SUSTAINABLE MANAGEMENT OF THE SUNDARBANS: STAKEHOLDER ATTITUDES TOWARDS SUSTAINABLE MANGROVE POLICY AND MANAGEMENT

by

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Abstract

The world's largest contiguous mangrove forest, the Sundarbans, is not only rich in biodiversity but also provides ecological, economic and cultural services to people surrounding the forest. The Sundarbans is one of the oldest systematically managed mangroves in the world, providing numerous benefits and services to local communities and the environment. The natural resources of the forest remain under threat from population pressure, over exploitation, natural disasters and lack of practical policy regimes. This study attempts to assess attitudes of stakeholders towards sustainable management and conservation of mangrove forests as a means to assist planners, policy-makers, and decision-makers. Improving attitudes of local stakeholders towards conservation of natural resources is one of the strategies for sustainable forest management. A mixed method approach was conducted to fulfill the objectives of this study. The study reveals that the people of Sundarbans Impact Zone (SIZ) are closely associated with the Sundarbans and are highly dependent on it for their livelihood. Collecting resources from both aquatic and terrestrial areas within the Sundarbans has been considered a traditional right for people within the SIZ. As such, people are increasingly becoming more conscious about government policy and associated laws and regulations. Most of the villagers participate in government and NGO's sponsored programs and they want the forest to be managed in a sustainable way. Generally, the language of government policy is very strong, but implementation of policy is difficult because of competing policies, weak infrastructure, inefficiencies, illegal approaches and corruption. Recognition of property rights along with education and more sustainable approaches to management is required.

Good governance and favorable policies along with financial, administrative, and institutional support are needed to ensure the resilience and ecological integrity of the Sundarbans. Moreover, increased collaboration and sharing of information between government and stakeholders would facilitate planning, management, and ultimately, wise decision making. Finally, efforts should be made to develop and advance coupled human–environment (socio-ecological) systems that call for more participatory approaches to management and thus permit stronger voices from the local community. Wider participation and 'empowerment' of stakeholders would improve governance of the Sundarbans and ensure common priorities and levels of agreement on both conservation and livelihood issues.

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Trishita Mondal

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List of Abbreviations and Symbols

BCE	Before Common Era
BCN	Biodiversity Conservation Network
BDT	Bangladesh Taka
BFD	Bangladesh Forest Department
BLC	Boat License Certificate
CBMFM	Community-Based Mangrove Forest Management
CMC	Co-Management Councils and Committee
CPG	Community Patrol Groups
DFID	Department for International Development
ECA	Environmental Conservation Act
ELAN	Ecosystems Livelihoods Adaptation Network
ESD	Education for Sustainable Development
FAO	Food and Agriculture Organization
FD	Forest Department
FDC	Forest Dependent Communities
GC-REB	Grenfell Campus Research Ethics Board
GOB	Government of Bangladesh
ITTO	International Tropical Timber Organization
MoEF	Ministry of Environment and Forest
NGO	Non-Government Organization
NTPs	Non-timber Forest Products
PF	Peoples Forum
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
SES	Social-Ecological System
SIZ	Sundarbans Impact Zone
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
SLR	Sea Level Rise
SRF	Sundarban Reserve Forest
UN	United Nations
UNDP	United Nation's Development Programme
UNESCO	United Nations Educational, Science and Cultural Organization
VCF	Village Conservation Forum
VTRT	Village Tiger Response Team
WRI	World Resources Institute

Chapter 1 Introduction

1.1 General information

The Sundarbans represent a cluster of low-lying islands in the Bay of Bengal spread across Bangladesh and the West Bengal region of India. This region, encompassing the world's largest contiguous mangrove forest, covers 1000000 ha in the Ganges delta of India and Bangladesh (Hussain and Acharya 1994; Roy 2016). The Bangladesh part of the Sundarbans (62% of the Sundarbans) (Figure 1) is recognized for its rich biodiversity of both flora and fauna representing thousands of species of plants, fishes, birds, crustaceans, reptiles and mammals, including the endangered Royal Bengal tiger (*Panthera tigris tigris*) (Kamruzzaman et al., 2018; Haque and Reza, 2017; Abdullah et al., 2016; Payo et al., 2016). A key influence on the ecological integrity, structure, and function of the Sundarbans is provided by the Ganges and Brahmaputra rivers that create a deltaic environment along the south-west coast of Bangladesh (Haque and Reza, 2017).

Iftekhar and Islam (2004) reported that the Sundarbans forest is one of the oldest systematically managed mangroves in the world. Worldwide, a number of workers (Mozumder et al., 2018; Islam et al., 2018; Isbell et al., 2017; Abdullah et al., 2016) have documented the economic, social and environmental benefits of mangroves to forest-dependent communities (FDCs). Around 3.5 million people of 17 adjacent subdistricts of the Sundarbans are critically dependent on the mangrove forest for their livelihood. These areas are collectively known as Sundarbans Impact Zone (SIZ) (Roy et al., 2013). The Sundarbans provide direct economic benefits to local people primarily through fishing and harvesting of non-timber products such as honey, beeswax, golpata, fruits, fuelwood,

