An Investigation into the Adequacy of Existing and Alternative Property Rights Regimes to Achieve Sustainable Management of the Sundarbans Mangrove Forest in Bangladesh

A Dissertation submitted for the award of

Doctor of Philosophy

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Dedicated
to
The Lotus Feet of
Param Doyal
Sri Sri Thakur Anukulchandra

Abstract

This thesis identifies theoretical gaps regarding the adequacy of property rights in achieving sustainable management in the world's largest Sundarbans Mangrove Forest (SMF) in Bangladesh. This will be achieved through an examination of existing and alternative property rights regimes. Gaps are also pinpointed regarding non-compliance with existing policy in conservation practices and the absence of clear quantitative and qualitative methodical approaches for identifying sustained conservation determinants of the forest.

This research aims to fill these gaps by addressing the questions of the adequacy of the existing property rights regime to achieve sustainability. It examines the interaction between property rights and conservation and the necessity for an alternative property rights regime of co-management. It focuses on state property rights regimes within mangrove conservation practices. The subject of this thesis is regarded as one of the oldest mangrove management systems in history, originating in 1875.

The thesis adopts a mixed methods research approach involving household survey, content analysis and focus group discussions. Multiple actors, scales and techniques—with a focus on Forest Dependent Communities (FDCs) and conservation practices by the Bangladesh Forest Department (BFD)—are involved in the study. This study considers FDC households as a unit of analysis. Field work was conducted in six villages of the Koyra sub-district and various government offices over a period of four months between November 2010 and February 2011. The field research moves from the household level to the national, division, district, sub-district and international levels. It undertakes a combination of process analysis to establish how mangrove forest conservation is enhanced, the role of FDCs in conservation and why policy fails to advance sustained conservation.

Following a review of descriptive statistics, logit model and content analysis, the study finds the state property regime to be inadequate due to the specific and changing socio-cultural, economic, political and ecological contexts of the SMF and its FDCs. Currently, there is a high prevalence of institutionalised corruption and elite dominance. Existing regime embeddedness obstructs FDCs in their attempt to play a role in management and policy-making processes.

Without understanding the emergence of the common property regime, FDCs' positive motivation and collective action cannot be incorporated into sustained conservation policy directives. Along with supply-side property rights interventions in line with Schlager and Ostrom's (1992) theory, this study justifies some key demand-side interventions to achieve sustainable management. This is expected to overcome state property-related hurdles in achieving sustainability of the SMF. Thereby, it highlights property rights embeddedness to improve FDCs' socio-economic context through a 'co-management-alternative livelihood mix'.

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After all your efforts and blessings, I am the only one who is receiving this degree. I promise I will make all efforts to put it to good use.

Heart-felt thanks to all.

Anjan Kumer Dev Roy
Monday, this 5th day of November 2012

Certification of Dissertation

This is to certify that the ideas, analyses, results and conclusions contained in this dissertation are entirely my own effort, except where otherwise acknowledged. It is also certified that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

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Signature of Candidate Date
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Endorsement

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Signature of Principal Supervisor Date
Dr. Khorshed Alam

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Signature of Associate Supervisor Date
Professor Jeff Gow

Acronyms and Abbreviations

ADP	Annual Development Programme
BBS	Bangladesh Bureau of Statistics
BFRI	Bangladesh Forest Research Institute
BIWTA	Bangladesh Inland Water Transport Authority
CBD	Convention on Biological Diversity
FAO	Food and Agriculture Organisation
FD	Forest Department
FDCs	Forest-Dependent Communities
BFD	Bangladesh Forest Department
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GLM	Generalised Linear Model
IFRI	International Forestry Resources and Institutions
IPAC	Integrated Protected Area Co-management
IPCC	Intergovernmental Panel on Climate Change
IS	Interview Schedule
ITTO	International Tropical Timber Organisation
IUCN	International Union for the Conservation of Nature and Natural Resources
LL	Log-likelihood
MOEF	Ministry of Environment and Forests
NFP	National Forest Policy
NSDC	Non-Sundarban Dependent Communities
NGOs	Non-Government Organisations
OLS	Ordinary Least Square
PIC	Project Implementation Committee
PRA	Participatory Rural Appraisal
PSC	Project Steering Committee
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SAARC	South Asian Association for Regional Cooperation
SDC	Sundarban Dependent Communities
SFO	Sundarban Forest Office

SIZ	Sundarban Impact Zone
SLR	Sea Level Rise
SMF	Sundarbans Mangrove Forest
S&O	Schlager and Ostrom
Sq. km	Square Kilometre
TA	Technical Assistance
Tg	Teragrams
TIB	Transparency International Bangladesh
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VIF	Variance Inflation Factor
WAPDA	Water and Power Development Authority

Glossary of Bengali Words

Aila and Sidr	Names of two devastating cyclones in the Bay of Bengal which caused huge damages to the SMF and its FDCs.
Aratdar	Wholesaler, commission agent and main provider of credit to the FDCs.
Bada	Local name of the SMF.
Bankar-Jalkar-Moukar	Tax imposed on timber, fisheries and honey-beeswax harvesting respectively from the SMF.
Bawalis	Local FDCs making livelihoods by cutting trees and *Gol* leaves from the SMF (also called *Bawals*).
Char	Shoal or sandbar (newly-emerged land in a river or sea channel).
Chira-Muri-Pitha	Local snacks used in rural villages for refreshments.
Dadon	Traditional local loan system as part of interlocked credit-marketing transactions in which the borrower has to sell harvested products to/through the loan provider at a discounted price.
Dadondar	Dadon loan provider who traditionally acts as moneylender cum trader because of providing these loans.
Gol	Type of leaves commonly harvested from the SMF, and mainly used for building roofs on local houses.
Jama	Amount of money fixed by the Government for reclamation.
Jele	Dominant local FDCs who harvest fish and crabs from the SMF.
Khas Mahall	Government-owned unallocated land (also called *Khas* land).
Mahajan	Traditional local money lender and powerful intermediary in the product value chain.

Mawalis	Local FDCs who harvest honey and beeswax from the SMF (also called *Mawals*).
Pashur-Goran-Gewa -Keora-Kankra	Dominant tree species of the SMF.
Sal	Main species of Tangail-Mymensingh-Dhaka protected forest (scientific name is *shorea robusta*).
Sundari	The main tree species from which the name ‘Sundarbans’ originated.
Union Parishad	Lowest level tier of Government.
Upazila	Lowest bureaucratic/administrative and second lowest Government tier (formerly known as Thana).
Zamindary	Previous ruling system of a particular area in lieu of offering revenue to the British Government.

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Chapter 1

Introduction

1.1 Introduction

Forests provide direct and indirect use and non-use benefits. Access to forest resources is an important source of livelihood and income generation for rural people (Babulo et al. 2008; Fisher 2004; Mamo et al. 2007; Vedeld et al. 2007). According to the World Bank (WB 2004), more than 1.6 billion people globally depend on forests to varying degrees for their livelihood. Around 60 million indigenous people rely almost fully on forests; and some 350 million people living in and around forests are highly forest-dependent for their income. The world's coastal zones are home to over 60 per cent of the global population. Coastal communities and indigenous people heavily depend on a range of products and services of mangrove forests in coastal ecosystems (Adhikari et al. 2010). This high anthropogenic dependence has resulted in at least 35 per cent global mangrove forest loss in the last two decades and this has exceeded losses for two other threatened environments: tropical rain forests and coral reefs (Valiela et al. 2001). Recently, Duke et al. (2007) and Giri et al. (2007) confirmed the rapid and alarming decrease in mangrove areas globally.

Conversion of forest land to non-forest use, along with forest degradation, is a price of human settlement (Maraseni 2007). According to the Food and Agriculture Organisation (FAO) (2010) of the United Nations, total global forest land is equivalent to 30 per cent of the earth and is being reduced by a factor of 200 square kilometres (sq. km) per day. Such conversion takes the form of deforestation and degradation, and has two adverse effects. First, it increasingly threatens the livelihoods of 1.6 billion forest-dependent people of the world (Plieninger 2009). Second, the reduction of forests is causing atmospheric concentration of carbon dioxide (Eckersley 1995; Kirschbaum 2003; MOEF 2005a; Prasad 1997; Quazi et al. 2008; Randall 1993; UNFCCC 1997). Thus, many developing countries are adopting

national forest conservation policies to secure the livelihoods of forest people and to try to achieve sustainable forest management. Hence, conservation policies are adopted through conservation practices defined as specific, science-based guidelines for conservation of rare species during forest resource harvesting (MDFW 2009).

By transmitting Brundtland's (1987) definition of sustainable development into sustainable forest management, although the ultimate objective of sustainable forest management is to meet the needs of forest-dependent communities (FDCs) without compromising the ability of future generations to meet their own needs, continuous tropical forest destruction poses a challenge in achieving such sustainability (Laurance 2007). Deforestation rates are severe in tropical parts of Asia and the Pacific with a reduction of 1.1 per cent/year in comparison with south and central America; and in Africa where the rate is estimated as 0.7 per cent/year (Dupuy et al. 1999). Although only 7 per cent of the world's total land is covered by tropical forests, they contain 50 per cent of all living species (Dupuy et al. 1999). Tropical forests are valued as the main source of FDCs' livelihoods through the generation of direct economic benefits and as the provider of many intangible benefits to society (Mahapatra & Kant 2005).

Historically, Asian forests are extremely rich in terms of tropical rain forests and biodiversity. Asian tropical forests, including biodiversity hotspots, are being destroyed at an alarming rate (Laurance 1999, 2007). The World Bank identified overharvesting of forest products by local FDCs as one of the major reasons for the loss of forest cover (WB 1993). Conventional forest management is based mainly on wood production with an application of numerous silviculture techniques and approaches (Biswas & Choudhury 2007). However, to achieve sustainability, forest management must include economic and human dimensions and go beyond just focusing on mere wood production.

Against this conventional forest management history, sustainable management has become a process of managing forest land to achieve selected objectives without undue reduction of its inherent values and future productivity with undesirable consequences on economics, society and the environment (ITTO 1992). To achieve these goals, forest policies have shifted from traditional harvesting of certain specific products, mainly wood, to the promotion of forest management for a continuous flow

of multiple benefits (Malla 2000). In the last decades, sustainable forest management has gained strong policy support from policy-makers and received unprecedented focus from scientists and researchers (Diaz-Balteiro & Romero 2004; Dupuy et al. 1999; Pearce et al. 2003). Hence, sustainable development of forests is defined as a "process that consists of maintaining indefinitely, and without unacceptable deterioration, the capacity for production and renewal, as well as the ecological variety of forest ecosystems" (Dulbecco & Yelkouni 2007, p. 1044). The ecological focus of this definition contrasts with the wider definition of Islam and Siwar (2010) which implies the sustainable utilisation of forest resources for the benefit of communities and states. This latter concept aims to maintain the value of forest resources by creating benefits through employment and income for the populations and states concerned.

However, the main objective of sustainable forest management is to enhance the natural forest by increasing the adoption of sustainable forest management practices on the part of forest managers and policy makers for the welfare of its dependent communities (Islam & Siwar 2010). This objective has not been realised in many tropical forests because of the lack of partnership between multiple actors (Ros-Tonen et al. 2008). This failure cannot be overcome without creating an institutional context for good forest governance, including mandating local community involvement (Andersson & Agrawal 2011). Following Ros-Tonen et al. (2008), national conservation policy becomes problematic when it avoids the concept of sustainable forest management in overlooking partnerships with indigenous and traditional forest users.

Because of these policy and management problems, the problem of forest clearing has become increasingly severe in developing countries (Panta et al. 2008). This is especially true for Bangladesh. According to the Ministry of Environment and Forests (MOEF) (MOEF 2005b), forests cover 17 per cent of the total land area of Bangladesh. However, Manna and Hasan (2009) question this figure and estimate the area to be only 7.7 per cent. They also predict the possible reduction of forest cover to 5 per cent of total land area within a few years due to massive deforestation, especially through illegal felling. The forest sector contributes 5 per cent to Gross Domestic Product (GDP) and generates 2 per cent of total employment of

Bangladesh (MOEF 2005c). Transparency International recorded the Bangladeshi forest sector's contribution to GDP as 1.52 per cent in 2006-07 (Manzoor-E-Khoda 2008). However, the FAO estimates this sector's contribution to GDP at only 1.7 per cent and as contributing insignificantly (0 per cent) to the total labour force (FAO 2011).

Bangladesh has 3 per cent of the global mangrove share—mainly via the world's largest mangrove forest, the Sundarbans Mangrove Forest (SMF). This forest is now facing high anthropogenic pressure to provide livelihoods for 3.5 million local forest-dependent people living in its surrounding villages. Except for three buffer zone areas with strict protection, a large number of areas are protected via conservation policy. Therefore, this mangrove forest is in need of special attention for sustainable conservation under protected area management of the BFD.

This chapter includes eight sections. Section 1.2 provides a short brief of the country's protected forest area management systems. Section 1.3 outlines the research problem that frames the central research objectives and questions in Section 1.4. A short synopsis of the research design and methodology is outlined in Section 1.5. Sections 1.6 and 1.7 present the scope and organisation of the research respectively. The chapter concludes with Section 1.8.

1.2 Protected Area Management in Bangladesh

Due to continuous deforestation and degradation, Bangladeshi policy-makers have sought to manage and protect forests through forest departments (FDs). The history of protected area management in Bangladesh dates back to 1875. In its early days, the aim of protected area management was to ensure secured resource extraction. Colonial British rulers transformed the indigenous decentralised forest management systems into a centralised system by consolidating forest administration through the creation of a forest bureaucracy, the Forestry Department, in 1865 (Kumar & Kant 2005). After independence in 1971, the newly-named Bangladesh Forest Department (BFD) inherited the same hierarchical colonial top-down organisational structure with past working practices unchanged. In 1979, the first national forest policy (NFP) was adopted. This made some small deviations from the colonial forest policy inherited from the British period and from 1962 forest policy in the Pakistan period.

The BFD maintains its primary role of 'revenue collector' for the Government exchequer through focusing on wielding power and authority over the forests and forest communities. Furthermore, it continues to be the national 'protector of forests' from local people who are 'notional thieves' in the eyes of government and BFD officials (Fernandes & Kulkarni 1983). Accordingly, the rules and regulations of the BFD were prepared and directed towards precluding local people from playing any role in the management of forests. The BFD continues to remain non-responsive to societal needs to this day. It is not surprising that this top-down exclusionary management system has resulted in hostility and conflict between the BFD and FDCs (Hossain et al. 2001; Iftekhar & Islam 2004a).

In the Sundarban Impact Zone (SIZ), the centralised and exclusionary management systems have worsened this hostility. Because of their heavy dependence on the forests for their livelihoods, in recent times the marginalised and disadvantaged communities started defying strict restrictive conservation policies (Kumar & Kant 2005). In addition, the failure of the state-centred policy of 1979 has seen a continued reduction of forest resources throughout the 1980s, with an annual estimated deforestation rate of 3.3 per cent (Alam 2009). Given this high deforestation rate, there has been a growing consensus among key forest policy-makers in Bangladesh in favour of moving to a more sustainable approach by involving local people in management (Salam et al. 2005). In this regard, the Government has given the highest priority to the adoption of a participatory forest resource management programme. This approach has been launched and has become the dominant focus of the country's forestry sector (Khan & Begum 1997).

The participatory forestry programme commenced in 1980 with the aim of extending forestry activities and initiatives under the auspices of the BFD. Salam et al. (2005) identified the specific objectives of the programme as: (i) involving local communities for the protection, management and development of forests in a sustainable way; (ii) increasing forest resources with a view to improving local environment; (iii) contributing to eradicating rural poverty by involving the local poor and vulnerable sections of society in the management of forests through income-generation activities; and (iv) enhancing institutional capacity of the BFD.

Although participatory forestry was targeted to achieve a paradigm shift in forest management, it did not occur in the case of the SMF. The local people were, and still are, excluded from mangrove management and policy formulation. There is still no consideration of the use of the forest for sustainable production and livelihood security for FDCs (Kabir & Hossain 2008). Rather, through conservation policy, the BFD has emphasised protection by proclamation as a reserved forest. It has consolidated state control by prohibiting the granting of new rights to FDCs other than strict access; and withdrawing rights granted through permit licenses. The BFD also restricts any sort of human activities inside the forest without their formal permission.

The second forest policy was adopted in 1994 after identification of the forest degradation and encroachment on forest land (Iftekhar & Hoque 2005). To address these problems, the policy recognised the role of local FDCs for the first time by committing to an equitable distribution of forest resources amongst them. However, the BFD violated its commitment to partnering in the case of the SMF by maintaining a strict conservation policy that excludes local people; and the BFD continues to implement previous long-held historical exclusionary policies. Thus, there is an urgent need to bring change to its organisational structure and culture.

1.3 Statement of the Research Problem

More than 50 per cent of Bangladesh's forests have disappeared in the last 30 years (MOEF 2008). This rate of deforestation is very severe. In one study, it was cited that 50 per cent of the SMF's total tree cover has been reduced over the past 20 years (Kabir & Hossain 2008). Such deforestation is due to the diverse nature of its resources and the huge demand for them. This overall reduction trend is threatening the livelihood security of the FDCs (Kabir & Hossain 2008).

Regarding forest reduction, a considerable amount of research has been undertaken in the area of forest conservation through community participation in a co-management system or structure. In the literature, co-management structures imply a division of authority and management tasks among various stakeholders, including public and private (Carlsson & Berkes 2005; Njaya 2007; Olsson et al. 2004; Plummer & Armitage 2007; Plummer & Fitzgibbon 2004a). This study applies

FDCs' involvement with defined property rights in a co-management structure for sustainable management of the SMF. In this regard, Ellis and Porter-Bolland (2008) identified that community involvement in forest management played a significant role in forest conservation. Theoretically, co-management promotes the access to, and exchange of, both material and immaterial resources such as money, technology, scientific knowledge, local experiences, and provides legitimacy (Sandstrom & Rova 2010). According to Sandstrom and Rova (2010), this concept of co-management is broad and limits its performance. Hence, this research scales down this concept of co-management into co-management structure to ensure authority and management tasks are allocated to the FDCs of the SMF.

However, others like Fraser et al. (2006) and Plummer and Fitzgibbon (2004b) criticised co-management for not being successful when its indicators were not reconciled with property rights. The term 'indicator' is used as the measurable criterion in the form of both qualitative and quantitative variables which can be monitored periodically to assess the change in sustainable forest management and to formulate related policy (Hickey 2008; Wijewardana 2008). Hickey (2008) identified the magnitude of the forest sustainability indicators as being very important for monitoring and policy formulation. Following foreshadowed definition, conservation practices of the SMF may be defined as a set of *de jure* rules and regulations for resource harvesting and management. For instance, conservation practices in the SMF include issuance of permit licences to FDCs for access and withdrawal rights; banning timber and timber-related resource harvesting since cyclone *Aila* in 2009; restricting fish and crab harvesting in the breeding season for a specific time and in specific forest land; etc. Thus, it is necessary to identify the indicators in terms of conservation practices and co-management structure to achieve sustainability. In spite of its importance, no study in Bangladesh has focused on the identification of such indicators for sustained conservation of the SMF (Salam & Noguchi 2005). Hence, FDCs' role in management and policy formulation for conservation has remained unexplored.

In Bangladesh, much of the literature on protected area management emphasises the poor condition of forests and existing management problems (Biswas & Choudhury 2007; Chowdhury & Koike 2010; Chowdhury et al. 2009; Muhammed et al. 2008).

The Forestry Master Plan of 1993 primarily guides current forest management. This plan has the primary objective of improving management practices sustainably by enhancing environmental preservation and conservation through increasing public participation whilst ensuring benefit streams from the forests (BFD 2005). Although sustainable forest management is the prime goal of forest conservation and FDCs' participation is the central component of the policy, no study has yet been conducted to identify the factors influencing FDCs' participation in sustained conservation practices in the SMF.

Present management system has failed to realise true sustainable indicators from overall stakeholders' viewpoints (Roy & Alam 2012). This includes avoidance of local people's customary rights and knowledge in resource conservation. The existing emphasis on exclusion has made forest management more complicated with numerous new objectives (Warner 1997). Sustainable forest conservation is hindered as a result of dense population pressure and weak law enforcement (Struhsaker et al. 2005). Sustainable forest conservation needs to go beyond mere forest ecosystem management to focussing on a broader approach of including local people and policy-makers in a partnership (Salam et al. 2005). Forest conservation needs to reflect the attitudes of communities by creating a dynamic interaction between them and policy makers; and explore the necessity of alternative livelihood options for FDCs to lessen pressure on forests. The impact of factors influencing conservation policies, property rights, economic activities and existing conflicts between local people and the BFD to achieve sustainability in the SMF has remained unexplored.

The provision of property rights to local people plays a vital role in environmental conservation and mangrove management (Amri 2005). However, despite a large body of literature, in-depth analysis of institutional and property rights issues of community-based conservation in Bangladesh is relatively rare. The FDCs in the SMF do not have recognised property rights. Moreover, the lack of alternative livelihood options for them is increasing pressure on the forest. Economic incentives, property rights and participation in co-management processes significantly influence the sustainable management of mangrove ecosystems (Walters et al. 2008). Investigation of strategies for achieving sustainable conservation practices in the

SMF through an inclusion approach with appropriate property rights allocated to FDCs remained unexplored.

1.4 Research Objectives and Questions

Firstly, the study aims to identify which factors influence the BFD's conservation practices in managing the SMF. This research, with the application of survey, focus group discussions (FGDs) and content analysis methods, will fill gaps in policy, theory and methods for participation, exclusion and an alternative property rights regime. Hence, it will identify and quantify conservation factors by obtaining a thorough understanding of the reserved forest management structure, community-forest relationships and deforestation threats. This study fills the gaps in the literature by examining community perceptions towards property rights and forest conservation. It is thus hoped that this study will enhance co-management policy perspectives for sustainable management of the SMF.

This research explores potential corrective policy and management approaches to reduce deforestation. It also aims to address the policy linkages between community and conservation to achieve sustainable forest management. In this regard, this study extends the analysis by involving communities in a system of inalienable common property rights.

Consequently, the main objective of this study is to investigate whether an alternative property rights regime can enhance sustainability in the SMF. To achieve this principal objective, research questions are designed based on three thematic issues: state property rights, co-management and demand-side interventions. The main research questions are as follows:

1. Is the existing property rights regime adequate to achieve sustainability?

2. How do communities perceive the interaction between the existing property rights regime and the conservation of forest resources?

3. Is an alternative property rights regime of co-management able to achieve forest sustainability?

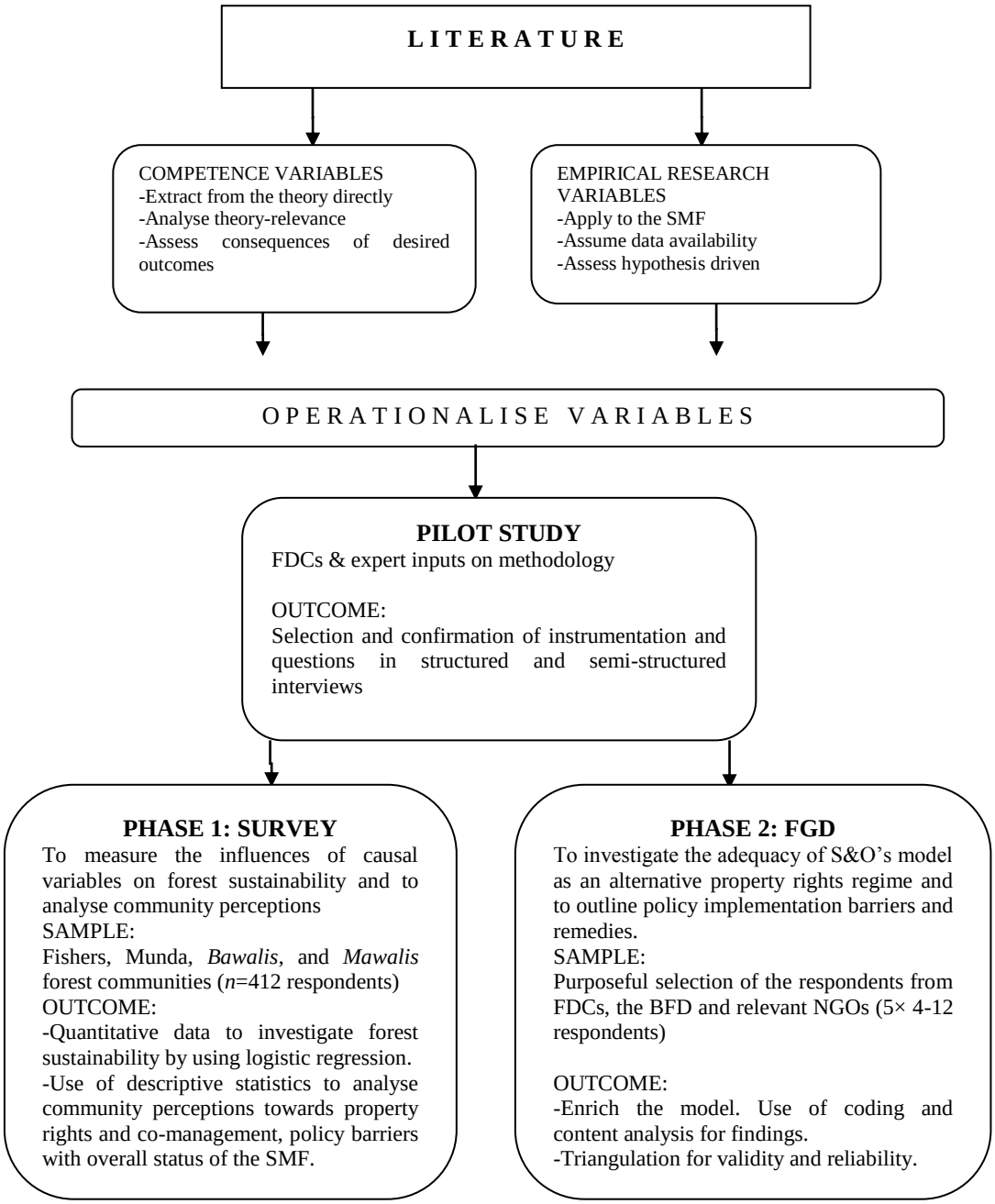
4. What are the barriers to implementation of co-management?

5. How can these barriers be overcome to achieve sustainability?

1.5 Research Design and Methodology

The research adopts a mixed method approach that involves the collection of both primary and secondary data and information. This research uses different methodological approaches. In this regard, a detailed content analysis has been conducted on historical policy regimes using Schlager and Ostrom's (S&O) (1992) property rights framework. The framework has been used to investigate the interaction and conflict between the state property rights regime and mangrove resource conservation practices. Various methods were used to generate data and information to answer the research questions. These include: (i) use of secondary sources for content analysis to address research question 1, (ii) household survey for research question 2, and (iii) focus group discussions (FGDs) for research questions 3, 4 and 5. For analysis of relevant stakeholder responses and to finalise the interview questionnaire, a pilot study was also conducted. Except for content analysis, the research design for the household survey and FGDs are outlined in Figure 1.1.

Figure 1.1: Research design



This study adopts an integrated approach examining multiple actors, scales and methods with a focus on state and common property rights regimes. The study has reviewed forest policies with respect to the SMF for the last five hundred years. In this regard, the content analysis method was used to identify the role of property rights in the outcomes observed in the literature.

This study considered the FDCs as a key focus for analysis purposes. Four highly-marginalised and disadvantaged FDC groups were selected. As well, BFD staff working at various levels, including the Sundarban Forest Office (SFO) and its lower offices, were included. Non-Government Organisations (NGOs), research organisations, other government offices from *Upazila* (sub-district) to ministry levels and university academics were also included. The mixed method approach helped comprehend how management of the SMF was being driven, who was driving it and, in spite of conservation interventions, why this forest was experiencing deforestation and degradation, and the role of FDCs in existing conservation practices.

The study thus examined the perceptions of various actors including FDCs and the BFD with regard to access to, and withdrawal and management of, forest resources. Current and alternative property rights regimes were examined against resource harvesting patterns, interests, and characteristics of FDCs and the BFD in the context of mangrove conservation. This approach was able to capture and understand the actions and activities of these two actors.

The integration of quantitative and qualitative methods is useful in an examination of property rights. Quantitative household survey methods were used to collect data and information on FDC perceptions regarding conservation practices, top-down management, resource extraction patterns, property rights and other socio-economic and demographic variables. Nonetheless, these data were not adequate to provide direct statements on what FDCs, the BFD and other actors are thinking. They are thus insufficient to allow an understanding of overall perceptions of mangrove conservation. Consequently, to complement the quantitative method, qualitative semi-structured interviews with these actors were also conducted.

This study investigated community perceptions by employing a binary logit model using dichotomous, continuous and other variables. For dichotomous variables, five-point Likert scale responses were converted into binary formats. This model is considered to be best adapted to capture the non-linear relationship between factors and forest outcomes that vary with the changes in the value of other factors. Logistic regression is widely used to capture and probe potential causal mechanisms. Because of the dearth of baseline information on forest conditions in the SMF, assessment of sustained conservation (forest growth) was complicated. An approximate subjective

assessment of sustained conservation from the FDCs was assumed to be the only way to overcome the problem.

The respondents were not experienced in survey participation. To make the questions accessible and understandable to the respondents, variable-related objective questions were mainly avoided.

1.6 Scope of the Study

Bangladesh has many different types of forests such as hill forests, mangrove forests, mangrove plantations and plain land *Sal* (*shorea robusta*) forests. This study focuses on the mangrove forest known as the SMF. This is a reserved forest, managed solely by the BFD. Under present management, FDCs are not involved in the policy formulation and management of the SMF, despite the country's forest policy supporting their involvement (GOB 1994). Under the present institutional framework, the FDCs enjoy only two types of property rights—'access' and 'withdrawal'—for a limited period, subject to renewal of permit licences. Thus, this study applies theories of conservation, property rights, co-management and social capital to investigate which types of property rights can ensure benefit streams for the FDCs. Primarily, adopting an alternative property rights regime under co-management may enhance such benefits and provide sustainability of the SMF. The study mainly uses S&O's (Schlager & Ostrom 1992) property rights typology.

This research introduces the concepts of market, corruption and the role of policy instruments in conservation. The existence of corruption, restriction of FDC specialisation and capital accumulation due to the current state property rights regime is explained in the literature review. However, these concepts are not assessed or measured by framing specific research questions. Other issues such as social justice and poverty are outside the scope of this study.

This study was limited to a policy evaluation comparing two policy regimes. An assumption of this study is that state forest management has failed and a co-management approach could lead to sustainable management of the SMF.

Although it is supposed that several factors or conditions make local peoples' forest management sustainable, this study assumed defined property rights as the most

significant factor to achieve sustainable forest management. Co-management is assumed to better regulate, monitor, and distribute resources among local communities with different interests and to achieve sustainability.

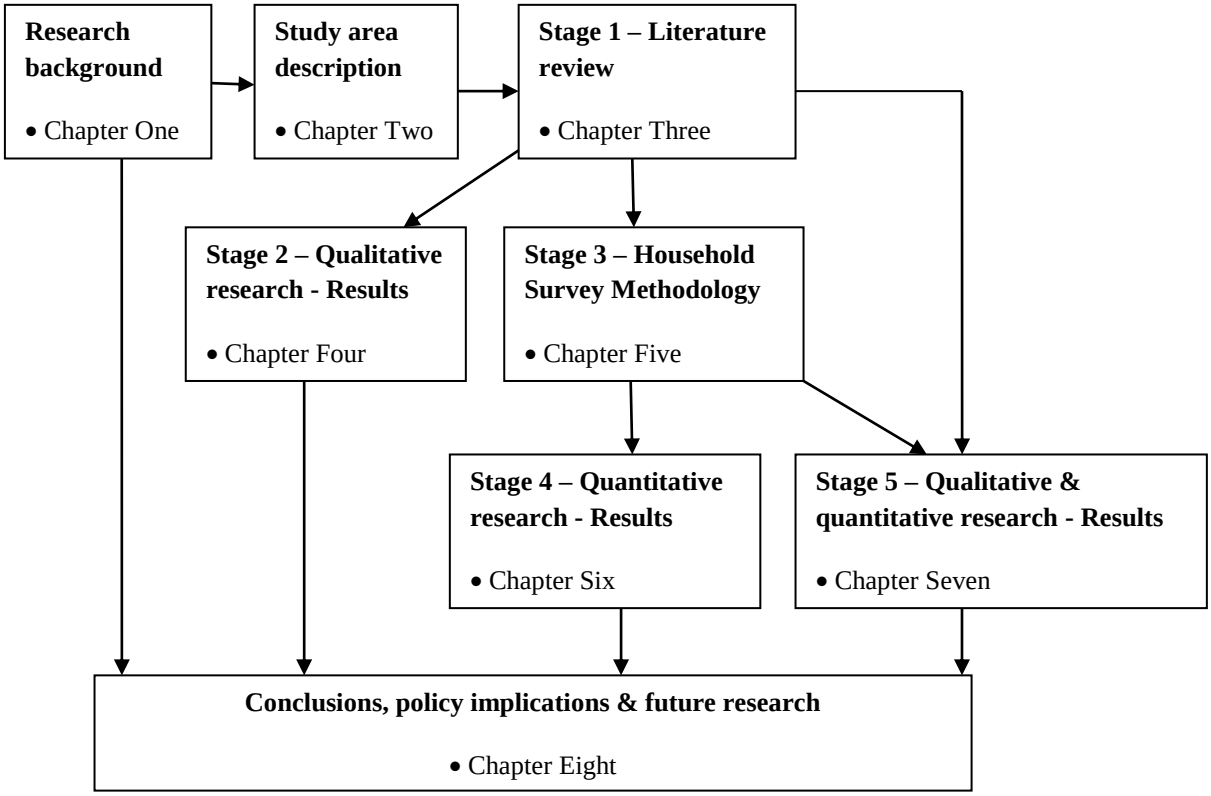
This study employs ecological reasoning and implications for useful and effective answering of the questions as to how property rights and co-management practice may contribute to FDCs' perceptions and their willingness to enhance mangrove conservation. It suggests property rights, co-management and social capital as factors driving the communities' perceptions to change. It presents and predicts a relationship between property rights and population pressure (i.e. growing human influence on forests). More people results in more demand for the forests and their products, hence, the study explores whether FDCs would refrain from excessive resource harvesting if greater access is granted. Along with customary knowledge, social capital, effective legal settings and enforcement, alternative income generation schemes are needed to achieve sustainability.

Most importantly, the security of property rights to forest communities links their livelihood security to improvement in socio-economic conditions. This study addresses these issues by examining demand-side interventions. These demand-side interventions can uplift the socio-economic conditions of FDCs, while co-management can achieve sustainability. This 'reciprocal relationship' between co-management forest policies and demand-side interventions aims to achieve sustainability of the SMF.

1.7 Organisation of the Thesis

This thesis comprises eight chapters (Figure 1.2). Following this introductory chapter, (i.e. Chapter One), Chapter Two backgrounds the study area. It presents local level contextual information with a brief description of the geographical area, resources, significance of, and threats to, this mangrove forest. Present and past management mechanisms with dependent communities are also presented.

Figure 1.2: Structure of the thesis



Chapter Three reviews the existing literature on achieving forest sustainability in developing countries through the implementation of a co-management structure. Importantly, it presents the theoretical underpinnings of co-management. In this regard, the application of the basic theory of property rights is critically reviewed to establish the theoretical foundation of the thesis by situating this research firmly within natural resource economics. By applying these theories, it examines the current property rights regime and its existing impact on the SMF. By reviewing the existing rights regime, this chapter justifies the concept of the embeddedness of common property rights as an alternative property rights regime. This is how the concept of embeddedness is valued, particularly from a common property rights regime perspective within the S&O's (1992) framework. Most importantly, it argues that property rights should be recognised as a priority for FDCs, which this study has identified as being among the most disadvantaged and marginalised sections of society.

Chapter Four provides the historical and policy context of the SMF and the role of FDCs in its management. It discusses the history of forest policy and development

since 1526 through content analysis. In particular, it elaborates this content analysis method and its application to policy. It highlights the management and conservation of this forest with the emergence and evolution of the role of property rights. It evaluates and discusses forest policies during four historical time periods: Mughal, British, Pakistan and Bangladesh. The history of forest policy is analysed with the application of S&O's (1992) property rights theory. This chapter pinpoints the issues of co-management processes through procedural and distributional power equity in common property rights regimes. In this regard, a policy model is prescribed.

Chapter Five discusses the research methodology used in quantitative research for this study. The process of face-to-face household survey is described within the analytical framework of validity and reliability assurance.

Chapter Six analyses the findings of the survey data. It presents community perceptions of state forest ownership and management towards the SMF. It presents statistical models and identifies the determinants of FDC participation in mangrove conservation practices. Regression analysis results are presented using theoretically referenced model variables regarding property rights, co-management and social capital.

Chapter Seven presents descriptive statistics and analyses the findings of the FGDs. It discusses the justification of the implementation of an alternative property rights regime of co-management. It investigates the barriers to co-management with measures to overcome them. It presents three main domains: state, common property regimes and demand-side interventions. It explores policy directives to enhance forest sustainability through improving the forest's condition and demonstrating the need for alternative livelihood options. Hence, it addresses the missing link between livelihood security and forest conservation. In this regard, results of barriers to, and remedies for, co-management are discussed.

Chapter Eight summarises the key findings of the study into three domains: state property rights, co-management and demand-side interventions. This chapter synthesises the findings by linking implications with theory, methods, policy and practice. The chapter also suggests areas for future inquiry to improve understanding of FDCs involvement in a co-management system for mangrove conservation.

1.8 Conclusion

This chapter has outlined the background to and proposed design of this research. It has described the qualitative and quantitative methodology used to answer the research questions. Furthermore, this chapter has explained the limitations of scope of this research by outlining the overall framework and parameters under which the research has been conducted.

CHAPTER TWO

STUDY AREA: THE SUNDARBANS MANGROVE FOREST

Chapter 2

Study Area: The Sundarbans Mangrove Forest

2.1 Introduction

The previous chapter outlined the context of forest management in Bangladesh. This chapter provides an introduction to the geography of the SMF and an historical perspective of its management, which was once closely linked to the colonial system. It explores the circumstances that helped implement the reserved forest policy in the SMF. It describes the importance of the forest to FDCs' economic and livelihood needs. It explains how the forest has been used for economic, social, political, cultural and religious activities and how it has become a prosperous and dynamic part of Bangladesh's economy today.

This chapter establishes that the most widely debated issues in the forest's history are agrarian stagnation, anthropogenic pressure, overharvesting, institutionalised corruption of the BFD and growing forest piracy. These issues are covered to understand the dominant discourse of state coercion, community livelihood dependency, contested cultures, practices and conceptions of forest use from a historical perspective.

The chapter is organised into nine sections. Section 2.2 gives an overview of global mangrove forests and their importance. Section 2.3 provides a geographical location of the SMF. Section 2.4 pinpoints the significance of the forest from cultural, international, environmental and economic perspectives. The biodiversity and ecosystems of the forest are revealed in detail in Section 2.5. Management and conservation, including early history and the present conservation system, are set out in Section 2.6. Section 2.7 explains the nature of FDCs and their dependence on the forest. Various threats to the SMF are reviewed in section 2.8. Section 2.9 summarises the chapter's findings.

2.2 Global Mangrove Forests Reduction and the Sundarbans Mangrove Forest

Mangroves are intertidal forested wetlands. They are confined to tropical and subtropical regions (Tomlinson 1986). The total global mangrove area is 18.1 million hectares, equivalent to 152,000 sq. km (Spalding et al. 2010). Mangroves are found in 123 countries and territories of the world. Mangrove coverage has been declining rapidly from original levels as a result of increasing human use and conversion. Jayagoda (2012) noted that mangroves now represent less than 1 per cent of global tropical forests and less than 0.4 per cent of the total forest estate worldwide of 39,520,000 sq. km. Mangroves reach their largest abundance and diversity along wetter coastlines and in estuarine and deltaic regions. The largest single expanses of mangrove forests are the SMF, the Niger Delta, and the complex deltaic coastlines of northern Brazil and southern Papua. These four areas comprise 16.5 per cent of the world's mangroves (Spalding et al. 2010). Mangroves possess an intense diversity of species. Among the Indo-West-Pacific, the largest diversity of mangrove species is in South-East Asia.

New research has shown that mangroves have higher levels of primary productivity than other temperate or tropical forests. Their levels of standing biomass are very high, even in low-stature forests. Mangrove forests preserve high levels of organic carbon in soils. Preliminary estimates suggest per year aboveground biomass of global mangroves contain over 3,700 Teragram (Tg) of carbon (1 Tg = 1 million metric tons). Further, sequestration of organic matter related to mangrove sedimentation is likely to be 14-17Tg of carbon (Spalding et al. 2010).

Other observations about mangroves include their extensive use by humans. The widespread human use of these forests is mainly for their high valued timber and non-timber forest products such as fuelwood, leaves, honey and fishing (Das 2006). Coastal people are now increasingly aware of the importance of mangroves as natural protection from storms, surges and erosion. Hence, there is an increasing need for planting and restoration of mangroves to protect coastal communities (Ren et al. 2008).

Continuing mangrove losses are very severe throughout the world. There is a general consensus that the original estimates of mangrove cover were over 200,000 sq. km

(Smith-Asante 2010). It is estimated that more than 50,000 sq. km, or a quarter of the original mangrove cover, has been lost due to human activities (Smith-Asante 2010). However, there is a consensus that between 1980 and 2005, some 35,600 sq. km of mangrove forest areas have been lost (Spalding et al. 2010). Rates of mangrove losses have been reduced from 1.04 per cent per year in the 1980s to 0.66 per cent per year in the five years to 2005 (FAO 2007). In spite of this reduction, these rates are still three to five times higher than overall forest losses worldwide (Spalding et al. 2010).

Across the globe, there are 1,200 mangrove protected areas which are equivalent to one-third of global mangrove areas (Smith-Asante 2010). Usually mangroves are surrounded by densely populated coastal areas. This imposes intense economic pressure on mangroves. Hence, remaining mangroves are facing huge anthropogenic pressure. The greatest drivers of mangrove losses are the conversion of mangrove land to aquaculture, agriculture and urban land uses.

Of more recent concern to mangrove loss is sea level rise (SLR) due to climate change (Rahman et al. 2011). There are two notable arguments regarding possibilities of addressing SLR challenges to mangroves. One is the accumulation of sediments and various organic matter in the soil to help mangrove forests keep up with the slight losses from SLR. Another is the possibility of transplanting mangroves inland to cope with SLR. Nonetheless, throughout the world it has been shown that neither of these options has prevented the loss of mangrove areas due to SLR.

The rate of mangrove degradation is mainly the result of local responses to decisions driven by market forces due to industrial demand, population expansion and poverty. However, in many countries, mangrove degradation is also due to high-level policy failures. For instance, state level aquaculture policy resulted in massive mangrove losses during the 1950s in The Philippines (Spalding et al. 2010). Like many other countries, Bangladesh has established general legal protection for mangrove resources. Existing conservation policy is implemented to maintain conservation values in mangrove-protected areas. Although it is suggested that the trends of mangrove gains or losses can dramatically be reversed, this has not occurred in the case of the SMF.

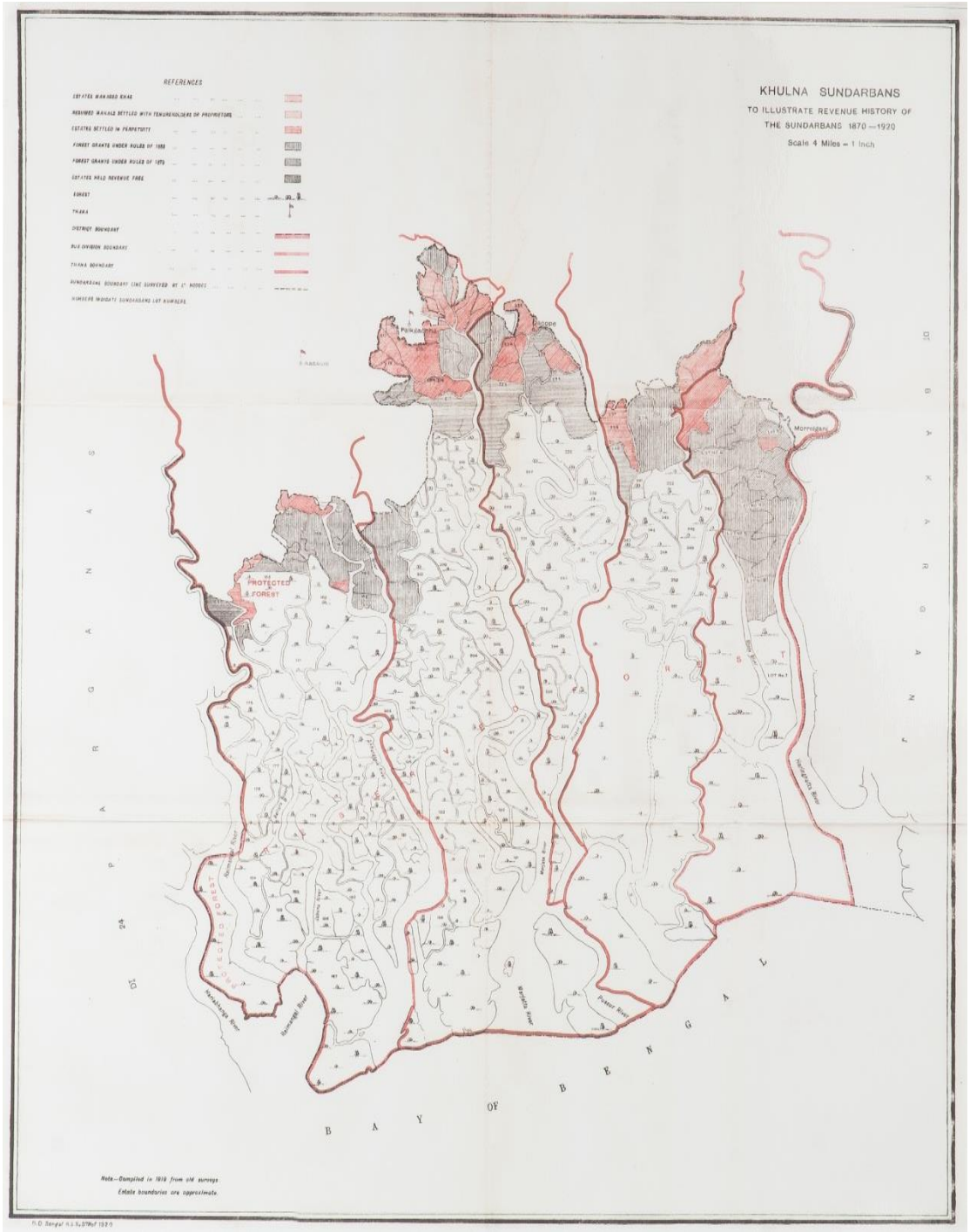
Use of licensing is a common conservation practice. Like many other countries, the BFD has established licensing systems to protect mangroves and to strictly control destructive activities. Application of a licensing system by the BFD is synonymous with economic instrument applied for conservation and protection. In spite of that, conservation policy for the SMF fails to establish appropriate legal frameworks and adopt development interventions when necessary. For instance, existing conservation policy does not have any standard for timber, aquaculture, or water quality protection from oil spillage from ships, engine-driven boats, etc. (UNEP 2011). In SMF, there is a dearth of activities to replace mangroves. The most notable example is the loss of Chakaria Sundarbans in Bangladesh (Hossain et al. 2001). This forest in Cox's Bazar was one of the oldest mangrove forests in the Indian subcontinent. Because of heavy human interference, the entire forest of 18,200 hectares has been cleared for shrimp farming and human settlement (Akhtaruzzaman 2000). Deforestation has affected the socio-economic conditions of more than 90 per cent of the local community (Hossain et al. 2001).

The rate of mangrove degradation in the SMF is greater due to conflicting pressures and points to a failure of existing conservation policy. According to Spalding et al. (2010), this conservation failure suggests the need to establish a clear management regime for mangrove management worldwide.

2.3 Geographical Location

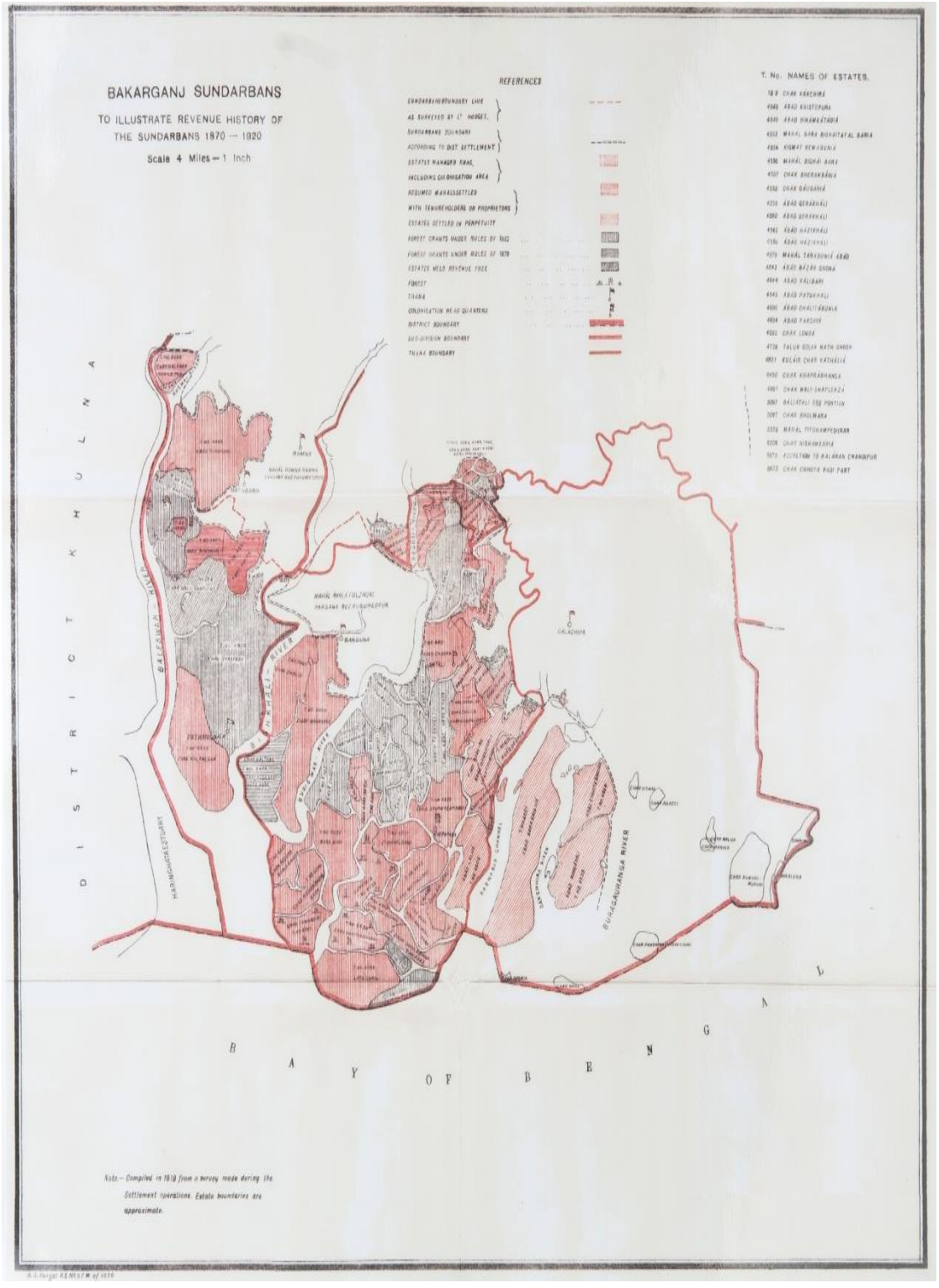
Up to 1816, the SMF was situated in the southern portion of the Ganges delta. It extended from the Meghna River on the east to the Hugli River on the west through the then districts of Khulna, Bakarganj and 24-Parganas (Pargiter 1885). Figures 2.1, 2.2 and 2.3 show the extent of the SMF in these three regions in the period between 1870 and 1920. Permanently settled lands of those districts limited the forest on the northern side. The United Nations Environment Programme (UNEP) (2011) recorded that this area is now approximately three-fifths of the total 16,700 sq. km that existed 200 years ago. Two-fifths of the forest has been cleared due to agricultural conversion, mostly in India. The SMF lies between Bangladesh and India, covering 60 and 40 per cent respectively.

Figure 2.1: The Khulna Sundarbans



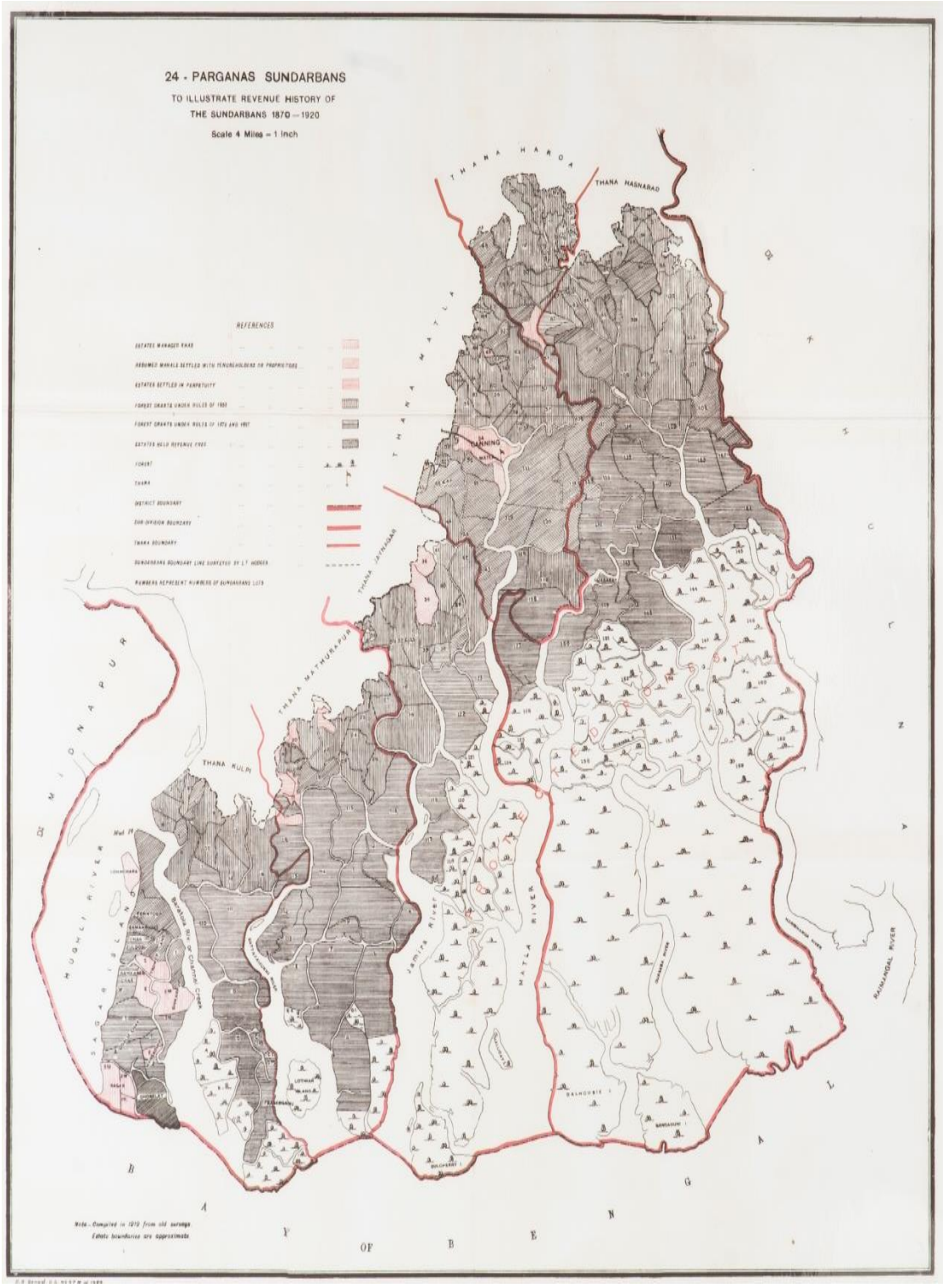
Source: Ascoli (1921)

Figure 2.2: The Bakarganj Sundarbans



Source: Ascoli (1921)

Figure 2.3: The 24 Parganas Sundarbans



Source: Ascoli (1921)

The SMF in the coastal area of Bangladesh was formed within the vast Bengal delta basin over 11,000 years ago (Mikhailov & Dotsenko 2007). The forest is located in

the old Ganges delta on the northern limits of the Bay of Bengal. Clay mineral and radiocarbon indicates that the lower Bengal delta plains of the SMF were originally formed with sediments deposited by the Ganges River (Heroy et al. 2003). It is the single largest area of productive mangrove forest in the world (Hussain & Karim 1994). The SMF is located in the southwest geographical corner, between 21º30´ and 22º30´ north and 89º00´ and 89º55´ east, in the area of Khulna, Satkhira, Bagerhat districts (Figures 2.4 and 2.5). The location of this forest is south of the Tropic of Cancer and at the northern limit of the Bay of Bengal. The forest lies 300 km south-southwest of the country's capital city, Dhaka. It is unique due to its size, productivity and significance and in terms of balancing the local ecosystem (Hoq et al. 2006). The whole area is treated as the SIZ, which consists of 2,268 villages and 17 *Upazilas* of five immediately-adjacent districts (Kabir & Hossain 2008). Not more than 200 years ago, the SMF extended further inland, including much of the Khulna region. The present area of the SMF is 6,017 sq. km which is 40 per cent of the total forest land under the control of the BFD. This area covers 4.07 per cent of the total land area in Bangladesh (MOEF 2005b).

