river management interventions. While TWINS tends to concentrate on conflict and cooperation in transboundary water issues, we tried incorporated it in a new dimension where the management interest is concentrated in local (and regional) delta management context to clarify the dynamic in intensity of conflict and co-operation to our analysis (based on Buzan et al. 1998; Neumann, 1998; Warner, 2004).

The TWINs approach distinguishes four levels of intensity of conflict: from non-politicization through 'normal' politicization via 'securitization' to 'violization' (Warner and van Buuren, 2009). In our study, those four levels were re-defined considering local and regional delta water management issues and situations. As the management issues, politics and over tensions in rural deltas especially in developing countries are unavoidably linked with social affairs, we focused on the community and society context. We labelled the intensity scale from socialization through *powerization* to securitization to violization.

Table 4.2: Intensities of conflict in TWINS model

← Low conflict intensity			High conflict intensity →
Socialized	Powerized (influenced by local power play)	Securitized	Violized (made violent)

Source: Redrawn from TWINs approach (Mirumachi and Allan, 2007; Warner and van Buuren, 2009)

In regional delta water management, conflict starts, when people raise their voices directly against implementation authorities in a 'water situation' (Ravnborg et al., 2012). Local people may go against some authority, when water interventions affect them socio-economically, without reaching the level of Parliament, Ministries, or the courts. That is why we used the label **'**socialized**'**, instead of non-politicized. However, it may be argued that in Bangladesh, where party politics and patronage pervade society to its core, it is challenging to separate 'politicized' from 'non-politicized' interaction. Power groups (both political and non-political) are always active in local water governance. Local community actions may also be influenced and motivated by different social activist groups, NGOs, or powerful persons or groups in the locality. Both politically and socially powerful people and institutions may insist on a conflictive course what we exactly refer to as 'powerized'.

In a regional water resource management system, a 'security' label may lift an issue above normal politics by elevating it to a life-and-death (existential) level bypassing normal rights and rules of political engagement and legitimizing extraordinary measures and resources, and so, giving powers to certain actors and institutions they could otherwise not claim (Buzan et al., 1998). However, subaltern actors may also 'securitize' an issue, legitimizing breaking the law, if they get enough resonance with their intended audience. In its most extreme case, a security condition can legitimize violence against opponents, such as local settlers who protest or take violent initiatives beyond the normal order, or police or armed forces repressing public demonstrations. In that case, the issue becomes 'violized' (Neumann, 1998).

Co-operation as alliance, partnership, and integration changes the arena in similar ways as politicization and securitization. The TWINs approach places confrontation of an issue that is verbally recognized/realized but without meaningful action at the low end of cooperation intensity (Table 4.3). Then it differentiates between speech acts stimulating ad-hoc interaction and those stimulating technical exchange. *Ad-hoc* cooperation and communication is defined as non-committal, that is to say: after information has been exchanged and any agreed (immediate) joint steps have been taken, each party involved goes it separate way. Technical cooperation may be defined as longer-term committed activities for co-operation, even when the political process breaks down. A joint defensive alliance - joint risk-taking in the model - goes beyond technical cooperation and may introduce formal agreements to stave off threats like flooding (Warner and van Buuren, 2009).

Table 4.3: Intensities of cooperation in TWINS model

Low ← cooperation intensity → High				
Confrontation of an issue	Ad-hoc	Technical	Risk-averting	Joint risk-taking

Source: Adapted from TWINs approach (Mirumachi and Allan, 2007; Warner and van Buuren, 2009)

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4.4. Methodology

To explore local (and regional) conflict and cooperation in water resource management, we conducted a scientific research project from 2012 to 2016 in Khulna, Jessore, and Satkhira Districts in the Southwest delta of Bangladesh (Figure 4.2) with a mixed methodological approach. In the study area a series of TRM interventions were proposed; some were already practiced as an option of delta management.

Our research was conducted as follows: (i) a quantitative inventory of conflict and cooperation events in water management in the study areas, based on archival research and interviews with key informants; (ii) 15 Focus Group Discussions (FGDs) and 50 interviews in different organizations to explore sources of conflict and scope of co-operation; (iii) 3 Local Stakeholder Meetings (LSMs) to clarify and validate the local water management intensity scale and examine the conflicts and cooperation extent related to TRM in the study area; and (iv) evaluation of the co-existence of conflict and co-operation in a local delta management system by applying the modified TWINS model.

An inventory of conflict and cooperation events was made through the evolution and practice of TRM in 1986-2015. All 'reported' and 'unreported' events were identified. 'Reported' events were defined as events about which information was found from institutional sources, newspapers, national and regional publications and leaflets, while 'unreported' events were events about which information was only found at the location of an event itself. The list of events was validated by elderly people and knowledgeable persons in the study area including the periphery of practiced or proposed TRM areas like *beel* Dakatia in Khulna, *beel Bhaina*, *beel Kedaria*, *beel Khuksia*, and *beel Kapalia* in Jessore, and *beel Pakhimara* in Satkhira districts.

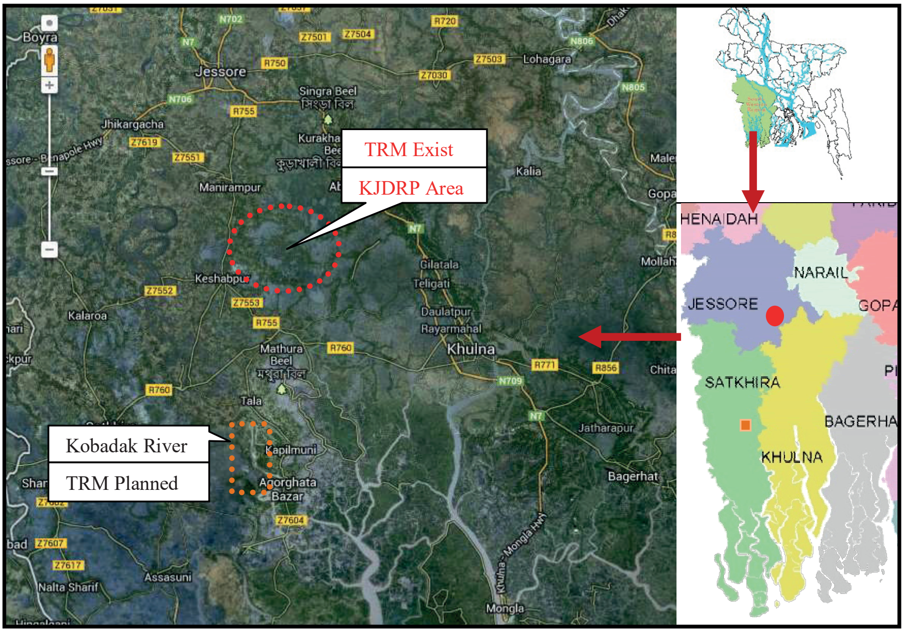

Figure 4.2: Study areas in three South-western coastal districts in Bangladesh (Google Earth, 2013)

The actors and sources as well as causes of reported water events were identified through FGDs at community level and meetings with key informants such as members of former Water Management Organizations (WMOs), current and former members of Local Government Institutions (LGIs), BWDB professionals, and representatives from the police, NGOs, and Civil Society Organizations (CSOs). Those interviews focused on conflict and cooperation events known to respondents familiar with TRM and general water management issues in previous and present years. The major part of those interviews were transcribed for analysis. Interviews with community stakeholders were noted down and, in some cases, also recorded, since most respondents did not allow recording, wanting to keep their information private.

Triangulation of inputs from community informants, respondents from relevant organizations, and reports/publications was applied to validate the information collected.

The adapted local conflict and co-operation intensity (LCCI) scale (Table 4.1) was shown at meetings of averagely 35 people representing local and regional stakeholders, who evaluated the nature and intensity of conflict and co-operation. In collective discussion and through knowledge sharing participants approved our adapted scale with respect to observed situations in their locality. They also evaluated the intensity of some events (Tables 4.2 and 4.3), which was then used to modify the TWINs model from a universal to a more site-specific, regional management context.

The identified events were listed in a chart indicating the timeframe and actors' involvement (Annex 1). The events were quantified by counting the incidence in each year from this chart. The nature and extent of events were assessed in a participant opinion checklist following the transcribed interviews. We rated the categories of intensity for conflict and co-operation with that checklist and presented them in Excel graphs in results section for a better understanding of their existence in a given timeframe. Past and present conflict and co-operation coexistence was evaluated, using the collected data (period and intensity) in the modified TWINs model. The TWINs model in TRM context was validated through discussions with academic experts and management consultants.

4.5. Results

4.5.1. Participatory identification of conflict and co-operation in delta water management

In our investigation we identified major and minor events related to local and regional delta system management. We recorded 32 major events, which occurred in relation to informal and formal practices of TRM from the mid-1980s to recent years (Annex B). Out of these events recorded, 23 (72% of total events) were evaluated as conflictive; the remaining 9 (18%) were co-operation events (see Figure 4. 3).

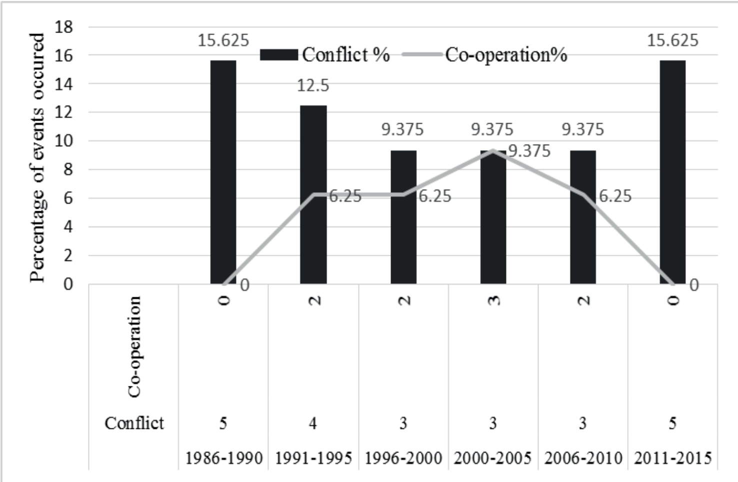

Figure 4.3: TRM-related conflictive and co-operation events in the study area over the last 30 years

The conflict and co-operation inventory shows that water management conflicts had mainly started from 1986, when the waterlogging problem had become severe in the area as a long-term impact of coastal embankment and poldering projects and also Flood Control and Drainage/Irrigation projects. While we recorded significantly more conflictive events than cooperation events, we found dynamic relationships among different parties in this local water management system. Evaluation of the conflictive and co-operative events yielded two historical main stems. The first is when the evolution of TRM began through a conflict over large infrastructural water control engineering versus local knowledge-based participatory land and water management in the 1980s and 1990s. Co-operative events were encountered only after the 1990s. These typically were in the nature of a negotiation and oral agreement with the authorities, and announcement of a rehabilitation programme or compensation.

The second stem concerns events that emerged, when multi-stakeholder participation in local and regional water management had been proposed, especially in implementing TRM, in 2000-2015. Co-operative situations were found in 1994-1996, when the government introduced integrated, participatory management through the set-up of formal community Water Management Organizations (WMOs) in the Khulna Jessore Drainage Rehabilitation Project. Major conflictive events took place again during formal TRM practice, and they appear to remain much more prominent than co-operative events. In fact, in the most recent time bracket of 2011-2015, no cooperative event was identified in the local water management system.

4.5.2. Stakeholders involved in water events

Our field assessment of stakeholder participation showed that the evolution of TRM reflects the history of conflict between community and the implementing organization, the BWDB. Also, the issue of tidal water use in South-west Bangladesh itself has been creating controversies between community groups themselves because of the personal interests of a few, specific groups (shrimp businesses). At the initial stage, TRM was already informally practiced in *beel Dakatia* and *beel Bhaina* by community members. At that time, the water management agency was the adversary. Once TRM was formally adopted, a multiple stakeholder system was initiated in theory and the involvement of all parties declared, but not enacted in practice. Based on our stakeholder identification, we drew up a simple list of stakeholders directly or indirectly involved in the local water management system (see Table 4.4).

Table 4.4: Stakeholder analysis in local delta water management

Stakeholders	Level of actor (based on involvement in water management activities)
Agro-farmers	Local community
Shrimp farmers	
Fisher folk	
Landless farmers	
Land leasers (shrimp business)	Local community (power group)
Water management organizations (WMOs)	Local community
Civil society organizations and local/regional NGOs	
Department of Agricultural Extension (DAE), the Department of Fisheries (DoF), and the Local Government Engineering Department (LGED) *etc.*	Government body (supportive organization)
Local Government Institutions (LGIs)	Government body (local administration and implementation)
Bangladesh Water Development Board (BWDB)	Water Management authority
District council and sub-ordinates	Regional decision making and policy supporting body
Ministry of Water Resources (MoWR)	National policy making body
Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modeling (IWM) *etc.*	Development support / consulting institutions

Source: FGDs, 2015

Community groups including agro-farmers, fish farmers, agricultural and fisheries labourers (landless but dependent on the TRM *beel* for their livelihood), and fisher folk are the primary stakeholders. In the area, WMOs, an institutional water management arrangement established in the mid-1990s in villages, are no longer active. NGOs and CSOs played an important role in formalizing TRM practice and mediating in conflict or cooperation events. Local government authorities are sometimes involved in implementation activities and support community stakeholders. While the BWDB is the implementing authority, DAE; DoF and LGED etc. also participate in integrated management. District councils and their sub-ordinate administrative units are involved here mostly as decision support groups. The Ministry of Water Resources (MoWR) is the national policy-making body, while CEGIS and IWM are the consulting institutions conducting field studies for the feasibility of TRM.

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4.5.3. Major sources of conflict and scope of co-operation in TRM

The South-west region of the Bangladesh delta is located in a climate-vulnerable area with a sensitive socio-economic system, which mostly depends on the land and water resources of the delta. Our research identified the following driving forces of water management events in the TRM practiced area.

Historical context: towards de-poldering

Local people have been practicing their indigenous measures to prevent floods and protect crops in the area from the beginning. Then large-scale water-related infrastructural constructions, like embankments and sluice gates, and regulator-based management projects came in but they failed to ensure a long-term solution to flooding in the tidal river catchments. These even created a new type of flooding (waterlogging). That was when locals raised their voices against poldering. Although they needed protection from salinity and storm-surge flooding, they obviously did not want waterlogging. From the mid-1980s to the early 1990s they staged several public demonstrations. Specifically, people made strong observations to the *Bhabodah* regulator (21 vents) in the *Hari River* catchment in Jessore District.

In the mid-1980s, when severe waterlogging started in Khulna and Jessore Districts, community members found that the *Bhabodah* regulator did not function in the project there. Moreover, it had trapped huge sediment upstream and reduced the drainage capacity of the Hari River, one of the main tidal drains in the area. Since 1986 there have been community outbursts against the polders and regulator system. These were aimed at removing the *Bhabodah* regulator and stopping further building of any large regulators in the tidal river systems in the area. Inhabitants even called the *Bhabodah* a death trap for them.

Evolution of TRM

When local people initiated informal TRMs (as noted in *beel Dakatia* and *beel Bhaina*) in the early 1990s, these were considered illegal 'public cuts' (Amir et al, 2013). Villagers had cut the embankment as an emergency measure to save their crops and household properties from severe waterlogging, but the BWDB took hundreds of people to court and even to prison. This action incited local people to turn against any initiative from government bodies, specifically the BWDB, in the 1990s. At the start of the *beel Bhaina* TRM (1997), the BWDB and community conflict became severe and turned into socio-political violence.

Technical context: interventions and strategy of TRM

After the formalization of TRM in delta management in Bangladesh (in 2001) local people and authorities again disagreed, this time about the best planning and implementation strategy. Villagers proposed an open embankment cut, which would allow water to flow into the *beel* area directly. Authorities, on the other hand, wanted to use a regulator to allow water as a control way (tides enter through a regulator, not directly) during a specific time (six months each year). Due to this conflict the implementation of a formal TRM in *beel Kedaria* was delayed. This made the area vulnerable to waterlogging again in early 2001.

Conflict situations is continued still. Local people and the authorities are become strong opponents with the issues of technical support like internal sediment management during TRM, the TRM operation timeline, selection of opening locations, operation and maintenance activities, and compensation.

Natural context: limited resources and multiple uses

Agro-farmers and large shrimp farmers (mostly involved in shrimp business) were conflicting whether or not to allow saline water into *beel* areas. The traditional agro-farmers at first did not want intensive shrimp farming in a *beel* due to risk for rice cultivation. Besides, they were mostly small and marginal farmers compared to the large shrimp farming community there. Since the formalization of TRM, also thanks to technical developments, the majority of the villagers has now become involved in a mixed agro-shrimp culture. Still, landowners and large shrimp farmers, who lease a major part of the *beel,* are struggling with each other on the question of opening a TRM in *beel Kapalia*.

Policy implication: participation and compensation policy

During the informal TRM, local people had not asked for any compensation, because they had wanted this action themselves (to save them from waterlogging). However, when the government officially implemented TRM with a participatory approach and support from the Asian Development Bank, villagers expected to be directly involved in the planning and implementation of TRM, and landowners demanded compensation for their loss of crops during TRM. The authorities were neither able to devise a sustainable community participation framework nor to arrange a compensation programme for affected people. In 2005, community members closed the gates of the *Bhabodah* regulator and stopped TRM in *beel* Kedaria. Then the water body launched a crop compensation scheme for landowners in TRM *beels*. The mechanism used is, in turn, a cause for (an ongoing) conflict, because it is considered to take too long and also hardly accessible to people in the margin.

Power relationships

In local people's perception, the BWDB is not really prepared to use a bottom-up approach, even though it had formally proposed such an approach. Analysing FGD reports and interviews, we found that the discrepancy between espoused and enacted TRM had led to an increase in conflicts and misunderstandings among stakeholders. Local political groups, large shrimp farmers, and local government bodies were found more important here than the primary stakeholders - farmers, landowners, and villagers -, who were affected by and directly involved in the *beels* for their lives and livelihoods. Moreover, the most powerful groups, those engaged in large-scale shrimp farming, managed to influence the administration and BWDB at the expense of the local community.

Political unrest, and law and order dysfunction

The national political situation in Bangladesh has been marked by unrest over the last few years. This unrest also affects local and regional politics and vice versa. In our study region, non-political activists and leftist parties (Communist) are active on different issues and raise their voices at some moments of crisis only. On the other hand, political groups supporting the government and supported by it in turn are very active, showing their power at local level. Mostly, they exert a strong influence on the local police. Some local groups are motivated by political as well as power-wielding people, take part in conflicts and create violence. The police nor local administration can play their mandated role in such situations.

In 2012-2013, there had been three very violent conflicting situations in the *beel* Kapalia area, but no one could clearly explain to us how it had come about and who had instigated it. According to some respondents, the situation was the result of conflicting parties having paid or bribed some political groups to increase their power.

Socio-educational structure

The study area includes very rural settings, with low levels of formal education. The illiterate and semi-literate people living in the margin of this rural society often do not understand the rather complex and bureaucratic compensation policy and/or do not know how to access the compensation mechanisms this policy provides. In this area, people mainly acquire land from family and relatives or buy it from others. In most cases, ownership transfers do not follow an exact procedure due to bureaucratic complexities. Since landowners needed to complete a huge amount of paperwork to prove their ownership, small and marginal farmers were unhappy with the TRM compensation mechanism and became opposed to the BWDB.

In the South-west area, community participation was introduced in IWRM, and community-based water management organizations (WMOs) and committees (WMCs) were installed since 1996 for local water management, thereby strengthening institutional cooperation. However, a platform of cooperation between community and authority was created in conjunction with the formalization of TRM in 2001 while international funding agencies (such as the ADB and the Dutch Development Cooperation Ministry) more or less demanded, then the government agencies change its mindset regarding community practices. But sustainability in co-operation in water management is still uncertain in this area. We found that, in general, most of the local, internal relations are positive, except those with the large shrimp-farming groups who are mostly come from outside for business. This is one of the main sources of third party imposed conflict now a days.

4.5.4. Participatory evaluation of conflict and co-operation intensity

The intensity of the recorded water management events has been assessed based on research participants' collective opinion following the Local Conflict Co-operation Intensity (LCCI) Scale (Figure 4.4).

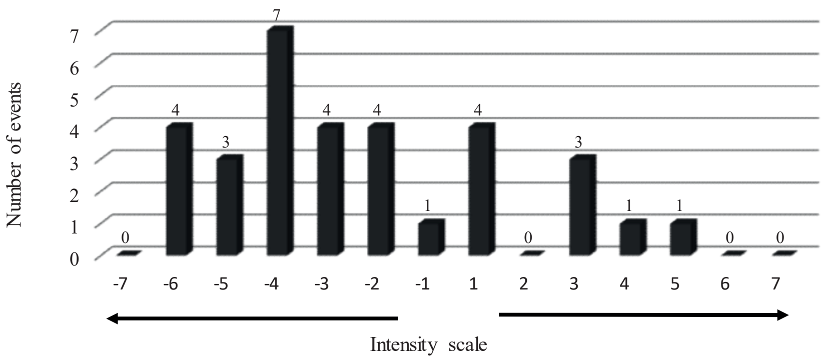

Figure 4.4: Intensity of conflict and co-operaion events in water management with TRM

More than one-fifth of the total recorded events (22%) are characterized by an intensity score of -4, denoted by public protest and demonstration. Unorganized violence events (-6) are identified as the second highest (almost 13 %) (see also Figure 4.5). In the 28% cooperative events, the majority were rated with lower intensity. Cooperation occurred with a score of 1 in almost 13% of the total events. Only about 9% were considered active co-operative events with a score of 3, defining non-strategic, social and scientific supportive activities. There have been no events with intensity 6 and 7 over the last three decades. This indicates that open discussion and regular facilitation of community organizations have not developed yet in local water management in this region.

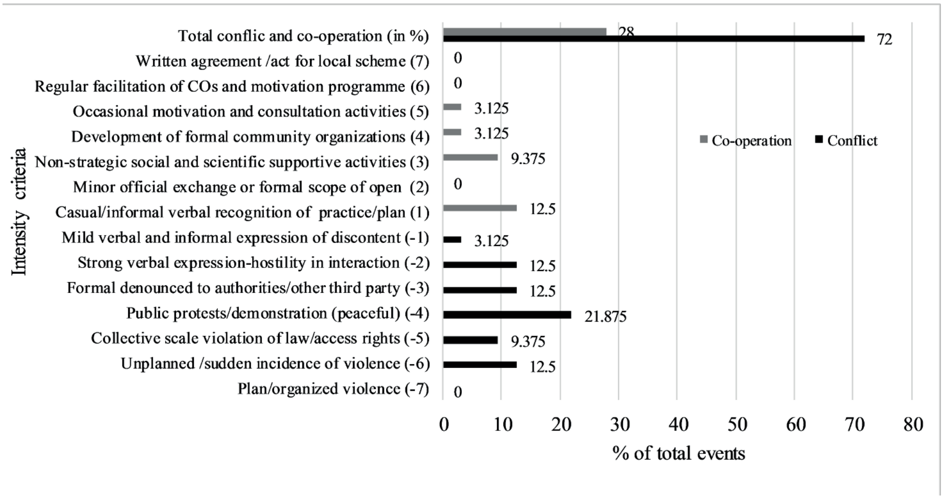

Figure 4.5: Intensity of water management events according to the local intensity scale

4.5.5. Dynamics of water management conflict and co-operation

The recorded events in delta water management were split up into two categories, based on stakeholders directly involved in the incidences. There were 16 conflictive events (50% of the total) - conflicts between community groups and management authorities. The number of co-operative events was 7 (19% of the total). Another category was later created, based on incidents within community groups, specifically between local farmers and commercial shrimp businesses (see Figure 4.6).

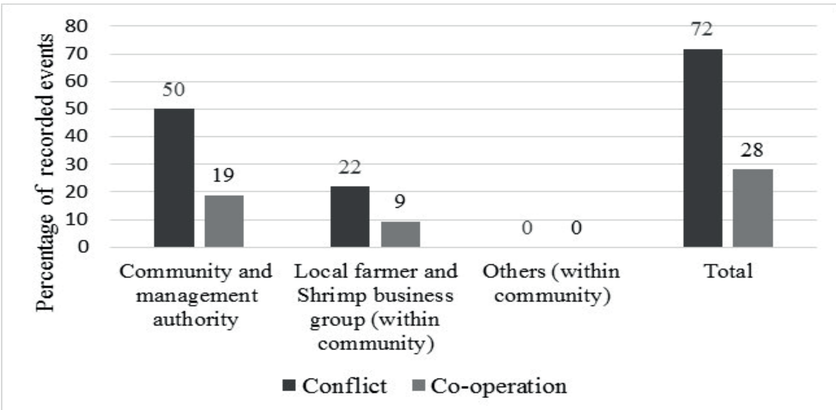

Figure 4.6: Categories of conflict and co-operation events in TRM-related water management

Evaluation of the interviews and collective responses in local stakeholder meetings formed a continuum of conflict and co-operation over the time period of initiation and implementation of TRM in the area. The intensity of conflict and co-operation between community and authority, specifically the BWDB, is shown in Figure 4.7a. Figure 4.7b represents the intensity of conflict and co-operation between farmers and shrimp businesses.

Figures 4.7a and 4.7b show that before the 1990s relations between local people and the BWDB were more conflictive and the intensity was higher (between -3 to -6). For instance in 1988, violence took place when locals protested against the implementation of typical structural engineering projects to improve the tidal river system in *beel* Dakatia. In that year, farmers (involving other local community groups) were also conflicting with the powerful shrimp farmers. The intensity had become higher, when farmers and social activists were holding a public demonstration (-4) against the intensive use of salt water in shrimp culture (Figure 4.7b). With the start of their 'indigenous' TRM - to drain out flood water in the 1990s-, people had violated the law by cutting the embankment, according to authorities. In 1997 again some villagers had cut the embankment, this time in *beel* Bhaina, and fought with the authorities as well as shrimp farmers to remove flood water from the villages and *beels*. (Intensity -5.)