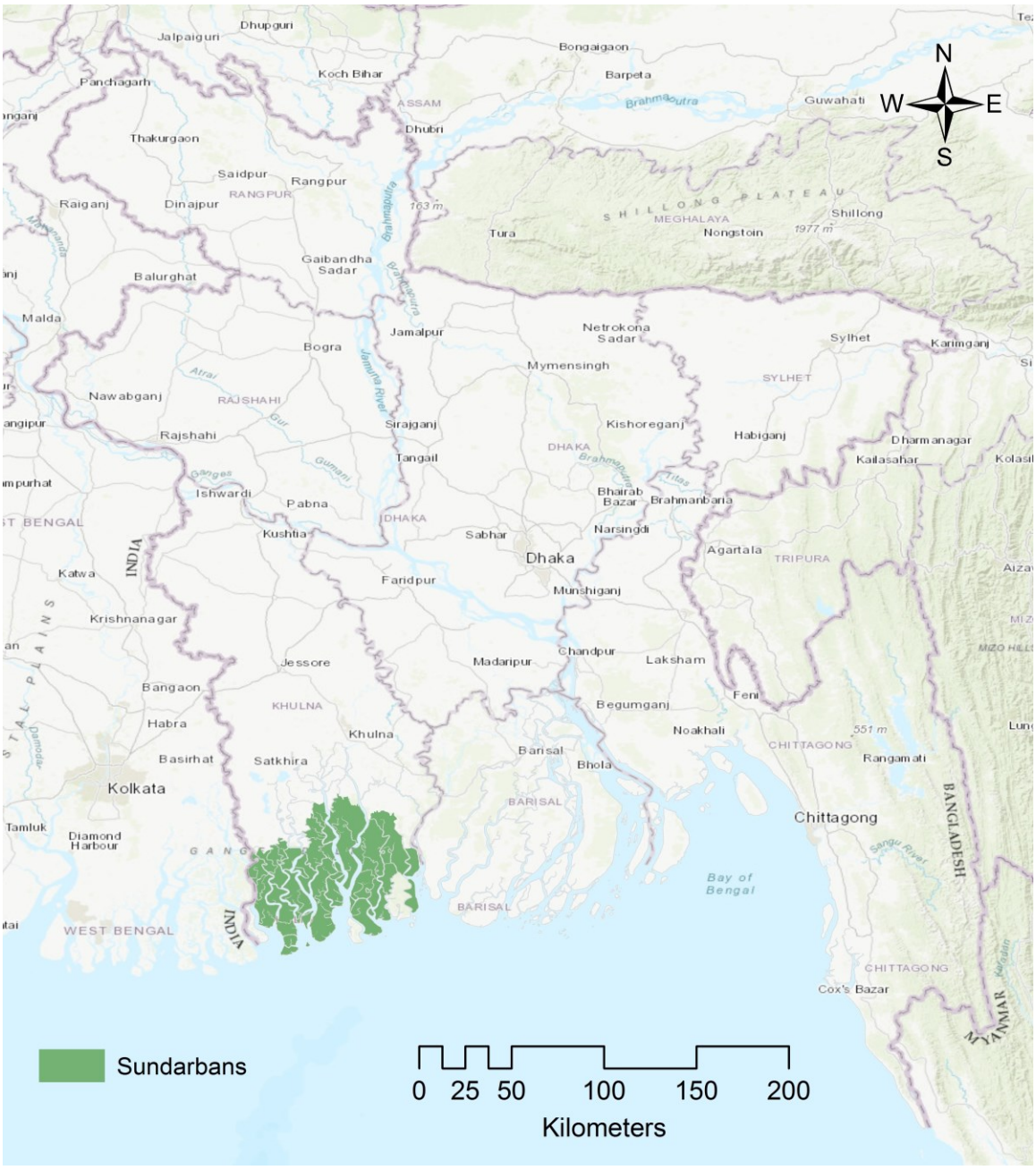

Figure 1. Location of the Sundarbans in Bangladesh

tannin, fodder, and thatch (Islam, 2011). Mangrove resources can be categorized into five types: timber, fish, crabs, nipa leaves and honey (Abdullah et al., 2016). Beyond the inherent value of biodiversity, the Sundarbans also play important additional roles in

ecosystem services. As a coastal belt, mangrove forests act as a buffer to tidal shores, cyclones and storms and protect more than two million people from natural disasters (Ishtiaque and Chhetri, 2016). These forests also help to ensure water quality and act as a filter to reduce pollution. The Sundarbans are also very important in atmospheric CO_2 sequestration, thereby mitigating climate change. Rahman et al. (2015) reported that mangroves represent one of the most efficient terrestrial carbon sinks, sequestrating carbon at a rate of two to four times greater than mature tropical forests. It is estimated that the Bangladesh part of the Sundarbans sequesters 4.8Mt of CO_2 annually which is 10% of the total CO_2 emissions of Bangladesh (Ishtiaque, and Chhetri, 2016).

Finally, the Sundarbans is also an important area for ecotourism, given that mangroves offer shoreline protection (coastal shelter belt), and provide a feeding and breeding ground for numerous animals and plants (Mazumder et al., 2018; Rahman et al., 2015).