Figure 2.4: Sundarbans mangrove forest, Bangladesh

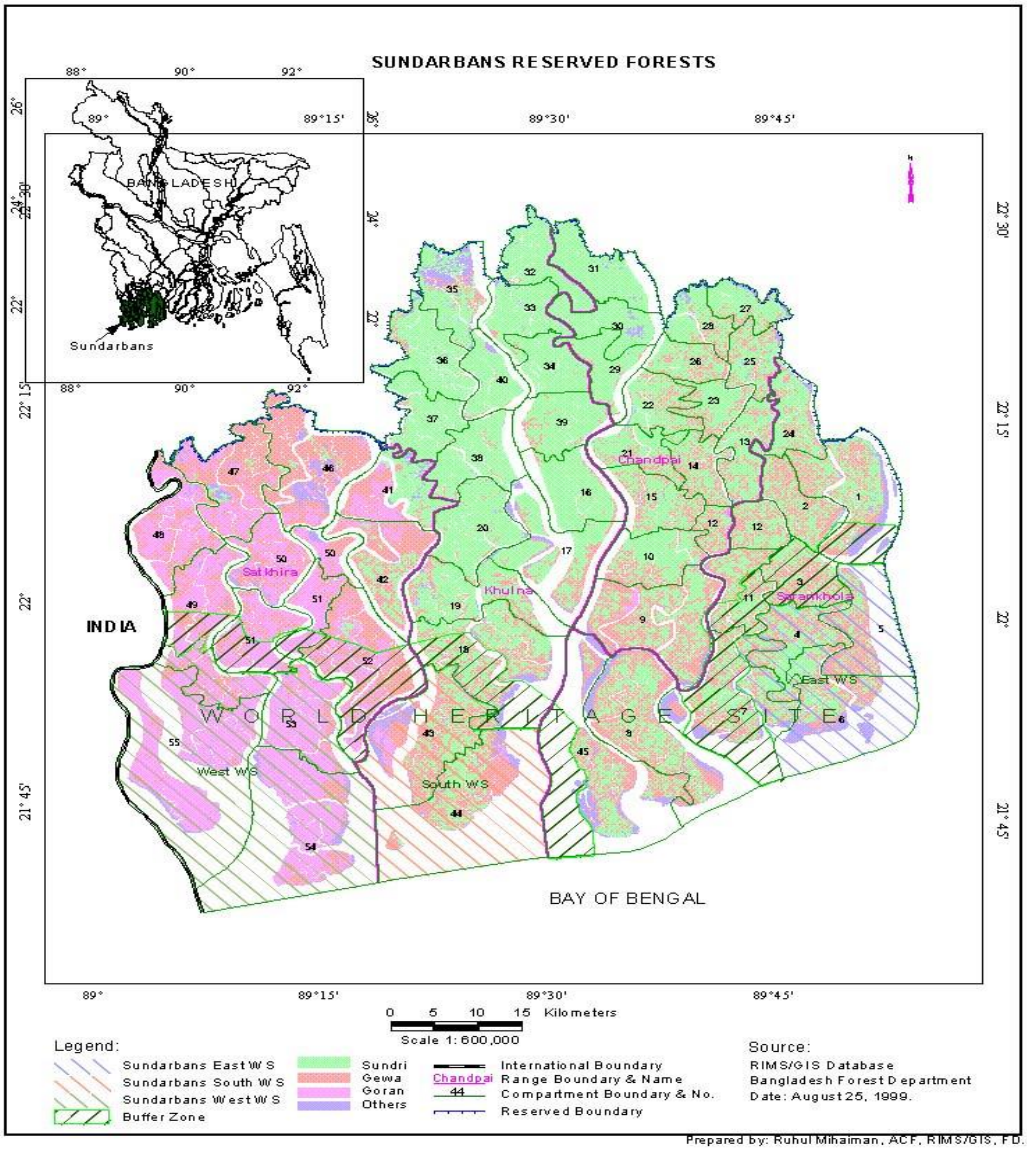
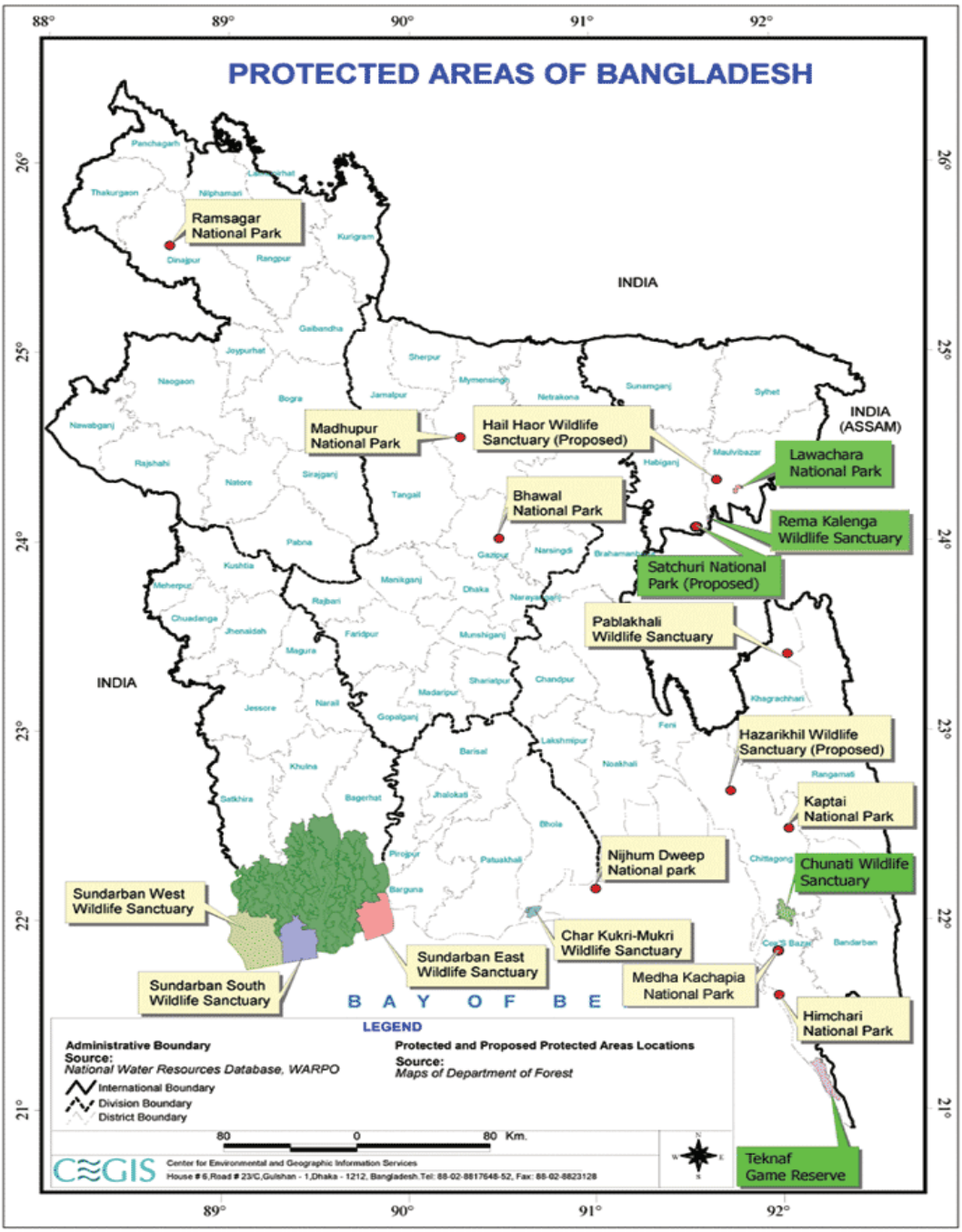


Figure 2.5: Protected areas of Bangladesh



The SMF consists of numerous small-forested islands and mudflats intersected by an intricate network of coastal waterways. These islands were formed by natural sedimentations between the Raimangal, the Harinbhanga and the Baleswar rivers. The forest is bounded by three famous deltaic rivers—the Ganges, Brahmaputra and Meghna. The forest lies across the outer deltas of these three rivers. A dense network of small rivers, canals, channels and creeks also contribute to sediment formation. The maximum elevation inside the forest is 10 metres above mean sea level. The

western and eastern limits of the SMF are defined by the course of a tributary of the Ganges named the Hooghly and Baleshwar rivers respectively. The river Ichamati or Raimongal (known as Harinbhanga in India) demarcate the border of the forest between Bangladesh and India. Out of three sanctuaries, its west and adjoining south sanctuaries adjoin the Indian section of the forest (UNEP 2011).

The current area within Bangladesh is 599,330 hectares and the Indian area is 426,300 hectares, lying in the 24-Paragnas district of West-Bengal. The above estimates of the mangrove forests sometimes differ in the two countries considerably (Gopal & Chauhan 2006). However, this study confines itself to the Bangladeshi part of the SMF.

The forest lies at the end of the basin facing towards the Bay of Bengal. It extends over 200 islands separated by 15 major distributary rivers flowing north-south across the country. Around 400 interconnected creeks and canals flow through the forest. Furthermore, an impenetrable saltwater swamp extends 100-120 km inland to support this tidal mangrove forest (UNEP 2011).

2.4 Significance of the SMF

Following sections describe the cultural, international, environment and economic significance of the SMF.

2.4.1 Cultural Significance

The SMF area has significant national importance for its cultural heritage and religious values. A Hindu religious festival named 'Rash Mela' is celebrated once a year in Dublar *Char* (island). The island is deep inside the forest. This attracts Hindu devotees from local and distant places. People visit the ruined Hindu temple of Sheikh at Shekher Tek to celebrate an annual festival (Ramsar 2003). Local and foreign visitors, irrespective of caste and creed, attend the festival.

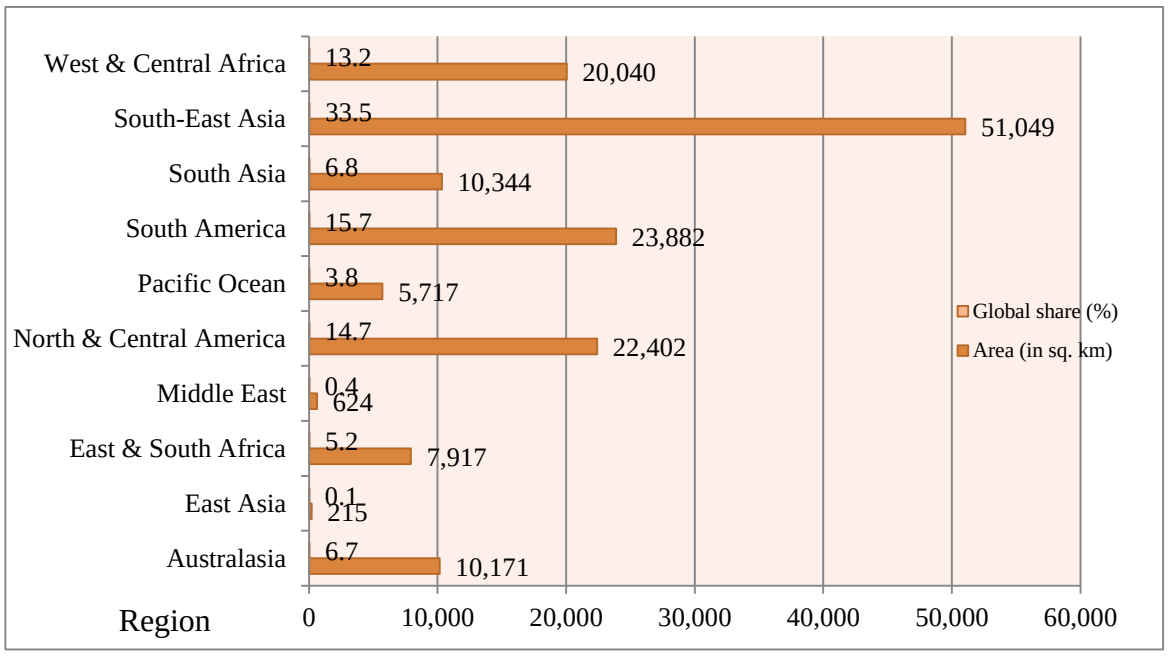
The forest has very significant cultural heritage value. The country's archaeological evidence demonstrates early human occupation on the deltaic islands. This denotes the previous supply of abundant fresh water from the Ganges and other non-saline ground water (UNEP 2011). The forest has been featured by many famous writers in both Bengali and English literature. Notable novels such as Bankim Chandra

Chatterjee's *Kapal Kundla*, Amitav Ghosh's *The Hungry Tide*, and part of Salman Rushdie's *Midnight's Children*, are set in the forest.

2.4.2 International Significance

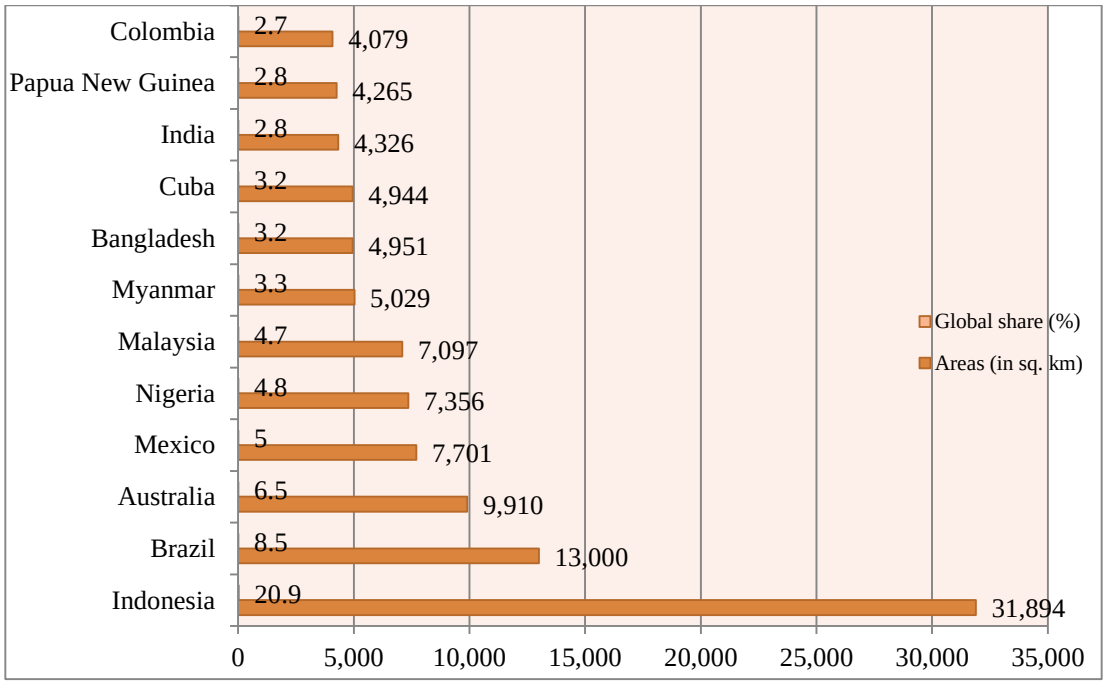
South Asia has some 7 per cent of global mangrove share (Das 2006) (Figure 2.6), placing it eighth globally. In terms of mangrove share, Bangladesh is eighth in the world and the SMF alone occupies more than 3 per cent of Bangladesh (Khan 2009) (Figure 2.7). Categorised as reserved forest, the SMF is unlike mangroves in other parts of Asia, Africa and Latin America in terms of forestry products and substantial fisheries (Hoq et al. 2006). It is the world's largest halophytic mangrove forest and, in terms of biological production, it is one of the most significant natural ecosystems. Furthermore, it has the longest history of scientific management in the world (UNEP 2011).

Figure 2.6: Regions of the world by mangrove share



Source: Adapted from Spalding et al. (2010)

Figure 2.7: Countries by largest mangrove share



Source: Adapted from Spalding et al. (2010)

This forest contains a rich biota, including endangered reptiles. It lies within a World Wildlife Fund Global 200 eco-region which has been declared as a Biosphere Reserve by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (UNEP 2011). Apart from three wildlife sanctuaries, this reserve contains a tiger reserve and national park. UNESCO included it in the World Heritage list in 1997. Accordingly, the government declared this forest a World Heritage Site in 1999. It was included as a Ramsar site in the Convention on Wetlands of International Importance held in 1971. Recently, the government declared the whole forest, equivalent to 601,700 hectares, as a Ramsar site (Ramsar 2003).

Globally, the total mangrove area is 152,361 sq. km. (Figure 2.6). The 12 countries in Figure 2.7 cover 68 per cent of global mangrove share.

2.4.3 Environmental Significance

Traditional lifestyles were comparatively well adapted to the unique characteristic of the forest. The forest provides protection from coastal surges generated through cyclones and storms in the Bay of Bengal. The SMF is an important buffer for

coastal inland zones from the ravages of cyclones. The swamp of the forest is extensively strengthened and embanked to buffer inland areas from devastating cyclones and storms. The waters are very rich in nutrients that provide a critical nursery for shrimps and other fish. These enhance the spawning grounds of crustaceans and fish along the whole coastline. Mangrove swamp covers over 50 per cent of the forest. The rest is largely covered by salty and brackish water.

The forest's wide range of flora and fauna is unique. It supports an exceptional biodiversity and concurrently ensures the viability of ecological processes such as monsoon rain flooding, tidal influence, delta formation, flooding and plant colonization (Amin 2002). The most extensive mangroves of the SMF are found in river deltas near to the sea. This creates new expanses of land through the active deposition of new sediments.

2.4.4 Economic Significance

The forest offers subsistence livelihoods for a huge number of residents (Agrawala et al. 2003; Kabir & Hossain 2008). This forest contributes 3 per cent of the total Bangladeshi GDP from the overall forestry sector contribution of 5 per cent (Khan 2009; MOEF 2005c).

In their recent study, Spalding et al. (2010) estimated the economic value of mangroves at between US$2,000 and $9,000 per hectare per year. Particularly over longer time horizons, these values are obviously higher than any other alternative uses such as aquaculture or agriculture. These ecosystems play an important role in meeting the needs and demands of local FDCs by providing food, timber, and employment in both cash and non-cash economies. Initially, the main demand was scientific timber harvesting (UNEP 2011). However, during the last few decades, non-wood products such as fish, crab, honey, beeswax, *Gol* leaves, thatching palm, grasses and crustacean shells have gained importance and play a vital role in rural coastal economies. Consequently, harvesting of these resources has been brought under BFD management control (Hussain 1997). In addition, the SMF has a huge non-use value and greater protective role from climate change. Being a storm protector and shore stabiliser, it has a great deal of economic importance to the

coastal zone. It also contributes to the economy by providing a source of timber and natural resources.

2.5 Biodiversity and Ecosystems

The SMF has a wide range of rare fauna including the Bengal tiger, estuarine crocodile, and various reptiles and birds. The forest is diverse, with 269 species of wildlife (Roy 2004). The intertidal zone is replete with trees, fisheries, and shrubs, including ferns and palms. In these deltaic lands, fresh water and sea together provide a home for a wide range of distinct species.

2.5.1 Abiotic Characteristics

The area experiences a sub-tropical monsoon climate and severe cyclonic tropical storms. Its annual rainfall ranges between 1,600 and 1,800 mm (Karim 1994a). The climate is humid sub-tropical, with an average of 70 to 80 per cent humidity. It has four main seasons: pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and the dry winter season (December-February) (Karim 1994b). The minimum temperature is 2-4º Celsius in winter to 32º during in the monsoon season and a maximum of 43º Celsius in March (Gopal & Chauhan 2006). Rainfall also increases from west to east with the mean annual variation from about 2,000 mm in the east to 1,600 mm in the west. Eighty per cent of the rains fall during the monsoon season. The forest is situated in the flat deltaic swamp on the greater Ganges-Brahmaputra estuarine complex. Thus, it ranges from 0.9 to 2.1 metres above mean sea level (Iftekhar & Islam 2004b). Its soil is of recent origin consisting of alluvium washed down from the Himalayas. The type of the entire soil geology is a mixture of quaternary sediments, sand and silt, interlaced with marine silt and clay.

Over two kilometres wide, straight rivers and their intricate network of waterways run north to south through the forest. The ecosystem is largely maintained by two diurnal flow and ebb tides, with a tidal range of up to 8 metres (Mandal & Ghosh 1989). Tides bear erosion-resistant clay and silt for the banks. Flood currents in the monsoon season deflect waves largely to the eastern part, and ebb currents to the western part. Significantly, these trends of currents redistribute river-borne sediments along the coast (Mandal & Ghosh 1989; Michels et al. 1998). The area comprises

three main hydrological zones—brackish, moderately saline and saline—to influence particular type of vegetation with dominance.

In addition to its protective aspects for coastal communities, the SMF's ecological processes of monsoon rain flooding, delta formation, tidal influence and plant colonisation are unique.

2.5.2 Biotic Characteristics

The forest is a rich source of flora. Its flora consists of a total of 69 species. However, a total of 425 species of wildlife have been recorded (Agrawala et al. 2003). Karim (1994c) reported a total of 334 species of trees, shrubs and plants. They belonged to 245 genera of Spermatophytes and Pteridophytes from this forest and its adjoining areas. Of these species, only 123 may be found at present (Karim 1994c) because of considerable changes in the status of different species and the taxonomic revision of mangrove flora (Khatun & Alam 1987). However, very few steps have yet been taken to investigate changes in the botanical environment within the forest (Karim 1994c).

Trees of the SMF are represented by 22 families within 30 genera. It is estimated that the total growing stock of the forest is 10.6 million cubic metres (Canonizado & Hossain 1998). Among all the species, *Heritiera fomes* is the single most vital species of the forest. As a pure crop and mixed with *Excoecaria agallocha*, this *Heritiera fomes* covers 18.2 per cent and 62.4 per cent of the forest area respectively (USAID 2001). *Heritiera fomes* dominates where the soil water is moderately fresh. Their dominance is in the north-east and on the higher ground. They currently form 60 per cent of commercially useful timber. However, recently the dominance of *Heritiera* forest type is decreasing (Iftekhar & Islam 2004a). This species is also affected by the 'top-dying' disease. Iftekhar and Islam (2004a) found that around 20.18 million *Heritiera* species occupying 198.5 sq. km were severely affected by this disease. They again added that these species also suffered from the effects of root rot and die-back diseases. These are unique in comparison with the non-deltaic coastal mangrove forests.

Besides tree species, the SMF is home to many animal species. The total listed official number of animal species is 453. Iftekhar and Islam (2004a) reported that

there are 120 species of fish, 290 species of birds, 42 species of mammals, 35 species of reptiles and 8 species of amphibian commonly found in the forest. These species currently represent 36 to 37 per cent of birds, 28 to 30 per cent of reptiles, and 33 to 34 per cent of the mammals of the country (Iftekhar & Islam 2004a). The SMF is famous as the world's largest remaining habitat of the Royal Bengal Tiger, *Panthera tigris tigris*. Other notable valuable animal species living in this forest include otters (*Lutra spec.*), squirrels (*Callosciurus pygerythus* and *Funambalus pennati*), rhesus macaque (*Macaca mulatta Zimmermann*), spotted deer (*Axis axis*), barking deer (*Muntiacus muntiak*) and wild boar (*Sus scrofa*); and in rivers and the sea, a number of dolphin species (Iftekhar & Islam 2004a).

In terms of vegetation, the SMF is classified into five categories: (i) moist tropical seral forest, (ii) low mangrove forest, (iii) tree mangrove forest, (iv) salt-water *Heritiera* forest, and (v) fresh water *Heritiera* swamp forest (UNEP 2011). Of these, the moist tropical seral forest comprises a mosaic succession of four types of tidal forest communities. However, much of the fresh water *Heritiera* swamp forest has been cleared for settlement (UNEP 2011). Further, the newly-accreted sites are vegetated with mainly *Sonneratia apetala,* followed by *Avicennia officinalis*. On the levee banks, *Golpata* or Nypa palm *Nypa fruticans* grow abundantly, provided they are well established (Miah et al. 2003). The dominance of *Exoecaria agallocha* increases with rising ground soils caused by sediment deposition.

The SMF is the home of diverse fauna. Forty-nine mammal species have been recorded in the forest (UNEP 2011). It supports one of the subcontinent's largest populations of the Bengal tiger *Panthera tigris.* UNEP (2011) estimates there is a total of 350 tigers in the forest. However, several other larger species of mammals such as the Javan rhinoceros *Rhinoceros sondaicus*, Indian rhinoceros *Rhinoceros unicornis* and Indian water buffalo *Bubalus arnee* are now locally extinct. Extinctions were due mainly to the increase of agricultural conversion and soil salinity in the late 20th century. Above all, human interference in the form of resource harvesting and top down forest management have had a significant effect on wildlife habitats and population degradation (Rashid et al. 1994).

The forest comprises a total of 315 species of varied and colourful birds. This number is recorded as 36-37 per cent of the national total (Rashid et al. 1994).

Around 53 reptile species, covering 53 per cent of the national total, and 8 amphibians are recorded as inhabiting the forest. The forest is known for its estuarine crocodile *Crocodylus porosus* of which some 100 still survive. Over 120 species of fish are commonly caught by fishermen (Seidensticker & Hai 1983). Moreover, in total, 400 species of fish and 48 species of crabs exist (UNEP 2011). From these, 20 shrimp, 8 lobster and 7 crab species are regularly caught. Brackish water and marine species are found to be dominant. Fresh water species are found only along the eastern edge of the Baleswar River. A rare species of Ganges river shark *Glyphis gangeticus* is found in the estuaries. UNEP (2011) also found that the forest supports 300 species of spiders and a large number of honey bees.

Because of these valuable plants and species, about one-third of the whole forest is designated as protected area for the conservation of biological diversity (Ramsar 2003). In addition, the forest is abundant in various wood, biomass and non-wood resources. These are mainly timber, fuelwood, pulpwood, leaves, shells, crabs, honey and fish. A significant portion of coastal local people make their livelihood from the harvest of these resources.

2.6 Management and Conservation

The colonial management history and current conservation systems are set out in the following sections.

2.6.1 Early Management History

The following sections describe human settlement of forestlands and revenue history.

2.6.1.1 Settlements of Forest Lands

Forestry provides a good example of the early management style of the British colonial period in India (Gadgil & Guha 1992; Phillips 1886). In 1853, the then British colonial government declared its paramount policy objective in the SMF as the speedy reclamation of the forest using absolute proprietary rights (Iqbal 2006). The British colonial government designated the forest as protected and reserved under the Indian Forest Act of 1865 (UNEP 2011). In 1883-84, the total area of reserved and protected forests under the FD was 12,012 and 5,957 sq. km respectively. Of that, the reserved forests in the SMF alone covered an area of 4,095

sq. km (Phillips 1886). However, much of the forest was later leased out by the British Government to local landlords for cultivation.

The government then sought to protect the forest from reclamation. For the first time in 1862, the necessity of conserving the forest was considered following a memorandum prepared by Dr. Dietrich Brandis, the Conservator of Forests in Burma (Ascoli 1921). Subsequently, in 1864 the whole area of SMF forest—equivalent to 3,403 sq. miles—was brought under the absolute jurisdiction of the government. In practice, the government leased out the entire area to the Port Canning Company who made a huge profit from forest produce (Pargiter 1885). Subsequently, in 1864, the government condemned the oppressive harvesting by the company and cancelled the lease order. The government then moved to a policy of reclamation to prevent a recurrence of oppressive harvesting methods (Ascoli 1921).

After the failure of the above policy, the government again realised that woodcutters involved in illegal harvesting had caused rapid and huge destruction to the most valuable *Soonder (Sundari)* tree tracts (Ascoli 1921). In that situation, the government agreed to protect the forest. In 1875, the government declared 500 sq. miles in Bagerhat and 385 sq. miles in Khulna sub-divisions as reserved *Sundri* forests (Ascoli 1921).

The government again released a portion of reserved forests for reclamation in 1891. Subsequently, FD adopted a working plan in 1891-92 to apply a strict conservation management policy within Bagerhat and Khulna blocks to all valuable timber such as *Sundari*, *Passur*, *Amur* and *Keora*. The area of reserved forest in Khulna was increased by 1,339 sq. km in 1900-1901 entirely through the inclusion of the water area. This policy enhanced revenue earnings which amounted to Rs. 6,30,808 against an expenditure of Rs. 1,01,555 (Ascoli 1921). However, it should be noted that no steps had been taken to reserve or protect any forest in the district of Bakarganj by the end of that decade.

It is debatable whether the forest was reserved with a view to supplying timber and obtaining a reasonable revenue. Huge wooden sleepers or railway ties were needed to develop 25,000 miles of railway system by the end of the eighteenth century (Hill 2008). Gadgil and Guha (1992) argue that many of the revenue departments

considered deforestation as a necessary function of government in the period to 1860. Thus, the government derived revenue of Rs. 2,68,778 between 1910 and 1920. This rate was equivalent to Rs. 415 per sq. mile per annum (Ascoli 1921). However, the government was ultimately unwilling to preserve and protect Bakarganj forest, which was wholly cleared in 5 or 6 years (Ascoli 1921). In 1874, for the first time the government decided to preserve the tract of the SMF as a source for the supply of wood, timber and fuelwood for Southern Bengal (Ascoli 1921). A separate office called the Commission of the Sundarbans was created to manage its revenue (Iqbal 2010). Nonetheless, these offices had no connection with the affairs of the SMF other than forest revenues being paid to its treasury (Beveridge 1876).

2.6.1.2 Application of Jalkars for Fisheries

Before 1859, no leases were granted for fisheries in the SMF. Afterwards, the government circulated orders to apply *Jalkars* or to tax the fisheries of the navigable rivers in 1859 (Pargiter 1885). However, overestimated *Jama* rates caused excessive bid values. Hence, farmers frequently defaulted and the government hastily mandated fresh settlements. In that period, there was conflict between forest and civil officers (Phillips 1886). Forest officers were inclined to preserve the forests; and, alternatively, civil officers were in favour of protecting the rights of the people. Thereafter, the government decided to stop further leasing of fisheries. Overall, that particular system of *Jalkars* did not work (Pargiter 1885).

2.6.1.3 Lease of *Bankar* for Forest Produce

For the first time, the government applied the *Bankar* or tax for the farming of forest produce by public auction. From 1864, the *Bankar* and *Maukar* (tax on honey and beeswax) were applied by the government on *Khas Mahalls* in some parts of the forest for five years. Unfortunately, the Port Canning Company bought most of the available farms at the auction at the first stage (Pargiter 1885). In one year, they again acquired the remainder and, thus, obtained a monopoly on forest produce (Pargiter 1885). Also, in one year (1867-1868), the Company gained a net profit of Rs. 42,849 (Pargiter 1885) through its oppressive harvesting methods (Ascoli 1921). Consequently, the government decided to cancel the *Bankar* system. It is evident that during the last 135 years, government initiatives focused mainly on leasing out the

forestlands. No initiative was recorded to protect local communities engaged in reclamation.

2.6.2 Present Management

The forest is currently under the sole management of the BFD. Because it is the largest mangrove forest in the world under commercial timber production management, forest protection advocates have increased the pressure on politicians, policy-makers and forest managers for scientific management of its resources (UNEP 2011). After independence in 1971, the forest increased in importance through the establishment of sanctuaries. Three wildlife sanctuaries were established under the Bangladesh Wildlife (Preservation) (Amendment) Act of 1974. The sanctuaries are Sundarbans South, with an area of 17,878 hectares; Sundarbans West, with an area of 9,069 hectares; and Sundarbans East, with an area of 5,439 hectares. Subsequently, in 1996, each of these sanctuaries was extended. The extended areas are 36,790 hectares for Sundarbans South Wildlife Sanctuary, 71,502 hectares for Sundarbans West Wildlife Sanctuary and 31,227 hectares for Sundarbans East Wildlife Sanctuary. The total area of World Heritage sites now covers 139,519 hectares (UNEP 2011).

Conservation practice in Bangladesh is based on the top-down management approach where upper level BFD managers make managerial and technical decisions as per the approval of the MOEF. Then the BFD forwards these decisions to their field offices for execution. This existing management mechanism does not allow for the participation of the FDCs at any stage. At the field level, there are two main offices of the BFD, namely, Divisional Forest Office (East) and Divisional Forest Office (West) under which there are 4 Range Offices and 72 Patrol Posts/Camps inside the SMF where a total of 1,167 staffs are working in different categories (BFD 2010). Under the present management structure, these field officials have no opportunity to incorporate local indigenous and customary knowledge of FDCs in designing conservation strategies. This exclusion approach violates NFP guidelines (GOB 1994).

The BFD has two divisional forest offices: Sundarban West Forest Division with their headquarters in the Khulna district, and the Sundarban East Forest Division

with their headquarters in the Bagerhat district. These divisional offices are divided into four administrative ranges: Chandpai, Sarankhola, Khulna, and Burigoalini. The forest is guarded by 16 forest stations and 55 compartments. On a 20-year cycle, the BFD harvests these compartments—lying in 9 blocks—in turn, along with the three peripheral wildlife sanctuaries on the coast. Early management emphasised revenue collection through simple felling, and encouraged overharvesting. Subsequently, conservation systems reduced the amount of overharvesting by enforcing a cutting rule for the four major timber species.

The present conservation system wisely uses its wetland resources through the establishment of protected areas along the southern periphery. The aim was to manage the forest sustainably for both timber and the needs of the local people (Seidensticker & Hai 1983). Nonetheless, forest management failed to achieve these planned objectives and the forest has showed continuous signs of degradation (UNEP 2011).

Past management approaches attempted to integrate conservation of wildlife with profitable exploitation of timber, forest products and fisheries (Blower 1985). Following this, a plan was drawn up in the 1990s with a target to manage the forest as a single unit. This supported the establishment of buffer zones at the peripheral level to restrict illegal access. To achieve this, an integrated Sundarbans management plan was initiated under the Sundarbans Biodiversity Conservation Project. The project was undertaken with funding support from the Asian Development Bank, Global Environment Facility and other funding agencies (Hossain & Roy 2007; MOEF 2000; Ramsar 2003). The overall objective of the project was to attain sustainable conservation of biodiversity and management of all reserved forest resources. In this regard, the key aim of the project was to ensure rational plans and participation of all key stakeholders (Reza 2004).

To achieve the above aim, three field stations were established to limit disturbances. The BFD controls the entry and collection of forest produce. It also issues licences for hunting under the *Bangladesh Wildlife (Preservation) (Amendment) Act, 1974*. However, in practice, such hunting licences are not issued, with a view to protecting biodiversity. Besides hunting, it also prohibits many activities within wildlife sanctuaries including residence, damage to vegetation, cultivation of land,

introduction of domestic animals and setting of fires (UNEP 2011). Nonetheless, the BFD can relax any such restrictions for scientific purposes, improvement of scenery or aesthetic enjoyment (Blower 1985).

To address deforestation and degradation of the forest, research is conducted under the management of the Bangladesh Forest Research Institute (BFRI). Although BFRI was established in 1955, mangrove research was initially overlooked. BFRI initiated a separate office in Khulna to enhance mangrove research only in 1985. There are eight field stations in the SMF to provide data for a number of its ongoing studies to BFRI researchers (UNESCO 2007). Nevertheless, it was unfortunate that this initiative was confined to supporting the scientific management of the forest and scientific aspects of the mangroves. Current research processes overlook socio-economic research aspects for mangrove conservation strategies and livelihood security of the FDCs. This missing link leaves a serious gap in achieving socio-political benefits from conservation policies.

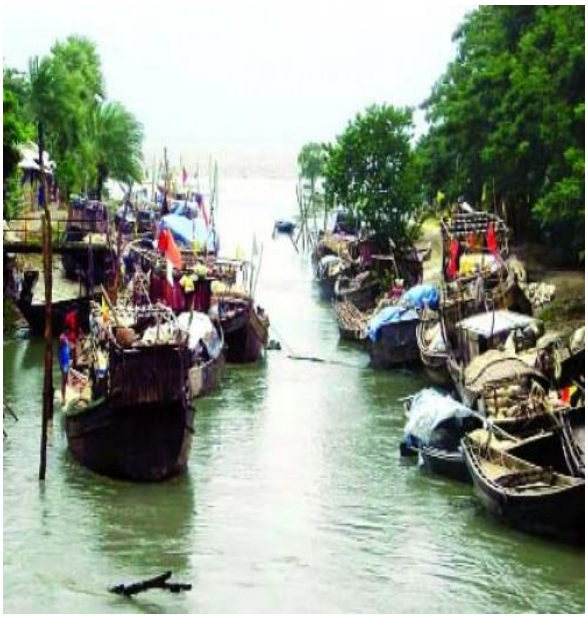
2.7 Local Forest-Dependent Communities

For many centuries, local communities have been harvesting resources and producing rice from farming through forest land conversion (Eaton 1990). Over the centuries, the local communities suffered from incursions by pirates, colonialists, cyclones and storm-surge devastation—all of which depopulated these local communities (Rainey 1891).

According to the FAO (1998) and UNEP (2011), the human population living in the area of the SMF is about 3.5 million and is estimated to have doubled in 34 years at a yearly population growth rate of 2.04. Iftekhar and Islam (2004a) identified 18 per cent of the households in the SIZ as having a direct dependence on the SMF. On the other hand, the FAO (1998) estimated the portion of this population to be 25 per cent on the basis of their full or part-time engagement in forest produce harvesting. This figure could be much higher if all members of the family were included. This population earns 46 per cent of their direct income from forest produce harvesting (FAO 1998). A recent study found 50 per cent of FDC households earn 70-100 per cent of their total income through harvesting resources from the SMF (Shah & Datta 2010). Figure 2.8 presents the principal harvested resources.

Figure 2.8: Principal harvested resources

(a) Fishing trawlers



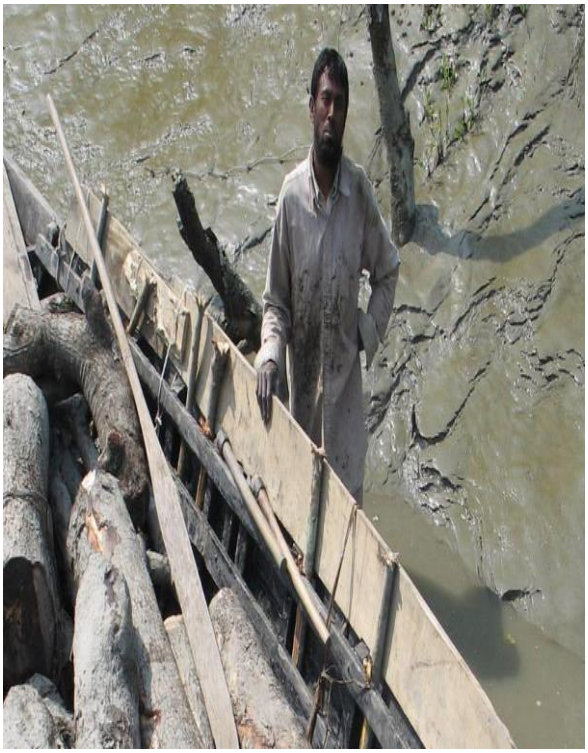
(b) Illegally harvested *Golpata* carrying as *Malam* in the sides of the boats

(c) *Golpata* harvested as thatch materials for roofing village houses

(d) Fish are being dried by the fishermen caught in winter fishery at Dublar *char*

Source (a-d): Ramsar, (2003)

(e) A wood-cutter with loaded boat



(f) A young fisherman with his equipment

(g) *Gol* leaves harvesting

(h) Crab harvesting

(i) Honey collectors racing into the forest

(j) Honey collectors most vulnerable to tiger-attacks

(k) Fisherwomen collecting shrimp fry

(l) A young girl at fishing

Source (e-l): Ahmad et al. (2009)

This forest has long been used for local community livelihoods. Originally, communities mainly cut wood (Ascoli 1921). Kabir and Hossain (2008) found five local communities directly dependent on the SMF, namely: *Bawalis* (wood cutters), *Mawalis* (honey collectors), *Golpata sangrahakari* (*Gol* leaves collectors), *Jele* (fishermen) and *Chunery* (snail and oyster collectors). Apart from these local

communities, there is only one indigenous Munda community, which moved to the Sundarbans region about 250-300 years ago from the Bihar province of India. *Zamindars* (landlords) brought them to clear this forest during British colonial rule. These communities are socially recognised and commonly cited by researchers to analyse the sustainability of this forest (Kabir & Hossain 2008). They are also identified based on resource harvesting patterns and allocation of property rights by the BFD.

Along with woodcutters, fish, crab, shell, honey and beeswax collectors, the forest provides livelihoods for timber traders and other workers. The number of harvesters has increased enormously. In one study, it was found that around 35,330 people work in the forest (Chakrabarti 1986). Of these, 4,580 collect timber and firewood, 1,350 collect honey and beeswax, and 4,500 harvest natural resources and hunt animals (mainly deer). The remaining 24,900 are engaged as fishermen, crab harvesters and shrimp farmers. Hussain (1997) assumes that the number of fishermen involved in year-round fishing is even larger. The number of honey collectors is less because of the short harvesting season which is limited to 3 months or 10 weeks starting from around the 1st of April each year. The BFD issues permits to the several thousands of FDCs to enter the forest for honey collection (Chakrabarti 1987).

Islam and Gnauck (2009) cited that the SMF employs 500,000-600,000 people for around six months of each year. They also cited the number of daily working fishermen and other stakeholders to be about 50,000. FDCs harvest wood and fish equivalent to US$100 million and US$304 million respectively, annually (Islam & Gnauck 2008). The harvested value of fish is three times higher than the annual value of forest products. The value of standing timber has been calculated at US$2.09 billion.

According to BFD estimates, around 45,000 people work in the forest in each day during the peak harvesting season (Hussain 1997). In addition, more than 10,000 fishermen set up fishing camps for three to four months in the winter (Hussain 1997). These fishermen mainly come from the distant Chittagong district and return home before the monsoon season starts. FDCs catch fish and crabs year-round (UNEP 2011). This is the most profitable and easiest source of income. In 1986, the average

annual fish catch was 2,500 tonnes (Chakrabarti 1986). This figure has continued to increase.

FDCs use extracted resources for their daily lives, to build houses and other necessities such as boats and furniture. They use timber for boats and furniture; charcoal and fuelwood for cooking; fish, crabs and fruit for food; poles for house-posts and rafters; Nypa palm thatch for roofing; reeds for fencing; grass for matting; and medicinal trees for local herbal treatment (UNEP 2011).

Because of tigers' significant dependence on the forest year-round, tiger-attacks are highest in the world (Barlow 2009). Each year some 300 people are killed by tigers and crocodiles in the forest (UNEP 2011). Locally-made non-mechanised boats are the only transport used by communities to harvest resources. However, mechanised boats are used by *Mahajans* and other local elite who employ FDCs for harvesting resources in larger quantity, such as for harvesting *Gol* leaves. Overall, these FDCs are very poor and live in a subsistence economy dependent on the forest.

Environmental problems affect multiple actors and agencies because of their uncertain nature and, typically, their multi-scale complexity (Reed 2008). Nevertheless, it is an imperative to understand that local stakeholder interests are directly affected by policy decisions (Hossain & Roy 2007). Decision-makers therefore need to understand how these local stakeholders are affected by the environmental policy decisions and actions they take and how their powers influence outcomes (Reed et al. 2009). In spite of a strict conservation policy, the forest is being degraded rapidly, posing a threat to the environment and the livelihood security of the FDCs. These threats are discussed below.

2.8 Threats to the SMF

The SMF is under severe threat of deforestation and degradation, in spite of long-term BFD management and a strict conservation policy (Akhtaruzzaman 2000; Primavera 1995). This, in turn, poses a threat to the livelihood security of FDCs.

2.8.1 Anthropogenic Pressure

The population pressure is significant in Khulna district with a household size of 5.2—higher than the national average of 4.9 and Khulna divisional average of 4.7

(BBS 2009). This district is the seventh largest district among the country's 64 districts in terms of household size (BBS 2009). On the other hand, this household size is the largest in comparison with 10 other districts of the Khulna division. This anthropogenic pressure increased the forest dependency of the population of the SIZ, as people mostly live below the poverty line (GOB 2005). For instance, in the 2001 population census, it was recorded that in Koyra *Upazila*, 67.89 per cent of household incomes were derived from agriculture (BBS 2007a). Out of these, cropping, livestock, forestry and fishery generated 44.96 per cent and the remaining 22.93 per cent came from agricultural labour.

Cyclone *Aila* caused the loss of income generation from agriculture and other sources, leaving them dependent on the forest. Tree density has decreased due to continuous logging (legal and illegal) and encroachment as a result of anthropogenic pressure (Iftekhar & Saenger 2008) (Figure 2.9). Shrimp farming and anthropogenic influences have destroyed 45 per cent of mangrove wetlands in Bangladesh (Islam & Gnauck 2008). This finding is in line with Barbier and Cox (2004). They found that increased shrimp farming accounts for 30 to 70 per cent of mangrove loss worldwide. The observed declining health of the SMF is particularly related to the high livelihood pressure exerted by high numbers of local people (Iftekhar & Islam 2004b).

Figure 2.9: Illegal harvesting

(a) Illegal fishing with the help of otter

Source: Ramsar (2003)

(b) Crab harvesting despite ban on catching and sale of crustaceans during breeding season

Source: The Daily Star, accessed on 24/2/2012, http://www.thedailystar.net/newDesign/index.php

(c) Illegal harvesters collecting *Keora* fruits by breaking branches of *Keora* trees

Source: The Daily Prothom Alo, accessed on 08/08/2011, http://www.prothom-alo.com/

(d) Illegal tiger hunting

Source: The Daily Star, accessed on 9/12/2012, http://www.thedailystar.net/newDesign/index.php

(e) Village elites illegally harvest *Goran* saplings to fence shrimp farms

(f) Illegal fishing in the Baleswar river with prohibited *behundi* and mosquito nets

Source (e-f): The Daily Prothom Alo, accessed on 09/2/2012, http://www.prothom-alo.com/

(g) Illegal woods seized by the BFD awaiting sale through tender

(h) Tree density degradation

According to the UNEP (2011), major anthropogenic effects include over-exploitation of wood and non-wood forest products and excessive poaching of animals. High coastal population demand enhances illegal activities. These activities include trawling for prawn seeds, creating irrigation and drainage canals, and building embankments for fishery and shrimp ponds. Over-exploitation is thus identified as the most pressing ongoing threat to both flora and fauna (UNEP 2011). Recently, it has been confirmed that anthropogenic pressure has already encouraged encroachment on the boundaries of eastern and western parts of the forest.

After two devastating cyclones (*Sidr* and *Aila* in 2007 and 2009, respectively), dwelling places of FDCs have been severely disrupted. Most people have now been resettled on embankments adjacent to the forest border. It is also assumed that further encroachment may occur unless this increasing and newly-settled population is stabilised along the borderline areas. Besides, like Chokoria Sundarbans, fishing camps are another major source of disturbance in the SMF.

Fishermen harvest excessive fish and crabs by breaking the prescribed rules. Similarly, woodcutters are also involved in extensive illegal and over extraction of resources, hunting and trapping (Blower 1985). Between 1981-81 and 1986-87, a total of 118 offences was recorded and over 3,300 metres of deer nets were removed (Habib 1989). Illegal activities are rampant due to the increased pressure after these

two devastating cyclones. It is thought that the SMF ecosystem normally takes 10-15 years to regenerate after damage caused by cyclone, provided there is no poaching or other human disturbances (UNEP 2011).

Anthropogenic pressure causes serious harm to the forest. For instance, green turtle *Chelonia mydas* is rarely seen because of excessive fishing. Excessive fishing is also destroying Hawksbills *Eretmochelys imbricate*. Several decades ago, smooth-coated otters *Lutrogale perspicillata* were estimated to be 20,000 in number (Hendrichs 1975). These are now domesticated by fishermen to drive fish into their nets (Seidensticker & Hai 1983). The number of estuarine crocodiles is being greatly depleted because of hunting and trapping for skins.

Salinity and inundation have also disrupted traditional livelihood practices and enhanced increased dependence on the forest. This, in turn, encouraged FDCs to move towards shrimp farming for the new export-oriented cash industry in the mid-1980s. However, artificial land inundation with brackish water during periods of low salinity by shrimp farmers has caused severe destruction to the forest cover (Agrawala et al. 2003). Depletion of forest was even faster because of increased pressures from waterlogged shrimp farming areas in other parts of the SMF.

2.8.2 Reduction of Fresh Water Flow

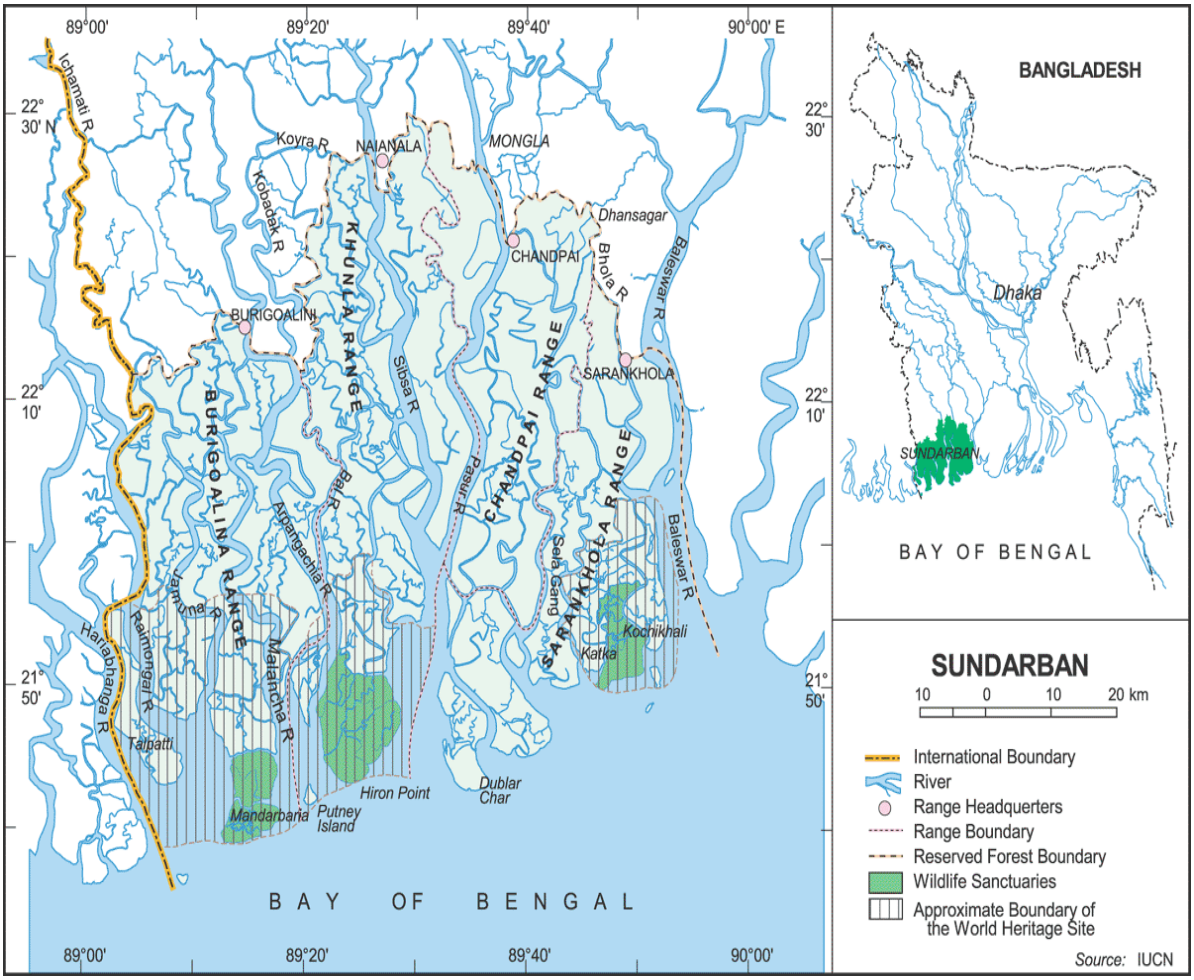
Geographically, Bangladesh is situated in the lower reaches of the Ganges delta. Freshwater flows come through the Ganges distributaries. However, India built the Farraka barrage just inside its border. Alteration of water flows of the Himalayan headwaters is one of the most notable disturbances threatening this mangrove forest (Rahman et al. 2011). The barrage is causing eastward migration of the Ganges. This has tremendously reduced and changed the fresh water flow of these rivers into Bangladesh and the SMF. The Passur, the Sibsa and the Koyra are fresh water rivers, whereas the Kholpatua and Madar rivers are semi-saline and saline water respectively. The reduced flow of fresh water is increasing the salinity in the forest and causing vegetation losses.

The vegetation of the forest is mainly comprised of six dominant species alongside these five river systems of the forest. These are *Sundari* (*Heritiera fomes*, Sterculiaceae) in the Passur river area; *Sundari*, *Passur* (*Xylocarpus mekungensis*,

Meliaceae) and *Kankra* (*Bruguiera gymnorhiza*, Rhizophoraceae) with scattered *Baen* (*Avicennia Officinalis*) in the Sibsa and Koyra river areas; and *Gewa* (*Excoecaria agallocha*, Euphorbiaceae) and *Goran* (*Ceriops decandra*, Rhizophoraceae) with few *Sundari* in the both the Kholpatua and Madar river areas (Hoq et al. 2006). Some of these species are not saline tolerant. For instance, the 'top dying' disease is common in the dominant plant species *Heritiera fomes*, practically unknown in any other mangrove forests across the globe.

The SMF waterways are dissected by seven north-south flowing rivers. These are the Raimangal, a mouth of the Meghna and a branch of the Hariabhanga to the Baleswar (Figure 2.10). The Ganges barrage has cut off most of the fresh water and shifted the outflow eastwards from the Bhagirathi-Hooghly channels (Seidensticker & Hai 1983). Thus, the whole waterways carry little fresh water, except for the Baleswar river on the eastern edge of the East Sanctuary (UNEP 2011). Salts are increasing in the south-eastern corner of Bangladesh that covers the whole of the forest area. Fresh water reduction has adverse effects on salt-tolerant fish harvesting during the dry season. In this period, fishing of salt-tolerant varieties becomes the main means of livelihood because of high salinity levels. Consequently, livelihoods are seriously hampered.

Figure 2.10: Map of the rivers and estuaries of the SMF



Source: IUCN (2011)

It is also reported that salinity ingress causes an increase in soil salinity in the forest areas. Increased salinity hampers complex forest processes of natural regeneration of vegetation and forest succession. This can significantly change the forest with discernible adverse impacts on forest regeneration and succession (Ahmed et al. 1999). For instance, the freshwater loving *Sundari* is anticipated to decline in number or disappear entirely due to such effects. This situation would make vegetation canopy sparse and plant height would be reduced. Consequently, productivity of the forest would seriously be hampered. According to Chaffey et al. (1985), increasing soil and river salinity reduces total merchantable wood volume. This view is supported by Ahmed et al. (1999) who suggested that disappearance of oligohaline areas combined with decreasing mesohaline would cause a 50 per cent reduction in merchantable wood.

The effects of climate change would be even more severe over the longer dry season from November to April. According to climate model predictions, there will be a reduction in precipitation in the period, which would reduce fresh water flows into the SMF (Agrawala et al. 2003).

2.8.3 Sea Level Rise

SLR has direct adverse impacts on the forest due to enhanced inundation and saline intrusion into river systems. Previous records present a higher SLR of 3.14cm against a world average of 2cm from 1983 to 2003 (UNEP 2011). Loucks et al. (2010) predict that the SMF will experience a 28cm sea level increase by 2070, which will cause severe habitat loss. This will leave outer islands of the forest to erode away. UNESCO cited an estimate that a 25cm SLR would destroy 40 per cent and a 45cm SLR would destroy 75 per cent of the total forest by the end of the 21st century (Colette 2007). According to Agrawala et al.'s (2003) Bangladeshi study, there is a likely SLR range between 30cm to 100cm by 2100. On the other hand, the Intergovernmental Panel on Climate Change (IPCC) projected a range of 26cm to 59cm of global SLR under scenario A1F1 (Meehl et al. 2007). Previously, potential SLR in Bangladesh was projected to be 30-150cm by 2050 (DOE 1993). However, following an IPCC report, as well as available SLR studies, Bangladesh National Adaptation Programme of Action suggested SLRs of 14, 32 and 88cm for the years 2030, 2050 and 2100 respectively (MOEF 1995).

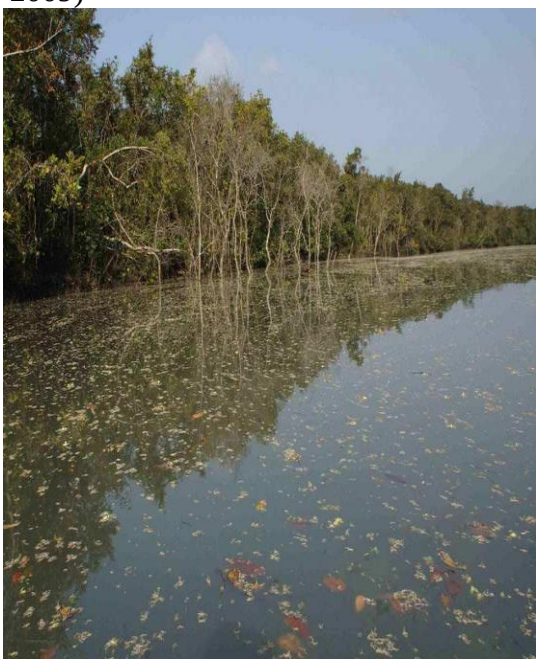
A study was carried out by the meteorological research council of the South Asian Association for Regional Cooperation (SAARC) on relative SLR in the Bay of Bengal for 22 years (1977-1998). SAARC's sea level data were measured and observed at Hiron Point. The result reveals a rise in sea level by 4.0 and 6.0mm per year respectively (SMRC 2003). It shows a much higher rate of SLR along the SMF in comparison with the yearly global rate of 1.0 to 2.0mm in the previous century (Karim & Mimura 2008). Figure 2.11 shows SLR-related vulnerabilities in the SMF.

Figure 2.11: SLR vulnerability

(a) *Upazila* headquarter and degree college under water during flood

(b) Damaged embankment

(c) SMF at high tide (Ahmad et al. 2009)



(d) Top-dying disease

(e) Main mode of transport to Khulna from Koyra

(f) Local protection of embankment with illegally harvested timbers

It is clear that a rise in the sea level will occur in the future. This would cause an increased backwater effect in the creeks and rivers and tend to push the saline front further inland. Although it is hard to precisely predict, the final location of the saline front will depend on two effects: enhanced fresh water flows from major Ganges distributaries; and enhanced backwater flows in the monsoon period (Agrawala et al. 2003). Thus, the backwater effect would reduce discharge of freshwater flows of the northern tributaries from the Ganges to the Bay. This would result in relatively

prolonged inundation of the SMF. Consequently, SLR, coupled with reduced fresh water flows, would increase dry season salinity levels in the SMF (Agrawala et al. 2003).

2.8.4 Environmental Degradation

Illegal felling of timber and poaching of wildlife are the two main environmental threats to the SMF (Agrawala et al. 2003). Over-extraction not only damages the SMF by reducing the resource stock, but also causes pollution from aquaculture. Other threats include uncontrolled oil spills and dumping of wastes, as well as natural disasters such as storms and cyclones.

After two recent cyclones, the construction of coastal embankments has changed previous synchronous hydrological ecosystems to a marginalised and scattered ecosystem (Hoq et al. 2006). Salinity increases various plant diseases. The land surface of the forest is flat. There are very few micro-topographical variations. Reduced flow increases sedimentation. Usually, the highest land is adjacent to watercourses. This is due to the sediment deposition caused when tides overflow their banks. Reduced water flows hasten sediment deposition. Besides, the construction of dykes has greatly affected fish and plant populations. Abovementioned environmental effects, coupled with pollution from industrial wastes from nearby Khulna and Mongla ports, have further deteriorated the health of the forest (Ramsar 2003).

Bordering rivers have been used to transport goods and materials from different countries, including India, to the Mongla port adjacent to the forest. This growing barge traffic is leading to oil spillage and adversely affecting the forest ecosystem (Agrawala et al. 2003; Blower 1985). Engine and speedboats used in tourism and patrolling have also caused damage through oil spillage. Harvesters also increase spillage at the time of harvesting. An example of oil spillage is the capsizing of a Panamanian cargo ship in August 1994 which caused the deaths of fish, shrimps, and other aquatic animals, along with *Heritiera Excoecaria* and grasses (Karim 1994b).

The construction of a series of embankments by the Government of Pakistan as an adaptation measure for coastal flooding in the late 1960s has caused environmental degradation. The authority did not recognise any adverse consequences during

construction design. Embankment water flow regulators were either not built properly as per design, or not maintained properly afterwards and, subsequently, caused water congestion. The area later experienced water logging starting from the early 1980s.

2.8.5 Inappropriate Property Rights

Despite strict conservation policies (to be discussed in Chapter Four) being in place with regulated restriction to entrance, rapid degradation poses a serious threat to the livelihood security of local FDCs. This is due to inappropriate allocation of property rights to FDCs which allows the BFD to allocate harvesting rights inappropriately to the vested groups. For instance, forest officials frequently have close links with contractors. In the recent past, the BFD employed around 4,500 contractors (UNEP 2011) to facilitate commercial logging of endangered timbers. In addition, the forest produces up to 45 per cent of total resources produced in the country's all state-owned forests, and the forest was the source of raw materials for the only newsprint paper mill in the country (Hussain 1997). Further, the forest regularly supplies raw materials to a number of hardboard mills, match and other industries. The BFD takes full ownership of this decision.

As the SMF is a reserved forest, the BFD is the sole manager, whereas MOEF is responsible for policy-making. The BFD allocates operational level rights through its local forest offices. Permits are mainly given to the *Jele*, *Bawalis* and *Mawalis*. These legal harvesters use *de jure* rights established through permits for entrance and use *de facto* rights for illegal harvesting. While FDCs use illegal *de facto* rights, the BFD exercises exclusive rights to monitor and manage resource harvesting. However, they fail to ensure sustainable harvesting of mangrove resources. The BFD has, to date, failed to make any attempt to attain sustainable harvesting through merging these *de facto* and *de jure* rights to manage the forest. Such attempts are needed to redefine the role of state property rights applied by the BFD.

2.8.6 Ineffective Laws and Management

Throughout 135 years of state management (Hussain 1997), the forest has been facing increasing threats. These problems have been accompanied by limited and poor implementation of enacted laws and management plans (UNEP 2011).

Unfortunately, poor management and the prevalence of corruption allow FDCs to practice illegal exploitation of resources.

Currently, military, police, navy, customs, fisheries and other departments are involved in the management of the SMF, along with the BFD. Involvement of multiple organisations influences degradation. These organisations render their duties independently, without any co-ordination. The BFD has no supervisory control over them. This creates a problem and has resulted in a failure to achieve the objectives of conservation. For instance, Hiron Point in the South Wildlife Sanctuary is a prime tourist spot inside the deepest forest. It is linked with the wider and open sea. Besides the BFD offices, naval and military camps are based there to ensure the security of the area. Their presence is intended to guard against smugglers moving to and from neighbouring India with contraband goods. Although they are meant to protect the forest, they are also involved in illegal poaching. Extensive illegal hunting and trapping by naval and military personnel in that area has been reported (Blower 1985).

Conflicts between the multiple organisations create serious obstacles for sustainable conservation. During the 1970s, a 31 km long shipping channel from Mongla to Ghasiakhali was introduced under the Indian water-protocol. The shipping route is used by the Bangladesh Inland Water Transport Authority (BIWTA) through the forest. This route causes harm to the water quality and disturbs the wildlife (Figure 2.12). Recently, this problem has become severe; and navigation problems have caused BIWTA to withdraw the channel. Since then, the BIWTA has been using an alternative, longer water route through the forest from Mongla to Sannashi (Suman 2011). The route includes huge ecologically-important areas of the SMF such as: Sannashi – Rayenda – Bogi – Shorankhola – Dudhmukhi – Harintana – Andarmanik – Mrigamari – Chandpai/Jaimanirgol. Surprisingly, the BIWTA did not seek permission for this activity from the MOEF or the BFD, although they regularly advocate against the use of the route (Suman 2011).

Figure 2.12: Unauthorised water route through the SMF

(a) Shipping channel along the SMF

Source: The Daily Janakantha, accessed on 23/11/2011, http://www.dailyjanakantha.com/

(b) Unauthorised route inside the SMF

Source: The Daily Ittefaq, accessed on 11/3/2012, http://new.ittefaq.com.bd/

Management systems are deteriorating since the occurrence of natural disasters because of disruption to government offices. After two recent cyclones, it was observed that the field stations, boats, jetties, and equipment of the BFD were washed away. For example, in 1997, there were 3 field stations in the West Wildlife Sanctuary. Each station had 9 staff, of whom 2 were officers and 7 were forest guards. Likewise, there were 2 and 3 stations in the South and East Wildlife Sanctuaries respectively. But cyclone *Sidr* had damaged and destroyed all stations and much of their infrastructure (UNEP 2011). Consequently, this drastically limited the BFD's authority and capacity to manage the forest and to prevent illegal harvesting and poaching of both marine and terrestrial fauna and flora.