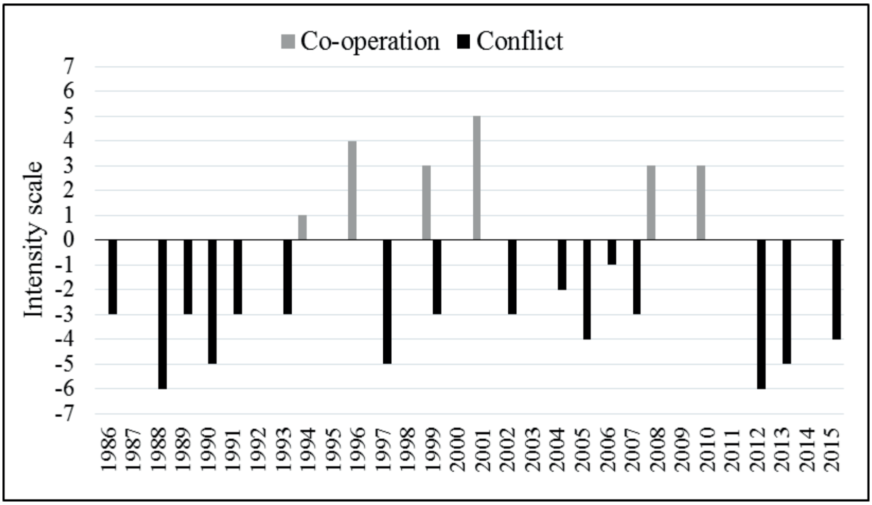

Figure 4.7a: Conflict and co-operation intensity in the context of the relationship between local community and authorities

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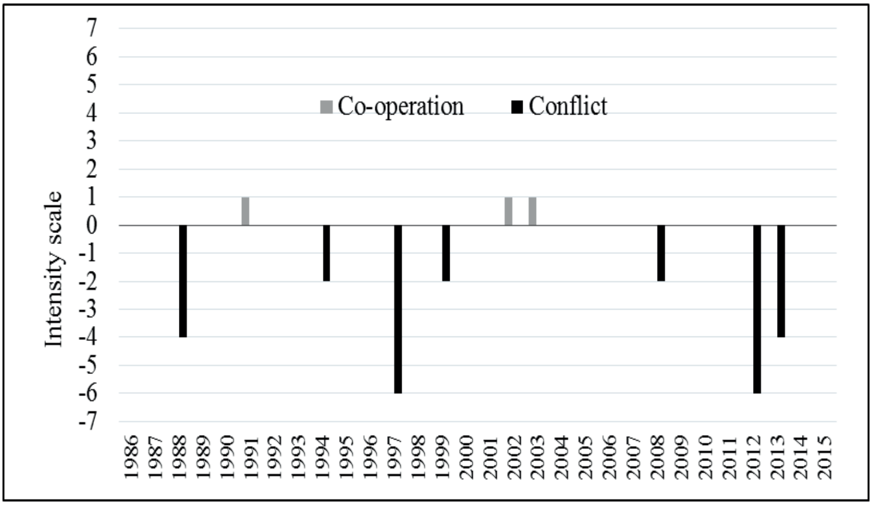

Figure 4.7b: Conflict and co-operation intensity in the relation between land owner farmers and shrimp businesses

Observing the effectiveness of TRM in removing waterlogging and at the insistence of donor agencies, BWDB officials formalized TRM in local delta management in the mid1990s. Though they had also adopted TRM and developed community-based management in the KJDRP area, the conflict did not resolve the issue of the right TRM implementation strategy to be pursued and the lack of maintenance activities. Conflict again took place in 2002 due to the community's non-acceptance of the BWDB-provided TRM mechanism. During the first officially implemented TRM (*beel* Kedaria), landowners demanded crop compensation and a stop to TRM. This was in 2005. An important cooperation event was identified in the early stage of *beel* Khuksia TRM (2006-08) regarding TRM implementation, when the BWDB promised crop compensation to landowners. The *Khuksia* TRM (2006) continued for about 7 years, but people and the BWDB have been at loggerheads again since 2012 about when to stop TRM.

The most severe conflict happened during June 2012, when a destructive violence occurred in *Kapalia* village: village people, social activists, and political groups were literally fighting with the police (intensity -6), when the BWDB had tried to start *beel Kapalia* TRM. Several people were injured, cars were burned, and thousands were arrested. This caused tremendous social and economic distress to the local people. The BWDB proposed TRM in *beel Pakhimara* in *Satkhira* District to remove waterlogging from the

Kobadak river basin with the support from most of the local people. But then, conflicts arose regarding compensation and land acquisition during implementation of the TRM in 2015. Cooperation in all groups were increased comparatively in 2001-2010. However, these cooperative relationships were rarely sustained in the present decade.

4.6. Conflict and co-operation co-existence in local water governance

While the history of TRM appears more conflictive than cooperative, we applied the TWINS matrix to learn more about significant historical and contemporary events' dynamics in a TRM-based delta management system.

The TWINS table shows the conflict and co-operation interaction path as 1→2→3→4→5→6, following a timeframe of significant water management events, which make a cyclic framework. Evolution of TRM (pointed 1) is observed within a range of 'socialized' (involvement, protest, and interaction of community groups) to 'violized' (the issue passed beyond the realm of public protest, when extreme measures were taken by the management authority) which is also extended to both lower and higher levels of conflict, as the nature of conflict is very dynamic, while co-operation is not observed at all.

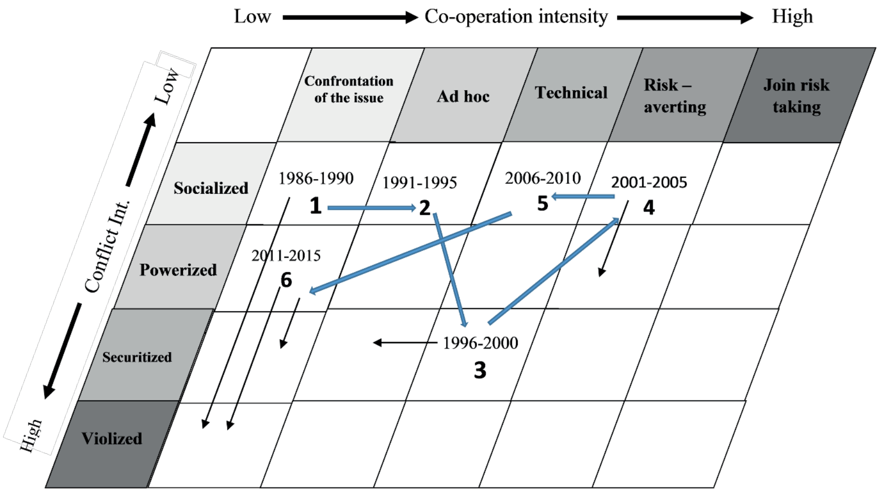

Figure 4.8: TWINS table applied to learn about crisis and collaboration with respect to TRM in the South-west region of the Bangladesh delta

(The single black arrows define that the nature also fit for indicated cell of the table).

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The relation of conflict and cooperation is changed as pointed 2, where cooperation was developed, though the level is not higher. During the community-practiced informal TRM (pointed 3), the conflictive events fitted in the range of 'securitization' (community ignored the management-made law and took its own measures to save their lives and properties from flooding). In this context, cooperation ranged from 'technical' to 'ad-hoc' (authority conducted social and technical survey on effectiveness of informal TRM). The highest level of cooperation in this local water management system was identified during formalization by the BWDB of TRM in regional delta management as a whole, to reduce the risk of waterlogging. This is situation pointed as 4, referring to low conflict and higher cooperation in water management in this area. At situation pointed 5, cooperation seems moderate and the conflict level is comparatively lower, because most local people worked together with the authorities in this period to implement TRM. In the most recent period, cooperation is rarely found and conflict is at a higher level. The conflicts are very dynamic, characterized by lower to higher intensity and extended from 'powerized' to 'violized' level.

4.7. Conclusion

Literatures on multi-stakeholder processes (Warner, 2006; Thomas and Warner, 2015) and the TWINS model (Mirumachi and Allan, 2007; Warner and van Buuren, 2009) suggest that conflict and cooperation are both essential in trying to meet environmental challenges with multiple uses and users of common-pool resources. Cooperation sounds desirable, but may bring complacency and remain superficial (Kistin, 2011). On the other hand, conflict should not necessarily be seen as problematic: it could facilitate learning about a particular problem and about other perspectives and interests (van Laerhoven and Anderson, 2013).

Our present analysis revealed the dynamic nature and intensity of conflict and co-operation in local water management providing better understanding and systematic learning for dealing with uncertainties to improve and sustain further multi-stakeholder management process. This research found that in TRM process, conflicts events triggered major changes and co-operations mostly taken place after higher intensity of conflicts. This is not to say that conflict is always productive while key requirements for so-called generative conflict are that the core actors perceive a common challenge (Röling and Woodhill, 2001) and develop joint trust and commitment (Sol et al., 2013). These conditions appear to have been met in the case of evolution and implementation of TRM while TRM came into being through conflicts between local people and management authorities. A majority of actors perceived waterlogging and siltation as common problems, and TRM as a potential solution, rooted as it was in traditional practice. But misconception, poor communication, insufficient compensation, and complex actor relationships, however, marred successful multi-stakeholder planning and sustainable implementation here. As a case in point, a formally established multi-stakeholder platform for consultation failed to sustain in TRM cases due to multi-dimensional sources of conflicts.

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Our research resulted that conflictive events were much more frequent than cooperative events in the evolution and implementation of a TRM-based delta management system in Bangladesh. We learnt that the involvement of different stakeholder groups, particularly community members, in formal TRM had increased not only conflict situations but also interaction among different levels of stakeholders in the society. Conflicts in TRM are now not only localized but also influential in regional and national water governance, because, in most cases, it is planned and implemented by the BWDB and its management actions and power orientations.

Since the village community is closely related to the delta system in the area, water management conflicts with socio-economic and political power are also emerging because of the technical and institutional limitations of the local BWDB and the regional water governance body. Cooperation events between community and the authorities were recognized but not frequent for sustainable management participation in this delta area. Another complexity in the successful adaptation of TRM was identified to be inter-community conflict. Traditional and modern agro-farmers are always conflicting with the powerful shrimp business people and their cooperation is rarely seen in a TRM-based system. Conflict is increasing in each categories, even as multi-party conflict (Farmer-Shrimp business-BWDB) are taking place in recent cases. In such a case, resistance would seem the 'Best Alternative to a Negotiated Agreement' (BATNA)[3] for some, and, indeed, in almost all management sites conflict has emerged, at times even violently so.

This article also resulted a linear, two-dimensional (timeframe versus societal actions) learning assessment of the nature of conflict intensity, ranging from optimal society orientation to extreme violence and lack of sustainability of cooperation in existing governance systems from a modified TWINS matrix. However, as our research for

[3] i.e. 'the most advantageous alternative course of action a party can take if negotiations fail and an agreement cannot be reached' (Wikipedia)

documenting sources of conflict and co-operation explored various dimensions of water management events in localized delta, the aspect of conflict-cooperation coexistence could be analysed in more than two dimensions in this delta management system for an efficient negotiation in a sustainable multi-stakeholder process. It could be studied from different management domains relevant to water governance such as regional, political, or policy contexts. This may contribute to the development of a new, extended assessment tool of water management events to improve people's participation in formal delta management.

Chapter 5

Enabling Stakeholder Partnership for Sustainable Delta Management in Bangladesh: Problems and Prospects for Multi-Stakeholder Learning and Participation

This chapter has been accepted (with minor revision) as:
Mutahara, M., Warner, J. F., Wals, A.E.J. and Khan, M.S.A. (2017). Enabling stakeholder partnership for sustainable delta management in Bangladesh: problems and prospects for multi-stakeholder learning in Special Issue of *International Journal of Environmental Policy and Governance.*

An earlier version has been presented in 6th International Conference on Water and Flood management (ICWFM, 2017) as:
Mutahara, M., Warner, J. and Khan, M. S. A. (2017). Designing multi-stakeholder partnerships with (re)frameing social learning for sustainable delta water management in Bangladesh, *5th International Conference on Water & Flood Management (ICWFM-2013),* Conference proceeding pp 151-158.

5

5.1 Introduction

Multi-stakeholder processes have played a crucial role in implementing sustainable development-related goals ever since the 2002 World Summit on Sustainable Development in Johannesburg (Pattberg and Widerberg, 2016). The concept of multi-stakeholder participation has been widely promoted as a promising means of dealing with challenges and making decisions in natural resource management (e.g. Thorne, 2014). Furthermore, the 'partnership' approach (Malena, 2004) is capturing the imagination of the international water sector in its attempt to respond to an increasing demand for participatory governance, stakeholder engagement, and interactive policy-making for sustainable development (e.g. Pahl-Wostl et al., 2007; Hajer et al., 2015).

In Bangladesh, government and international development agencies have adopted a participation-oriented discourse since the 1990s (Dewan et al., 2014). However, little is known about how this discourse works in practice and the extent to which it enables participation and learning in a multi-stakeholder context. The limited research that is available suggests that multi-stakeholder participation has rarely been effective in governmental projects, especially in the Bangladeshi water management system (Tutu, 2005; CEGIS, 2014). The Bangladesh Water Development Board (BWDB) formally introduced participatory water management in the southwest coastal region in the mid-1990s, based on the concept of Integrated Water Resource Management (IWRM) (CEGIS, 2003). It was thought that this approach would be a remedy to the dysfunctional situation which had arisen from conflicts and complexities in social interaction and stakeholder relationships regarding the changes in delta water management (Haque et al., 2015). However, successes have been limited over the last two decades and the sustainable adaptation of delta management has become deeply uncertain in this area (Nowreen et al., 2014).

The present research is based on the assumption that sustainable delta management requires effective participation and stakeholder co-ordination in which scientists, government authorities, policy-makers, and community stakeholders will overcome the considerable obstacles to learning and managing a common challenge together. Social learning as a co-creative process involving multiple actors with different backgrounds but with mutual interests, is considered desirable to carefully integrate different perspectives and to develop a shared vision and plan (Benson et al., 2016). Social learning is all about 'managing processes of social change' in which people learn from one another about ways that may benefit the wider social-ecological system (Ison and Watson 2007; Mostert et al. 2007; Medema et al. 2015). Although globally social learning has gained enormous popularity during the last decade in the context of multiple-stakeholder natural resource and environmental management (Reed et al., 2010; Muro and Jeffrey, 2008), it's utilisation in Bangladesh has been rather minimal.

This article, then, aims to analyse current factors impacting organized participation and to evaluate the opportunities of learning-oriented partnerships creating a more sustainable delta management system. Our current research assesses the scope and challenges of a Multi-Stakeholder Learning Partnership (MSLP) in a dynamic delta characterized by complex social, political, and economic changes. The study is based on four research questions:

- How does multi-stakeholder participation function in regional delta management in Bangladesh?
- What is the role of trust, motivation and commitment to improve participation and expand social learning in a multi-stakeholder network?
- What are the boundaries in improving participation and successful orientation of participatory learning in the delta management in Bangladesh?
- How could an effective Multi-Stakeholder Learning Partnership (MSLP) be developed in a regional delta management system?

We aim to investigate the existing participation processes and mechanisms through which the stakeholders either hinder or support a functional partnership in a local and regional delta management system such as Tidal River Management (TRM) in the south-western part of the Bangladeshi delta.

5.2 Tidal river management as a regional delta management system

This research concerns a local and regional delta water management system: TRM. TRM refers to an integrated multi-stakeholder management system that was developed in the southwest Bangladesh delta to resolve the serious waterlogging problems that communities have experienced since the 1990s (Amir et al., 2013). Originating in indigenous knowledge of sediment management practices, TRM was informally started by the community of stakeholders in *beel Dakatia* in 1990. Although the management authorities (i.e. BWDB) proposed a participatory management approach in the mid-1990s, they do not officially accept TRM. TRM has become formalized in coastal water management since 2001-2002 under the extended Khulna Jessore Drainage Rehabilitation Project (KJDRP) in the south-west coastal delta in Bangladesh (see Figure 5.1).

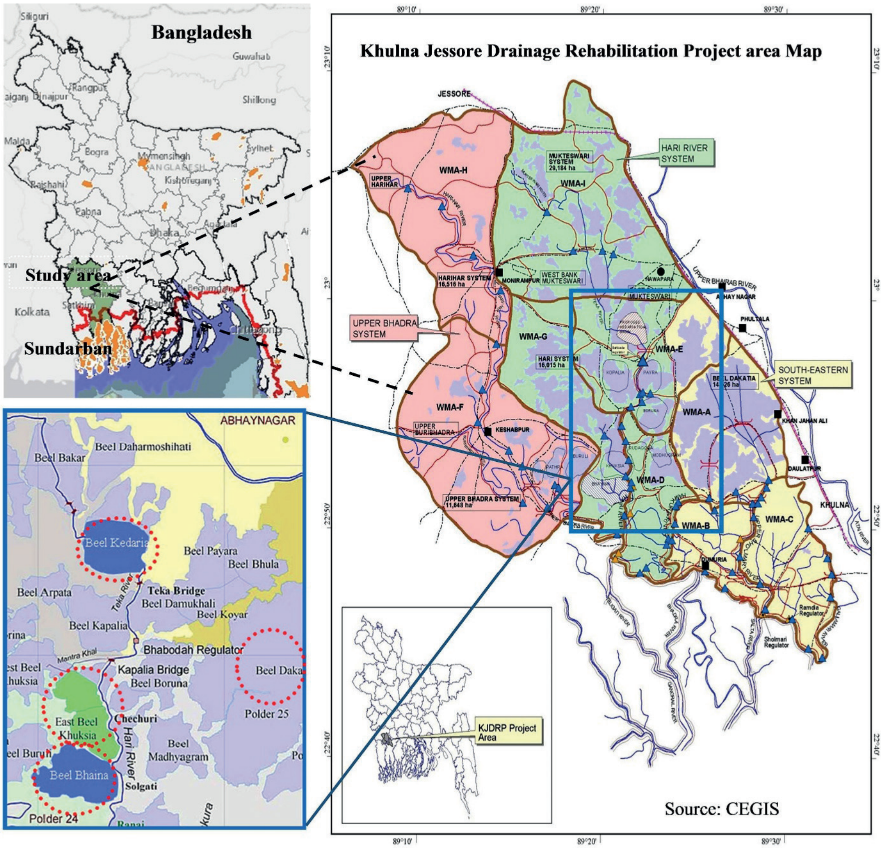


Figure 5.1: TRM case study area under KJDRP in the SW coast area in Bangladesh delta (Source: Prepared from IWM, 2014; CEGIS, 2014)

TRM represents a more natural and less structural type of intervention in tidal river catchments designed to reduce excessive sedimentation, restore tidal rivers and to prevent waterlogging (Tutu, 2005; Kibria and Mahmud, 2010). Technically, TRM allows for the natural movement of sediment-borne tidal water into an embanked tidal basin or *beel* during high tide while also enabling the deposition of sediment. During low tide the outgoing silt-free, high-velocity water erodes the riverbed and increases its drainage capacity (Amir et al., 2013; Khadim et al., 2013). This eventually leads to internal sedimentation and the raising of the land level within the embanked area. This unforeseen secondary benefit creates an opportunity for increased crop production and habitation on higher flood-free lands (Nowreen et al., 2014).

The initial success of TRM encouraged the government agency (BWDB) to formalize the TRM and take up large-scale projects under the KJDRP (Amir et al., 2013). The feasibility study revealed that continuous and rotational implementation of TRM is a prerequisite for achieving a sustainable solution for waterlogging (CEGIS, 2003). However, the proposed TRM project (at *beel Kapalia* in 2012-2013) in the KJDRP area has not been implemented yet, mainly due to stakeholder conflict caused by lack of community collaboration and lack of stakeholder co-ordination. This research investigates both informal, community practiced, and formal, BWDB implemented, manifestations of TRM.

5.3 Conceptual framework

Multi-stakeholder processes bring different stakeholders (actors) together a joint learning process that can enable innovation, improve or expand decision-making, and can, ultimately, lead some kind of action (Malena, 2004). In this article, we have conceptualized 'Multi-stakeholder Partnership' (MSP) concerning improvement of participation and learning as a collaborative and interactive approach to managing changes, improving social capacity and promoting a sustainable management in a river delta (Brouwer et al., 2015). Multi-stakeholder processes are viewed as a means to: support participatory planning in river basin management (Pahl-Wostl, 2006; Woodhill, 2004; Warner, 2006; Bréthaut, 2016), improve actor interactions in sustainable water governance (Sol et al., 2013; Medema et al, 2015) and, finally, to strengthen participatory rural research in developing countries (Davidson-Hunt, 2006; Rist et al., 2006).

Multi-stakeholder interactions and social learning

The interactions between stakeholders in land and water management and their constituencies, facilitate innovation and foster a pathway for positive transitions in socio-ecological systems (Cundill, 2010; Tukker and Butter, 2007). These interactions do not take place in 'flat' networks but rather in a multi-scale network (Pahl-Wostl 2007; 2009) based on 'Communities of Practice' (Wenger, 1998). They are influenced by the water governance structure in which they are embedded (de Boer et al., 2016). Furthermore, interactions and collaborations may improve with the generation of new knowledge and learning in multi-actor innovation networks (Pekkarinen and Harmaakorpi, 2006) where, for instance, farmers, scientists, students, NGO's and policy makers together can find answers to existing social, economic and ecological problems (Sol et al., 2015). Figure 5.2 shows the network of multi-stakeholder participation and learning at three different levels of involvement. It is assumed that learning occurs or needs to occur within and in between those levels to introduce successful participation in delta water governance.

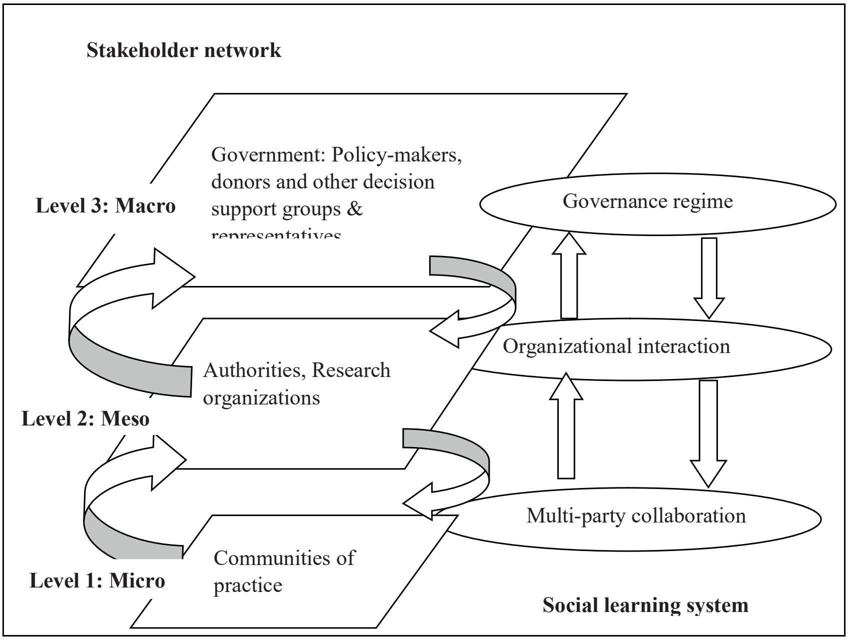


Figure 5. 2: Stakeholder network and concept of multi-level participatory social learning

● Level 1: Micro - multi-stakeholder collaboration in which representatives from different stakeholder groups interact at local level regarding practical issues and changes.

● Level 2: Meso - the stakeholders in the water management regime consisting of more or less organized groups, e.g., authorities, associations, organizations that may partly engage in bilateral interactions.

● Level 3: Macro - the level of change in governance and societal structure (formal and informal institutions and power relations, cultural values and norms).

Social learning is addressed here as an interactive process in a multi-actor system where actors seek to improve their practices (single loop learning), reconsider the assumptions on which there practices are based (double loop learning), and, ideally, reflect on the way learn and try to make change (triple-loop re-consideration/transformation) (e.g. Medema et al., 2015) Social learning can be viewed as a form of participation that stimulates changes of individuals, collectives and systems through an ongoing process of learning and negotiation (Reed et al 2010; Brouwer et al., 2015). Theories about social learning suggest that processes of multi-loop learning are major features of social learning. The evaluation of multi-loop social learning requires attention to a range of change factors like content (what is being changed), context (pre-existing forces which may impact the system), process (how change is organized) and individual attributes (who affects the change process) (Walker et al., 2007; Medema et al., 2015). In addition attention needs to be paid to the role of power and trust as the process of social learning is embedded in a web of power and trust relationships (Leeuwis, 2000; Sol et al., 2014). Here, we assume social learning to be a dynamic process, in which trust, motivation and commitment are continuously produced and reproduced through the (inter)actions of the individual or group of actors (Sol et al. 2013). Since these three elements are quite central in the research we will look at them in more detail.

Trust promotes cooperative behaviour within organizations and between stakeholder groups, and fosters commitment and motivation (Lewis, 1999; Osterloh and Frey, 2000). This is seen as a pre-requisite for creative innovation and knowledge sharing. Trust is expressed by participants' willingness to share responsibility, power, and sensitive information. Motivation is expressed by participants' willingness to engage, take initiative and to go beyond what is expected or asked from them. Commitment connects with motivation, but also is expressed by participants' willingness to 'invest' their own resources and to stay with the network/project during times of low progress/energy and beyond its formal duration (long-term). While the level of motivation is assumed to be based on stakeholder response to the management goal, stakeholder commitment indicates their performance in achieving the management goal (see Table 5.1). In order to build social cohesion in tidal river management, strong motivation, joint commitment and mutual trust among stakeholders is considered critical for realizing generative outcomes. In the research these expressions were used as indicators to be able to gauge any changes in these areas within the TRM configurations.