According to the World Resources Institute (WRI), the world lost a total of 474,000 ha of mangrove land from 2001 to 2012 (1.38% since 2000) (WRI, 2015). Gilman et al. (2008) stated that due to anthropogenic and natural causes about 35% of the world's mangrove forest area has been lost in the past two decades with an annual loss rate of 1-2%. In the developing countries of Asia, the losses of mangrove forest are in the range of 50-80% due to conversion of forest to shrimp farming (Roy et al., 2013). Agricultural expansion and the use of fertilizers and pesticides is deemed to be the major cause of the mangrove reduction in Asia (Sarker et al., 2019). Population pressure and urbanization are also responsible for clearing considerable mangrove lands (WRI, 2015). Despite numerous benefits, the destruction of the Sundarbans in Bangladesh continues at an alarming rate

(United Nations Educational, Science and Cultural Organization [UNESCO], 2017; Sabbir, 2012). Two factors, over exploitation of natural resources and adverse climatic conditions, are reported to be significant in the degradation of the Sundarbans (Roy, 2016; Hussain, 2014). Before the cyclone Aila in 2009, 29% of the SIZ economy was based on agriculture and small-scale businesses, supported by well-developed infrastructure. Currently, approximately 80% of the people in the SIZ are directly dependent on the Sundarbans due to damages of infrastructure as well as loss of income generation opportunities because of recent natural disasters (Swapan and Gavin, 2011). These adverse effects threaten the sustainability of the Sundarban Reserve Forest (SRF) and the livelihood security of forest dependent people (Badola et al., 2012).

Given the vulnerability of the Sundarbans, the conservation of biodiversity and the sustainability of the mangrove reserve forests is considered high priority in Bangladesh. The current paradigm of conservation planning continuses to focus on establishment of protected areas and recognition of important habitat (Hansen et al., 2010). As well, resilience thinking has become an important concept in managing the complex and diverse relationship of humans and nature (Mazumder et al., 2018). To increase resilience of systems, Hansen et al. (2010) introduced the "climate-smart" conservation principle along four basic tenets: *"*protect adequate and appropriate space, reduce non-climate stresses, apply adaptive management to implement and test adaptation strategies immediately, and reduce the rate and extent of climate change to reduce overall risk to the conservation unit of concern" (Hansen et al., 2010, p. 63).

The general purpose of this thesis is to review existing policies and management regimes governing mangrove forests in the Sundarbans mangroves of Bangladesh. Further, the study aims to explore stakeholder attitudes with a view to advancing sustainable management and conservation of the Sundarbans.

1.2 Objectives

The overall objective of this research is to examine attitudes of stakeholders in forest-dependent communities within Sundarbans mangroves of Bangladesh and consider recommendations to improve sustainability of the resources.

1.2.1 Specific objectives

1. To review the evolution of forest policies and management in Bangladesh and to use this as an analytical framework to identify key factors influencing the management of mangrove forests.

2. To provide an analysis of attitudes held by local stakeholders towards conservation and management of the Sundarbans.

3. To explore if property rights issues are of concern to communities involved in the use or management of the Sundarbans.

4. To provide recommendations to improve policies guiding the implementation for sustainable management of the Sundarbans.

1.3 Research questions

1. How does past forest management and policy affect sustainable forest management in the Sundarbans?

2. How do local stakeholders value the Sundarbans and do their attitudes reflect a need for improved forest policy and management in the Sundarbans?

3. What specific policy instruments might enhance sustainable management of the Sundarbans?

1.4 Outline of the thesis

This thesis encompasses six chapters. The first chapter provides general information on mangrove forests, most notably the Sundarbans. The second chapter describes the current status of the forest resource in Bangladesh and more specifically the importance of the Sundarbans to the people of the SIZ. Chapter three proposes a framework which describes strategies of conservation of mangroves focusing on the livelihood of local people. The research methodology is outlined in Chapter four. The results and discussion from analysis of the survey questions are discussed in Chapter five. Chapter six summarized the thesis and suggests policy recommendations for the future.

Chapter 2 Literature Review

2.1 Present status of the forests of Bangladesh

2.1.1 Overview of forest sector in Bangladesh

Bangladesh, a country of 14.757 million ha, is a low-lying deltaic country with a very diversified forest coverage and traversed by numerous branches of rivers (Alam, 2009). The country has 2.6 million hectares of forest cover which is about 18% of the total geographical area of the nation. According to Choudhury and Hossain (2011), there are four categories of forest areas in Bangladesh: hill, sal (Shorea robusta), mangrove and village forest. The Forest Department (FD) of Bangladesh manages only 10.84 % of the total land area including hill, sal and Sundarbans forest (Forest Department [FD], 2016; FAO, 2006). The remaining types of forest cover are designated as unclassified state forest including village forests, fresh-water wetlands and mud floods which are managed by the ministry of land. Hill forests are distributed mainly in the eastern border of Bangladesh while the mangrove forest is situated in the South-west part of Bangladesh. The central lowland and floodplain consist of most of the Sal forest. Most of the village forests are under private ownership (FD, 2017). The village forests are the most productive forests in Bangladesh and provide sources of fruits, fuel, timber, fodder, house building materials and bioproducts (Chowdhury, 2014). In addition to direct economic benefits, the forest also contributes a range of ecological and social services. The demand for forest products is often high and commonly outstrips supply (Biswas and Choudhury, 2007). As a result, the forest is overexploited and the forest land is decreasing day by day (Rahman, 2017). FAO (2015) reported that from 1990 to 2015 the forest decreased from 1.494 million ha to 1.429

million ha; a depletion rate of 0.2% annum^{-1} (FAO, 2015). However, in recent years the government has taken initiatives to achieve the 'sustainable development goals (SDG)' introduced by the United Nations (UN) in 2015 (Rahman, 2017). Table 1 summarizes the present types, location and status of forest land cover in Bangladesh. The forest cover density is relatively low in the country and concentrated mostly in the mangrove forest and the hill forest (figure 2).