In this situation, the international community has offered to become involved in the management of the area. For instance, UNESCO (2007) proposed re-establishing the management capacity of the BFD after *Sidr*. The proposal was made to avoid any irreversible damage from the risk of uncontrolled resource exploitation. However, their financial help in the form of a grant of US$100,000 was insufficient to restore

destroyed infrastructure (UNEP 2011). Consequently, even after two years, most of the damaged field stations remained unusable, specifically in the eastern part of the forest. Most importantly, radio communication towers remained completely out of service. The international community has instead ensured its involvement in managing the area by developing a five-year development project. This is how, in the name of re-establishment of the destroyed infrastructure, they consolidate their interference in the conservation management of the BFD.

2.9 Conclusion

Continuous deterioration of the SMF has become a serious threat to both its ecological systems and economic production. Most of the problems are attributed directly or indirectly to its rapidly dwindling condition that is firmly associated with historically unsustainable forest use. Anthropogenic pressure and natural calamities have enhanced FDCs' dependence on the forest.

Because of its importance, there cannot be any justification in allowing further losses from this forest. There needs to be sound implementation of conservation policy and planned interventions for the restoration of the forest. This necessitates adoption of a holistic approach to forestry, fisheries and the environment by ensuring active participation of FDC stakeholders. Redirection of the existing management regime and conservation interventions is needed, with a target to halt the rate of loss and to attain sustainable management.

In the long term, conservation policies have changed and been revised frequently. However, conservation issues in terms of habitats and wildlife protection have continued to be ignored. Policy-makers and BFD biologists frequently fail to explain effective conservation priorities. These, to some extent, ultimately become a political process. The success of this process lies in the wider participation of local FDCs in launching conservation activities. This aspect has long been missing. Consequently, one of the keys to successful conservation is a national political consensus on wider participation. Unfortunately, neither the colonial nor the present government has addressed this issue.

The forest is again facing threats posed by both human beings and nature. For sustainable conservation, FDCs' involvement and ownership in management and

decision-making is a prerequisite to ameliorating most of the threats. This needs a consensus to be reflected in the political process as well. In the absence of such a consensus, overcoming key challenges to achieve environmentally friendly and socially equitable benefit streams will remain a distant dream.

The forthcoming chapter presents the existing literature review of property rights and co-management in relation to forest sustainability.

CHAPTER THREE

PROPERTY RIGHTS AND CO-MANAGEMENT FOR FOREST SUSTAINABILITY

Chapter 3

Property Rights and Co-Management for Forest Sustainability

3.1 Introduction

The previous chapter explained the study area and its vulnerability due to a range of natural and artificial challenges. It described existing management of the SMF under the control of the BFD to substantiate the aims and objectives of the study. This chapter presents a conceptual and theoretical framework to understand a mangrove forest management regime as applied to the SMF. This framework is developed to inform policy decisions regarding an alternative property rights regime and demand-side interventions. The concepts and theoretical debates relating to FDC participation and the benefit-sharing mechanisms in a co-management structure are discussed. The discussion involves reviewing existing literature regarding forest conservation, property rights and co-management structures. The chapter also provides an outline of the existing state property rights regime. To develop the conceptual framework, some linkages between conservation and FDC livelihood security are considered in the context of the management of the SMF.

This chapter includes nine sections. Section 3.2 narrates the basic theory of property rights. Section 3.3 describes types of property rights. Section 3.4 provides a snapshot of natural resource management problems. Section 3.5 presents an overview of state property regime and its problems with the SMF. Section 3.6 pinpoints the rationale for an alternative property rights regime in the management of the SMF. Section 3.7 outlines the conceptual framework of the research. Section 3.8 identifies policy, theoretical and methodological gaps in the literature. Section 3.9 concludes the chapter.

3.2 The Basic Theory of Property Rights

From the writings of Adam Smith (1776) to the recent theory of economic growth of Barro and Sala-i-Martin (1995), it has been well established that an individual's increased production of economic outputs is the basic source of economic growth. It has two components. One is specialisation and the other is accumulation of capital. These are described below.

3.2.1 Specialisation and Accumulation of Capital

Specialisation

Within the context of forest conservation, specialisation needs elaboration. First, it describes the division of labour between individuals. Specialisation between firms means that the most efficient firms produce each commodity. The same can be applied to countries, with each producing goods with which it has comparative advantage.

Specialisation obviously needs trade. In the absence of trade, people will be forced to produce their own requirements themselves, without developing any specialisation. This was a common practice in primitive societies. Of course for trade, property rights are a prerequisite as trade is, in simple terms, a transfer of property rights. Without property rights there can be no trade and there can be little or no economic specialisation.

Accumulation

Capital refers to assets including physical, human, social and natural capital. Accumulation of capital needs property rights. Obviously, one cannot save valuables in the form of physical capital, natural resources or even human capital unless one has adequate property rights over one's accumulation. Accumulation of capital means sacrificing current consumption. It means individuals necessarily expect to be sure of gaining from the accumulation in the future. Without property rights this is not possible. Second, some individuals decide to consume assets lest others seize their accumulated assets. In that case, they consume over a short time period to overcome such an outcome. Therefore, in the absence of property rights, there will

be no accumulation and "what capital there might exist will be quickly seized and squandered" (Arnason, 2005, p. 245).

3.2.2 Property Rights and Market Creation

From this reasoning, it is recognised that property rights are a basic prerequisite for specialisation and accumulation of capital to occur. These arguments underpin one of the fundamental theorems of economics. This theorem is about the necessity of property rights for a high supply of goods and, indeed, economic progress in general (Arnason 2005).

Any trade presupposes property rights over the commodities to be traded. Theoretically, if property rights are in place, there remains the opportunity for FDCs to reap benefits from production specialisation of resource-specific harvesting. In this situation, trading will occur. According to Arnason (2005), the reverse situation is not true when the existence of markets leads to the creation of property rights. Hence, a causal relationship can be derived from property rights to markets and then trade. It does not operate in reverse.

Thus, it is clear that property rights systems are pragmatically based upon the existence of markets. Markets automatically exist if there are property rights. That means markets cannot arise without property rights, but property rights do not depend on markets. Hence, property rights are fundamental to market creation.

3.2.3 Property Rights and Externalities

Without defined property rights, a common problem in market production is the existence of externalities. For instance, externalities are pervasive in mangrove fisheries and mangrove forest resources. It is widely accepted that the market system is efficient when there is no externalities (Arrow & Hahn 1971; Debreu 1959). In this regard, what is less familiar is the close causal relationship between externalities and lack of property rights.

When property rights are missing, resource harvesters simply take as much as they want. Otherwise, they take to the extent allowed by the existing social custom. This creates a different situation in case of scarce mangrove resources when the act of 'taking' diminishes resources available to others in the society. Alternatively,

dependent FDCs are adversely affected by this ‘taking’. Hence, a negative externality is created.

However, having property rights in place restricts such ‘taking’. Nonetheless, it cannot be mentioned that full and complete property rights can be applied or such property rights are necessarily desirable in a particular economic situation of mangrove forest conservation. Consequently, in any regime, ‘taking’ as an output of negative externalities or ‘giving’ as an output of positive externalities occurs provided there is an exchange of property rights. This method of property rights exchange is obtained through purchase. Purchase price will be positive in an economic situation where resources are scarce. That means that the owner of previous property rights will be compensated for handing the property rights over to another party.

3.3 Types of Property Rights

Marshall (1890) identified that political economy examines the role of social and individual action more closely in connection with the attainment and material prerequisite to wellbeing. However, while Gordon’s (1954) work on the economic theory of a common property resource was stimulating, original and an important study, it escaped the theoretical discussion of Marshallian contributions. From earlier times, the economics of the forest has continually been under revision because of the efficiency of production being dependent on scarce resources and their appropriation (Scott 1955). Hence, allocation of appropriate property rights is necessary to emphasise the Marshallian concept that price and output of scarce mangrove forest resources reach a trading equilibrium.

Property rights regimes specify user rights for specific actors with comparable duties and obligations to others. These rights and duties have various dimensions. Economists distinguished four types of resource management regimes, namely: state, private, common, and open-access regimes (Bromley 1991). The following sections review these regime types.

3.3.1 State Property Regime

State property is property owned by all and its access and use is controlled by the state (Guerin 2003). Anything registered with the state becomes state property and the state may reserve the use of the property. Government is responsible for undertaking all maintenance and investment to guard against unauthorised use. Governments claim ownership of many natural resources because of their vital importance to society and the nation. The state exerts control over the use of a resource where local communities or groups of users find it difficult or impossible to control usage in the absence of recognised rights to the resource.

This underlying debate demonstrates the imperative of state ownership and raises legitimate questions about why a specific group of resource users should have property rights transferred to them. However, in reality, the state often lacks the capacity to enforce state property rights and regulations for extensive resources such as forests, marine fisheries, rangelands and irrigation. In this management vacuum, state property, in effect, becomes openly accessible where there remains no management and anyone can exploit resources—leading to resource depletion and overuse (Agrawal & Ostrom 1999). Under state regimes, sanctioned users and owners have rights against encroachers. Users without property rights are unlikely to be able to exclude logging companies or commercial fishing trawlers to prevent overharvesting. When rights are held by the state, local communities and indigenous user groups cannot apply *de facto* customary rights in resource management.

Under this regime, the state acts as a provider of property rights and incurs costs such as deliberations, rule-making, negotiations, dispute resolution, monitoring, detection, judicial proceedings and punishment (Eggertsson 2003). Taxation or other economic instruments cover these costs. It is sometimes argued that property rights arrangements incur two types of cost: exclusion and internal governance costs (Eggertsson 2003). The state property rights regime arguably mitigates exclusion costs with its own set-up or organisation to protect rights and to defend them from outsiders. Alternatively, internal governance costs are avoided through governing the behaviour of independent insiders who share the property.

The allocation of full authority is advocated to regulate the resource with the external agency in state property regimes and reduce overexploitation of an asset (Hardin 1968). However, it is observed that state property rights play a dominant role over the asset. Consequently, the inefficiency of state control as the dominant form of property ownership sometimes leads to the adoption of alternative forms of control (Chopra & Gulati 1997).

3.3.2 Private Property Regime

In private property rights regimes, access, use, exclusion and management are controlled by a private owner or by a legally defined group (Sheehan & Small 2002). The efficiency of property rights arrangements depends on each particular situation. It is sometimes observed that private property rights may emerge internally as a result of an individual agent's desire to avoid cost externalities (Birdyshaw & Ellis 2007). It is argued that private property rights are a set of workable rules to solve society's increasingly complex economic problems (Epstein 1995). Private property rights promote faster and fuller investment in maintenance and improvement of resources through investment in institutional and technological development. They change the structural response to each circumstance. They require higher outputs and incomes in comparison with other alternative arrangements. Non-secured property rights inhibit conservation by reducing capital investment because of uncertainty of gains. Private property rights overcome this problem of negative predictable consequences through rights enforcement.

It has been argued that the problem of over-exploitation and degradation of environmental resources can be resolved only by creating and enforcing private property rights (Demsetz 1967; Johnson 1972). However, it is important to note that no right in property can ever be absolute. State imposition or legal dictates may restrict even the use of private property in cases of emerging environmental significance or where there are amenity values adjacent to the property (Chopra & Gulati 1997). In private property, responsibilities in relation to the ownership, use and management of environmental resources usually fail to meet the collective or public need for environmental protection (Lawrence 2000), because actors' interests are not automatically compatible with environmental protection in spite of the existence of property rights. Leopold (1968) raised the question of whether an

environmental ethic is consistent with the notion of private property rights. Exclusive rights of individual owners cannot ethically and aesthetically promote positive good with an economic expedient. The use of private property rights to regulate natural resources is controversial because of two critical issues: the allocation of wealth in society; and the conservation and management of limited resources (Barnes 2009). Thus, this rights regime lacks complex forms of holding such as stewardship to meet physical, legal and moral imperatives associated with natural resources. This has made private property rights an unsuitable and ineffective means of regulating natural resources.

3.3.3 Common Property Regime

According to Chopra and Gulati (1997), common property comprises the setting up of a regime structure of rights and obligations with reference to the members of a specific group who are eligible to obtain access to the resource in question. This access carries with it certain obligations on the part of each member.

Under common property regimes, members enjoy not only access and withdrawal rights but also full rights of management and the exclusion of non-members (Eggertsson 2003). Pure common property regimes do give full rights of alienation or transferable asset titles to its members. This limitation differentiates common regimes from other types of exclusive rights (Eggertsson 1992). Common property regimes link user rights to a resource to membership of the resource management group. This management mechanism is expected to resolve disputes. Moreover, common property regimes maximise wealth through investment from social groups. This investment is expected to return a positive yield. Hence, it removes the costlier initiation of property rights.

Common property regimes lie between private and open-access rights (Eggertsson 2003). Common property regimes are complex structures that need rules and regulations with enforcement mechanisms to regulate exclusions and governance. When an asset is defined as common property, a specific group or insiders can easily use, control and manage the resource with exclusive use rights. Outsiders are not allowed to enjoy the resource. However, there may be an exception where rights of isolated groups may be based on customary law and social norms in some traditional

societies. In both cases, insiders with exclusive rights to a specific resource act as rational actors to avoid adverse effects on the supply-side. This provides incentives to invest in resource improvement and maintenance.

3.3.4 Open-Access Regime

Open access occurs when there are no property rights. This asserts that everybody's property is nobody's property (Bromley 1991). Actors enjoy both privileges and no rights for use and maintenance of an asset. In this system of privilege without rights, no actor has the right to preclude use by others. This fails to control resource use (Bromley 1991). In reality, it increases demand for the resource, which ultimately exceeds its rate of regeneration. The absence or breakdown of management and authority systems in open access regimes fails to introduce and enforce actors' specific resource use norms. Open-access regimes hamper actors' investment in the form of capital assets such as improvement of tree species. The institutional vacuum of open access expedites use rates and, therefore, the eventual depletion of the asset (Bromley 1991).

Unlike under common property systems, outsiders have access in open-access regimes. Actors are authorised to enter or withdraw resources under an ideal or pure open-access regime. However, no one or group has exclusive rights to manage or sell the asset (Eggertsson 2003). Additionally, no individual bears the full cost of resource degradation. This situation results in 'free riding' and over-exploitation which was termed the 'Tragedy of the Commons' by Hardin (1968).

Open access lies at one end and individual property lies at the opposite end on a individualisation of ownership measurement scale (Eggertsson 2003). Open access creates problems when independent actors enjoy both incentives and the ability simultaneously to withdraw on a large scale from an asset they access. In that situation, negative externalities and adverse consequences arise, such as inadequate provision, maintenance and investment in improvement leading to economic and biological degradation of the resource. Hence, open-access regimes cause the supply-side reduction in resources (Barzel 1997).

These regimes also incur undesirable consequences on the demand-side through accelerated and excessive withdrawal (Eggertsson 2003). Actors have an incentive to

be first to remove a resource as long as it remains abundant. Actors' motives drive them to unsustainable withdrawal of renewable natural resources such as fish and forest products. In fact, open access users have an incentive to deplete the resource to zero (Gordon 1954; Scott 1955). This regime does not contribute to accumulation.

3.4 Overview of Natural Resource Management Problems

In one way or another, all environmental and natural resource problems relate to over-exploitation and the provision of public goods in state property rights regimes. This arises from ill-defined and enforced property rights, formal or informal, to an individual or a group (Libecap 2009). In this situation, FDCs with high anthropogenic pressure behave as private owners and cause degradation. They are less motivated to consider internalising social benefits and costs in their production or investment actions—a view supported by Coase (1960).

Gaps between private and social net returns result in externalities. This includes overharvesting resources from a forest. This situation is a typical example of the 'Tragedy of the Commons'. The tragedy occurs through reducing aggregate short-term production or enhancing high use levels. Long-term investment to offset the stock is too low. These spillovers generate a damaging rush to exploit common-pool resources. Involved parties cannot bargain with one another in a manner described by Coase (1960). Dissipation or re-allocation of the resource to high-valued uses at present or in future does not occur. This situation does not provide price signals to reveal the opportunity cost and to correct wasteful use decisions. Hence, free riding is rampant and reduces resource stocks. This causes state property rights regimes to divert valuable and designated labour and capital from productive investment to predation and defence (Libecap 2009).

Regarding the above consequence of property rights and anthropogenic pressure, the wasteful situation is associated with common pool resource management such as mangrove forest management. According to Libecap (2008), this problem needs to be addressed to overcome wastage and to enhance social savings. He suggests that social savings are needed to avoid property rights problems by adopting several options: (i) providing incentives for collective action to develop informal property rights for the individual or group; (ii) if these are not feasible, *de jure* government

official regulations are needed to secure access and withdrawal of resources and their use; and (iii) allocating common property rights for private restrictions on resource extraction and use behaviour.

Achieving each of these options is not easy. First, there is a need to consider whether the beneficiary groups of the common property are small and homogeneous in costs, discount rates and production objectives (Baland & Platteau 1996; Ostrom 1990). By meeting these criteria, cooperative rules can be agreed upon to manage the resource and to provide group goods (Libecap 2009). In reality, it does not happen as there may be more than one group. Resource harvesting interests may differ from one group to another. This is very common for mangrove forests where there is interplay between fish and timber.

Exogenous factors raise the incentives for defection among existing group members. These attract more heterogeneous new entrants outside of the original group; and leave less incentive to overcome common property constraints. Unless the state recognises and enforces localised arrangements, new entrants will deplete existing resource stocks. In reality, this may happen due to the fact that group members are not as politically influential as the new entrants (Fog 1956; Hay & Kelley 1974).

Regarding the second option, government regulations such as tax schemes may bring private and social use costs into closer alignment (Pigou 1920). These tax schemes may remove effects of externalities through the implementation of central command and control regulations. Effective regulation and tax schemes need policy-makers and regulators to comprehend information on both the social costs and optimal levels of production. This includes private production and compliance costs of individual users. For mangrove forest conservation with state property rights regimes, these may not be applicable. FDCs cannot bear the compliance costs without alternative livelihood options. Hence, very few regulators can meet these requirements. As a result, in the case of mangrove forest conservation, state property rights regimes completely rely on the uniform standardised government regulations to address negative externalities. These include standardised controls on access as a regulatory instrument and the imposition of fixed tax levels as an economic instrument.

Although uniform regulations appear to be equitable and politically attractive, they fail to reflect differences in both production and compliance costs. Centralised rules for mangrove conservation are unlikely to provide incentives to the actual users of the resources due to the high vulnerability of poor FDCs. Rather, central regulations and tax policies are evaded—and are expensive to enforce. FDCs are not 'owners' under regulation and tax policy schemes of the FDs. Hence, FDs typically do not capture the increased social returns from the protection or investment in mangrove stock through conservation. Rather, they illegally allow FDCs to maximise private returns through cheating and malpractice (Johnson 1995). Hence, it often appears to be against the state's interests and fails to mitigate anthropogenic pressure by enhancing resource stock depletion.

3.5 Current Property Rights Regime in the SMF

The following sections describe existing state property rights and challenges in the SMF.

3.5.1 State Property Regime in the SMF

The creation of protected forests under the sole management of a forest bureaucracy has become synonymous with forest conservation since its commencement in the early 19th century (Colchester 2004; Nyhus & Tilson 2004). Likewise, the BFD is solely responsible for undertaking conservation and development initiatives in the SMF. However, the top-down conservation mechanism does not share its power and control of forests and forest resources other than with relevant government bodies. The BFD and MOEF make necessary investment through the Annual Development Programme (ADP). Development projects are implemented and monitored by the BFD.

The BFD uses licensing as an economic instrument as a corrective tax on harvesters to reduce the amount of harvesting effort. Harvesting effort is usually denoted as a function of the capital and labour inputs used to harvest resources. The objective of corrective taxation is to reduce the amount of effort and allow the forest time to regenerate. Economic instruments allow rights-based management in conservation practices. This form of rights allocation is intended to alleviate common-pool losses. Permit involves the granting of a right to specified time and catch allowed in a

nominated area. However, the BFD does not grant a right to the stock. For instance, individual permit rights give a weekly allowable catch in fishery and crabs. Permits are also issued to harvest various wood and non-wood forest products for up to thirty days. Present conservation policy applies permits as an economic instrument for this shorter term. The BFD initiates the guarantee of secured access and withdrawal rights to FDCs.

Through these regulatory instruments the BFD adopts legal regulations and statutes. Legal regulations can be prescriptions or proscriptions and laws, ordinances, decrees, and other forest conservation-related directives and regulations can also be legally binding. They are based on state authority directed from the BFD and MOEF. These legal regulations and statutes are used as a threat of coercion in a case of non-compliance. Regulatory instruments are enforced to conserve protected areas under the NFP, as are various laws such as conservation and hunting laws.

3.5.2 Problems with the State Property Regime

According to Libecap (2009), property rights arrangements provide multiple advantages to the conservation of natural resources through information generation, cost-savings, flexibility, transfer to high valued uses, and alignment of incentives for conservation initiatives. However, using case study and survey, Kumar and Kant (2005) identified that forest bureaucracy lacked accountability, responsibility and responsiveness to community interests. In other research, Spinesi (2009) found that the FDs often unnecessarily exacerbated income inequality by diverting resources from innovative activities and failing to ensure the livelihood security of forest communities. They argued that the bureaucracy was mainly responsible for dealing with its dysfunction in forest management, particularly by sharing power with the forest communities. Korten and Uphoff (1981) conducted additional research and identified the bureaucracy as comprising individual members with a mentality in which they behaved and expressed attitudes differently from those set out in forest conservation policy. Colchester (2004) and Sekher (2001) identified a link between forest sustainability and the secured tenure of forest land with access to resources. However, the existing regime fails to produce any approach to guarantee such a relationship under the traditional top-down conservation policy in the SMF. In line

with the findings of these studies, the existing state regime fails to capture negative externalities in this forest.

The central point of this debate is how the rights regime can capture externalities efficiently. In any case, the regime cannot leave an economic trading system that allows resource users to accumulate capital through specialisation. Thus, the state regime fails to address the missing link between conservation and the livelihood situation of the FDCs. Pavri and Deshmukh (2003) identified this rights regime as unlikely to develop any best-fit model to ensure sustainable forest management and establish desired forest-people relationships. In examining such forest-people relationships and their interaction within the state-managed property rights regime of the BFD in the SMF, it is clear that the present regime's efficacy hinges on satisfying user demands by allowing appropriate property rights. The top-down institutional structure has largely failed to cement regime legitimacy and historical relationships between property rights and FDCs. Motivation theorists identified this aspect and noted that non-satisfaction of higher level needs by the bureaucratic structure caused the lack of such willingness (Maslow 1943). In line with Robbins (1998), this ultimately impacts the quality and quantity of resource harvesting of the SMF.

The state property rights regime underlies mangrove forest management and provides full state ownership (Sudtongkong & Webb 2008). This model is applied in the management of the SMF where communities have no right to manage the resources or be involved in policy-making. This top-down management structure, thus, does not address the livelihood security of FDCs. In this regard, other management models such as open-access, full or partial privatisation and co-management models can be applied to the SMF.

Because the SMF has national and international significance, as well as huge anthropogenic pressure, the open-access management model is not suitable. In addition, it is not realistic for this forest to be fully or even partially privatised because of national and global importance. Thus, the best possible management model is considered to be the co-management option which has gained prominence as a means to obtain the sustained interest of communities in a participatory form with defined property rights (Plummer & Fennell 2007).

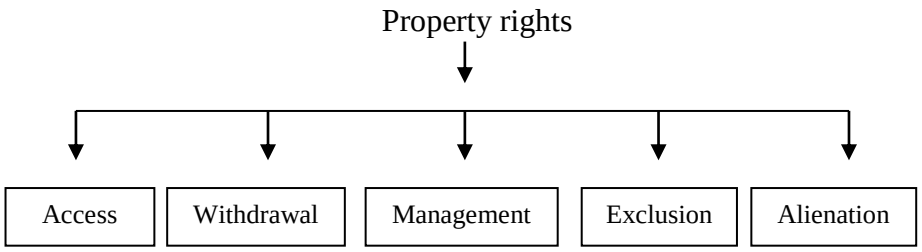
3.6 An Alternative Property Rights Regime for the SMF

3.6.1 Common Property Regimes

S&O (1992) differentiate property rights and categorise them into four classifications: (i) authorised users, who have access and withdrawal rights; (ii) claimants, who have rights to manage resources; (iii) proprietors, having rights to exclude others from use of the resource; and (iv) owners, having rights of alienation to divest the resource. These classifications may be held in common by FDCs who harvest from, use, and/or maintain one or more forests and who share the same rights and duties to harvest products from the forest(s). These classifications are used to allocate property rights in a co-management system for common-pool resources.

In regard to common pool resources, S&O (1992) identified operational-level property rights as access and withdrawal rights and collective choice property rights as management, exclusion, and alienation rights. They categorised these rights as authorised entrant (having access right), authorised user (having access and withdrawal rights), claimant (having access, withdrawal and management rights), proprietor (having access, withdrawal, management and exclusion rights), and owner (having all rights) (see Figure 3.1). The absence of these types causes ill-defined property rights and enhances degradation through the creation of negative externalities (Tietenberg 1992). Prasad (1997) also supported this view, which he perceived as de-motivating individuals and organisations to use forest resources efficiently and thereby resulted in a negative interest in forest conservation and management initiatives. From various empirical studies, Ostrom (2003) inferred that at least the rights of proprietorship (up to an exclusion right) made the communities govern and manage the common pool resources more effectively.

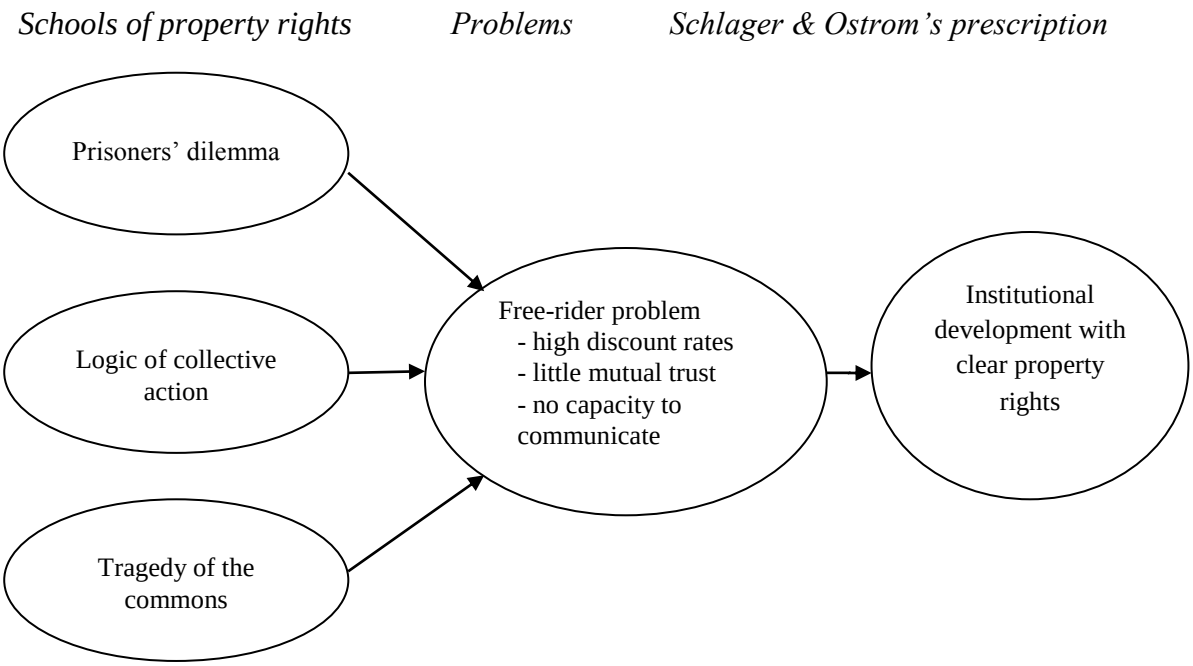
Figure 3.1: Typology of property rights



Source: Schlager and Ostrom (1992)

Many studies identified that ensuring property rights was a prerequisite for successful co-management where allocation of private tenure rights were not possible (De-Lopez 2005; Irimie & Essmann 2009). Their findings showed that those rights allowed access to jurisdictions and, therefore, incentives to the community to protect forests. Those studies were mainly conducted in European and North American contexts (Bouriaud 2007; Irimie & Essmann 2009), and very few were in a developing country contexts (Namaalwa 2008). However, Ostrom (1990, 2003) elaborated the property rights arguments by criticising the assumption that self-interested rational individuals did not cooperate. According to her, the tragedy of the commons (Hardin 1968), the logic of collective action (Olson 1965), and the prisoners' dilemma (Tucker 1950) are all inadequate because of the free-rider problem (Figure 3.2). Consequently, S&O (1992) argued for developing institutions as the basis of collective action; and identified five types of rights for governing common-pool resources from the experiences of the United States of America, Europe and other countries (Figure 3.1).

Figure 3.2: Genesis of S&O's property rights theory



Common property rights are regularly found in many parts of the world and often become an effective arrangement for institutional management (Chhatre & Agrawal 2009). The most common property right in forest management is access to a defined physical property and the harvesting of forest products. FDCs holding these two rights are defined as authorised users; and are hypothesised to have very weak incentives to limit their harvesting effort (Coleman 2011). Limited ownership restricts efforts by FDCs to develop specialisation. They have no right to make rules to limit forest use or harvesting effort in their attempts to obtain sustainable forest management. Consequently, authorised users who limit their harvesting efforts are disadvantaged by other (illegal) users who do not follow the same behaviour.

In a cooperative mechanism, FDCs will enjoy the rights of management as claimants to regulate internal forest use and prevent overuse. Although this right provides comparatively more extended ownership over the resources, right holders cannot exclude other entrants. Hence, rights holders are unable to reap benefits from trading their harvested resources. Moreover, previous research has found that this arrangement provides somewhat weak incentives to reduce overharvesting (Coleman 2011). Therefore, without rights of exclusion, FDCs are unlikely to extract expected benefits from the rules they establish in a co-management arrangement. Under this arrangement, FDCs are defined as proprietors who allocate access and withdrawal

rights to members within their group. Proprietors are hypothesised to have somewhat stronger incentives to sustainably harvest as they receive benefits from doing so and they can exclude others from the forest.

Many authors argue that the right to alienate, that is, the right to sell or lease any of the above rights, is a very crucial characteristic of effective property rights (Schlager & Ostrom 1992). These rights encourage resource owners to reap maximum benefits from long-term actions that ensure sustainable forest management. With these alienation rights, FDCs can lease or sell the benefits to those who value the benefits most. Owners are distinguished from proprietors as the latter only have rights to realise benefits from sustainable forestry, but the former can sell those benefits to those who value them the most (Coleman 2011). Thus, full ownership is hypothesised to provide the greatest incentive to sustainably manage resource stocks. However, by definition, these rights are absent in common pool resources (e.g. the SMF) where government regulatory bodies act as the owner and manager. Table 3.1 describes the theoretical typology of property rights.

Table 3.1: Typology of property rights bundles and right holder designation

Property right holder	Property rights	Expected incentives to manage resource stock
Authorised user	Access + withdrawal	Weak
Claimant	All the above rights + Management	Better
Proprietor	All the above rights + Exclusion	Strong
Owner	All the above rights + Alienation	Very strong

Source: Adapted from Schlager and Ostrom (1992)

The above table demonstrates that proprietors have strong incentives to manage resources sustainably. This authority allows right holders to accumulate capital through specialisation. Through the operation of the market system, the rights holders gain from benefit sharing.

The theoretical framework of this research is based on this classification of property rights bundles. In this study, a common property setting is applied to the co-management model. It analyses how FDCs may gain specialisation and accumulation of capital through the application of common property rights. Hence, it is necessary to understand how S&O's framework applies common property rights for managing resource sustainably.

3.6.2 Schlager and Ostrom's Framework

Operational level rights are translated into operational-level rules used to conduct daily activities. According to S&O (1992), "by the term 'rules' we refer to generally agreed-upon and enforced prescriptions that require, forbid or permit specific actions for more than a single individual" (p. 250). An example of an operational rule is the specification of the types of authorised or forbidden fishing or timber harvesting technologies.

Collective level rights frame operational rules for individuals' participation in activities. A collective-choice action can necessarily change operational rules. The typical operational rule is devised or changed with the right to participate in decisions. For example, allowing the types of authorised or forbidden fishing in a particular location is a collective-choice right (Schlager & Ostrom 1992).

Although users of natural resources frequently apply the terms 'rights' and 'rules' interchangeably, S&O's (1992) classification distinguishes them as 'rights' which are the product of 'rules'. The terms clarified as 'rights' refer to particular authorised actions; and 'rules' refer to prescriptions leading to authorisations. Although S&O (1992) rest their approach completely on property rights, they specify that all rights have complementary duties.

S&O (1992) classify access and withdrawal rights. Access is the right to enter a defined area; and withdrawal allows extraction of a resource. For example, if a group of wood cutters hold an access right, they may have authority to enter a defined area subject to following the rules specified for them to exercise this right.

According to S&O (1992), collective choice rights are so powerful that they provide authority to devise future operational-level rights. Management rights allow property rights holders to regulate internal use patterns and to make improvements to a resource for transformation. For example, fishers have the authority to determine the zoning plan for limiting various types of harvesting activities with the demarcation of catch areas in fishing grounds. An exclusion right authorises property rights holders to determine who will have access rights to a resource and how this right may be transferred to other individuals. For example, fishers who confine access to their fishing grounds to males of a certain age group belonging to a particular community

and who use particular types of gear are characterised to exercise a right of exclusion (Schlager & Ostrom 1992).

Although these five property rights are independent from one another, they are frequently used in the cumulative management of fisheries or forests. Significantly, this concept can be applied for mangrove forest management. For example, it is possible to have entry rights without withdrawal rights; to have withdrawal rights without management rights; to have management rights without exclusion rights; and to have exclusion rights without rights of alienation.

S&O (1992) warn that these property rights bundles may cause harm within a single common property resource. A conglomeration of *de jure* and *de facto* property rights may overlap or complement to create conflict between property rights. For instance, a government may allow fishers *de jure* rights of access and withdrawal; and retain the formal rights of management, exclusion and alienation for itself. In this situation, fishers may not be able to exercise management and exclusion rights to define among themselves how harvesting may take place and who will harvest from the defined fishing grounds.

Demsetz (1967) argued that private property rights have the predominant influence over investment. S&O (1992) argued that private ownership was not the only structure of property rights that encourages investment. For example, the right of exclusion provides strong incentives for owners and proprietors to encourage investment because, with this right, proprietors and owners can make decisions as to who can or cannot access a resource. S&O's (1992) model allows researchers to explore the variations of property rights in common property settings and investigates their effects on natural resource conservation. This study uses the S&O model to categorise adults from the FDCs into ownership categories.

3.6.2.1 Criticisms of Schlager & Ostrom's Theory

S&O's (1992) theory is becoming increasingly popular in interpreting forest resource management (Coleman 2011; Dorji et al. 2006; Roy et al. 2012). In spite of that, this theory is criticised, first, as a normative framework and a blueprint and because it largely focuses on internal dynamics of resource management (Steins & Edwards 1999). Second, Agrawal and Chhatre (2006) identified gaps in this theory as it failed

to address forest-people relationships in investigating the range of causal variables. They also explained that this theory in diverse institutional settings failed to shape forest conditions. Third, full ownership may cause a reduction of forest resources because of the existing poverty of the forest communities.

Thus, this study will enrich S&O's (1992) model by focusing on the adequacy of proprietorship or any bundled property rights for co-management and their influences on the sustainability of the SMF.

3.6.2.2 Adaptation and Adoption of the Framework

In spite of the above criticisms, S&O's (1992) framework is used extensively in the literature. Existing literature commonly cites the S&O ownership framework in areas such as fisheries (Iglesias-Malvido et al. 2002; Rudd 2004; Sekhar 2004), forests (Barsimantov et al. 2011; Behera & Engel 2006; Coleman 2011; Coulibaly-Lingani et al. 2011; Hayes 2007; Hayes & Persha 2010; Thanh & Sikor 2006), wetlands (Ahmed et al. 2008; Ambastha et al. 2007) and irrigation (Kolavalli & Brewer 1999; Meinzen-Dick & Bakker 2001). Nonetheless, it is found that most of the studies cite S&O without framing key discussions or hypotheses within the property rights typology. In many studies, the use of the full typology of property rights such as access, withdrawal, management, exclusion and alienation is absent (Dorji et al. 2003). According to Ahmed et al. (2008), typically, authors use one set of S&O's typology (i.e. authorised user to assess or analyse a common property regime) and only a few researchers have used S&O as a general theoretical framework.

Mangrove forest conservation is different from general forest conservation due to joint production with mangrove fisheries and aquaculture. For example, mangroves present a special case where multiple resources such as forests, fisheries, and other vegetation are extracted by community members. Living along the interface between land and sea, the mangoves support diverse and rich habitats of aquatic and terrestrial organisms. Because of this greater diversity of habitats, mangrove biodiversity is subject to various pressures with respect to developmental needs and over-exploitation. Overall, this causes a steeper reduction trend in productivity for mangrove forests than for other forests (Kathiresan & Qasim 2005). Therefore, mangrove management is different from other forest management because of four

management domains: mangroves, fishery, wildlife and eco-tourism. In this regard, Kathiresan and Qasim (2005) suggest conservation of mangrove habitats and their biodiversity should form a top priority for preservation purposes and the sustainable utilisation and restoration of ecology.

The S&O framework offers a great deal of flexibility in analysing property rights in such a multi-pronged but composite resource system for mangrove resource management. This implies that mangrove conservation requires policy to also jointly examine aquaculture development (Armitage 2002; Farley et al. 2010). It is important to note that no published research has yet applied S&O's (1992) model to assessing such differences in mangrove conservation (Adger & Luttrell 2000; Farley et al. 2010; Primavera 2000; Saunders et al. 2010). Furthermore, no research has investigated the role of property rights in developing specialisation and enhancing accumulation of capital by the FDCs of the SMF.

3.6.3 Co-Management

To understand the existing negative outcomes of the state property rights regime, the following sections discuss the application of S&O in co-management of the SMF.

3.6.3.1 Basic Concepts of Co-management

The increasing interest in the co-management of forests has become pivotal in the last two decades. Plummer and Fitzgibbon (2004a) defined co-management as "the distribution of rights and responsibilities pertaining to a particular resource" (p. 878). Matose (2006) defined co-management as the management of reserved and protected forests by the government where surrounding communities can actively be involved in designing, planning and execution. These are blended with theory and practice and shared with government and local users. This study is primarily concerned with the body of knowledge of co-management and how such knowledge can be applied to the SMF. It will enrich the theoretical model by explaining the inadequacy of distributing property rights to ensure the continuous benefit stream and looks into the need for alternative income-generating activities within them to shape the co-management definition for the SMF.

Following on from the above definitions set out in the literature, it is argued that co-management is a key to sustainable forest management (Jumbe & Angelsen 2007; Matose 2006; Plummer & Fitzgibbon 2004a). The aspiration to involve communities and invite them to share responsibility for forest management, benefits and decision-making powers at all levels has become a big concern to the policy-makers, researchers and development practitioners (Kant 2004). In the last few decades, the debate over community-managed conservation for forest resources against the failure of fortress-style conservation under the FDs has become of interest to all concerned. And this is related to the measures concerned with the production and preservation of forest lands and resources for forest conservation. Hence, cooperation from the local community is pivotal (Quazi et al. 2008).

However, local people's cooperation in co-management framework is not easy. In a recent study, Behera (2009) identified that access by local people in forest resource management had been recognised as an important policy gap in many developing countries. In practice, however, social capital was not enhanced. Social capital can be described as features of social organisation such as networks, norms and trust which facilitate collective action through coordination and cooperation for mutual benefits (Putman 1993). By building relations, trust, altruism and civic responsibility among the members of the forest commons, social capital has immense positive externalities and effects on sustainability (De-Lopez 2005). Hence, it is fundamental to allocate property rights to the FDCs to ensure the development of their social capital. This gap occurs in Bangladesh where the NFP allows the involvement of local people on paper, but in practice the BFD excludes them from overall management of the forests (GOB 1994).

Furthermore, Kolavalli (1995) identified that the main features of co-management—the mutual acceptance of responsibilities, rights, and accountability by the FD and local people together—very often remained absent. For example, by using survey and FGD methods, Behera and Engel (2006) identified that FDs did not bear adequate accountability to ensure property rights in co-management. Rather, local people became vulnerable to the exploitation of local and national elites. In Nepal, Adhikari and Lovett (2006) used field survey and participatory rural appraisal (PRA) methods in their research and found that the highest transaction costs appeared to be

the 26 per cent of resource appropriation costs borne by the poorer households in comparison with 14 per cent borne by rich households. This indicates that co-management has been unsuccessful in addressing the equity issue under the FDs and policy-makers still have a long way to go to ensure it.

3.6.3.2 Failures of Co-management

Although co-management has emerged from the backdrop of centuries-old forest management systems by the FDs, it could not overcome the major gaps in theory and practice. Charnley and Poe (2007) identified those gaps as the failure of equitable power distribution from states to communities with emphasis on local control over forest resources. These failures were due to the lack of power within communities for decision-making, management and protection of forests from undue interventions of the FD (Bhattacharya et al. 2010) which, concurrently, were caused by the absence of appropriate property rights.

To avoid the above problem, theorists typically identified decentralisation reforms for forest bureaucracies by allocating property rights to enhance efficiency, accountability, equity and responsiveness to the demands of the local people (Webster 1992). Ribot et al. (2006) conducted comparative analysis in Senegal, Uganda, Nepal, Indonesia, Bolivia and Nicaragua by applying case study methods for forest management. They found that fundamental bases of decentralisation "including discretionary powers and downwardly accountable representative authorities are missing in practice" (p. 1865). However, these studies failed to prescribe any effective decentralisation mechanism for accountable institutions at government level to establish and secure property rights as the basis for autonomous decision-making opportunity for communities. In addition, these studies failed to identify the appropriateness of property rights and any alternative for co-management. To enhance forest sustainability, improvement of community livelihoods is necessary to lessen the dependence of FDCs. Without addressing the missing link between livelihood security and forest conservation, even conservation policy with co-management may not cap deforestation and degradation.

3.6.3.3 Role of Property Rights in Co-management

It is sometimes argued that regulation and tax policy have roles in response to the 'Tragedy of the Commons'. This is mainly because of the lack of feasible alternatives to correct market forces. This approach also restricts the number of entrants. Hence, the high resource costs of defining and enforcing rights-based arrangements emerge. Another reason is the lack of any possibility of privatising common-pool resources due to high political costs with high social value. The lack of a rights-based approach in forest conservation and centralised standard prescriptions not only ignore real costs but also fail to address anthropogenic pressure. Therefore, centralised regulations are costlier and have proved to limit effectiveness.

From this backdrop, property rights might not be a solution to address the externality directly. They are not able to provide individual incentives to participate in conservation for environmental and natural resource use. Theoretically, property rights allow markets. Markets provide price signals for alternative use of costs and benefits for all forms of common-pool extraction and provide environmental amenities (Demsetz 1967). The application of property rights in common-pool resource management needs to define and enforce resource use in allocating and demarcating entitlements. This helps in arbitrating disputes and enhances policy compliance.

The allocation of property rights under conservation policy has high political costs due to the impact of rights assignments on wealth distribution and political influence (Libecap 2008). In the case of forest resources, FDs need the right of exclusion to make rights effective. Exclusion ultimately creates winners or losers. Theoretically, property rights allow resource ownership to obtain the stream of net benefits from production specialisation, investment and trade. Resource ownership is expected to allow stock rebound from open-access depletion and is associated with huge wealth distributional impacts.

However, in reality, this may not occur due to high community dependency on resources. Forest resources cannot cope with the high demand of the poor dependent communities, who, as a result, over-harvest. This situation is worsened with the

shorter period of property rights allocated by permits. This economic instrument neither develops ownership in the FDCs nor enhances specialisation or accumulation of capital. This situation may cause deterioration of social cohesion and the possible losses of other collective values, supporting 'the Comedy of the Commons' (Rose 1986).

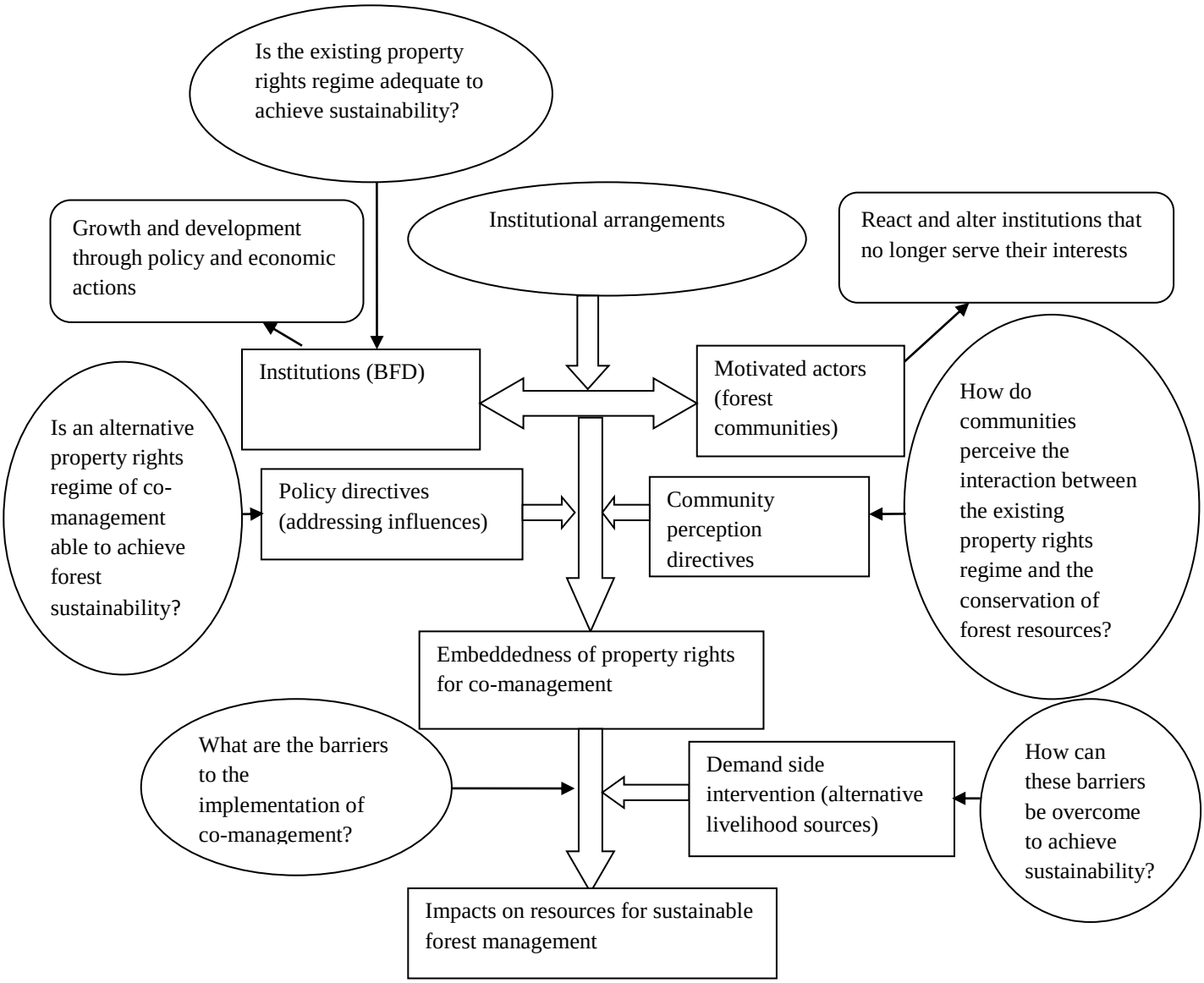
To overcome such dissatisfaction, it is necessary to mitigate distributional reaction and to secure socially and politically desirable outcomes. For this reason, many economists support not only common property rights, but also grandfathering or first possession of property rights (Libecap 2007). However, the grandfathering or first possession concept is criticised as it restricts new entrants. In this situation, market forces do not work to allow trade to gain from specialization, and capital accumulation by resource users. Thus, theoretically, the benefits of property rights depend on the level of rights granted and its ability to address the 'Tragedy of the Commons' (Guyader & Thébaud 2001).

However, in reality, the 'Tragedy of the Commons' can be addressed if high anthropogenic pressure of the resource users is addressed. The trend towards degrading of mangrove forest is due to not meeting the demands of large FDCs, even after the allocation of common property rights. The adoption of alternative livelihoods is needed to lessen the pressure. The common property regime is efficient when there is expected benefit-sharing to offset the costs involved through the creation of alternative livelihood opportunities. Then, this regime provides gains to the society in addressing the externalities via reduced overharvesting, more investment and trade. It also allows the losers, due to allocation of rights, to be compensated politically through side payments or supply-side interventions for alternative livelihoods from the wealth saved from open-access losses (Libecap 2009, p. 129). These supply-side policy interventions might include short-term subsidies or the creation of alternative livelihood options for the longer term.

3.7 Conceptual Framework

On the basis of the above literature review and research questions, the conceptual framework for the proposed research has been developed in Figure 3.3.

Figure 3.3: Conceptual framework of forest sustainability with co-management



Institutional arrangements are key to socio-economic development because they shape policy and the behaviour of economic actors. The existing top-down institutional structure has failed to address relationships in the way that motivated actors could react if institutions did not serve their interests. Thus, S&O's (1992) theory synthesises property rights to gain better outcomes from the involvement of these motivated actors. According to this theory, such relationships are regulated by set institutional arrangements and should have impacts on resources. This study treats the BFD as an institution, and forest communities as the motivated actors. The present reduction trend of the SMF suggests that this theoretical approach is

currently absent. Thus, this research investigates whether these communities are satisfied with the present institutional structure by understanding their perceptions towards existing property rights and the conservation of the SMF. If they are dissatisfied, such perceptions will help explain the justification of co-management as the alternative with defined property rights for the communities.

Following the above justifications, this research proposes a co-management approach for the sustainability of the SMF. For the SMF, a mangrove co-management approach will be an arrangement in which both *de jure* and *de facto* responsibilities and obligations for sustainable management of the SMF are negotiated, shared and delegated between the BFDs and the FDCs. However, this research critically evaluates whether this co-management approach is able to achieve sustainability of this forest or whether any alternative livelihoods options are necessary.

In this regard, this research will also explain perceptions of those rights and conservation determinants for the SMF. Simultaneously, this research will identify the barriers to and remedies for the distribution of property rights for co-management. Thus, this research will assess whether S&O's embedding of common property rights is adequate for forest sustainability, or whether any demand-side intervention is also needed to ensure impact on resources for sustained conservation. It is thus expected to suggest the need for corrective policy directions focusing on embedding property rights in a co-management structure and the sustainable management of the SMF.

3.8 Gaps in the Literature

The review of the literature reveals the following gaps in theory, method and policy:

i. There is no known study that investigates the adequacy of the existing property rights regime for the SMF by applying S&O's (1992) theory. Earlier research is not based on theories that investigate whether the existing property rights regime is conducive to its sustainability. Thus, the intensity of community dependency and policy failures leading to ill-defined property rights causing rapid reduction remained unexplored.

ii. The above studies regarding the theoretical aspects of property rights were conducted in countries where there was an established co-management structure. Ill-defined property rights are identified as the root cause of rapid degradation of the forest area despite the existence of conservation policies. In the context of Bangladesh, past studies did not highlight these issues and were conducted outside the reserved forest. Neither were they within the purview of the conservation policy. Muhammed et al. (2008), Salam and Noguchi (2006), Salam et al. (2005) and Salam and Noguchi (1998) conducted studies to investigate farmers' participation in the central *Sal* (*Shorea robusta*) forest of Bangladesh. Those studies totally excluded the range of causal influences perceived by the communities regarding property rights in shaping forest conditions under prevailing top-down institutional settings. Furthermore, they did not consider community perceptions of the interaction between the existing property rights regime and the conservation of forest resources.

iii. No studies have yet examined the rationality of existing state property regimes. Alternative property rights regimes for co-management as policy options have not been explored.

iv. Only one study was conducted to identify the status of the SMF by using the PRA method (Kabir & Hossain 2008) without considering any theoretical framework. No studies have investigated its sustainability by using community household surveys based on a model derived from S&O's (1992) theory, along with content analysis and FGD methods.

v. Earlier studies did not challenge S&O's (1992) model by investigating the necessity of demand-side interventions along with property rights bundles for sustained conservation of the SMF.

3.9 Conclusion

This chapter addresses the broader issues of property rights as incentives to sustainable forest conservation. Forest management in the SMF is top-down. This institutional structure has neglected community-based conservation and failed to contribute to the development of forest resource management organisations at the local level. Forest conservation policies rely primarily on existing economic and regulatory instruments, as well as BFD's technical precepts. Because of significant anthropogenic pressure and ill-defined or limited property rights, FDCs cannot gain from trading. Even so, the BFD has not yet made any attempt to use the range of benefit-sharing mechanisms that would involve the local FDCs.

Although there is much literature on community involvement in forest management throughout the world, there is a lack of consensus on which management mechanisms will achieve sustainable conservation. Because of diversified resources and easier harvesting processes, mangrove forests are being degraded at a fast rate. Hence, only co-management with defined property rights may overcome this problem and achieve sustainable conservation. Demand-side interventions are also needed. In this regard, this study will contribute to the literature in terms of theory, method, policy and practice by addressing the identified gaps.

The next chapter reviews the role of property rights and forest policies in the management history of the SMF by applying S&O's (1992) property rights typology.

CHAPTER FOUR

PROPERTY RIGHTS IN FOREST POLICIES FOR SUSTAINABILITY OF THE SUNDARBANS MANGROVE FOREST

Chapter 4

Property Rights in Forest Policies for Sustainability of the Sundarbans Mangrove Forest

4.1 Introduction

Following earlier discussions on property rights, this chapter critically analyses the adequacy of the existing property rights regime to achieve sustainability of the SMF. Bangladesh, as a signatory to many international forums and protocols including the Kyoto Protocol and International Convention on Biological Diversity (CBD), commits to implementing international guidelines by incorporating sustainability into national forestry directives to ensure FDC livelihood security. In this regard, this chapter articulates a historical analysis of property rights in forest policies. The analysis critically reviews management options and policy amendments through different historical time periods that address the possibility of benefits to FDCs through rights embeddedness.

Forest policies of the SMF in Bangladesh have a long history of state management. The analysis synthesises forest policies from four distinct historical time periods. The embedding of property rights during those periods reflects S&O's (1992) theory. Thus, the analysis provides reflections of property rights in policy interventions and then their contribution to resource extraction. It also identifies an immediate alternative regime intervention for sustained conservation of the forest.

The rest of the chapter comprises seven sections. Section 4.2 presents the historical approach as a framework for forest policy analysis. Details of the use of the analytical method for content analysis are highlighted in Section 4.3. Section 4.4 is concerned with the critical evaluation of four historical forest policy periods for managing the SMF. This is continued through a discussion of the reflection of property rights in the policy interventions in different time periods by developing a

content analysis matrix in Section 4.5. Section 4.6 designs an overall policy model for the sustainable management practices of this forest. Section 4.7 concludes the chapter.

4.2 Framework for Forest Policy Analysis

Because of analytical complexities of policy change, the process of forest policy explanation becomes difficult for researchers, practitioners and policy-makers (Villamor 2006). Policy analysts thus adopt different approaches. According to Cubbage et al. (1993), there are several approaches for forest policy analysis: (i) the historical approach; (ii) the institutional approach; and (iii) the analytical/procedural approach. The historical approach reviews past events and laws for describing forest resources policy evolution. The institutional approach looks into the institutions and organisations responsible for forest policy formulation. In a different way, a model of political decision-making is used in the analytical or procedural approach. Cubbage et al. (1993) identified shortcomings in all three approaches. According to them, the first approach is comparatively simple for forest policy process analysis, whereas the second approach is confined to specific institutions for forest policy process analysis. For the last approach, there is an absence of clear criteria to judge the implementation of a particular policy initiative.

The abovementioned limitations of all three approaches make policy analysts and researchers struggle to choose the most effective approach to analyse the policy processes that, in reality, are detailed and complex (Cubbage et al. 2007; Villamor 2006).

Considering the above limitations and availability of data and information, the historical approach is applied in analysing forest policy in the SMF. However, the use of an historical approach to explain the process of policy change has its own complexities. This is due to the absence of a functioning and dedicated institution in early colonial periods. It is also not possible to develop any particular political decision-making model over the long term due to the lack of a structured political base. Consequently, the long historical policy context is considered to be an appropriate framework for analysing policy processes for this forest. In this regard, the analysis of forest policies is divided into four time periods, namely, Mughal,

British, Pakistani and Bangladeshi. These periods are reviewed for past events and laws to explain the evolution of resource management policies for the SMF.

4.3 Objectives and Research Methodology

The objective of this research is to analyse the implicit hypothesis that existing state property rights lead to a greater sustainability of the SMF by answering the following research question:

"Is the existing property rights regime adequate to achieve sustainability of the SMF?"

Content analysis method was used to critically evaluate the reflection of property rights for the FDCs in various forest policies. Two broad concepts—'factors' and 'actors'—of forest policies are identified in terms of property rights (Irimie & Essmann 2009). Thus, this chapter considers property rights as only one explanatory variable as its role has not yet been investigated thoroughly in environmental economics (Glück 2002; Irimie & Essmann 2009). The analysis also extends investigation into how the SMF became a distinct area of interest in policy interventions in the last few centuries. In this regard, the study covers policy documents from the period 1526 to 2000 during which extreme changes of policy formulation were common. Additionally, it covers other current textual documents.

With regard to integration, a qualitative content analysis is used to conceptualise raw data (Irimie & Essmann 2009). Thus, this research carried out conceptual analysis of content analysis "to capture the beliefs of the policy actors" (Villamor 2006, p. 165). Concepts were chosen to examine the number of occurrences within the text recorded as per the research question.

To ensure replicable and valid research findings (Krippendorf 2004) in addressing the research question, this method blends property rights with forest policies to comprehend the qualitative and quantitative reduction of the SMF. S&O's (1992) theory was used to investigate how forest policies shaped property rights in four historic periods and how they currently conserve this forest from the state's perspective. Although a detailed review of relevant policies and property rights

issues is conducted using the content analysis method, personal discussions were held with FDCs and key personnel working at the policy and community level to manage this forest.

4.3.1 Content Analysis

According to Berelson (1952), content analysis is a research tool for a particular objective to manifest content of communications with systematic and quantitative descriptions. Content analysis is roundly known as the application of different specific methods and techniques (Krippendorf 2004). As a research method, content analysis focuses on the actual content and internal features of a research issue. This method is commonly used to identify the presence of particular words, concepts, themes, phrases, characters, or sentences in particular texts or sets of texts (Tharenou et al. 2007). This method is used to quantify the presence of these issues in an objective manner. In this regard, this method uses texts such as books, reports, essays, interviews, discussions, newspaper headlines and articles, historical documents, speeches, conversations, advertising, informal conversations, or other occurrences of communicative language. After that, texts are coded and broken down into manageable categories on different levels such as word, word sense, phrase, sentence, or theme and then analysis is completed by following a particular coding and thematic method.

Following Tharenou et al. (2007), content analysis for this research was conducted manually. This method was used to review the two abovementioned broad concepts in policy documents and in various consultations with relevant stakeholders. Detailed conceptual analysis was conducted by tallying these concepts. In describing the findings, a coding method was applied using theme cards. The following sections describe the use and procedure of content analysis.

4.3.1.1 Use of texts

Based on the above methodological concept of content analysis, this research focused on the actual content and internal features of forest policy documents. To conduct this analysis, texts were defined first as follows:

i. Various forest policy documents of four distinguished time periods;

ii. Published reports from the MOEF and BFD;

iii. Journal and newspaper articles; and

iv. Formal and informal interviews and conversations with those concerned.

Property rights issues in forest policy documents as texts are unclear prior to the Mughal period which began in 1526 (Kabir & Hossain 2008). Thus, the period before 1526 is not considered in the textual analysis. All other texts from (ii-iv) are considered, depending on their relation to the SMF and the allocation of rights to its dependent communities.

4.3.1.2 Conceptual Analysis

Although content analysis is traditionally most often thought to be conceptual analysis, it consists of two general categories. These are conceptual and relational analysis, of which conceptual analysis is assumed to establish the existence and frequency of concepts in a text (Villamor 2006). Consequently, this research uses conceptual analysis to address the research question.

After defining concepts within texts, conceptual analysis frames actual contents or themes of the property rights regime in forest policy documents and discussions. In this regard, two concepts were determined for the analysis, namely, (i) 'actors' to draw internal features as policy actors' interests and (ii) 'factors' in terms of 'allocation of property rights' to the FDCs for livelihood security and 'capping degradation' of the forest through different policy interventions. These concepts were chosen for examination and the frequency of their occurrence within the above texts. Once identified, concepts were broken down into manageable categories on the level of sentence and theme. After breaking down the content of policy materials into meaningful and pertinent units of information, the analysis was conducted as per selected concepts with characteristics of property rights and degradation.

The analysis examined the texts for the existence of certain words with relation to the research question (Tharenou et al. 2007). While examining the texts, attention was given to identifying the positive words for the development of an argument as opposed to negative words for building current status. This conceptual analysis was undertaken only to determine the presence of selected concepts so as to investigate

whether there is a stronger presence of positive or negative words with respect to a specific argument.

4.3.1.3 Quantifying and Tallying Concepts

As the conceptual analysis was carried out to capture the beliefs of the policy actors, the word 'concept' itself was chosen for investigation; whereas 'analysis' indicates the involvement of quantifying and tallying its presence (Villamor 2006). In this regard, the main focus of this conceptual analysis was to "look at the occurrence of selected terms within texts, either implicit or explicit terms. The choice of concepts was based on the research questions" (Villamor 2006, p. 165). In line with Villamor (2006), who used 22 documents and 4 consultations, this research used a total of 26 official and publicly-accessible documents and 14 consultations. Ten consultations were with the FDCs and 4 were with relevant government and NGOs officials. Documents were later grouped and coded words were interpreted.