Table 5.1: Properties of learning interaction in multi-level stakeholder networks within TRM

Variables of learning interaction	Indicators	Contexts of multi-level stakeholders		
		Micro	Meso	Macro
Mutual trust	Changes in underlying beliefs to actions of other stakeholders	Trust in the willingness of management authority to implement TRM	Trust in the integration of community and authority	Trust in the effectiveness of community knowledge
Motivation	Response to changes in management interest and TRM goals	To direct involvement and long term benefits	To ensure required interim management	Promote social and ecological conservation
Commitment	Performance/activitie s to achieve the TRM goals	Provide resources (i.e. allow to use land for TRM)	Proper timing and provide compensation	Develop/change the management policy

Learning-partnership for effective participation

The concept of 'partnership' in a participatory multi-stakeholder process refers to the way in which groups of people can make decisions and take action for the collective good, at the local, regional, and national scale (Brouwer et al., 2015). Bäckstrand (2006) conceptualized partnerships as a multi-sectoral network that provides a framework for evaluating legitimacy, accountability, and effectiveness of networked governance. In recent years, the notion of governance in natural resource management has been conceived as multi-scale and polycentric in nature inviting a large number of stakeholders at different levels and institutional settings to contribute in overall management goals (Pahl-Wostl et al., 2009).

In this research a Multi-stakeholder Learning Partnership (MSLP) represents a particular participatory approach in water governance for connecting levels of participation to improve vertical coordination by improving co-operation and utilizing social learning (Pahl-Wostl, 2007). It is assumed that within a water management regime, changes in management practices, actors' involvement, governance structure, and underlying values and paradigms cannot occur in isolation from the societal context. Figure 5.3 shows the conceptual framework of multi-level learning in regional water governance used in this research where the key focus lies on the questions why, to what context, with whom, and how are multi-stakeholder learning partnerships formed?

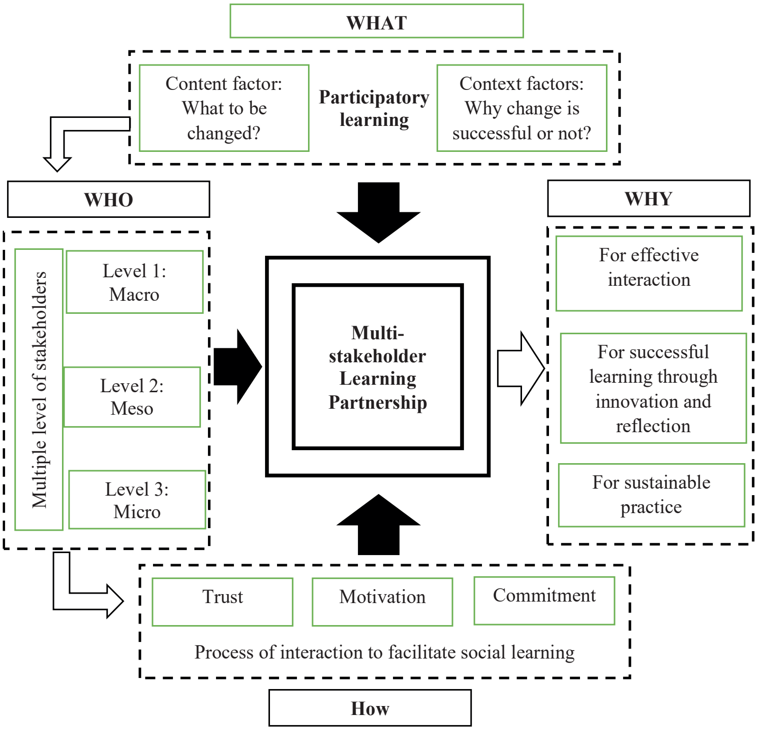


Figure 5. 3: The conceptual framework of multi-level learning in regional water governance.

The three levels distinguished in Figure 5. 3 (micro, meso, and macro) are interdependent, and multilevel change is assumed to proceed in an iterative fashion. Learning partnerships are assumed to develop in such iterative fashion within a management system network to expand participation and improve sustainability (Pahl-Wostl et al., 2009).

The moving between levels and stakeholder perspectives and interest requires boundary crossing. In a multi-stakeholder and multi-level management system, boundaries or discontinuities that are likely to exist between the different stakeholders can create uncertainties for achieving sustainable management goals and can be a source of friction between actors (Falkenmark & Lundqvist, 1998). Boundaries can be defined as 'socio-cultural differences leading to discontinuity in action or interaction which can, depending on how they are managed, either stimulate or block learning' (Cremers et al. 2016). There could be very complex issues in a three-level stakeholder system relationship that can become boundaries or boundary objects related to a range of factors (e.g. power inequalities, differences in technical capacity and political contexts and socio-economic conditions). At the same time boundaries need not just to be considered a source of potential difficulties but can also be regarded as new opportunities for improving learning (Wenger, 2000; Cremers et al. 2016). Thus, the identification and discussion of boundaries is an essential part of facilitating multi-stakeholder participation and understanding participants' interests and stakes within the partnership (Tippett et al., 2007).

5.4 Methodology

We have conducted an integrated delta management study to examine current stakeholder participation and to assess its prospects for future the tidal river management in Bangladesh. Rapid Water Management Appraisal (RWMA) (Wester and Bron, 1996), adapted from the Rapid Rural Appraisal (RRA) method (Chambers, 1994), was used to learn about rural conditions in an intensive, iterative, and expeditious manner. RWMA is usually conducted in small teams involving multi-level participants. We used this approach here, because it was developed, and proved to be generative, within the context of water management system research in Bangladesh before (Wester and Bron, 1996). What was somewhat unique in this study is that we combined RWMA with participatory evaluation (Guijt, 2014). Participatory evaluation requires the involvement of all the stakeholders in the evaluation of an activity or process, here TRM. This involvement can occur at any stage of the evaluation process, from the evaluation design to the data collection and analysis and the reporting of the study, but ideally stakeholders are part of all stages. Still, the type and level of stakeholder involvement inevitably will vary (Guijt 2014, p.1).

Participatory evaluation represents a form of reflexive inquiry that enables researchers to (re)describe and (re)interpret data, ideas and concepts (Rodela et al., 2012; Dillon and Wals, 2006). A key part of facilitating the participation process is the use of methods and tools that help people visualize and understand issues, to communicate with each other, analyse options, and reach decisions in an iterative but structured way (see Figure 5.4). The 'participatory RWMA' took place over a 4 year time period between 2012 and 2016 thoroughly documenting the experiences and the learning of the local community regarding TRM in the KJDRP project in southwest Bangladesh. We also made use of used earlier data on changes and interactions since 2008-2009 from personal and professional experiences as well which were retrievable from the archives of local and national level institutions.

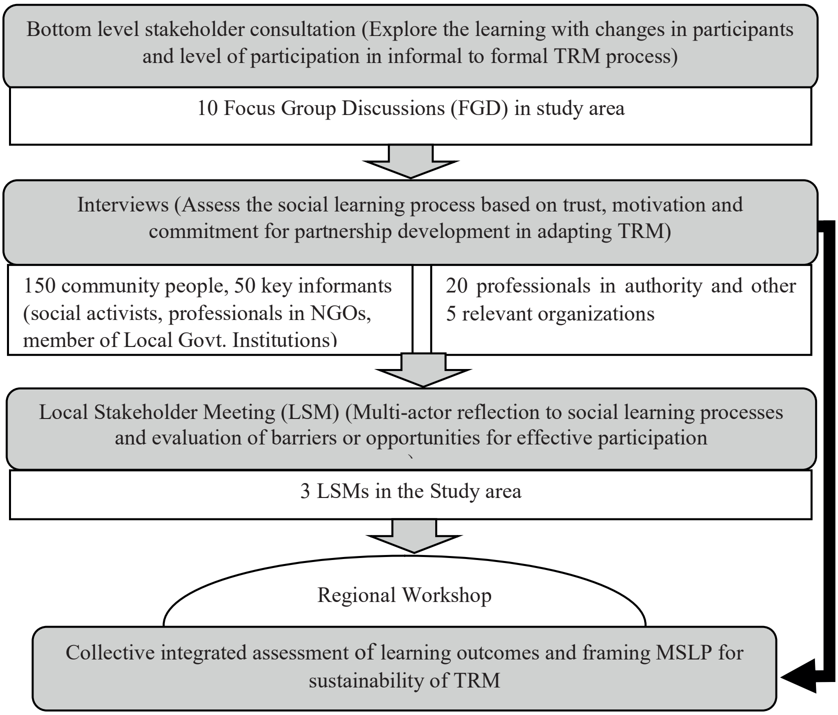


Figure 5. 4: Methodological framework of the present participatory evaluation approach

In this research, ten Focus Group Discussions (FGDs) were conducted at the community level to: explore the changes in management participation and to identify and describe the contexts of multi-stakeholder learning. We also have recorded individual interviews of community people, pragmatically selected informants (teachers, journalists etc., who had long been involved in water management activities in that area), professionals and scientists from BWDB and other relevant organizations using primarily open questions that could trigger a more in-depth conversation. These questions were:

1. How did you get involved in TRM?
2. What is your main interest in participating?
3. What did you learn through your experience with changes from an informal to a formal process of TRM?
4. Do you trust other stakeholders and their actions in adapting TRM?
5. Are you motivated by the goal and effectiveness of TRM?
6. How did you commit to an effective partnership development?

7. What changes or learning intervention would you expect in the future for sustainable partnership development?

The interview notes and transcripts were analysed and compared qualitatively with the intent to discover some learning interactions and coherency. Several aspects of regional stakeholders' ideas and experiences tended to repeat themselves with some variation, and after several rounds of interpreting, the properties of actor interaction have emerged in relation to trust, motivation and commitment (see Table 5.1) within management network.

Lessons learned, with regards to the key elements in facilitating multi-stakeholder learning, could be drawn by integrating past experiences of stakeholders and mirroring them with the information and observations of the researchers (Brouwer et al., 2015; Rodela et al., 2012). So, three local stakeholder meetings were arranged to gauge social cohesion and partnership development in tidal management system. Those meeting were conducted in the presence of local communities and organizations with an average of 35 participants: representatives of NGOs, CSOs, and local government institutions and the BWDB. The first author facilitated the meeting and two research assistants documented the reflections on individual learning outcomes from different groups of participants.

The aim of this research is to gather a deeper understanding of the role and prospect of learning in relation to multi-stakeholder partnership development. Although in this case where the lead author engaged in the interpretation of her own interpretations and experiences, multiple-level of stakeholders participated in the analysis and final interpretation of the data in order to reach some form of learning contexts and consensus about the way they involved to the management network. Finally, synthesis of systematically gathered information on learning contexts and processes was coordinated in a regional delta management workshop in the presence of most participating stakeholder representatives which recommended the prospects of learning partnership for sustainable delta management in Bangladesh.

5.5 Research findings

Dynamics of participation in TRM practices

During FGDs the lead author recorded the discussion of participants and took notes about practice and participation to TRM. Those records revealed that indigenous TRM practices or informal TRM, had been carried out in *beel Dakatia* in the *Hamkura* river catchment and *beel Bhaina* in the *Hari-Mukteswary* river catchment in KJDRP from 1990 to 2001. Those were implemented by local communities without any support from management authority. However, when TRM was transformed from an informal to a formal practice, different actors (see Table 5.2) was involved in management system which introduced the concept of multi-stakeholder participation in the water management programme.

Table 5.2: Stakeholder analysis within the multi- level network of delta water management

Stakeholders	**Groups of actors (based on mode of action in regional system)**	**Multi-level network**
Agro-farmer, Shrimp farmer, Fisher folk Landless farmer, Land leaser (shrimp business: local power)	Local community	Micro level
Water Management Groups (WMGs), Local/regional NGOs, CSOs	Local community (Institution)	Meso level
Department of Agriculture (DAE), Department of Fisheries (DoF), Local Government Engineering Department (LGED)	Govt. organizations (supportive organization)	
Local Government Institutions (LGIs)s	Administrative authority (local administration)	
Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modelling (IWM) etc.	Research organizations	
BWDB (Local /regional level)	Main authority of implementation	
BWDB (Central level)	Authority of planning and decision making	Macro level
District and Upazila Commission	Administrative authorities	
Ministry of Water Resources (MoWR)	Higher authority and decision maker	
Asian Development Bank (ADB); Dutch Govt.	Donors	

Source: Grey literature review and field research 2012-2013

The government authority (BWDB) and decision makers were convinced of TRM's value by the way it seemed effective in *beel Bhaina's* informal TRM. Subsequently, more formal TRMs were implemented in *beel Kedaria* and *beel Khuksia* in the *Hari-Mukteswary* river catchment from 2002 to early 2013, using a participatory approach (Amir et al, 2013; CEGIS, 2014). The FGD reports documented the shifts in stakeholder participation over the years and stakeholders' responses in informal and formal TRM practices (see Table 5.3).

Table 5.3: Changes in participation and response of multiple level of stakeholders in TRM

TRM		Informal practice				Formal practice					
		Beel Dakatia		*Beel Bhaina*		*Beel Kadaria*		*Beel Khuksia*		*Beel Kapalia* (proposed)	
Timeframe		1990	1995	1997	2001	2002	2005	2007	2012	2013	2016
Involvement											
Micro		P	P	P	P	P	O	P	O	O	O
Meso	NGOs, CSOs	P	P	P	P	P	O	P	O	P	P
	LGIs	O	O	O	P	P	O	P	O	P	P
	BWDB	O	O	O	P	P	P	P	P	P	P
Macro		O	O	O	P	P	P	P	P	P	P
MSPs		**No**	**No**	**No**	**Yes**	**Yes**	**No**	**Yes**	**No**	**No**	**No**

Here: P = Proponent; O = Opponent
Source: Field investigation 2012-2016

Sustainable MSPs were rarely formed within TRM stakeholders. In every cases, effective interactions between all stakeholders and positive responses in different levels of stakeholders were not continued well over the operational timeframe (normally 4-5 years for each case of TRM). In the *beel Kedaria* TRM, community people (specifically local landowners) became opponents before completing the TRM. It was stopped in 2005 due to non-cooperation between community and higher level stakeholders (most notably BWDB). Similarly, although TRM had started with multi-actor participation in *beel Khuksia* in 2006, the operation was not actively monitored by the higher authorities. Moreover, activities of the local community-based water management groups vanished in the study area. Community level stakeholders also became adversaries and took action to protect their own individual and group interests, essentially ignoring the authorities and stopping the formalized TRM altogether. As a result, no active TRM has been in place in KJDRP since 2013 and, indeed, waterlogging returned in about 50 villages during 2016.

Multi-loop social learning for reframing participation

During individual interviews, community-level stakeholders were found enriched in their local and regional water management knowledge. Both community members and organizations engaged in some form of ad-hoc experiential learning, however, more integral and coordinated multi-level social learning was found to be rare in practice (see also: Mutahara et al., 2017). In the case of the present research, changes in practices of TRM were evaluated both summative and formatively, to assess and to help facilitate multi-loop social learning. As the participation changed with the transition of TRM process, assessment of internal learning approaches were integrated to explore the multi-loop social learning in water governance systems in such a regional delta management (see Figure 5.5).

TRM in *Beel Dakatia*: 1990-1994	TRM in *Beel Bhaina*: 1997-2001	TRM in *Beel Kadaria*: 2002-2005	TRM in *Beel Khuksia*: 2007-2012
Content factor: What is being changed?			
Only the local community had participated to remove water logging	Communities (with support of NGOs and CSOs) started TRM	BWDB formalized TRM proposing participation of multi-level stakeholders	BWDB started TRM concerning community and other level of stakeholders
Factors influencing implementation and learning: Why are changes successful or not?			
- No vertical co-ordination in water governance network - No funding - No planning - Authority stopped TRM practice	- Limited space of interaction in actor network - Nothing planned - No information management - Authority stopped practice	- Weak integration between community, organizations and authority actions - Huge lack in between plan and activities (in use); - Community stopped TRM	- BWDB was leading but limited coalition with communities - Weak time management to implement TRM - Community stopped TRM practice
- Experiences of local communities were used in practicing TRM - No collaboration with others	- Conflicts within communities and authority - Started negotiation for formalization of TRM	- No reflective actions from previous practices - Ignore community interests of compensation and maintenance	- Compensation plan did not work effectively - No physical & social management during implementation
Individual attributes: Who effects the change process?			
- Community proposed and implemented TRM - Management authority opposed	- The authorities specially BWDB did not co-operate - Community also failed to motivate BWDB	- BWDB accepted TRM but failed to develop trust - Community did not co-operate	- Community WMGs do not work consistently - Higher authorities were not transparent in planning & action

Figure 5. 5: Factors affecting implementation and learning within Tidal River Management over time (1990-2012).

Analysing the gathered information, we found mostly experiential and experimental learning within TRM at community level and within management organizations (Table 5.4).

Table 5.4: Participatory evaluation of social learning in practicing TRM

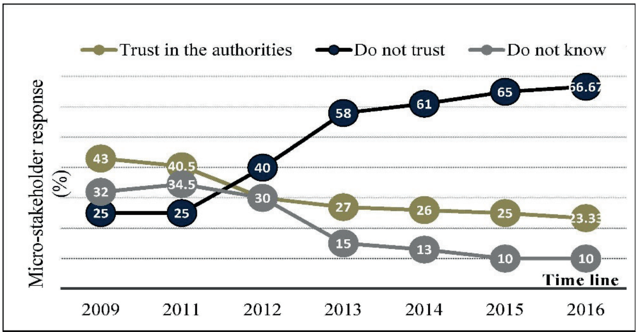
What has been learnt?						
Traditional knowledge base TRM is effective for solving waterlogging problem	Practice of TRM needs participation and effective multi-stakeholder process	Sufficient compensation bring functional participation	Active motivation with proper compensation is required for community participation	Local community and power groups create complexity and conflict	There is no integration between TRM planning and implementation agencies	Management authority is not willing to practice TRM concerning local stakeholders
Who has learnt?						
Community stakeholders, NGOs, CSOs	Policy makers	External researchers	Local NGOs, CSOs, LGIs	Management authority	Local NGOs and LGIs	Marginal stakeholder
How do they learn?						
Practical experiences	Information sharing/ global discourse	Observations and information sharing with different stakeholders	Experiment and community consultations	Observation	Observation	Experience and inter community discussions
Mode of learning: learning analysis in present research						
Single loop learning (with changing the tools of water management)	Single loop learning (in developing a process)	Single loop learning (with change in actions)	Single loop learning (with change in actions)	Single loop learning (with change in community behaviour)	Single loop learning (with change in action)	Single loop learning (with change in behaviour of management authority)

As shown in Table 5.4, lessons learnt from prior TRM experiences were hardly utilised and little social learning took place in efforts to improve delta management. Multi-loop social learning is rare in part due to lack of vertical interaction and integration between communities and higher-level stakeholders.

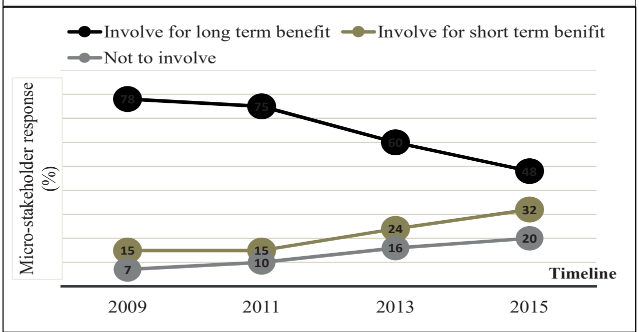
Learning interactions for partnership development

To explore the learning interaction in the multi-stakeholder participation in planning and practicing TRM, we have analysed the information regarding changes in interaction through trust, motivation, and commitment (see Table 5.1) within the different stakeholders over the time.

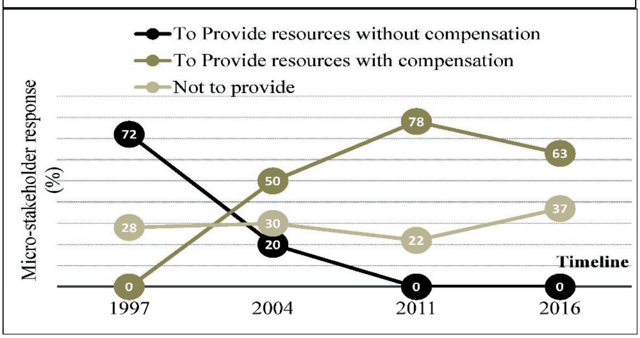
Micro-level: Although most interviewed community stakeholders see the potential of participatory TRM in tidal river systems management, they have little faith in the willingness of BWDB to improve and adopt TRM. Individual assessment showed that as time went by people at the community-level lost their trust in actions of BWDB and government organizations due to lack of transparency during previous project implementation, limited maintenance activities, and poor quality in stakeholder interactions (see Figure 5.6a).



a. Major responses go to "do not trust". Therefore, within micro-level stakeholder trust in management authority is decreasing over the time.



b. In micro-level, willingness to involve with long term benefi of TRM is declining. People became interested in short term benefit.



c. Commitment to allow assets and skills for management goal in decreasing in micro-level

Figure 5. 6: Changes in mutual trust, motivation and commitment in micro-level stakeholders

Figure 5.6a also shows that the response “do not know” was decreasing over the years within the community stakeholders. This may indicate that community stakeholders became more aware of their role and participation in TRM. However, the motivation to help realize the goals of TRM seems to be declining more recently due to lack of information and reflection on implementation barriers. Even in recent years, the community motivation to work towards long term collective benefits of TRM has gone down (see Figure 5.6b). The participatory evaluation also shows that during informal practice (before 2001) community stakeholders used their resources for TRM happily. However, about 63% of the community stakeholders is still committed to providing their resources (i.e. land) in accordance with TRM in recent year, but they also expressed a need for financial and livelihood support from the government during TRM implementation (see Figure 5.6c).

Meso-level: At the local and regional level BWDB officials and engineers had trust and faith in TRM but also expressed concern about local socio-political complexities in proposing community participation in future initiatives. Since they do not have sufficient regular communication with local communities, these officials have limited trust in community activities based on local knowledge. At the organizational level we noted that most of the local and regional NGOs and CSOs (85% of respondents) did not trust the BWDB’s willingness to implement TRM and to involve communities in its planning and implementation. On the other hand, 56% of the mid-level participants believed in the effectiveness of TRM but they had less faith in the co-ordination between community-initiated and BWDB-initiated activities. In the southwest area of Bangladesh, NGOs and CSOs are quite important in providing public support to resolving water logging problems and to agro-ecological development through sustainable TRM. However, motivations and intentions of the government and associated administrative authorities were not very explicit, which made a synergetic response difficult. Since the 1990s, CSOs have become sceptical of the commitment of BWDB and the government. But BWDB have already failed its commitment in completing TRM practices in a timely manner and in providing adequate compensation to communities. In addition, research organizations within the existing stakeholder networks (e.g. CEGIS, IWM, etc. who are mainly involved as consultants) are mostly governmental and are heavily tied to the government strategy.

Macro-level: In the Bangladeshi context, participation and systemic co-ordinated learning at the macro-level is not easily explored. Particularly the ambivalent attitude of government representatives makes this difficult. Only a few individual interviews (n= 7) could be held with national-level water management actors. In most of the cases, they tended to focus on formal government policies rather than on practical partnership building. The interviewees' awareness of and sensitivity to community knowledge, local level issues and problems appeared limited. Therefore, they collectively do not have much faith in the potential of community participation. Also, whereas the decision makers were strongly motivated in global social and environmental conservation discourse, they failed to reflect/translate this motivation into local practices, and were unable to transcend rather theoretical dialogues showing policy consciousness and tendencies towards being diplomatic.

Limitations of participation in social learning

This research suggests that existing uncertainties in actions and relations between different levels of stakeholders represent a serious barrier to effective participation and facilitation of social learning. The results of the multi-actor evaluation identified five factors which make the functional participation challenging in TRM.

i. Dynamics of stakeholder conflict

Since multi-level participation in the management system had not been significantly experienced before, community-based, local stakeholders had limited space to express their knowledge, thinking, and to exercise their capacity to manage change. This allowed for differences to remain under the surface, but once a participatory approach was introduced, these differences were expressed. This led to frequent conflict. In the transition from an informal to a formal process of TRM, conflict between BWDB and the community emerged with different levels of intensity. In some cases even public demonstrations took place. According to some of the actors these disruptions and tensions did provide for reflection and debate on project planning, area selection, determination of compensation, and changes in land ownership.

In other, but related contexts, conflicts between agro-farmers and aqua-farmers (mainly shrimp farmers) about land and water claims and use, were less generative and impeded TRM Also conflict between BWDB and local government institutions related with tendering and the use of money in construction activities, did not lead to joint learning. In 2012, in the proposed *beel Kapalia*, TRM inauguration, the conflict between authority and community became so severe that it turned into a case of socio-political violence.

ii. Inequality in power relationship

In this study BWDB was the main implementing authority of delta management under the Ministry of Water Resources (MoWR) which controls all pertinent planning and construction activities. BWDB was seen as the supreme power within the regional stakeholder network. But socially and financially, empowered local groups are active at micro level and they also wield at least some power. For instance, the large shrimp business holders have the capacity to influence the local administrative authority as well as BWDB. In the rural setting, however, marginalized community people are not financially empowered and have high levels of illiteracy. Their voices do not tend to get through to BWDB or top governance levels. They mainly depend on local government organizations and political leaders as well as NGOs. This creates difficulties in developing consistent and efficient multi-layered interaction in management networks.

iii. Political influence and corruption

Although political parties are not explicitly involved in water management, invisible politics are everywhere, especially in participatory events like public consultations and meetings. In construction activities and compensation distribution, political influence determines to a large degree who gets what and how much, as elected members of local government and society leaders tend to belong to political parties. BWDB's construction activities require the hiring of construction companies that have political ties or try to bribe decision-makers. Corruption at local and regional organization levels is very common in regional management.

iv. Time constraints

Due to lack of integration in management activities as well as due to poor communication and co-operation between different stakeholder groups, the period of implementing an intervention always failed to conform to the planning schedule. For example, *Khuksia* TRM was continued for about seven years instead of the four years that were planned. As a result, in connection with an extra long-term TRM practice in one *beel*, communities and BWDB have been at loggerheads since 2012 on the issue of stopping TRM. Another issue is the timing of initiating a TRM, which is closely linked to local weather conditions. Community members always ask BWDB to avoid the monsoon season for large-scale construction and mud work. But the agency gets its budget during June in the middle of the monsoon. The infelicitous timing for planning and implementation also creates tension in the compensation process, which was one of the main complications in *beel Khuksia* TRM.

v. Financial complexities

Most community stakeholders did not have and still do not have clear understanding of the mechanism of community stake-holding. The current land requisition and compensation process related to TRM is not clearly understood by the poor, semi-literate, and illiterate marginal communities due to lack of capacity-building (e.g. lack of education), lack of incentives and awareness, and limited access to higher level actors. Since they never received proper financial back-up during TRM, they will not be committed to co-operate further.