Table 1. Present status of the forests in Bangladesh

Forest Type	**Location**	**Total area coverage (ha)**	**% of the total forest-land**	**% of total land of the country**	**Example of some trees**
Tropical Evergreen and Semi evergreen Forests (Hill Forest),	Chittagong, Cox's Bazar, Chittagong Hill Tracts and Sylhet	670000	44%	4.54%	Garjan (*Dipterocarpus spp*.), Chapalish (*Artocarpus chaplasha*), Telsur (*Hopea odorata*), Tali (*Palaquium polyanthrum*), Teak (*Tectona grandis*), Gamar (*Gmelina arborea*), Mehogani (*Swietenia spp*) etc.
Tropical Moist Deciduous Forest (Sal forest**)**	Most of the lowlands and floodplains in the central and western parts of the country	120000	7.5%	0.81%	*Shorea robusta, Albizzia procera*, *Dillenia pentagyna*, *Cassia fistula*, *Terminalia belerica*,*Terminalia chebula, Bauhin ia acuminate* etc.
Natural Mangrove Forest (Sundarbans)	South-western region of Bangladesh including Satkhira, Khulna and Bagerhat districts	601700	38.12 %	4.13%	Sundri (*Heritiera fomes*), gewa (*Excoecaria agallocha*), goran (*Ceriops decandra*), passur (*Xylocarpus mekongensis*), dhandal (*Xylocarpus granatum*) etc.
Coastal Afforestation	Southern part of Bangladesh	196000			*Sonneratia apetala*, *Avicennia officinalis* etc.
Swamp Forest	North-eastern part mainly in Sylhet and Sunamganj district of Bangladesh	23000	1.44%	0.16%	Hijal (*Barringtonia acutangula),* Koroch *(Pongamia pinnata)* etc.
Village Forest					*Cocos nucifera, Samanea saman, Mangifera indica, Areca catechu* etc.

Source: FD, (2017). Retrieved on September 11, 2017 from http://www.bforest.gov.bd/.