4.3.1.4 Theme Cards

This study used theme cards to extract thematic qualitative information or textual materials for subjective understanding and for the exploration of new insights for the research objective (Tharenou et al. 2007). A unitary theme card was used for 'property rights' to write the details of each category and subsequently create transcripts for discussion. Although each card contained only one category related to property rights in the forest policy texts, expression was made in more than one sentence. The theme cards were then sorted to develop categories inductively in such a way that common categories could be separated from others. Then the passages were content-analysed individually to distinguish positive or negative information with regards to theme and categories. In this way, theme cards facilitated the collection of data for the discussion of property rights under different policies of the SMF and their effects on FDCs. This is how forest policy analyses and discussions were undertaken in the subsequent sections of this chapter.

4.3.1.5 Use of Coding

The use of conceptual analysis in this study involves the identification of codes with categories prior to data collection (Liamputtong & Ezzy 2007). As coding is one of

the central processes of this method, it is used carefully in identifying the theme to establish the categories (Creswell 2003). Before coding, selected materials were first read carefully to identify and list the main themes following categories as a "group of words with similar meaning or connotations" (Weber 1990, p. 37). In various forest policy documents for the SMF, there were many overlapping and duplicate categories that required combination. According to Crabtree and Miller (1992), a comprehensive list of all categories was prepared as per two main broad concepts—factors and actors—as mentioned earlier. Preparation of a codebook became important to generate themes with patterns and their interrelationships for qualitative interpretation of this research (Tharenou et al. 2007).

4.3.2 Validity and Reliability

The issues of validity and reliability were concurrently ensured with the application of content analysis in the following ways:

i. Breaking down the material into the themes was expected to stabilise this research by having the same information presented in the same way over a period of time for reproducibility and accuracy. This was possible for the classification of texts related to the forest policies for specific historical time frames.

ii. Identifying the presence of selected concepts related to the research question was expected to solve the overarching problem of conceptual analysis and allow a challengeable conclusion. The greatest reliability was achieved by reducing overlapping through coding categories with clear statements (Sommer & Sommer 1991).

iii. To generalise, determining the concepts is imperative in order to define categories for accurate investigation of the research question. This research determined the concepts by triangulating them with concepts used by other researchers. For example, the abovementioned two broad concepts were used by Irimie and Essmann (2009) to investigate property rights in public policies for achieving societal change. This triangulation is expected to achieve reliability of those categories over a period of time and promote the stability of the research conclusion.

iv. As a useful technique for improving validity, pattern matching was used in this study for conceptual qualitative content analysis (Tharenou et al. 2007). In this regard, prior to data collection, 'property rights' was anticipated as a particular pattern variable derived from existing formal property rights theory pioneered by S&O (1992). This anticipated pattern served as a benchmark to interpret forest policy information for the SMF. This pattern was also compared with other patterns predicted from the same theory for empirical analysis and examined its degree of fit to achieve validity of this research finding (Lee 1999).

By ensuring reproducibility, overcoming the overarching problem of conceptual analysis and for generalised conclusions, this approach is expected to ensure the validity and reliability of this research.

4.4 Evaluation of Forest Policies

The following sections describe a brief history of forest policies, management and embeddedness of property rights for FDCs of the SMF. Before the Mughal period, the SMF extended from Hatiagarh, south of Diamond Harbour which comprised Sirkars Satgaon and Khalifabad of the undivided India (Kabir & Hossain 2008). At that time, no specific management regime could be identified. It was assumed that there were no restrictions on harvesting resources from this forest. The other four periods are analysed below.

4.4.1 The Mughal Period (1526-1765)

Until the beginning of the 19th century, the SMF had an area of 274 km (170 miles) eastwards along the coast from the estuary of the Hoogly of present-day India to that of the Meghna in present day Bangladesh. At that time, incentives were provided to claim areas of this forest for agricultural cultivation (Kabir & Hossain 2008). According to the description of the Royal historian of the Mughal Emperor Akbar, the SMF extended further north up to northern Nadia, a district of India and northern Jessore, now a district of Bangladesh (Kabir & Hossain 2008). From that description, the forest was then full of tigers and crocodiles.

The Mughal policy for managing this forest was indifferent and they used it mainly for game reserves and sports. They were also interested in extracting timber and used the forest for aesthetic and utilitarian purposes (Kabir & Hossain 2008). During this period, Sundarbans became a frontier zone for human settlement and colonisation. It was an economic frontier to local communities of wet rice farmers who converted its land to agricultural use; a political frontier for expanding centralised states from north India; and a cultural frontier for the worldwide Muslim community to spread Islam by occupying its land (Eaton 1990). However, they did not formulate any comprehensive policy concerning forests in general, including the SMF. Rather, they introduced a state recognition of forest clearance to produce substantial revenue by allowing agriculture (Biswas & Choudhury 2007; Chowdhury et al. 2009; Iftekhar & Islam 2004b). As there was no strict management policy, the local people basically treated the SMF as a public good with open access for harvesting and conversion for agriculture (Eaton 1990).

4.4.2 The British Period (1765-1947)

The end of the Mughal period was followed by the invasion of the East India Company, later transmitted to British rule. That period brought major changes in managing forests, including the SMF. During 1765 to the mid-1800s, the SMF was subjected to over-exploitation for two main reasons: shipbuilding and railway sleeper production. British India was then going through a massive rail infrastructure development and required the shipping of local resources abroad by waterways. Furthermore, over-exploitation was due to a focus on the SMF for revenue realisation from the export of forest produce (Chowdhury & Ahmed 1994) and for timber extraction for trading. In 1793, British rule introduced the *Zamindary* (Landlordship) system under the Permanent Settlement Act. The Act contained provision for landlords to lease out the *Chars* of the forest for agriculture. After 1813, the Zamindars started to bring the indigenous Munda people into the SMF region to clear the forest for cultivation, which reduced its size significantly. Although in 1855 the first memorandum with a plan for forest conservation was issued to proclaim the whole forest area of India, the SMF came into distinct focus only after the finalisation of the Forest Act in 1878. Realising the importance of various mammals and other resources, the British enforced its closure to ban shooting, hunting and

fishing in 1880 (Kabir & Hossain 2008). The enforcement was executed with the newly-established Forest Management Division in 1879 under the management of a professional forester stationed at Khulna (Chowdhury & Ahmed 1994).

However, the first formal NFP was introduced later in 1894 for the whole of British India to ensure the rights and interests of FDCs, including those in the SMF (Kabir & Hossain 2008). However, it did not give any formal rights to these communities for resource harvesting, except grazing rights in other low-yielding forests without promoting any community institutions (Kabir & Hossain 2008).

4.4.3 The Pakistan Period (1947-1971)

British India was divided as India and Pakistan in 1947. After partition, the Government of Pakistan (then West Pakistan and East Pakistan; now Pakistan and Bangladesh respectively) inherited the NFP 1894 with forest areas equivalent to less than 2 per cent of the country's land. Most importantly, that forest policy neither encouraged an increase in forest area nor emphasised sustained harvesting of forest resources from existing forests (Kabir & Hossain 2008). Thus, recognising the importance of the forestry sector, the Government of Pakistan started to reorganise forest policies for the new state. To address the deficiency of the NFP 1894, the Pakistan Forestry Conference was held in 1949 and adopted guidelines for forest management. Following this initiative, a new Forest Policy was declared in 1955, mainly to consolidate state control over forests that were being commercially exploited. The policy did not change the reserved forest status of the SMF. However, this policy emphasised the exploitation of forest produce from East Pakistan to West Pakistan and primarily targeted the SMF as a source of industrial raw materials (Kabir & Hossain 2008). Despite its status as a protected forest and the establishment of the Sundarban (East) Wildlife Sanctuary in 1960 (MOEF 2005d), over-extraction continued under the state property rights regime. The post of Chief Conservator of Forests was also created in 1960 that expedited overharvesting following the existing system of resource harvesting. Again, in 1962, the Forest Policy of 1955 was revised to strengthen the commercial use of the SMF, undermining its conservation values (Chowdhury et al. 2009). The revision did not define any rights for FDCs. The main aspects of the Forest Policy 1955 and its subsequent revision in 1962 are set out below.

4.4.3.1 Forest Policy 1955

Promulgated by the Pakistan Government in 1955, the policy aimed at increasing available allocations of forest area in unused government lands to enhance forest cover. This directed the classification of the forests in terms of utility for proper utilisation of allocations. One of the main aspects of this policy was the recognition of non-use intangible values and benefits of forests for the first time (Alam 2009). Such recognition was enhanced through the provision of careful preservation of forests and their scientific management. However, through this policy, the Pakistani Government intended to consolidate their control over forest resources with strict management. The policy was adopted to manage all forests under approved management plans where there was no involvement of FDCs. This policy under the colonial rule of West Pakistan targeted East Pakistani forests primarily for monetary gains and maximising revenue (Muhammed et al. 2008). This policy encouraged illegal felling and became highly detrimental to the sustained conservation of the SMF.

4.4.3.2 Forest Policy 1962

Revising earlier policy in 1962, the Government of Pakistan adopted the second policy having five foci: forestry, watershed management, farm forestry, range management and soil conservation (Millat-e-Mustafa 2002). It made some unconventional suggestions to gain commercial benefits from first growing species and grazing from public forests with intensive management (Alam 2009). Because such management for commercial gain was the main aim of the policy, the SMF was targeted for resource extraction to meet huge industrial demands. For instance, this policy emphasised the use of *Gewa* to support the supply of raw materials for the state-owned Khulna News Print Mill (Choudhury 1994). The use of this species was minimal prior to the establishment of this mill. However, following its establishment, the SMF started an annual supply of over 4 million cubic feet of pulpwood to continue its production (Choudhury 1994). This supply was unsustainable and caused a huge degradation of this species. Consequently, the policy was not conducive to the growth of the SMF due to the over extraction of resources to meet excessive commercial demand (Hakim 2007). This new policy was basically introduced to emphasise an over-exploitation of forest resources from East Pakistan.

High anthropogenic pressure started to grow during that time. For instance, in Pakistan, the population growth rate was 3.45 per cent per annum between 1961 and 1972 (Bean 1974). In 1971, the net rate of population growth was 3.3 per cent and population was expected to be doubled in 25 years (Ahmad 1972). This increased population caused illegal felling and overharvesting, leading to ecological degradation of bio-diversity and tree density. Adequate institutional support to address these issues was denied (Khan 2001). Consequently, the principle of sustainable harvesting was ignored in the SMF.

4.4.4 The Bangladesh Period (1971–to the present)

After independence from Pakistan in 1971, Bangladesh adopted the following conservation policy initiatives.

4.4.4.1 Bangladesh Wildlife (Preservation) Order 1973

The Bangladesh Government adopted the Bangladesh Wildlife (Preservation) Order in 1973 (henceforth Wildlife Order) to protect and preserve valuable forests, including the SMF (MOEF 2005d). As per Article 23 of that Wildlife Order, the SMF was redefined as a reserved forest with a Wildlife Sanctuary status and was closed to hunting, shooting and trapping of wild animals. This allowed undisturbed breeding and the protection of its wildlife and natural resources. The Article also kept the provision to protect the forests by prohibiting activities therein. Basically, the Wildlife Order designated the SMF as a ‘reserved forest’ under the Forest Act of 1927 wherein everything was prohibited without any formal permission of the BFD (Rahman 2005).

4.4.4.2 National Forest Policy 1979

Although overharvesting was experienced under the Government of Pakistan, the first NFP was adopted in 1979 (GOB 1979) without addressing this issue. The policy had several foci: restructuring of the BFD, horizontal expansion of forest, scientific management, careful preservation, optimum extraction, and establishment of new forest-based industries (Alam 2009). The policy was considered very general and vague in terms of providing specific directions to achieve these aims. The notable

aspects of the policy were to designate all government forests as national forests and to strictly limit the conversion of forests to other non-forestry uses.

The major drawback of the policy was its continued philosophy of previous colonial governments in treating local people as the main threat to forests (Ali 2002). Thus, the main aim of the policy was to provide authority to the BFD to protect forests from local communities by applying strict rules. That exclusionary approach to forest protection had negative effects on SMF resources in the long run (Choudhury 2003). It did not address the fundamental and crucial issues, in particular, functional classification and forest use as an ecological foundation for sustainable production and the livelihood-security of huge FDCs (Kabir & Hossain 2008). These deficiencies necessitated the government amending its policy for management change in the SMF. Subsequently, the government adopted a 20-year Forestry Sector Master Plan for the period of 1993-2012. This plan emphasised the SMF's protection as a reserved forest and consolidated state control and prohibited the granting of any new rights to FDCs. It maintained the restriction of any human activity inside the forest.

4.4.4.3 National Forest Policy 1994

This is the second and the current forest policy adopted against the background of rapid and continuous forest depletion at a rate of 90 sq. km/yr (FAO 1999). Thus, by amending Forest Policy 1979, the Government adopted the new NFP to bring remarkable changes to forest management (GOB 1994). Notably, this NFP recognised the interests of marginalised and disadvantaged local communities by committing to the equitable distribution of forest resources among them (GOB 1994). The policy also sought to address the encroachment and degradation of the SMF (Iftekhar & Hoque 2005). Overall, this policy was developed to ensure the livelihood security of the people who depend on trees and forests, along with their participation in afforestation programmes. This allowed the incorporation of opinions and suggestions of local people in the planning and decision-making processes.

Among others, one of the objectives of that policy was to prevent illegal occupation of forest lands through local people's participation. In this regard, it was noted that the role of forests should include the socio-economic development of the FDCs

(Muhammed et al. 2008). However, by 2002 it was reported that the increase of forest resource cover was only 1 per cent. This rate was far below the estimated target and highly unrealistic in comparison with policy declaration (Muhammed et al. 2008). Moreover, this policy violated its participatory commitment by maintaining a conservation policy that excluded FDCs from management and policy formulation and did not allocate them an appropriate level of property rights.

4.4.4.4 Government Notification, 1996

In 1996, Bangladesh Wildlife (Preservation) Order 1973 was modified by issuing a notification that designated some parts of the SMF as protected forest, including three wildlife sanctuaries (UNESCO 2008). The notification also redefined the Sundarban East Wildlife Sanctuary established in 1960 (MOEF 2005d). This approach not only restricted the use of buffer zones to ensure the survival of large mammals and birds and provide food, nesting and roosting sites over larger areas, but also restricted harvesting. However, no clear consideration was given to granting property rights options for FDCs to reduce extraction pressure on remaining sites.

4.4.4.5 Forest (Amendment) Act 2000

As a result of the commitment to the earlier policy, a Master Plan was developed in 1995 (Muhammed et al. 2008). Under the plan, a good number of development projects were undertaken for the SMF with financial and Technical Assistance (TA) from different development partners and organisations including the World Bank, Asian Development Bank, United Nations Development Programme and the FAO. Thus, it was necessary to ensure the livelihood-security of FDCs and their involvement by enhancing the earlier policy with the newly-enacted Forest (Amendment) Act 2000. Consequently, the Forestry Act was amended in 2000 only to accommodate social forestry (Alam 2009). However, the Act overlooked the role of FDCs. Rather, it emphasised social forestry with the involvement of the local people with defined entitlement to gain benefits from selling forest resources other than from the SMF.

Thus, the livelihood-security of a large number of these people remained unaddressed in the Act, and forest degradation continues at an alarming rate. As an example, among all development interventions under the Master Plan, the largest one

was the Sundarbans Biodiversity Conservation Project, financed by multiple development partners. This development project was undertaken for the period of 1999-2006 under the sole management of the BFD, with the aim of promoting biodiversity conservation in the SMF by involving its dependent communities. The project could not attain its goals and objectives and was cancelled (Hossain & Roy 2007). At the time of cancellation in January 2005, the physical progress of the project achieved "only 24 per cent against an elapsed project period of 75 per cent" (ADB 2008, p. 9). Thus, it was clear that policies aimed at making local people responsible in managing the SMF needed to be implemented.

4.4.5 Evaluation Summary

Historical analyses of management practices of the SMF reveal that this forest has been under significant anthropogenic pressure for a long time. No past policy allowed appropriate property rights for local FDCs. Thus, over-exploitation has led to the degradation of the SMF—which continues at an alarming rate. Consequently, today this forest covers only half the area it covered in the late Mughal and early British periods. In spite of that, no policy has sought to define property rights for its FDCs, nor sought to involve them in management and policy-making. According to Kabir and Hossain (2008, p. 69), "uncontrolled deforestation and land settlement caused this reduction in the forest's size" during the Mughal and early British periods. Although the conservation of the SMF has received high priority from policy-makers in different time periods, they did not link their conservation efforts with the livelihood-security of the local dependent people. Furthermore, policies did not recognise any FDC attachment and belonging to the forest. Policy-makers in the four time periods appeared to treat the forest as a public good under state property rights regime.

4.5 Discussions

The following sections discuss the implications of property rights for the above policies and how they affected the sustainability of the SMF.

4.5.1 Property Rights Regimes and their Sustainability Implications

The evolution of forest policies in Bangladesh provides an historical analytical framework for the management of the SMF (Iftekhar & Islam 2004b). Under the colonial governments of Britain and Pakistan, the role of property rights in managing the SMF was minimal. This trend still persists. Management plans under the first policy of British period in 1894 categorised SMF as a 'production forest'. The Pakistan Forest Policy 1955 and 1962 emphasised 'commercial use' of this forest (Iftekhar & Islam 2004b). Since the Mughal period, there has been a tendency by state property regimes to emphasise and facilitate overharvesting and to consolidate state hegemony over the forest (Eaton 1990). That tendency resulted in forest depletion. Consequently, the 1994 policy advocated a common property rights regime in its Declaration No 1 for "the active partnership of the local people" (GOB 1994, p. 3). However, this is still not practised.

Since the Mughal period, state property rights regimes in the SMF has hinged on satisfying outsiders' demands. The implications of those policies in the sustainable management of this forest are narrated in the following sections.

The application of S&O's theory (1992) to different property rights regimes in a content analysis matrix is discussed. The analyses present how forest policies of these historical periods distorted the sustainable management of the forest. According to Colfer et al. (1999), one criterion for sustainable forest management is that people link their own and their children's futures to forest resource condition. Defined property rights for forest users are conducive to achieving this criterion of sustainability. However, policy-makers have failed to develop any best-fit measures to establish a clear connection between sustainable forest management and appropriate types of property rights regimes to address forest-people relationships (Pavri & Deshmukh 2003). In the case of management of the SMF, the underlying relationship between the BFD and the FDCs is legitimised by the current institutional systems of government rules and rights for determining how the resources will be extracted and by whom (Bromley 1991; Herath 2005). This relationship is imposed upon the FDCs by the BFD who define institutional efficacy in terms of community behaviour patterns and environmental practices. This ultimately impacts on the quality and quantity of resource harvesting in the SMF (Robbins 1998). Based on

these issues, investigation was made as to how the property rights regime affected the sustainability of this forest by enhancing institutional efficacy in management. This discussion thus lays the groundwork of investigating the adequacy of the existing property rights regime to achieve the sustainability of the SMF. Thus, the following sections reflect whether the existing property rights regime is adequate to achieve sustainability.

4.5.2 Content Analysis Matrix

A reciprocal relationship between forest policies and outcomes needs to be generated for the benefit of FDCs. This denotes incentives and rationales for the sustainability of the SMF. Policy without defined property rights for these communities does not ensure their livelihood-security. Furthermore, it does not develop ownership to conserve the forest; rather, it results in continuous overharvesting. Property rights of different regimes appear in the following qualitative content analysis matrix. This matrix has been developed on the basis of the grounded property rights regimes and their time periods. They are interpreted with S&O's (1992) constituents of property rights bundles.

The property rights theory explains the role and functioning of property rights over the resources of the SMF "and in part their emergence (*ex ante* design)" (Irimie & Essmann 2009, p. 96). In this regard, it also interprets how property rights bundles become the subject of policy actors' interests (*ex post* enforcement) towards the 'factors' such as 'allocation of property rights' and 'capping degradation'. Thus, these bundles are interpreted with the 'factors' and 'actors' of the policies adopted in different time periods.

The matrix (Table 4.1) analyses attitudes and behaviours of owners of the SMF in relation to physical outcomes from their actions. In the Mughal period, rights to forest produce were regulated with the combination of two types of property rights regimes: state and open access. The first type appeared to allow the then state property regime use for hunting and sport (Muhammed et al. 2008). The second type was subsequent to the absence of any forest regulatory control, resulting in FDCs also using the SMF as an open access regime (Iftekhar & Islam 2004b).

Table 4.1: Community property rights for different periods based on S&O's (1992) typology

Periods	State property regime	Common property regime	Open access property regime	Private property regime
Mughal	Access and withdrawal	-	Access and withdrawal	-
British	Access and withdrawal	-	-	-
Pakistan	Access and withdrawal	-	-	-
Bangladesh	Access and withdrawal	-	-	-

Today's reduced SMF size indicates the degradation that has occurred due to overharvesting and encroachment under an open access property rights regime. A strict conservation scheme under British rule failed because it aimed primarily to produce exports. For instance, it promised a net revenue of Rs.1.5 lakhs from tax collections on forest products export (Ascoli 1921). At that time, FDCs had no property rights to support their livelihood-security beyond access and withdrawal. During the Pakistani period, the government legalised overharvesting for commercial gain (Chowdhury et al. 2009) without allocating any new rights to these communities. Thus, the matrix shows that the FDCs never enjoyed rights beyond authorised use. Being an important resource stake, their exclusion from forest management led them to undermine the process of conservation. They were not recognised, as per Colfer et al. (1999), for their proximity to the forests, pre-existing rights, dependency, poverty, local knowledge, and importance of the forest to their culture. Neither were existing stakeholder power deficits recognised, such as those suggested by Colfer et al. (1999). This undermined their status as key stakeholders.

The theoretical framework of property rights distribution under different regimes reveals interests of the state and Government undermining FDCs' livelihood security. In this regard, earlier governments did not understand the multifunctional use of the forest. This attitude undermined the sustainability of the forests, and the interests of these communities and individuals. In this regard, the multiple use of this forest could be better regulated on a larger scale if a common property regime were

considered. This could engage the entrepreneurial spirit of the FDCs by generating direct benefit streams.

It is sometimes argued that the state has more physical or material capacity to regulate forest economies of scale with organised state administration, and can allocate resources for forest management better than its non-state counterparts (Irimie & Essmann 2009). This argument was wrong in the case of the SMF. Under the top-down state control during all periods, the SMF was subject to constant degradation. For instance, the regular reclamation of the SMF is said to have started in 1830. A large part of this forest was cleared from 1830 to 1875 (Karim 1994a). Further, the Mughal was a period of *de facto* open access and caused resource degradation. In none of the periods were the communities given common property rights, despite at times playing a more positive role in forest management than the state. In common property regimes, communities take advantage of their own strengths with low enforcement costs. In contrast, state property regimes displace this potential management capacity, and communities perform poorly (Irimie & Essmann 2009).

Another major reason for degradation of the forest is the tripartite management role and interrelations between FDCs, the BFD staff and forest policy stakeholders. In this management system, the government undermined the role of property rights that might yield better outcomes under the common property regime structure. In protection of its own interests, in different time periods the government received significant benefit streams from unsustainable resources. Moreover, it paid much attention to enforcing and establishing property rights, with less attention directed towards a sustainable ecosystem management. This disintegration of management in all periods not only allowed the forest personnel and policy stakeholders to act unsustainably, but also to gain illegally from the forest resources. Thus, it hindered institutional changes in property rights regimes.

Consistent with the concept of new institutional economics, the BFD was very wary of losing out with any likely changes. They remained cautious of not disrupting their illegal stream of benefits and protecting state access to the unsustainable overharvested resources. This enhanced the motivation of FDCs to defend and change the institutional structure to gain recognition of property rights. This context

helps understand the conflicts between forest communities and the FD that has encouraged overharvesting in the absence of defined and structured property rights for the former. However, FDCs were powerless to raise their voice against the well-structured institutional power of the BFD. Their poor socio-economic condition also enhanced exploitation and the authoritarian rule of the FD in all periods.

4.5.3 Supply of Forest Products

The conservation rule of 1878 brought the extraction of resources under direct control of the then British Government. It was targeted mainly to meet national demands for building infrastructure. In fact, during the British rule, the only vital mode of transport was via the waterways. Even today, Bangladesh is a country of rivers. Thus, it can easily be understood that the water system was very important for transportation during British rule. The then largest Mongla seaport was established at the Mongla *Upazilla* in the SIZ. After that time, the British Government extended the transportation system by establishing railway networks that needed a large supply of sleepers from the forest.

In the Pakistani colonial period, *Gewa* timber was used as a raw material in the Khulna Newsprint Mill to supply under-priced paper to the newspaper industries and government offices (Hakim 2007). Because of the unsustainable supply of *Gewa* as a raw material (Figure 4.1), the forest could not meet the mill's production needs and it was permanently closed down in 2002 (Alauddin 2010). Likewise, many small and large plant-based industries were developed in the region, including the Khulna Hardboard Mill based on *Sundari* as its raw material. Other important plant-based industries are match factories, furniture making and boat-building. These are based on raw materials from the forest and these industries continue carrying on production without considering adverse consequences to the forest. The forest-based industrial development in the Khulna region does not focus on the needs of millions of forest-dependent people; rather, it stimulates illegal felling and overharvesting to meet industries' needs. For instance, the main two species *Heritiera fomes* and *Excoecaria agallocha* declined by 42 per cent and 34 per cent per hectare for trees with a diameter at chest height of 7.5 cm or more in blocks 1-6 for the former, and in the entire forest for the latter between 1959 and 1983 (Chowdhury & Ahmed 1994). The merchantable volumes of species *Bruguiera gymnorrhiza* and *Heritiera fomes* also

declined by 45 per cent and 8 per cent respectively in the same period (Chowdhury & Ahmed 1994).

Figure 4.1: Supply of *Gewa* as pulpwood to the Khulna newsprint mill

Source: Ramsar (2003)

The abovementioned commercial and industrial aspects of resource extraction policies demotivated FDCs in becoming conservation-friendly because rules and regulations were not designed to benefit them. Moreover, these rules and regulations supported forest-based industries and the position of elites overlooking the needs of large dependent communities.

4.5.4 Extra-legal Arrangements

State property regimes have allowed the government to make arrangements to provide forest products from the SMF to people, mainly in administration. These people pursue such arrangements for their own interests by issuing instructions from the MOEF which, in turn, "accelerate resource destruction" (Ostrom 2009, p. 419). These instructions are issued by Government Order that provides a 'withdrawal' right. Such arrangements are completely against the Forest Policy 1994 that promised sustainability of the forest and an increase in forest cover. These high-profile vested administrative interests can gain access to such orders without any reference to the main policy instrument or the government officials making these arrangements. In other words, they provide justification while making arrangements

to supply timber products for their own needs. In reality, these people rarely use their allocated timber for their own consumption. Immediately after securing the allotment from the MOEF, most of them sell their timber allotment to selected brokers. This has become a regular phenomenon among government officials, politicians and the elites, even though these politicians often make commitments to end this cycle before each election (Roy 2010).

4.5.5 Illegal Felling and Overharvesting

The exclusion approach to forest policy did not become a pragmatic means for the BFD to protect the SMF; rather, it increased new conflicts with neighbouring FDCs. Earlier forest policy (1979) was targeted to commercialisation and generation of state revenue through unsustainable extraction of forest resources. The poor livelihood conditions of the marginalised and disadvantaged FDCs and their lack of any alternative income-generating opportunities in the SIZ have been exploited by the timber traders, who have engaged them in illicit forest cutting and other activities detrimental to the SMF. This finding is supported by Safa (2005) who found that FDCs in and around the *Sal* forest of Bangladesh were induced by the illegal timber traders "to join the illegal felling activities instead of bribe" (p. 2).

In spite of these adverse consequences, the previous management principles were not amended to address community livelihood insecurity and overharvesting issues. Instead, the forest has been controlled in a traditional bureaucratic way and without partnership with the FDCs. The BFD creates harvesting rules without any reference to communities' needs for the wider varieties of forest products instead of particular and limited forest products. Thus, the majority of FDCs are forced to meet their needs by entering the forest and harvesting resources illegally. A notable example of overharvesting a non-wood forest product in the Bangladeshi period is fish. Fishing effort increased 43 per cent from 2003 to 2009 (MOF 2009). This increase caused serious harm to the growth of the forest's mangroves because of conversion of forestland into fish farms. The violation of the Forest Policy 1994 and exclusion of these communities is causing a rapid decline and depletion of forest resources.

Cyclone *Aila* caused huge damage to agriculture and shifted livelihood pressure to the forest (Figure 4.2). The denuding of and encroachment on the SMF is largely led

by local poor FDCs and illegal timber traders patronised by the BFD, local politicians and elites. More recently, overall degradation is happening due to illegal harvesting by local, politically, financially and socially influential people. Illegal fish overharvesting in the Dubla *Jele Palli* (fisher villages) is an example (Dulal 2012).

Figure 4.2: Livelihoods vulnerability after *Aila*

(a) Homeless people living on embankment

Source: Daily Star, accessed on 2/5/2011, http://www.thedailystar.net/newDesign/index.php

(b) Saline water in the cultivable lands in Koyra after *Aila*

Source: The Daily Prothom Alo, accessed on 23/5/2011, http://www.prothom-alo.com/

(c) Female harvesters lost their jobs and put pressure on the SMF

Source: Unknown

(d) *Aila*-hit people cry for rehabilitation in the capital city

Source: The Daily Star, accessed on 26/5/2011, http://www.thedailystar.net/newDesign/index.php

4.5.6 Deforestation

The direct causes of deforestation include the under-development of the SIZ, inappropriate forest policies and regulations affected by bureaucratic and political corruption. For instance, the BFD collect excess money equivalent to Tk 50 million yearly in the name of revenue from the fisher villages in Dubla; while they deposit less than 30 to 40 per cent of the collected money equivalent to Tk 15 to 20 million into the government exchequer (Dulal 2012). Besides illicit felling and over-exploitation, there is a qualitative depletion of forest resources due to salinity intrusion and 'top-dying' disease of trees (Iftekhar & Islam 2004b).

Although the prevalence of corrupt practices is the subject of much discussion and perceived as usual practice within the policy-making process (FAO 2003), there is little concern expressed when it comes to the area of forest resource management in Bangladesh. One study found that FDCs perceived present malpractices by the BFD officials and local elites to be the major cause of deforestation and degradation of this forest under the prevailing structure (Iftekhar & Hoque 2005). Such illegal

practices could be either deliberate corrupt activities by BFD staff and elites, or determined as limitations of existing administrative capacity.

The implementation of the state property rights regime heavily depends on the availability of foreign funds and technologies overlooking the development of socio-economic conditions of the forest people. For example, the share of foreign funds for the MOEF was more than 50 per cent in the 2008-2009 ADP (MOEF 2009). The amount was around 6 per cent more than the country's overall foreign fund allocation (MOF 2009). These funds are mostly allocated for the implementation of TA projects to address deforestation, rather than basic investment for the development of the forest. For example, for the same period MOEF implemented 35 projects of which 17 were TA projects. However, compared to 2008-2009 the amount of foreign funds has significantly increased (by 63 per cent) in 2010-2011 (PC 2010).

The allocation of foreign funds to the MOEF is higher than to other ministries and indicates the extent of foreign technical (consultancy) dependence for the development of the forest sector. This over-reliance on TA overlooks the use of *de facto* customary knowledge for both forest protection and community livelihood-security. These limitations undermine the forest people's capacity to mobilise local resources, control deforestation and develop their socio-economic condition.

4.5.7 Protection of the SMF

The BFD, under the state property rights regime, has issued some Government Orders. These include provisions to manage the forest by forming committees such as the Stewardship Committee, comprising eminent, concerned persons to provide overall guidelines to BFD officials, as well as the Project Steering Committee (PSC) and the Project Implementation Committee (PIC) whose roles are designed to facilitate policy implementation. These committees are proposed and approved by the MOEF (PD 2008), however, local people are never consulted. The Stakeholder Council has authority to engage representatives from various extractor groups and others from the SIZ to facilitate forest management. The Upazila Council is responsible for facilitating these committees and helping them implement necessary activities to support the BFD. Although the Stakeholder Council has a provision for community involvement, in reality, it has no financial and administrative powers to

execute its decisions over management. Besides, its situation at the bottom level of power impedes its contribution to policy formation under the hierarchical structure of the BFD. All other committees, without involvement from FDCs, have some financial and administrative role to monitor development activities and expenditures. These committees inappropriately use their roles to have extra legal arrangements. The Government is taking the opportunity to exclude communities from committees, as they have no property rights. Thus, the rights of FDCs are denied in efforts to protect the forest.

4.5.8 Ignorance of Community Customary Knowledge

It is now theoretically assumed that local forest people have some comparative advantages over the state in managing the forests at local levels, especially for better monitoring, enforcement of rules and regulations and adaptation to local conditions (Behera 2009). A large number of empirical studies found a comparative advantage of local users over resource management and show their potential interest and skills in solving management-related problems (Baland & Platteau 1996; Ostrom 1990). The experience of community involvement in forest management suggests that this local level institution is very successful in enhancing effective management systems and in ensuring equitable distribution of forest resources and benefits derived from the forests (Behera 2009). Thus, in recent days, many governments have adopted a forest co-management structure to allow a process of decentralisation and devolution where costs and benefits are shared with communities (Baland & Platteau 1996; Gautam 2006).

However, the above concept of community involvement with permit licensing mechanisms does not involve community customary knowledge in management and policy formulation. Thus, the government has failed to achieve the objectives of SMF management in creating a social fence for its protection from depletion with encroachment, illegal felling and overharvesting. Consequently, the depletion of the SMF is still rampant as there is no recognition that these *de facto* rights are essential in managing forest sustainably.

4.5.9 Policy Instrument as Disincentive

It is generally accepted that an incentive-process policy instrument in a co-management structure with the involvement of FDCs generates better output than a regulatory-process policy instrument in a top-down conservation structure (Guldin 2003). Community exclusion from policy structures prevents them playing any role in capping overharvesting and other negative externalities (Libecap 2009). Thus, regulatory-process policy instruments have been less successful compared to incentive-process policy instruments (Guldin 2003).

Current economic and regulatory instruments do not have any provision to gain private returns from community investment in conservation. Consequently, they maximise private returns through cheating—for example, through wilful bribery in Dubla *Jele Palli*. These instruments become agents against the state and resources suffer. Drawing on Libecap (2009), the key point is that the benefits for FDCs of existing regulation enforcement through state property rights in mitigating open-access losses relative to resource and political costs are absent. This is because of the failure of socially preferred rights-based regimes solutions to the 'Tragedy of the Commons' in the SMF.

Alternatively, present top-down conservation policy instruments focus on a regulatory approach prohibiting the use of the products of this forest without the permission of the BFD. In contrast, the extra legal bylaws have permitted the overuse of forest products to cater to the activities of higher-level civil servants and politicians working at the policy level. In allocating property rights, it is very important in the long term for policy interventions to designate a defined role for the dependent communities if they are to have an effect on the sustainability of the forest (Gautam 2006). FDCs can then also gain from reduced over-use of the forest.

4.6 Suggestions for Sustainability of the SMF

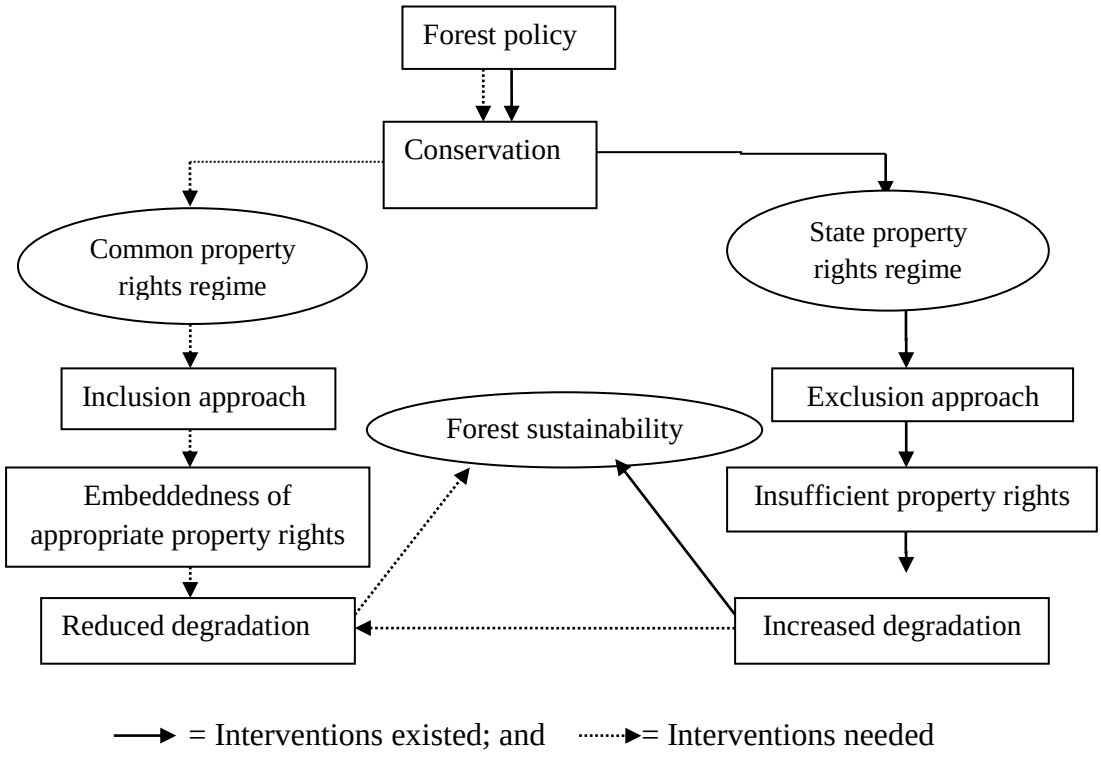
In the management of the SMF, the underlying relationship between the BFD and FDCs is legitimised by current government rules and rights to determine who will extract the forest's resources and how they will be extracted. This relationship is imposed upon communities by the BFD who define the present institutional arrangement for this forest to determine community behaviour patterns and to

produce sustainable management practices. Selected FDCs now enjoy certain rights allocated by the BFD under permit licences to control the quality and quantity of resource harvesting. These insufficient rights are solely designed and controlled by insiders (i.e. the BFD) and are unable to meet the livelihoods needs of all outsiders (i.e. FDCs) (Roy et al. 2012). This enhances degradation with the de-motivation of deprived outsiders and the failures of insiders to ensure equitable distribution of forest resources. It also generates negative community interest in conservation and management initiatives of the SMF. The BFD's institutional setup needs to recognise forest property rights.

However, a change in property rights enforcement within prevalent rights regimes may be proved wrong. The policy analysis of this chapter recognises that state property rights over resources of the SMF did not play much of a role in regulating externalities and developing entrepreneurship to manage resources. Property rights are not static. They evolve continuously in periods of political, economic and social change (Irimie & Essmann 2009). Property change occurs as a result of action and reaction of actual and presumptive owners (motivated actors) through gradual increases in bargaining power. In the long historical management of the SMF, this process of property rights change is absent. The forest remains under state ownership where the BFD has failed to show its entrepreneurship role in sustained conservation.

Thus, a shift in rights regime is inevitable. For the sustainable management of the SMF, defined rights up to a level of 'exclusion', meaning 'proprietorship', are necessary. This inevitably must involve FDCs in management and policy formulation for the sustainable management of the SMF (Figure 4.3). FDCs with sufficient rights of 'proprietorship' could encourage interested stakeholders' long-term investment in the SMF. This is how inclusion approach interventions in a common property regime may enhance conservation of the forest.

Figure 4.3: Suggested Policy Model for the SMF



4.7 Conclusion

This chapter critically reviews forest policies and institutional settings in addressing sustainability issues of the SMF in four major time periods. It demonstrates the historical importance of the forest to the various rulers under different regimes. The forest was not only over-exploited in colonial times, but is also being over-exploited currently under the strict state property rights regime. Dependent forest communities have never been part of the development process for its conservation—either within a co-management structure or with defined property rights—other than strictly limited and controlled 'access' and 'withdrawal' rights for harvesting only.

State property rights regimes using the hierarchical institutional setting not only failed to address local needs in the policy process, but also increased forest dependency and depletion. This increased depletion indicates the inadequacy of the existing property rights regime in achieving sustainability of the forest. Findings of this research suggest that regime efficacy should be fostered from state-forest community partnerships with a clearly embedded property rights regime. Existing traditional management patterns need to be amended to adapt to changing contemporary socio-spatial contexts with necessary modifications to prevailing

‘access’ and ‘withdrawal’ rights up to the granting of ‘exclusion’ rights for FDCs. Consequently, this research concludes that the existing property rights regime is not adequate to achieve the sustainability of the SMF. In this regard, common sense suggests that managing this forest sustainably requires using an appropriate property rights regime, and for the state to mediate resource access to ensure the sustainability of the SMF.

The next chapter discusses the methodology and explains how the quantitative research into FDC perceptions towards existing SMF conservation efforts was carried out.

CHAPTER FIVE

RESEARCH METHODOLOGY, SURVEY DESIGN AND DATA COLLECTION

Chapter 5

Research Methodology, Survey Design and Data Collection

5.1 Introduction

The aim of this chapter is to describe the methodology and survey design procedures to understand the interaction between the existing property rights regime and levels of conservation of forest resources in the SMF. Data were gathered from both primary and secondary sources regarding existing property rights, harvesting systems and perceptions of overall management of the SMF. A variety of socio-demographic data was collected. Data collection procedures included both qualitative and quantitative methods and techniques. Methods to ensure the validity and reliability of the data are also described.

This chapter is divided into twelve sections. Section 5.2 presents various data collection methods. Section 5.3 narrates the survey design procedure including collection mode, outlining target populations and units of analysis. Section 5.4 describes the sample frame and sample selection procedure. Section 5.5 outlines fieldwork and data collection procedures. Section 5.6 introduces the survey instruments. Its design frame includes co-management and sustainable forest management issues in Section 5.7. This is continued with an outline of property rights and demand-side policy intervention-related questions in Section 5.8. Section 5.9 justifies issues of validity and reliability in survey design. Techniques and measures to achieve accuracy in data collection and descriptions of various potential validity and reliability measures are analysed in Section 5.10. Section 5.11 explains the methods of data analysis and various test statistics for interpreting data. Discussions in Section 5.12 conclude the chapter.

5.2 Methods

Various methods were adopted for data collection including: (i) case study, (ii) survey, (iii) use of secondary sources, (iv) content analysis, (vi) direct observation, (v) focus group discussions (FGDs), and (viii) personal discussions with local communities. The main source of data was through the use of written surveys using close-ended questionnaires for households. Questions were related to the theoretical framework of this study. A significant portion of questions focused on demand-side interventions and alternative property rights. All data and information were collected through field visits between October 2010 and February 2011. The various data collection methods and survey design are now described in detail.

(i) Case Study: Case study is very important as the researcher should integrate real-world events with the needs of data collection plan (Yin 1994). Behera (2009) strongly supports the use of the case study method for participatory forest management research. Here, the investigation is substantiated through the estimation of parameters and relationships between variables identified. Data relating to current conservation policy and practices, resource extraction, degradation trends, and socio-economic conditions of the forest people were collected. While staying in the study area for three months, regular personal visits were made to the Dakshin and Uttar Bedkashi Unions (Union is the lowest local government tier in Bangladesh), particularly from Jurshing to Hariharpur (this village is in Uttar Bedkashi Union) villages and Gharilal Bazar to Gulkhali villages. Several trips were made inside the SMF from the Bojbaja Forest Office (this forest office is 2 kms inside the SMF) by trawler (Bojbaja in Figure 5.4). Case study method was used to help draw the policy inference regarding community involvement in management of the SMF.

(ii) In Person Survey: Quantitative surveying has become a widely used method of enquiry in social science research (Neuman 2003). The applied survey method, based on a deductive approach with empirical measurement and data analysis, is used here.

Because of the absence of co-management in the SMF, alternative property rights regime-related data were totally unavailable. To address this gap, data were collected for selected variables through closed-ended questionnaires for quantitative analysis and through semi-structured questionnaires for qualitative analysis. The survey

instrument asked questions on property rights regimes and alternative livelihood options. This was to generate primary data regarding formulation of demand-side policy interventions. The theory of property rights and demand-side management intervention concepts, described in Chapter Three, were used to investigate community perceptions regarding common property rights regimes.

(iii) Use of Secondary Sources: Secondary information is required in order to interpret the current conservation policy and resource extraction methods. Current management and alternative livelihood-related data were collected from many sources. The local office of the Bangladesh Bureau of Statistics (BBS) at Koyra *Upazila* headquarters was the main source of information related to socio-demographic conditions of the community. The observed method was also used to collect data regarding community livelihoods, income and expenditure. Data from both government and NGO sources have been used to examine alternative property rights. Special care was taken to triangulate the data and interpret research findings. Variations in information provided by government and private sources are acute in Bangladesh. For instance, there is a difference between the indicated prices of harvested resources as determined by the BFD and the actual market prices. Usually market prices of harvested resources are found to be higher (Roy 2009). Secondary sources of data are various. A complete list of sources is provided in Appendix 1. Additional data and information were collected from many sources. These included:

- Newspapers and magazines
- Journals and periodicals
- Research reports (draft and completed)
- Published and unpublished reports, monographs and literature
- Authenticated official and institutional records
- Various websites.

When conducting this research, many government officials and NGOs were visited for in-person discussions and interviews. These personal communications helped authenticate the collected data by matching it with secondary sources. In Bangladesh, collecting data from government sources is time-consuming due to cumbersome bureaucratic procedures. So, face-to-face communications and consultation with the

relevant government departmental bureaucrats were instrumental in gathering appropriate information.

Face-to-face personal communications were also very helpful in seeking expert opinions regarding alternative property rights regimes and alternative sources of forest community livelihoods. These personal consultations were made with educationists, researchers, departmental experts, concerned officials and consultants (Appendix 2). Such consultations not only helped validate the research findings, but also ensured their reliability. The collection of these opinions was mainly confined to policy formulation and implementation regarding the NFP 1994. Specifically, face-to-face discussions with these organisations and persons were very helpful in clarifying and modifying the baseline questions.

(iv) Content Analysis: A content analysis of national daily newspapers to investigate the management problems of the SMF was also undertaken. Six famous national dailies were selected. Of those, four were in the local language (Bengali), namely, *The Daily Purbanchal, The Daily Prothom Alo, The Daily Janakantha* and *The Daily Jugantor* and two were in English, namely, *The Daily Star* and *The Daily Independent*. Among them, *The Daily Prothom Alo* and *The Daily Star* are the most circulated newspapers in Bengali and English respectively. *The Daily Purbanchal* is the most famous local national daily published in Khulna. This analysis was conducted over the time period between 1 January 2010 and March 31 2011. The data and information were collected from the internet versions of these six newspapers.

(v) Direct Observation: The researcher was based in the Planning Commission of Bangladesh and made several visits to many sub-districts in the SIZ. Direct visits to the SIZ played a vital role in shaping the research design. During field visits, the researcher spent three months in Binapani village of Dakshin Bedkashi Union adjacent to the SMF. During this stay, several visits were made to the SMF. Relevant Forest Offices were also regularly visited. The researcher made several trawler trips in the rivers and canals to see the current level of tree density (Figure 5.1). Almost every day, visits were undertaken to forest community households to generate data, information and other relevant concepts.

Figure 5.1: Trips to the SMF

(a) Trawler trips to the SMF

(b) Visit made to inside the SMF

(c) Bojbaja Forest Office inside the SMF

(d) Pugmark in the SMF

The researcher conducted several meetings with the forest communities. The researcher also participated in meetings held with both the BFD and communities in the presence of local leaders. The BFD conducted all of these meetings to create awareness among the forest communities and local leaders. Data on the views of these stakeholders towards the conservation policy and sustainable management of the SMF were collected at these meetings.

(vi) Focus Group Discussions: FGDs, in which communities and concerned organisations actively participated, were also conducted. These discussions were undertaken for two underlying reasons, namely, (i) to shape the survey questionnaires; and (ii) to outline the views of policy and decision-making authorities regarding conservation policy and community livelihoods options. These FGDs were conducted with the communities, academics, environmentalists, forest bureaucrats, civil society activists, NGO experts and development practitioners. The missing link between forest community livelihoods and conservation policy was investigated in the FGDs. Such discussions gave deep insights into the prospects for policy adoption of the common property rights regime.

(vii) Personal Discussions: Apart from the above methods, personal discussions were undertaken with the communities and community leaders to shape the survey instrument and to develop rapport.

The following sections of the chapter discuss the survey design and probable biases in detail.

5.3 Design of the Survey

The overall survey design of this research is now outlined.

5.3.1 Method for Conducting Interviews

There are many types of data collection survey such as mail surveys, telephone interviews, face-to-face interviews or web surveys. This study was conducted in one of the remotest areas of Bangladesh. In a developing country like Bangladesh, mail or telephone interviews are not possible due to the widespread unavailability of these facilities. No community member had land phone connection. Only one post office is found in the local area and it does not distribute letters to villagers—rather, they have to collect them personally. Therefore, in this situation mail surveys would be unworkable. Moreover, there is no directory containing the full addresses of local community members. Most respondents are illiterate or have very little education. These illiterate people are not able to read mailed survey instruments. Any survey reliant on the use of internet is also impractical and not common in Bangladesh. Web-based interviews were also not possible due to technological unavailability.

Thus, in-person surveying was conducted for this study (Figure 5.2). This method provides the advantage of deriving more information by building rapport between the interviewer and interviewee. It can also allow complicated scenarios to be outlined. This method is very convenient as it leads to a purposeful conversation between the interviewer and interviewee and can be used in different situations to generate data about a multidimensional topic (Oishi 2003).

Figure 5.2: Conducting survey

(a) One-to-One Interview with the FDCs

5.3.2 Target Population for the Survey

For any research, determining the correct target population is very important for the collection of relevant data and information (Berkowitz 1996a). The 'correct' target population enables investigators to draw wider inferences through the application of sample statistics (Groves et al. 2004). Thus, target populations of this study were defined in size, specified with time restrictions and observable (Groves et al. 2004).

Primary data were collected using a multi-stage sampling method. The SMF is situated in the geographical area of three districts, of which Khulna (the third largest city in the country) was randomly selected. This city is in close proximity to FDCs. Key government departments are located here. Khulna district has 14 *Upazilas*, of which 6 *Upazilas* border the forest. From these 6 *Upazilas*, Koyra *Upazila* was selected randomly at the second stage. Likewise, Dakshin and Uttar Bedkashi Unions

were randomly selected from 5 adjacent Unions of Koyra. Maps of Koyra and the study area are provided in Figures 5.3 and 5.4. These two unions have 12 villages, from which 6 were again selected randomly. Five villages were from Dakshin Bedkashi and one village was from Uttar Bedkashi. Lastly, 412 respondents were randomly selected from these six villages in proportion with household size from each of them. A lottery method was used for all of these random selections. It should be noted that the list of adjacent *Upazilas*, Unions and villages of the SIZ were collected from the BFD (BFD 2011). The sample size is more than the optimal size suggested for a quantitative research (Perry 2008). The survey was conducted between November 2010 and February 2011 using experienced interviewers and a pre-tested questionnaire. Seventy-four per cent of households are primarily dependent on this forest for their livelihoods. The interviews were conducted in the local Bengali language. Data were analysed using 3 statistical software programmes: SPSS/PASW version 19, STATA version 11 and R version 2.13.0.

Figure 5.3: Map of Koyra *Upazila* in Khulna district

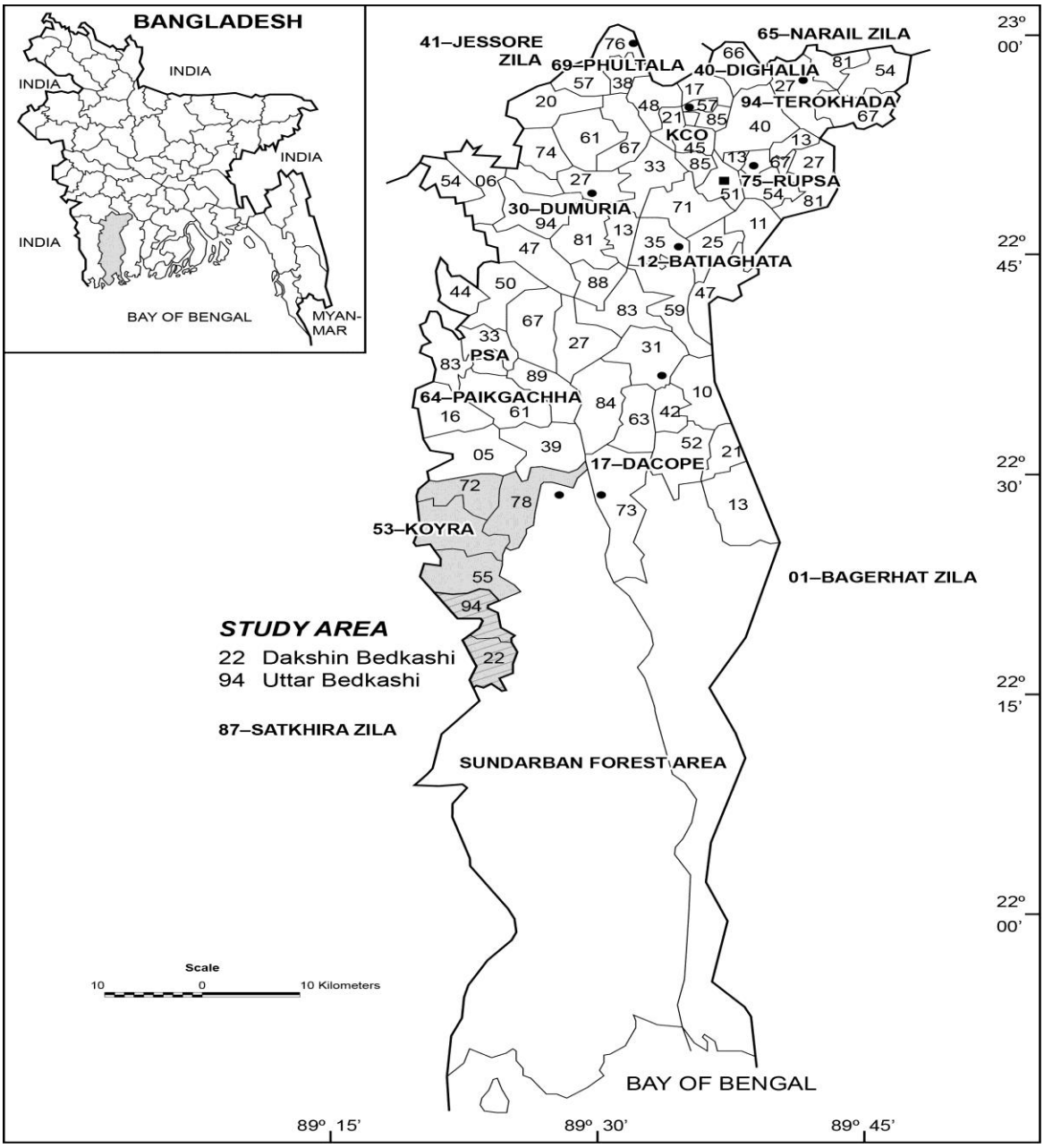
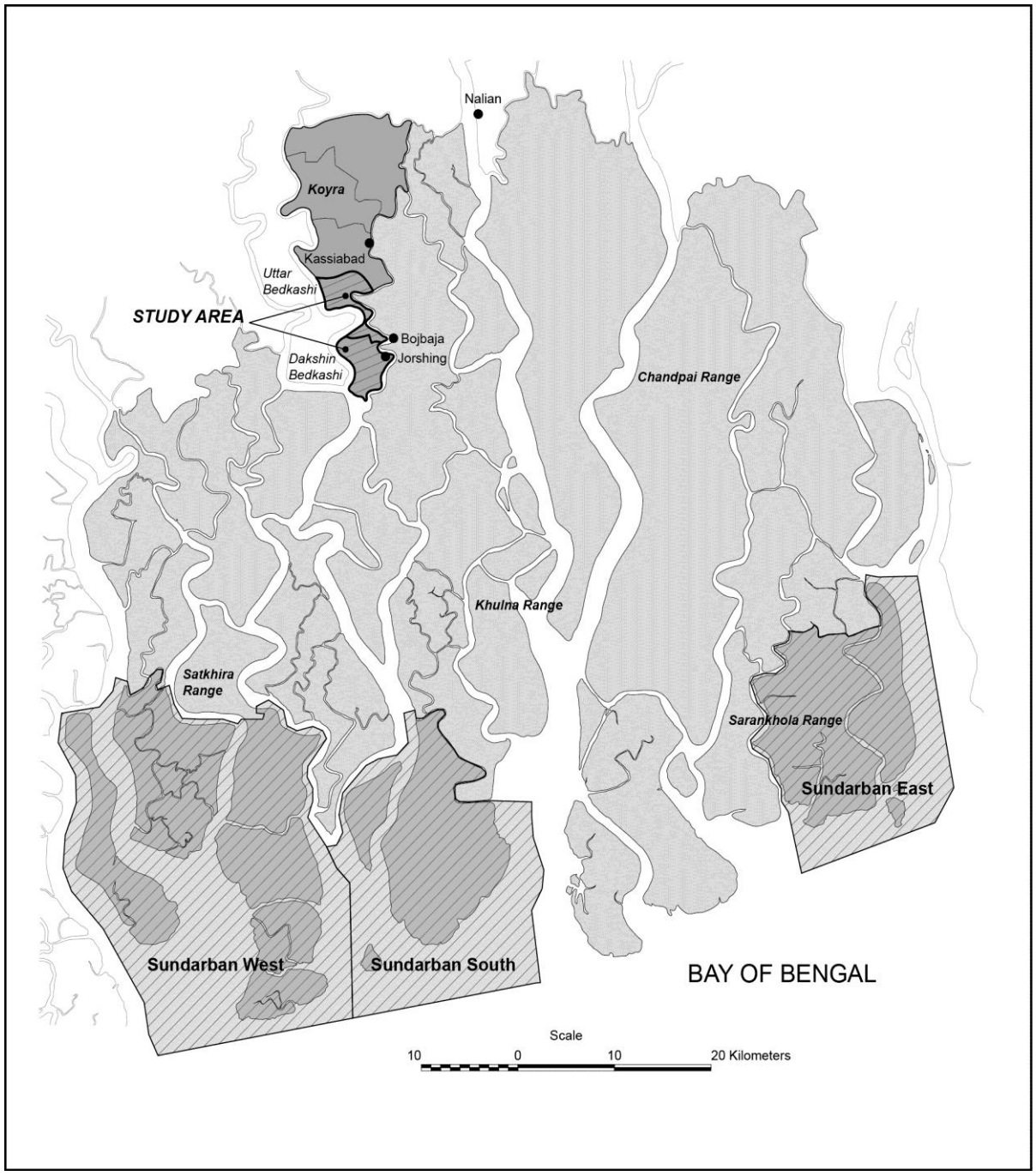


Figure 5.4: Map of the study area



Ninety thousand forest people live in the Koyra and nearby Paikgacha sub-districts (Unnayan-Onneshan 2009). The target population of the survey is, thus, forest communities. Using socio-economic and demographic data such as household size and literacy rate, it is found that all the sub-districts of the SIZ are almost identical (BBS 2001). Target populations of this survey are the residents of a house—either an independent house or a shanty on the embankment. Of the 90,000, 40,000 are living in these two unions of Koyra (Unnayan-Onneshan 2009). These villages are adjacent

to the SMF. All of the five different forest communities—fishers, Munda, *Bawalis* and *Mawalis*—were represented.

5.3.3 Unit of Analysis

In sampling, one of the most vital components is the unit of analysis (Liamputtong & Ezzy 2005). Usually, units are decided on the basis of previous research analysis. In this study, 'household' was taken as the unit of analysis rather than individual respondent. 'Household' here was defined as an occupied housing unit where all persons of a family live and eat together. The reason behind such selection was related to the family structures most evident in Bangladesh. This allows both individual households and joint-family systems to co-exist, where income is generally earned by the main member (head of the household) of the family, and expenditures and other family decisions are made by him/her too. In this research, the researcher had defined household as "a dwelling unit where one or more persons live and eat together under a common cooking arrangement" (BBS 2007b, p. 147).

5.4 Sampling Frame and Sample Selection Procedure

In the last population census in 2001, BBS selected this Khulna district for the sample frame which again included Koyra for designing Enumeration Areas (BBS 2007c). A total of 2,299 households are living in these six villages, with an average of 5 persons per household (BBS 2007a).

In selecting the sample from the target population the researcher needs to pay acute attention to how the respondents are selected. For framing the sample, the most convenient option would have been to use the list of the permit holders in the forest communities. However, the BFD does not retain such a list for the case study area.

To strengthen the sample selection from the target population of 1,705 households, Bangladesh's voter list was used. This number was the proportion of total forest community households (2299) engaging in resource harvesting from the SMF. Bangladesh first prepared electronic voter lists in 2008. Consequently, this survey used the voter list to finalise the sampling frame. Relying on the voter list, personal communications were made with members of the Union *Parishads* and villagers to identify samples of the four forest communities.