On the other hand, money needs to be invested to operate activities of local-level community WMGs, especially in communication, meeting arrangements and awareness raising programmes. During the KJDRP project, registered community organizations received some financial support from social research agencies like CEGIS which covered the expenditure (as a token financial contribution to voluntary support to the institutions, mostly for communication and logistic purposes) (CEGIS, 2003). However, in the post-project stage there was no financial support to conduct meetings and advocacy programmes. Therefore, the WMGs became ineffective.

Bearing in mind the above limitations, we have tried to explore a way to overcome these barriers and develop a functional Multi-stakeholder process (MSP) for regional delta management in Bangladesh.

Participatory recommendations for developing MSLP in delta management

In the 'Dynamic Deltas' regional workshop held in *Jessore* in 2016, various learning outcomes from this research were presented by the representatives from different stakeholder groups, including government and non-government organizations, communities and academic experts. A collective and integrated analysis and discussion took place there on development, feasibility and sustainability of MSLP. Here are specific recommendations, distilled from the participants' assessments of the significance of the learning outputs:

- Proper identification of micro-level stakeholders and their prioritization (based on livelihood security) should be the first step towards a MSLP in a sensitive delta management system;
- Leadership skills need to be improved at both community and government agency levels, and a mind-set change to get collaboration should be facilitated for developing a learning network;

- To realize systemic changes in planning and practice, local values and voices should not be ignored in negotiation and in developing collective interest and dealing with conflicts successfully;
- Regular interaction between micro and meso level stakeholders and development of local learning platforms, can restore mutual trust between local communities and organizations. The creation of such platforms could be a serious contribution to re-motivate the community groups to management goal and to keep collaborative ownership of delta management interventions;
- A more reflexive and learning-oriented approach to TRM requires knowledge and awareness-building events (drawing competition, essay writing, drama etc.) linked to innovation of the local and regional educational system (primary and high schools, colleges). This will over time help to build capacity in illiterate and semi-literate community groups in the rural delta system;
- A compensation and rehabilitation policy should be revised bearing in mind the lessons learnt from the changes in social and financial mechanisms. For example, in the case of TRM, the compensation policy could be modified for more effective use following the local land leasing mechanism
- Local administrative agencies, NGOs, and CSOs can spread a joint persuasive narrative about the importance of co-operation and knowledge co-creation between the three levels as long as there is a clear vision of a sustainable management process.
- Transparent and accessible interaction and knowledge dissemination between micro-level and macro-level stakeholders should be increased in a structured and planned way. Government and non-government studies and data should be accessible to the public.
- The effectiveness of practices, efficiency of institutions, and the benefits of a healthy socio-ecological system should be assessed by ensuring regular technical, social, and environmental monitoring. Government agencies should invite academic researchers and university students to help innovate new learning and reframe management processes but make sure that these invited researchers and students are able to ‘connect’ with the local people and their socio-cultural and historical context.

5.6. Discussion: Multi-stakeholder learning toward effective participation

The participatory evaluation shows that community groups, NGOs, and CSOs, and even Local Government Institutions (LGIs), despite some fundamental differences in power, access and capacity, do have some common interests and values, shared problem perceptions, and joint possible mitigation measures for TRM practices. Still, the outcome of the present study reveals that effective community involvement in delta water management is not an easy affair due to what, we might call a gap in social learning. This gap has been created by a weakening of the community-BWDB relationship in the transition of informal to formal TRM. TRM-based delta management in the southwest delta needs a more functional participation that requires vertical, multi-level interaction between the local community, management organizations and decision makers. Such functional participation also requires reflection and re-integration of knowledge and techniques from previous actions of local communities, consultants and management authorities. At the moment little is learnt from the past and the lack of learning histories and reflexive capacity causes what might be called a form of collective learning amnesia.

In recent TRM practices, conflict between communities (including related CSOs and NGOs) and management authorities happen repeatedly as issues of power and politics inevitably surface in multi-stakeholder settings (Brouwer et al., 2015). When there is a power imbalance, strategic behaviour is invited and trust is undermined, which further limits effective participation in a socially, ecologically, and technologically integrated system, which TRM is, from emerging.

In Bangladesh, there is less clarity on who is to take responsibility for facilitating effective participation and developing functional partnerships to make the delta management system sustainable. Avoiding field realities and continuously, and consciously escaping complexities, creates inequality of commitment and power within the delta management network. In the stakeholder meetings and workshop, participants put strong emphasis on a collective responsibility to manage the change process with respect to mutual trust and motivation, but without declaring their own actual commitment and responsibility. However, it mostly appears that regular interaction and follow-ups with communities and organizations may energize the social network and change their mind-set. As the donor and national and international research organizations are now concerned about community knowledge, they can advocate to develop meaningful interactions with local communities and participation in governance and policy-making. The collective integrated assessment showed that community and local level organizations now have a renewed sense of urgency, also in light of emerging regional management challenges in connection with climate change, to re-establish relationships, trust, and commitment.

5.7 Conclusion

Our research shows that establishing learning-based partnerships between multiple management stakeholders (i.e. representing a conglomerate of communities, civil society organizations, business research, governance, and water management agencies) in the Bangladeshi delta remains challenging. This is in spite of the push from government authorities and water management organizations for a 'partnership discourse' as a means to achieve the goal of a more sustainable form of tidal river management in the delta. Even though multi-stakeholder participation as a process is apparent in the delta management system in Bangladesh, its effectiveness remains limited and its potential largely untapped due to technical, socio-political, and institutional boundaries. It appears that successful participation can happen only when consistent interactions and follow-ups between stakeholders pay attention to a wide range of factors including; the quality of social relations between actors, the positive utilization of differences and even conflicts between actors, and, lastly, creating a more reflexive environment that enables learning from the past. In addition, positive interactions may invite trust and agency, and, subsequently, a tendency towards more the transparency of the process, the role of power and inequity in gaining access to the process. The provision of adequate time and financial support is a critical pre-condition for this to happen. It also appears from this research that in a risky environmental setting, like the vulnerable coastal area of Bangladesh, social learning is both challenging and dynamic. In deltas, development programmes and management activities, as well as the use of technology, may bring significant changes in relationships among the actors in the system. However, facilitating mutual trust, increasing stakeholder motivation, and strengthening relational commitments seems conditional in learning for, more sustainable water management.

With TRM aiming to resolve waterlogging challenges and stimulating agro-ecological development in the dynamic delta system of Bangladesh, issues of ownership, motivation, power, and commitment were mentioned as priorities in the context of sustainability. Facilitation is important when feelings of uncertainty and of relational insecurity emerge, for instance, when people keep changing their minds in a decision-making process (Wals et al., 2009; Wals and Schwarzin, 2012). Social learning ideally can offer a place or space where the majority of actors can feel secure, can safely experiment and mediate between the settings and interests and between actors and their constituencies. Therefore facilitating social learning for framing a functional MSLP at micro, meso, and macro levels appears essential for effective and sustainable water management in fragile and dynamic deltas where communication and trust are currently sorely lacking.

Chapter 6

Discussion and Conclusion

6.1. Introduction

This thesis was inspired by a practical interest in exploring a range of "no-regret" responses to managing flood risks in a dynamic delta with the aim to increase understanding, develop learning and facilitate multi-stakeholder processes for more adaptive and sustainable management for deltas and delta societies. It has investigated participatory management processes that address dynamic issues, multiple interrelationships and actors in a delta management system. To date there was limited scientific documentation that systematically examined the functionality of community participation in water management or explored the complexities in multi-stakeholder processes in the Bangladesh delta. Four distinct but inter-related studies were conducted on the functioning of Tidal River Management (TRM) in the Southwest coastal delta of Bangladesh, to assess the changes in management processes from hierarchical ones towards more participatory ones in relation to the capacity of delta rural communities that are facing the uncertainties in sustainable management processes in this naturally vulnerable and socio-politically sensitive Delta.

As such this thesis contributes to a better understanding of the changes and challenges in establishing more participatory forms of management that seek to utilize social learning (SL) as a component of multi-stakeholder participation (MSP) for sustainable delta management in rural Bangladesh. My thesis has the following more specific objectives: 1) to explore the current transition in delta water management and its effects on the total delta system; 2) to examine the social learning that occurs with the changes in an existing delta management process; 3) to analyze the conflict and co-operation in the practiced delta management system in relation to multiple stakeholders' participation; 4) to determine whether the participation of multiple levels of stakeholders contributes to the learning within and the adapting of sustainable management in an underdeveloped rural delta system.

These four objectives have been translated into four research questions:

- How does TRM frame the management transition in the Bangladesh delta and what transformation, if any, does it enable in the south-west delta in particular?
- How does learning and participation occur in practicing TRM and how does it contribute to an adaptive delta management in the country?
- What is the role of conflict and co-operation in a multi-stakeholder process and in adapting TRM as a regional delta management system?

- How does multi-stakeholder learning contribute to reframing the participatory process for sustainability in adaptive delta management?

In this thesis, an integrated and participatory evaluation approach was used to not only answer the research questions, but also to capture the changes in the delta water management system and to help create a learning space attuned to the dynamics of management process. Such an approach fits the multiple contexts and multi-stakeholder processes in which capacity development and sustainable TRM in Bangladesh need to occur simultaneously.

6.2. Overview of major findings

The study's somewhat sobering finding is that despite the rhetoric and despite the policy frameworks outlining TRM and a more socio-eco-technical systems approach to delta management, the performance of such a framework and approach on the ground is rather limited even when special provisions were made to stimulate community participation. This finding makes it necessary to reflect on why sustainable management may be so difficult to achieve in the context of the Bangladesh delta. Some previous studies already found that TRM is a promising, technically feasible, and environmentally sound alternative for delta management in a sediment-loaded coastal area instead of dredging and creating large-scale concrete infrastructure (Amir et al., 2013; de Die, 2013). This thesis sought to contribute to a better understanding of how learning and change processes have developed in adapting TRM and of the role of multiple-stakeholders and the interactions between them in strengthening the sustainability of delta management. In this thesis, an important concern was to integrate and explore social learning in delta management as a way to facilitate multi-actor participation and improve effectiveness of practice. This final chapter of the thesis focuses on what has this thesis has unearthed, untangled, revealed and contributed.

Prospects of community management practice and transformation in the Delta

The study documented in Chapter 2 sheds light on the first research question focussing on how TRM influences the aspired transition towards a more participatory co-management oriented delta management system in the Southwest delta of Bangladesh. Although there is some evidence that in some area's there are shifts from state -based to multi-stakeholder-based management forms, as well as from individual water control towards more communal water control, and a shift away from more technical, hydraulic engineering to more socio-ecological management, those shifts are mainly visible in policy and less so in practice. Furthermore, the research reveals a tension between emerging approaches that call for a shift from a socio-technical approach to a more integrated socio-eco-technical one. It is appropriate to reorient TRM towards ecological conservation and more equitable management practices. While delta management in the Southwest delta in Bangladesh seems to provide a testing ground for a new institutional arrangement and opens up possibilities for community participation in delta management, implementation of TRM not only brings protection from waterlogging but also increases tensions and uncertainties in local water governance.

Social learning for change management and capacity development

Social learning in the formal and informal implementation of TRM is investigated in Chapter 3, which focusses on knowledge creation and sharing as a means to improve stakeholders' participation. Learning occurs with changes in TRM practices. In an ideal situation, learning should be achieved among and within all stakeholders, at all levels and at every stage of implementation. Although the local communities have experiences of engaging in joint learning in times of crisis and have shown to incorporate indigenous knowledge through inter-generational learning, the implementation of a social learning orientation towards TRM has shown to be challenging in a rural delta system. Especially the inter-level learning between micro and meso- level stakeholders in local and regional platforms, where all stakeholders can express and co-ordinate their views and learn together, so far has been problematic. In part, this is the result of the discontinuities in the composition of stakeholder groups and organizations involved which leads to a lack of continuity but also to a loss of 'learning memory' as new actors come in and while old ones leave or when too much time passes between interactions. As a result, these platforms tend to have greater concern with the priorities of the day and are drawn to ad-hoc popular approaches of implementation that come from outside. This pragmatism can easily reduce the quality of multi-stakeholder social learning that seeks to generate more self-determined, over-arching and more future-oriented reflexive processes which are considered prerequisites for a more sustainable TRM.

Conflict and cooperation analysis for improving multi-stakeholder process

Chapter 4 analysis conflict and co-operation in a local (or regional) delta management process focusing on community participation in TRM. As delta management inevitably involves multi-stakeholders with diverse knowledge, backgrounds and interests, conflict is unavoidable here. The conflict-cooperation discourse in TRM is not only much more localized now but also strongly influences regional and national water governance as tension gradually increases between the local community and the management authority. Co-operation between different interest group seems limited here due to the technical and institutional limitations of local and the regional water governance. As the society is intertwined with the delta and delta management system in this area, the conflict and co-operation are influenced more by the societal affairs.

The application of the modified Transboundary Water Interaction NexuS (Mirumachi and Allan 2007) model to TRM cases has provided important insights into the manifestations of conflict and cooperation. Although a linear two-dimensional (timeframe versus societal actions) assessment shows the increasing conflict intensity, even to the level of extreme violence and a corresponding lack of sustainability in co-operation in the existing governance system, it also revealed that in order to conduct a full-fledged conflict-cooperation analysis other dimensions need to be considered as well, including the regional, political and policy domains.

Multi-stakeholder learning for sustainable delta management

Chapter 5 addressed the question of how multi-stakeholder learning contributes to the reframing of participatory processes within an adaptive delta management system. Here the research shows that establishing learning-based partnerships between multiple stakeholders representing a conglomerate of community groups and networks, civil society organizations, business research, governance, and water management agencies in the Bangladeshi delta, remains challenging at best and highly problematic at worst.

This study reveals the limitations of stakeholders' learning when the participation is thin, in terms of (lack of) deep engagement in the process, and narrow, in terms of inclusiveness of all stakeholders and levels. These limitations lead to gaps in the advocated and aspired joint learning process as key levers for such learning - trust, motivation and commitment within stakeholder network – are only modestly present. As stated repeatedly in this dissertation, people are not necessarily inclined to learn from others when there is a lack of trust and motivation at the level of individuals and groups (Pratt et al., 2009; Wals, 2010). Motivation in part is derived from the perceived importance and urgency of the issues at stake by stakeholders (Kouèvi, 2011). This research shows that the current challenges in delta management in the study area are more connected to the institutional, social and political aspects of water management than to the physical domains. The major restrictions come from the gaps in actions and interactions between communities, authorities and other development agencies, or from the limitations in learning orientations between individuals' and organizations' relevant to water management.

This research also provides guidelines for developing functional multi-stakeholder processes for sustainable delta management. A multi-stakeholder process ideally can offer a place or space where the majority of actors can feel secure, can safely experiment and mediate between the settings and interests and between actors and their constituencies. So, facilitating a functional multi-stakeholder learning platform that operates at micro, meso, and macro levels appears essential for balancing conflict and cooperation in fragile and dynamic deltas where communication and trust are currently far from optimal.

6.3. Reflections on critical findings and research outputs

The research carried out for this thesis serve two different types of outputs. First, the specific research findings following the objectives and research questions. The above-described overview of research finding expresses them in brief. However, the additional output which is more important for an academic research, lies in a tentative integrative model that can help capture the dynamic role of learning and participation in managing a complex delta system (Figure 6.1).

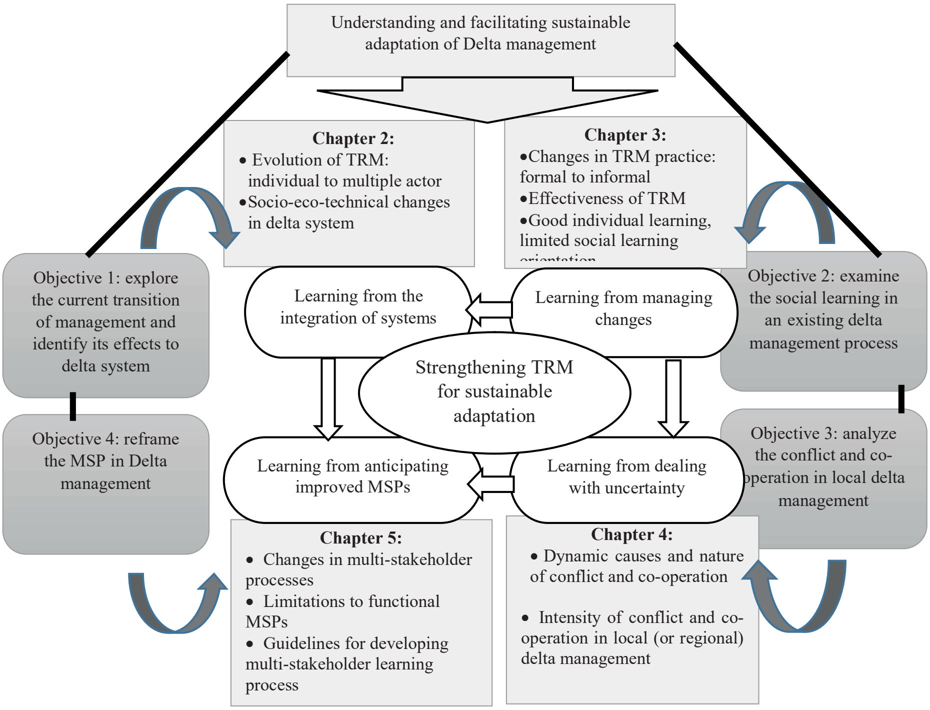


Figure 6.1: Critical overview of thesis outputs

This thesis assumed a multi-purposive learning process following pragmatism and enthusiasm in interdisciplinary research. Under the four specific objectives and research questions I tried to incorporate a systematic documentation of learning and participation informed by an analysis of the science-policy-governance-stakeholder interface in delta management in Bangladesh. In this thesis, I have examined the social learning orientation because the target delta consists of a sensitive and complex rural setting where multiple actors are active in dynamic management processes. The research shows, however, that the level of social learning taking place is lower than expected in part through changes of management practices, limited capacity development of the community, and lack of trust between stakeholders. On the plus side, this thesis also shows that conflict is not only a problem but also a good opportunity for learning from the uncertainties that arise in a multiple stakeholders involved management process, provided that social cohesion is strengthened among all actors within and in-between the different levels. An efficient conflict-co-operation analysis contributes to effectively dealing with the constraints in adaptive management. In this thesis I investigated the existing multi-stakeholder processes in TRM and the result calls for an upgrading of stakeholders' role in delta management. By providing the concept of multi-stakeholder learning partnerships, this thesis reveals an approach that can help improve learning co-ordination vertically between the different levels of management stakeholders by establishing joint trust, motivation and commitment.

6.4. Research limitations and methodological constraints

In this synthesis of the thesis, as an exercise in critical reflection and learning, I am going to conclude with a personal reflection on the over-all research process and methods used.

This thesis has deployed interdisciplinary research methods to consider both natural and social science aspects for optimized land use and water resources management practices in the Bangladesh delta. In the methodology, I referred to my intention to consider this PhD research as a learning process involving an integrated and participatory research framework. Following the perspective of pragmatism and dynamism, different theoretical concepts and tools of participatory research were used in the research design. In this thesis, I utilized an integrated and participatory evaluation approach to explore the dynamics in delta management and the social learning configurations within them and their implications for tidal river management in the context of creating a more sustainable delta. I assumed that the validity of those evaluations and analysis methods in this thesis has been augmented by direct community participation and the mirroring of the findings with the participants in the study, for as much as possible, in different stages of this research. It is really a community involved multi-level stakeholder approach where secondary data support was used when needed. I heavily relied on the feedback of local and regional government stakeholders on my learning outputs and findings as needed. I also assumed that the social learning theory and multi-stakeholder processes underlying the sustainable practice of delta management focused on in this thesis must be understood and appreciated as an integrated and situated phenomenon.

This thesis uses participatory evaluation and triangulation; however it also includes exploratory and empirical research approaches in order to facilitate multi-actor processes and generate justified and trustworthy answers to the research questions. In this section I look back on the main research strategies used (methodical review, survey, participatory assessment and synthesis) which require some reflection to have more acceptability of my research findings. What follows are four areas of deliberation and concern that need to be considered in this light.

a) ***Lack of integration and co-ordination in management research***

At the start of my research, I had some practical experiences of observing severe waterlogging and its impacts on inhabitants in the southwest coastal delta. However, I observed some unusual strains in the water management process when I reviewed the project reports of KJDRP and other TRM related published materials. There was contradiction in arguments of government organizations and non-government organizations in contexts of goals and strategies of TRM. Hence, it was quite difficult to simplify the past and present history of TRM as a promising regional delta management process. But the participation of different levels of stakeholders in my research helped identify the most plausible story in most of the cases. During the survey stage the participatory appraisal of the management transition also provided meaningful insights in multidisciplinary research as it operates at the intersection of social, technical and ecological perspectives.

b) ***Multiple dimensions of issues and information***

During the journey of my research, the choice of multiple methods for data collection and analysis served as a triangulation tool and resulted in drawing more balanced conclusions. As I had designed an interdisciplinary research, multiple methods were used to increase confidence in the validity of the research findings. To conduct a proper scientific research, I had developed my conceptual view through a systematic review of literature. Trying to be sensitive to and inclusive of multiple perspective of a complex system, I found myself continuously struggling to be on the right track in finding appropriate scientific theory. Once, I became confident about this, I came to use different tools for searching data sources and collecting diversified data. I needed to cross-check the data collected from different level of respondents. I had to organize collective response sessions for obtaining a justified synthesis of data and statements of the stakeholders. I have faced open verbal conflicts between community stakeholders and management actors, however at the end I was able to find strong evidence in and against their arguments. In those cases I received help from some local knowledge informants and social activists who could facilitate the decision making. In my research, I used the institutional survey to supplement the data for primary investigation. Those data collaborated the community data and increased the credibility of my findings.

c) ***Lack of transparency in management processes hinders learning research***

In the field-based interdisciplinary research, there is always a chance to be biased, so I took some measures to reduce these biases. During joint events such as in stakeholder meetings and workshops, I have invited community participants as well as representatives of other stakeholders. In my research, it was difficult to convince both the academic experts in Bangladesh and The Netherlands and the management professionals with the theoretical basis of the learning research. The management professionals in Bangladesh also argued the point of ineffective participation processes in Bangladesh. It was really time-consuming and sometimes difficult to arrange meetings or interviews with government officials.

e) ***Lack of mutual trust and motivation limits the scope of learning***

My study area is not only dynamic in natural settings but also very sensitive in socio-political issues. Additionally, the activities of the government water agency have been criticized in this area for decades and currently the community becomes extremely antagonistic towards the staff of BWDB due to their long term sufferings. So, during the field visits the first question from the community respondents was "Are you from the Water Board?" It was a big challenge to gain their trust and to convince them of my good intentions.

During my research, I also discovered the tension between making explicit social learning configurations in my learning process and the conceptual background of different stakeholders. The marginal community people do not really care about the theory of learning in knowledge sharing in the rural area. However, they have a typical process of learning and doing from experiences. In addition, the political influence and pressure is very strong in the rural society. In this situation, working with multiple stakeholder groups and facilitating a social learning research was not impossible but challenging as it required careful maneuvering and navigation of force-fields and tensions, a skill which took me some time to develop.

As monitoring social and institutional contexts in the study area has been quite rare and not very significant, I had to use limited observation data and qualitative assessment of stakeholder perceptions to understand the learning and participation processes taking place (Chapter 3 and 5). Also, there were data gaps in secondary data of some bio-physical components and seasonal variation in some of the key parameters (Chapter 2).

In my research, the selection of study area was very simple: I covered the area of a well-known water management project, KJDRP, which is also popular as the home ground of TRM. The selection of sample villages for socio-economic data collection however was difficult because the land-owner farmers live in different villages that are often quite far removed from the TRM *beels*. So, I was randomly sampling the nearest villages of TRM *beels* within the same tidal river catchment following the local union map. In the field survey, I used a zoom-in map that included the TRM *beels*, however during thesis writing I used the published KJDRP map provided by management authority which led to some discrepancies.

From an analytical point of view, this research has explored the transitions of management by mainly looking at changes in practice, paying less attention to policy. For examining the social learning in practice, TRM cases were selected both in KJDRP area and in *Kobadak* river rehabilitation project area, assuming a critical comparison and change assessment with different location of practices would be possible. However, TRM in *Kobadak* was delayed and was not implemented within the research period. So, I had to continue the analysis with cases in different *beels* but within same management project which made assessing the presence and nature of social learning in existing participation process more difficult (Chapter 3 and 5).

There are several departments and organizations working on water management-related topics at different times and different locations in the southwest coastal area. Therefore, to do stakeholder analysis, I only considered the organizations who are long time involved in TRM and delta management as the stakeholders in this study. The fact that some of the newer organizations that are emerging more recently are not included can be considered a weakness. Future research in TRM in the Bangladesh delta would have to include these organizations as they may represent new ways of working and interacting.

By carrying out intensive participatory research in a rural coastal area, I did gain access to real-life experiences with illiterate and semi-literate people, and was able to discover that they are indeed self-educated to cope with frequent natural hazards. Most of the local people I encountered in the research turned out to be very sharp and transparent, even in knowledge sharing. However, it also became clear that the organizations and management authorities challenged their self-generated literacies and considered their knowledge inferior to their own.