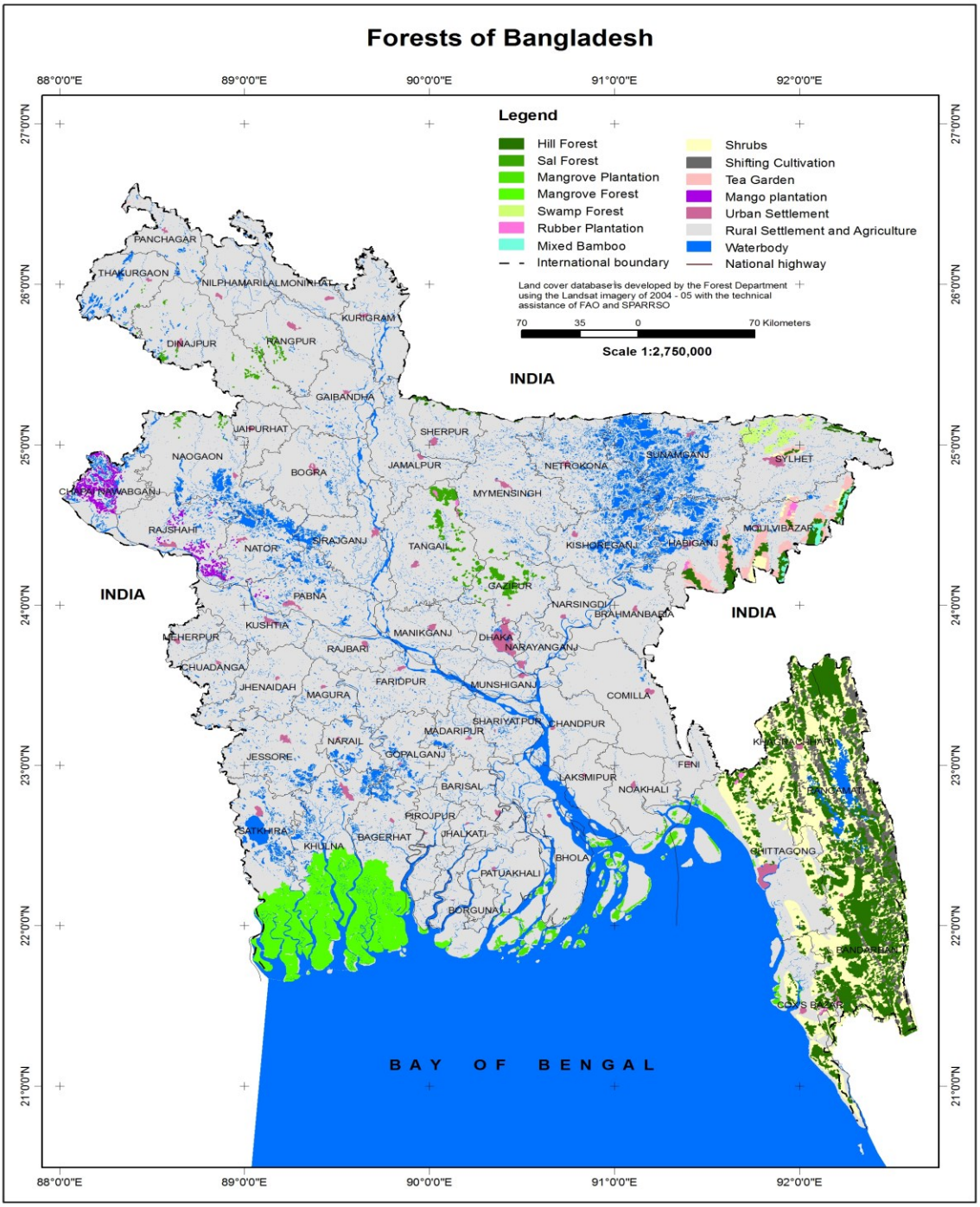

Figure 2. Map of forest cover in Bangladesh (Source: FD, 2017)

2.1.2 Protected areas

For the conservation of natural resources, declaration of protected areas is an effective and widespread strategy around the world (Mukul, 2007). The government of Bangladesh has realized the necessity of protected areas and took steps as long ago as the 1960s to establish protected areas. National legislation passed in 1973 included provisions for declaring forests as national parks, wildlife sanctuaries and game reserves for the protection of the natural forest resources. Sadath and Krott (2012) provide an extensive analysis of forest sector policy over two decades noting steps taken by the Bangladesh Forest Department (BFD) under the Wildlife (Protection and Safety) Act, 2012 (Act No. 30 of 2012) to enhance conservation efforts. The BFD under the Ministry of Environment and Forests (MoEF) is responsible for the management of all protected areas within Bangladesh. These protected areas cover about 618253.49 hectares of the total forest land which represents 4.19% area coverage of the total geographic land. Protected areas (Table 2) are categorized as wildlife sanctuaries, special biodiversity areas (e.g. Ratargul Swamp forest of Sylhet), eco-parks, safari parks, botanical gardens, national parks, and vulture safe zones (FD, 2019). Among the protected areas, 17 national parks and 20 wildlife sanctuaries are considered for the protection and conservation of wildlife and biodiversity. To pay extra attention, the Government of Bangladesh (GOB) declared specific biodiversity areas as 'protected areas' under the provisions of sections 13, 17, 18 and 19 under Chapter IV, section 22 under Chapter V and section 23. Moreover, since 1989, timber extraction from reserved forests (protected) is prohibited to promote the conservation of natural resources

(GOB, 2017). The World Heritage site Sundarbans is the biggest protected area in Bangladesh (FD, 2017).

Table 2. List of protected areas in Bangladesh

Sl. No.	Protected Areas	Location (District)	Area (ha.)	Date Established
National Parks				
1	Bhawal National Park	Gazipur	5022.29	1982
2	Madhupur National Park	Tangail and Mymensingh	8436.13	1982
3	Ramsagar National Park	Dinajpur	27.75	2001
4	Himchari National Park	Cox's Bazar	1729.00	1980
5	Lawachara National Park	Moulavibazar	1250.00	1996
6	Kaptai National Park	Chittagong Hill Tracts	5464.78	1999
7	Nijhum Dweep National Park	Noakhali	16352.23	2001
8	Medhakachhapia National Park	Cox's Bazar	395.92	2004
9	Satchari National Park	Habigonj	242.91	2005
10	Khadimnagar National Park	Sylhet	678.80	2006
11	Baroiyadhala National Par	Chittagong	2933.61	2010
12	Kuakata National Park	Patuakhali	1613.00	2010
13	Nababgonj National Park	Dinajpur	517.61	2010
14	Singra National Park	Dinajpur	305.69	2010
15	Kadigarh National Park	Mymensingh	344.13	2010
16	Altadighi National Park	Naogaon	264.12	2011
17	Birgonj National Park	Dinajpur	168.56	2011
Wildlife Sanctuaries				
1	Rema-Kalenga Wildlife Sanctuary	Hobigonj	1795.54	1996
2	Char Kukri-Mukri Wildlife Sanctuary	Bhola	40.00	1981
3	Sundarban (East) Wildlife Sanctuary	Bagerhat	122920.90	2017
4	Sundarban (West) Wildlife Sanctuary	Satkhira	119718.88	2017
5	Sundarban (South) Wildlife Sanctuary	Khulna	75310.30	2017
6	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	42069.37	1983
7	Chunati Wildlife Sanctuary	Chittagong	7763.97	1986
8	Fashiakhali Wildlife Sanctuary	Cox's Bazar	1302.42	2007
9	Dudpukuria-Dhopachari Wildlife Sanctuary	Chittagong	4716.57	2010
10	Hajarikhil Wildlife Sanctuary	Chittagong	1177.53	2010
11	Sangu Wildlife Sanctuary	Bandarban	2331.98	2010
12	Teknaf Wildlife Sanctuary	Cox's Bazar	11614.57	2009
13	Tengragiri Wildlife Sanctuary	Barguna	4048.58	2010
14	Dudhmukhi Wildlife Sanctuary	Bagerhat	170.00	2012
15	Chadpai Wildlife Sanctuary	Bagerhat	560.00	2012
16	Dhangmari Wildlife Sanctuary	Bagerhat	340.00	2012
17	Sonarchar Wildlife Sanctuary	Patuakhali	2026.48	2011
18	Nazirganj Wildlife (Dolphin) Sanctuary	Pabna	146.00	2013