Sample Size: In planning a sample survey, one of the most important issues to clarify "is that of determining how large a sample is needed for the estimates to be reliable enough to meet the objectives of the survey" (Islam 2009, p. 115). A sample size of around 30 cases seems to be the bare minimum to analyse statistical data for a study (Champion 1970). However, many researchers argue for 50; and some regard 100 cases to be the minimum (Islam 2009). Chhatre and Agrawal (2009) used a sample size of 80 to conduct their research for testing the hypothesis for carbon storage and livelihood generation. Behera (2009) surveyed 55 households to explain the performance of state-community joint forest management in India. On the one hand, from different empirical studies, Perry (2008) suggested the optimal sample size to be 350 for a structured interview. However, on the other hand, Meyers et al. (2006) suggested larger samples for logistic regression than for linear regression for valid interpretation of results.

This study determined sample size by using a more statistically sound approach such as "determination of sample size in estimating population proportion" (Islam 2009, p. 118). Sample size of 296 is robust when the population size is regarded as large and a sample size of 313 is robust when the population size is regarded as small. If it is assumed that the proportion of the total population of 2299 with a particular characteristic is not known or difficult to assume, robust estimates give a sample size of 384 (Islam 2009). Details of sample size estimation in three scenarios are explained in Appendix 3. This study interviewed 412 households, which is more than the required sample size and exceeds that used in previous research. Although larger samples can cause a non-response bias by lowering response rates (Berkowitz 1996c), this did not occur here. This survey minimised non-response rate to only 4 per cent, much lower than 10-15 per cent suggested by United Nations (UN) (2005) for a community household survey. The sample selection and details of the population proportions are presented in Table 5.1.

Table 5.1: Target population and sample selection

Name of village	Total number of households	FDC households	Number of FDC households selected for the survey
Gulkhali	660	637	154
Jurshing	677	538	130
Patakhali	280	250	60
Binapani	447	90	22
Ganthirgiri	87	70	17
Hariharpur	148	120	29
Total	**2299**	**1705**	**412**

Source: Dakshin Bedkashi and Uttar Bedkashi Union Parishad Offices

In the villages, the major problem encountered was in identifying households other than the forest communities. In most cases, non-forest community households also collect resources casually from the SMF. On the other hand, except for fishers, some forest communities do not harvest resources all the year round. All of these issues posed a problem in ensuring an authentic and representative sampling frame. Thus, this survey addressed these issues by adopting the following methods and techniques to build the sampling frame of the FDC households.

Stratifying Random Sampling: For any study, it is necessary to make sure that the sample is representative of the population (Neuman 2003, 2006). A stratified simple random sampling technique was applied in this study to separate two subpopulations: forest-dependent households and others. One group was the population whose major professions were selling labour, fish farming, livestock, agriculture, etc. The other group was forest-dependent households who relied on resource harvesting from the SMF.

As per the above interpretation, each village was stratified into two constituents: 'Sundarban dependent communities (SDC)' and 'non-Sundarban dependent communities (NSDC)'. The sample of 412 SDC households was taken from each village proportionately to their population. The number of households ranged between 17 and 154 in each village within the SDC (Table 5.1). The selection of samples was based on the simple random technique followed by a lottery method to select the SDC households. Thereby, the research reached a trade-off between accuracy, cost and time.

Household Selection: Research associates were appointed and trained in data collection. They observed physically the location of SDC in each village and finalised the listing of the total number of households for each village. They listed the households from the entrance of the village and ended with the last household, interviewing in that order. The entrance is assumed to be the household at the start-point of a village from the largest road that touches the village. To make the selection random, every 4th household was selected for interview. If the selected household was not available for interview, three more visits were made in the following three days to attempt to conduct the interview. After three visits if the selected household was not available then the household next to the selected household located before and after were contacted respectively as a 'replacement sample' (Alam 2003).

Selection of the Respondent: The last phase of this sample selection procedure was the selection of the respondent from the selected household. For this purpose, a 'contact paper' was prepared (Appendix 4). After visiting the household, the interviewer first asked for permission from the adult person who first came to talk to him/her regarding the interview. The interviewer then listed the full identity of the respondents who were eligible to take part in the survey. Three criteria were considered to be an eligible respondent of the survey. These were: (i) a respondent must be above 18 years of age, (ii) respondent must be a member of the forest communities, and (iii) respondent should be mentally and physically sound. In this regard, it should be mentioned that in Bangladesh sometimes any relative aged above 18 years is found to live in a particular household. In this survey, such temporary-outsider members were excluded, as they had no power in decision-making in the family.

Eligible persons of a household were listed by their names and gender. According to social custom in Bangladesh, women usually do not tell the names of their husbands and fathers-in-law. In that case, instead of names of the households, serial numbers were used. Generally, in Bangladesh, two scenarios are common. First, the oldest person of the household is selected by the household members to respond. Second, the husband is usually selected by the wife to take part in the survey. In both cases, these persons were treated as the head of the households. In Bangladesh, the head of the household was selected as the respondent for the last 'Household Income and

Expenditure Survey 2005' conducted by BBS. This survey defines "head of household means a member of the household who is the decision-maker regarding the different activities of the household. This household is also being run under his command .....… a member is regarded as head of a household when the other members consider him so" (BBS 2007b, p. 148).

After selecting the head of the household as the contact person, the interview was conducted on the same day, provided he/she agreed to take part in the interview. It should be mentioned here that the interviewer requested the interview be held on the same date since visiting the same place at different times would be time-consuming and expensive when: (i) these communities live in the remotest part of the country; (ii) the interviewers live in a different part of the villages (in most cases in different villages) which required them to walk on foot; (iii) there is no mode of transport available in the selected villages; (iv) there is a fear of 'tiger-attack' and other sorts of physical insecurity; and (v) communities live in different areas. Alternatively, another mutually accepted date was fixed. It is mentioned here that the Munda community use their own indigenous language, which is not familiar to the interviewers. Thus, all interviews were conducted in Bengali—the dominant local language.

5.5 Data Collection and Fieldwork Procedures

During this data collection period, eight interviewers, who were trained and supervised by the researcher, conducted the survey. They were trained for one day regarding the theoretical and conceptual aspects of the research. Training content included basic aspects of the research such as objectives, socio-demographic aspects of the households, interview techniques, interview scheduling, and possible biases of interviewers. They were also trained in conducting FGDs.

In the training session, the interviewers were intensively trained to understand every single question, its objective(s) and prospective answer(s). The objectives of the training were to direct them to extract accurate answers. In this regard, during training, several mock interviews were conducted on how to conduct the interview.

All eight interviewers were from selected villages in the study area due to their familiarity with norms, culture and geographical locations of the forest communities.

Of the eight interviewers, seven were male and one was female. One interviewer was from the Munda community. Munda and Mahato are the two indigenous communities living at Koyra. Munda is the main community with its own language and culture. The selected Munda interviewer has vast experience in data collection. Consequently, he was selected for his access to and well-established rapport with his own community.

Of these eight interviewers, four were primary school teachers from two government primary schools situated in Binapani and Gulkhali villages. They were trained in school classrooms. The other interviewers previously worked in different NGOs such as: Pradipon, Unnayan Onneshan, ASA, and BRAC. They were trained at the BRAC Training Centre at Koyra. Lunch, morning and evening tea and transport allowances were given to the participants for attending the training.

There was no payment to the survey respondents. Forest community households were very enthusiastic and curious about the survey. In personal and informal discussions with respondents, it was found that they were enthusiastic about the research topic. Almost all respondents were participating in an interview for the first time in their life. Almost all of the respondents did not have any previous knowledge of offering information regarding the linkage between conservation of the Sundarbans and their livelihoods. The concepts of property rights and demand-side interventions were new and created enthusiasm among respondents. Respondents were very courteous during the interview and on many occasions they entertained the interviewers with light refreshments including home-made food items like *Muri* (fried rice), *Chira* (rice-made snacks), *Pitha* (rice-made bread) etc. At the time of the researcher's final departure from the village, many forest community members came and provided harvested forest resources (such as honey) as gifts.

Four hundred and thirty households were contacted to achieve the target of 412. Interviews continued until the expected number of samples was achieved for each village. After collection, each survey instrument was carefully checked by the researcher as to whether there was any inconsistency or non-response. Except in very few cases, there were no discrepancies identified in the completed instruments. Most of the discrepancies were solved through additional consultations with the interviewers. In a few circumstances, an insignificant numbers of gaps were

identified which were again sent back to the interviewers for corrections or, if necessary, for re-interviews. As the interviewers were local people, it was very easy for them to re-communicate with the respondents to make corrections. On average, each interview took 29 minutes, the shortest time was 22 minutes and the longest time was 54 minutes. The response rate of the respondents was very good at 96 per cent (details are given in Appendix 5). This was due to the emphasis on making convenient times and place for interviews and on employing efficient and educated local interviewers. The researcher oversaw all aspects of the data collection effort.

5.6 Survey Instrument

The Human Research Ethics Committee of the University of Southern Queensland provided ethical clearance for conducting the survey. The development of the questionnaires was completed by August 2010. An initial version of the Interview Schedule (IS) was modified through two informal FGDs and ten one-to-one trial interviews with prospective respondents. The revised pilot instrument was then executed with fifteen respondents. The IS was also continuously revised as per feedback obtained from interviewers in the initial days of conducting interviews. The overall anatomy of the survey instrument was developed by adopting the following procedures.

Focus Group Discussions: Two informal FGDs were conducted in two different locations of the study area (details of the FGD method will be discussed in Chapter Seven). According to Stewart et al. (2007), the contemporary focus group interview usually involves 8-12 individuals who take part in the discussion for one-and-a-half hours to two-and-a-half hours regarding a particular issue. But as a rule of thumb, FGDs should not last more than two hours and in most cases should be completed within one-and-a-half hours (Liamputtong & Ezzy 2005). On the other hand, Bloor et al. (2001) recommend 6-8 members as the optimum size for a group; whereas Pugsley (1996) and Thomas (1999) opined that the range of the size of a focus group should be 3-14 participants. In this study, each focus group contained 6-10 members, of at least eighteen years of age, and involved in forest resource harvesting as their main occupation. Each discussion lasted for one-and-a-half hours to two hours. FGDs method has two main criticisms: (i) it does not yield quantitative data and (ii) the group members may not be representative of a larger population (Stewart et al.

2007). Female members were also invited to avoid gender biases. Discussions were very successful due to the homogeneous nature of groups with similar social and cultural backgrounds. This enabled them to talk to one another comfortably and openly. The researcher's role of a moderator was to steer the interaction and to ensure that the discussions continued towards the topic of interest (Berkowitz 1996b).

The purpose of the FGDs was to test the IS for respondent understanding and to gather their suggestions for further revision. Following the FGDs, ten trial interviews were conducted to finalise the IS. All of these interviews were held in FDC households.

The interview period coincided with the peak season for harvesting resources by FDCs. Thus, the opportunity cost of attending the FGDs for them was high. Considering their opportunity costs, all FDC attendees were given a gift voucher of Tk. 100 (US$ 1.5). All participants accepted it very happily.

Pre-testing of Survey Instruments: Berkowitz (1996a) stresses pre-testing as essential for an in-person survey instrument because of the necessity to examine whether the appropriate questions are being asked to respondents and the correct information is being collected. Berkowitz (1996a) also added that "pre-testing involves administering the instrument to a small number of persons as similar as possible to the proposed respondents using exactly the same procedures that are used in the full study" (p. 47). Following this assertion, pre-testing was conducted to address two main issues. One was to modify the IS for better understanding by incorporating easy and socially- and culturally-acceptable wording to respondents; and, secondly, to develop interview techniques and methodology for the collection of correct data and information (Alam 2003).

In pre-testing, emphasis was given to examining the correctness of the structures of the IS by adopting the same method to be followed in the real survey. In this regard, special focus was given to three elements of the IS: (i) to amend the questions of the Likert scale in order to make the variables understandable to respondents; (ii) to extract accurate answers regarding the alternative property rights regime; and (iii) to ensure accurate alternative livelihoods information.

Pre-testing certainly detected major problems in structure, pacing, questions and wording and necessitated further adjustments of the IS. In that process, the construction of the IS and its logical sequence were very carefully scrutinised and then reframed accordingly. In most cases, the modifications needed were in wording and sentence structure.

At the time of pre-testing, it was found that interviewers were taking too long to complete interviews and in most cases many questions remained unaddressed. The main reason was the language barrier, especially for the Munda communities as they use their indigenous language rather than Bengali. Another problem related to the original version of the questionnaire, in English, gaining approval from the Ethics Committee. The translation from English to Bengali was reframed according to the local colloquial terms to make it more understandable to them.

During pretesting, replacement samples were made after finding the absence of the head of the household in three subsequent visits in three consecutive days. However, an exception was made for *Mawalis* and fishers who stay deep in the forest for around 30 and 15 days respectively.

Finalisation of the IS: The original preliminary questionnaire sought to incorporate all necessary elements including variables and a wide range of issues. After pretesting, the IS was modified and made ready for the main survey by following several techniques. Appropriate, understandable words were inserted where necessary to add understanding. Social-religious customs and norms were also followed to avoid any embarrassing situations at the time of conducting the survey. The draft was finalised after taking final opinion from supervisors at the University of Southern Queensland. The principal supervisor of this research was from Bangladesh. Thus, the IS was continuously developed with his close guidance. The final version of the IS comprises 27 main questions in four sections. Appendix 6 provides a full version of the IS.

Conducting the Main Survey: The final survey was conducted between 1 December 2010 and 15 February 2011. Due to the damage of the WAPDA embankment from Cyclone *Sidr* and *Aila*, the whole of Koyra was under water in the month of October 2010.

Post-survey Crosschecking: Post-survey assessment was necessary in a few cases to fill in gaps in skipped questions and to verify responses. This post survey check was performed by the researcher within two weeks of the completion of the IS by mobile phone. This enhanced the reliability of the survey data. To conduct this check, 30 respondents who owned mobile telephones were selected. Those respondents were asked whether they were satisfied with the interview procedure and whether all the aspects were understandable to them. The consistency of their responses in this second discussion to their initial responses was closely examined. The full version of the questionnaire format for the re-interview is in Appendix 7.

Use of Likert Scale: Following Likert's (Likert 1932) work, respondents were asked to give their views on a five-point scale to investigate whether variations in question structure have any detectable effects on survey findings (Schuman & Presser 1981). It is found that 'the use of scales in attitude testing has been well established for several decades' (Ryan & Garland 1999, p. 107). Thus, Likert scale type questions are commonly used to capture subjective assessments of phenomena for eliciting the opinions, attitudes and perceptions of respondents in social research (Ryan & Garland 1999). As this study was designed to measure subjective community perceptions about tree density of the SMF, the Likert scale was found to be the most useful research method. This study used a 5-point scale to measure the perceptions of the FDCs of the SMF. This scale was used in and cited for participatory forest management research by Kearney and Bradley (1998), Lund et al. (2010) and Shahbaz (2009).

5.7 Elements of the Interview Schedule

Gomm (2004) opines that the first issue of any questionnaire relates to its construct validity, that is, to make it free from any biases. The structure of the questionnaire was arranged in a logical sequence as it needed to address selected variables and issues from the theoretical and conceptual framework to test the hypothesis. Data and information needed to be reliable and valid to obtain authentic results. According to Gelcich et al. (2007), it is important to know harvesting behaviour under the state conservation system to enhance biological sustainability through the proper allocation of property rights. Thus, three basic domains were identified in the IS: (i) forest conservation, (ii) co-management and property rights and (iii) alternative

livelihood options. Questions related to socio-economic, demographic conditions and perceptions of the respondents were also asked. An introductory statement explained the purpose of the survey to respondents.

Section-wise contents of the IS are described in turn:

(i) Opinions and General Information: The first section was designed to understand the perceptions and attitudes of the respondents towards the overall management of the SMF and resource harvesting patterns. It consisted of respondents' general opinions on various issues around sustainable management of the SMF and its present status. First, the respondents were asked to identify which community they belong to. They were asked to quantify the importance of the SMF for their livelihoods and its status in terms of tree density on a five-point scale such as: (i) very high; (ii) high; (iii) medium; (iv) low; (v) very low. They were then asked about the overall management of the SMF, again on a five-point scale such as: (i) very good; (ii) good; (iii) barely acceptable; (iv) poor; (v) very poor. Respondents were then asked about any changes in tree density in the SMF over the years. Where decreases were noted, they were then asked to nominate five main reasons for this occurrence. The respondents were asked whether they feel there is a need to protect the SMF. They were also asked to give information regarding their resource harvesting activities over the past month: (i) number of visits; (ii) days stayed; (iii) kinds of resources derived; and (iv) distance of harvesting sites from their homes.

The intensity of the communities' opinions about the reasons for degradation under the state property rights was also identified. These questions presented in-depth insights into the perceptions and attitudes of the forest communities regarding the use of this forest. These questions presented core information on underlying beliefs and values of forest community members living adjacent to the SMF.

(ii) Variables for Sustainable Forest Management: The questions in this section were aimed at identifying variables regarding management and harvesting in the SMF. All variables were taken from S&O's theory of property rights and empirical research findings. First, respondents were asked to identify the policy instrument through which they were allowed to harvest resources. The next questions sought

their opinions on various variables on a five-point Likert scale such as: (i) strongly agree; (ii) agree; (iii) undecided; (iv) disagree; (v) strongly disagree. The first five questions captured property rights-related variables: 'access', 'withdrawal', 'management' and 'exclusion'. Other questions were asked to capture other variables such as: consultation, tree plantation, conflicts of interest, discrimination, social capital and intention to participate in co-management. They were then asked whether they can harvest resources without any harassments/hazards. In case of 'no', they were asked to rank the identified harassments/hazards. The section ended by estimating the level of social capital with respect to the length of involvement in the community-based organisations.

(iii) Co-management: This section began by asking respondents how long they have been living in their villages. Then they were asked to identify specific property rights regimes. They were then requested to choose one of the four property rights regimes, namely, state, private, common, and open-access property regimes. Remaining questions were posed to gather information regarding co-management structure in the SMF. These included whether the respondents intended to be involved with a co-management regime. In the case of a 'yes' response, subsequent information was gathered as to how they would like to be involved in co-management and what contribution they would make. These questions gave them multiple options for involvement in co-management such as: management process, developing community institutions, benefit-sharing structure, selling cheapest labour and others. The options for their contribution to co-management were: labour, monitoring, management, awareness building or all of the above.

Next, the respondents were given the opportunity to identify the rights they would like to enjoy under a co-management structure. The property rights bundles of this theory were translated into understandable wording. 'Access', 'withdrawal', 'management' and 'exclusion' rights were translated into 'to harvest specific products', 'to regulate harvesting patterns to improve harvested resources', and 'to make decisions regarding the access and transfer of access rights to others', respectively. These rights were also blended to identify 'authorised claimant' and 'proprietor' bundles of rights associated with their positions.

All of these questions were framed to draw out their willingness to be involved in co-management. The last two questions sought to understand what they thought were the barriers to co-management and how those barriers could be overcome. They were also asked to explain potential measures to overcome those barriers.

(iv) Socio-economic and Demographic Information: The last section of the IS derived detailed information on socio-economic and demographic characteristics. Information obtained included household income, education, age, family-size, employment, marital status, and types of dwelling. These data are very important for three main reasons. First, these data allow testing as to whether the sample is representative of the population of the study area. Second, they explain how FDCs react to state property rights regimes and how their circumstances impact on their differing property rights choices. Third, they enable essential and detailed social analysis of households' perceptions, attitudes and understanding towards broader issues of sustainable natural resource management.

5.8 Framing the Property Rights and Demand-side Intervention Questions

The techniques of framing the property rights and demand-side intervention questions are narrated below.

5.8.1 Property Rights Question Formats

The S&O's (Schlager & Ostrom 1992) model was used in framing the property rights questions. These questions were framed on a five-point Likert scale and in multiple-choice options. These questions were designed to apply Common's (1968) view as to how a property right becomes enforceable, enabling particular actions in a specific domain such as sustainable forest management. Respondents were given an opportunity to translate property rights by defining their actions in relation to others (Ostrom 2003). For 'access' rights the question asked whether forest communities are allowed to harvest forest resources. The next question asked whether communities expect to gain desired benefits from harvesting through permits to reflect the 'withdrawal' right. It asked whether forest communities are able to make decisions about internal use patterns and transform harvested resources by making improvements, representing the 'management' right. Information on the 'exclusion' right was obtained by asking whether forest communities are able to make decisions

about which community members can use the forest. Lastly, respondents were given these rights as options and asked which one they prefer under a co-management system. By answering these particular questions, respondents basically identified their positions on common-pool resource management. The positions are authorised entrant, authorised user, authorised claimant and proprietor.

5.8.2 Demand-side Management Question Format

Forest resources are often exploited at unsustainable rates because of their common property characteristics (Caviglia-Harris et al. 2003). Supply-side policies are primarily responsible and can be overcome by introducing demand-side policies which create alternative livelihoods through managing forest communities' demands in a sustainable and alternative way. Consequently, research questions were framed related to demand-side policy-related interventions and alternative livelihoods. Following Caviglia-Harris et al. (2003), these questions gathered information to (i) enhance long-term conservation; (ii) promote the achievement of economic efficiency; and, most importantly, (iii) render greater political acceptability compared to supply-side policies.

In relation to income and expenditure, respondents were asked to give their income earned from resource harvesting from the SMF and other sources. Respondents were asked where they get financial help in case of financial difficulties. They were then asked to identify the major problems in acquiring jobs other than forest resource harvesting. From the FGDs at the stage of piloting the IS, it was found that after Cyclone *Aila* in 2009 the forest communities became more dependent on the SMF for their livelihoods. In this regard, two questions were framed: (i) what was their income before and after *Aila* and (ii) what were the sources of income then and now. It was expected that answers to these questions might suggest that a shift to demand-side policies could encourage a pro-poor conservation approach to create viable future opportunities outside the SMF for the dependent forest communities (Tumusiime et al. 2011).

5.8.3 Follow-up Questions

The re-interview schedule was designed to examine how well the survey accurately derived data and information (Cantor et al. 2007). These questions gathered data

from the respondents to allow a comparison of the estimates of the demographic and socioeconomic information and the findings of property rights, co-management and livelihood-related questions.

5.9 Validity and Reliability

It is very important to establish the validity and reliability of the research. It is very difficult to assess validity and reliability by establishing the standardisation of data collection in any particular research method, especially in qualitative research (Kumar 2011). In spite of these difficulties, these methods are described below:

5.9.1 Validity

This study tests several validity measures: (i) construct validity; (ii) instrument validity; (iii) criterion validity; (iv) content validity; (v) face validity; and (vi) translation validity. *Construct validity* relates to the measure of various abstract concepts with regard to intelligence, motivation, perceptions and attitudes (Black 1999). The questions used appropriate wording and statements to minimise false and distorted answers that often arise from bias, misinterpretation and social desirability. *Instrument validity* was ensured through piloting the questions to extract the most valid indicators with greatest commonality for the final instrument. According to Pokharel and Suvedi (2007), validation of variables are achieved through conducting a pilot study. *Criterion validity* was ensured by checking the variables in the instrument with the other instruments of a similar nature. The variables in the research instrument were compared with instruments used by Salam et al. (2005) (for forest management related variables) and Ahmed et al. (2008) and (Coleman 2011) (for property right-related variables).

Content validity ensures "the subjective measure of how appropriate the items seem to a set of reviewers who have some knowledge of the subject matter" (Litwin 1995, p. 35). This validity assessed an organised review of the survey's content to ensure the inclusion of every necessary and relevant aspect. The review was performed by the two supervisors of this research and two well-regarded researchers and academicians from Bangladesh. One expert was from Unnayan Onneshan (The Innovators), and has extensive knowledge of working with forest communities of the SMF. Unnayan Onneshan is a pioneer Dhaka-based independent research

organisation with which the researcher had very good rapport during data collection. As content validity is not quantified (Litwin 1995), only these experts' views were reflected in designing the instrument and survey. This provided a good foundation for building a methodologically rigorous assessment of the survey instrument's validity.

Face validity is achieved by casual assessment of item appropriateness by a few untrained individuals (Berkowitz 1996a; Litwin 1995). The researcher used one research assistant from Unnayan Onneshan working at Korya and one community member to review the appropriateness of the IS items. The concerned head of its forest research department instructed the local officials positioned at its Khulna Divisional Office and Koyra Office to intensively help the researcher in conducting the field survey and collecting various secondary data. Necessary amendments were made as per their comments on vagueness, cultural connotation, use of colloquialisms and item inappropriateness.

As the instrument was prepared in English and then translated into Bengali with local colloquial language to make it understandable to the respondents, ensuring *translation validity* became a benchmark criterion for assessing its quality (Mueller 1986; Pokharel & Suvedi 2007). Thus, this translated version of the IS was first reviewed by the principal supervisor of this study. To fit with the local colloquial understanding, the translated version was again reviewed by the research assistant of Unnayan Onneshan who hails from Koyra and by another community member from Binapani Village. After that, the translated version was finalised through individual piloting and FGDs.

The validity of this survey was ensured by comparing it with the household survey guidelines of the Department of Economic and Social Affairs of the Statistics Division of UN (UN 2005). Careful consideration of this guideline helped achieve valid responses from the respondents (detailed elaboration of this is contained in Section 5.9.3). Validity was also established through extended analysis of the socio-economic and demographic characteristics of the respondents and drawing comparisons with local and national data. Moreover, numerous statistical measures were employed to test hypotheses using an econometric model (described in the next chapter). The test results also established the validity of the research.

5.9.2 Reliability

Reliability is the measure by which an instrument replicates the same findings with repeated administration (Graziano & Raulin 2010). A highly reliable instrument gives more confident results reflecting an individual's true score by measuring the variability among responses (Black 1999). However, it is difficult to ensure reliability in any research as "no instrument is perfect, so you can expect some error to occur during the measurement process" (Litwin 1995, p. 6). To ensure the reliability of results of the household survey, a post survey check approach and a variant of test-retest were undertaken to lower the measurement error of the collected data. Re-interviews were also conducted. Following Vaus (2002), the researcher re-interviewed the same respondents using eight questions two weeks after completion of the IS. Since "there is no evidence regarding the ideal interval between testing and retesting" (Considine et al. 2005, p. 21), due to time constraints, the researcher considered two weeks as the appropriate interval period. This approach is also supported by Vaus (2002).

The process adopted was to randomly select 30 cell-telephone owning respondents from a total of 42 cell-telephone owning households. The lottery method was applied for selection. A few questions were repeated from the IS to test reliability (Appendix 7). The re-interview found high correlation of the responses in the survey and post-survey check, giving an authentic reliable measurement of the survey. The findings showed few discrepancies. Two respondents gave inconsistent answers in selecting property rights bundles. One incorrectly identified the main barrier of co-management. All discrepancies were adjusted. The overall finding is that minimal discrepancies occurred.

5.9.3 United Nations' Guidelines

Although household surveys are commonly used by many researchers for cross-sectional data collection, no standard guideline to establish validity and reliability is agreed. The Statistics Division of the Department of Economic and Social Affairs of the UN appointed a group of experts with multidisciplinary and multinational background to develop 'Designing Household Survey Samples: Practical Guidelines' (hereafter UN guidelines) to design and implement various techniques for data

collection (UN 2005). The guidelines recommend sample survey design, administration and data analysis practices to be followed by researchers and analysts involved in sample survey work and activities. According to the guidelines, a well-designed household survey and its proper implementation can guarantee data and information with sufficient quality and accuracy with speed at a relatively low cost (UN 2005).

The survey instrument and procedures followed the recommendations of the guidelines, except in a few cases. The exceptions were due to geographical conditions of the study area, time and budget constraints. The respondents were also extremely poor and illiterate, or very poorly educated. The detailed comparison between the recommendations in the UN guidelines and the survey procedure applied for this research are incorporated in the Appendix 8.

5.10 Potential Sources of Bias and Remedial Measures

Examining validity and reliability is very important as the implementation of household surveys suffers from various types of biases related to survey and sampling designs. For household surveys, it is necessary to be aware of some aspects of bias to reduce total error (Henry 2009). The survey procedures adopted some remedial measures to overcome potential sources of bias in the design of the IS. According to Henry (2009) and Singer (2006), the main sources of bias in household surveys are: (i) sampling design and (ii) non-responses. These aspects are described below:

Non-sampling Bias: This bias arises from the difference between the true target population value and the obtained population (study population). In this study, two indigenous communities were identified: Munda and Mahato (as they originated from Munda, they can be treated as a sub-group). Mahatos were found in one of the six study villages, but in very insignificant numbers. They are not very involved in resource harvesting from the SMF; rather, they make their livelihood by selling physical labour. Moreover, they were not included in the survey due to the non-availability of a Mahato interviewer and other logistic support. Mahatos return at night from their work place. At the time the survey was conducted in Binapani village, there was no electricity or road communication to reach the Mahato *Para*

that was around 2-3 km away from Binapani. Due to presumed difficulties in communicating with them, they were excluded from the survey. This sub-group is very minor in respect of fishers, *Bawalis*, *Mawalis* and Munda. Consequently, omission of this sub-group from data collection is not expected to create a bias.

Non-response Bias: Usually non-response results "from the researcher's inability to contact certain members of the population or from some target population members' choice to exercise their right not to participate in a survey or provide other data for the research" (Henry 2009, p. 87). Non-response creates a serious error if it is not random. However, non-response does not represent a bias if it is truly random (Fowler 2009; Henry 2009).

Empirical research suggests that non-response more frequently comes from sub-groups (Henry 2009). This study found that few Munda households declined to participate in the survey. This was assisted by developing good relationships and employing a Munda interviewer. Overall, the total number of non-responses was considerably reduced by employing highly trained interviewers, asking understandable and easy questions (Vaus 2002) and developing very good relationships with the communities. If the inferential paradigm of probability sampling is seen as the relationship between non-response rates and non-response bias, it is found that this survey does not have any problem in this regard (Singer 2006). The low 4 per cent non-response rate was found to be extremely random. Consequently, a potential non-response bias did not arise (UN 2005).

Non-response is very common and important in cross-section household surveys. This non-response bias happens when some crucial characteristics of individuals or existing differences between two populations of respondents and non-respondents is evidenced (Garcia et al. 2009). Sample selection bias can also arise due to the difference between observable or non-observable characteristics for each sub-sample. This survey design was carefully structured to avoid these sources of non-response biases. The socio-economic characteristics of the respondents and non-respondents were identical. Various sub-groups such as: Fishers, Munda, *Bawalis* and *Mawalis* have the same observable characteristics. Most importantly, non-responses were not a problem in this survey.

In the survey, the number of non-responses was 18. The failure to interview these people was due to their non-availability at contact time period for three visits. No contacted respondent refused to take part in the interview, with the exception of one woman. Respondents showed enthusiasm for the survey because of its close relation to their livelihoods.

Non-sample error was extremely minimal due to the in-person face-to-face interviews.

Information Bias: Inexperienced respondents can lead to this bias occurring because of their insufficient knowledge regarding the research issue. The survey necessarily addressed issues like the degradation trend of tree density; alternative property rights regimes and possible policy interventions. All of these issues needed authentic and appropriate information provided by respondents. To reduce this bias, the age of the respondents was a minimum of 18 years.

Interviewer Bias: Careful selection of interviewers and intensive training are very important in conducting unbiased surveying. The interviewers were recruited independently from a pool of experienced local and relevant interviewers. They were intensively trained and guided to comprehend each question. However, comparing survey results among interviewers was not considered as a test of potential bias for two reasons. First, the author reviewed the IS responses from interviewers regularly. Second, little variation was found due to the unique nature of socio-economic characteristics of the respondents and their extensive training and motivation.

Although potential biases can exist, the above sections show that the methods adopted to obtain estimates from households minimised biases.

5.11 Data Analysis and Selection of Test Statistics

Survey data and information were collected using various sources and methods. The overall objective was to assess the present management regime of the SMF and investigate the interaction between existing property rights and conservation of forest resources. The investigation was carried out by developing an extended logit-model using property rights and management-related variables—described in the next chapter. The analysis will lead to an assessment of the acceptability of alternative

property rights regimes. The survey data are also extensively analysed using descriptive statistics (see Chapter Seven).

Data analysis methods were selected on the basis of the required statistical analysis and nature of data collected. The use of descriptive statistics is expected to achieve this purpose. Following this, the level of measurement was designed to be categorical and mostly on a nominal scale with non-parametric estimates. Hence, hypothesis tests were designed to establish the relationship between 'forest condition' and other variables. Null hypotheses (H_0) were established with the assumption of H_0 = relationships do not exist; meaning that willingness to conserve is independent of property rights or other socio-demographic variables. Pearson's chi-square (χ^2) test is applied with respect to accepting or rejecting H_0. In this regard, two types of χ^2 tests are employed: χ^2 test for goodness of fit to describe a single categorical variable; and χ^2 test for independence is applied to interpret relationships between two categorical variables. These tests are employed to find differences between two or more actual samples. This assesses the difference between an actual sample and another hypothetical or previously-established distribution to examine whether the expectation is due to chance or probability. The following equation has been used to employ χ^2 test.

$$\chi^2 = \sum \frac{(F_o - F_e)^2}{F_e} \quad \text{..... (Eqn. 5.1)}$$

where F_o = observed and F_e = expected frequencies of the distribution.

Although an alpha (α) cut off value of 0.05 is suggested for rejection of H_0, this study applies 0.10 as α cut off value. This value is commonly used by researchers, for example, Alam (2011) and Joshi and Arano (2009).

Considering the socio-economic characteristics of FDCs, present resource harvesting patterns, policy implications and experience from other empirical research (Behera 2009), this study has used a logit model for econometric analysis to address the second research question.

A discrete and continuous variable logit analysis is used to identify the indicators that may influence the adoption of co-management in the SMF. Researchers have successfully used this model to test forest sustainability (Behera 2009; Salam &

Noguchi 2005; Salam et al. 2005). Following Salam et al. (2005), one model of this research uses the variation of predictors with dichotomous type questions. It is expected that respondents' attitude measurement will allow more useful information and avoid a serious multicollinearity problem. Thus, for this study, this allows a correct interpretation of the decisions of the respondents as to whether they agree that the current conservation policy is conducive to sustainable management of the SMF. It assumes that community members are faced with a choice between two alternatives and a set of potential scale items rated on a 1-5 agree-disagree scale of responses. The choice depends on identifiable variables whose magnitudes denote the embeddedness of property rights and impacts on sustained conservation. A logistic probability function has been used to model this kind of cumulative density function.

The model findings are interpreted through the maximum likelihood method with the use of R^2, coefficients, *p*-values, odds ratios, Wald statistics, marginal effects, elasticities and beta coefficients. These tools are used to investigate the statistical validity of community perceptions regarding the interaction between existing property rights and the conservation of forest resources.

5.12 Conclusion

This chapter describes different methods to gather data and information. The survey instrument was designed to apply property rights bundles to assess the current management system of the SMF and to investigate the need for alternative livelihood measures. The IS was examined through FGDs and piloting to make it pragmatic and understandable to the respondents. Appropriate wording and colloquialisms were used in line with local needs and contexts. A detailed description of potential biases associated with measurement instruments was made to ensure the accuracy of survey data and information by applying relevant validity and reliability measures. This description was extended with the application of recommendations made by UN guidelines for household surveying with few exceptions necessary for particular contextual and geographical conditions of the study area. These recommendations are expected to achieve high validity and reliability of the survey findings.

The chapter also explains how descriptive statistics and regression analysis is applied to interpret the survey data and information. Based on the survey methods and procedures as described in this chapter, the forthcoming chapter assesses community perceptions regarding the interaction between the existing property rights regime and the conservation of forest resources. These data and information are also used in Chapter Seven to investigate whether an alternative property rights regime of co-management is able to achieve forest sustainability of the SMF.

CHAPTER SIX

DETERMINANTS OF FOREST-DEPENDENT COMMUNITY PARTICIPATION IN MANGROVE CONSERVATION PRACTICES

Chapter 6

Determinants of Forest-dependent Community Participation in Mangrove Conservation Practices

6.1 Introduction

The theories and methods described in Chapters Three and Five are applied in this chapter to examine the factors that influence conservation practices in the SMF. It measures variables of interest from theories of conservation, property rights, co-management and social capital. The first aim of this chapter is to analyse the efficacy of a state property rights regime in managing the SMF. In this regard, it examines the association between ownership and mangrove conservation practices. The second aim is to explore FDCs' perceptions about their participation in conservation practices and management in the SMF. This chapter applies S&O's (1992) theoretical framework to examine the role of ownership variations in common property resource management. In its application to the SMF, a survey of 412 FDC households was undertaken.

Based on FDC views, this chapter examines whether different ownership positions could increase the community desire to participate in mangrove conservation activities. Consequently, to achieve conservation through co-management, the aim of the study is to identify factors that could influence conservation practices of the FDCs in the SMF. Thus, this study addresses the following research question:

How do communities perceive the interaction between the existing property rights regime and the conservation of forest resources?

The chapter is divided into fourteen sections. Section 6.2 pinpoints the necessity of perception study. Section 6.3 is concerned with participants' socio-economic and demographic attributes. Section 6.4 describes the efficacy of state property rights in

managing the SMF. Section 6.5 examines whether there is any association between ownership positions and mangrove conservation practices. Section 6.6 analyses the perceptions of FDCs about their potential participation in mangrove practices. A model of factors influencing forest condition using four theories is presented in Section 6.7. Section 6.8 elaborates the use of econometric models and their specifications with variables. Section 6.9 establishes the reliability of the models by presenting various diagnostic tests. Estimation of the results of the statistical models is provided in Section 6.10. Section 6.11 discusses the findings for each of the independent variables. Section 6.12 justifies model elasticities for forecasting, with quantifying relative significance of model determinants in Section 6.13. Section 6.14 concludes the chapter.

6.2 Necessity of Perception Studies

In the context of developing countries, researchers have studied local people's perceptions of conservation with the assumption that sustainability, more responsibility and long-term management of forest resources depend on local residents' support (Triguero-Mas et al. 2010). From various research findings, it is known that FDCs' socio-economic characteristics such as age, gender, schooling, affluence, household size, types of dwelling, marital status, property rights, co-management and social capital can partially determine attitudes towards conservation (Heinen & Shrivastava 2009; Infield & Namara 2001; Macura et al. 2011; Mehta & Heinen 2001; Shibia 2010). Attitudes of FD staff and their perceptions of conservation practices also affect FDC perceptions towards sustainability. For instance, conflict between FDCs and FD staff on resource harvesting allowances, strict rules on access, and rude behaviour or harassment by FD staff generates negative attitudes towards conservation. The lack of FDC involvement in decision-making processes and forest management is also a vital determinant of negative attitudes towards conservation (Silori 2006). Although there is a large body of research analysing local people's attitudes towards conservation, an analysis of perceptions towards the SMF is absent. For example, the establishment of reserved forests has affected FDCs since colonial times (Guha 1983), but nothing is known about their attitudes towards this reserved forest. To address this gap, this study aims to assess perceptions towards management regimes and conservation practices in an

effort to discern the main factors that influence these perceptions. This will enable an understanding of potential FDCs' participation in management and policy-making.

Sustained conservation practices are community-promoted activities to balance the conservation-development nexus from a dynamic-institutional perspective (Tai 2007). It is acknowledged that a medley of political, historical, social and economic factors influence community participation in natural resource management (Agrawal & Gibson 1999; Horwich & Lyon 2007). Thus, mangrove conservation policy and management need to reflect the perceptions of local communities. This enhances an understanding of the factors influencing conservation choices, economic activities and existing conflicts between their actions and conservation practices. No research has explored such perceptions for the SMF. Hence, this chapter focuses on an assessment of factors responsible for the existing level of FDCs' participation in mangrove conservation. Econometric/statistical software such as SPSS/PASW version 19 and STATA version 11 are used for data analysis.

6.3 Respondents' Characteristics

The socio-economic and demographic characteristics of the FDCs are important in assessing their relationships with existing conservation practices and the effects of external factors for future design (Infield & Namara 2001; Sarker & Røskaft 2011). Household characteristics of the respondents are presented in Table 6.1. The survey data reflect the commonality regarding respondents' sex. This is due to the issuing of permits by the BFD to male FDCs only. The BFD does not allow women to enter the SMF on the grounds of security and social norms (Kabir & Hossain 2008). According to Kabir and Hossain (2008), all members of the indigenous and FDCs believe that the SMF is a sacred place where the presence of women would violate its sanctity because of their menstruation. As the focus of this study is on the resource users' knowledge, perceptions and attitudes, male respondents were interviewed purposively in larger numbers. Moreover, all age groups above 18 years were interviewed in order to understand the mode of transmission of customary knowledge to upcoming generations. The minimum age of the respondents is 20 and maximum age is 80, with a mean age of 44 years. Most of the respondents were either illiterate or had primary school level education. Monthly incomes of respondents ranged from two thousand to more than ten thousand Tk (US $1 = Tk 68, February 2011).

Seventy-four per cent of village households in the villages of the study area were found to be directly dependent on the SMF.

Fishing and crab harvesting are the main sources of income. Secondary activities are wood and/or firewood harvesting. Other sources of income are honey and *Gol* leaves collection in a three month production period. Few respondents earn income from agriculture and livestock rearing.

Table 6.1: Household characteristics

Variable	Description	Number	%
Gender	Male	400	97
	Female	12	3
Age	18-29	26	6
	30-39	145	35
	40-49	134	33
	50-59	49	12
	60+	68	14
Education level	No school	133	32
	Primary	174	42
	Secondary	102	25
	Higher secondary/Graduate	3	1
Primary sources of income	Fishing and crab harvesting	351	85
	Wood and firewood harvesting	36	9
	Honey harvesting	4	1
	Gol leaves harvesting	24	6
	Other	6	1
Monthly income from all sources	<Tk. 2000	16	4
	Tk. 2001-4000	216	52
	Tk. 4001-6000	117	26
	Tk. 6001-8000	38	9
	Tk. 8001-10000	31	8
	>Tk. 10000	4	1
Marital status	Unmarried	18	4
	Married	388	94
	Widowed	2	1
	Divorced/separated	4	1
Types of dwelling	*Gol* leaves/straw/wood	218	53
	Chala/mud	26	6
	Tin/wood built	157	38
	Cement/brick built	1	0.2
	Others	10	2
Household size	1-2	19	5
	3-4	166	40
	5-6	149	36
	7-8	59	14
	9-10	14	3
	11+	5	1

Most of the FDCs lost their houses during *Sidr* and *Aila* cyclones in 2007 and 2009 respectively. They are now living on the flood-control embankments. Because of poverty, they built their houses with materials such as *Gol* leaves, stretching materials and wood collected from the SMF. Only a few built their houses with wood and corrugated sheet to cover the roof. Sheets are locally known as *tin* and were given mainly free as 'cyclone relief' by the Government and other NGOs working in this area. Wood was collected illegally from the SMF. Among the respondents, most are married and over 18 years. The average household size is 5. Prior to independence in 1971, the country's average family size was 6 whereas in rural areas it was 5.4 (Ahmad 1972). The finding is very significant in that after 40 years of independence the household size has not changed significantly. It clearly indicates the enormous pressure on the SMF by continually increasing population. Seventy-six per cent of respondent households range in size between 3 and 6. This is because of the lower average age of marriage by Muslim couples which is 23.05 years for males and 15.11 years for females (Uddin 2007). Women produce more babies in their full reproductive life cycle between 15 and 45 years.

6.4 Role of the State Property Rights Regime

Respondents' attitudes towards various ownership positions are presented with categories based on S&O's (1992) theory. Two hundred and twelve forest people (51.5%) harvest resources with permits from the BFD (Figure 6.1). The number of illegal harvesters is almost similar (48.5%). Permit holders are allowed access and withdrawal rights. The choices of respondents for various categories of property rights are authorised user, claimant and proprietor. Following S&O, these categories of property rights allow access and withdrawal, management and exclusion (Schlager & Ostrom 1992).

Figure 6.1: Present users of the SMF

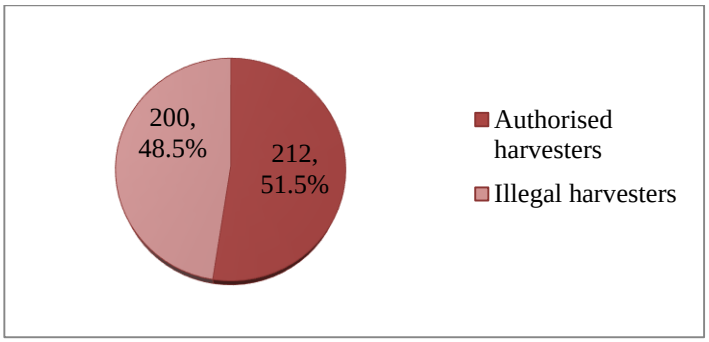


Table 6.2 shows that the respondents overwhelmingly believe there has been a reduction in tree density. The question posed was: "Do you think that there have been any changes of tree density of the Sundarbans over the years?" Almost all the respondents observed long term damage. However, non-responses for the 30 year time horizon are mainly seen among younger respondents.

Table 6.2: Perceptions regarding tree density changes in the SMF

Time horizon (Years)	Authorised harvesters		Illegal harvesters		Missing/no response	
	Increase	Decrease	Increase	Decrease	Authorised harvesters	Illegal harvesters
5	9%	90%	5%	95%	1%	-
15	2%	98%	2%	98%	-	-
30	1%	91%	2%	86%	8%	12%

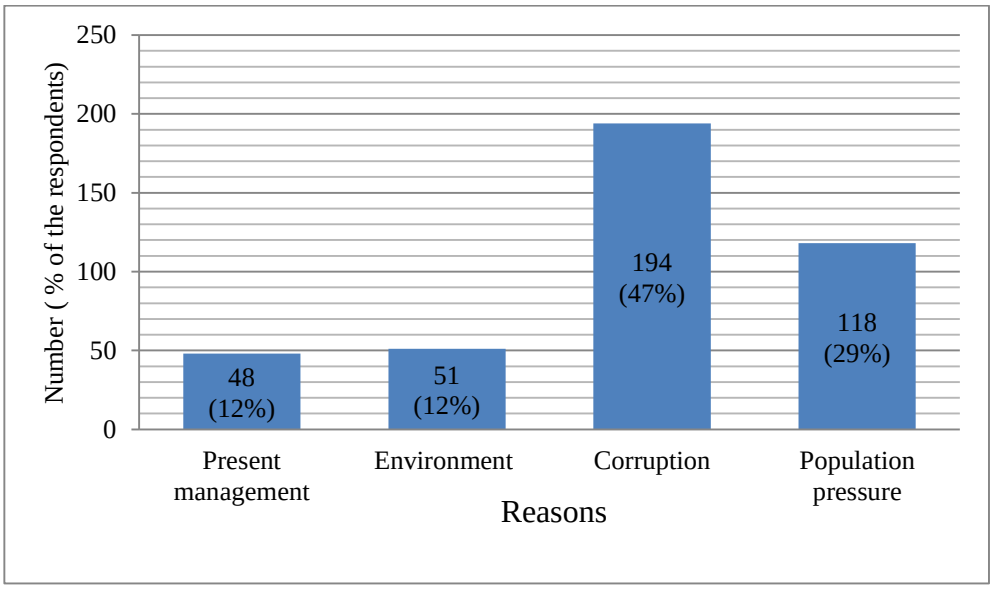
Table 6.3 shows that respondents believe there was a 41 per cent reduction in tree density reductions in last 30 years. The degradation rate in the last 5 years was 20 per cent. This is mainly due to the damage caused by the two recent devastating cyclones. There were no remarkable differences between authorised and illegal harvesters.

Table 6.3: Quantifying tree density changes in the SMF

Time horizon (Years)	Authorised harvesters		Illegal harvesters	
	Increase	Decrease	Increase	Decrease
5	1%	19%	<1%	22%
15	<1%	29%	<1%	34%
30	<1%	40%	<1%	42%

Respondents were given four options to rank and identify the reasons for such degradation. As shown in Figure 6.2, almost half (47%) the respondents identified 'corruption' as primarily responsible for the evidenced degradation. This finding is similar to the Transparency International Bangladesh (TIB) report. TIB found yearly trafficking of valuable logs including *Sundari*, *Pashur* and *Goran* to be worth about Tk 2.41 billion by *Bawalis* and *Mawalis*, in connivance with the BFD and local police (Manzoor-E-Khoda 2008; Zaman & Manzoor-E-Khoda 2011). The report also exposed annual bribe income of Tk 230 million and Tk 62.5 million by BFD officials from fishers and *Bawalis* respectively.

Figure 6.2: Reasons for tree density reduction in the SMF



Bangladesh is facing high population pressure with an exponential growth rate of 1.42% per year (BBS 2006). As a result, respondents identified population pressure as the second largest influence on degradation. However, a low number of

respondents identified present top-down management and overall environmental degradation as the main reasons for tree density reduction in the SMF.

Socio-demographic and economic characteristics of the FDCs are very important as they could impinge on forest conditions, although not always linearly (Agarwal 2009). These characteristics of the respondents need to be selected carefully as they vary in most of the cases (Sarker & Røskaft 2011). Many researchers like Sarker and Røskaft (2011), Chang et al. (2009), Coulibaly-Lingani et al. (2011) commonly used education, occupation, household size, sex and age of the respondents as variables in perceptions and attitude studies about conservation or protected areas and people's participation in management. Following them, this researcher has used these common characteristics in this analysis.

Throughout much of the world, extra-legal exchanges (corruption), in the form of bribery and illegal exchange, allow access to natural resource management and become the rule rather than the exception (Robbins 2000). In Table 6.4, the researcher demonstrates that there is no significant association between the perceptions of the top-down bureaucratic management system and the socio-demographic characteristics of the FDCs except for age, which is significant. This immediately suggests the need for alternative livelihood measures for the two largest age groups of 30-39 and 40-49 to lessen their pressure on the SMF. Participants' education, age and sex have no significant association with perceptions of environmental degradation. Industrial effluents, oil spills and chemical fertilizer use in agriculture are the main sources of environmental degradation (Awal 2010). Respondents, however, do not perceive them to be major problems. It was found that FDCs' main occupations (fishing and crab harvesting) and their household incomes are significantly associated with perceptions of environmental degradation of the forest. This means that the BFD has failed to monitor overharvesting.

Table 6.4: Concerns about tree density degradation in the SMF

	Present management		Environment degradation		Population pressure		Corruption	
	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
Education level	16.384 (df=20)	0.693	7.076 (df=12)	0.853	26.123 (df=12)	0.010	25.032 (df=12)	0.015
Main occupation	9.402 (df=10)	0.494	13.458 (df=6)	0.036	21.547 (df=6)	0.001	9.184 (df=6)	0.163
Household income	25.138 (df=25)	0.455	29.117 (df=15)	0.016	73.126 (df=15)	0.000	84.611 (df=15)	0.000
Sex	1.373 (df=5)	0.927	1.898 (df=3)	0.594	2.846 (df=3)	0.416	11.504 (df=3)	0.009
Age	29.127 (df=20)	0.085	11.376 (df=12)	0.497	19.654 (df=12)	0.074	10.828 (df=12)	0.544

Population pressure is highly associated with demographic characteristics except sex, which might be explained by the male domination of respondents. Perceptions of corruption are also highly associated with almost all demographic characteristics except age and occupation. Corruption is common and widespread under the state property rights regime. During the field work, respondents expressed the opinion that BFD staff take bribes at every opportunity, from collecting permits to the end of resource harvesting. They take bribes from both authorised and unauthorised users. At the time of permit issuance, BFD staff charge several times higher than the actual fees set by the Government. Permits are issued for seven days. Usually poor communities cannot complete harvesting in this short time, as they need to leave the forest to sell their harvested resources. BFD staff also take bribes in addition to actual fines for staying each unauthorised day in the forest. To meet the expenses of bribes, harvesters extract more resources than the limits determined by the BFD who also remain indifferent to overharvesting. This corruption negatively impacts existing ownership positions of the BFD and sustainable mangrove conservation practices.

At harvesting time, BFD retains a certain amount of money in the name of a ‘duty charge’ from the FDCs. Although everyone has to pay this illegal ‘duty charge’, the rate is more for illegal harvesters than for permit holders. If they decline to give

bribes, BFD staff intimidate them by lodging false forest cases against them. Again, these BFD staff have a close liaison with the illegal harvesters from whom they take money to allow them to illegally harvest timber. Respondents indicated that in lieu of only Taka 250 (US $3.68), BFD staff allow illegal harvesters to collect timber at night time. They are the lowest level forest officials responsible for the management and implementation of licensing. These staff have an interest in undermining the monitoring and enforcement of access rules in return for bribes.

Corruption is also facilitated by the lack of accountability of the BFD to the local community or any institution at the local level. It is important to note that all the FDCs live in abject poverty (Unnayan-Onneshan 2009). Eighty-seven per cent of people of Koyra lost their source of income from agriculture and became mostly dependent on the SMF as a result of cyclone *Aila* (Unnayan-Onneshan 2009).

6.5 Ownership Positions and Mangrove Conservation

From the above discussions of the role of the state property rights regime, it is necessary to understand the concerns about tree density degradation from the perspective of authorised and illegal harvesters, and those with and without access and withdrawal rights. The differential analyses of these two groups will contribute to comprehending further tree density degradation under existing mangrove conservation practice.

As shown in Table 6.5, it is found that for authorised harvesters, their level of education, gender and age are not associated with degradation. On the other hand, main occupation and household income are significantly associated with degradation. This means that community household incomes come from the major activities of fishing and crab harvesting and cause huge environmental degradation. Income and gender are also associated with corruption as a reason for tree density reduction. This means that harvesters have to pay bribes to the BFD staff for resource harvesting, despite having permits for enjoying access and withdrawal rights.

Table 6.5: Concerns of authorised harvesters about tree density degradation

	Present management		Environment degradation		Population pressure		Corruption	
	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
Education level	7.387 (df=12)	0.831	2.036 (df=9)	0.991	12.693 (df=9)	0.177	8.292 (df=9)	0.505
Main occupation	12.709 (df=8)	0.122	20.514 (df=6)	0.002	18.659 (df=6)	0.005	4.560 (df=6)	0.601
Household income	17.380 (df=20)	0.628	28.600 (df=15)	0.018	22.841 (df=15)	0.088	32.308 (df=15)	0.006
Sex	2.099 (df=4)	0.718	0.549 (df=3)	0.908	2.119 (df=3)	0.548	8.656 (df=3)	0.034
Age	16.288 (df=16)	0.433	8.793 (df=12)	0.721	16.213 (df=12)	0.182	6.922 (df=12)	0.863

In comparison with the above associations of authorised harvesters, when the researcher examined illegal harvesters and the reasons for tree density degradation, significantly different results were found. Table 6.6 indicates that the socio-demographic characteristics of illegal harvesters are more significantly associated with the causes of degradation. Unlike authorised harvesters, education and main occupation are significantly associated with the view that the current conservation practice is a reason for degradation. However, except for income of the illegal harvesters, no other socio-demographic characteristics are associated with environmental degradation. In contrast, education, main occupation and income are highly significant and strongly associated with population pressure and corruption. Further, gender is also found to be significantly associated with corruption.

Table 6.6: Concerns of illegal harvesters about tree density degradation

	Present management		Environment degradation		Population pressure		Corruption	
	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
Education level	26.260 (df=16)	0.050	10.695 (df=12)	0.555	21.842 (df=12)	0.039	26.537 (df=12)	0.009
Main occupation	18.783 (df=8)	0.016	7.339 (df=6)	0.291	22.728 (df=6)	0.001	17.236 (df=6)	0.008
Household income	22.338 (df=20)	0.322	22.869 (df=15)	0.087	54.317 (df=15)	0.000	74.867 (df=15)	0.000
Sex	2.169 (df=4)	0.705	3.005 (df=3)	0.391	1.145 (df=3)	0.766	6.788 (df=3)	0.079
Age	20.602 (df=16)	0.194	12.067 (df=12)	0.440	13.449 (df=12)	0.337	12.242 (df=12)	0.426

From the above comparison presented in Tables 6.5 and 6.6, it is found that socio-demographic features of the illegal harvesters are strongly associated with degradation. Furthermore, it can be noted that respondents saw degradation as mostly associated with the population pressure and corruption, suggesting a lack of other options for livelihood other than harvesting. Consequently, these illegal harvesters are being victimised by the corruption of BFD staff. This is mainly due to their higher dependence and lack of any property rights for entrance and harvesting.

As the government owns the SMF, it is necessary to know whether there is any association between ownership positions and mangrove conservation practices adopted by the BFD. It is surprising that all respondents know that the forest is protected with certain restrictions and rules regarding resource harvesting. They, thus, believe that the present management system assigns the BFD the sole authority to manage this forest. To this end, respondents were asked to assess the overall management of the SMF by the BFD. Most respondents believe that the overall management by the BFD is barely acceptable. Ten per cent of respondents were found to be happy with the overall management of the forest. These people were found to have close relations with BFD staff who allow them to illegally harvest. A significant portion of the respondents (41%) were found to be satisfied with the

present management due to transmitting *de jure* rights into corruption-led *de facto* rights. The remaining (49%) of the respondents were unhappy. This finding is in contrast with the earlier perceptions regarding the role of the BFD in enhancing tree density degradation through corruption.

From the above views of the respondents, it is necessary to find out whether there is any significant association between tree density degradation and the current management by the BFD. As outlined in Table 6.7, it is found that there are significant associations between the existing state property regime with respect to most of the participants' demographic characteristics. Participants' main occupations are highly associated with present management. This indicates the high dependence of FDCs on their occupations as sources of income. Gender and age are also highly significant. It is to be noted that almost all the resource harvesters are males. Alienation rights allow illegal entrance and overharvesting without any oversight.

Table 6.7: Perceptions regarding state property rights regime

	State property rights regime	
	χ^2	*P*-value
Education level	22.900 (df=16)	0.116
Main occupation	29.563 (df=8)	0.000
Household income	21.310 (df=20)	0.379
Sex	19.022 (df=4)	0.001
Age	27.210 (df=16)	0.039

Education level was not found to be significant. This may be due to only 58.5% literacy rate of respondents, which is almost the same as the national level of 58.6% for males (as almost all respondents are male) in rural areas (BBS 2009). In comparison with the definition of literacy (BBS 2007c), this study defines literacy as having education up to grade two level. These FDCs with basic literacy realise the degradation trend to be unsustainable in the present organised *de jure* rule system. They understand that corruption has become a special form of resource management by the BFD. However, there is no significant association between household income and current management. This means that the degraded SMF cannot alleviate the

livelihood pressures of highly dependent FDCs. For instance, around 50,000 people are in the forest each day for resource harvesting. Although, the BFD is supposed to govern both the timing and spacing of individual extraction behaviour, the allowing of illegal harvesting demonstrates there is an extra-legal relationship between them and the FDCs. This results in overharvesting. The state property rights regime does not ensure conservation practices by merging formal constituted national and regional rules with local systems to create the actual "operational" rules of use (Ostrom 1990). Higher levels of education help the respondents predict that state sponsored institutions commonly encourage corruption where BFD staff have a monopoly over the use of the SMF.

One of the key findings of this study is that there is a significant association between existing overall management of the SMF and key demographic characteristics, except education. This striking result particularly demonstrates that the forest is the only source of income for the poor FDCs. Under the ownership of the BFD, the state property rights regime has failed to create any avenues to apply conservation-friendly *de facto* rights by creating a co-management partnership culture.

6.6 Community Perceptions towards Participation in Conservation Practices

Figure 6.3 presents the rights categories FDCs preferred; and Figure 6.4 presents the preferences expressed by authorised and illegal harvesters. The researcher finds a very surprising and interesting result with a huge difference in the preferences for ownership positions by the two groups. It is also found that there is highly significant association between the FDCs' views regarding current management and their desire for expected rights (χ^2 = 39.250; df = 16, p = 0.001). Following this finding, it categorises respondents depending on their preferences for rights possession to participate in conservation. Figure 6.3 indicates that only 18 respondents desire access and withdrawal rights to be authorised users, of whom 11 are authorised harvesters. This is in sharp contrast to the number of respondents using access and withdrawal rights through permits under the current management system. This may be an indication of communities' dissatisfaction towards the BFD. It indicates that there is no correlation between current rights holdings and preferences for rights. Hence, it appears that present authorised users have no role in conservation activities without any collective choice right. This means that the BFD is only interested in

resource harvesting without taking any initiative to allow communities to participate in conservation. Insufficient rights, thus, de-motivates FDCs to participate in conservation. This finding is also in line with the literature which suggests investment withdrawal in common property resources without community involvement (Ahmed et al. 2008).