6.5. Research contribution and implication

This thesis highlights some of the issues that arise when trying to facilitate learning-based approaches to TRM involving multiple stakeholders. Its main practical application lies in providing insights in the barriers and opportunities that can help improve such approaches in rather volatile and complex environments. The thesis shows that deep, reflexive learning at multiple levels and in a setting where interests and values are not well aligned due to historical, social and political inequities, is rather problematic. The alternative – looking for short-term ad-hoc solutions that do not disrupt these inequities but, if anything, maintain them is more attractive than taking the path of most resistance and remaining committed to co-creating new practices that represent a transition towards sustainable delta management.

6.5.1. Contribution to scientific theory and research

This thesis also provides insights in the possibilities and limitations of interdisciplinary and collaboration research in natural resource management in Bangladesh. In the past, there has been a weak uptake of scientific knowledge created through the FAP (Flood Acton Plan) studies in Bangladesh, with a strong isolation between the natural and social sciences communities concerned with flood management, and a similar isolation between government and the sciences (Cook and Lane 2010). This integrated environmental and social research took place at the intersection of social and natural systems which requires the development of integrative scientific processes (Macleod et al. 2008; Norgaard et al. 2009) that combine insights from the social and the natural sciences and promote collective understandings between scientists, policy-makers, civic society and the private sector.

This thesis hopefully will also contribute to further developing resilience studies in relation to vulnerability and adaptive capacity (Gallopín 2006). The study on management transition (Chapter 2) can enhance a socio-eco-technological systems approach by incorporating indigenous ecological knowledge. The evaluation of the social learning in management practices (Chapter 3) suggests a modification of "Community of Practice" theory (Wenger, 1998) incorporating collective reflection (from both individuals and institutions) in changes of practice to make the use of CoPs attractive in the rural development studies. In future, an action research could be utilized in such a delta area to facilitate participatory learning focusing the use of indigenous knowledge and traditional practices by the communities to achieve a more sustainable solution to water management problems. Government authorities can involve NGOs and Civil-society organizations to play a role in advocacy of the marginal communities in the future.

The participatory assessment of conflict and co-operation and the use of water intensity nexus, the TWINS model (Mirumachi and Allan, 2007) (Chapter 4) in local water governance indeed found conflict and cooperation to coexist, with a predominance of conflict. That research also recommended the incorporation of multiple scales of analysis of conflict and cooperation. So, instead of a two-dimensional linear inter-relationship, the conflict and co-operation intensity nexus could be modified into a multi-dimensional assessment model including community, political, regional and policy domains.

Although this research mainly used a conventional participatory approach for the monitoring and evaluating learning and participation in a delta management system, the final step of this research (Chapter 5), opens up possibilities for the creation of a Multi-stakeholder Learning Partnership (MSLP) as a methodological approach that links science and society as the academic research becomes part of a co-creative process, not just extracting data but adding agency and relevance to the science-policy-stakeholder interface in delta resource management.

6.5.2. Implications for policy and society

This thesis affirms the need to complement or even reconsider the hegemonic focus on hardcore engineering technology at best combined with organizational learning, by incorporating or even centering on the community knowledge based technology and social learning aspects. However, it also shows that such a shift only makes sense when functional multi-stakeholder participation (Hage et al. 2010) based on social learning processes, aimed at improved sustainability in a complex delta management system, is possible. More functional multi-stakeholder participation does represent a potential approach to implementing ambitious management policies in Bangladesh (National Water Policy 1999, National Land Use Policy 2001, Coastal Zone Policy 2005) in the future but only when basic needs of the community are met, social cohesion between actors and levels is improved, interdependencies between stakeholders are recognized and mutual trust is increased. At the same time, recognizing changes in other actor relationship, the government itself should be willing and able to become co-learners, which also implies that the policies need to allow for more equitable participation and should not be frozen in time but be responsive to change.

The participatory research methodology that has been used in this research, despite its weaknesses, is highly appreciated at the community level in the study area and the findings should encourage the local NGOs, and the civil-society organizations to put their efforts in promoting indigenous management knowledge for local management action plans. The overall findings could contribute to increase communication and co-ordination within and in between the delta communities and the government authorities. However, this research also shows that parties must learn to accept that the outcomes not always represent the ones they were aiming for. Over the last 30 years the government agencies took engineering-based technical rehabilitation initiatives for coastal polders and affected tidal river systems, incorporating interventions like drainage re-excavation, regulators or sluices and embankments construction. This study suggests that the modification of management planning in the delta river basin rehabilitation and polder development projects in the southwest, one that reduces construction of large structures, might be more effective in improving TRM in a dynamic delta system. As the concept of adaptive delta management has been formally incorporated in the Bangladesh Delta Plan 2100 (GoB, 2014) the present thesis' findings might help incorporate social learning in adaptive delta management in Bangladesh and improve collaboration with international research alliances in deltas, bearing in mind the constraints this research exposed.

6.6. Final remarks

The challenges for sustainable natural resource management in the Bangladesh delta are immense, not only because of the projected climate change impacts (Cook and Wisner 2010) or because of natural hazards, but also by the pressure of increasing population density and associated competing usages of land and water resources. During the survey research I experienced that the delta water management system in Bangladesh is becoming vulnerable not only due to decreasing infrastructural protection but also due to the limitations in water governance, and lack of knowledge dissemination and capacity development. My research pointed out the limitations of social learning in re-orienting TRM towards a more integrative socio-eco-technical approach that seems to be more generative in moving towards sustainable delta management. This thesis recommends that facilitation of multi-stakeholder learning processes within and across a multiple-stakeholder management system is certainly an important mechanism for dealing with delta management concerns in which various actors with different perceptions and interests have a stake in how the problems are defined and dealt with.

The adapted version of a participatory research approach used in this thesis also suggests that investing in inclusive monitoring and evaluation can help generate high quality feedback, exchange and insights, and facilitate interactive activities in policy, intervention and governance cycles conducive to social learning and vice versa. However, what has become clear over the last five years is that effective community participation in delta water management is not an easy affair in Bangladesh due to complex system relationships and participatory learning gaps that reduce trust and commitment across the major stakeholders. At the time of writing these final paragraphs of this dissertation, the mutual trust especially among the communities and the government authorities, is declining day by day. These limitations undermine the effectiveness of TRM and reduce the sustainability of delta management in Bangladesh. It also creates more uncertainties in participation and limits the capacity development of community stakeholders to cope with natural hazards as well as climate vulnerability in future.

To end on a more positive note, this research suggests that capacity development can help improve more relational thinking, integrative design, conflict management, reflexive monitoring and evaluation, among all stakeholder groups (e.g. the local community, farmer associations, landowners, local government, civic society organizations, and government organizations). These capacities seem critical for sustainable TRM. In addition, the variety of discussion settings included in the multi-stakeholder partnership development showed that the conflict and co-operation continuum, when managed properly, can lead to more effective participation and sustainable adaptation of TRM.

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Summary

This thesis analyses the role of participation and learning in enabling more sustainable land and water management processes in the southwest coastal delta of Bangladesh. A large portion of this coastal delta is frequently flooded, in part due to the waterlogging and drainage congestion caused by large-scale structural engineering (e.g. the creation of embankments and polders). To relieve drainage congestion and restore rivers and conserve tidal nature in this area, the Tidal River Management (TRM) approach has become the formally accepted strategy of Bangladesh's public-sector water management. Local communities had earlier established the TRM process, which has its roots in indigenous knowledge, without the support of government authorities, but in 2001 it was approved formally as a novel re-interpretation of the polder concept. This thesis aims to explore whether this new shift in emphasis towards a centring of learning and participation for developing stakeholders' capacity to flood risk reduction in Bangladesh delta. It focusses on innovative 'delta triangular' (Δ) relationships using a socio-eco-technical systems approach, social learning orientation, conflict and co-operation dynamics and multi-stakeholder process for exploring TRM as a modality of adaptive delta management.

The people of the southwest part of Bangladesh delta have adapted to the forces of nature (storm surges-salinity-flooding) for generations. They have traditional wisdom and some practical knowledge to face the hazards. It would stand to reason that the community people have the right to take part in the delta management system in this area. However, effective participation and sustainable stakeholder co-ordination is still challenging in the existing management approach which is theoretically introduced as multi-stakeholder process, but is not functional in practice.

Within this thesis, the General Introduction (Chapter 1) is concerned with defining the aim of the overall thesis as it intends to contribute to an understanding of how learning and change processes have developed (or, as the case may be, failed to develop) in adapting a delta management system and how multi-stakeholder approaches are utilized. The overall strategy includes documentary research, local surveys, multi-stakeholder focus groups both with subgroups and all aforementioned communities to enable social learning, dialogue and co-ordination. A historical analysis is made of the origins of TRM and the continuing struggles local stakeholders face with government agencies concerning this innovation.

Chapter 2 explores the transitions of delta management in Bangladesh, following the history of the waterlogging hazard in the Southwest and strategies to deal with it.

Transformation of the dynamic delta system is also outlined here under a multi-dimensional socio-eco-technical approach that shows bio-physical restoration, socio-economic transformation and socio-institutional adaptation due to TRM implementation in the southwest delta in Bangladesh. Evolution and formalization of Tidal River Management (TRM) has restored the river's capacity, reduced waterlogging and improved agricultural land in the study area. The developed land reforms made tremendous changes in the production system, introducing large-scale agro-fisheries mixed cultivation in most of the *beel* (depression) areas. Due to the intensive shrimp aquacultures in saline water, severe environmental degradation and ecological imbalance occurred in this sensitive area. This chapter also discusses community institutionalization, change in conflict and complexities within adaptive delta management.

To improve the understanding of Tidal River Management in the Southwest delta in Bangladesh, Chapter 3 analyzes four cases of TRM from a social learning perspective. Formal and informal TRM cases were investigated following an integrated participatory evaluation based on individual and organizational learning outputs regarding the adaptation of TRM. Individuals and groups of community stakeholders have gained and shared knowledge through their experiences and efforts. Although government agencies and other involved organizations leave some space for experimenting and monitoring, they rarely practice knowledge sharing and exchange with others due to their entanglement in a complex bureaucratic system. Social learning processes in most cases of TRM that seem to dominate, represent individual and single-loop learning, that is, learning to improve existing practices. Only a few instances of double-loop learning were found. Hence, a rethinking of assumptions and strategies to change the process was rare. It was found hard to ascertain double or triple-loop learning particularly, because of stakeholders' fixation on pre-determined TRM goals, leaving little room for deeper reflection.

Chapter 4 analyses the conflicts and cooperation in a local (and regional) delta management system with planning and practicing Tidal River Management (TRM) by applying a modified Transboundary Water Interaction Nexus model which provides a clearer understanding of the conflict and co-operation dynamic in local water governance. Applying the model, revealed that the recently the conflict continuum has become more "powerized" and "violized" than before while co-operation has declined significantly. This research indeed found conflict and cooperation to coexist, with a predominance of conflict, and recommends incorporation of multiple-scales of analysis of conflict and cooperation (i.e. political, local/regional and policy scale) in this complex delta management system.

Since Chapter 3 showed that social learning only took place sporadically in formal and informal TRM cases, Chapter 5 looked at the presence of social learning in stakeholder participation in management transitions and at the levers and obstacles that emerge. Using a participatory evaluation methodology, problems and prospects of effective stakeholder participation in the delta management focusing on Tidal River Management in Bangladesh were investigated. The result shows that multi-stakeholder partnerships have rarely functioned in government-implemented delta management projects. In regional water governance, trust and commitment is even declining in the social network due to a gap in learning integration. It appears that a generative learning partnership needs to exist both horizontally and vertically, and needs to be more equitable to enable more effective participation, successful social learning and, ultimately, sustainable delta management.

Chapter 6 delineates and integrates main findings, reflections and recommendations. The thesis, as a multi-purposive learning process, led to a clearer understanding of the complexities of implementing and supporting multi-stakeholder networks and communities, and of creating societal impact in the context of TRM adaptation. The challenges in this delta management are connected as much to or even more to institutional, social and political aspects than to the physical domains. The final chapters of the thesis focus on some of the cross-cutting issues that are emerging and on some of the difficulties encountered during the research. The major restrictions this research reveals are the gaps in actions and interactions between communities, authorities and other development agencies, but also the limitations of learning between individuals' and organizations. This chapter recommends to integrate social learning in multi-stakeholder partnerships within the delta management system as a way to facilitate multi-actor participation and to improve the effectiveness of delta water management practices.

Summary in Dutch

Als je de nadruk legt op participatie- en leerprocessen, wordt land- en watermanagement aan de zuidoostelijke delta van Bangladesh dan duurzamer? Een groot deel van deze delta overstroomt geregeld, door bodemverzadiging en verstopte drainagekanalen ten gevolge van grootschalige waterwerken, zoals dijken en polders. Om deze wateroverlast te reduceren, rivieren te herstellen en natuurwaarden in het getijdenlandschap in dit gebied te behouden, is sinds 2001 Tidal River Management (TRM) officieel geaccepteerd als vorm van publiek waterbeheer. In aanleg was dit een inheemse praktijk: vroeger praktiseerden lokale gemeenschappen TRM zonder enige overheidssteun; nu is het officieel geworden, een innovatieve vorm van polderen. Dit proefschrift richt zich op de driehoeksrelaties in de delta (Δ): ik volg een socio-eco-technische systeembenadering waarin met TRM wordt geëxperimenteerd als vorm van adaptief deltabeheer. Ik laat ook zien welke rol sociaal leren en inspraak in waterbeheer spelen bij capaciteitsopbouw en of het risico op hoogwater in een dynamisch deltasysteem erdoor vermindert.

Dit proefschrift valt uiteen in zes hoofdstukken, waarin verslag wordt gedaan van het onderzoeksproces en de bevindingen. Hoofdstuk 1 schetst het algehele idee achter het onderzoek, de hoofddoelen en achtergrond ervan, de specifieke onderzoeksvragen en het conceptuele kader alsook een beknopt overzicht van de methodologie. De bevolking van zuidwestelijk Bangladesh past zich al generaties lang aan de natuurkrachten (stormvloeden, verzilting en hoogwater). Ze bezit traditionele kennis en praktische vaardigheden waarmee ze de natuurgevaren tegemoet treedt. Het ligt dan voor de hand dat de lokale bevolking ook het recht moet hebben deel te nemen in beslissingen over hoe het gebied wordt beheerd. Het blijkt echter nog een hele uitdaging doeltreffende inspraak en duurzame afstemming tussen belanghebbenden te bewerkstelligen. Inspraak is in theorie ingevoerd middels een multi-stakeholderproces, maar in de praktijk functioneert het niet. Dit hoofdstuk sluit nauw aan bij het algehele doel van het proefschrift: bij te dragen aan een beter begrip van hoe leer- en veranderingsprocessen zich al dan niet hebben ontwikkeld bij de lokale vertaling van het deltamagement en welke rol multistakeholderprocessen daarbij spelen. De onderzoeksstrategie betreft documentenrecherche, lokale enquetes, multi-stakeholder focusgroeppen, zowel in subgroepen als met alle voornoemde lokale gemeenschappen, alles met het doel sociaal learen, dialoog en onderlinge afstemming te bevorderen. Het hoofdstuk biedt een historische analyse van de herkomst van TRM en de voortdurende strijd die lokale belanghebbenden met overheidsdiensten uitvechten over deze innovatie.

Hoofdstuk 2 duikt in de achtergronden van de overgang naar een andere vorm van deltamanagement in Bangladesh: de geschiedenis van wateroverlast in het zuidwesten en de strategieën om daarmee om te gaan. De transformatie van het dynamische deltasysteem wordt hier ook geschetst vanuit een multi-dimensionele socio-eco-technische benadering: herstel van het biofysische systeem, socio-economische transformatie and socio-institutionele adaptatie waarmee de invoering van TRM in de zuidwestelijke delta in Bangladesh gepaard is gegaan. De ontwikkeling en formalisering van Tidal River Management (TRM) leidde tot herstel van de riviercapaciteit, vermindering van de wateroverlast en betere landbouwmogelijkheden in het onderzoeksgebied. In de ontwikkelde gebieden traden enorme veranderingen in de voedselproductie op: in de meeste *beel-gebieden* zijn inmiddels grootschalige gemengde bedrijven (landbouw en visteelt) te vinden. Intensieve garnalenteelt in brak water om hogere opbrengsten te realiseren bracht aantasting van het milieu en verstoring van de balans in dit kwetsbare gebied. Dit hoofdstuk gaat ook kritisch in op institutionaliseringsprocessen, conflicthantering en de vraag waarom adaptief delta management zo gecompliceerd is.

Voor een beter begrip van de op zich zo veelbelovende managementpraktijk van Tidal River Management in de zuidwestelijke delta van Bangladesh, analyseer ik in hoofdstuk 3 vier gevalsstudies waarbij ik zowel officiële als informele vormen van TRM vanuit de invalshoek van sociaal leren beschouw. Er is een geïntegreerde, participatieve evaluatie van de uitkomst uitgevoerd op basis van wat zowel op individueel als op organisatizational niveau geleerd is over de vertaling van TRM naar de lokale context. Al doende hebben mensen door hun ervaringen en inspanningen op beide niveaus kennis opgedaan en uitgewisseld. Omdat organisaties in de publieke sector en andere betrokkenen verstrikt zitten in een complex bureaucratic systeem, wisselen ze zelden kennis met anderen uit, ook als er wel enige ruimte is voor experiment en monitoring. In de meeste gevalsstudies rond TRM domineren individuele en enkelslag- ('single-loop') leerprocessen - dat wil zeggen; leren met het doel de bestaande praktijk te verbeteren. Ik vond maar weinig voorbeelden van dubbelslagleren ('double-loop learning') waarbij reflectie leidde tot andere vormen van innovatie, en bezinning op de aannames en strategieën voor verandering was al helemaal zeldzaam. Het bleek lastig voorbeelden van 'dubbel-' of 'drieslagleren' te constateren met name omdat belanghebbenden gefixeerd waren op instrumentele doelen en vooraf bepaalde doelen voor TRM, waarbij maar weinig ruimte over bleef voor diepere reflectie.

Hoofdstuk 4 analyseert conflict en samenwerking in lokaaal (and regionaal) deltabeheer bij de planning en praktijk van Tidal River Management (TRM). Het onderzoek in dit deel van het proefschrift betreft de participatieve inschatting van conflictdynamiek ter plaatse: de actoren, oorsprong, en mate ervan afgezet op een conflict- en samenwerkings intensiteitsindex, die ik heb naar het lokale niveau heb vertaald. Om te bezien of conflict en samenwerking bij TRM in Bangladesh samengaan is een aangepast Transboundary Water Interaction NexuS (TWINS)-model gebruikt. Daaruit kwam naar voren datm gezien op het continuum van conflict naar samenwerking, er bij recente conflicten juist meer machtspolitiek en geweld te zien is dan voorheen, terwijl de mate van samenwerking maar weinig voorstelt. Uit het onderzoek bleek verder dat conflict en samenwerking in sommige gevallen inderdaad samengaan, al overheerst het conflict daarbij, en is het aan te raden in zo'n complex deltamanagementsysteem in te zetten op verschillende niveaus van conflict en samenwerking (i.e. de politieke, lokale/regionale en beleidssfeer).

Als we ervan uitgaan dat sociaal leren noodzakelijk is voor duurzame inspraak van belanghebbenden bij overgang naar andere vorm van deltabeheer, dan resteert de vraag waar je dan tegenaan loopt? Omdat het oorspronkelijke plan te kijken naar sociaal leren in bestaande inspraakprocessen maar zelden vruchtbaar bleek (hoofdstuk 3), onderzoek ik in hoofdstuk 5 aan de hand van een participatieve evaluatie wat leren in de weg kan staan en wat het kan aanzwengelen. Dit hoofdstuk onderzoekt wat voor uitdagingen en welke mate van effectiviteit je kunt verwachten bij stakeholderparticipatie bij deltamanagement rond Tidal River Management in Bangladesh. Het beoogde multi-stakeholder partnerschap blijkt zelden te hebben gefunctioneerd bij deltaprojecten die door de overheid zijn ingezet. Bij regionaal watergovernance gaat de made van vertrouwen en betrokkenheid van het sociale netwerk zelfs achteruit: äls er al iets geleerd is, dan wordt dat onvoldoende geïntegreerd. Wil de inspraak effectiever worden, meer succes worden geboekt bij sociale leerprocessen en, per slot van rekening, het deltabeheer verduurzaamd, dan zal er zowel in horizontale als verticale richting een 'generatief leerpartnerschap' moeten komen, en zal dat op een rechtvaardigere manier op de aanwezige behoeften in het stakeholdernetwerk moeten inspelen.

Hoofdstuk 6 integreert de vier voorgaande interdisciplinaire deelonderzoeken: de belangrijkste bevindingen, reflecties en aanbevelingen. De bevindingen van deze dissertatie, op zichzelf al een leerproces met meerdere doelen, hebben tot een beter begrip geleid van de complicaties die optreden bij projectimplementatie, bij de implementatie en ondersteuning van een multi-takeholdernetwerk en bij het streven maatschappelijk effect te sorteren bij de lokale vertaling van TRM. De problemen die in deze delta optreden hebben minstens zoveel te maken met institutionele, maatschappelijke en politieke aspecten als met het fysieke domein. De slothoofdstukken van dit proefschrift gaan in op transverszale kwesties die daarbij optreden en uitdagingen die het onderzoek met zich mee bracht. De belangrijkste beperking betreft de kloof tussen actie en interactie tussen de mensen in het veld, overheden en andere ontwikkelingsorganisaties, dan wel de beperkte mate van leergerichtheid tussen individuen en organisaties. Een aanbeveling in dit proefschrift is dan ook om leren, dan wel sociaal leren, beter in het deltabeheerssysteem te integreren als een goede manier om participatie van verschillende.

Annex- A

Published article: Sustainable livelihood security model for coastal area

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ORIGINAL PAPER

Development of a sustainable livelihood security model for storm-surge hazard in the coastal areas of Bangladesh

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Abstract Coastal communities in Bangladesh are at great risk due to frequent cyclones and cyclone induced storm-surges, which damages inland and marine resource systems. In the present research, seven marginal livelihood groups including Farmers, Fisherman, Fry (shrimp) collectors, Salt farmers, Dry fishers, Forest resource extractors, and Daily wage labourers are identified to be extremely affected by storm- surges in the coastal area of Bangladesh. A livelihood security model was developed to investigate the security status of the coastal livelihood system in a participatory approach. In the model, livelihood security consists of five components: (1) Food, (2) Income, (3) Life & health, (4) House & properties, and (5) Water security. Analytical hierarchy process was followed to assess the livelihood security indicators based on respondents' security options. The model was verified through direct field observation and expert judgment. The Livelihood Security Model yields a Livelihood Security Index which can be used for assessing and comparing the household security level (in %) of different livelihood groups in the storm-surge prone coastal areas. The model was applied with data from two major coastal areas (*Cox's Bazar* and *Satkhira*) of Bangladesh and is applicable to other coastal areas having similar settings.

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List of symbols

I_p	Present value of individual indicator
I_s	Standard value of individual indicator
I_d	Percentage of unit difference between present value of indicator and standard value of indicator
i	Livelihood Indicator
j	Security aspects/options
n	Number of indicators responds to an individual security options
N	Number of security aspects present in the final index
SI	Livelihood security index that calculates the security level for household in %
X	Positive value of I_d/security score for individual indicator
Y	Negative value of I_d/Insecurity score for individual indicator
X_{ij}	Positive score/security score of ith indicators under jth aspect
M_j	Maximum score of total indicators under jth aspect
SI_j	Security index under jth individual aspect
SI_1	Food security
SI_2	Income security
SI_3	Health and personal security
SI_4	Security of house and properties
SI_5	Water security

Annex A

1 Introduction

The Bay of Bengal is prone to tropical cyclones and accounts for 5.5 % of the global total cyclonic storms (Ali 1996, 1999). From 1797 to 1998, 67 major cyclone induced storms and tidal surges (Brammer 1999; Chowdhury 2002) struck the Bangladesh delta, including the highly destructive cyclones *Sidar* and Aila in November 2007 and May 2009 respectively (BUET 2008; Hasegawa 2008; Mutahara 2009).

The coastal resource system of Bangladesh consists of rich terrestrial and marine ecosystems, including vast mangroves (the *Sundarbans*) and a large number of estuaries (Islam 2004). The livelihood pattern of the coastal communities mainly depends on the availability of these resources in terms of ownership and access (Soussan and Datta 2002). In many countries, higher population density on the coast is accompanied by intensification of human activity, developments, and changes in land-use (Levy and Hall 2005). However, in Bangladesh, overcrowding in the mainland drives the poor and landless people to live in the coast where they are exposed to frequent cyclone and storm surges (IPCC 1996; Rahman 2004). Staying alive, and livelihood security is central to the welfare of the coastal communities (Mutahara et al. 2013); and increasingly perilous as the frequency of cyclonic storm-surges are increasing due to climate change (Emanuel et al. 2008).

This article represents a conceptual model to assess the household livelihood security against cyclone and storm-surge risks in the coastal area. The livelihood security model is generally a combination of three intervention strategies at the household level such as livelihood promotion (development oriented programming), livelihood protection (rehabilitation/mitigation oriented programming) and livelihood provisioning (relief-oriented programming) (Frankenberger and McCaston, 1998). Based on these strategies, the model assesses the livelihood protection and provision required for the coastal community vulnerable to storm surge. The livelihood security model developed here draws on the Socio-economic Vulnerability Index (SeVI) (Ahsan and Warner 2014), which measures socio-economic vulnerability to climate change disasters along the Bangladesh coast. It intends to bridge the gap between the necessities and priorities of communities at the micro level and policy variables at the meso level.