19	Shilanda-Nagdemra Wildlife (Dolphin) Sanctuary	Pabna	24.17	2013
20	Nagarbari-Mohanganj Dolphine Sanctuary	Pabna	408.11	2013
Special Biodiversity Conservation Areas				
1	Special Biodiversity Conservation Area (Ratargul)	Sylhet	204.25	2015
2	Altadighi water based Special Biodiversity Conservation Area	Naogaon	17.34	2016
Marine Protected Area				
1	Swatch of No-Ground Marine Protected Area	South Bay of Bengal	173800	2014
Vulture Safe Zones				
1	**Vulture Safe Zone -1**	The safe areas of vulture under Sylhet, Dhaka (partial) and Chittagong division	7459.182 square kilometers	
2	**Vulture Safe Zone -2**	The safe areas of vultures under Khunna, Barisal and Dhaka (partial) division	7846.258 square kilometers	
Botanical Gardens				
1	National Botanical Garden	Dhaka	84.21	1961
2	Baldha Garden	Dhaka	1.37	1909
Safari Parks				
1	Bangabandhu Sheikh Mujib Safari Park	Gazipur	1493.93	2013
2	Bangabandhu Sheikh Mujib Safari Park	Cox's Bazar	600	1999
Eco-Parks				
1	Madhabkundu Eco-Park	Moulavibazar	265.68	2001
2	Sitakunda Botanical Garden and Eco-park	Chittagong	808	1998
3	Modhutila Eco-Park	Sherpur	100	1999
4	Banshkhali Eco-Park	Chittagong	1200	2003
5	Kuakata Eco-Park	Patuakhali	5661	2005
6	Tilagar Eco-Park	Sylhet	45.34	2006
7	Borshijora Eco-Park	Moulavibazar	326.07	2006
8	Rajeshpur Eco-Park	Comilla	185.09	

Source: Forest Department, (2017). Retrieved on October 11, 2017 from http://www.bforest.gov.bd