Figure 6.3: Overall community preferences for ownership positions

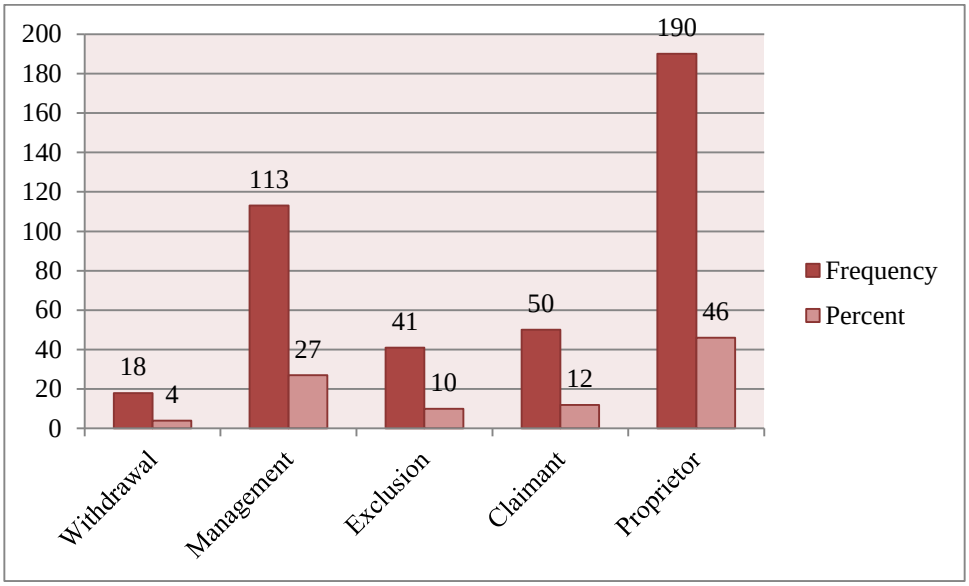
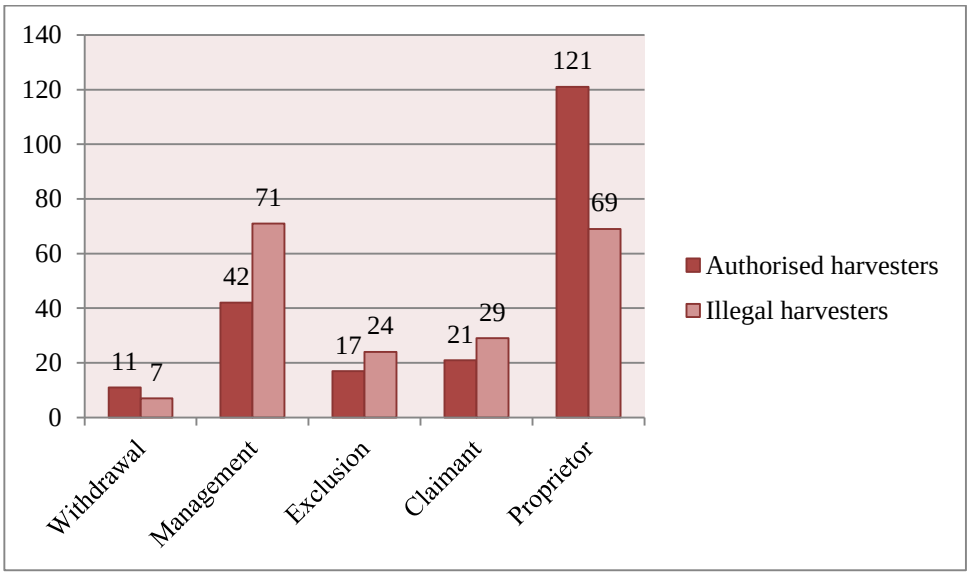


Figure 6.4: Preferences for ownership positions by authorised and illegal harvesters (in frequency)



One hundred and thirteen respondents chose the right "to regulate harvesting patterns and improvement of harvested resources" for management rights. As illegal harvesters are not getting permits, most of them (71) opted for this right. The option for exclusion rights such as "to make decisions regarding the access and transfer of access rights to others" is chosen by comparatively less respondents. Only 50 respondents chose rights up to management level. These can be categorised as claimants. This is because FDCs have no faith in the current forest bureaucrats. Harassing of individuals in communities is a common practice and it has become institutionalised in the local BFD offices. It appears that the right to manage is not enough to change this bribery-led institutional culture.

To address this culture, respondents opted for more power sharing with the BFD to ensure and sustain their involvement in conservation practices. However, surprisingly, the largest number (190) desire to have rights up to exclusion. These respondents chose the two statements above in addition to access and withdrawal rights. It is important to note that most of these respondents are authorised users (121). A significant number of illegal users (69) also opted for this right category. Basically, illegal users doubted that the state property rights regime will share their rights and power under the current bureaucratic administrative arrangements. According to S&O (1992), with rights categories up to exclusion level, these respondents can be classified as proprietors. This implies that FDCs desire rights to decide who has access to the SMF and who does not. This finding is consistent with the designated exclusion rights of joint forest management in India where rule enforcement allows communities the right to cancel an individual household's membership and to decide who has access to the forest and who does not (Behera & Engel 2006). The respondents indicated that management rights were not enough to stop corruption as the BFD's hegemony would persist. This finding clearly shows a demarcation between authorised users and proprietors seeking exclusionary rights.

Table 6.8 summarises the second aim of the study that explores the attitudes of FDCs towards their participation in conservation practices. The key finding here is that the allocation of rights to FDCs is highly significant and associated with tree density degradation. If FDCs are allocated rights up to their desired level (up to exclusion level), they will be able to contribute to conservation practices with their active

participation in management. Rights up to proprietor level can certainly be expected to ensure their participation in conservation practices to reduce corruption and environmental degradation through improved management.

Table 6.8: Participants' perceptions towards rights allocation

	Present management		Environment degradation		Population pressure		Corruption	
	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
FDCs' perceptions for rights allocation	34.218 (df=20)	0.025	33.260 (df=12)	0.001	49.045 (df=12)	0.000	55.343 (df=12)	0.000

6.7 Model for Sustainable Forest Management

The concept of institutional resource regime refers to the ownership and rights to a resource and to the policies that regulate the use and protection of a particular resource (Gerber et al. 2009). Thereby, this study has used the theories of conservation and property rights to assess the bundle of property rights and their association with natural resource conservation. Allocation of property rights is very important to ensure public participation in natural resource management in a co-management structure. This also involves social aspects of participation in networks, shared values, understanding and norms (Plummer & Fitzgibbon 2006). This study, thus, also uses theories of co-management and social capital.

6.7.1 Theory of Conservation

To provide both economic benefits to people and conservation benefits to wildlife and biodiversity, conservation theory suggests the need for strictly protected areas to enable a full complement of biological diversity for a particular region to persist over the long term (Noss et al. 1999; Nyhus & Tilson 2004). Following this theory, buffer zones are frequently established within the core protected areas as the most common practice of combating population growth impacts and maintaining the integrity of flora and fauna (Groom et al. 1999). This theory endorses the expectation that mangrove buffer zones would extend the availability of habitats for plants and animals, as well as providing resources and services to people (MacKinnon et al.

1986). Hence, management authority enhances strict compliance of conservation practices in the buffer zones without restricting FDCs from resource harvesting. However, in reality, one of the great challenges is to identify land use systems and its management to meet both the above roles simultaneously (Salafsky 1993), while minimising conflict among mangrove resource management and FDCs (Nugent 2003). Conservation is not achieved in many countries under the sole bureaucratic management of FDs (Davidar et al. 2008; Stone et al. 2008) which do not allocate property rights to FDCs at an appropriate level (Schlager & Ostrom 1992). Thus, it is hypothesised that conservation can be achieved by maintaining good forest conditions with inclusive and participatory policy and practice with defined property rights. These policies and practices need to focus on understanding the attitudes, needs and aspirations of local people (Mehta & Heinen 2001).

6.7.2 Theory of Property Rights

While transaction costs and agency theories of organisation offer an optimistic perspective of equilibrium, classical property rights theory is better placed to handle shared ownership (Kim & Mahoney 2005). 'Classical' forms of property rights theory pay greater attention to historical and institutional contexts to shape and change property rights (Coase 1937, 1959, 1960). However, the theory fails to explain situations where inefficient outcomes persist. This fails to link the roles of FDCs to mangrove conservation efforts because of ill-defined property rights (Barbier 2006; Nugent 2003).

One of the most important issues regarding resource governance is to explore the relationship between equality of power among stakeholders and governance outcomes (Brockington 2002). From this perspective, many researchers and scholars have shown interest in the application of the theory of property rights for local level sustainable forest resources outcomes (Hayes & Persha 2010; Irimie & Essmann 2009).

Consistent with S&O (1992), a relationship between the FDCs and policy-makers is perceived as inevitable for community outcomes and their collective action (Irimie & Essmann 2009). Ostrom and Ahn (2003) proposed that property rights theory needed

to link with other resource-based theories such as theories of co-management and social capital. This would enable sustainable management to be achieved.

6.7.3 Theory of Co-management

Central to the theory of co-management is the distribution of property rights and responsibilities related to a particular resource. This demonstrates reciprocal altruism by providing property right bundles to local user groups at an appropriate level (Plummer & Fennell 2007; Plummer & Fitzgibbon 2004a). Thus, the theory of co-management supports the application of community customary knowledge and joint monitoring to cap illegal harvesting (Jentoft 1989; Matose 2006). Co-management involves the process of sharing management decisions between centralised government agencies and local user groups (Beem 2007). Hence, co-management needs to be translated into area and region specific co-management structure to frame operational mechanism to achieve sustainability. In fact, co-management structures involve a range of relationships by conferring power sharing, and decision-making authority, and adopting a people-centred governance approach for problem solving (Berkes 2009).

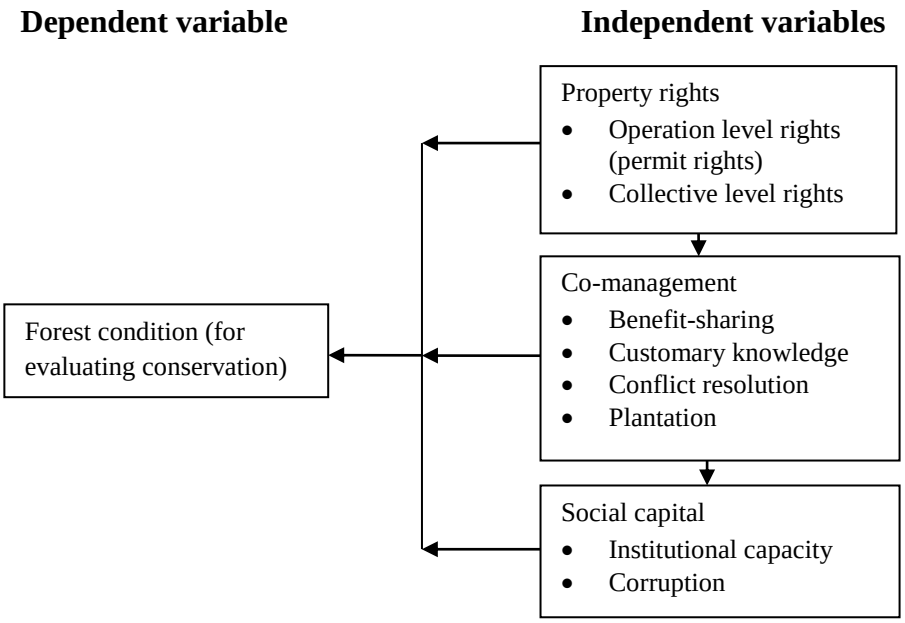
6.7.4 Theory of Social Capital

However, co-management has failed to improve forest condition where limited attention has been given to the nestedness of community-based organisation (Brown et al. 2007). Gough et al. (2008) identified improper attention to enhancing community social capital as the underlying reason for such failure. Spellerberg (2001) defines social capital as relationships among actors of individuals, groups and/or organisations that drive the development of mutual benefit or common purpose. In the absence of social capital, cooperative behaviours are not developed to solve problems pertaining to group governance (Adhikari & Goldey 2010). In this regard, the theory of property rights fails to recognise shared ownership as a valid incentive structure between contracting parties. Hence, the theory of social capital refers to social assets formed through enhancing the institutional capacity of local users (Adhikari & Goldey 2010).

In this regard, the above four theories are applied in developing a model for sustainable management of the SMF. Figure 6.5 presents a model of factors

influencing forest conditions as a function of property rights, co-management and social capital variables.

Figure 6.5: A model of factors influencing forest condition



Investigating FDCs' attitudes, taking into account their needs, and respecting their opinions should become a priority to enable community participation in conservation of the SMF. Following Agarwal (2009), tree density is used as a proxy for forest condition for subjective measurement of forest conservation. This approach replicates the existing top-down conservation approach of the BFD. Consistent with S&O (1992), this study translated permits as access and withdrawal, termed as operation level rights; and management and exclusion as collective level rights. FDCs use collective level rights to gain livelihood benefits from forest ecosystems that invariably require collective choice governance approaches to function as a collective endeavour. Consequently, they are more likely to use customary knowledge as a conflict resolution mechanism to reduce illegal harvesting through joint monitoring in benefit-sharing participation. This regime should enhance conservation practices through vertical and horizontal relationships between FDCs and BFD staff with extended participation of the former in management and policy making. This co-management regime also encourages plantations to offset tree density reduction. Thus, perceptions regarding the interaction between the existing

property rights regime and conservation of forest resources are assessed to understand the level of conservation practices in the SMF.

6.8 Statistical Model

The above model is analysed using regression techniques to examine the effects and magnitude of the abovementioned factors on forest conditions. The following sections present the logit model derivation and specification for this study.

6.8.1 Derivation of Logistic Regression Model

The conditional normal model for flexible generalisation of ordinary linear regression is a generalised linear model (GLM). A GLM describes a relationship between the mean of a response variable Y and an independent variable x. But the relationship may be more complicated than the $E(Y_i) = \alpha + \beta x_i$.

A GLM consists of three components: random, systematic, and link function (MO 2010).

(1) The response variables $Y_1, \dots \dots, Y_n$ are the random component. They are assumed to be independent random variables, each with a distribution from a specified exponential family. The Y_is are not identically distributed, but they each have a distribution from the same family: binomial, poisson, normal, etc.

(2) The systematic component of the model is the function of the predictor variable x_i, linear in the parameters, which is related to the mean of Y_i. So the systematic component could be $\alpha + \beta x_i$ or $\alpha + {}^{\beta}/_{x_i}$, for example.

However, in case of a simple logistic regression, only $\alpha + \beta x_i$ is considered here with an assumption "that there are no significant outliers, the data are not over or under dispersed, and that neither of the variables require transforming" (Hutcheson & Sofroniou 1999, p. 130).

(3) Finally, the link function $g(\mu_i)$ links the two components by asserting $g(\mu_i) = \alpha + \beta x_i$,

Where $\mu_i = E(Yi)$.

The conditional normal regression model is an example of a GLM. In that model, all responses, Y_is, have normal distributions. Of course, the normal family is an exponential family in the random component. This forms the regression function as α + βx_i in this model which is the systematic component. Finally, the relationship μ_i = $E(Yi)$ = α + βx_i is assumed. This means the link function is $g(\mu) = \mu$. This simple link function is called the identity link.

Another very useful GLM is the logistic regression model. In this model, the responses Y_1, …, Y_n are independent and $Y_i \sim Bernoulli\ (\pi_i)$. The Bernoulli family is an exponential family with $E(Y_i) = \pi_i = P(Y_i = 1)$. Here, π_i is assumed to be related to x_i by

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \alpha + \beta x_i \quad \text{..... (Eqn. 6.1)}$$

The left-hand side is the log of the odds of success for Y_i . The model assumes this log odds (or logit) is a linear function of the predictor x. The Bernoulli probability mass function can be written in exponential family form as:

$$\pi^y(1-\pi)^{1-y} = (1-\pi)\exp\{\, y log\left(\frac{\pi_i}{1-\pi_i}\right)\}\,.$$

The term $log\left({\pi}/{(1-\pi)}\right)$ is the natural parameter of this exponential family and the link function $g(\pi) = log\left({\pi}/{(1-\pi)}\right)$ is used in equation 6.1. It is called the canonical link when the natural parameter is used in this way. In that case, equation 6.1 can be rewritten as:

$$\pi_i = \frac{e^{\alpha+\beta x_i}}{1+e^{\alpha+\beta x_i}} \quad \text{..... (Eqn. 6.2)}$$

Or, more generally, $\pi(x) = \frac{e^{\alpha+\beta x_i}}{1+e^{\alpha+\beta x_i}}$ ..... (Eqn. 6.3)

It is seen that $0 < \pi(x) < 1$ which seems appropriate because $\pi(x)$ is a probability. If it is possible that $\pi(x) = 0\ or\ 1$ for some x, this model is not appropriate. Thus, if $\pi(x)$ is examined more closely, its derivative can be written as follows:

$$\frac{d\pi(x)}{dx} = \beta\pi(x)\big(1-\pi(x)\big) \quad \text{..... (Eqn. 6.4)}$$

As the term $\pi(x)(1-\pi(x))$ is always positive, the derivative of $\pi(x)$ is positive, 0, or negative according to β is positive, 0, or negative. If β is positive, $\pi(x)$ is strictly increasing function of x; if β is negative, $\pi(x)$ is strictly decreasing function of x; if $\beta = 0, \pi(x) = {e^{\alpha}}/{(1+e^{\alpha})}$ for all x_s. As in simple linear regression, if $\beta = 0$, there is no relationship between $\pi \; and \; x$. Also in a logistic regression, it is found that $\pi\left(-\frac{\alpha}{\beta}\right) = \frac{1}{2}$. A logistic regression function exhibits this kind of symmetry for any $c, \pi\left(\left(-\frac{\alpha}{\beta}\right)+c\right) = 1-\pi\left(\left(-\frac{\alpha}{\beta}\right)-c\right)$.

The parameters $\alpha \; and \; \beta$ have meanings similar to those in simple linear regression. Setting $x = 0$ in equation 6.1 yields α to be the log-odds of success at $x = 0$. For any x, evaluation of equation 6.1 at $x \; and \; x+1$ yields

$$\log\left(\frac{\pi(x+1)}{1-\pi(x+1)}\right) - \log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \alpha + \beta(x+1) - \alpha - \beta(x) = \beta.$$

Thus, β is the change in the log-odds of success corresponding to a one-unit increase in x. In simple linear regression, β is the change in the mean of Y corresponding to a one-unit increase in x. Exponentiating both sides of this equality yields

$$e^{\beta} = \frac{\pi(x+1)/(1-\pi(x+1))}{\pi(x)/(1-\pi(x))} \quad \text{..... (Eqn. 6.5)}$$

The right hand side is the odds ratio comparing the odds of success at $x+1$ to the odds of success at x. In a logistic regression model, this ratio is constant as a function of x.

Finally, it is found $\frac{\pi(x+1)}{1-\pi(x+1)} = e^{\beta}\frac{\pi(x)}{1-\pi(x)}$ ..... (Eqn. 6.6)

That means e^{β} is the multiplicative change in the odds of success corresponding to a one-unit increase in x.

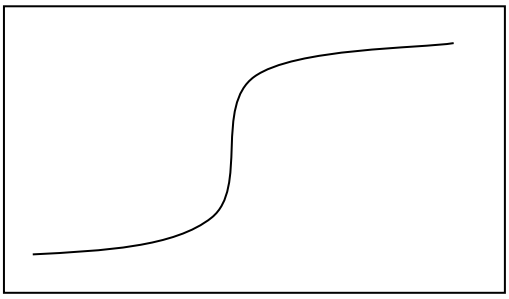
6.8.2 Model Explanation

The above central mathematical concept underlies logistic regression as the logit—the natural logarithm of an odds ratio. The simplest example of a logit derivation is from a 2 × 2 contingency table where a test of independence using chi-square could

be applied (Peng et al. 2002). This regression is well suited for interpreting and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictors. With an Ordinary Least Squares (OLS) regression equation due to the dichotomy of outcomes, two parallel lines are difficult to explain; rather, categories for the predictors may be created along with the computation of the mean of the outcome variable for the respective categories. Although the plot of categories' means appears in the middle, much like an ordinary scatter plot, the curves at the ends become S-shaped (Figure 6.6). Such sigmoidal or S-shaped curve is difficult to describe with a linear equation because of the extremes not following any linearity. Logistic regression solves this problem by logit transformation to the outcome variable. Thus, the simple logistic model has the following form suggested by Peng et al. (2002).

logit (Y) = *natural* log(*odds*) = $\ln(\frac{\pi}{1-\pi}) = \alpha + \beta X$ ..... (Eqn. 6.7)

Figure 6.6: S-shaped curve of logistic regression



Taking the antilog of equation 6.7 on both sides, the derivation of an equation to predict the probability of the occurrence of the outcome of interest is as follows:

π = *Probability* (Y = outcome of interest | X = x, *a specific value of X*) = $\frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}}$

…….. (Eqn. 6.8)

where π = probability of 'event' of outcome of interest, α = Y intercept and β = is the regression coefficient and e = the base of the system of natural logarithms.

An extension of the above logic from simple to multiple regression predictors is as follows:

$\text{logit}(Y) = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2$ ..... (Eqn. 6.9)

Therefore,

$\pi = \textit{Probability}\ (Y = \textit{outcome of interest} \mid X_1 = x_1,\ X_2 = x_2) = \frac{e^{\alpha + \beta_1 x_1 + \beta_2 x_2}}{1 + e^{\alpha + \beta_1 x_1 + \beta_2 x_2}}$

..... (Eqn. 6.10)

where βs are the regression coefficients and *X*s are a set of predictors and α and βs are typically estimated by the maximum likelihood method over the weighted least square approach.

The model states null hypotheses that βs equal zero where rejection of null implies at least one β does not equal zero in the population. This means the logit model predicts the probability of the outcome better than the mean of the outcome variable *Y*.

6.8.3 Application of the Model to Forest Conservation

To identify factors influencing the perceptions of FDCs towards sustainable conservation practices, a discrete variable logit analysis was adopted. Participants' views as to whether they believed 'sustainable conservation practices under the existing management system were not possible' were framed as a binary-choice model using tree density changes over the last ten years as a proxy. The model assumed a choice between two alternatives—an increase or a decrease of tree density.

Let T_i represents a dichotomous variable. It is 1 if the participant believes tree density has decreased and 0 otherwise. So, the probability of a participant 'agrees', Pr (T_i =1), is a cumulative density function F evaluated at $X_i\beta$, where X_i is a vector of explanatory variables and β is a vector of unknown parameters. A logistic probability function is used to model this cumulative density function (Salam et al. 2005). The form of the logistic probability function is as follows:

P_r (community members agree with forest conservation in terms of tree density) =

$$P_r(T_i = 1) = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)} \quad \text{..... (Eqn. 6.11)}$$

This study builds an empirical relationship between the probabilities of dichotomous options [$X_i(1,0)$] and a set of explanatory variables relating to current conservation practices in the SMF. The logistic transformation estimation form of this probability of community members' opinions in favour of sustainable conservation practices $P_r(T_i = 1)$ is expressed in the following form:

$$\mathbf{Ln}\left[\frac{\mathbf{Pr}(\boldsymbol{T_i}=\mathbf{1})}{\mathbf{1}-\boldsymbol{P_r}(\boldsymbol{T_i})}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_n X_n \quad \text{Eqn. 6.12)}$$

Where, β_0 is the "intercept" and β_1, β_2, β_3, ……., β_n are the "regression coefficients" of X_1, X_2, X_3, ……., X_n respectively.

To estimate the parameters of the variables, a maximum likelihood method is used (Chatterjee & Hadi 2006; Gujarati 2003).

6.8.4 Model Variables

The dependent variable

International Forestry Resources and Institutions (IFRI) commonly assessed outcome variables based on a subjective assessment of 'forest condition' (Agrawal & Chhatre 2006; Andersson & Agrawal 2011; Coleman 2011). Following Behera (2009), Hayes (2006) and other IFRI researchers and protocol mentioned by Lund et al. (2010), the outcome variable is sustainable conservation practices in terms of tree density changes used as a proxy. Thus, causal influences explain the interaction between existing property rights, management of the BFD and participants' social capital.

Independent variables

It is hypothesised that the property rights categories of S&O (1992) influence participants' perceptions towards sustainable conservation practices. Four rights categories are drawn from S&O's (1992) model—access, withdrawal, management and exclusion—and are used as variables. Other factors, listed in Table 6.9, are extracted from the literature (Behera 2009; Ostrom & Ahn 2003; Salam et al. 2005) and from the pre-test pilot of the survey instrument. All the factors are selected from the theoretical model outlined in Figure 6.5 and translated into quantifiable variables and described in Table 6.9. Furthermore, it can be mentioned that the choice of

explanatory variables for this study was based on data availability and literature. The variables used are in parentheses.

Table 6.9: Independent variables

Variable code	Variable	Variable description	Theory
AR	Access right (Behera 2009; Kabir et al. 2011)	'Access' rights to enter the SMF under present conservation practices allocating permit licences to the FDCs	Theory of property rights ('access' and 'withdrawal' as operation level rights and 'management' and 'exclusion' as collective level rights)
WR_D	Withdrawal Right (Kabir et al. 2011)	Harvest with permits as per FDC demands	
WR_T	Withdrawal Right	Completion of harvesting time as per permits	
MR	Management right (Coleman 2011)	FDCs' decisions about internal use patterns and transform harvested resources by making improvements	
ER	Exclusion right (Coleman 2011)	FDCs' decisions about which community member can use the SMF	
CM	Benefit-sharing partnership (Salam et al. 2005)	FDCs' intention to be involved in management of the SMF	Theory of co-management
CHD	Customary knowledge (Salam et al. 2005)	Consultation between BFD and FDCs regarding harvesting and distribution	
PMCI	Conflict resolution (Agrawal & Chhatre 2006; Kabir et al. 2011)	Conflicts between present management and community interests	
SSP	Plantation (Salam et al. 2005)	FDCs' satisfaction in species plantation	
CBO	Institutional capacity building (Behera 2009)	FDCs' satisfaction with involvement in community-based organisations	Theory of social capital
DCP	Corruption and discrimination	Discrimination or corruption in allocating permits	

6.8.5 Model Specification

In the following specification based on Eqn. 6.12, all variables from Table 6.9 are included. Following Salam et al. (2005), to identify factors that may influence the mangrove conservation, a discrete variable binary logit analysis was carried out. The logistic analyses results of these factors are assumed to present the perceptions of the FDCs towards current conservation policy and practices. Findings are expected to provide guidelines to policy-makers and practitioners for subsequent conservation

interventions of the SMF. Given the above-hypothesised factors in favour of sustainable forest conservation, the model to be estimated is:

$$\mathbf{Ln}\left[\frac{\mathbf{Pr}(\boldsymbol{T_i}=\mathbf{1})}{\mathbf{1}-\boldsymbol{P_r}(\boldsymbol{T_i})}\right] = \beta_0 + \beta_1(\text{AR}) + \beta_2(\text{WR}_\text{D}) + \beta_3(\text{WR}_\text{T}) + \beta_4(\text{MR}) + \beta_5(\text{ER}) + \beta_6(\text{CM}) + \beta_7(\text{CHD}) + \beta_8(\text{PMCI}) + \beta_9(\text{SSP}) + \beta_{10}(\text{CBO}) + \beta_{11}(\text{DCP}) + Є \quad \text{..... (Eqn. 6.13)}$$

Moreover, χ^2 tests for independence and goodness of fit were applied to examine the null hypotheses whether there where relationships existed between sustained conservation and other socio-demographic variables. Hence, a separate multiple regression model was also used to examine the relationship between socio-demographic attributes of participants and their attitudes to mangrove conservation. These variables are of both discrete and objective or continuous types. As mentioned in Section 6.4, these attributes are used to understand effects on forest conditions. Thus, this model is assumed to provide guidelines on how FDCs' socio-economic conditions help in shaping conservation policy and practices for the SMF. The following model was estimated using the socio-economic attributes of the respondents, namely, age, education, income, household size, gender, dwelling pattern and marital status.

$$\mathbf{Ln}\left[\frac{\mathbf{Pr}(\boldsymbol{T_i}=\mathbf{1})}{\mathbf{1}-\boldsymbol{P_r}(\boldsymbol{T_i})}\right] = \beta_0 + \beta_1(\text{age}) + \beta_2(\text{education}) + \beta_3(\text{income}) + \beta_4(\text{hhsize}) + \beta_5(\text{sex}) + \beta_6(\text{dwelling}) + \beta_7(\text{marital}) + Є \quad \text{..... (Eqn. 6.14)}$$

These models present coefficients and other results of the socio-demographic and policy-related variables separately. Factors influencing participation in the management of the SMF conservation programme is predicted to be influenced by these socio-demographic and policy-conservation factors (Coulibaly-Lingani et al. 2011). In both the models Є is the error term.

6.9 Model Reliability and Diagnostic Checks for Empowerment

The estimation of the binary logit model was undertaken based on model reliability. In the initial run, duration of stay and distance to harvesting site were added to the model. Subsequently, they were dropped, as they were not significant. Moreover, both the models were used with or without some of the explanatory variables, such as

community capacity building and monitoring, presuming these variables to be endogenous, as found in the literature (Coleman 2009). The results showed that after inclusion of these variables, no significant change in the parameter estimates occurred. The following diagnostic tests were undertaken to establish model reliability and empowerment.

6.9.1 Normality Test

The nominal scale outlier test was performed following Tabachnick and Fidell (1996). No outlier was identified except 'benefit-sharing partnership', which had less than 10 per cent (7.3 per cent) of the sample in one of its two categories. However, following Salam et al. (2005), who used a variable with 2.1 per cent of samples in one of two categories, this lop-sided variable was not removed from analysis.

For ratio variables, a normality test was performed to test the disturbance terms based on the OLS estimation of both regression models for empowerment (Kabir et al. 2011). To draw a conclusion as to whether values of ratio variables were large enough in varying significantly from normality, *z*-scores were considered (Manning & Munro 2007). Following the criteria suggested by Tabachnick and Fidell (1996), for samples >300, if estimated *z*-value exceeds an absolute value of 3.29 ($p < 0.001$), the skew and kurtosis are considered as significant. Following this criterion, the skews of 'education' and kurtosis of 'age' were 3.092 and 0.942. These non-significant ($p > 0.001$) absolute terms indicated the normality of distribution. On the other hand, the ratio of skew to Standard Error for 'income' and 'household size' were significant (11.05 and 8.275, $p < 0.001$). However, these two variables were not square-rooted or log transformed as they were categorised and ranged for analyses. Moreover, considering the original scale to be widely understood and meaningfully interpreted (Manning & Munro 2007), the researcher chose not to transform them.

6.9.2 Collinearity Test

Before performing the logistic regression, multivariate correlation analysis was conducted to examine collinearity between the covariates (Coulibaly-Lingani et al. 2009). The values were all above the expected threshold levels, meaning there were no collinearity problems. It was found that correlation of the variables was $p \leq 0.05$ (estimated $p \leq 0.03$) for both the models.

6.9.3 Multicollinearity Test

The models were tested for multicolliniarity using a correlation matrix. Moreover, the OLS models were fitted and the models were again tested for multicollinearity by using a tolerance and variance inflation factor (VIF). According to Menard (1995), a tolerance value less than 0.1 always indicates a serious collinearity problem. For socio-economic and sustainability models, estimated tolerance values are more than 0.1 (0.856 to 0.928 and 0.772 to 0.946 respectively). On the other hand, Myers (1990) suggests that a VIF value greater than 10 causes multicollinearity. The OLS models show VIFs for all variables are less than 10. VIFs were found to be 1.045 to 1.169, and 1.057 to 1.295 for socio-economic and sustainability models respectively. These indicate that multicolliniarity in these models is not a serious problem at all (Appendices 9-12).

6.9.4 Likelihood Ratio Test

Finally, the model was run and tested for validity using several tests. From the application of a backward likelihood ratio method, the classification tables indicate the proportion of correct assignments with 84 and 85 per cent accuracy of the socio-economic and sustainability models respectively. This is an improvement of the intercept-only rate of 83 and 82 per cent.

6.9.5 Residual Chi-square Test

Variables not in the equations 6.13 and 6.14, report that the residual χ^2 statistic indicates the coefficients for the variables. The variables are significantly different from zero for socio-economic $\{\chi^2$ (df = 7, n = 412) = 39.236, p = 0.000$\}$ and sustainability $\{\chi^2$ (df =11, n = 412) = 71.885, p = 0.000$\}$ models. The π for residual χ^2 is < p = 0.05, meaning that the addition of one or more of these variables to the model will significantly affect its predictive power (Field 2009). If residual χ^2 would have been > p = 0.05, none of the variables excluded from the models could make a significant contribution to the predictive power.

6.9.6 Omnibus Test

The overall fit of the model is assessed using the log-likelihood (LL) statistic. This is predicted as $P(Y_i)$ for π that Y occurs for the ith respondent, based on the

observations to denote whether the event did occur for that respondent. This could be denoted "as Y_i, the actual outcome for *i*th person" (Field 2005, p. 221). Predicted $P(Y)$ will be the value lying in either 0 or 1. Thus, for the observed and predicted values to assess the fit of the models, the following formula was applied.

$$\log - \text{likelihood} = \sum_{i=1}^{n}\{Y_i \ln(P(Y_i)) + (1 - Y_i)\ln[1 - P(Y_i)]\} \quad \ldots\ldots \text{(Eqn. 6.15)}$$

Following this formula, the bottom line is that larger values of the LL statistic represent a poor fit with the statistical model. The log-likelihood results of both models met the conditions of having less than the values when only a constant was included in the model. The value is multiplied by -2 referred to as -2LL to have an approximate χ^2 distribution to compared values against those that are expected through chance alone. 2LLs were found to be 371.598 and 317.947 for the socio-economic and sustainability models respectively. But after inclusion of variables these values reduced to 329.935 and 238.017 respectively. These indicate the better predictive display rule of the models.

However, this raises a question of how much better the models predict the outcome variable. These were assessed through the model χ^2 statistic to measure the difference between the models with constant values and the models after inclusion of predictors. Subtracting 2LLs of new models from the baseline ones, the values stand at 41.663 (371.598-329.935) for socio-economic and 79.929 (317.947-238.017) for sustainability models. Applying Omnibus tests of model coefficients, it is found that the models have χ^2 (df = 7, n = 412) = 41.663, p = 0.000 and χ^2 (df = 11, n = 412) = 79.929, p = 0.000. Hence, these models show a statistically significant χ^2 distribution.

6.9.7 Hosmer-Lemeshow Test

Alternatively, testing for goodness of fit was conducted for model χ^2 to establish statistical significance. A non-significant Hosmer-Lemeshow goodness of fit test indicates a good model (Manning & Munro 2007). This test π indicates that the models are not significant. Using a criterion of $\alpha = 0.05$, the models are a particularly good fit. A finding of χ^2 (df = 8, n = 412) = 6.940, p = 0.543 for socio-economic and χ^2 (df = 8, n = 412) = 8.318, p = 0.403 for sustainability models is non-significant. These high p-values indicate that all the systematic variance has been accounted for by the models (Gray & Kinnear 2012).

6.9.8 Model Fit

Moreover, following Nagelkerke (1991), moderate R^2 were found in the equations (Tables 6.10 and 6.13). The models explain 16 and 35 per cent variations respectively. This indicates the strength of the relationship in the models. Alternatively, demand for Pseudo R^2 measures of fit is undeniable in logistic regression (Shtatland et al. 2002). Thus, calculated Pseudo R^2 values are inherent in cross-sectional studies. Significant Z-statistics showed overall significance and goodness of fit of the models.

All of these tests suggest that the econometric property of model reliability to be statistically significant.

6.10 Results

Considering the size of sample, results are based on Wald statistics where a coefficient is 0 and has a χ^2 distribution corresponding at the 1 per cent, 5 per cent and 10 per cent level of significance to determine an acceptance or rejection of the null hypothesis.

6.10.1 Analysing the Socio-demographic Attributes

Socio-demographic attributes (Eqn. 14) accounted for 16 per cent of the variation in the attitudes towards conservation of the SMF (Table 6.10). Although the goodness of fit of the model appeared to be low (0.2), similar range of values are found for other cross-section studies (Atmis et al. 2007). Overall, regression analysis findings provide many important insights into the variables that affect FDCs' perceptions towards sustained forest conservation.

Table 6.10: Results of the logistic regression analysis with socio-demographic attributes

Dependent variable: FDCs' attitudes towards sustained conservation			
Independent variable	Co-efficient	Standard Error	Odds-ratio
Sex	-1.646**	0.720	0.193
Age	-0.383**	0.139	0.682
Education	-0.441**	0.195	0.643
Income	-0.326***	0.129	0.722
Marital status	1.527***	0.529	4.601
Dwelling	-0.311**	0.144	0.733
Household size	0.254***	0.091	1.289
Constant	-2.231		
Model χ^2	41.66***		
Nagelkerke R^2	0.162		
Pseudo R^2	0.112		

Note: ***p<0.01; and **p<0.05; *p<0.1

The respondents' household size has positive effects on sustained conservation, indicating that the heads of the households with more dependent family members are more engaged in resource harvesting than those with a lower number of dependents. Most of the heads of the households are single earners, meaning that larger household size contributes the same harvesters as smaller ones. A huge number of dependents have been identified as unadult in the study area, with no direct or indirect contribution to family income meaning that the head of the household is responsible for feeding them and maintaining their expenses. Consequently, income pressure has negative effects on harvesting and causes tree density degradation. The result supports earlier findings that identified individuals with larger families as heavily dependent on forest resources to diversify household livelihoods (Coulibaly-Lingani et al. 2009). This is due to FDCs' difficulty of access to any alternative sources of livelihood. The significant negative relationship of income with sustained conservation needs to be overcome. Earlier findings show that higher income is expected to be associated with higher probabilities of engaging in forest management activities by allowing increased capacity to acquire resources (Joshi & Arano 2009).

In most cases, FDCs collect dwelling house building materials illegally while harvesting fish and crabs. Consequently, dwelling pattern has a significant negative

relationship with mangrove conservation. Likewise, education has a significant negative relation with conservation, meaning that FDCs having higher education are better informed about the pros and cons of conservation. Therefore, they can better understand mangrove degradation associated with corrupt engagement of BFD staff in forest management activities.

In many studies, other attributes such as gender, age and marital status indicated positive or negative associations with forest conservation (Coulibaly-Lingani et al. 2011; Joshi & Arano 2009). This may be due to the nature of mangrove conservation that differs from other forest conservation practices. However, here, regression analysis results provide negative associations between gender and mangrove conservation. This may be due to the bias of the BFD in issuing permits to male harvesters only. Likewise, there is negative relationship of the youth and inexperienced to conservation. Younger harvesters are less conservation friendly, indicating lower age enhances more resource harvesting.

Marital status has positive effects on conservation. This means women's contributions to income generation activities are gained by processing harvested resources in local and traditional ways. Moreover, women potentially have access to alternative resources. Shova and Hubacek (2011) found this to be an important factor influencing reduction of resource extraction behaviour.

6.10.2 Marginal Effect Analyses of Socio-Economic Attributes

However, the premise of the tree density reduction is the independent and homoscedastic disturbance terms of the basic model in equation 6.9. It is widely recognised that parameter estimation from discrete choice models like probit or logit have to be transformed for marginal effects estimations (Anderson & Newell 2003). Hence, the change is predicted probability associated with changes in the explanatory variables (Greene 2002). The parameter estimates of the logit model provide only the direction of the effect without showing any magnitude. Independent variables do not show any effect on the response variable. Thus, estimates neither represent the actual magnitude of change nor probabilities. Hence, it is necessary to differentiate equation 6.9 in relation to the independent variables to provide marginal effects of the predictors. The measure of marginal effect is an instantaneous effect of changing in a

specific covariate with predicted probability of *y* keeping other covariates fixed. With respect to *x*, the derivation of a marginal effect computation applied the following equation.

$$\frac{\partial E(y|\mathrm{x})}{\partial x} = \left[\frac{\partial F(\beta'x)}{\partial \beta'\mathrm{x}}\right]\beta = f(\beta'\mathrm{x})\beta \quad \text{..... (Eqn. 6.16)}$$

Now it is necessary to find the marginal effects or marginal probabilities that have the function of the probability of a predictor itself. This will measure the expected change in probability of a particular choice which is made with respect to a unit or discrete change in a predictor from the mean (Greene 2002). However, a unit change in the independent variables is reported for measuring expected change in probability of a particular choice for continuous variables (Deressa et al. 2009). Following this, the estimated coefficients of Table 6.10 need to be compared with the base category of no sustained conservation practices. Table 6.11 represents the marginal effects of the attributes.

Table 6.11: Marginal effects from the logistic regression analysis with socio-demographic attributes

Dependent variable: FDCs' attitudes towards sustained conservation			
Independent variable	Marginal effects	Standard Error	*P* level
Gender	-0.192	0.084	0.022
Age	-0.045	0.016	0.004
Education	-0.051	0.022	0.021
Income	-0.038	0.015	0.011
Marital status	0.178	0.061	0.003
Dwelling	-0.036	0.017	0.028
Household size	0.030	0.010	0.004

The results show that gender and marital status provide excellent marginal values. Male-headed households do not contribute to conservation. Male-headed households were 19 per cent less likely to conserve the forest and are reluctant to regenerate. This is due to male dominance in resource harvesting. The result is supported by Agarwal (2009) and Agrawal and Chhatre (2006) who found women's greater participation in a common-pool resource such as a forest leads to better resource conservation and regeneration. The study finds that this is one of the major causes of deforestation and degradation of the forest. However, marital status was found to

increase the probability of conservation by 18 per cent. When harvesting as the main source of income generation is shared by other income generation activities performed by wives, male households tend to harvest less resource.

Representing age as experience (Deressa et al. 2009), less experienced households are greater in number. For instance, a unit increase in change of the age of household head leads to a 5 per cent decrease in the probability of conservation. One unit change in income and a discrete change in dwelling has a similar negative effect on conservation with a 4 per cent probability. Education implies the important role of increased institutional support and promoting the use of conservation options to reduce the negative impact of conservation by 5 per cent. However, household size has a 3 per cent probability of increasing conservation. It can be inferred that the larger the size of the household, the better the chance of conservation management due to diversified use of harvested resources and household engagement in other income generation activities.

6.10.3 Characteristics of Other Model Variables

Table 6.12 presents variables of the logistic regression model (Eqn. 13) and their characteristics. Three hundred and forty-three participants (83%) were found to be against sustained conservation practices. Almost all the participants (372) did not want wilful entrance. Two hundred and seventy participants were dissatisfied with harvesting permits not fulfilling their demands. In this regard, only 142 managed to complete their harvesting time as per their permits. Many participants (273) could not make decisions regarding internal use patterns and transformation of harvested resources to make necessary improvements. A significant portion of the participants (332) could not make any decisions regarding the use of the SMF for their community members. Most participants (307) disagreed that BFD consulted FDCs regarding conservation activities. For instance, 351 participants were dissatisfied with the historical process of mangrove plantation conducted by the BFD staff alone. A majority portion (81%) thought that existing conservation practices created severe conflicts, whereas major discrimination and corruption in issuing permits were identified by 309 participants. However, 277 participants were happy with their involvement with community-based organisations other than the BFD; whereas 77 were not involved because of lack of available opportunity. To overcome these

problems, FDCs (93%) expressed their willingness to participate in the conservation practices in a co-management structure.

Table 6.12: Characteristics of model variables

Variable	Yes (%)	No (%)
Dependent variable		
FDCs' attitudes towards sustained conservation	16.7	83.3
Independent variable		
Whether believe in entrance into the forest as per their wills (AR)	9.7	90.3
Whether harvest with permits as per their demands (WR_D)	41.7	58.3
Whether harvesting is completed in time allowed by permits (WR_T)	34.5	65.5
Whether able to take decisions about internal use patterns and transform harvested resources by making improvements (MR)	33.7	66.3
Whether able to make decisions about which community member can use the forest (ER)	19.2	80.6
Whether intend to be involved in co-management (CM)	92.7	7.3
Whether the BFD consults FDCs for harvesting and distribution (CHD)	25.5	74.5
Whether present management conflicts with community interests (PMCI)	81.1	18.9
Whether satisfied in species plantation (SSP)	14.8	85.2
Whether satisfied with the involvement in various community-based organisations (CBO)	67.2	14.1
Whether there is any discrimination or corruption in giving permits (DCP)	75.0	24.8

6.10.4 Parameter Estimation of the Logistic Regression Model

Table 6.13 presents the logistic regression model with tests of its 11 independent variables. The results suggest that participants' beliefs in entrance to the forest as per their wills (AR) are significantly different from zero at 5 per cent significance level of χ^2 with a highly expected negative sign. Harvesting with permits as per community demands (WR_D) is significantly different from zero at 10 per cent significance level with an expected positive sign. The odds-ratio indicates that participants who show satisfaction with their lawful entrance to the SMF are 2.7

times more likely to show an interest in sustained conservation than those who are dissatisfied with the lawful entrance without any restriction. Participants are highly dissatisfied with the harvesting time completion (WR_T), which is significantly different from zero at a 1 per cent level with an expected negative sign.

Table 6.13: Results of the logistic regression analysis

Dependent variable: FDCs' attitudes towards sustained conservation			
Independent variable	Co-efficient	Standard Error	Odds-ratio
Whether believe in entrance into the forest as per their wills (AR)	-0.996**	0.469	0.369
Whether harvest with permits as per their demands (WR_D)	1.007*	0.379	2.738
Whether harvesting time completed as per permits (WR_T)	-1.228***	0.378	0.293
Whether able to take decisions about internal use patterns and transform harvested resources by making improvements (MR)	-0.975***	0.398	0.377
Whether able to make decisions about which community member can use the forest (ER)	-1.008***	0.393	0.365
Whether intend to be involved in co-management (CM)	1.314***	0.555	3.722
Whether the BFD consults FDCs for harvesting and distribution (CHD)	-0.928**	0.407	0.395
Whether present management conflicts with community interests (PMCI)	0.883**	0.388	2.417
Whether satisfied in species plantation (SSP)	-1.335*	0.748	0.263
Whether satisfied with the involvement in various community-based organisations (CBO)	-1.337**	0.683	0.262
Whether there is any discrimination or corruption in giving permits (DCP)	0.851**	0.376	2.341
Constant	-2.718		
Model χ^2	79.93***		
Nagelkerke R^2	0.346		
Pseudo R^2	0.251		

Note: ***p<0.01; and **p<0.05; *p<0.1

Community concurrence towards taking decisions about internal use patterns and transform harvested resources (MR) is significant at zero at a 1 per cent χ^2 value with an expected negative sign. Even so, concurrence of the participants to make

decisions about using the forest (ER) is also significantly zero at a 1 per cent χ^2 value with an expected negative sign. FDCs' desire to be involved in co-management (CM) is significantly different from zero at a 1 per cent significance level with an expected positive sign. The odds-ratio indicates that the participants who are assured of their involvement in co-management are 3.8 times more likely to show interest in tree density reduction, meaning sustained conservation, than those who are not. The BFD's consultations with the FDCs also show significantly different from zero at 5 per cent χ^2 value with an unexpected negative sign meaning the dearth of fruitful consultation might not halt tree density reduction. Existing conflicts due to present conservation management (PMCI) is significantly different from zero at 5 per cent level of significance of χ^2 value with an expected positive sign. The odds-ratio shows that participants who can resolve conflicts are 2.4 times more likely to have an interest in sustained conservation than those who cannot resolve conflict. Community satisfaction with species plantation is significantly different from zero at 10 per cent χ^2 value with an expected negative sign.

Community social capital with the involvement in community-based organisations (CBO) is also significantly different from zero at 5 per cent χ^2 value with an unexpected negative sign. Existing discrimination or corruption under the present management system (DCP) is also found to be significant and highly different from zero at a 5 per cent χ^2 value with an expected positive sign. The odds-ratio indicates that participants who are involved in discrimination or corruption are 2.3 times more likely to show an association with tree density reduction in comparison with those who are not.

6.10.5 Marginal Effects of the Sustainability Model

The above parameter estimates of the logit model provide only directions of the effect for the outcome variables on the response variable. Consequently, such estimates do not represent the actual magnitude of change or probabilities (Deressa et al. 2009). Marginal effects from the model would be needed to measure the expected change in the probability of a specific choice. The choice, here, is being made with respect to a discrete change in the outcome variable for reporting and discussions (Agarwal 2009).

The marginal effects of the above logit model are presented in Table 6.14.

Table 6.14: Marginal effects of the logistic regression analysis

Dependent variable: FDCs' attitudes towards sustained conservation			
Independent variable	Marginal effects	Standard Error	*P* value
Whether believe in entrance into the forest as per their wills (AR)	-0.125	0.074	0.088
Whether harvest with permits as per their demands (WR_D)	0.091	0.035	0.009
Whether harvesting time completed as per permits (WR_T)	-0.134	0.045	0.003
Whether able to take decisions about internal use patterns and transform harvested resources by making improvements (MR)	-0.106	0.048	0.028
Whether able to make decisions about which community member can use the forest (ER)	-0.120	0.058	0.040
Whether intend to be involved in co-management (CM)	0.185	0.105	0.076
Whether the BFD consults FDCs for harvesting and distribution (CHD)	-0.106	0.056	0.057
Whether present management conflicts with community interests (PMCI)	0.102	0.055	0.063
Whether satisfied in species plantation (SSP)	-0.087	0.032	0.007
Whether satisfied with the involvement in various community-based organisations (CBO)	-0.091	0.032	0.004
Whether there is any discrimination or corruption in giving permits (DCP)	0.093	0.047	0.049

The above marginal effects of independent variables are discussed in the following sections.

6.11 Discussions

6.11.1 General Patterns

Table 6.13 presents the results of the logistic regression model of the factors of forest conservation across the top-down management structure of the BFD. Overall, the model is significant at a 1 per cent significance level from the maximum likelihood-ratio test.

In considering the results of the individual variables in the model, it is found that all the variables are showing expected signs. Permits for harvesting wood and wood products were banned after *Sidr* and *Aila*. However, FDCs harvest illegally or by making extra-legal arrangements with the BFD.

6.11.2 Theory of Property Rights and Mangrove Conservation

6.11.2.1 Operational-level Rights

The variables—access (AR) and withdrawal rights (WR_D and WR_T)—are conversely related to conservation, meaning that the present conservation system imposes strict restrictions for access to and withdrawal of resources from the forest to community members holding permits. Many researchers found that opportunity costs of harvesting resources had reverse relations (Gunatilake 1998; Gunatilake & Chakravorty 2003). It means opportunity costs decrease as distance to the forest increases. The negative relationship of access with conservation indicates communities from a long distance are willing to be involved in alternative income generation activities. In this regard, the short distance of resource harvesting places from adjacent villages enhances FDCs' resource harvesting interests due to their easy illegal access. A discrete change of access has a 13 per cent probability of overharvesting or reducing tree density. Thus, instrument-based control increases the likelihood of reducing harvesting and positively impacts on tree density reduction by 9 per cent. Community access and withdrawal show a significant relationship between harvesting of resources and forest conservation at an increasing rate of harvesting with decreasing distance from the SMF.

Completion of resource harvesting within the permit times (WR_T) was found to be significantly associated with the forest conditions, meaning present permits allocating only seven days for resource harvesting are too short. The researcher found that around 66 per cent of the FDCs are not satisfied with this harvesting time. These communities were 13 per cent more unlikely to increase tree density. Being unable to complete harvesting in that time period, they stay more days and harvest illegally. Usually, permitted harvesting time starts from the date of issuing permits. FDCs cannot cover fish and crab harvesting for the spring tides periods in which the difference between high and low tides is the greatest. This occurs when the moon is

either new or full, and the sun and the moon are in line with the earth. When this is the case, their collective gravitational pull on the earth's water is strengthened.

Either of the two tides occurring at or just after new moon and full moon aligning with the tide-generating force of the sun acts in the same direction as that of the moon, reinforcing it and causing the greatest rise and fall in tidal level. This is the best time for the harvesters to catch vast amounts of fish and crabs. In that case, harvesters disregard harvesting time periods; rather, they concentrate on harvesting in the spring tides periods due to their huge demands as this is their only source of livelihood. They manage this unauthorised harvesting by offering bribes to BFD staff.

6.11.2.2 Collective-level Rights

Regarding collective-level management (MR) and exclusionary (ER) rights, statistical analyses identified some significant factors that might influence FDCs' perceptions towards sustained conservation. Around 66 per cent of participants are not satisfied with the management rights of taking decisions about internal use patterns and transforming harvested resources by making improvements. On the other hand, more participants—around 81 per cent—are dissatisfied with the exclusionary rights and the government making decisions about community use of the forest. Consequently, logistic regression analysis results indicated that satisfaction with management and exclusionary rights were significant factors with negative effects on sustained conservation. Under present top-down management, a discrete change in management and exclusion would result in an 11 and 12 per cent decrease respectively in conservation probability. These factors imply FDCs' expectation to be involved in conservation practices. This can be addressed by involving communities in management and decision-making processes and by allocating appropriate property rights.

6.11.3 Co-management

6.11.3.1 Benefit-sharing Partnership

Community-based conservation needs to develop effective partnerships for sustained management with a view to securing joint benefits by sharing government-owned

restricted and protected forestlands. The results indicate that having access to co-management has significantly positive effects with an extraordinary increase in likelihood of conservation of 19 per cent. This is very important in ensuring long-term sustainability and replication of partnerships through creating an environment from which FDCs can gain constant economic returns (Jain & Singh 2000). For example, an introduction of a community forestry in Nepal, or a joint forest management system in India made economic contributions to the local people from the final harvested resources for secured, stable and reliable livelihood contributions as the most important motivation for collective management (Sarin 1995; Thoms 2008). However, the present management of the SMF fails to create such a bond with the BFD. Rather, the technicalities of using permit systems create conflicts that make resource harvesters suspicious of collecting resources as per their demands. This ultimately hinders sustained conservation by causing tree density reduction.

The regression analysis result is similar to co-management studies where community contribution was found to increase tree density (Nagendra & Gokhale 2008; Zoysa & Inoue 2008). However, this raises questions about the success of co-management under the present structure and control of the BFD. The weakness of the field of collective action and common property often determines the debates regarding collective ownership as a feasible form of property to manage natural resources, especially forest management (Cleaver 2000; Ostrom 1990). Contrary to largely traditional views of state or private property (Hardin 1968), it is very important to note that common property regimes under co-management are very supportive of assigning well-defined property rights. This collective co-management system needs to be enhanced with an incentive-oriented environment. This may encourage communities to invest in the resources for future benefits.

6.10.3.2 Customary Knowledge

Three-fourths of the participants asserted that the BFD officials never consulted with them about the resource harvesting system or the distribution of permits (CHD). Regression analysis significantly supports the hypothesis that the non-use of community customary knowledge is negatively related to sustained conservation through reduction of tree density. Avoidance of using customary knowledge decreases the probability of tree density reduction by 11 per cent. Many researchers

find that forest management interventions become more potential and successful in achieving sustainability in places where FDs work jointly with local people (Agarwal 2009; Behera 2009; Behera & Engel 2006). This success is due mainly to two factors. First, joint management ensures mutual benefits in a continuous stream by allowing FDCs greater access to forest resources and, second, it reduces protection costs for successful forest management (Behera 2009; Stone et al. 2008). The regression analysis results strongly support the hypothesis that an absence of consultation systems between the BFD and FDCs regarding the use of community customary knowledge for resource harvesting and distribution (CHD) has a negative impact on the SMF condition. This absence is due to no bonding or linking of social capital.

6.11.3.3 Conflict Resolution

Social, economic and political factors required to develop successful forest management by the implementation of a successful natural resource conservation policy may conflict with FDCs' needs (Castro & Nielsen 2001). The regression analysis results significantly support the hypothesis that conflicts between the present management and FDC interests (PMCI) have a positive impact on the sustained conservation of the SMF. The reduction of conflict increases the probability of tree density reduction by 10 per cent. From various experiences, it is shown that under the state property rights regime the BFD not only escalates existing conflicts, but also caused new conflicts (Hossain & Roy 2007). In reality, this happens even after the BFD allocates access and withdrawal rights, due to a tendency of strengthening BFD's control over resource policy, management and allocation. This arrangement further marginalises communities and resource users instead of empowering FDCs. The present cultural, political and legal obstacles are encountered by communities who are unable to be involved in co-management arrangements or participate in decision-making. In this regard, one of the major problems of conservation practices is that the BFD isolates FDCs from benefit by treating them from a narrow focus. This 'monocultures of mind' characterised by Shiva (1993) poses a threat to the FDs, policy makers and scientists to progress from a narrow focus to a wider appreciation of conservation practices to achieve targets and goals of sustainability. To draw a fundamental consensus by resolving conflicts is necessary through enhancing local

level meetings for relevant negotiation and planning (Ramirez 1997). A common understanding and common mental mapping are needed to bridge differences by promoting an agreed conservation language.

6.11.3.4 Plantation

The regression analysis results significantly support the hypothesis that disagreement of the local people with species plantation (SSP) has a negative impact on the likely decrease of sustained conservation by 9 per cent. The results imply that species plantation is a very significant factor for effectively offsetting the current high deforestation and degradation trend. At present, plantation programmes of the SMF are conducted under the sole authority of the BFD once a year, mainly in the dry season (October-March). MOEF allocates a block budget for plantation programmes each year. Budgets are then disbursed via the BFD to the Sundarbans East and West Forest Offices. Under the direct supervision of the Range Officers, these funds are spent preparing seedbeds to grow nursery tree plants and plant them in deforested areas. The whole process of existing plantation programmes faces five serious problems. Firstly, when funds are reached after passing so many bureaucratic tiers, there remains very little time for implementing plantation programmes. Secondly, there is a lack of monitoring by BFD staff of the plantation programmes. Thirdly, the plantation closest to the Range Offices in shortest time yields very little to the forest growth due to the set in of the rainy season which causes huge damage to the plants. Fourthly, due to the long bureaucratic process and ineffective inter-ministerial cooperation over many years, the block allocation is not reached from the Ministry of Finance to the forest Range Offices. For instance, the researcher was informed by the Conservator of Forest, Khulna Circle, that in this study year (2010) no plantation was implemented because there were no funds available from the BFD head office. Fifthly, the existing plantation system does not have any assessment procedure for future betterment. Neither is there a mechanism for maintenance of high conservation value forests. Moreover, existing plantation planning and management are guided solely by the Forest Range Offices without any co-monitoring guidelines. Co-management may help to overcome such constraints, especially by ensuring monitoring occurs, making necessary investments for FDCs, and increasing government transparency and commitment to constituents.

6.11.4 Social Capital

6.11.4.1 Institutional Capacity Building

In Andhra Pradesh of India, social capital, proxied by the number of forest-related active community-based organisations, is found to have a positive effect on forest growth outcomes (Behera 2009). Conservation management needs to have contractual agreements specifying the distribution of authority, responsibilities, agreement tenure, and the share of benefits through expanding vertical and horizontal relationships (Salam et al. 2005). The current conservation practice of the SMF does not have such arrangements. This implies a certain negligence on the part of BFD officials in relation to ensuring community participation in conservation. There is no forest-related community-based organisation that has had any contact with the top-down conservation management of the SMF. The participants are involved in a few NGOs from where they borrow money in case of difficulties. This is the only source of nascent social capital (CBO) found, and decreased the likelihood of tree density reduction by 9 per cent, as presented in Table 6.14. It is indicated that communities having high social capital are more likely to effectively manage forests in enhancing their economic activities in general and manage natural resources in particular at community level (Naidu 2009). Many studies also confirm that social capital increases institutional capacity building at local community level for the sustained conservation of natural resources (Ostrom & Ahn 2003; Pretty 2003). This is completely absent for the sustained conservation of the SMF.

6.11.4.2 Corruption and Discrimination

The regression analysis results strongly support the hypothesis that willingness of FDCs to reduce their involvement in corruption and discrimination (DCP) under present conservation practices in getting permits has a positive impact on sustained conservation. A discrete change in household exclusion from corruption or discrimination was 9 per cent more likely to conserve the forest. The findings indicate that existing conservation practices lack transparency and accountability to any other community or civil society organisation. This provides the BFD staff ample opportunity to profit from corruption and discrimination. Linking social capital is associated with reducing corruption through building vertical relationships.

FDCs need social organisation to be capable of advocating for mutual benefits (Peh & Drori 2010).

6.12 Elasticity Measures of the Independent Variables

For policy-making and forecasting, the relative measure of elasticities is more useful than the coefficient of an independent variable itself (Wang & Jain 2003). Theoretically, elasticity of a model variables x_1, ……., x_n are defined to be the per cent change in *Y* for 1 per cent change in each *x*. For an overall elasticity measure of these two models, the means of *Y* and *X* were used by applying the following mathematical formula.

$$E_x \text{ (Elasticity of } x) = \frac{\Delta Y/\overline{Y}}{\Delta X/\overline{X}} = b\frac{\overline{X}}{\overline{Y}} \quad \text{..... (Eqn. 6.17)}$$

From the elasticity measures, the magnitude of individual variable change has been derived in Tables 6.15 and 6.16. For example, the elasticities of 'marital status' (E_{ms}) and 'household size' (E_{hh}) show higher and high positive relative changes of 3.640 and 1.530 respectively in socio-economic model. As explained by Wang and Jain (2003), this means that on average for a 1 per cent increase in these two variables in real conservation measures, forest cover will increase by 3.640 and 1.530 per cent. Alternatively, lowest and lower elasticity of 'sex' (E_s) and 'age' (E_a) were -2.043 and -1.347; indicating that on average for a 1 per cent increase in real conservation it will cause forest cover loss by 2.043 and 1.347 per cent.

Table 6.15: Elasticities of independent variables in socio-economic model

Variable	Mean	Regression co-efficient	Elasticity	Magnitude	
				Positive	Negative
Sex	1.03	-1.646	-2.043		Lowest
Marital status	1.98	1.526	3.640	Higher	
Types of dwelling	1.82	-0.311	-0.682		Moderate
Age	2.92	-0.383	-1.347		Lower
Education	0.94	-0.441	-0.499		Moderate
Income	2.67	-0.325	-1.045		Low
Household size	5.00	0.254	1.530	High	

In the sustainability model, the elasticities of 'benefit-sharing partnership' (E_{bp}) and 'conflict resolution' (E_{cr}) were highest and higher at 1.472 and 0.862 respectively.

This means that 1.472 and 0.862 per cent of forest cover is expected to increase due to, on average, a 1 per cent increase of these two variables in real conservation measures. However, 'plantation' (E_p) and 'institutional capacity building' (E_{icb}) provided the lowest and lower elasticities at -1.367 and -1.337. This means that on average for a 1 per cent increase in absolute conservation measures, tree density will decrease by 1.367 and 1.337 per cent. Elasticities for the remaining variables of these models provided moderate change.