The current study focuses on the marginal livelihood groups and measures their *household livelihood security* to determine a comparative statistics of security level for different livelihood groups as well as different coastal settings. Livelihood security is an integrated concept, comprised of the capabilities, assets and activities required for a means of living. A livelihood system is sustainable if it can cope with and recover from stress and shocks (Charvet et al. 2014), maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation (Chambers and Conway 1992). The Sustainable Livelihood Security Model defines dynamic livelihood systems, identifying the security options, synthesizing the security indicators (Goodin and Wright 1998; Saaty 1980, 1988) with participatory approaches and finally, integrating a Livelihood Security Index to quantify household livelihood security.

2 Coastal livelihoods in the Bangladesh delta

According to Edward and Frank (2001), a livelihood comprises *"the assets (natural, physical, human, financial and social capital/resources), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household"*. Livelihoods have differed as to their environmental, social, and institutional settings and often vary in terms of resource base, production relations, and marketing (PDO-ICZM 2002). In the coastal area, some people work independently (e.g. fry collector), some work as lessees or share croppers (e.g. salt farmers, shrimp farmers) and some are contracted labourers (Ahmad 2003; Rahman 2004). Some people make a living from the exploitation of natural resources (e.g. salt farmers, fry collectors, fisherman, honey collectors) and some live on skill-based human resources (e.g. boat-building carpentry, net making). We conducted this study on livelihood groups in the storm-surge affected areas in Bangladesh (PDO-ICZMP 2003). The storm-surge risk is the most severe for the marginal people who are fully dependent on the natural resources of the coast (Khalequzzaman 1988). The first step of the study entailed an analysis of existing information sources to determine the livelihood classes in the coastal areas of Bangladesh.

Coastal livelihood groups listed in Table 1 have been defined considering the following contexts:

- Income time frame of coastal livelihood groups is influenced by the occurrences of cyclone induced storm-surges (generally occurring during the pre- and the post-monsoon) (Ganter 1996).
- Cyclones and tidal surges cause loss of life and damage resources in various ways: For examples, agro-products, shrimp, and salt are washed away; fisherman cannot go out fishing; people cannot go outside for food, water, fuel, and daily needs; houses and sanitation systems are badly damaged.

3 Approach and methodology

Two case studies were selected for the current research. Coastal districts *Cox's Bazar* and *Satkhira* (Fig. 1) are located near the southeast and south-west boundaries of the

Annex A

Table 1 Marginal livelihood groups in Bangladesh coast

Livelihood groups	Resources and opportunities	Income time frame
Farmer	Agricultural products i.e. paddy, vegetables, and shrimp farms	Round the year
Fisherman	Estuary, open sea (The Bay of Bengal), Rivers and *Khals* especially in the *Sundarbans* area	Round the year
Dry fisher[a]	Fish captured from the sea and other sources	Seasonal (6–months in a year)
Salt farmer	Salt cultivation in the coastal area	Seasonal (6 months in a year)
Fry collector	Estuary, coast line of the Bay of Bengal, Rivers and *Khals*, especially in the *Sundarbans* area	Round the year
Forest extractor (*Bawals*, *mouals*)[b]	The *Sundarbans* (the largest mangrove forest in the world)	8–10 months in a year
Wage Labourer	Agriculture, culture fishery (Shrimp *Ghers*), fish processing factories and others	Round the year

[a] Dry Fisher means people who are only involved in fish drying and selling

[b] *Bawals* refers to wood, leaves, and shell collectors*; Mouals* means honey and wax collectors

(PDO-ICZMP 2004; Mutahara 2009; Mutahara et al. 2013)

Bangladesh delta in the high and medium cyclone and surge risk zones (PDO-ICZMP 2003).

Livelihoods in rural Bangladesh are diversifying (Toufique and Turton 2002). Our field investigation confirms that this observation applies even more to the coastal zone in Bangladesh. Livelihood patterns in *Cox's Bazar* and *Satkhira* are different due to different biophysical settings as well as available resource systems. *Cox's Bazar* is located along the long open seashore and *Satkhira* is bounded by the largest mangrove forest in the world: the *Sundarbans.* The main methodological concept has been developed in a participatory approach (Huq 2001; Evan et al. 2005) followed in environmental and social research. It includes designing an indicator framework having a set of indicators for the security criteria in the livelihood resources system (Fig. 2) in the context of a developing country.

Indicators were identified under natural capital/resources, human capital/resources, social capital/resources, physical capital/resources and financial capital/resources representing the main livelihood sub-systems in the coastal area. In each study sites, a two-step participatory approach was adopted. First, Focus Stakeholder Meetings (FSMs) (Mutahara 2009) were conducted to understand the local livelihood systems as well as to develop an indicator framework. Second, indicators' responses towards specific livelihood security options were evaluated with a participatory approach using Analytical Hierarchy Process (AHP) (Saaty 1980, 1988); a multi-criteria decision making (MCDM) method commonly used in studies for risk-based environmental decision-making process (Tesfamariam and Sadiq 2006; Sadiq and Tesfamariam 2009). AHP provides a rational choice of different alternatives (the initially developed indicators) by identifying relevant criteria and evaluating a weighted score for each alternative that reflects its strength of preference (Goodwin and Wright 1998).

We used AHP to integrate subjective and personal preferences of indicators in performing the base analyses to develop the model. It is a systematic, explicit, and robust mechanism for eliciting and quantifying the subject judgment. Indicators were chosen from the initial indicator list under different livelihood-security aspects/options (Mutahara 2009): (1) Food security, (2) Income security, (3) Health and personal security, (4) Security of house and properties, and (5) Water security. Top-ranking indicators have been defined as the potential indicators to explore individual option of security which are the main inputs to the model.

In the second step, FSMs and individual household interviews were conducted to evaluate indicators for livelihood groups. Standard threshold values for the indicators were calculated from national and regional-level secondary information sources, including the Bangladesh Bureau of Statistics (BBS), the Local Government Engineering Department (LGED), Bangladesh; PDO-Integrated Coastal Zone Management Office; the Asian Development Bank; and the Center for Environmental and Geographical Information Services (CEGIS), Bangladesh. The model was verified through direct field observation and expert judgment. We also checked the validity of the application of the model to both field sites. For that, 10 households with approximately the same income level which had survived well through several storm-surges within the last two decades were selected randomly. We used an average value of livelihood indicators for those households to calculate the expected/standard household security level, to validate the livelihood security model developed here.

Annex A

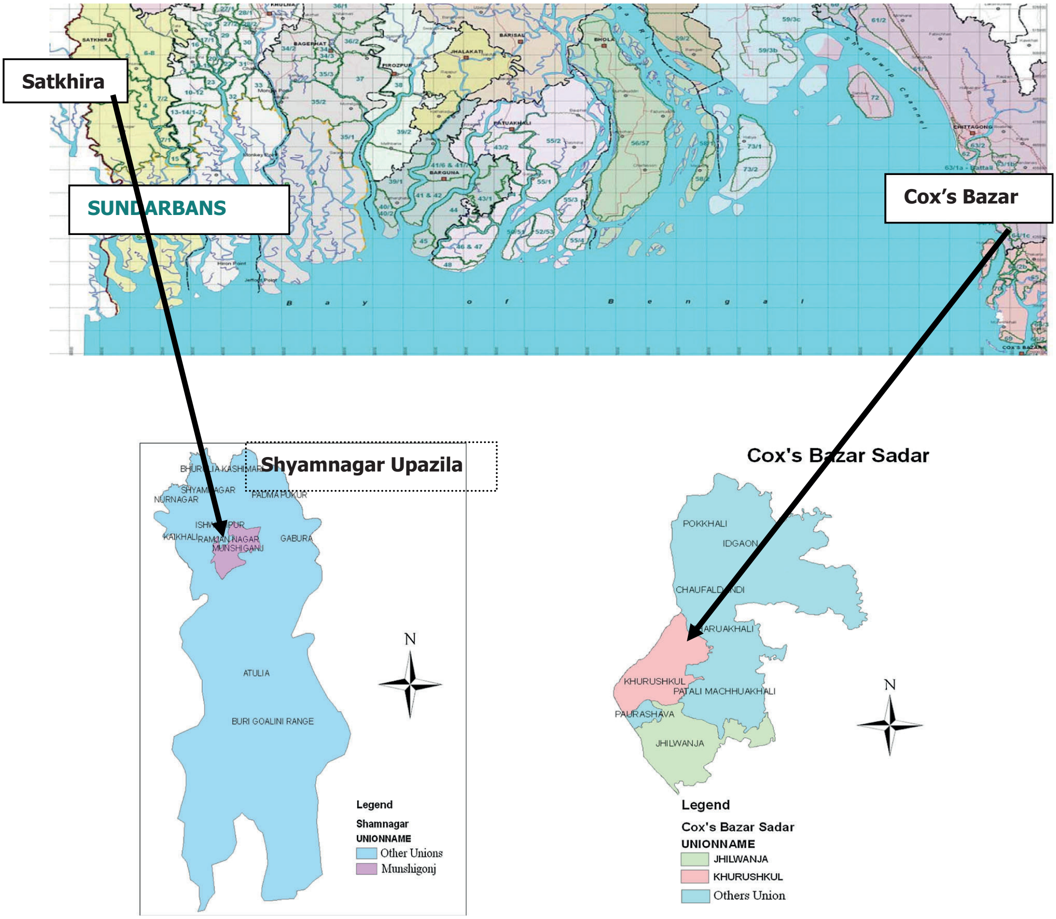

Fig. 1 Study area map showing the study sites in the coastal zone of Bangladesh

4 Model development for livelihood security

4.1 The conceptual model

The conceptual framework focuses on integrated assessment of the livelihood security required for livelihood protection and provision. The model broadly covers livelihood security against storm-surge risks and relates to the characteristics of the coastal livelihood systems in the Bangladesh Delta (Mutahara 2009; Mutahara et al. 2013).

Figure 3 conceptually shows the model for coastal livelihood security with its three major elements: (a) contexts, (b) livelihood system and strategy, and (c) livelihood security dimensions/outcomes. Contextual factors situate in the household and community. The model is constructed to identify the level of (in) security of the coastal people/household exposed to storm-surge hazards. In that sense storm-surge and its destructive actions is defined as the key contextual factor affecting the livelihoods.

The coastal livelihoods and their stakeholders are the basic elements of the model (CEGIS 2007). It has been defined as the element of vulnerability in that study field (Chadwick 2003; CEGIS 2007). In the model, the affected party i.e. the coastal livelihood groups have been introduced including their household activities, resources, and strategies. Here, the aim of analyzing livelihood system and strategy was to understand the typical accessibility of human, social, economic, and natural capital in households and the nature of production, income, and exchange activities. Livelihood security indicators are the analytical inputs to the model, which were defined for the household

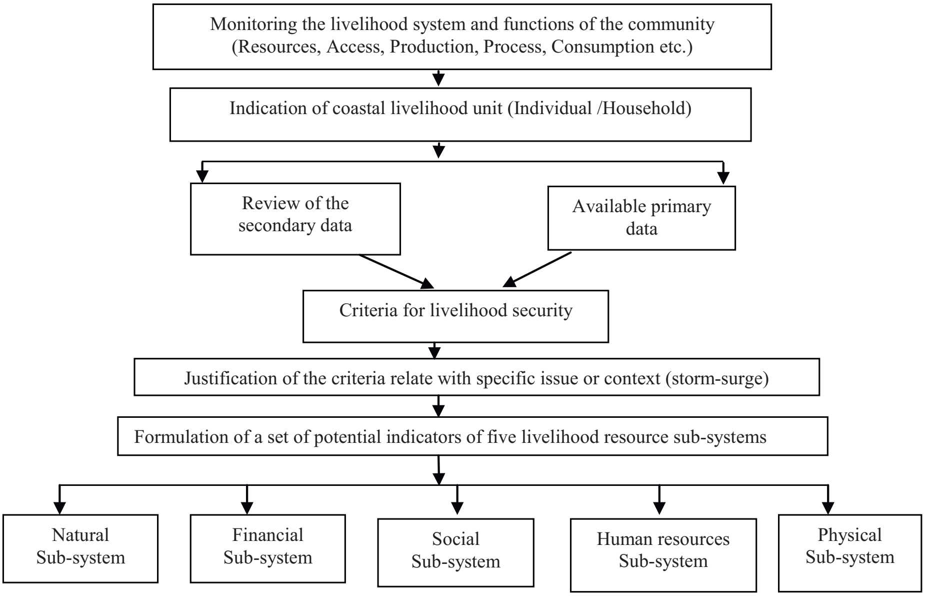

Fig. 2 Schematic representation of indicator frame work development process

unit in the livelihood system of a coastal community. The identified indicators are listed in Table 2.

In the model, the standard threshold value of a livelihood indicator is used to analyze the security level. The threshold level could be a constant value or could vary by month, season, or year (Fleig et al. 2006). Table 2 shows the security standard (threshold value of livelihood security indicators) has been shown according to national/regional statistics (yearly) in Bangladesh (BBS 2001, 2011; NWRD 2010). The security level was calculated for individual livelihood groups. Analytically, the model produces a Livelihood Security Index (SI) which is a combination of the parameters defined in Table 3.

4.2 Designing a livelihood security index from the conceptual model

The developed model is a scientific tool for assessing household security for any livelihood group in the coastal areas exposed to storm-surge hazard. The following steps were followed in developing the Security Index.

Step 1 Two types of values for each selected indicator have been calculated through analyzing secondary data, FGDs and mostly household interviews in the coastal area. Here, change between the present value and standard value was calculated for each individual indicator which is shown as percentage of unit difference. Change in Individual indicator was calculated under an individual security aspect by the following equation:

$$|\mathbf{I_d}| = \{(\mathbf{I_p} - \mathbf{I_s})/(\mathbf{I_p} + \mathbf{I_s})\} \times \mathbf{100} \quad (1)$$

Here, I_p is the Present value of individual indicator, I_s is the Standard value of individual indicator, I_d is the Percentage of unit difference between the present value of indicator and the standard value of individual indicator.

Step 2 A value exchange scale is defined in this step to identify the security score from the result of Step 1 because the value of I_d may represent alternative directions, i.e. either positive (+) or negative (−). Here, the positive direction shows security and negative direction shows insecurity.

In this model development process, we used only positive scores because conceptually this model is able to measure security at the household level. Insecurity level for the same household can be identified directly and easily using the model upshot.

Step 3 Security of household (in percentage) for individual livelihood security aspects/options which is at risk of storm-surges in the coast has been measured by the index defined below. The security level for household in individual security aspects/option (j) can be calculated by using security scores of indicators (i = 1,

Annex A

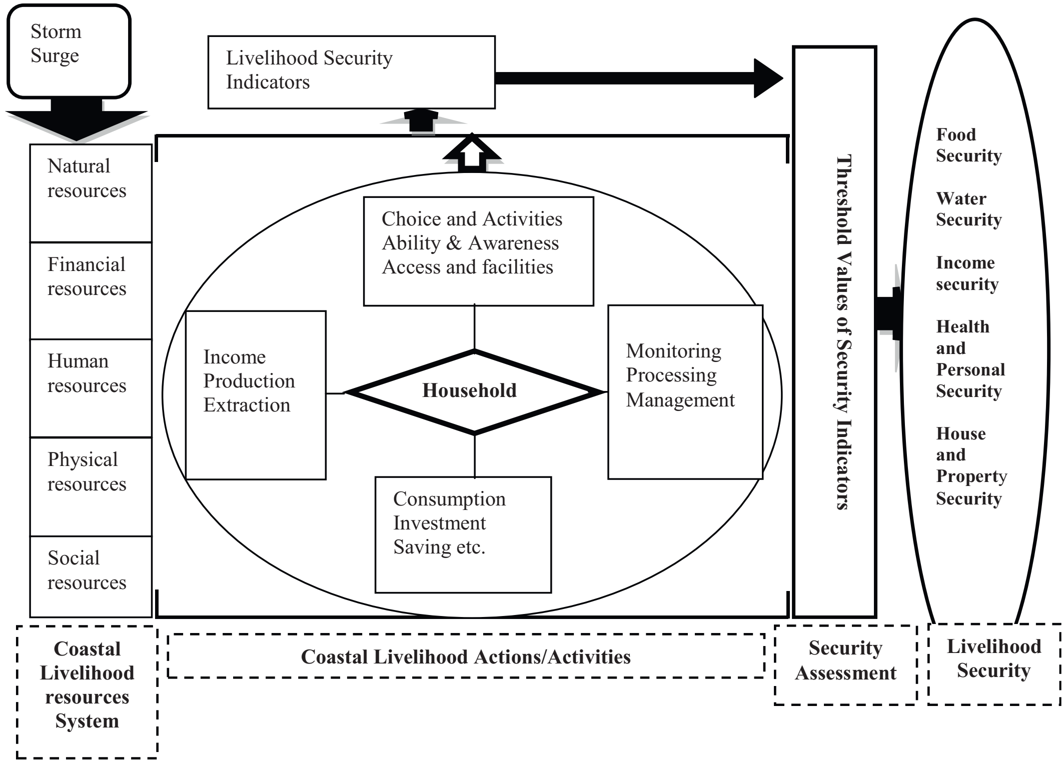

Fig. 3 Components of the model of livelihood security against storm-surge hazards in the coastal area

2,…, n) those respond to such security aspects j in the following equation:

$$SI_j = \left\{ \sum_{i=1}^{n} X_{ij}/M_j \right\} \times 100 \tag{2}$$

where, SI_j is the Security level under jth individual aspect, X_{ij} is the Positive score of ith indicators under jth aspect.

The value of X for the different indicators (i = 1 to n) has been calculated by counting the numbers of positive (+) signs. n is the Number of individual indicators sensitive for individual aspect, M_j is the Total score of responsive indicators under jth aspect, j is the Different security aspects (1–5)

Now the overall livelihood security at the household level of a coastal community against the hazard (storm-surge) can be calculated through combining the security scores under all denoted security aspects. The composite Security Index consisting of different aspects has been expressed as follows:

$$SI = \sum_{j=1}^{N} SI_j/N \tag{3}$$

where, *SI* level of livelihood security for household (in percentage), *N* number of security aspects considered in the composite index.

5 Model application

The assessment of security level may have to deal with multiple sources of uncertainty that the model can consider automatically as per its analytical approach. In this model, uncertainty factors are directly related to the the storm-surge charecteristics: its action, scope of defenses etc. and also human behavior. It may also have to deal with the ecosystem conservation knowledge as well as institutional capacity. All those factors and their relevance were studied and justified using expert's opinion in indicator development process. Therefore, we are confident that the indicator

Annex A

Table 2 Primarily identified security indicators for livelihoods in the coastal community

Resources	Indicator	Unit	Standard/threshold value
Natural resources	Frequency of storm-surges (normal/frequent)	Binary	1
	Storm-surge period (normal/high tide)	Binary	1
	Surge height from mean sea level (normal/high)	Binary	1
	Duration of surge (regular/long term)	Binary	1
	Rate of vegetation around the area	%	25
	Time frame for resource collection or production	Month	12
	Performance of natural drainage system	%	80
	Rate of possible resource quality improvement	%	50
	Access to alternative resource base	No.	3
	Available energy/fuel supply	%	90
Financial Resources	Homestead production	% of TI	40
	Ownership on main production or income	%	75
	Scope of food storage (Yes/No)	Binary	1
	Rate of saving	% of TI	25
	Reliability of saving system	Binary	1
	Access of women to economic activities	%	50
	Scope of alternative economic activities (Yes/No)	Binary	1
	Access to financial loan (Yes/No)	Binary	1
	Portion of HH income earned from rest of the country	%	20
Human Resources	Rate of education/literacy	%	80
	Knowledge on first aid	%	70
	Knowledge on storm-surge risks	%	80
	Access to nearest district town (Yes/No)	Binary	1
	Access to medical services (No. of doctor/50 HHs)	No.	2
	HH population having training on surge protection	%	50
	Active population of HHs	%	50
	Response to early warning system	%	65
	Rate of out migration of HH members	%	10
	Response to adaptation technology	%	75
Physical Resources	Safe housing infrastructure/condition	%	60
	Performance of hospital/health centers	Scale	3
	Performance of/access to cyclone shelters	%	90
	Availability of drinking water (safe water)	%	90
	Sanitation facilities	%	90
	Access of Radio/TV/Cell phone	%	75
	Availability of paved road	%	60
	Transportation facilities	%	60
	Part of area under protection structure	%	80
	Fitness of protection structure	%	80
Social resources	Performance of weather forecasting	Scale	3
	Community participation practice	%	80
	Activeness of local GOs	Scale	2
	Inter-relationship with NGOs	Scale	2
	Performance of social law and regulations	Scale	2
	Political influence on social group/committee (Yes/No)	Binary	1
	Performance of local disaster management committee	Scale	2
	Activeness of social organization of livelihood groups	%	80
	Awareness program on protection measures (No/Yes)	No.	2

(*Source* BBS, NWRD and Field study 2008–2009, 2011–2013)

Annex A

Table 3 Indicator parameters and symbols used in the model

Parameters	Unit	Denoted by
Measured/present value of individual indicator	Specific unit	I_p
Standard value of individual indicator	Specific unit	I_s
Difference between the present value of indicator and standard value of individual indicator	%	I_d

selection and scoring procedure will work sufficiently to identify and resolve such uncertainty. We applied the livelihood security model against storm-surge hazards in two selected areas; a high storm-surge risk area in *Cox's Bazar* and a medium storm-surge risk area in *Satkhira* (PDO-ICZMP 2004).

5.1 Assessment of livelihood security indicators

We used the indicators for constructing a model for both qualitative and quantitative requirements. The indicator values have been analyzed under specific units or scales such as percentage, number, degree and binary options (shown in the Table 2). Some values have been calculated from the relevant data-base and some have been defined from direct household interview in the study areas. Appendix Tables 8 and 9 shows the present measured value of indicators (Ip) for different livelihood groups in the study areas (a) the *Cox's Bazar* and (b) *Satkhira*. During evaluation of indicators from data analysis (results shown in Appendix Tables 8 and 9), we found two major categories: 1) common/same values for livelihood groups and 2) different values for individual group in each area. The first type of indicator shows the collective security status that means the same value for overall community households in the defined area and the second type actually indicates the value especified as individual household basis for different groups. For example, the indicator "performance of hospital/health center" shows the same measured unit value for all livelihood groups living in the same area where the "Rate of production" shows different value for different groups in such area.

5.2 Security scoring for individual indicators

We used AHP methods to make the decision for priority of indicators under the security options, and these can then be taken up in quantitative surveys. The priority-scored indicators have been used for measuring security level under individual security options such as food security, income security and so on for each livelihood group. Priority selection is shown in Appendix Table 10. The security score under individual indicators has been estimated from the comparative analysis between present field survey data (I_p) (Appendix Tables 8 and 9) and standard threshold values (I_s) (Table 2) according to national average value (from BBS year books, NWRD and Local Government Organizations) by using Eq. 1 described in Sect. 4.2. From the difference of individual indicator's values the security scores have been found under different security options. For better understanding of security scoring process, we used a sample calculation where we used the limited number of indicators ($n = 5$) with only 2 security options for one livelihood group.

Table 5 shows a sample input data calculation for the livelihood security measurement of farmer households in *Cox's Bazar* applying steps 1 and 2 of the model described in Sect. 4.2. Here, in the second row of the Table 5, individual indicator $i = 1$ was selected under the food security (j1) aspect for the farmer group in *Cox's Bazar*. The present value of i1 is 0 where the security standard (defined in Table 2) is 1. Now the value difference (I_q) is about 100 % with negative direction that means i1 shows insecurity in food with score 3 according to the security scale defined in Table 4. In the same process, $i = 2$ and $i = 3$ were investigated where $i = 2$ was not responding for food security according to the AHP analysis (Appendix Table 10). So, i2 is not scored under food security, however it scored 1 for income security (j2) in the negative direction i3 is scored for both security options as 1 in the negative direction. However, $i = 4$ and $i = 5$ indicators have shown in scores 1 and 2, respectively food security and income security was relatively in the positive direction. Here, the calculated score under food security aspect/option ($j = 1$) is 3, whereas the total score is 7 ($M_1 = 7$). So, in the model, $\sum X_1 = 3$.

Table 4 Scale for security scoring in individual indicators

Positive I_d = Security		Negative I_d = Insecurity	
Security score (X)	(+) Value range (%)	Insecurity score (Y)	(-) Value range (%)
+	0–30	–	0–30
+ +	31–60	– –	31–60
+ + +	61–>	– – –	61–>

Here, *X* security score for individual indicator, *Y* insecurity score for individual indicator

Annex A

Table 5 Calculation for security scoring of five indicators (farmers in *Cox's Bazar area*)

SL	Indicators (i)	Unit	I_s	I_p	I_d (%)	Direction	Food security (j = 1)	Income security (j = 2)
1	Duration of storm-surge (short term/long term)	Binary	1	0	100.00	Negative	− − −	− − −
2	Rate of vegetation around the area	%	25	15	25.00	Negative	x	−
3	Time frame for resource collection/production	Months	12	8	20.00	Negative	−	−
4	Rate of possible resource quality improvement	%	50	60	9.09	Positive	+	+
5	Access to alternative resource base	No.	3	6	33.33	Positive	+ +	+ +
	$\sum$**X**						3	3
	M						7	8

(*Source* Model results 2011; 2013)

5.3 Calculation of security level for individual security options

The levels of different security options have been measured by using Eq. 2 under Step 3.

$$SI_1 = \left(\sum X_1/M_1\right) \times 100 = (3/7) \times 100$$

$$j = 1, \text{defines food security}$$

$$= 42.86\,\%$$

Therefore, the calcutated food security for the sample indicators is 42.86 % (sample calculation partially using only 5 indicators, it is not the complete scenario). Tables 6 and 7 show the complete measured value of security (as a percentage) under the individual security option (SI_j) for the selected livelihood groups in the study areas.

In Table 6, security levels under individual options have been presented for the defined livelihood groups in *Cox's Bazar* area. These results were measured by using Eq. 2 of the model. The same process was followed in *Satkhira* area; the results are shown in Table 7. The values shown in Tables 6 and 7 are the input data for Eq. 3 of the model.