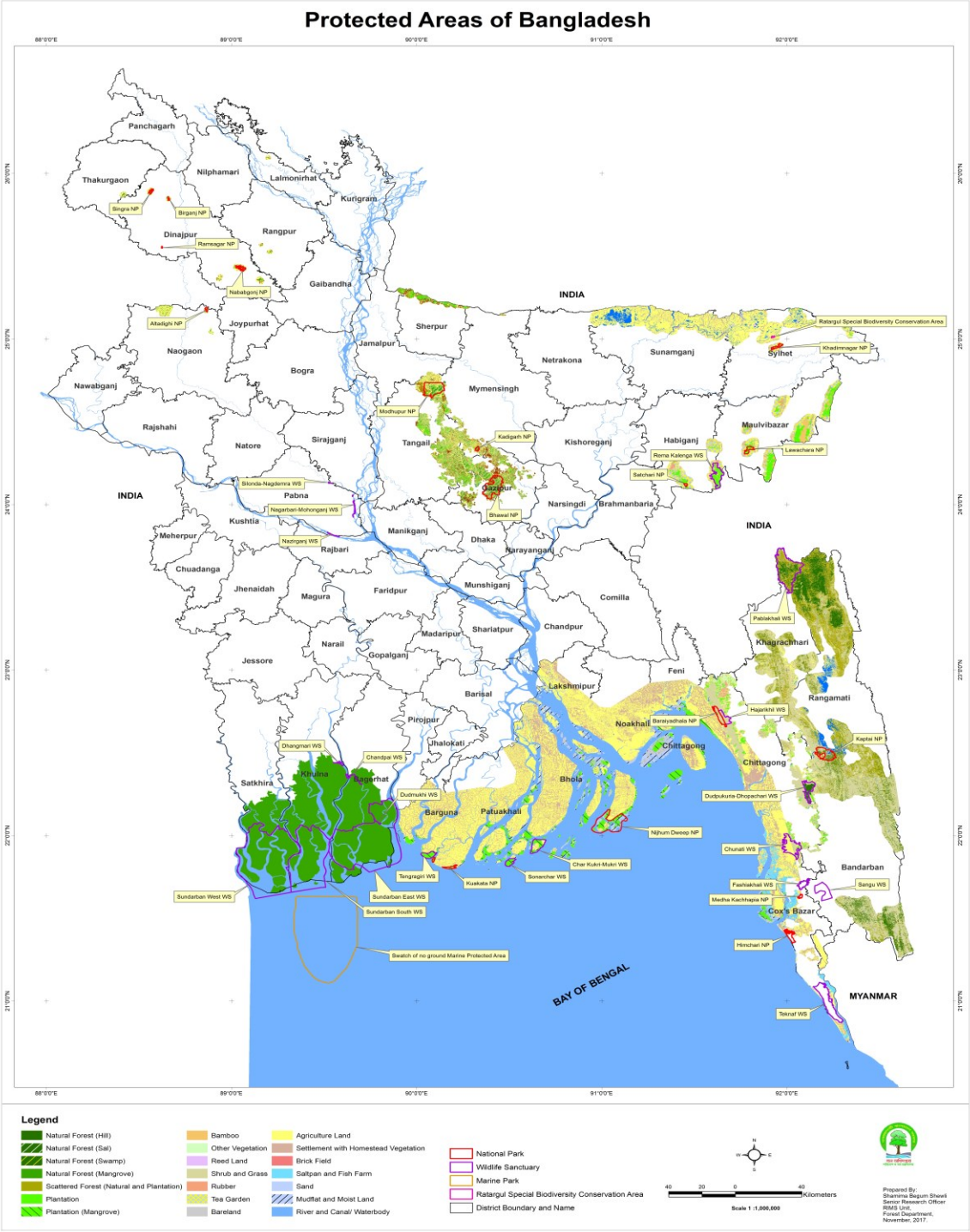

Figure 3. Map of protected areas in Bangladesh (Source: FD, [2019])

2.1.3 Sundarbans

2.1.3.1 Location

The largest single block mangrove forest of the world, the Sundarbans, is situated at 21°27′30″ and 22°30′30″ N and 88°02′00″ and 89°00′00″ E, covering about 10,000 km^2 of land in both Bangladesh and India (Aziz and Paul, 2015). Within Bangladesh, it is situated at 21°30″ to 22°30″ N and 89°00″ and 89°55″ E, covering a forest landmass of 6017 km^2; this represents 60% of the total land cover of the Sundarbans and 23% of the total forestland of Bangladesh (Kamruzzaman et al., 2018; Roy, 2016; Rahman et al., 2010) .

2.1.3.2 Ecology and biodiversity

Three ecological zones have been described within the Sundarbans: Oligohaline (fresh water), mesohaline (moderately saline water) and polyhaline (salt-water). These zones receive an average rainfall of 1800-2790 mm per year. The diversity of plant communities is largely influenced by salinity levels of the different ecological zones (Kamruzzaman et al., 2018). The low-aying mangrove swamps are subject to tidal inundation on a regular basis of six hours intervals, causing significant siltation in the mangrove ecosystem. Soil erosion is also a common phenomenon in the Sundarbans. Raymongol, Sibsha, Malancha, Bal, Passur and Arpangashia represent important rivers of the Sundarbans (Haque et al., 2015).

The mangrove forest, Sundarbans is well recognized for its diversified flora and fauna due to both aquatic and terrestrial species in the same wetland. Rahman et al., (2015) reported 528 vascular plant species in the mangrove forest of Bangladesh including 345 herbs, 89 shrubs and 94 trees species. Within 356 genera and 111 families, only 24 species were true

mangrove species, the remainder were mangrove associates. *Heritiera fomes* (Sundari) is the main tree species which occurs on 73% of the total forest land (Rahman and Asaduzzaman, 2013). Some of the other plant species are *Excoecaria agallocha* (gewa), *Ceriops decandra* (goran), *Sonneratia apetala* (kewra), *Abutilon indicum* (golpata), *Barringtonia racemose* (hijol) and *Albizia procera* (koroi). Most of these plant species are found in the oligohaline zone of forest margins which have great economic value to the stakeholders within the SIZ. Eleven threatened plant species are known to occur within the Sundarbans (Rahman et al., 2015). The Sundarbans is also rich in faunal diversity. Officially, 453 animal species have been recorded (Anon, 2001) including 49 mammals, 8 reptiles, 53 amphibians, and 315 species of avifauna (Gopal and Chauhan, 2006). The Sundarbans is also the home of various wild animals, notably the world-famous Royal Bengal Tiger (*Panthera tigris*), crocodile (*Crocodylus porosus*), spotted deer (*Cervus axis*), wild boar (*Sus scrofa*), and several wild cats (*Felis bengalensis,* F. *chaus and* F. *viverrina*). (Rahman et al., 2015; Gopal and Chauhan, 2006). The rivers of the Sundarbans are abundant source of fish (53 pelagic and 124 demersal) (Sarker, 1989; Rainboth, 1991). In a detailed study on the fisheries of the Sundarbans, Islam and Haque (2004) reported the distribution of fish species according to the level of salinity. For example, *Pangasius pangasius* and *Lates calcarifer* are freshwater species whereas *Harpodon nehereus* is a saline water species. The most abundant species, *Hilsha ilisha*, occurs in moderate salinity (brackish water) (Islam and Haque, 2004).

Climate change is reported to have a great effect on the Sundarbans. Temperature has already increased more than 1^0C since 1880 (Nishat and Chowdhury, 2019). According