Table 6.16: Elasticities of independent variables in a sustainability model

Variable	Mean	Regression co-efficient	Elasticity	Magnitude	
				Positive	Negative
Access right	0.10	-0.996	-0.120		Moderate
Withdrawal right (WR_D)	0.42	1.007	0.510	Moderate	
Withdrawal right (WR_T)	0.34	-1.229	-0.503		Low
Management right	0.34	-0.975	-0.399		Moderate
Exclusion right	0.19	-1.008	-0.231		Moderate
Benefit-sharing partnership	0.93	1.314	1.472	Highest	
Customary knowledge	0.25	-0.928	-0.280		Moderate
Conflict resolution	0.81	0.883	0.862	Higher	
Plantation	0.85	-1.335	-1.367		Lowest
Institutional capacity building	0.83	-1.337	-1.337		Lower
Corruption and discrimination	0.75	0.851	0.769	High	

The findings give a clear picture to policy-makers of the immediate necessity for policy directives to increase tree cover and conservation of the SMF by enhancing positive-effect variables. However, the results show a clear failure of the BFD in controlling negative effects found from the majority of the variables. Most importantly, positive-effect variables, especially 'benefit-sharing partnership', support the theory of co-management and its application to the management of the SMF. This finding will be of interest to policy makers in favour of common property rights regime.

6.13 Relative Importance of Model Determinants

Although the above analyses provide direction, magnitude and relative measures, they do not quantify relative importance clearly for policy directives. To overcome this main limitation, Meyers et al. (2006) suggested the application of a relative importance measure for independent variables while identifying their ranks. This estimate produces standardised (Beta) coefficients by transforming above unstandardised logit coefficients. Beta co-efficient estimates usually apply a regression model with normalized data. This is applied for the above regression models (Eqns. 13 and 14) by following Eqns. 6.18 – 6.21.

$$y_t = \frac{Y_t - \overline{Y}}{s_Y} \quad \text{..... (Eqn. 6.18)}$$

$$x_t = \frac{X_t - \overline{X}}{s_X} \quad \text{..... (Eqn. 6.19)}$$

$$\hat{y}_t = b'_1 x_{1t}, + \text{.....} b'_n x_{nt} \text{..... (Eqn. 6.20)}$$

However, because of a fixed relationship between the beta coefficients (b'_1, ….., b'_n) and the regression coefficients (b_1, ……, b_n) of the original models in Eqns. 13 and 14, Eqn. 21 was employed to find out beta coefficient (Tables 6.17 and 6.18).

$$b'_1 = b_1' \frac{s_X}{s_Y} \text{.....} \quad \text{(Eqn. 6.21)}$$

The results of individual explanatory variables x_1, ……., x_n provided relative importance against all other variables of the models. In absolute terms, 'household size' and 'sex' showed the largest and least beta coefficients in the socio-economic model. This indicated that 'household size' is relatively more important than other variables. The beta coefficients of 'household size' and 'sex' are 1.271 and -0.739, meaning that 1 standard deviation change in these two variables will result in a 1.271 and -0.739 standard deviation change in *Y*. Consequently, these were the most and least important variables. This provides an urgent call to the policy makers to address existing high anthropogenic pressure. However, of no less importance is gender, which interestingly indicates the impracticality, from a conservation perspective, of the BFD's issuing permits with a bias towards males. This is easy to correct by

issuing a mere Government Order from the MOEF/BFD to authorise harvesting rights irrespective of sex.

Table 6.17: Beta coefficients in socio-economic model

Variable	Standard deviation	Regression co-efficient	Beta coefficient	Rank relative importance
Sex	0.168	-1.646	-0.739	7th
Marital status	0.295	1.526	1.204	2nd
Types of dwelling	0.986	-0.311	-0.820	6th
Age	1.133	-0.383	-1.160	3rd
Education	0.781	-0.441	-0.921	4th
Income	1.027	-0.325	-0.892	5th
Household size	1.871	0.254	1.271	1st

Likewise, 'withdrawal' (WR_T) and 'access' rights indicated the largest and least relative important variables in the sustainability model. Beta coefficients of 'withdrawal' and 'access' are -1.564 and -0.788, indicating that a 1 standard deviation change in these variables will result in a -1.564 and -0.788 standard deviation change in *Y*. This finding regarding 'access' is commensurate with previous findings of moderate marginal effects. Hence, it is necessary to overcome the limited harvesting time. That means the BFD should only be able to exercise a strict harvest time control, and provide policy directives that can lessen harvesting pressure and violation of harvesting time. Currently, because of significant livelihood demands and other associated factors such as illegal harvesting opportunities and indebtedness to *Mohajan/Aratdar/Dadondar,* FDCs have become unable to complete their harvesting within the prescribed time period. However, this issue can be partially addressed by creating a community level institution, granting unbiased harvesting rights (WR_D) and adopting plantation measures to overcome deforestation. Beta coefficients of these variables rank them as having second, third and fourth relative important variables.

Although elasticity 1.472 of 'benefit-sharing partnership' previously indicated highest enhancement of conservation, its beta coefficient (0.913) indicated lesser relative importance here. This might be tantamount to community level institution building for conservationists and policy-makers. This means that a 1 standard deviation change in institutional capacity building will result in -1.355 standard deviation change in *Y*. Hence, it ultimately affects 'benefit-sharing partnership'.

Table 6.18: Beta coefficients in sustainability model

Variable	Standard deviation	Regression co-efficient	Beta coefficient	Rank relative importance
Access right	0.296	-0.996	-0.788	11th
Withdrawal right (WR_D)	0.494	1.007	1.330	3th
Withdrawal right (WR_T)	0.476	-1.229	-1.564	1st
Management right	0.473	-0.975	-1.233	5th
Exclusion right	0.395	-1.008	-1.065	7th
Benefit-sharing partnership	0.260	1.314	0.913	10th
Customary knowledge	0.436	-0.928	-1.082	6th
Conflict resolution	0.392	0.883	0.925	9th
Plantation	0.356	-1.335	-1.271	4th
Institutional capacity building	0.379	-1.337	-1.355	2nd
Corruption and discrimination	0.432	0.851	0.983	8th

6.14 Conclusion

In the SMF, the absence of a shared understanding about rules of access, inappropriate government regulations, along with a lack of effective enforcement and dispute resolution through community institutions, together fail to achieve sustained conservation. A successful conservation strategy would need a partnership between FDCs and the BFD. Defined property rights and local level community institutions are needed to secure long-term rights and benefits to protect the forest. It appears from previous research that the link between assured benefits and sustained conservation is very strong in Bangladesh (Salam et al. 2005).

Results show that FDCs under the current property rights regime have less participation in and lower motivation for, the conservation of forest resources. The stricter the conservation practices implemented by the BFD, the less likelihood of community contribution to conservation. The conservation of resources can be achieved by the allocation of community roles, partnerships, trusts, and norms for sustained benefit by forming horizontal and vertical networks with FDCs. Communities desire clear and expanded property rights to engage in conservation

management, practices and policy formulation. Findings suggest that constructing effective strategies to promote sustainable mangrove conservation require these factors to be addressed. Consistent with S&O's (1992) theory, results indicate the necessity for ownership and management changes to ensure FDCs' participation in conservation practices. The time to sustainably manage the SMF is now.

The forthcoming chapter elaborates the justification of an alternative property rights regime of co-management with its pros and cons to achieve forest sustainability.

CHAPTER SEVEN

PROPERTY RIGHTS REGIME OF CO-MANAGEMENT FOR THE SUNDARBANS MANGROVE FOREST

Chapter 7

Property Rights Regime of Co-management for the Sundarbans Mangrove Forest

7.1 Introduction

Following the investigation of the interaction between the existing property rights regime and the conservation of forest resources in the previous chapter, this chapter looks at the challenges of achieving sustainable management of the SMF. During the past two decades, mangrove-livelihood conflicts and uncertainty have emerged and continue to persist. These issues reflect substantial pragmatic shifts in pursuing and understanding alternative livelihood strategies to lessen anthropogenic pressure for mangrove forest sustainability.

This study explores an alternative property rights regime of co-management in the SMF. This indicates the possibility of a common property regime to be applied in a co-management structure specific to the SMF. By using theories of property rights and co-management, this chapter envisions the prospects of a 'co-management-alternative livelihood mix' strategy as an alternative approach to achieving sustainability of the SMF. This study applies FGD and survey methods in appraising an alternative property rights regime of co-management. Attention is given to potential barriers and remedies to systematically direct conceptual, technical, ethical and practical dimensions for co-management. While co-management as an alternative property rights regime is clearly not a universal answer, experiences and knowledge from natural resource management suggest a 'co-management-alternative livelihood mix' as a positive nexus of supply and demand-side interventions. If insightfully applied, this could achieve sustainable management of the SMF.

The chapter is divided into seven sections. Section 7.2 outlines the objectives and research methodology. Section 7.3 describes the data collection procedure and FGD methods applied. Section 7.4 provides the background of the FGD method and data.

Details of descriptive statistics for survey data regarding conservation and harvesting practices, FDCs' co-management perceptions and demand-side interventions are presented in Section 7.5. Results and discussions of the study are presented in Section 7.6. In Section 7.7 conclusions are drawn.

7.2 Objectives of the Chapter and Research Methodology Used

The evaluation of alternative management scenarios in the study area is expected to result in policy options for designing and implementing a common property rights regime. Thereby, the objectives of this chapter are to investigate the following research questions:

i. Is an alternative property rights regime of co-management able to achieve forest sustainability?

ii. What are the barriers to the implementation of co-management?

iii. How can these barriers be overcome to achieve sustainability?

The long historical conflict between the FDCs and the FD over management regimes has been ignored in policy discussions. Thus, the above research questions are designed to address the existing conflict between the FDCs and the BFD. Focus groups are inherently social phenomena through which the complex and dynamic social context of groups can importantly be understood (Hollander 2004). According to Stewart et al. (2007), the FGD method is best suited for such conflictual research contexts and problems. This method is shaped by multiple contexts usually ignored by researchers using quantitative methods.

It is worth noting that methodological literature on other quantitative and qualitative methods has considerably emphasised more attention to the social context of interaction than the focus group literature. Hollander (2004) identified that "in practice many researchers do not seem to attend to these issues" (p. 605). To this extent, this study relevantly applied content analysis and survey research methods in the previous two chapters. There is a criticism that FGDs are artificially formed from

a researcher's objective to have 'contrived' speech, whereas survey interviews capture more 'natural' speech (Hollander 2004). In this research situation, the researcher used both methods to extract instances of property rights regimes interaction. According to critiques, thus, 'naturally occurring' speech would be subject to the same interactional and contextual constraints as the 'contrived' speech that occurs in the FGDs. However, the criticism is expected to be overcome through the triangulation of findings between both sets of research in the case of policy intervention. Consequently, the findings of these research questions were anticipated widely and to be applicable to comprehend the FGD results and their linkage with survey results. This would enhance the understanding of the everyday interaction of the FDCs and the BFD in explaining the crucial role of the property rights regime context in achieving sustainable management of the SMF.

7.3 Focus Group Interviews

As a research method, FGD is considered to be an instrument for in-depth qualitative information from a selected group of individuals on a particular topic to learn their opinions, views, attitudes and experiences (Balana et al. 2010). It needs organised discussions and facilitation by an experienced moderator with a small number of carefully selected people. Puchta and Potter (2004) found that questionnaires constrained participants' responses. That is why the researcher of this study applied FGDs from a strong sense that while questionnaires fail to take larger views of the FDCs, the FGDs could allow participants to give their views in their own ways and in their own words. This can be understood from the definition of a FGD which is "a series of audio-recorded group discussions held with differently composed groups of individuals and facilitated by a researcher, where the aim is to provide data (via the capture of intra-group interaction) on group beliefs and group norms in respect of a particular topic or set of issues" (Bloor & Wood 2006, p. 88). FGD is used to collect selected information and data by using preselected questions and thematic issues. This allows the researcher to act as a facilitator or moderator. The role of a facilitator is substantial in conducting a FGD. The facilitator precedes the discussion by question and answer to generate a common and general discussion within the group on the selected issues under a specified topic (Bloor & Wood 2006). The facilitator achieves this by adopting different techniques, for example, in a self-effacing way by

asking the questions in sequence. The group members may be asked to perform special tasks by identifying the importance of a particular issue by ranking importance or correctness. This is sometimes very important when a series of reasons are given by the group members. Then they can be asked to rank the importance through intra-group discussions about which one carries the most importance. The underpinning reasons are also found out from this process of FGDs.

Composition of the FGD is very important. Heterogeneity among the groups very often sees contrasts within the group (Bloor & Wood 2006). Consequently, homogeneity is very important, and achieved by grouping people of the same social status and socio-economic conditions. Homogeneity among the closest peers, friends, relatives or neighbourhood is convenient to promote group interaction. Thereby, such interaction with the pre-existing relationships enhanced desired data and information collection from these two groups. Otherwise, the process would become very slow and troublesome to this researcher. Thus, this study wisely kept FDCs in one group and participants from the BFD and NGOs in other groups (Figure 7.1). FDCs have regular interaction with the BFD officials in resource harvesting.

Figure 7.1: Conducting FGDs

(a) FGD with the FDCs

(b) FGD with the BFD

(c) FGD with IPAC

However, many critics do not support this as a bar to the focus group members to be known with one another (Kitzinger 1994). To them, focus group formation needs to consider the pre-existing purpose-constructed issues related to the sensitivity of the discussion topics (Morgan & Krueger 1993). Otherwise, pre-existing friendship groups become uncomfortable about over-disclosing relevant information in the heat of the discussion. This study considered the issues by developing a semi-structured

questionnaire with 11 main discussion topics (Appendix 13) and dividing the abovementioned three groups based on pre-existing relationships.

Focus group formation needs consideration of size. Smaller groups are found more conducive to the research objectives and manageable to moderators, transcribers and researchers (Kerr et al. 1998). It gives in-depth exploratory investigation of issues in comparison with larger groups. However, the researcher experienced typical primary problems with small groups regarding participant recruitment. Moreover, the member(s) of a small group may vitiate the discussion with the possibility of the non-arrival of some of the participants (Bloor & Wood 2006). This often needs researchers to compensate by having measures in place for recruiting participants. Thus, many researchers suggest the focus group be between 6 and 8 individuals to operate in a manageable way (Bloor et al. 2001). However, such group size needs to avoid the vulnerability of disruption by non-attendance.

Apart from the size of the focus group, other important issues are the selection of venue and offsetting the time of the participants. In the case of venue, the prime considerations are to select an interview place that is convenient and comfortable. For instance, the researcher of this study selected the FGD venues at nearby locations for the FDCs and at the office rooms for the BFD and NGOs.

For academic social science research, the role of audio-recordings is very important. For particular research, usually more than half a dozen of such recordings are conducted. The success of FGD largely depends on the transcripts of such recordings needed to maintain the ordering of data. In this regard, one particular FGD usually generates more than 100 pages of transcript (Bloor & Wood 2006). Thus, this researcher remained aware of the absolute minimum consistent with covering the range of study population with the number of focus groups to be conducted for this research.

FGD is not only restricted to the stand-alone method to explore data and information for group norms, beliefs, and attitudes; rather, it is now considered to be valuable as an ancillary method (Bloor & Wood 2006). Following such consideration, this study used this method for piloting the articulation of FGDs. In this study, the researcher collected data on group norms, behaviours; and day-to-day language used by the

FDCs, the BFD staff and other NGO people. Through this procedure, the researcher formulated and planned his next phase of the final FGD research.

In this era of technology, researchers use 'virtual' focus groups where the facilitators operate from a pre-determined email distribution list (Bloor & Wood 2006). This eliminates the risk of participants' non-attendance and transcription costs. It takes more time, usually a period of weeks or months, which need the facilitator to set a deadline. However, such virtual focus groups are popularly used in a study population where the respondents have internet facilities and easy access. In this regard, it can further be mentioned that such technique of data collection is used only for conventional focus groups (Bloor & Wood 2006). For the SMF, this is simply impossible as the FDCs are extremely poor people; and do not have such facilities. Likewise, it was not possible for the Ministry, NGOs or BFD officials as most of them also have no internet connection.

7.4 Data and Focus Group Discussion Method

The following sections describe the application of the FGD method.

It is very important to understand that intrapersonal influences affect group outcomes and have consequences for individual behaviours (Stewart & Shamdasani 1990). Past research indicates that individuals in FGD behave differently to when participants remain alone (Shaw 1981). Considering the group characteristics, individual behaviours were considered to influence group behaviours and reaction. To minimise the effect of such influences, personal characteristics of group individuals such as physical, personality and demographic characteristics were considered carefully. The following characteristics were considerably combined to influence group behaviours.

Age

In accordance with the social rules and norms, the level of internalisation increases with increasing age and then decreases (Stewart et al. 2007). Consequently, FGD for this research consisted of adult members to bring variation in perceptions. A careful mixture of various age groups among the adult group was considered. However, it was not necessary for the focus groups conducted with the BFD staff and NGO

participants. The participants of these focus groups had variations in age because of their different official rankings.

Sex

The role of sex in resource harvesting is different for male and female FDC members. As female FDC members are not granted permits by the BFD, it was expected that in the group dynamics they would behave differently. Besides, it is found that women are more prone to conformity and better able to explain emotions than men. Men are usually more aggressive with both verbal and nonverbal dominance: exchange of body language including eye contact, aggressiveness and emotional expressions (Frieze 1980). Moreover, in Bangladesh, usually women are found to be very shy to talk in front of men. All of these issues were considered by the moderator of this study to bring equal and acceptable interactions in the groups. Hollander (2004) and Stewart et al. (2007) experienced these situations where female participants felt unsettled because of the composition and context of male-dominated mixed-sex groups. Consequently, women participants were not included in the FGDs. Rather, other aspects were ensured from the experience of initial pilot stage focus groups. These are: the same level of intelligence, knowledge to facilitate the same level of interaction and same socio-economic backgrounds.

It should also be mentioned that no females were employed at the Bojbaja Office of the BFD or the IPAC office. Further, no female officer was found at the Khulna Forest Circle Office and Divisional Forest Offices. Hence, only male participants were recruited.

Dress

Clothing style was also very important as it has impressions and effects on interaction (Gibbins 1969). This is an important determinant of impressions when information is scant. Initial impressions shape the future direction of discussions (Frieze 1980). This study addressed this issue. The moderator dressed —formal and official dress was worn at the time of conducting FGDs with the BFD staff, casual dress was used for FGD with NGO workers and informal and local dress for the FDCs.

Language

Bengali is the only language used throughout the country. This language is also the country's official language. This language was used in the FGDs for easy understanding, conversations and expressions of emotions and opinions of the participants. However, when necessary, colloquialism was used with FDC members.

7.4.1 Conducting Focus Group Discussions

A semi-structured interview guide was developed to keep the discussions focused and well-centred (see Appendix 13). There were two sections of the interview guide. The first section was about overall management of the SMF by the BFD and the second section was about co-management and its applicability to the SMF. The first section asked about various issues, including decision-making and implementation processes. Questions relating to the degradation of the SMF and various interventions for its sustainability were also asked. The second section asked questions related to the appropriateness of co-management to achieve sustainability of the forest and consideration of various issues such as: defined property rights, power relationship, equity, local institutions and community involvement in management and policy formulation. Questions regarding the adequacy of government initiatives for co-management, implementation barriers and potential remedies were also asked. The discussion ended with an open-ended question.

Views and perceptions were elicited from five selected focus groups. In addition, two FGDs were conducted as a pre-test. Participants were purposively drawn from the aforementioned six villages. The number of participants in each FGD ranged from 4 to 12 persons following the recommendation of Tang and Davis (1995). This range was expected to produce information regarding management of a local forest unit.

Three stakeholder groups were carefully selected for discussions from the BFD, relevant NGOs and FDCs. FDCs were included as local forest users. Lower and higher level foresters and NGO workers were included as practitioners and experts. Two FGDs were conducted for FDCs and two for the BFD. Only one FGD was conducted for the relevant NGOs. Selection of the group ensured balance in terms of representation, professional backgrounds, knowledge and experience regarding the

administrative, technical and historical perspectives of the SMF. Local knowledge, livelihood patterns, resource harvesting techniques, specific role in conservation and experience in local leadership were considered for participation in FDCs' team membership (Balana et al. 2010). FGDs with FDCs consisted of ordinary resource harvesters (community members), a community leader (selected member of the Union *Parishad*) and a local religious leader as participants. For FGDs with the BFD, senior experienced Forest Guards, Boatmen, Officers-in-charge of forest camps at lower level; the Conservator of Forest (Head of Khulna Divisional Forest Circle Office), Divisional Forest Officers, Deputy Conservator of Forests and Range Officers at higher and middle level foresters were selected. Forest experts working at Khulna District and Koyra sub-district were selected for the FGD with NGOs considering their extensive fieldwork and past work experience in community livelihood and SMF management. The researcher of this study acted as both moderator and facilitator of the discussions.

Group discussions provided adequate information for understanding the prevailing environmental and local socio-economic conditions of the forest and communities respectively. Information coming from FDCs and the BFD helped frame the existing conflicts between them over forest management and resource harvesting. Using this information, an alternative property rights regime of co-management was outlined and discussed to ensure sustainability of the forest.

During the five months of recurrent FGDs, a change in the attitude of participants was observed. Initially, participants were shy and hesitant to talk. During the first two FGDs, only a few people talked. After building a personal bond and rapport with all, the willingness of participants to talk gradually improved. An increasing open-mindedness among the participants was noticed during the second round of FGDs, when there was more willingness to display individual initiative by contributing to discussions, arguments and criticisms. Each FGD lasted from 70 to 100 minutes.

As mentioned in Section 5.6, all FDC attendees were given a gift voucher to offset their opportunity costs.

The tape-recorded FGDs were transcribed and coded. Key words were used in coding the FGD interviews.

7.4.2 Validity and Reliability

The study achieved validity and reliability of FGDs to generalise the findings. The interview guide was validated through pre-testing. *Face validity* was conducted to have a cursory review of the items by a local expert working with FDCs. *Translation validity* was ensured to make the interview guide more understandable to the participants. Reliability was ensured through triangulation of the responses of FDCs and the BFD with the third eye views of NGOs. The conjunction of FGDs and survey methods is expected to improve overall verification and triangulation for reliability (Scott 2011).

7.5 Descriptive Statistics

To answer the above research questions and to analyse the FGD results, it was necessary to present information regarding FDC perceptions towards overall state and alternative property rights regimes. It was, therefore, necessary to gather information on FDCs, their livelihoods, resource harvesting patterns and predicted co-management. In this regard, necessary information was presented to substantiate FGD results and discussions. The following sections elaborate FDC knowledge, attitudes, expectations and opinions to cover areas of conservation problems and state of the SMF. The responses are analysed mainly with frequencies, contingency tables and χ^2 goodness-of-fit to provide insights with respect to the SMF. The distributions of variable-wise values of interest are given below. SPSS/PASW version 19 and R version 2.13.0 have been used.

7.5.1 General Features of Conservation and Harvesting Practices

Before collecting information regarding conservation and harvesting practices, it is necessary to know the nature of FDCs and their livelihoods. It was found that FDCs were from five different communities (Table 7.1). The majority of community people are fishers. The table shows that respondents identified themselves as belonging to more than one group. Because of illegal harvesting opportunities and to earn subsistence level incomes, they harvest more resources. For instance, fishers obtain permits for fish and crab harvesting, however, they harvest wood and wood products illegally.

Table 7.1: Structure of FDCs

Community	% of responses	Count	% of total count
Munda	8.6	50	12.2
Bawalis	18.8	110	26.8
Mawali	7.5	44	10.7
Gol leaves collector	3.4	20	4.9
Fisher	61.6	360	87.6
Total	100.0	584	142.1

Source: Household survey

Respondents were asked about the importance of the SMF for their livelihoods. They were also asked to provide their views about the overall management of the SMF in terms of its development, conservation and distribution of resources (Tables 7.2 and 7.3). Most of the respondents (86.4 per cent) opined that the importance of the forest was 'high' and 'very high' to them. In contrast, a majority of FDCs (42.5 per cent) considered that the present management status under top-down forest bureaucratic management was barely acceptable. Responding to the question, respondents (48.1 per cent) expressed concern about the status of the tree density of the forest. Consequently, almost all respondents (99 per cent) advocated the necessity of protecting the SMF.

Table 7.2: Importance of the SMF for FDCs' livelihoods

Scale	Frequency	% of responses
Very high	192	46.6
High	164	39.8
Medium	53	12.9
Low	2	0.5
Very low	1	0.2
Total	412	100.0

Source: Household Survey

Table 7.3: FDC views regarding overall management

Scale	Frequency	% of responses
Very good	42	10.2
Good	168	40.8
Barely acceptable	175	42.5
Poor	22	5.3
Very poor	5	1.2
Total	412	100.0

Source: Household Survey

Among the respondents, 50 per cent go to the forest twice a month for resource harvesting (Figure 7.2a). However, during the spring tide, fish and crab harvesters (77 per cent) stay 2-15 days for colossal harvesting (Figure 7.2b). Twelve per cent of the respondents stay for a longer time in the forest—up to 16 to 30 days at a time. It should be noted that permits are given for 30 to 45 days to the harvesters to collect *Gol* leaves, honey and beeswax. So, in the main, these harvesters stay 16 to 30 days.

Figure 7.2: Visits to and days in the SMF in one month

Figure 7.2 (a): Visits made

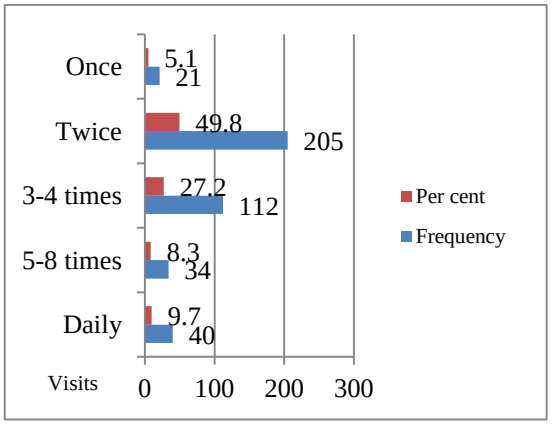
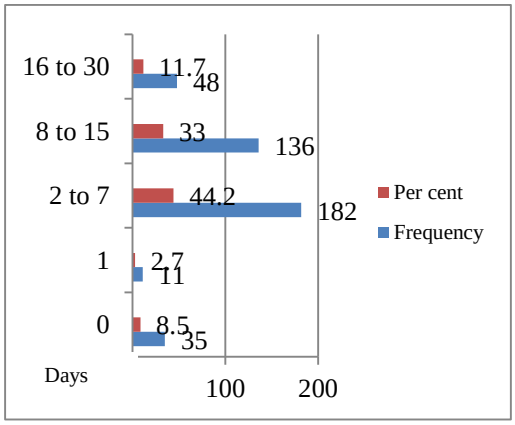


Figure 7.2 (b): Days stayed



Source: Household Survey

FDCs harvest five major resources. It was found that almost all respondents were engaged in harvesting more than one resource (Table 7.4). They take permits for fish and crab harvesting round the year and for *Gol* leaves, honey and beeswax for three months. The table shows that they harvest other resources illegally because of the imposition of a ban on wood and wood-related resource harvesting since *Aila*. An

insignificant number of FDCs harvest fodder because of limited grazing land damaged by two cyclones.

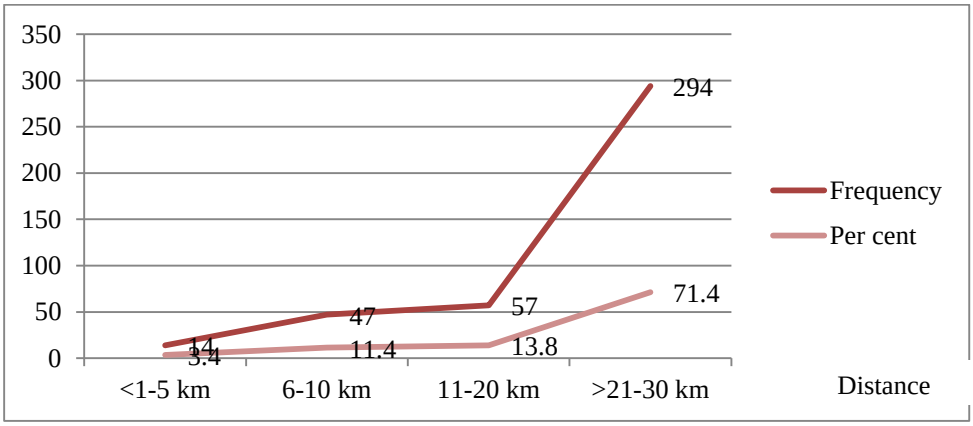
Table 7.4: Resources derived from the SMF

Resource	Responses	Per cent
Fish and crab	399	35.3
Honey	208	18.4
Gol leaves	197	17.4
Wood and firewood	320	28.3
Fodder	6	0.5
Total	1130	100.0

Source: Household Survey

There is no distance limit of harvesting sites from respondents' homes. They go as far away as 20 to 70 kms. Figure 7.3 shows that more than 71 per cent of the respondents collect resources from remote locations. Respondents noted that their harvesting site selection was based on resource availability. Although there are restrictions on harvesting from particular creeks, canals, rivers and buffer zones, in most cases they disobey such regulatory instructions with the cooperation of corrupt BFD staff.

Figure: 7.3: Distance of harvesting sites from home



Source: Household Survey

In this regard, almost 99 per cent of the respondents opined that they could not harvest resources without harassment or hazards. The main harassment and hazards are (i) forest and police department officials, (ii) forest pirates, (iii) tiger attacks, (iv)

Aratdars/Mahajans/middlemen and (v) political/social elites. These were identified through FG and personal discussions and presented in Table 7.5.

Table 7.5: Perceptions of resource harvesting harassments or hazards

Scale	Forester and Police		Forest pirates		Tiger attack		*Aratdar*/*Mahajan* / Middlemen		Political/ Social elite	
	Frequency	% of responses	Frequency	% of responses	Frequency	% of responses	Frequency	% of responses	Frequency	% of responses
Very high	89	21.6	142	34.5	175	42.5	0	0.0	7	1.7
High	77	18.7	146	35.4	175	42.5	1	0.2	15	3.6
Medium	230	55.8	105	25.5	53	12.9	10	2.4	14	3.4
Low	14	3.4	17	4.1	8	1.9	189	45.9	155	37.6
Very low	2	0.5	2	0.5	1	0.2	181	43.9	187	45.4
No response							31	7.5	34	8.3
Total	412	100.0	412	100.0	412	100.0	412	100.0	412	100.0

Source: Household Survey

The above table shows that tiger attacks and forest pirates are the two principal hazards, whereas most respondents perceived foresters and police as a medium level hazard in harvesting resources. Human-tiger conflict in the SMF has become a serious problem after *Aila,* with 72 yearly human killings in 2009-2010 (Kajal 2010). The BFD does not provide any protective role for harvesters. Although a proposal to provide financial compensation to the FDCs has been sent to the MOF recently, no decision has yet been taken. FDCs have long been facing piracy in the SMF (Figure 7.4). Pirates regularly kidnap harvesters for extortion. In the case of failure to pay amounts fixed by pirates, they mercilessly torture or kill kidnapped FDC members. It is commonly known that these pirates are backed by political elites and the BFD. According to one FDC, "there is no excuse other than paying extortion if we are kidnapped by them". In addition, at the time of these personal interviews, a FDC member informed the researcher that he was kidnapped for three days until a fixed extortion rate was paid by family members. During this time, he was made to row the pirates' boat continuously and not allowed to sleep. Whenever he fell asleep, pirates beat him mercilessly. Hence, these two were identified as very high hazards.

Figure 7.4: Exchange of firing between rapid actions battalions and pirates in the SMF

Source: The Daily Star, accessed on 17/3/2012, http://www.thedailystar.net/newDesign/index.php

However, because foresters and police can be easily managed by paying certain bribes, again fixed by them, they were identified as medium hazards. Respondents perceived interventions of *Atartars/Mahajans* and political or social elites as 'low' or 'very low' hazards. The reason was the availability of prompt financial help from them, albeit with high interest. In lieu of that, these local lenders use them as bonded labourers perpetually.

A question was asked whether the BFD consults FDCs regarding certain activities. Five options were given: tree plantation, resource harvesting, monitoring of planting, reduction of tree density, and development of the SMF. Unfortunately, most of the respondents did not tick the options. According to them, the BFD never consults them regarding any of the activities. They opined that they were hired by the BFD to sell their labour during plantation time only.

Respondents were found to be living since their birth in these respective villages. They were involved with NGOs in borrowing money. The main lending NGOs in the study area are BRAC, ASA, PRADIPON and RUPANTOR, of which the latter two are Khulna based. Their involvement was only for 2 to 5 years on average.

7.5.2 *Ex-ante* Perceptions Regarding Co-management

To overcome the above backdrops of conservation and harvesting practices of the BFD and police personnel, respondents were asked 'who should manage the SMF'.

Surprisingly, almost all of them (93.2 per cent) suggested joint forest management by the BFD and FDCs (Table 7.6). This means that they advocated a common property regime for the forest.

Table 7.6: Proposed managers of the SMF

Manager	Frequency	% of responses
BFD	4	1.0
BFD and FDCs	384	93.2
Private ownership	22	5.3
None	2	0.5
Total	412	100.0

Source: Household Survey

Respondents were willing to be involved in and contribute to the proposed co-management framework. Almost all the respondents expressed their willingness to be involved in the proposed co-management of the SMF. In this regard, they provided their choices of proposed mechanisms for and their involvement in the framework set out in Tables 7.7 and 7.8. The majority of the respondents (41.1 per cent) desired to be involved in the co-management through developing their own institutions. It was found that 50 per cent of respondents wished to contribute to all activities mentioned in Table 7.8.

Table 7.7: Proposed involvement in the co-management

Involvement	% of responses
Through management process	17.1
By developing community institutions	41.1
In benefit-sharing structure	14.5
By selling cheapest labour	27.3
Total	100.0

Source: Household Survey

Table 7.8: Contributions to co-management

Contribution	Frequency	% of responses
Labour	95	23.1
Monitoring	45	10.9
Management	25	6.1
Awareness building	62	15.0
All (from 1-4)	185	44.9
Total	412	100.0

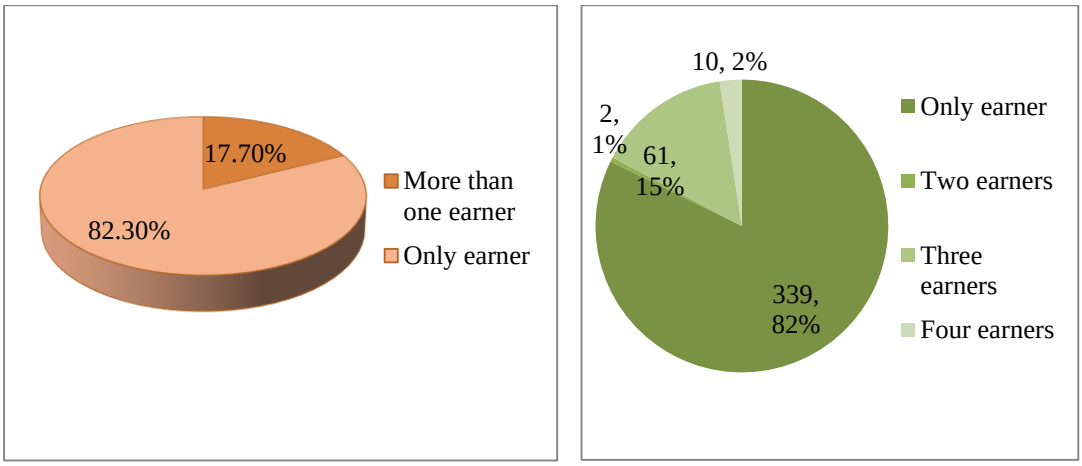
Source: Household Survey

7.5.3 Information for Demand-side Interventions

Respondents opined that their involvement needed to extend to the development of demand-side policies to lessen increasing pressure on the SMF. They assumed demand-side incentives for income generation substitutes would lessen the pressure on harvesting and enhance resource conservation of the SMF. Therefore, socio-economic and demographic statistics presented in the previous chapter are not adequate to address demand-side interventions as core issues of the thesis. It is necessary to present more information to consider demand-side interventions in the proposed co-management policy options.

The sample of 412 has a total of 2,060 family members. Of these, 62 per cent are adult members (over 18 years old) and 38 per cent are non-adult members (below 18 years old). Adult members range from 1 to 10 persons per household and non-adult members range from 0 to 6 persons per household. The majority of the respondents, consisting of 200 or 48.5 per cent and 138 or 33.5 per cent respectively, have an equal number of 2 adult and 2 non-adult family members. That means that 82 per cent of the households have 4 dependent family members. On the other hand, of 412 sampled households, 339 households have only one earner (Figure 7.5). Only a few, consisting of 73 households, have more than one earner.

Figure 7.5: Earning family members (in per cent)



Source: Household Survey

Although 111 households, consisting of 27 per cent, have 1 to 5 children, they were not all attending school. The ages of these children were between 6 and 18 years. It was found that the majority of the children (63.27 per cent) went to primary school only. Of the remainder, 32.12 per cent go to secondary school and 4.62 per cent go to college (grades 11 and 12). It is interesting to note that there is a huge dropout after primary education (i.e. after grade 5). This indicates a high dropout rate.

Respondents were asked about how much time they spend in a year on income generation (see Table 7.9). The table shows the prevalence of disguised unemployment. Fishers and *Bawalis* harvest almost all year round, but *Mawalis* harvest seasonally. The findings have two implications. There is an existence of overlapping harvesting by the fishers. On the other hand, a few *Gol* leaves collectors also harvest *Gol* leaves out of season illegally. However, it can be noted that there are no daily fixed hours for resource harvesting during harvest time. Respondents spend as many hours as possible harvesting.

Table 7.9: Time spent by fishers, *Bawalis* and *Mawalis*

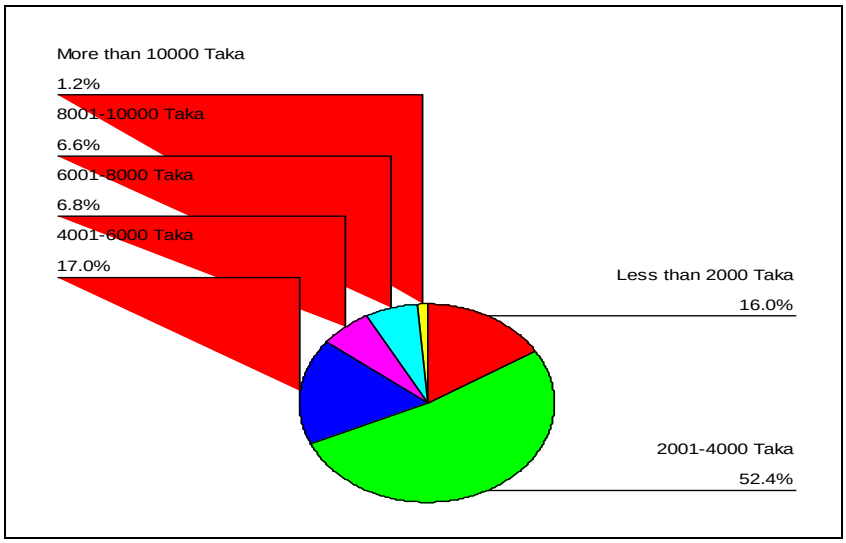
Months	**Fish and crab Harvesting**		**Wood and firewood**		**Months**	**Honey and beeswax**		**Gol leaves**	
	Frequency	Percent	Frequency	Percent		Frequency	Percent	Frequency	Percent
0-5	84	20.3	379	92.0	0	241	58.5	232	56.3
					1	129	31.3	71	17.2
6-9	200	48.5	27	6.6	2	40	9.7	46	11.2
10-12	128	31.1	6	1.5	3	2	0.5	59	14.3
					4-7			4	0.9
Total	412	100.0	412	100.0	Total	412	100.0	412	100.0

Source: Household Survey

In spite of prohibitions, 92 per cent FDC involvement in wood and firewood harvesting indicates a clear failure of the harvesting-ban rule. As a conservation practice, this has been in vogue since *Aila*. The finding indicates a failure in executing this conservation practice. Harvesting rates of honey, beeswax and *Gol* leaves are almost equal (58.5 and 56.3 per cent). This is because permits for harvesting these resources are issued for the same time period.

Figure 7.6 presents the average monthly income from the SMF for resource harvesting, processing, labour engagement, etc. More than half the respondents earn between Tk. 2001 to Tk. 4000. Surprisingly, this percentage is almost the same for those respondents who earn the same amount from all sources presented in Table 6.1. That means more than 50 per cent of the FDCs have no income sources other than harvesting resources from the forest.

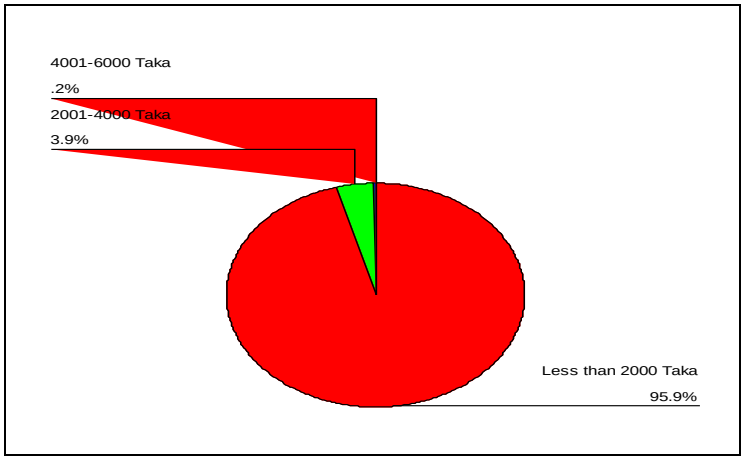
Figure 7.6: Monthly income from the SMF



Source: Household Survey

Following the above monthly income from the SMF, it is necessary to compare the income range of respondents' earnings from sources other than the SMF. Figure 7.7 presents income ranges earned from agriculture, service, and small local business. It was found that 96 per cent of respondents earn within the range of Tk. 0-2000. Surprisingly, 60 per cent of them do not have any alternative sources of income, whereas 15 per cent earn only Tk1000.

Figure 7.7: Monthly income other than the SMF



Source: Household Survey

For comparison with the monthly income from all sources, it is also necessary to identify the monthly expenditures of the respondents. Figures 7.8 (a) and (b) show

that there is a gap in upward income and expenditure ranges. More than 50 per cent of respondents earn a subsistence income from their livelihoods. It was very surprising that 52.4 per cent of the FDCs earn the same amount of Tk. 2001-4000 for 'income from the SMF' (Figure 7.6) and 'income from all sources' (Figure 7.8a). However, other gaps indicate that respondents have to borrow money from lending institutions or other sources to maintain their livelihoods during financial hardship.

Figure 7.8: Comparison between average monthly income from all sources and expenditure

Figure 7.8 (a): Monthly income

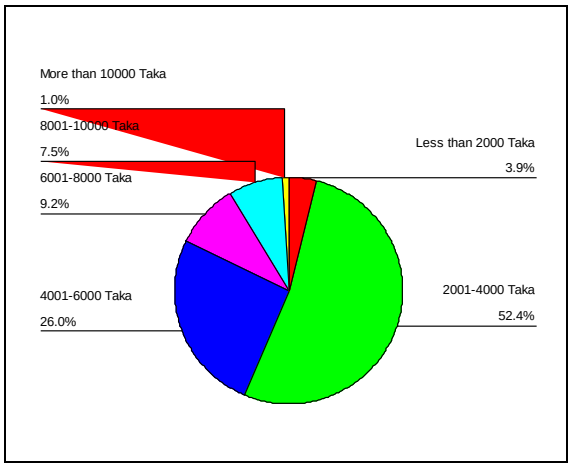
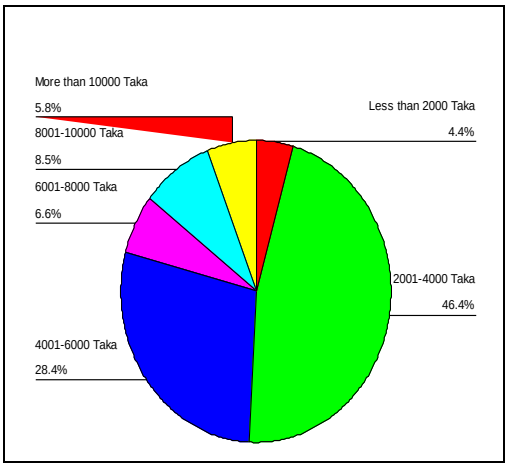


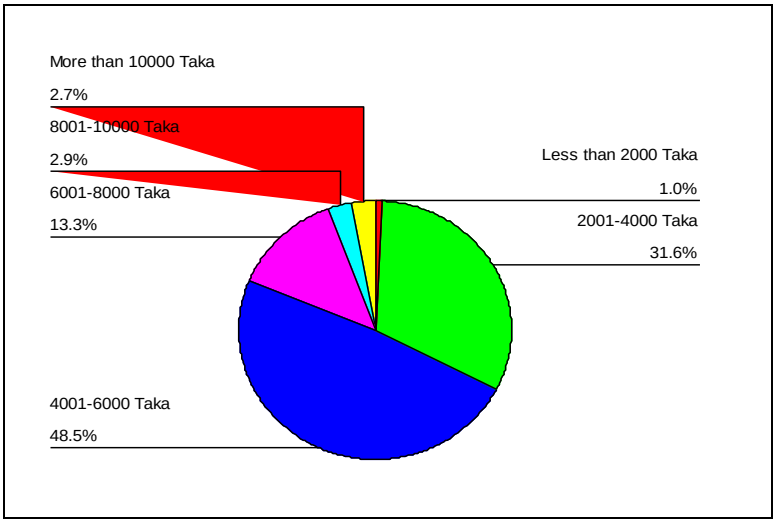
Figure 7.8 (b): Monthly expenditure



Source: Household Survey

As two devastating cyclones caused huge damage to the forest and reduced livelihood incomes, it is necessary to distinguish income sources and ranges before *Aila*. Figure 7.9 and Table 7.10 present income ranges and sources before *Aila*. Income before *Aila* was found much higher.

Figure 7.9 Average monthly incomes before *Aila*



Source: Household Survey

It was evident that there were several income generation options before cyclonic damage for economic activities (Table 7.10). Unfortunately, FDCs lost their previous income generation options because of the intrusion of salt water to their homesteads and arable lands. They lost their fish farming, agricultural, vegetable gardening, selling labour, poultry farming, small business, goat and sheep rearing and other income generating opportunities. Shrimp farming was the most profitable in these localities. Because of high export demand, shrimp was called 'white gold'. After *Aila*, 89.1 per cent of FDCs lost their job opportunities from agriculture and shrimp farming.

Table 7.10: Sources of income before *Aila*

Sources	Frequency	Per cent
Agriculture	61	14.8
Fish farming	164	39.8
Livestock	12	2.9
Day labourer	142	34.5
No income	24	5.8
Missing responses	9	2.2
	412	100.0

Source: Household Survey

Changing income levels from different sources indicate a disparity in prevalence of elite dominance. This can be seen from the average income generation displayed in Table 7.11. The following disparity analysis shows a huge income differentiation,

except income derived from sources other than the SMF. This indicates scanty income opportunities in the SIZ. The most alarming disparity lies in income generation from the SMF. This is due to elite domination and illegal liaison with the BFD by a particular group of respondents to access more resource harvesting. However, before *Aila*, the scenario was the same because of elite ownership of agricultural lands and fish farms where a portion of the respondents used to sell their labour. The analysis shows that there were no problems in maintaining their family because of alternative livelihood options. After *Aila*, harvesting resources from the forest became the only source of income. This has exerted huge pressure on the forest.

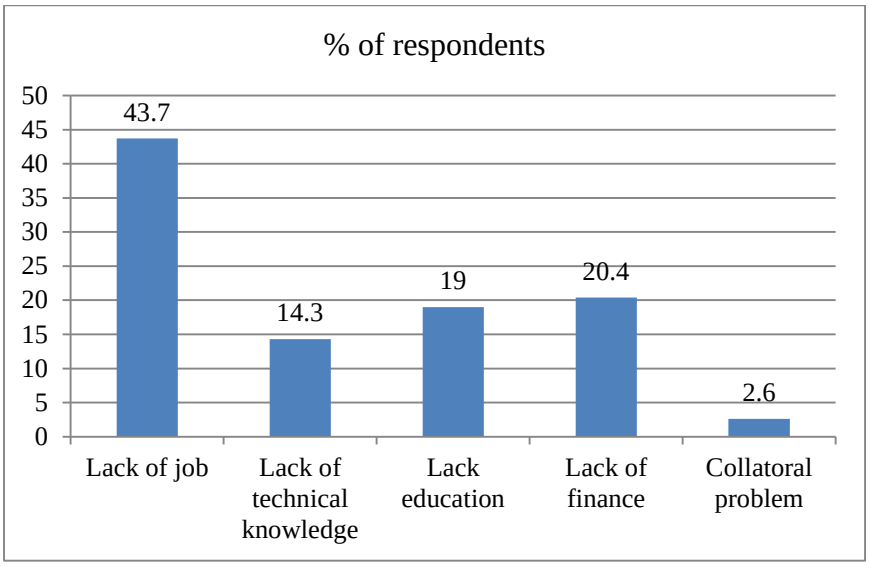
Table 7.11: Income disparity analysis

Income	Minimum	Maximum	Mean	Std. Deviation
Monthly income from all sources	1000	15000	4723.85	2155.35
Monthly income from the SMF	1000	19200	4203.82	2354.12
Monthly income from other than the SMF	0	5000	560.32	837.20
Monthly family expenditure	1500	13000	5056.19	2406.22
Monthly income before Aila	2000	20000	5426.22	2186.72

Source: Household Survey

With respect to more expenditure than income, respondents were asked to describe barriers to acquiring jobs other than forest resource harvesting (Figure 7.10). Most of them described a lack of other job opportunities as a major problem. However, a significant portion described a lack of financial assistance and literary knowledge as being similarly responsible for their entering into income generation activities.

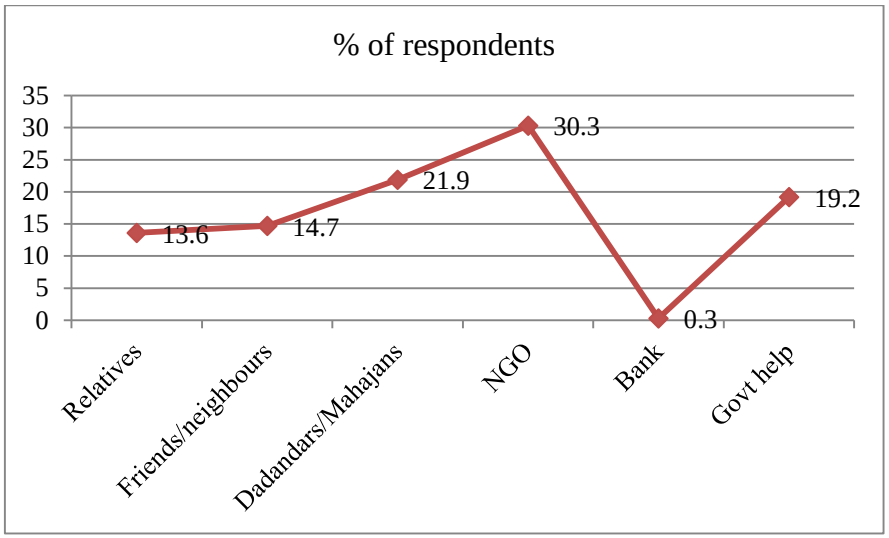
Figure: 7.10: Barriers to getting jobs



Source: Household Survey

Because of higher expenditure and lack of job opportunities, respondents have significant financial constraints. There is no designated government organisation from which FDCs can take loans. Furthermore, they have no community level institutions to help them during financial crises. However, the government had been providing 20 kg rice as relief rations to each household since *Aila* in June 2009. Unfortunately, the government stopped this ration after just 18 months in December 2010 without rebuilding lost livelihood opportunities. The government also provided Tk 20,000 to each household to build a makeshift house in response to *Aila*. When asked from where they get financial help in the case of hardship, this assistance was identified by 19.2 per cent of respondents as coming from government sources (Figure 7.11). However, the majority of them noted that they borrowed money from NGOs and local middlemen known as *Dadandars* or *Mahajans* with very high interest. The majority of the FDCs borrow money locally, known as *Dadon*, from these middlemen. These lenders entrap borrowers who pay a significant portion of their income as weekly or monthly interest. The severity of taking loans from the latter is not foreseen by them, and borrowers become bonded labourers. Borrowers must sell their harvested resources to them as a condition of repayment. Lenders calculate lower prices for the resources which borrowers are not allowed to sell in the markets. This repayment process continues perpetually.

Figure 7.11: Sources of financial help in case of difficulties



Source: Household Survey

7.6 Results and Discussions

In this section, FGD results and discussions are presented in detail. The results were analysed from two perspectives: similarities and differences. The findings have been organised into three categories: (1) recognising an alternative property rights regime for sustainable forest management, (2) barriers to the implementation of co-management and (3) potential remedies. Among these categories, demand-side interventions or alternative livelihoods options were identified as the main theme for FDCs' livelihood security. All the findings are presented as a reflection of participants' livelihood nestedness with the forest, experiences, perceptions, and attitudes. The findings therefore focus on a process of change, rather than on specific data regarding social and forest management conditions (Ljunggren et al. 2010). An analysis of the coding process and content analysis is summarised in Table 7.12 as an example.

Table 7.12: Coding process and content analysis example

Main theme	Category	Code
Strategy for alternative livelihoods option for sustainable management of the SMF through reducing high anthropogenic pressure	Recognising an alternative property rights regime of co-management	Livelihoods security Anthropogenic pressure Property rights Skills Influence
	Barriers to co-management	Communication mechanisms Understanding Awareness Respect Working together/non-kin bond Community institutions
	Remedies for co-management	Bottom up approaches Transparency Building trust in the community Friendship Status/reputation Mutual interests Training

Next, the results of the content analysis are presented. Then the policy implications are discussed.

7.6.1 Recognising Alternative Property Rights Regime

Respondents perceived the following issues regarding an alternative property rights regime.

7.6.1.1 Planning Diversification

Participants from all focus groups assessed the existing central conservation policy guidance for "keeping intact of biodiversity of the forest, water, fish and wildlife-based SMF through integrated resource management in order to ensure their diversified usage" according to the Declaration No. 9 of the NFP 1994 (revised) (GOB 1994). Participants, except for BFD staff, perceived a failure to translate this policy guidance into local planning and practice. FDCs viewed the existing management system as over-restrictive and limiting their involvement.

Participants were divided into two blocks. From the experience of the FDCs, conservation policy is solely focused on the *in situ* management of the SMF that fails to build the nexus of diversified usage with livelihood diversification activities. On the other hand, the BFD sought to keep intact the biodiversity through strict controls without integrated resource management and partnership building with the FDCs.

These findings illuminate vital differences between the BFD and others with respect to the scope, definition and appropriateness of addressing population pressure through planning diversification for community livelihood development. FGDs revealed that any change from traditional dependency on and use of the SMF to enhance 'development activity' would encourage community livelihood diversification. These views are illustrated in the following statements:

> "When our children starve, we have no other option other than entering the forest legally or illegally". (FDC, focus group 3)

> "If we follow the current policy system focusing on the conservation only, there is no focus on livelihood issues for FDCs". (Forester, focus group 2)

> "We always implement the conservation policy to regulate harvesting. However, this policy supports the British-enacted Forest Act and encourages stealing too. There is no diversification to maintain incomes of the FDCs as a legitimate activity from other alternative sources". (Forester, focus group 2)

> "We feel an urgent call to overcome the policy hurdles that narrow livelihood diversification. However, we think that livelihoods diversification needs to be defined from the FDC perspective to focus on and translate into policy interventions. Perspectives and focus need adherence to the actual and appropriate alternative livelihoods measures in this backward rural area". (NGO representative, focus group 5)

However, similar to planners in other countries (Scott 2011), the BFD is inclined to favour and pursue a stricter definition of conservation which proscribes diversified forest resource use activities. The BFD could promote alternative livelihood opportunities—rather, they apply traditional top-down restrictive planning procedures as supportive of conservation policy. The inability and unwillingness of

these planners to accept the local people's interests in resource management and livelihood diversification are identified as being at the heart of the conflict in natural resource management (Scott 2011). Basically, participants of the focus groups saw in the BFD an inability and unwillingness to create a climate of innovation and creativity in discussing possibilities for FDC livelihood diversification. This is despite the clear connection between wider community livelihood development and conservation activities within the NFP of 1994 (GOB 1994).

7.6.1.2 Community Perceptions of Mangrove Conservation

Significantly, FDCs perceive conservation in its entirety rather than comprising different elements and features. It is imperative to conceptualise a holistic conservation practice approach. FDC participants felt conservation policy and management strategies lacked the foresight to be able to achieve long-term sustainability. FDCs expressed dissatisfaction with the BFD for hiding actual data and information to reveal the current status of forest resources. This, they argued, reinforced the failure of past development interventions. These views are supported by the following statements from respondents:

> "Presently, foresters apply a set of rules in an orthodox fashion which fail to foresee the bigger picture of sustainable ecology of the forest". (Community leader, focus group 1)

> "They [foresters] never share any information with us. They always perceive that the *Bada* [the SMF] is rich with resources. But, if you enter the *Bada*, you can see huge degradation". (FDC, focus group 3)

> "True, several years ago we could not see even the sunshine due to tree density. Now, you can play football in some places. Well; it is the forester who acts as facilitator to the illegal fellers instead of being protector of the SMF". (FDCs, focus groups 1 and 3)

Surprisingly, foresters denied the views of FDCs and presented their success stories for conservation, including:

> "Well; we took lot of initiatives to stop overharvesting and illegal felling. As per our observations, the quantity of trees [tree density] has increased by 2

per cent. Look, this is definitely a very positive sign". (Forester, focus group 4)

These discourses uncovered a divide in the interpretation of conservation that has previously escaped significant attention. FDCs made negative assessments in a straightforward way. This negativity was reinforced by older community members who had experienced rapid degradation of the SMF. Their antipathy towards the present resource status of the SMF was evident. They expressed the view that from the periphery of adjacent villages and from nearby canals and rivers that are accessible to visitors, little degradation has occurred. The BFD hoodwink visitors by maintaining a minimum quality of forest health at the periphery. In the FDCs' opinion, huge deforestation starts from one or two kilometres inside the forest.

There is a common view among foresters that FDCs are ignorant of such matters. Not surprisingly, all focus groups provided very strong support for conservation of the SMF. In this regard, the discourse was interesting and showed polarised views between FDCs who see the forest as the only means for their livelihood and foresters who see the FDCs as a threat to the forest.

7.6.1.3 Alternative Livelihoods Options

During the FGDs, participants were asked whether the existing interventions to increase community livelihood security were adequate and, if not, what else could be done. Almost all participants agreed that current interventions do not look into developing any alternative livelihood possibilities. NGOs provide credit or financial loans to create alternative livelihood opportunities. Most NGO initiatives fail due to the absence of monitoring and skills training. The adverse impact of such loans increases income pressure on FDCs and causes overharvesting as a means to generate more income for repayment of these loans and interest. The following statements support this view:

> "I think livelihood diversification needs to be treated from a much broader dimension of various potential livelihood options such as: fish farming, transport, poultry, livestock, horticulture, small grocery, local business, salt-tolerant agriculture, aquaculture fish farming". (FDC and NGO representatives, focus groups 1, 3 and 5)

> "Well: it is true; lack of diversified usage of resources encourages illegal harvesting from the forest as the sole source of income to maintain their families. I suggest that the Government needs to reduce FDC livelihoods pressure on the forest". (NGO representative, focus group 5)

The FGD results reveal two important patterns based on the participants' perceptions of resource availability. A significant portion of the FDC participants have no land for cultivation. Their lands were lost due to the cyclonic damage to the embankment, as well as river erosion and intrusion of saline water. A small group of FDC participants consisting mainly of social and community leaders have a little cultivable land. The demographic structure of FDC households limits the amount of investment capital available for alternative livelihood activities. In discussions, participants highlighted that non-forest activities are more lucrative than forest-related activities such as agriculture, small business, fish farming, poultry and horticulture. FDCs mentioned that capital constraints limit a household's potential investment in profitable non-farm income generating activities.

Social and community leaders are less likely to pursue forest activities. Although crop cultivation was found to be a dominant livelihood option to overcome poverty, it is not achievable due to a lack of capital and available cultivable lands. Eighty per cent of the households do not own their own agricultural lands in Koyra *Upazila* (Unnayan-Onneshan 2009). Before *Aila* and *Sidr*, only 34.15 per cent of the population were employed in Koyra (BBS 2007a). Of these employed people, 22.14 per cent were working in agriculture and the rest were in business and other employment. This argument is consistent with similar findings in other developing countries. For instance, Barrett et al. (2005) in their case studies in Côte d' Ivoire, Kenya and Rwanda, and Babulo et al. (2008) in their case study in Tigray in Northern Ethiopia found that in adverse agri-ecological zones, crop production was unlikely to meet basic household consumption needs. Consequently, further policy directives to develop appropriate alternative livelihoods options are necessary. From the participants' opinions and personal discussions with the FDCs, the BFD and NGO officials, the researcher came to experience that adoption of coastal region-specific livelihood options for the study area would be more cost effective. The main

suggested options are: less capital intensive local industry and farming, and creation of a revolving fund for non-farm income and other opportunities.

7.6.1.4 Imperatives of Alternative Property Rights

Although the NFP of 1994 advocated a common property rights regime, this has not yet been implemented by the BFD. FGDs tried to assess how imperative is the introduction of FDCs into the planning and policy practices in the SMF.