5.4 Calculation of security level of livelihood groups

The overall security level of the coastal livelihood groups were calculated using Eq. 3 in the third step of the Livelihood Security Model. For example, in the*Cox'sBazar*

Table 6 Individual security level (%) for livelihood groups in *Cox's Bazar* area

Security options (j)	Farmer	Fisherman	Wage labourer	Fry collector	Dry fisher	Salt farmer
Food security $\mathbf{SI_1}$	41.67	41.18	19.35	16.13	40.82	45.83
Income security $\mathbf{SI_2}$	44.68	42.86	23.08	17.86	39.58	47.92
Health and personal security $\mathbf{SI_3}$	38.30	37.25	13.79	11.48	35.42	42.55
Security of house and properties $\mathbf{SI_4}$	45.65	42.86	18.87	15.79	40.43	48.94
Water security $\mathbf{SI_5}$	39.13	35.29	14.29	13.56	34.69	40.43

(*Source* Model results 2011; 2013)

Table 7 Individual security level (%) for livelihood groups in *Satkhira* area

Security options (j)	Farmer	Fisherman	Wage labourer	Fry collector	Forest extractor
Food security $\mathbf{SI_1}$	34.00	27.27	13.43	17.54	26.92
Income security $\mathbf{SI_2}$	37.25	28.30	16.39	18.18	25.93
Health and personal security $\mathbf{SI_3}$	30.77	18.18	6.15	12.73	22.41
Security of house and properties $\mathbf{SI_4}$	36.54	26.92	13.11	18.52	29.09
Water security $\mathbf{SI_5}$	31.37	20.00	8.06	13.73	21.43

(*Source* Model results 2011; 2013)

Annex A

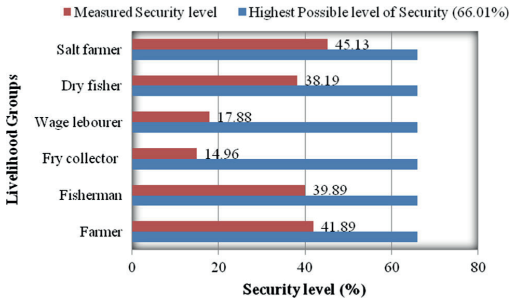

Fig. 4 Computation of security level at *Cox's Bazar* for the period of 2013 (*Source* Mutahara and Haque 2011; Mutahara et al. 2013)

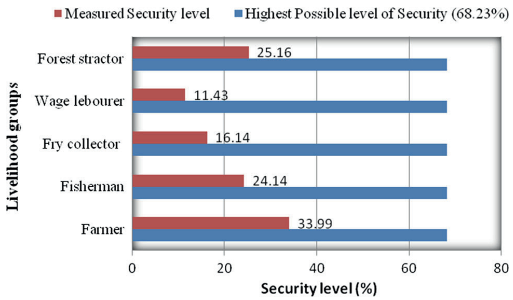

Fig. 5 Computation of security level at *Satkhira* area for the period of 2013 (*Source* Mutahara and Haque 2011; Mutahara et al. 2013)

area, the security level of the farmer group is calculater as follows:

$$\begin{aligned} SI_{Farmer} &= (SI_1 + SI_2 + SI_3 + SI_4 + SI_5)_{Farmer}/5 \\ &= (41.67 + 44.68 + 38.30 + 45.65 + 39.13)/5 \\ &= 41.89(\%) \end{aligned}$$

Figures 4 and 5 show the overall model results.

Annex A

6 Results and discussion

Figures 4 and 5 present the model results for *Cox's Bazar* and *Satkhira* areas, respectively. In both areas, the results have determined the livelihood security of individual groups. The lowest security level 14.96 % was found for fry collectors (Fig. 4). In the *Cox'sBazar* area, the fry collectors live at a very marginal level, with access to but not ownership of marine resources. Women and children are mostly involved in fry collection using very traditional instruments. In most cases they lost their instruments and cannot go to sea during and also long time after a storm-surge. Wage labourer group is also less secure (17.88 %) because of limited scope of work during and after a storm-surge. However, they have some access to rehabilitation work with other groups like agriculture, salt farmer or dry fisher. On the other hand, the highest security was found for salt farmer group in *Cox's Bazar*. They have ownership to land which they use for salt farming. They have seasonal investment and income. We found that farmers can pre-serve the produced salt in the field giving mud cover during the occurence of a storm-surge. Farmer, fisherman and dry fisher groups were also at relatively higher security levels.

The models result from *Satkhira* area is shown in Fig. 5. In *Satkhira* the wage labour group was found as the least secure livelihood group. This area is highly dependent on culture fisheries (shrimp culture). The labourers mainly work in the shrimp field on a daily basis. Therefore, they do not have independent access to income generation. Fry collectors are also in a less secure zone. The highest security level (33.99 %) was found for farmers in *Satkhira*. In this coastal area farmers cultivate rice and vegetables. Currently they use high yielding varities of rice. Crop rotation also make them secure against the loss from storm surges. The forest extractors were also found to have a relatively higher security level because of their seasonal income opportunity. However they are still vulnerable in their dependancy on forest resources only.

In Figs. 4 and 5, the standard household security level has also been determined. The standard level is used for the justification of model application. The standard method of model validation could not be followed properly for the model in such a very rural coastal area. With this limitation, we checked the model with a pre-defined standard security (degree of safety) level for households in each coastal district, as perceived by the community. In both areas(*Cox's Bazar* and *Satkhira*), the local communities responded positively to the defined possible standard security level as they expected. The standard livelihood security value is about 66.01 % in the *Cox's Bazar* area. Following the same methodology, the standard level of security value may be as high as 68.23 % in *Satkhira*. Figures 4 and 5 shown that marginal livelihood groups have very low levels of livelihood security. Even the security levels of the livelihood groups having the highest security levels, e.g. salt farmers in *Cox's Bazar* (45.13 %) and farmers in *Satkhira* (33.99 %), are low compared to the standard level of security.

The model results indicate another important finding. We can easily draw a comparative assessment among the commom livelihood groups in different cases. In this study, we found four common groups (farmer, fisherman, fry collector, and wage labourers) in two study areas. Figure 6 shows the variation in household security level among theses common livelihood groups in *Cox's Bazar* and *Satkhira*.

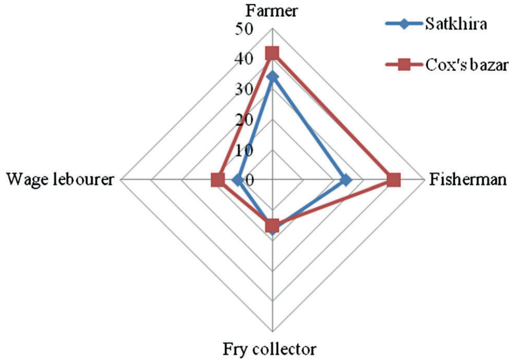

Fig. 6 Comparative analysis of livelihood security in two study sites (Mutahara et al. 2013)

In our findings, the major difference is shown in the fisherman group. The fisherman group in *Cox's Bazar* (39.89 %) is more secure than in *Satkhira* (24.14 %). This is likely due to the long open seashore in *Cox's Bazar* and fishermen have more finiancial and logistical support in *Cox's Bazar* (Mutahara et al. 2013). The level of security for farmers in *Cox's Bazar* is 41.89 % whereas in *Satkhira* it is 33.99 %. The farmers in *Cox's Bazar* are more secure than in *Satkhira* due to land use pattern. In *Sathkhira*, farmers generally cultivate rice in shrimp fields during the dry season. However, in *Cox's Bazar*, we found separate fields for shrimp and rice production. The level of security of fry collectors is better in *Satkhira* (16.14 %) than in *Cox's Bazar* (14.96 %). The fry collectors mainly access the rives and *khals* (tidal channels) in *Satkhira* whereas in *Cox's Bazar* they mostly use the open sea.

7 Conclusion

In this study, seven (7) marginal livelihood groups have been identified including their specific livelihood opportunities and resources in two study areas (*Cox's Bazar* and *Satkhira*) in Bangladesh. In specific, six (6) groups were living in *Cox's Bazar* area and five (5) were in *Satkhira*. However, four (4) livelihood groups (farmer, fisherman, fry collector, and wage labourer) were common in both sites.

Livelihood security is an impotrant issue in the strom-surge affected areas of the Bangladesh coast. It is not only due to physiographic and socio-economic conditions but also due to climate change vulnerability. In our study, the livelihood security model has two main outcomes. First, it introduced a holistic analytical approach for assessing livelihood security levels. Second, it contributed a tool of livelihood protection and system development for the coastal area. The livelihood Security Index (SI) calculated the overall household security level (in %) for livelihood groups against the risk of storm surges. The model result shows the livelihood security levels for the marginal livelihood groups in both coastal areas. It also shows a comparative view of livelihood security in common livelihood groups in the different coastal area of Bangladesh.

This study can contribute to future coastal resource management and livelihood development programs. It could play a vital role in the sustainable planning for disaster risk reduction and adaptation management in the Bangladesh coast. Although this model has been developed and applied in the Bangladesh delta, it can also be applied in the coastal zones of other deltas for developing sustainable coastal zone management planning.

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Appendix

See Tables 8, 9 and 10.

Table 8 Input data for livelihood groups in *Cox's Bazar* area

Indicators	Farmers	Fisher-man	Fry collectors	Salt farmers	Dry fishers	Wage labourers
Frequency of storm-surge (Irregular/regular)	0	0	0	0	0	0
Storm surge period (low tide/high tide)	0	0	0	0	0	0
Surge height from the main sea level	0	0	0	0	0	0
Duration of storm surge (short/long term)	0	0	0	0	0	0
Rate of vegetation around the area	15	15	15	15	15	15
Time frame for resource collection/production	8	10	7	6	6	12

Annex A

Table 8 continued

Indicators	Farmers	Fisher-man	Fry collectors	Salt farmers	Dry fishers	Wage labourers
Performance of natural drainage system	55	55	55	55	55	55
Possible improvement of resource in each year	60	80	75	75	80	50
Access to alternative resource base	6	6	5	4	5	2
Access to energy/fuel supply	70	50	60	60	60	60
Household production	40	12	15	45	30	10
Ownership on production	75	50	60	60	60	18
Scope of food storage	1	1	0	1	1	0
Rate of saving	25	30	6.67	20	16.67	0
Reliability of saving system (Yes/No)	1	1	0	1	1	0
Access of women to economic activities	60	40	75	30	65	45
Scope of alternative economic activities	1	1	1	1	1	1
Access to financial loan	1	1	0	1	1	0
Portion of HH income	15	12	6	32	19	3
Rate of education/literacy	52	46	34	44	52	25
Knowledge on first aid	46.22	30	31	43	22	18
Knowledge on storm surge risk	66.9	82	66	80	67.97	43
Access to nearest district town (Yes/No)	1	1	1	1	1	1
Access to doctor service (doctor/100 HHs)	2	2	2	2	2	2
HH population having training on surge protection	30	43	17	47	41	7
Active population of HH	52	46	34	44	52	25
Response to early warning system	63	67	48	65	68	50
Response to adaptation technology	75	76	54	80	77	38
Rate of out migration of HH member	10	11	6	12	9	3
Safe housing infrastructure/condition	40	39	31	62	41	14.89
Performance of hospital/health center	2	2	2	2	2	2
Performance of/access to cyclone shelter	70	70	70	70	70	60
Availability of drinking water (safe water)	45	48	26	56	41	35
Sanitation facilities	55	61	26	67	38	35
Access of media connection/Radio/TV/Cell phone	80	65	48	75	56	38
Availability of paved road	60	60	60	60	60	60
Transportation facilities	60	60	60	60	60	60
Part of area under protection structure	50	50	50	50	50	50
Fitness of protection structure	60	60	60	60	60	60
Performance of weather forecasting	2	2	2	2	2	1
Community participation practice	75	80	65	85	80	40
Activeness of local GOs	2	65	40	62	60	30
Interrelationship with NGOs	2	75	88	55	70	80
Performance social law and regulation	2	2	1	3	3	1
Political influence on social group/committee (Yes/No)	1	1	0	1	1	0
Performance of local disaster management committee	2	2	2	2	2	2
Activeness of social organization of livelihood groups	60	80	50	85	80	45
Awareness program on protection measure (No/Yes)	2	2	2	2	2	2

(*Source* Survey 2010–2011)

Annex A

Table 9 Input data for livelihood groups in *Satkhira* area

Indicators	Farmers	Fisherman	Fry collectors	Forest extractors	Wage labourers
Frequency of storm surge (Irregular/regular)	0	0	0	0	0
Storm surge period (Low tide/high tide)	0	0	0	0	0
Surge height from main sea level	0	0	0	0	0
Duration of storm surge (Short term/long term)	0	0	0	0	0
Rate of vegetation around the area	18	18	18	18	18
Time frame for resource collection/production	8	10	7	8	12
Performance of natural drainage system	40	40	40	40	40
Possible improvement of resource in each year	60	80	75	30	50
Access to alternative resource base	6	6	5	4	2
Access to energy/fuel supply	45	25	25	25	25
Household production	40	12	15	40	10
Ownership on production	70	70	60	60	20
Scope of food storage	0	0	0	1	0
Rate of saving	20	10	5.33	25	0
Reliability of saving system (Yes/No)	1	0	0	1	0
Access of women to economic activities	50	30	66	20	55
Scope of alternative economic activities	1	1	1	1	1
Access to financial loan	1	1	1	1	0
Portion of HHs income earned from rest of the country	18.65	6	2.75	9.68	5
Rate of education/literacy	48	39	31	35	18
Knowledge on first aid	29.1	12	36	47	20
Knowledge on storm surge risk	52	63	65	72	46
Access to nearest district town (Yes/No)	0	0	0	0	0
Access to doctor service (No. of doctor/100 HHs)	1	1	1	1	1
HH Population having training on Surge protection	25	38	18	56	5
Active population of HHs	48	39	31	35	18
Response to early warning system	55	65	42	67	47
Response to adaptation technology	62	46	47	64	52
Rate of out migration of HH members	8	5	2.75	8	1.5
Safe housing infrastructure/condition	46	22	22	48	9
Performance of hospital/health center	2	2	2	2	2
Performance of/access to cyclone shelter	60	60	60	60	70
Availability of drinking water (safe water)	48	28	24	35	33
Sanitation facilities	48	32	20	38	33
Access of media connection/Radio/TV/cell phone	78	35.5	30	30	40
Availability of paved road	65	65	65	65	65
Transportation facilities	55	55	55	55	55
Part of area under protection structure	35	35	35	35	35
Fitness of protection structure	40	40	40	40	40
Performance of weather forecasting	1	1	1	3	1
Community participation practice	65	60	50	60	40
Activeness of local GO	1	40	35	45	30
Interrelationship with NGO	2	80	90	65	80
Performance social law and regulation	1	1	1	3	1
Political influence on social group/committee(Yes/No)	1	1	0	1	0
Performance of local disaster management committee	1	1	1	1	1
Activeness of social organization of livelihood groups	50	60	55	70	50
Awareness program on protection measure (No/Yes)	0	0	0	0	0

(*Source* Survey 2010–2011)

Annex A

Table 10 Priority calculation under different security options (selected indicators by AHP)

Resources	Indicator	Priority/response to different security options				
		Food	Income	Health and personal	House and properties	Water
Natural resources	Frequency of storm surge (Irregular/regular)	0.02	0.01	0.01	0.01	0.04
	Storm surge period (Low tide/high tide)	0.02	0.01	0.01	0.01	0.03
	Surge height from mean sea level	0.02	0.01	0.01	0.01	0.03
	Duration of storm surge (Short term/long term)	0.02	0.01	0.01	0.01	0.02
	Rate of vegetation around the area	0.00	0.01	0.01	0.04	0.01
	Time frame for resource collection/production	0.05	0.04	0.00	0.00	0.00
	Performance of natural drainage system	0.00	0.00	0.01	0.04	0.08
	Rate of possible resource quality improvement	0.08	0.02	0.00	0.00	0.00
	Access to alternative resource base	0.05	0.03	0.02	0.02	0.02
	Access to energy/fuel supply	0.04	0.01	0.02	0.00	0.05
Financial resources	Homestead production	0.08	0.03	0.01	0.02	0.02
	Ownership on main production or income	0.05	0.04	0.02	0.03	0.09
	Scope of food storage (Yes/No)	0.04	0.00	0.02	0.00	0.00
	Rate of saving	0.04	0.01	0.02	0.03	0.06
	Reliability of saving system	0.03	0.02	0.01	0.02	0.05
	Access of women to economic activities	0.02	0.02	0.00	0.02	0.04
	Scope of alternative economic activities (Yes/No)	0.02	0.01	0.00	0.01	0.00
	Access to financial loan (Yes/No)	0.01	0.01	0.01	0.01	0.03
	Portion of HHs income earned from rest of the country	0.01	0.01	0.00	0.01	0.00
Human resources	Rate of education/literacy	0.02	0.03	0.01	0.03	0.02
	Knowledge on first aid	0.06	0.00	0.02	0.00	0.07
	Knowledge on storm surge risk	0.06	0.02	0.01	0.02	0.02
	Access to nearest district town (Yes/No)	0.03	0.02	0.01	0.03	0.02
	Access to doctor service (No. of doctor/100HHs)	0.00	0.00	0.02	0.00	0.06
	HH Population having training on Surge protection	0.04	0.02	0.01	0.02	0.03
	Active population of HHs	0.03	0.02	0.01	0.01	0.02
	Response to early warning system	0.03	0.01	0.01	0.01	0.02
	Response to adaptation technology	0.02	0.01	0.01	0.01	0.02
	Rate of out migration of HH member	0.00	0.01	0.00	0.01	0.00
Physical Resources	Safe housing infrastructure/condition	0.11	0.04	0.03	0.04	0.09
	Performance of hospital/Health center	0.00	0.00	0.01	0.00	0.04
	Performance of/access to cyclone shelter	0.05	0.03	0.01	0.03	0.04
	Availability of drinking water (safe water)	0.04	0.00	0.01	0.00	0.03
	Sanitation facilities	0.03	0.00	0.01	0.00	0.02
	Access of Radio/TV/Cell phone	0.00	0.02	0.01	0.02	0.04
	Availability of paved road	0.02	0.01	0.00	0.01	0.00
	Transportation facilities	0.06	0.01	0.01	0.02	0.02
	Average area with protection structure	0.00	0.01	0.00	0.01	0.01
	Fitness of protection structure	0.00	0.01	0.01	0.02	0.00
Social resources	Performance of weather forecasting	0.10	0.00	0.03	0.03	0.04
	Community participation practice	0.06	0.02	0.02	0.02	0.07
	Activeness of local GO	0.04	0.05	0.01	0.02	0.04
	Interrelationship with NGOs	0.02	0.02	0.01	0.02	0.03
	Performance social law and regulations	0.00	0.00	0.01	0.01	0.03
	Political influence on social committee (Yes/No)	0.02	0.02	0.00	0.01	0.00
	Performance of local disaster management committee	0.03	0.01	0.01	0.01	0.02
	Activeness of social organization of livelihood groups	0.02	0.02	0.01	0.01	0.01
	Awareness program on protection measure (No/Yes)	0.02	0.02	0.01	0.02	0.05

Annex A

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Annex A

Annex B: List of recorded Conflict and Co-operation events in study are

Recorded water management events related to TRM (Chapter 4)

Situations	Year	Identification of events	Proponents	Opponents
Public protest against largest regulator *Bhabodah* (called a death trap for the locality)	1986	Thousands of people stood up against the operation of this largest regulator (21+9 vents) Public demonstrations, community meeting, protest to District Council (DC) and *Upazilla*, road blockage for expecting a solution of severe waterlogging and huge river system disruption	Local community LGIs sometimes support locals for emergency measures	BWDB and administrative authority (DC, UNO, etc.)
Dohuri embankment cut (near *beel Bhaina*)	1988	Twenty thousand people took part in public demonstration One teacher and one police man were killed and more than hundred people injured Local shrimp-business power group and BWDB took legal steps against 300 community members The victims got relief from false allegation from opponents and harassment after 11 years	Community (farmers, fisher folk, etc.), NGOs, CSOs, and local political activists (leftist group)	Large shrimp business and farm groups, local police, and BWDB
Beel Dakatia embankment cut (informal TRM)	1989-1990	People made embankment cuts in 4 places in *beel Dakatia* One farmer leader who was actively involved in the demonstration against large	Community people, NGOs, Local social and cultural groups, women's federation	BWDB and administrative authority (DC, UNO, etc.)

Situations	Year	Identification of events	Proponents	Opponents
		structural interventions, was killed by unknown person(s) Local people took part in road protest, community meetings, and peaceful gathering for protest Newspapers and local media highlighted the issue		
To protect large structures and save the *Hamkura* River, drained out the logged water and restored the tidal river systems in the KJDRP area	1993 -1997	KJDRP started People protested against poldering and large regulator construction in *Tiabunia* in *Hamkura* catchment Use of alternative water way created conflict between two local, village groups The involved community's water management proposal was ignored at first ADB promised the community to arrange a scientific study to save the river. BWDB was not willing to make one and ignored community initiatives The *Beel Dakatia* WM Association (WMA) was formed to pilot community-based WM organizations in the area	Community people, NGOs (Uttaran, CDP, Pani Committee)	BWDB, LGIs (in some cases) and part of community people (shrimp-business group)
Beel Bhaina TRM (public	1997	Thousands of local people took part in opening *beel*	Community people, NGOs,	BWDB, local administration,

Situations	Year	Identification of events	Proponents	Opponents
cut/ informal TRM)		*Bhaina* BWDB called police to stop them but failed Community people were harassed by police due to legal step of BWDB ADB influenced BWDB to conduct technical, environ-mental, and social studies on TRM	local social associations, Pani Committee, and others	local police
Against large structure (*Kashimpur* regulator)	1999	BWDB again proposed a 22- vent regulator in *Khashimpur* in KJDRP, while locals were trying to get community-based TRM Community people raised their voices and conducted public meetings, also at regional level in *Khulna* ADB and KJDRP representatives took part in a regional meeting with journalists BWDB skipped this large structural intervention, but did not consider TRM in community selected beel	Major groups of stakeholders	N/A
Official TRM in *Beel Kedaria*	2002- 05	Community-based management groups were set up under KJDRP BWDB started official TRM BWDB ignored community perceptions and their experiences	Landowners	BWDB

Situations	Year	Identification of events	Proponents	Opponents
		during TRM Landowners demanded compensation for crops or other production, and BWDB had no option but to comply Landowners arranged to stop TRM by closing *Bhabodah* regulator		
Starting *beel Khuksia* TRM	2006	BWDB initiated official TRM	BWDB, NGOs, and community groups	
Compensation for *beel Khuksia*	2007-08	BWDB proposed compensation for land requisition Compensation mechanism is not easy for marginal people	Landowners, land users	BWDB
Planning and inauguration of *Beel Kapalia* TRM	2012	Local community has controlled access in inauguration meeting BWDB selected participants without informing all community groups People protested against change of location of the cut point due to the position of a famous Hindu Temple in *Kapalia* Number of cars were burned, hundreds of people were injured, police also arrested significant community members	BWDB, administration, part of local community	Part of community: fish farm owners (also business party from outside)
Closing *Beel*	2012-13	BWDB failed to fill in their	Community	BWDB

Situations	Year	Identification of events	Proponents	Opponents
Khuksia		target timeframe for TRM and extra-long time TRM caused serious impact to the society. Community people themselves closed TRM in this beel with financial support from a locally powerful family.		
Further initiatives for opening *Beel Kapalia* TRM	2013	Violence took place near the *Bhabodah* regulator with the issue of sudden embankment cut in *beel Kapalia* at night. There were no early notice from management authority. One part of *beel* community was protesting to start TRM in Feb-March because rice and fish, both productions were still in the beel that year. TRM do not started in *beel Kapalia* yet (2014-2016).	Unknown	Landowners in *Kapalia Beel*
TRM in *Pakhimara beel* in Kobadak river system in Satkhira	2015	Community people and land owners opposed TRM due to the difficulties in compensation process. Community group also protested to save three family graveyards near the link channel.	Management authority	Community land owners specially affected people who permanently lost their land in link channel for TRM, marginal small land owner in the *beel*

Annex- C: Methodology of Data Collection and Synthesis

For this research, I used a mixed-method approach in the field of Delta water management in Bangladesh. Both qualitative and quantitative data were collected and used for exploring multi-stakeholder processes and evaluating social learning in the delta management transition and practicing of Tidal River Management (TRM) in an ever dynamic coastal deltas.

Selection of Study Areas and Mapping

Following the history of coastal water management in Bangladeshi Delta I decided to select two study areas for my PhD thesis to define the transition of water management in a rural delta and also highlighted the waterlogging issue as a current devastating hazard for coastal livelihood and living. Therefore, I selected the South-West districts of *Khulna*, *Jessore*, and *Satkhira* in the *Khulna* Division (see Figure 1.3 in chapter 1) in which areas waterlogging became severe since last three decades and peoples are trying to adapt their indigenous knowledge in parallel to hard core hydraulic engineering management. The evolution of TRM in this area is the result of the severity of the waterlogging.
The study areas were selected considering the following representative criteria:

- The area should be included in Coastal management projects
- The area should have remarkable vulnerabilities on flooding or specific type of flooding (waterlogging)
- The area should have consist completed or ongoing TRM practices for removing waterlogging

So this study investigated TRM cases in two larger coastal water management projects in two different river systems in the South-West Bangladesh.

Table 1: Selected study areas

Coastal water manageme nt project	River catchment	District	Selected Thana	TRM cases	Name of Selected Union	No. of villages selected
KJDRP*	*Hari-Mukteshawri* River	*Jessore*	*Keshobpur & Monirampur*	*Bhaina, Khuksia, Kedaria, Kapalia*	*Gourighona, Supholakati, Monoharpur& Nehalpur*	12
	Hamkura River	*Khulna*	*Dumuria*	*Dakatia*	*Rudaghara & Dhamalia*	4
Kobadak River Restoration project	*Kobadak* river	*Satkhira*	*Tala*	*Pakhimara*	*Jalalpur & Khesra*	8

**KhulnaJessore* Drainage Rehabilitation Project

The case of *Pakhimara* TRM did not used in major analysis because it is an ongoing project and all physical changes were not shown yet. However, in conflict study I used this as case.

For my study, I developed project maps collected data from secondary sources like CEGIS, IWM and BWDB. A base map of the study areas (see Figure 1.2) was taken from KJDRP project reports prepared by CEGIS (2007 and 2014). However I prepared study map for social study (see Figure 2.5) in KJDRP area including selective TRM *beels* by using ArcMap software.

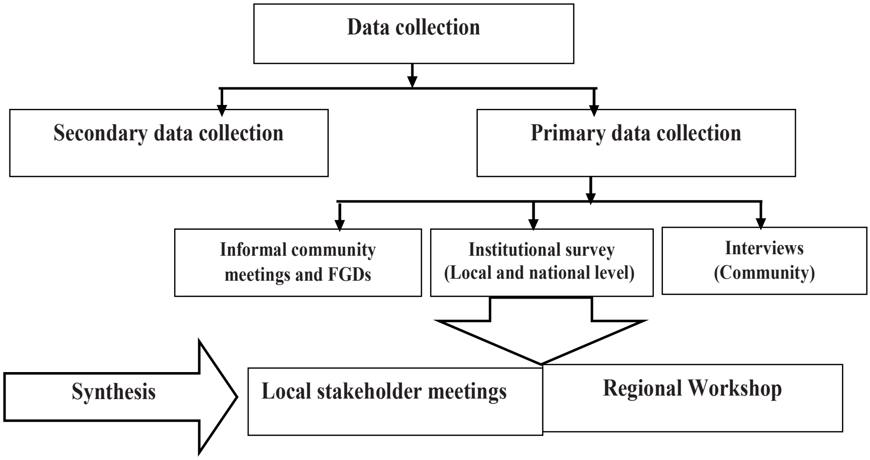
Literature review and secondary data collection

Preliminary study and literature reviews helped articulate the research background and develop the hypothesis and conceptual framework. I reviewed published scientific research: journal articles, working papers and academic papers, and books written on water resources, delta management systems, transition, multi-stakeholder process, learning and social learning. Library in Wageningen University and Research was the main sources of scientific documents in my research. I also reviewed the history of delta water management in the Netherlands and Bangladesh. I used secondary sources of information like the Center for Environmental and Geographic Information Services (CEGIS), the Institute of Water Modelling (IWM), Bangladesh Water Development Board (BWDB), and the Institute of Water and Flood management (IWFM). Demographic and other required information was found from the Bangladesh Bureau of Statistics (BBS), National Water Resource Database (NWRD), PDO-Integrated Coastal Zone Management office (WARPO), Asian Development Bank, Bangladesh University of Engineering and Technology (BUET), some local NGOs, and relevant websites.

Secondary data regarding bio-physical changes, capacity of previous interventions, function of polders and history of TRM planning, hydro-morphological data, land use and relevant images and physical model data (river flow, cross-section, rate of sedimentation) were from published reports and research findings in KJDRP project studies conducted by government and non-government organizations as also from research institutes like BWDB, CEGIS, IWM and UTTARAN. I have collected special event and incidence information relevant to TRM and other water issues with support of local and national newspapers, leaflets and some writings from local persons' knowledge.

Field investigation and primary data collection

The field study followed principles of Rapid Water Management Appraisal (RWMA) (Wester and Bron, 1996), which is an adaptation of Participatory Rural Appraisal (PRA) techniques [http://www.fao.org/docrep/006/w2352e/W2352E03.htm]. I used formal and informal participatory tools in the study areas during the field investigation from 2012 to 2016. The major data were collected using field investigation methods defined below.

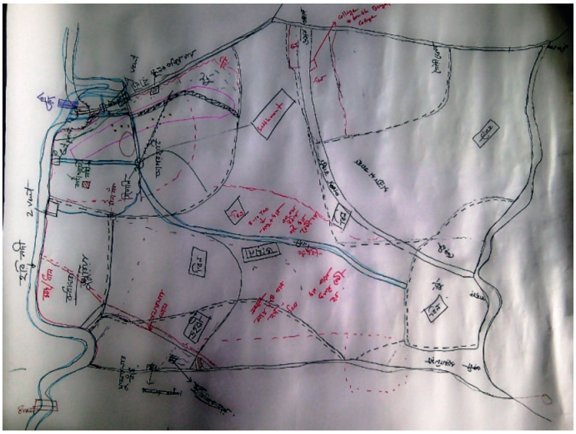


Informal Community Meetings

In first year of my PhD research, I had conducted several informal community meetings (I did not count because those were random) in public places (tea stalls, village markets, *beel* areas, boat stations etc.*)* in the study area for sharing local knowledge and understanding views of the local community to the previous and current flooding and waterlogging and water management initiatives in their locality. My research assistants and me took notes and in some cases recorded the open discussion of community members. Generally we conducted those meeting in the presence of 6-15 people from different livelihood groups but not necessarily involved with TRM.

Focus Group Discussions

Total 15 Focus Group Discussions (FGDs) were conducted with local farmers, fisher folk, landless peoples groups who were directly connected or affected (positively or negatively) as well as business groups, and others. About 10-12 persons took part in each FGD. Elderly people were encouraged to talk about the history of water management in their areas including traditional and current practices. We prepared historical timeline (Figure 2.4 in chapter 2) of water management transitions in this area based on collective community inputs in those meetings. Participants drew *beel* resource maps (4 in KJDRP and 1 in *Kobadak* project) for making our clear ideas on location and distribution of the existing tidal basins.

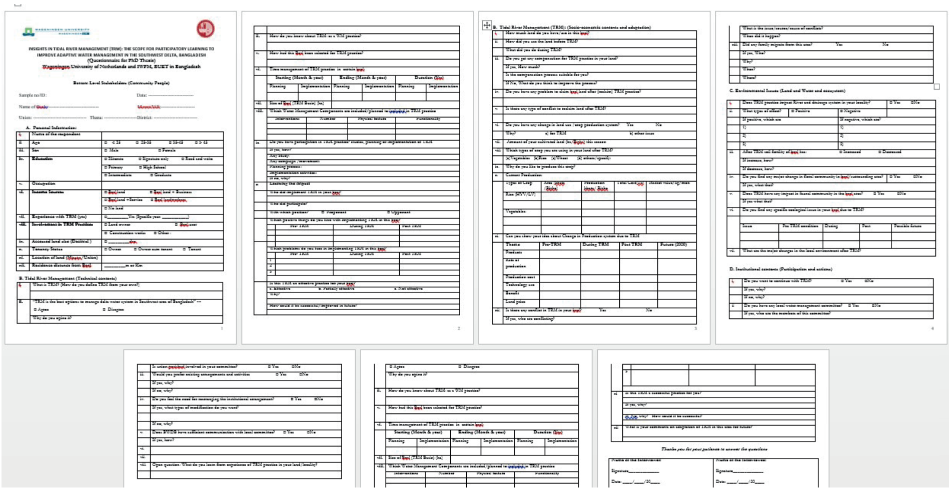


Resources: Mapping in Beel Bhaina

<u>Interviews:</u>

In my total research period I and my two research assistants interviewed 210 community members with household unit in selective villages in the surrounding of TRM *beels*. At first we designed the interviews based on focused indicators discussed in order to collect useful data. The questionnaire included bellow issues:

- General information , knowledge and involvement to TRMs
- Environmental and social contexts of TRM
- Income, production and livelihoods access
- Institutional experiences or Interactions with other stakeholders



Questionnaire for community interviews

The sampling of the community interviews was very random in selected villages in the study area concerning the land ownership and access to the TRM *beels*. My research assistants and me filled-up the questionnaire according to the respondents' answers.

Community interview near beel Bhaina

Community interview in beel Khuksia

In addition, there were open questions for social learning evaluation which were used in organizational investigation in officials and people work with relevant issue in different government and non-government organizations in regional and national level (see Section 3.4 and 5.4 in this thesis).

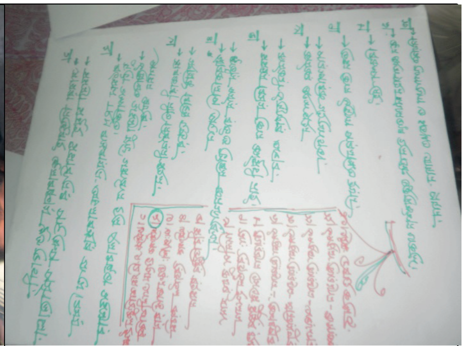
Local Stakeholder Meetings

I organized three (3) large local Stakeholder Meetings (LSM) in three important *union* (bottom level administrative unit) focusing on knowledge sharing and collective assessment of social learning in practices. Community representatives, civil society correspondents, school and college teachers, students, and local BWDB officials took part in those meeting. I found 28-35 participants in each LSM who were invited for group work to assess and clarify our field findings from individual surveys.

Table 2: Schedule of local stakeholder meetings

Location of meeting	Date	Relevant *beels*	Participants
Nehalpur Union *Parishad, Monirampur*	28/05/2015	*Kapalia* and *Kedaria*	28
Agorhati primary school, *Gourighona, Keshobpur*	03/06/2015	*Bhaina*	35
Supholakati Union *parisad* auditorium	09/06/2015	*Khuksia*	30

The participants opined and discussed about the sensitive social network in delta water management, their knowledge on the changing land water system with TRM practices, the adaptation capacity and its potential in future delta water management systems. I used the transcripts of those meetings taken by the RAs in synthesizing participation processes, institutional impacts and conflict dynamics in my thesis.

	
Local Stakeholder Meeting in *Agorhati* Primary school	Output of LSM in Suphalakati UP auditorium (in Bengali)

<u>Institutional Survey</u>

I have conducted about 20 institutional surveys among local, regional and national level organization. I also talked with seven professionals from decision making groups. I have visited Union *parishad*, *Upazila* agriculture, fisheries, land survey and social welfare offices. I talked with engineers and professionals in BWDB, ministry of water resources, WARPO, CEGIS, IWM, and IWFM-BUET. I transcribed their points of discussion, their opinions and suggestions. I tried to explore their knowledge and learning to the effectiveness and sustainability of participatory process with TRM. I also invited the participants in my research workshops for a collective evaluation of learning and participation in a multi-stakeholder platform.

Institutional survey in Government Office

Synthesis and Data analysis

Regional Workshop

Regional research workshop was planned for integration of communal, inter-disciplinary and inter-organizational (Bos et al, 2013) learning on TRM practices and facilitating the further improvement of water management systems in Bangladesh delta. After intensive field investigation in the study areas since 2012 to 2015, a regional workshop was hold in the conference room in a NGO *Banchte shekha* in *Jessore* in February 7, 2016.

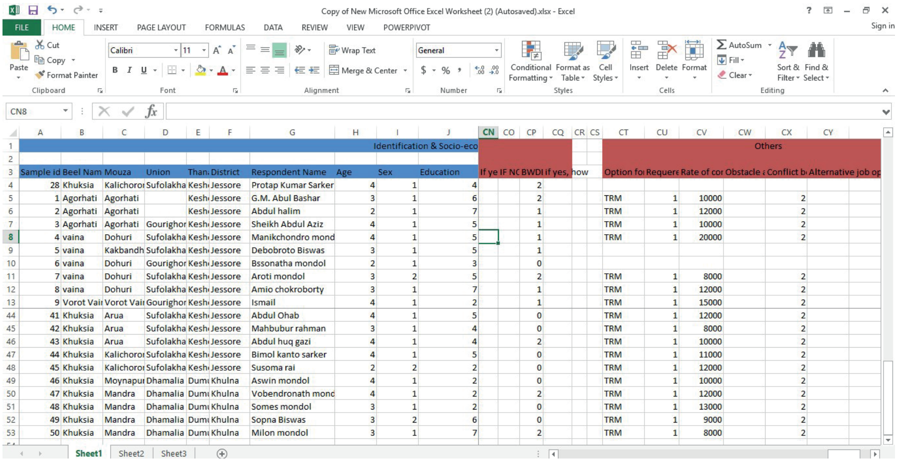
Active participation in workshop

Learning evaluation by participants

The goal of this workshop was to disseminate the collected information with different stakeholder groups. Preliminary field results were presented by me. My co-promotor Dr. Jeroen F. Warner and Prof. M. Shah Alam Khan gave brief speeches on community capacity and multi-stakeholder participation research in Netherlands and Bangladesh. To fulfill the objective of my research I and my RAs divided the participants in five different groups where 10 participants of similar level of stakeholders were included in each group. We provided two pages written exercise to different groups of stakeholder for collective evaluation of social learning in the TRM practices from their knowledge and experiences. After one and half hour paper exercise, representatives from each groups presented their learning findings. Prof. Khan facilitated a plenary for discussing and synthesizing the participatory learning in the stakeholder networks.

Data analysis

Interpretation of qualitative and quantitative data were contrasted and compared through triangulation (Yin, 2009) of field notes, interview results and transcript of individual and participatory meetings. In the analysis phase, at first I made contextual data sheets: physical data, institutional and participation process data, socio-economic data, conflict data and learning data in Micro-soft Excel.



	A	B	C	D	E	F	G	H	I	J	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY
1										Identification & Socio-eco										Others		
2																						
3	Sample id	Beel Nam	Mouza	Union	Than	District	Respondent Name	Age	Sex	Education	If ye	IF NC	BWDI	if yes, how			Option fo	Requere	Rate of co	Obstacle a	Conflict b	Alternative job op
4	28	Khuksia	Kalichorol	Sufolakha	Kesh	Jessore	Protap Kumar Sarker	4	1	4			2									
5	1	Agorhati	Agorhati		Kesh	Jessore	G.M. Abul Bashar	3	1	6			2				TRM	1	10000		2	
6	2	Agorhati	Agorhati		Kesh	Jessore	Abdul halim	2	1	7			1				TRM	1	12000		2	
7	3	Agorhati	Agorhati	Gourighor	Kesh	Jessore	Sheikh Abdul Aziz	4	1	5			1				TRM	1	10000		2	
8	4	vaina	Dohuri	Sufolakha	Kesh	Jessore	Manikchondro mond	4	1	5			1				TRM	1	20000		2	
9	5	vaina	Kakbandh	Sufolakha	Kesh	Jessore	Debobroto Biswas	3	1	5			1									
10	6	vaina	Dohuri	Gourighor	Kesh	Jessore	Bssonatha mondol	2	1	3			0									
11	7	vaina	Dohuri	Sufolakha	Kesh	Jessore	Aroti mondol	3	2	5			2				TRM	1	8000		2	
12	8	vaina	Dohuri	Sufolakha	Kesh	Jessore	Amio chokroborty	3	1	7			1				TRM	1	12000		2	
13	9	Vorot Vai	Vorot Vai	Gourighor	Kesh	Jessore	Ismail	4	1	2			1				TRM	1	15000		2	
44	41	Khuksia	Arua	Sufolakha	Kesh	Jessore	Abdul Ohab	4	1	5			0				TRM	1	12000		2	
45	42	Khuksia	Arua	Sufolakha	Kesh	Jessore	Mahbubur rahman	3	1	4			0				TRM	1	8000		2	
46	43	Khuksia	Arua	Sufolakha	Kesh	Jessore	Abdul huq gazi	4	1	4			2				TRM	1	10000		2	
47	44	Khuksia	Kalichorol	Sufolakha	Kesh	Jessore	Bimol kanto sarker	4	1	5			0				TRM	1	11000		2	
48	45	Khuksia	Kalichorol	Sufolakha	Kesh	Jessore	Susoma rai	2	2	2			0				TRM	1	12000		2	
49	46	Khuksia	Moynapur	Dhamalia	Dumu	Khulna	Aswin mondol	4	1	2			0				TRM	1	10000		2	
50	47	Khuksia	Mandra	Dhamalia	Dumu	Khulna	Vobendronath mond	4	1	2			2				TRM	1	12000		2	
51	48	Khuksia	Mandra	Dhamalia	Dumu	Khulna	Somes mondol	3	1	2			0				TRM	1	13000		2	
52	49	Khuksia	Mandra	Dhamalia	Dumu	Khulna	Sopna Biswas	3	2	6			0				TRM	1	9000		2	
53	50	Khuksia	Mandra	Dhamalia	Dumu	Khulna	Milon mondol	3	1	7			2				TRM	1	8000		2	

Using those data sheet, we prepared graphs, tables and maps which are represented in my thesis chapters as required. In the specific model analysis like TWINS nexus, we used data and information which was transcribed in LSMs and workshop. The learning outcomes were synthesized based on stakeholders' responses and collective assessment in workshop. I have shown the learning summary and participatory recommendations for multi-stakeholder partnerships specifically in the findings section of chapter 3 and chapter 5.

ACKNOWLEDGMENTS

Bangladesh, by default, is one of the most disaster hit delta countries of the world. The hurting memories of destruction of the cyclone *Aila* in 2009 (25 May) has drawn my attention to work with people living in the coastal area in Bangladesh. Fortunately, or unfortunately, I had to have a close look at the delta peoples' endless sufferings at that time due to working in the affected area to complete my research for M. Sc. thesis. Then I had decided to work with the natural resources management in the coastal area of Bangladesh for my PhD. I was determined to conduct interdisciplinary learning research with the development of coastal livelihood systems, climate change adaptation and environmental management for better living of the coastal people.

For this important issue, I have tried to turn this work into one that explores and provides learning the people's participation in the regional management of flooding in Bangladesh delta where participatory learning is not effective successfully in delta management yet. The idea of doing a PhD thesis on Tidal River Management (TRM) came up when I started working with "Centre for Environmental and Geographic Information Services (CEGIS) (*A Public Trust under the Ministry of Water Resources, Bangladesh*)", a leading research organization and Center of excellence in integrated natural resources management studies in Bangladesh since 2009. Working with various government water resources management projects of Bangladesh Water Development Board and the Government's Water Resources Ministry in the coastal area specially south-west area of Bangladesh, I had decided to conduct learning research for proper understanding of the problems and prospects in delta management in the rural area and focused to the TRM practices in the Southwest area in Bangladeshi Delta.

I would never have started this journey if Dr. Flip Wester wouldn't have had enough trust in me as a potential PhD candidate in the Dynamic Deltas project. Flip, thank you for being my co-promotor and supporting me throughout. I am also ever grateful to Dr. Jeroen F. Warner to be my regular supervisor and co-promotor as a little later but has been joined the supervision team from first day. It has been a true honor that Professor Arjen Wals has stood by me as my promotor even after one year working with other promotor. I am grateful for his ability and willingness to openly think along with me, always constructive, helpful and inspiring in working with social learning in a rural society. Thank you Arjen for your enthusiasm and pushing me beyond what I thought to be my capabilities. Special thanks to

Mrs. Wals who encouraged me and tried to make me happy for some moments when I was passing my lonely time in Wageningen leaving my seven months old twin babies.

Deltas are dynamic in nature. Similarly my entire journey of PhD to Bangladesh Delta is effervescent and most exciting period in my life because my PhD thesis and my Twins were growing parallel in last three years. I am so proud of my three babies: my son, my daughter and my thesis.

Since I started my PhD, I found the journey not to be so smooth. It would never have been accomplished without the support and cooperation of different people and organizations, at different levels. I think a word of advice, an encouragement, provision of information, material or time, all manner of contributions were means, however small or unquantifiable, was a means by which I successfully completed this work. I am therefore greatly indebted to all those that I came in contact with during my period of study, too many to mention by name. Specifically, I am particularly grateful to people of the Institute of Water and Flood Management in Bangladesh University of Engineering and Technology and CEGIS in Dhaka, Bangladesh. I want to say a very big thanks to Dr. Hamidul Haq who introduced me with the project "Dynamic Deltas". I am also thankful to Prof. Anisul Haque who encouraged me a lot to work in the coastal delta in Bangladesh. Most especially I am really grateful to Prof. Shah Alam Khan who was my local advisor and project coordinator in Dynamic Deltas. Thank you Prof. Khan for your guidance, support and co-authorship in my articles.

I am grateful to the people in Irrigation and Water Engineering, now Water Resources Management group of Wageningen University for their support and care to me. I thank Linden Vincent for her comments and suggestions in designing my research in first year of this PhD journey. I have thoroughly enjoyed my time working at this group at 2012. Thank you Harm Boesveld, Alex Bolding, Petra Hellegers, Deepa Joshi. Special thanks to Bert Bruins, Gerda de Fauw and Maria Pierce for their co-operation and assistance in my PhD journey. I also want to say thanks to the Education and Competence Studies group and Disaster Studies group of Wageningen University for allowing me to use office space in *Leeuwenborch*. Special thanks to Nicolette Tauecchio for her kind co-operation and support in the final stage of my thesis.

I am obligated to the entire Dynamic Deltas team and of course NWO/WOTRO for making it possible for this PhD journey. To my colleagues with deltaic PhD strugglers- Farhana Ahmed, Arjen Zegwaard and Martijn van Staveren: I want to thank all of you for your companionship and knowledge sharing. Special gratitude to Arjen for giving me company to travel to hospital for TBC checking and also to collect residence permit during my first days in Wageningen. Thanks to Martijn and Milagros for their friendship and support during living in Wageningen. Thank you all so much for all the interesting meetings, discussions and field trips in Bangladesh and Netherlands. Jeroen, thank you for the many inspiring get-togethers we've had and thanks for your music in your place in the Deventer. Also grateful to you for translating my thesis summary in Dutch. It was very interesting, supporting and great experience to have MSc thesis students Leendert de Die, Jan van Minnen join and Rik Heinen in our journey in Bangladesh delta. Thanks a lot to Mr. Aminul Haque, Mr. Mynul Hasan and Mr. Anjan Bhattacharjee for their assistantship in the field investigation and to the transcription of interviews. Thanks to Mr. Rifat for helping me to prepare field map. Thanks to Mr. Rasel for his careful and efficient car driving during my field investigation.

I would like to acknowledge the Local Government Authorities of *Keshobpur* and *Monirampur* upazila in the *Jessore* district in Bangladesh for organizing stakeholder meetings and providing field information. Special thanks to local NGOs: *Uttaran* and *Bachte Shekha* for their cordial help in conducting this research. The research in Bangladesh delta rural areas would not have been possible if not for the help of local communities in the TRM area. We are especially grateful to local groups of stakeholders like farmers, fisher folks and other livelihood groups who have allowed me to go around and spared me a lot of time, sharing their knowledge and showing me what they do. The moments of sitting and talking with people working in the *beel*s have been most enriching and enjoyable. We are also thankful to the Bangladesh Water Development Board, Institute of Water Modeling and Water Resource Planning Organization in Dhaka, Bangladesh for providing secondary data and their co-operation in field research.

Over the last three years, my concern to my family has become more flexible due to more involvement in PhD thesis preparation in Bangladesh and in Netherlands, thanks to the people who were supporting my family specially my new born twin babies at that time. Heartiest gratitude to my Mother, my parents-in-law and my youngest sister Runi for their total care for my babies that made me more dedicated to complete the thesis. Thanks to all my brothers and sisters, my nephews and nieces for always being around when needed.

My final thanks to my dearest husband, Dr. Syed Emdadul Haque and my babies Ehan and Maheen, for standing by my side in any hardship.

About the Author

Mahmuda Mutahara was born on October 12, 1982 in the District of Satkhira in Bangladesh. She passed her primary and secondary education in her home town. She completed her BSc in Environmental Science in Khulna University, Bangladesh. She obtained her MSc degree in Water Resource Development from Institute of Water and Flood Management in Bangladesh University of Engineering and Technology, Dhaka. She started her professional life in Khulna University as a contract teacher in Environmental Science on 2008. She did join to the Centre for Environmental and Geographic Information Services (CEGIS) (*A Public Trust under the Ministry of Water Resources, Bangladesh*)", a leading research organization and Center of excellence in integrated natural resources management studies in Bangladesh on September, 2009. During her academic and professional career, she worked in livelihoods and environmental impacts and social welfare in the coastal delta in Bangladesh. As a PhD fellow, Mahmuda Mutahara became a part of Dynamic Deltas project in collaboration with Wageningen University of Netherlands and Institute of Water and Flood Management in Bangladesh University of Engineering and Technology, Dhaka on March, 2012. In her PhD research she has explored the applied field of multi-stakeholder processes and social learning in delta management in a most climate vulnerable rural coastal area in Bangladesh. She is now involved as the Chief Executive Officer in the Bridge of Community Development Foundation, a non-government research and development organization, in Dhaka, Bangladesh since March 2017.

Mahmuda Mutahara
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research Approach in Land and Water Management, IWE 32306	WURWRM, WUR: IWE32306	2012	6
Practical (in Spain) on Sustainable land water management, IWE 33306	WUR	2012	6
Delta lesson seminar	BUET & WUR	2012, 2013, 2014, 2016	4
Dynamic delta project workshop and stakeholder meeting	BUET & WUR	2016	1
PhD discussion group	ECS and WRM, WUR	2012-2016	2
B) General research related competences			
Disaster-proof Planning and Preparedness in flood management, ESS 52306	WUR	2013	6
Introduction course	WASS	2015	1
'Livelihood system and challenge of living in the coast: a case study in the south-west coastal area of Bangladesh'	4th International Conference on Water and Flood Management in Dhaka, Bangladesh	2013	1
'Understanding the Water management Systems in the Southwest Delta of Bangladesh: Learning from the practicing Tidal River Management'	5th International Conference on Water and Flood Management in Dhaka, Bangladesh	2015	1
'Tidal River Management: Learning from the Water Management Practices in Bangladesh Delta'	7th International Sustainability Transitions Conference 6th – 9th September 2016, Wuppertal, Germany	2016	1
'Designing multi-stakeholder partnerships with (re)framing social learning for sustainable delta water management in Bangladesh,'	6th International Conference on Water and Flood Management in Dhaka, Bangladesh	2017	1
C) Career related competences/personal development			
Facilitating Multi Stakeholder Partnerships and Social Learning	CDI, WUR	2015	4
Training (1 day) and workshop (2 days) on comparative analysis at 2012	W. Olsen and WRM, WUR	2012	1
Total			**35**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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