The results reveal significant differences between the FDCs and foresters and planners regarding definitions, scope, appropriateness of livelihood security and dependence on the forest. This dramatically illuminated the gulf in understanding and beliefs between the two parties. FDC participants viewed livelihood security through co-management as a way to achieve sustainability. They suggested changes to traditional resource usage like harvesting; monitoring and plantation to promote sustainability.

> "I feel livelihood security is something that should be forest sustainability-related. This issue is completely ignored in the present management structure of the BFD". (FDC, focus group 1)

However, foresters favoured and pursued much stricter control over the SMF and were unwilling to discuss alternative livelihood activities for the FDCs. FDC participants consistently raised suspicions and expressed scepticism of BFD motivations. In contrast, foresters highlighted how achieving these alternative livelihoods might be impossible. Comments show the polarised perceptions:

> "They [foresters] are all the same; protect, protect, protect; well, we, the poor people are fully dependent on *Bada* and our houses need protection. When there is no money, then we go to the forest". (FDC, focus group 3)

Attitudes towards conservation were prompted by foresters in a similar exchange.

> "Shame on all FDCs who pursue deforestation through illegal harvesting. Look, their incomes are very good".

"No, I do not feel like that they are FDCs, are they? They take the permits and enter the forest with access rights. You see, they use materials collected illegally to build their houses and cook meals".

"Yes, we agree, they might need a local resource-based industry to sustain the population".

"In fact, I believe, we don't need an idyllic FDCs dependent on the SMF only. Yes, there should be a balance; if there is no opportunity for them to work there, they should look for alternatives".

"We must agree to adopt alternative livelihoods measures to stop illegal harvesting".

"No way is this community to be involved in the management. This would be simply catastrophic".

(Foresters, focus groups 2 and 4)

The benefit of the FGDs lays mainly in uncovering the very strong and increasing multifaceted perceptions of participants to mangrove management and conservation issues. Community perceptions of exclusion were evident and expressed in subtle ways in the FGDs. This demonstrated the importance of forest professionals, academicians and researchers to examine policy options for managing the SMF in more holistic and functional ways.

Participants made positive assessments of the SMF as a valuable community livelihood and wildlife resource. These views were uncontroversial and straightforward. Participants felt an urgent need to enhance conservation. FDCs expressed their desire for involvement in the management and policy making of the SMF. Implementation of declarations 1 and 9 of the NFP 1994 to promote partnerships would achieve this goal.

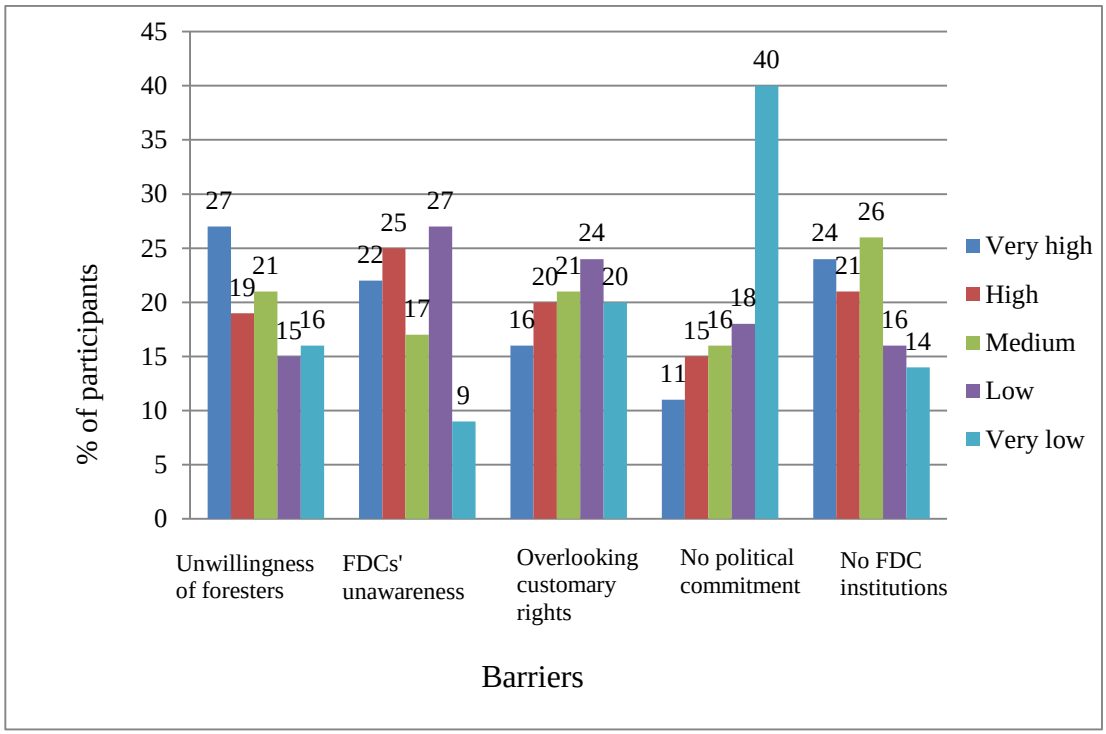
7.6.2 Barriers to Co-management

Co-management strategies are seen as important tools for sustained conservation. However, there is a feeling that they have not lived up to their potential (Darlow et

al. 2008). At the community level FGDs participants discussed how socio-demographic and forest management related factors act as barriers to co-management. They perceived socio-demographic factors such as severe poverty, low educational levels, unwillingness of the BFD to cooperate, negligence of customary rights, lack of political commitment and absence of community level institutions as barriers to implementing co-management. The survey captured community perceptions towards co-management issues, which are presented in Figure 7.12.

It was found that the unwillingness of the BFD and absence of political commitment to be the most (27%) and least (40%) notable hurdles respectively in achieving co-management. This result is similar to the core concept of neo-classical economist North (1990) regarding institutional theory, and S&O's theory (1992) of property rights.

Figure 7.12: Barriers to co-management (*n* = 412)



For reliability purposes, it was necessary to assess these differences of opinion in the scale by measuring whether the observed values could reasonably come from a known distribution. Thus, it was necessary to compare observed values with expected values by employing χ^2 goodness-of-fit according to the model of equal responses (Table 7.13).

Table 7.13: Measure of observed and expected counts for co-management barrier

Barrier	χ^2	df	*P*-value
BFD's unwillingness	99.748	5	0.000
Lack of community awareness	130.359	5	0.000
Overlooking customary rights	89.204	5	0.000
Lack of political commitment	207.369	5	0.000
Lack of community institutions	20.379	5	0.000

The critical value of χ^2 is 11.070 for five degrees of freedom at a 5 per cent level of significance. The obtained values of χ^2 were greater than the critical values for co-management barrier responses. Consequently, the obtained *p*-value (<0.0001) for χ^2 test justified the rejection of the null hypotheses. Hence, there were differences among very high to very low observed and expected responses. The estimated proportion of the population indicated that the BFD's unwillingness and absence of community level institutions were at 51 per cent. This also indicated that the distribution of barriers responses was skewed towards a 'very high' value. As the test demonstrated that this sample proportion was not due to a chance variation, these barriers need to be addressed in policy directives.

In this research, the BFD is treated as the institution and FDCs as the motivated actors as per the conceptual framework outlined in Figure 3.3 in Chapter Three. The findings support the hypothesis as existing institutional settings of the BFD fail to meet the needs and desires of the motivated actors. There is also a highly significant association between unwillingness of foresters for partnering with FDCs and forest cover decrease $\{\chi^2$ (df = 16, n = 412) = 39.145, p = 0.003$\}$. The current conservation practices provide only regulated access and withdrawal rights. These limited rights have failed to reduce the demand on resources facing continuous degradation. Consequently, FDC satisfaction was investigated based on the present institutional structure by understanding their perceptions towards current property rights and forest conservation. It is found that they are highly dissatisfied with the BFD and identified it as the number one barrier to achieving co-management.

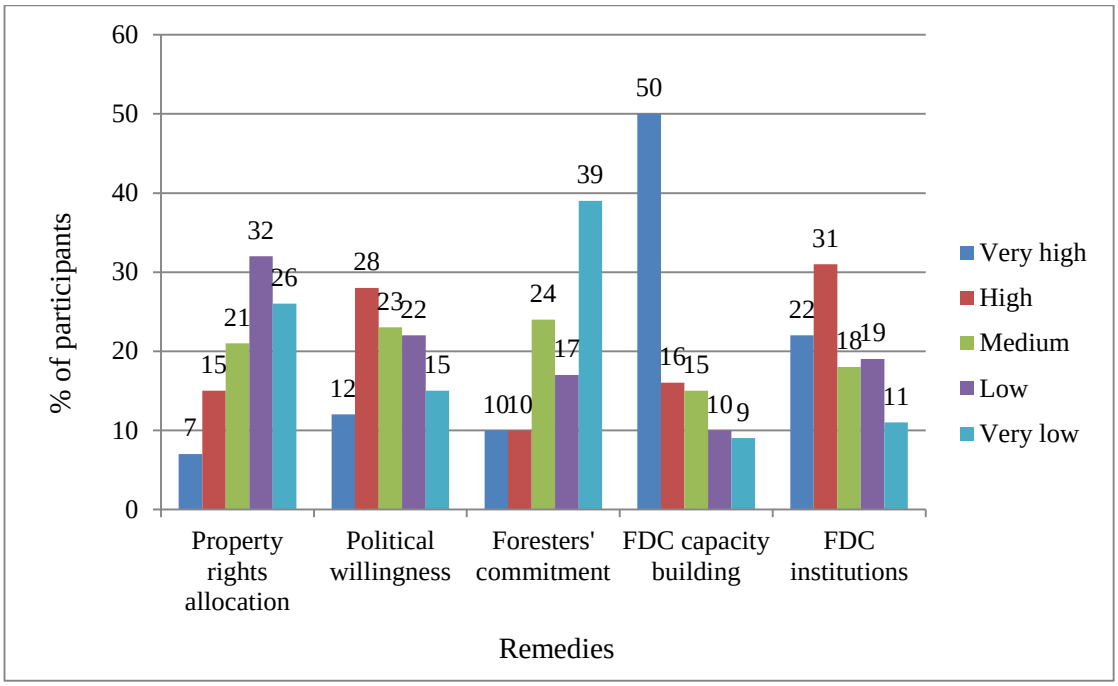
Participants identified political commitment to co-management as the lowest ranked barrier. This was for two reasons. First, FDCs are so marginalised and disadvantaged that they cannot be heard in the absence of community level institutions. This results in a failure by the FDC to understand the role of political leadership in potentially changing policy direction. Second, FDCs realise that the BFD is the key policy stakeholder. Political leaders engage with policy stakeholders; and the BFD drafts policy and legislation at their behest.

7.6.3 Achieving Co-management

Participants identified the allocation of property rights, political willingness, commitment from the BFD, formation of institutions and capacity building at the community level as preconditions for co-management being successfully implemented.

Results in Figure 7.13 reveal pragmatic and exciting findings. FDC capacity building is the number one option selected by participants as a means of achieving co-management for conservation $\{\chi^2$ (df = 16, n = 412) = 27.333, p = 0.038$\}$. However, allocation of property rights was found to be the least. This means that the allocation of property rights would not contribute significantly to sustained conservation unless community capacity is also enhanced to manage the forest properly. Thereby, participants identified the development of FDC institutions as the second most needed remedy for co-management. Such institutions are very important for the application of rules and regulations with respect to property rights in overcoming tree density reduction $\{\chi^2$ (df = 16, n = 412) = 24.172, p = 0.086$\}$. In Nepal, it is found that power-based vertical relations in society and upward enforcement of rules enable elites to capture resources with impunity (Adhikari & Goldey 2010). Several other studies have found that elite capture of resources at community level collective resource management is common (Esman & Uphoff 1984; Malla et al. 2003). Thus, it is expected that the development of local level institutions might encourage FDCs to be motivated actors. These institutions would form social capital to tackle elite dominance.

Figure 7.13: Achieving co-management (*n* = 412)



Participants did not rate political willingness and commitment of the BFD (only 12% and 10% respectively) as important factors in achieving co-management. In FGDs, the participants were then asked why they were inclined more towards capacity building (50%) and the creation of local level institutions (22%) and less towards the outright allocation to them of property rights (7%). Basically, by identifying FDCs' capacity building, the participants were suggesting more pressure for demand-side policy interventions than supply-side interventions. Creation of community level institutions and the allocation of property rights are supply-side interventions depending on political willingness and the BFD's commitment to co-management. FDCs perceived these supply-side interventions would not be enough unless alternative livelihood measures were also adopted.

To assess these differences, it was also necessary to compare the observed and expected frequencies by employing χ^2 goodness-of-fit (Table 7.14). The critical value of χ^2 is 9.488 for four degrees of freedom at a 5 per cent level of significance. Based on this critical value, the obtained values were found to be greater. Therefore, it could be concluded that the difference between the frequencies of respondents was not due to chance. The small *p*-value (<0.0001) for the χ^2 test showed that there were enough justifications not to accept the null hypotheses of no statistical difference

among population proportions. Hence, 72 per cent observed differences data for 'very high' frequencies of community capacity and institutions were sufficiently statistically significant to identify them as a remedy for forest degradation and deforestation.

Table 7.14: Measure of observed and expected counts for co-management remedy

Remedy	χ^2	df	*P*-value
Rights allocation	80.112	4	0.000
Political willingness	35.087	4	0.000
BFD's commitment	119.699	4	0.000
Community institution	43.364	4	0.000
Community capacity building	239.189	4	0.000

Participants revealed the necessity for demand-side interventions for farm and non-farm livelihood opportunities to reduce their forest dependence. They notably suggested further development of forest resource-based industries. Currently, the main harvested non-wood products are fish, crabs, honey and *Keora* fruits. FDCs sell these products just after harvesting to middlemen in two local village markets. There is no local processing industry to add value to their harvested products. Further, the only way to transport these harvested products to the Khulna district is via the water ways. All the perishable harvested resources of FDCs are impeded by the unreliable and irregular nature of water transport. In this instance, then, participants noted that they could not even afford to buy their daily meals. This situation forces them to borrow money from the local village lenders who exploit their labours perpetually. If, however, these products were processed locally and marketed through FDC institutions, there is a huge potential for non-farm income generation and employment opportunities. They also suggested that another promising alternative livelihood option is poultry farming. The demand for poultry is exponentially increasing due to the expansion of the urban population in the various districts and cities, and poultry could be a vital alternative cash income-generating activity. This view is supported by Babulo et al. (2008) with identification of poultry as a vibrant alternative livelihood option for the FDCs in northern Ethiopia. Likewise, there is a

good opportunity to develop a pickle industry for *Keora* fruits that could have a huge demand.

To make co-management successful, demand-side interventions as are equally important as the supply-side interventions of property rights allocation, community level institution formation and community capacity building. Implementation of these initiatives largely depends on political commitment.

7.7. Conclusion

Because of the complexities involved in deconstructing top-down bureaucratic management problems, a range of qualitative and quantitative research techniques and approaches is required. The argument here is that such techniques will provide better results and a clearer picture to inform pragmatic policy for resource conservation (Burgess 1999). FGDs were used in this study to extract the views of the two conflicting groups: FDCs and foresters.

The analyses of the discourses and participants' perceptions reveal the necessity of implementing an effective strategy for sustainable management of the SMF. This requires the development of a partnership between the BFD and the FDCs by adopting a common property rights regime and initiating demand-side interventions. This partnership needs the allocation of an appropriate level of defined and secured property rights to FDCs. The existing missing link between conservation and livelihood security needs to be addressed through both supply- and demand-side interventions. Existing theories mainly support supply-side interventions by bringing FDCs into a co-management regime in terms of resource extraction, use and policy-making. The results also support adoption of demand-side interventions through alternative livelihoods measures, allowing FDCs to lessen pressure on the SMF.

Existing policy fails in two main areas. First, the absence of a real management partnership inhibits the sustainable usage of resources. These potential benefits may not be achieved unless measures for the creation of FDC capacity-building through community level institutions are adopted. Thus, this study gives an urgent call to policy-makers and the BFD to adopt a strategy that incorporate FDCs and their expectations into conservation practices of the SMF. Second, alternative livelihood measures are necessary to address the economic pressure from FDCs on the SMF.

Therefore, urgent policy measures are suggested incorporating a ‘co-management-alternative livelihoods mix’ in line with the results of this study.

Based on the findings of this chapter, as well as results and discussions of the previous chapters, the next chapter summarises the arguments of the research and makes recommendations for future policy implications.

CHAPTER EIGHT

CONCLUSIONS AND POLICY IMPLICATIONS

Chapter 8

Conclusions and Policy Implications

8.1 Introduction

It remains in this chapter to take a final step to synthesise and to draw together the thesis. The aim of this concluding chapter is to summarise the knowledge gained and the understanding that can be derived from analysing an alternative property rights regime to achieve sustainability in the SMF. In doing so, it is necessary to go back to the aims and objectives of the research. This commenced with an understanding of the existing state property rights regime through an investigation as to the viability of an alternative property rights regime of co-management. The research was driven by five closely related research questions on property rights and co-management.

In Chapter One of the thesis, a fundamental distinction was made between the existing property rights regime and the conservation of forest resources. Critical discussions of the study area were presented in Chapter Two. Following these aims and objectives, the research critically reviewed relevant theories and concepts of property rights and the co-management literature. This review established the conceptual framework described in Chapter Three. Then, in Chapter Five, the research outlined the methodologies to be used to answer the research questions and form parts of Chapters Four and Seven.

The triangulation of the survey and FGDs results is expected to provide robustness and authentication of the overall findings of the study. Results and discussions of analyses were presented in Chapters Four, Six and Seven.

This chapter comprises five sections. Section 8.2 summarises the major findings of the thesis. Section 8.3 pinpoints implications of rights embeddedness for collective management in theory, methods and policy and practice in the SMF. Section 8.4

identifies avenues for future research. The thesis concludes with final comments in Section 8.5.

8.2 Summary of the Major Findings

The major findings of the thesis relate to the five research questions. Firstly, the findings of research question 1 regarding the adequacy of the existing property rights regime are presented in a 'state property regime' thematic analysis. Secondly, FDC perceptions regarding the existing property rights regime and the conservation of forest resources are summarised to answer research question 2 in 'common property regime'. Then, prevailing conflicts between the BFD and FDCs are explored to pinpoint whether an alternative property rights regime would be able to achieve sustainability in the SMF as per research questions 3, 4 and 5. These colliding discourses are concluded in the 'demand-side interventions' discussion.

8.2.1 State Property Rights Regime

The research drew on several streams of empirical literature to examine the role of property rights in achieving sustained conservation of the SMF. This was done to address research question 1. The research critically evaluated various property rights regimes and forest policies for four distinctive historical time periods. During these periods, FDCs were not given any role in managing the forest. Due to its status as an economic, cultural and religious frontier zone, the forest has been facing deforestation and degradation over the longer term. The Colonial Government focused more on revenue generation and other development strategies that were based on forest products and lands. This undermined sustainable conservation and the livelihood security of its dependent communities.

Top-down management has failed to achieve forest conservation. Forest management can be improved through co-management. In many developing countries, the emergence of co-management came as an alternative response to the perceived degradation of forests under state property rights regimes. This is because of the adoption of effective protective systems by the users. Because of the long historical dominance and coercive management by the BFD, collective action is unlikely to be initiated by local FDCs. The BFD should impose new arrangements of co-

management to resolve social tensions that prevail between themselves and dependent communities.

A specific co-management structure designed for the SMF can help reverse degradation and help regeneration of its degraded areas. The top-down state mechanism of the BFD has not improved the forest condition. The dominance of forest officials is a major reason for current and previous state-managed conservation practices resulting in forest degradation. This degradation was caused by the politics of the previous FDs and current BFD, where FDCs are deprived of information and authority over the management of the SMF. The conservation interests of the BFD were not often shared by the FDCs.

Although existing access and withdrawal rights are assumed to provide economic gains to the FDCs, benefits are scant as their livelihood security is sublimated to BFD objectives. The state property regime does not support the livelihoods of the poor and dependent FDCs. The underlying cause for this is the bias of BFD management toward illegal interests.

Present state forest management does not allow social, cultural and economic benefits from a community participation process to occur. This shrinks the flow of overall direct benefits to FDCs and has created frustration among them. State interventions do not motivate communities to act collectively. The research found that FDCs wish to be motivated actors and to take part in collective management. The study finds that the existing state regime does not allow this to occur and has proved inadequate in achieving sustainability.

8.2.2 Common Property Regime

While community involvement in forest management is established in policy, it is not implemented in practice. Present conservation systems of the top-down bureaucratic framework in the SMF contain serious flaws. FDCs' proposal for common property rights could be effective. The BFD has failed to halt forest degradation. This failure results from ignorance of local communities' needs and the top-down nature of the management system.

The failure of the BFD to recognise the marginal socio-economic situation of FDCs institutionalises biases and encourages harvesting pressure. These are the pitfalls of bureaucratic, authoritative management control. Again, the danger of such management is it mainly serves external interests in particular the interests of community elites aligned with those interests. Consequently, the success of the institutions depends on the interrelationships between communities and the BFD by transferring power into a common property rights regime. Hence, interventions are needed which can be guided by the directions, magnitude and relative importance of the factors examined here.

8.2.3 Demand-side Interventions

The combination of both qualitative and quantitative methods provides a vivid picture to policy-makers. In response to research question 3, FDCs perceived existing conservation practices as maximising the self-interests of the BFD. FGDs captured the conflict between the BFD and the FDCs regarding *de jure* and *de facto* conservation practices. FGDs provided a different window on social interaction and substantiated the individually focused or survey method results. In Chapter Seven, the results of the FGDs indicated endemic existing conflict between FDCs and the BFD. A dearth of demand-side incentives underlies the persistence of such conflict, and results in the failure of environmental and economic trade-offs. In existing permit systems for supply-side interventions, the BFD has encouraged classic 'rent seeking behaviour' comparable to the private sector, and made it difficult to withstand the excess demand pressures on resources.

FGDs assessed the efficacy and relevance of state regimes for conservation policy and FDC livelihood security initiatives. The assessment considered key research question 3 as to whether an alternative property rights regime of co-management could achieve forest sustainability. These issues were investigated through research questions 4 and 5. FGDs assessed existing supply-side interventions, an exclusion approach, conservation policy impacts and an understanding of demand-side intervention policy issues. Hence, this provided a window into existing conservation insights and critically examined the relative strengths, weaknesses and policy options for a more inclusive approach.

The research establishes the imperative of an alternative property rights regime of co-management to hope to achieve sustainability in the SMF. However, one of the main lessons of this research is that unless demand-side incentives aimed at reducing deforestation and degradation are accompanied by co-management supply-side control measures, they are unlikely to be effective as a means of mangrove conservation. Survey and FGDs results presented FDCs' income losses after *Sidr* and *Aila* and the increased pressure on resource harvesting. A majority of the FDCs have lost their income generation opportunities from agriculture, fish farming, selling labours and other sources. Existing supply-side incentives do not provide any opportunity to the FDCs to obtain financial assistance to offset difficulties. Traditional marketing systems and infrastructure again deprive harvesters of correct prices for harvested resources. Poor FDCs access financial help from NGOs and the village *Mahajons, Aratdars and Dadandars* who are local elites. They remain indebted to these money lenders, particularly to the latter who, in turn, use them as bonded labourers for long periods of time. Hence, these lenders bound them to sell their harvested resources at lower prices fixed arbitrarily at the lenders' sole discretion. FDCs, thus, engage in overharvesting to maintain their family and to satisfy the demands of lenders.

Furthermore, since these two cyclones, FDCs have been living on the WAPDA embankment that borders the SMF. In the absence of alternative livelihood generation opportunities, they put further pressure on the forest. Unless policy interventions are adopted for alternative livelihoods, conservation measures—even with an inclusive approach and strong control—will likely remain ineffective in sustainably managing the forest.

This research also examined demand-side policies that can develop substitutes in income generation for the FDCs. It also investigated this as a means of addressing anthropogenic pressure on the forest. Findings of this demand-side policy focus on the development of a demand for alternative income generation outside the SMF ecosystem. These demands will substitute for the renewable resources of the SMF. Hence, the results suggest that these policy directives should reduce demands of the resources of the SMF. Based on participants' opinions, adoption of the following

demand-side interventions for alternative livelihood creation in the SIZ is suggested. Proposed interventions need to:

- Establish fish and fruit processing industries in adjacent markets and centres.
- Establish alternative livelihood opportunities such as: poultry, *Keora* pickle industry, fish industry, goat and sheep rearing farms.
- Adopt innovative income generation avenues appropriate for the climatic conditions of the SIZ such as hanging vegetable gardening due to SLR, salt-tolerant agricultural and other cultivations.
- Create non-farm income generation and employment opportunities through marketing and supply chain management.
- Produce aqua-cultured fish in tanks or artificial ponds or farms to reduce the pressure on wild mangrove fish stocks.
- Promote reforestation in deforested and degraded barren mangrove lands to provide high levels of ecological services.
- Provide skill training to the FDCs.
- Create a revolving fund to provide financial support to FDCs in case of emergency and to remove the bonded labour system.

8.3 Implications of the Research

This research has implications for theory, methods, policy and practice. There are very few studies on the SMF. Most importantly, quantitative studies with econometric analysis are absent. No study has previously investigated the role of property rights in the long-term management of this forest. Existing studies have narrowly focused on the socio-economic aspects of conservation. Few studies have examined the interests of FDCs using a property rights regime perspective. No study has focused on FDC involvement in a co-management structure and examined issues of demand-side interventions through the creation of alternative livelihood options. The following sections present implications of the research.

8.3.1 Implications for the Theoretical Framework

The application of common property rights regimes in collective management is area and region-specific. Community participation is embedded in changing social,

economic, cultural, political and ecological factors. Application of property rights as suggested by S&O (1992) is too mechanistic and fails to capture the socio-economic and cultural embeddedness of anthropogenic pressure. Appropriate community property rights support decision-making and cooperative relations to conserve resources sustainably only when there are interdependences among property rights, conservation and livelihood security. This research has demonstrated that collective management is embedded with social, economic, cultural and political factors relevant to community livelihood security. Without understanding the livelihood complexities of FDCs, co-management will be difficult to implement. S&O's framework suggests allocation of appropriate level property rights to FDCs for sustained common-pool resource management. The study treated this as supply-side interventions. The findings of this study extend the framework with a suggestion of focusing alternative livelihoods as demand-side interventions to achieve sustainability in common-pool resource management.

8.3.2 Implications for the Methodology

The research applied three methods to investigate the potential of using alternative property rights regime in the SMF. The research also identified and quantified determinants of participation of FDCs in mangrove conservation practices.

For the first time, content analysis used property rights as an explicative variable to establish the argument of FDCs' role in achieving conservation of the SMF. Qualitative content analysis of various historical 'factors' and 'actors' examined showed that existing traditional management patterns need to be amended to adapt to a changing contemporary socio-spatial context with necessary rights regime modifications.

This cross sectional survey provided a reliable and rich data source. This thesis has made credible findings in comparison with other studies that focused on qualitative and scientific aspects of forest management. Most of these studies have relied on limited data information. This might not easily be replicated. Thus, the possibility remains for suggesting policy implications of doubtful worth.

In the absence of baseline information, the assessment of tree density growth for specific time periods is complicated. The research conducted a subjective assessment of tree density improvement.

Many previous studies could not produce convincing econometric results. Compared with previous studies, this research provides practical mangrove conservation explanations.

The findings of the FGDs ensured triangulation of survey results. As participative tools, focus group results provide remarkable potential for environmental policy-making.

Finally, this research is the first study that undertakes a rigorous assessment of the effects of conservation policy on the SMF. In this regard, it gives valuable insights into the sustainability of this forest under current and alternative property rights regimes.

8.3.3 Implications for Policy and Practice

The findings of the thesis clearly contradict the belief that protected areas conserve mangrove forests. It is true that the legal designation of protection may shape a basic institutional infrastructure to support conservation. Empirical findings of this research outline the huge degradation rate in the SMF. These findings support the empirical findings of IFRI studies that demonstrate that protected areas do not have a higher level of vegetation density than forests not legally designated as protected areas (Hayes & Ostrom 2005). Consequently, the negative trend of forest cover change in the SMF shows that protected area conservation policies do not ensure mangrove conservation.

Forest conservation policies depend on a range of factors. Notably, they include local recognition of the validity of the protected area policy, biophysical features, financial and human resource supports, as well as appropriate mechanisms to resolve conflicts (Hayes & Ostrom 2005). All of these factors are absent in case of conservation policies in the SMF. Forest conservation largely depends on the viability of local level institutions. Therefore, the most notable findings of this study are the failure of the BFD offices to recognise and comprehend the significance of FDCs' potential

rule-making, monitoring and enforcement role in conservation. These activities are significantly and positively correlated with abundant mangrove vegetation density. A broader institutional framework is necessary to provide protected area policies where FDCs can assist in formulating and achieving conservation policies. Overall, the study found a lower level of vegetation density, due mainly to the lack of FDCs' rule making, monitoring and enforcement rights.

A community awareness building mechanism needs to be developed to provide the capacity to communities to enforce forest management rules. A system of community rights and conservation policies to link the BFD and FDC conservation efforts will bring greater protection outcomes in the SMF.

In doing so, policy makers should not assume co-management to be the only means of forest improvement. Rather, the distinction must be made between livelihoods and conservation. Forest produce surplus may not be able to generate income to offset anthropogenic pressure. Such policy intervention may not be ideal for biodiversity conservation. The development of communities' administrative and economic status should be central to achieving co-management.

8.4 Future Research

The thesis has addressed the implications of planning common property rights regime for sustainable management of the SMF. Suggestions for further research into various aspects of sustainable mangrove forest management and related key areas are outlined as follows.

Mangrove management must be considered separately from other forest management regimes, because of the interrelationships of forests and people. This requires an understanding of mangrove vegetation, dependent communities and relevant bodies of governance.

It is necessary to investigate the rationality and role of alternative livelihood interventions to promote conservation in general. To draw comparisons, other types of participatory research on natural resource systems need to be conducted. This should focus on the future articulation of mechanisms for positive discrimination toward marginalised and disadvantaged dependent communities. Future research

needs also to look into policy insights pertaining to the emergent framework of Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanisms. REDD+ may be blended with the legal framework of CBD to ensure the involvement of indigenous peoples at national and local levels in resource policy, management and conservation strategies of the SMF.

The geographical scope of the research is limited to a mangrove forest in a coastal area of Bangladesh. There is the possibility to undertake similar kinds of research in other types of terrestrial forests in other parts of the country, and in other developing countries as well. There is a pressing need to apply property rights analysis in these contexts. Assessment also needs to evaluate the performance of other regulatory frameworks and instruments.

8.5 Final Comments

As a newly-established and poor country, two forest policies were adopted by the Bangladeshi Government at a time when the experimental and research knowledge of forests and their ecosystems was scarce. Thus, based on imperfect and insufficient knowledge of ecosystems, socio-economic structures and their interrelationships, policies and property rights were imperfect and incomplete and have not achieved sustainability of the forest. These policies did not take into account the needs of the huge forest communities whose livelihood concerns were relegated to non-wood forest products.

This research has presented the underlying pitfalls associated with top-down bureaucratic management processes. The outcomes of the thesis include suggestions regarding initiating co-management interventions in policy and practice. While co-management is found to be significant in attaining management justice, it also has a vital role in conservation, but must be accompanied with alternative livelihood options for the fully-dependent marginalised and disadvantaged FDCs. Any imposition of co-management and a standardised mechanism to mangrove management from the top down will not result in FDC participation. An appropriate mechanism needs to be implemented to rein in the coercive, exploitative and authoritative role of the BFD.

In very recent times (2011), the MOEF has assigned IPAC to initiate co-management activities in the SIZ. IPAC has formed only two co-management committees in Mongla and Sarankola sub-districts. The researcher attended co-management meetings and conducted focus group and personal discussions with all concerned. It has been found that the MOEF is attempting to implement 'benefit-sharing' instead of 'co-management'. More than 50 per cent of the members of the co-management committee are from the BFD and other government bodies. Most importantly, the chair of the committee is the local Union *Parishad* Chairman—who is a political person. Selection of FDC members is highly biased, with elite dominance. IPAC is responsible for implementing the decisions, whereas the BFD remains in charge with its supervisory role. The committee has not yet involved FDCs in management and policy-making. It is, thus, expected that the findings of this research should be of great help in future co-management framework implementation.

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APPENDICES

Appendix 1: List of offices visited for data and information collection

Bangladesh Bureau of Statistics

Bangladesh Bureau of Statistics (BBS)
Upazila Statistics Office, Koyra

Bangladesh Forest Department

Bojbaja Forest Office, Bajbaja, Koyra
Bangladesh Forest Department (BFD)
Bangladesh Forest Industries Development Corporation (BFIDC)
Bangladesh Forest Research Institute (BFRI)
Chandpai Range Office, Chandpai, Mongla
Divisional Forest Office, Khulna Wildlife Management and Nature Conservation Division, Khulna
Sundarban Forest Office (SFO), Khulna
Sundarban West Forest Division, Khulna
Wild Management and Nature Conservation Division, Khulna

Election Commission of Bangladesh

Upazila Election Office, Koyra

International Organisations

International Union for Conservation of Nature and Natural Resources (IUCN), Bangladesh

Local Government Organisations

Dakshin Bedkashi Union Office, Dakshin Bedkashi, Koyra
Uttar Bedkashi Union Office, Uttar Bedkashi, Koyra

Ministries/Divisions

Economic Relations Division (ERD), Ministry of Finance
Ministry of Environment and Forests (MOEF)
Ministry of Primary and Mass Education (MOPE)

Non-Government Organisations

Bangladesh Rural Advancement Committee (BRAC)
Integrated Protected Area Co-management (IPAC)
Prodipan – a leading local NGO in Khulna, Bangladesh

Rupantor - a leading local NGO in Khulna, Bangladesh

Non-Government Research Organisations

Divisional Office of Unnayan Onneshan, Khulna
Unnayan Onneshan, Dhaka Office

Other Government Organisation

Space Research and Remote Sensing Organisation (SPARSO)

Planning Commission of Bangladesh

Agriculture, Water Resources, and Physical Infrastructure Division
General Economics Division (GED)

Universities

University of Dhaka, Department of Statistics, Biostatistics & Informatics
University of Jahangirnagar, Department of Statistics

Upazila Level Government Offices

Office of the Upazila Nirbahi Officer, Koyra
Upazila Local Government and Engineering Office, Koyra
Upazila Fisheries Office, Koyra
Upazila Primary Education Office, Koyra

Appendix 2: Personal consultations/discussions with relevant persons[1]

Designation of the person	Name of the organisation
Secretary (Highest bureaucratic position of the Government, and next to Minister) Deputy Chief (Planning) Deputy Secretary (Administration) Senior Assistant Secretary (Forest Section) Senior Assistant Chief (Forest Section 1) Senior Assistant Chiefs (Forest Planning) Assistant Chief (Forest Planning) Administrative Officer (Forest Section 1)	MOEF
Additional Chief Conservator of Forests (Planning) Conservator of Forests (Administration & Finance) Conservator of Forests (Wildlife) Assistant Chief Conservator of Forests Accounts Officer Head Assistant (Administration)	BFD
Conservator of Forests (Khulna Circle) & Project Director Deputy Conservator of Forests (Khulna Circle) Divisional Forest Officer (Sundarban West Forest Division) Divisional Forest Officer (Sundarban East Forest Division) Divisional Forest Officer (Wildlife Management and Nature Conservation Division, Khulna) Range Officer (Chandpai Range, Mongla) Officer-in-Charge (Bojbaja Forest Camp) Station Officer (Chandpai Range, Mongla) Forest Guards, Boatmen, and Cook (Bojbaja Forest Camp)	SFO and BFD (Khulna Forest Circle Office)
Divisional Head (Mangrove Silviculture Division) Scientific Officer	BFRI
Cluster Director, Sundarban Cluster, Khulna PMA Research Associate Sundarbans Cluster, Khulna Communication and Outreach Facilitator, Sundarban Cluster Site Facilitator, Chandpai Site	IPAC
Joint Chief (Forest Wing)	PC
Joint Chief (Europe Wing)	ERD
Senior Assistant Chief	GED

[1] This list does not include community households, local leaders, *Mahajans/Aratdars/Dadondars*, political and social elites and many other key informers.

Upazila Nirbahi Officer *Upazila* Engineer *Upazila* Statistics Officer *Upazila* Election Officer *Upazila* Primary Education Officer	Koyra *Upazila Parishad*
Professor of Statistics	University of Jahangirnagar
Lecturer of Statistics, Biostatistics & Informatics	University of Dhaka
Project Coordinator	Unnayan Onneshan
Coordinator Project Coordinator	Pradipon
Chief Executive	Rupantor
Manager, Koyra	BRAC
Principal	Kopatakka Degree College, Koyra
Lawyer, Forest Court	Koyra
Local Journalists	Koyra

Appendix 3: Determination of sample size

Sample surveys frequently encounter the problem of estimating population proportions or percentages such as: proportion (1705 forest community households) of total households (2299) engaged in resource harvesting from the SMF. Thus, *p* is assumed to be a proportion having a given attribute of being forest community households, and *q* is the proportion not having this attribute such that $p+q = 1$. In that case, assuming 2299 households to be the sufficiently large population, the formula for estimating the sample size is:

$$n_0 = \frac{z^2pq}{d^2} \quad \text{..... (i)}$$

where, n_0 = desired sample size

z = standard normal deviate usually set at 1.96, and it corresponds to the confidence level at 95%.

p = assumed proportion of the target population with particular characteristic to be estimated.

d = desired degree of accuracy in the estimated proportion.

Employing the above formula (i) for this study, $z = 1.96$, $d = 0.05$ and $p = 0.74$ (1705 forest community households are 74% of total households). Thus, within 5 per cent points of *p*, the estimation of the true proportion in the population will be within $p = 0.74 \pm 0.05$. Consequently,

$$n_0 = \frac{z^2pq}{d^2} = \frac{(1.96)^2(.74)(.26)}{(.05)^2} = 296$$

However, guessing that *p* is not known or even not easy to assume for this study, "the safest procedure to take *p* as 0.50 which maximises the expected variance and therefore indicates a sample size (*n*) that is sure to be large enough" (Islam 2009, p. 118). This can be applied in assuming the population size (*N*) as small. If *N* is small, assumed formula to be used is as the following form:

$$n = \frac{Nz^2pq}{Nd^2 + z^2pq} \quad \text{..... (ii)}$$

Thus, according to Islam (2009), this formula (ii) can also be expressed as

$$n = \frac{Nn_0}{N+n_0} \quad \text{.....(iii)}$$

In practice, n_0 is first calculated. In case of negligible n_0/N, n_0 is regarded to be the satisfactory approximation to n (Islam 2009).

Taking p to be 0.50, in case of its difficulty to assume the event is:

$$n_0 = \frac{(1.96)^2(.5)(.5)}{(.05)^2} = 384$$

Supposing N = 1705 to be the small population, previous estimates of n is revised as follows:

$$n = \frac{Nn_0}{N+n_0} = \frac{1705 \times 384}{1705 + 384} = 313$$

Considering the above three scenarios for determination of n in estimating population proportion by using statistical formulas for this study, selection of n as 412 is more than satisfactory.

Appendix 4: Contact form

(English translation from Bengali)

Code No:

(Fill the code with same number for this contact form and interview schedule provided the respondent agrees to participate in the survey.)

CONTACT FORM

I am Anjan Kumer Dev Roy, a PhD student, in the School of Accounting, Economics and Finance, Faculty of Business and Law, University of Southern Queensland, Australia, conducting a survey for the research project about 'An investigation into the adequacy of existing and alternative property rights regimes to achieve sustainable management of the Sundarbans Mangrove Forest in Bangladesh'. I would like to invite you to take part in this survey. I would remain grateful if you help me in this regard.

For this survey, your household has been selected as sample using random sampling technique. I would like to interview the head of the household. I guarantee to keep the information given by the respondents confidential. I also assure that this research does not bear any relationship with the government policies. The interview will take about 35 minutes.

Q.1 Please tell me whether your head of the household agree to take part in the interview?

1 [ ] Yes 2 [ ] No (Skip to Q.5)

Q.2 Could you please tell me the nick names of the mentally and physically fit household members aged over 18 years?
(From the oldest to the youngest)

No	Nick name	No	Nick name
1		5	
2		6	
3		7	
4		8	

Q.3 Number visits to the household to conduct the interview. (This is for the interview only)

No of visit	Date and time	Comment	Contact address
First			
Second			
Third			

Q.4 Being the head of the household, you have been identified purposively to be interviewed in this survey. Do you agree to take part in the interview now?

1 [ ] Yes 2 [ ] No

Q.5 Could you please tell me the reason why you did not agree to take part in the interview?

1 [ ] Lack of time
2 [ ] No financial incentive
3 [ ] No confidence regarding the result of the survey
4 [ ] Scared to speak
5 [ ] The respondent is absent
6 [ ] Others (Specify)

Q.6 Could you please tell me your age? ..... years

Q.7 Could you please tell me your occupation? .....

Appendix 5: Response rate

(i) Total houses visited	430
(ii) Nobody found after three visits	3
(iv) Fail to interview after three visits	15
(v) Replacement sampling	18
(iii) Interview completed First visit: 321 Second visit: 79 Third visit: 12	
(vi) Total survey completed	412
(vii) Response rate (412/430)×100	95.81%

Appendix 6: Full version of interview schedule

(Confidential)

(English translation from Bengali)

Name of the Respondent: …… Date: ……. Place of interview: …… Time: ……..to …….. Sub-district: ……Union: …….. Ward: …… Village: …… Mohalla: ……..	Code No:

INTERVIEW SCHEDULE

Greeting. I am now going to ask you some questions regarding the overall management of the Sundarbans mangrove forest and the way you prefer its management. The prime purpose of this survey is to investigate whether an alternative property rights regime can enhance forest sustainability in the SMF.

It is highly expected that you will respond the questions with utmost honesty and truthfulness at best of your knowledge. There is no right or wrong answer. Your opinions, knowledge, attitudes and expectations will be highly valued and counted in understanding some pressing issues of prevailing management systems and how this forest can better be managed to provide benefits to the forest-dependent communities.

You are expected to respond every question with the best possible answer(s) and knowledge reflecting your opinion(s). Please follow the instructions before responding any particular question whether it is single or multiple. Your responses will be completely confidential and will not be used for any other purposes other than this PhD research at the University of Southern Queensland, Australia.

Section-A (Attitude and Perception)

1. Which community do you belong to?
1 [ ] Munda 2 [ ] *Bawali* 3 [ ] *Mawali* 4 [ ] Gol leaves collector 5 [ ] Fisher

2. What do you think about the importance of the Sundarbans for your livelihood?
1 [ ] Very high 2 [ ] High 3 [ ] Medium 4 [ ] Low 5 [ ] Very low

3. What is your view about the overall management of the Sundarbans that means its development, conservation, distribution of resources, etc?
1 [ ] Very good 2 [ ] Good 3 [ ] Barely acceptable 4 [ ] Poor 5 [ ] Very poor

4. Do you think that there have been any changes of tree density of the Sundarbans over the years? [Please tick (√) where appropriate]

Year	**Yes**	**No**

(over the last)	**Increase**	**Decrease**	**Percentage (%)**	
5				
15				
30				

a. If decreased, could you please rank five reasons?
1 [ ] Present management system 2 [ ] Environmental degradation
3 [ ] Too much population pressure 4 [ ] Corruption
5 [ ] Others (Specify) …….

b. Do you think that there is a need to protect the Sundarbans? 1 [ ] Yes 2 [ ] No

5. How are you concerned about the status of this forest in terms of tree density?
1 [ ] Very high 2 [ ] High 3 [ ] Medium 4 [ ] Low 5 [ ] Very low

Section-B (Management and Harvesting)

6. Please provide information of resource harvesting from the Sundarbans over ONE month.

Times		**Day**		**Benefit**		**Harvesting**	
Visited the Sundarbans	Put tick (√)	Average days stayed in one visit	Put tick (√)	Benefits/ resources derived	Put tick (√)	Harvesting sites distance from home (km)	Put tick (√)
Daily		0 (none)		Fish & crabs		<1	
5-8 times		1		Honey		1-5	
3-4 times		2-7		*Gol* leaves		6-10	
Twice		8-15		Wood & fuelwood		11-20	
Once		16-30		Fodder		21-30	
Others (Specify) … ……		Others (Specify) ….. ……..		Others (Specify) …. ……		Others (Specify) …..... ……..	

7. How do you harvest resources from the Sundarbans?
1 [ ] With Permits 2 [ ] Illegally 3 [ ] Others (Specify) ..……..

8. Could you please rank your views regarding the following issues of the Sundarbans?
1=Strongly agree 2=Agree 3=Undecided 4=Disagree 5=Strongly disagree

Issue	**Rank**				
Present management is conducive to the increase of tree density in last 10 years	1	2	3	4	5
Forest communities who are willing to harvest forest resources are allowed to do so					
Communities can harvest with permits as per their					

demands					
Harvesting time as per permits is always completed					
Forest communities are able to make decisions about internal use patterns and transform harvested resources by making improvements					
Forest Communities are able to make decisions about which community member can use the forest					
Forest Department consults forest communities regarding harvesting and distribution					
Communities are satisfied with various species plantation					
Present management conflicts with community interests					
Discrimination or corruption prevails in giving permits					
Your involvement in various community-based organisations is satisfactory					
Communities intend to be involved in the management					

Are there any comments you would like to make regarding above issues? .....
……

9. Are you able to harvest without any harassments/hazards from the Sundarbans?
1 [ ] Yes 2 [ ] No

i. If 'no', could you please rank the sources of harassments/hazards (from 1-5)?
1 [ ] Forest Department and Police 2 [ ] Forest pirates
3 [ ] Tiger attacks 4 [ ] *Aratdars/Mahajons*/Middlemen
5 [ ] Political/social elites 6 [ ] Others(Specify) .....
…….

ii. For which of the following activities Forest Department consult you?
1 [ ] Tree plantation 2 [ ] Resource harvesting
3 [ ] Monitoring of planting 4 [ ] Reduction of tree density
5 [ ] Development of the Sundarbans 6 [ ] Others (Specify) ……..

10. Please name your community-based organisation. .....
a. Year(s) of involvement: ……..year(s) ……month(s)

Section-C (Rights, Barriers and Remedies)

11. How long have you been living here?
1 [ ] Since birth 2 [ ] Last 10-20 yrs 3 [ ] 1-10 yrs 4 [ ] <1 yr

a. Where did you come from (for 2-4)? …… b. Why? .....

12. Who should manage the Sundarbans?
1 [ ] Forest Department 2 [ ] Forest Department and communities
3 [ ] Private owners 4 [ ] None 5 [ ] Others (Specify) ……

Please give me the answers of few questions regarding co-management.

13. Forests are conserved through 'co-management' in many countries of the world. In this co-management system:

i. Do you like to be involved in the co-management for the Sundarbans?

1 [ ] Yes 2 [ ] No

ii. How would you like to be involved in the co-management for the Sundarbans? (More options are allowed)

1 [ ] Through management process 2 [ ] By developing community institutions
3 [ ] In benefit-sharing structure 4 [ ] By selling cheapest labour
5 [ ] Others (Specify) ……

iii. What do you like to contribute to the co-management?

1 [ ] Labour 2 [ ] Monitoring 3 [ ] Management
4 [ ] Awareness building 5 [ ] All from 1-4

14. Which rights should communities be allowed for co-management?

1 [ ] To harvest specific products
2 [ ] To regulate harvesting patterns and improvement of harvested resources
3 [ ] To make decision regarding the access and transfer of access rights to others
4 [ ] Rights from 1-2 5 [ ] All the above rights from 1-3
6 [ ] Others (Specify) ……..

15. Could you please rank the barriers to the implementation of co-management?

1 [ ] Forest Department's unwillingness 2 [ ] Lack of community awareness
3 [ ] Forest Department neglects customary knowledge
4 [ ] Lack of political commitment 5 [ ] Lack of community institutions
6 [ ] Others (Specify) ……

Could you please explain the reason of your first barrier identification?

……

……

16. Could you please rank your suggestions to overcome barriers of co-management?

1 [ ] Property rights allocation 2 [ ] Political willingness
3 [ ] Forest Department's commitment 4 [ ] Community capacity building
5 [ ] Creating community level institutions
6 [ ] Others (Specify) ……

Could you please explain the reason of your first overcome option identification?

……

……

Section-D (Socio-demography)

17. Record sex of the respondent (without asking) 1 [ ] Male 2 [ ] Female

18. What is your highest level of education? ..... years

19. What is your age? ..... years

20. Including you, how many adult and minor members live in this household?
1 [ ] Number of adults (>18 years) 2 [ ] Number of minors (≤18 years)

21. Are you the only earner of your family? 1 [ ] Yes 2 [ ] No

i. If 'no', please mention the number of earning members? ……. persons
ii. What is the number of primary school completion literate family member(s)? ...…. persons
iii. What is the number of 6-18 years old children going for education?
Goes ..... persons, do/does not go ..... persons
iv. Please provide the number of children attending which level(s) of education:
Primary: ……. Secondary: …….. College/University: …….

22. (a) What is the average monthly income of you and all your family members earning from all sources including harvesting from the sundarbans, wages, salaries, agriculture, livestock, etc.? ..... Tk.

(b) Please provide the following information regarding your occupation(s) and income(s)?

Name of the occupation		Type of occupation		Time engaged		Monthly income
		Primary	Secondary	Months per year	Hours per day	
1	Fish & crab harvesting					
	Wood & firewood Harvesting					
	Honey harvesting					
	Gol leaves harvesting					
2	Agriculture					
3	Fish farming					
4	Livestock					
5	Selling labour					
6	Transportation					
7	Others (Specify) ……					

i. Yearly income from the Sundarbans (resource harvesting, processing, labour, etc.): …… Tk.
ii. Yearly income from other than resource harvesting from the Sundarbans (agriculture, service, etc.): ……. Tk.
iii. Yearly expenditure of your family: …… Tk.
iv. From where do you get financial help in case of difficulties/hardships?

1 [ ] Relatives 2 [ ] Friends/neighbours 3 [ ] *Dadandars/Mahajans* 4 [ ] NGOs
5 [ ] Banks 6 [ ] Government help 7 [ ] Others (Specify) …….

v. What are the major barriers of getting jobs except forest resource harvesting in this region?

1 [ ] Lack of other job opportunities 2 [ ] Lack of technical knowhow
3 [ ] Lack of education 4 [ ] Lack of finance
5 [ ] Collateral with *Dadandars*/*Mohajans* 6 [ ] Others (Specify) …….

vi. (a) What was your monthly income before *Aila*? ..... Tk.
(b) What were then sources of income other than resource harvesting from the Sundarbans?

1 [ ] Agriculture 2 [ ] Fish farming 3 [ ] Livestock
4 [ ] Day labourer 5 [ ] Others (Specify) .....

23. How would you describe your marital status?

1 [ ] Never married 2 [ ] Married 3 [ ] Widowed
4 [ ] Divorced/separated 5 [ ] Unwilling to disclose

24. Type of dwelling (Record, if possible)

1 [ ] *Gol* leaves/straw/wood 2 [ ] *Chala*/mud 3 [ ] *Tin*/wood built
4 [ ] Brick built 5 [ ] Others (Specify) …….

25. Can I/researcher communicate with you for any further information?

1 [ ] Yes 2 [ ] No
If yes, please provide your contact details (including cell phone no): ……

26. Would you like to contact the researcher to enquire about the research?

1 [ ] Yes 2 [ ] No
(If yes, please provide the contact address of the researcher)

27. Are there any comments you would like to make regarding the overall management of the Sundarbans? …….
…….

(Please say): Thank you for your cooperation

Appendix 7: Full version of re-interview schedule

(Confidential)
(English translation from Bengali)

Date: …….
Sub-district: ……Union: ……..
Ward: ……... Village: …….....
Mohalla: …….....

Code No:

My name is Anjan Kumer Dev Roy. At present, I am doing my PhD at the University of Southern Queensland in Australia. One of my research associates collected survey data on management issues of *Bada* (Sundarbans) on ..... I am very grateful to you for your participation in the survey. I would like to ask you few questions to assess whether the research associate did his/her job perfectly as well as to examine the consistencies of your information provided at the time of the interview. I would take about five minutes time to complete this job. I would be grateful to you if you could cooperate me.

Whether or not you are willing to participate in the interview?

1 Yes [Start interviewing]

2 No [Stop and go to other participant]

Q. 1 Record respondent's sex (do not ask)
1 [ ] Male 2 [ ] Female

Q. 2 What is your highest level of education? ..... years

Q.3 Who should manage the Sundarbans?
1 [ ] Forest Department 2 [ ] Forest Department and communities
3 [ ] Private owners 4 [ ] None
5 [ ] Others (Specify) …….

Q.4 Which rights should communities be allowed for co-management?
1 [ ] To harvest specific products
2 [ ] To regulate harvesting patterns and improvement of harvested resources
3 [ ] To make decision regarding the access and transfer of access rights to others
4 [ ] Rights from 1-2 5 [ ] All the above rights from 1-3
6 [ ] Others (Specify) …….....

Q.5 Could you please rank the barriers to the implementation of co-management?
1 [ ] Forest Department's unwillingness 2 [ ] Lack of community awareness
3 [ ] Forest Department neglects customary knowledge
4 [ ] Lack of political commitment 5 [ ] Lack of community institutions
6 [ ] Others (Specify) ……

Q.6 What is the average monthly income of you and all your family members earning from all sources including harvesting from the sundarbans, wages, salaries, agriculture, livestock, etc.? ..... Tk.

Q.7 From where do you get financial help in case of difficulties/hardships?
1 [ ] Relatives 2 [ ] Friends/neighbours 3 [ ] *Dadandars*/*Mahajans* 4 [ ] NGOs
5 [ ] Banks 6 [ ] Government help 7 [ ] Others (Specify) ……....

Q.8 Would you like to contact the researcher to enquire about the research?
1 [ ] Yes 2 [ ] No

(Thank you very much for your cooperation)

Appendix 8: Comparison between UN guidelines and applied household survey design procedures

UN guideline		**Applied survey measure**
No	***Survey planning and execution***	
1	Clearly spelled survey objectives	Described at the outset of conducting survey
2	Direct observation (for small sample sizes and populations)	UN guidelines followed (hereafter followed)
3	Recruitment of qualified interviewers	Followed
4	Training of interviewers	Followed
5	Personal interview	Followed
6	Pre-testing of questionnaire	Followed
7	Avoidance of 'loaded' questions	Followed
8	Question sequence	Followed in 4 sections.
9	Question construction with 'yes', 'no' and 'other' options	Followed
10	Question wording	Followed
11	Cross-tabulations	Followed
12	Data analysis plan	Followed
13	Arrange meetings with local opinion leaders	Followed
14	Legal provision for conducting the survey	Followed (Formal written permission taken from the MOEF)
15	Field supervision (Supervisor : Interviewers = 1 : 4 or 1: 5)	Ratio 1 : 8 was followed (Researcher supervised 8 interviewers).
16	Follow-up of non-respondents	Followed
Sampling strategies		
17	Probability sampling in stages such as: suggested probability of selecting a household is 1/50 (10/100 multiplied by 1/5)	Followed (the probability was very high such as 1/11 (6/13 multiplied by 412/1705)
18	Calculating probability of household selection such as 1 in 5 households (1/5=0.2).	Followed (412 in 1705 households that means 412/1705 = 0.24).
19	Defined target population	Followed.
20	Sample size determination (5% or 10% of the population).	Followed (24% of the population)
21	Rule of stratification	Followed in five stages (district-*Upazila*-union-village-household)
22	Target population definition and coverage	Followed
23	Handle non-responses with 3-5 call-backs	Followed (3 call-backs)
24	Reducing non-response bias	Followed

25	Minimise non-response to 10-15%	Followed non-response rate at 4% (18 out of 430)
26	Random sampling with replacement	Followed
Sampling frame		
27	Relationship between sampling frame and target population	Followed
Reducing sampling errors		
28	Assessing biases through comparison with more reliable sources	Followed
29	Consistency checks	Followed
30	Sample verification	Followed
31	Post-survey/re-interview checks	Followed
Data processing		
32	Data preparation in the field	Followed
33	Coding	Followed
34	Editing and checking of data	Followed
35	Handling missing data	Followed

Source: UN (2005)

Appendix 9: Correlation matrix for socio-demographic attributes

Variable	Constant	Sex	Marital status	Dwelling	Age	Education	Income	Household size
Constant	1.000	-0.549	-0.561	-0.121	-0.173	-0.331	-0.227	-0.253
Sex	-0.549	1.000	-0.152	0.096	0.166	0.151	0.012	0.053
Marital status	-0.561	-0.152	1.000	-0.155	-0.314	0.062	0.018	0.044
Dwelling	-0.121	0.096	-0.155	1.000	0.062	-0.069	-0.117	-0.020
Age	-0.173	0.166	-0.314	0.062	1.000	0.244	0.105	-0.226
Education	-0.331	0.151	0.062	-0.069	0.244	1.000	-0.122	0.042
Income	-0.227	0.012	0.018	-0.117	0.105	-0.122	1.000	-0.174
Household size	-0.253	0.053	0.044	-0.020	-0.226	0.042	-0.174	1.000

Appendix 10: Tolerance and VIF for socio-demographic attributes

Collinearity Statistics		
Variable	Tolerance	VIF
Sex	0.928	1.078
Marital status	0.910	1.099
Types of dwelling	0.957	1.045
Age	0.861	1.161
Education	0.856	1.169
Income	0.916	1.092
Household size	0.904	1.106

Appendix 11: Correlation matrix for sustainability model variables

Variable	Constant	Access right	Withdrawal right (WR_D)	Withdrawal right (WR_T)	Management right	Exclusion right	Benefit-sharing partnership	Customary knowledge	Conflict resolution	Plantation	Institutional capacity building	Corruption and discrimination
Constant	1.000	-0.346	-0.230	-0.230	-0.076	0.090	-0.332	-0.104	-0.190	-0.540	-0.595	-0.095
Access right	-0.346	1.000	0.074	0.149	-0.019	0.105	0.089	0.033	0.103	0.136	0.161	-0.033
Withdrawal right (WR_D)	-0.230	0.074	1.000	-0.215	-0.177	-0.224	0.304	0.029	0.121	-0.088	0.110	0.021
Withdrawal right (WR_T)	-0.230	0.149	-0.215	1.000	0.229	-0.115	0.014	0.074	-0.006	0.012	0.040	0.080
Management right	-0.076	-0.019	-0.177	0.229	1.000	-0.099	-0.071	-0.353	-0.078	0.000	0.085	-0.190
Exclusion right	0.090	0.105	-0.224	-0.115	-0.099	1.000	-0.197	0.118	0.048	0.018	-0.125	-0.078
Benefit-sharing partnership	-0.332	0.089	0.304	0.014	-0.071	-0.197	1.000	-0.064	0.063	-0.209	0.022	-0.027
Customary knowledge	-0.104	0.033	0.029	0.074	-0.353	0.118	-0.064	1.000	-0.023	0.089	0.030	-0.106
Conflict resolution	-0.190	0.103	0.121	-0.006	-0.078	0.048	0.063	-0.023	1.000	-0.026	-0.031	-0.289
Plantation	-0.540	0.136	-0.088	0.012	0.000	0.018	-0.209	0.089	-0.026	1.000	0.001	0.029
Institutional capacity building	-0.595	0.161	0.110	0.040	0.085	-0.125	0.022	0.030	-0.031	0.001	1.000	-0.010
Corruption and discrimination	-0.095	-0.033	0.021	0.080	-0.190	-0.078	-0.027	-0.106	-0.289	0.029	-0.010	1.000

Appendix 12: Tolerance and VIF for sustainability model variables

Collinearity Statistics		
Variable	Tolerance	VIF
Access right	0.946	1.057
Withdrawal right (WR_D)	0.888	1.126
Withdrawal right (WR_T)	0.867	1.154
Management right	0.772	1.295
Exclusion right	0.878	1.139
Benefit-sharing partnership	0.922	1.084
Customary knowledge	0.834	1.198
Conflict resolution	0.852	1.174
Plantation	0.913	1.096
Institutional capacity building	0.939	1.065
Corruption and discrimination	0.802	1.246

Appendix 13: Interview guide for focus group discussions

(Confidential)

Interviewer's name: ……
Name of interviewees (optional): ……....
Official/current address: ……
Date, time and location: ……
Briefing research objectives and confidentiality:

Interview Guide:

Section A: Overall Management of the Sundarbans

1. What did you think about the forest conservation in Bangladesh?
2. What are the issues relating to the conservation of the Sundarbans?

   The significance of the Sundarbans at local and national level
3. Decision making and implementation processes at different levels

   The role of the MOEF, BFD and forest-dependent communities
4. Do you feel that the Sundarbans is being degraded? If so, how?
5. What are the interventions for the sustainability of the Sundarbans?
   a. Interventions for the development of the Sundarbans
   b. Interventions for the community livelihood security.
   c. Are these interventions enough? If not, what else can be done?
   d. Does the BFD consult communities regarding interventions?

Section B: Co-management for Sustainability of the Sundarbans

(Explanation of 'Co-management' by the Moderator)

6. Is the co-management able to achieve sustainability in the Sundarbans?
7. What issues of co-management need to be considered? (e.g. defined property rights, power relationship, equity, local institution, community involvement in management and policy formulation)
8. Has Government taken any steps to implement co-management in the Sundarbans?

   Are the steps adequate? If not, why?
9. What are the barriers to the implementation of co-management?
10. How can these barriers be overcome to achieve sustainability in the management of the Sundarbans?
11. Is there anything else about the sustainable management of the Sundarbans that you would like to share that we have not yet touched upon?

(Thank you for your cooperation)