to Payo et al. (2016), the Sundarbans is also under the threat of sea level rise (SLR) because the elevation of the Sundarbans is approximately 2m above the mean sea level. The predicted global sea level rise will be approximately up to 0.98m or greater by 2100 relative to records between 1985-2005 (Church et al., 2013). According to the Intergovernmental Panel for Climate Change (IPCC), the sea level may rise up to 58 cm by the end of the century which, along with increased salinity levels, will have serious implications for the coastal region of Bangladesh. It is anticipated that the distribution and composition of species will be affected due to changes in temperature and salinity gradients (e.g. shift of species to favorable saline/temperature gradients), and to changes in phenology and genetics. Such changes could result in the disappearance of species or lead to evolution of new species (Abdullah et al., 2016). A number of workers report the Sundarbans has already started showing climate changing effects. Several low saline tolerant tree species such as Sundri (*Heritierra fomes*), Shingra (*Cynometra ramiflora*), Passur (*Xylocarpus granatum*) are decreasing, while more salt tolerant species like Goran (*Ceriops roxburgii*), Gewa (*Excoecaria agallocha*), Kewra (*Sonneratia apetala*), and Kankra *(Bruguiera gymnorhiza*) are occupying the spaces (Islam et al., 2019; Nishat and Chowdhury, 2019; Mondal, 2017; Payo et al., 2016). From 1959 to 1969, the growing stock of Sundari and Gewa trees has declined by 50% and 67% respectively (Choudhury, Abdullah, and Hossain, 2011). In addition, a noticeable change has been found in faunal composition (Haque et al., 2015). These trends indicate the mangrove ecosystem is under stress from natural factors. Climate change impacts (some of which are human-induced) are difficult to quantify but variations in floral and faunal composition, loss of biodiversity, and habitat loss, may be exacerbated by projected changes in climate.

As mentioned above, the Sundarbans is also very important for carbon stocking. Rahman et al., (2015) revealed that the carbon stock varied significantly within different salinity zones and vegetation types.

2.1.3.3 Socio-economic and cultural condition of people surrounding Sundarbans

Mangroves represent a unique ecosystem that supports surrounding local communities economically (Malik et al., 2015). The SIZ is 15,352 square kilometers which is 10.4% of the total country land that accommodates about 8.5 million people. Roughly, 3.5 million people of SIZ are fully or partially dependent on the Sundarbans. For example, the mangrove resource supports commercial fishing and shellfish enterprises (Roy, 2016). Gopal and Chauhan (2006) reported that, among commercially exploitable groups, 24 species were shrimps, 7 species were crabs and 8 species were mollusks. Besides water resources, local inhabitants collect honey, beeswax, golpata (*Nipa fruticans*), fodder, and firewood from the forest. The local people use these resources in two ways: by selling the product in local markets and by consuming it for their own livelihood (Getzner and Islam, 2013). In the SIZ, the main income generating sources are small enterprises depending on the raw products of the Sundarbans. Activities range from woodlots, agricultural farms, and shrimp farms (gher), and include products such as honey and fuelwood, all of which support the local and national economy. Residents of the SIZ face many livelihood challenges including poor economic structure, lack of fresh water, lack of energy and fuel supply, irregularity of fund allocations, corruption, poor marketing services and risks of life and property (Mozumder, Shamsuzzaman, Rashed-Un-Nabi and Karim, 2018). Moreover, lack of education, employment and alternate income generating sectors, illegal

settlements, political issues, robberies and poor management cause duress. Ultimately, for many residents these factors impose a greater dependency on the natural resources of the Sundarbans (Getzner and Islam, 2013). In turn, human activities in the SIZ are having deleterious effects on the natural beauty and ecological integrity of the mangrove forest. The mangrove forest is also worthy for its spiritual and recreational value to local people. The unique ecosystem provides opportunities for manifestations of cultural, aesthetic and religious beliefs (Abdullah, 2014). The Hindu community surrounding the forest pray to goddess 'Bonbibi' (the lady of forest) before entering into the forest. The community also takes part in a religious festival '*Rash mela'* in the forest of Sundarbans. In recent times, students also visit the Sundarbans for excursion and experiments (Islam and Hossain, 2017).

2.1.3.4 Relationship of humans with the biota of the Sundarbans

The local community has a complex relationship with the diverse ecosystems of the Sundarbans. It is a place of livelihood and well-being and therefore appears to have high economic, aesthetic and environmental value to most villagers. It is recognized that while the mangrove forest may meet the livelihood demand of the local community, it may suffer degradation and impact as a result of utilization (Rivera-Monroy et al., 2017). Similarly, the beauty of the Sundarbans also attracts many tourists which in itself can cause disturbances of natural habitat. Government has been managing the Sundarbans for more than one-hundred years. Though different management plans and policies have evolved to manage the forest, it continues to pose management challenges and is showing signs of degradation (Iftekhar and Islam, 2004). Given that all humanly used resources are

embedded in complex, social-ecological systems (SESs) characterized by resilience, adaptability and transformability (Holling 1973; Walker et al., 2004; Ostrom (2009), it is imperative that efforts be made to consider a systems approach to future analysis and assessment of the Sundarbans. Therefore, the relation of human beings with the mangrove forest can best be described as a 'Social-Ecological System' (SES) which introduces ecological services over conventional knowledge (Berkes and Folke, 1994). In a developing country like Bangladesh, the SES approach offers opportunity for both livelihood and sustainable management of the forest. Indeed, Mozumder (2018) posits that resilience thinking is the root of sustainable management of the forest resources. Resilience thinking allows the integration of different concepts to manage the resources in a sustainable way. Thus, conservation of the elements of nature is the primary objective of resilience thinking. Strategies for sustainability must take many forms - there is no "one size fits all" approach. It is on this basis that novel frameworks are needed to address the many complexities and interactions inherent in SESs. A noteworthy example within the Sundarbans is the conflict between humans and the endangered Royal Bengal tiger (*Panthera tigris tigris* L). In the Sundarbans, the highest predator Royal Bengal Tiger is threatened by extinction (Inskip et al., 2014). Paradoxically, the tiger presents a challenging management problem. On the one hand, it may act as a 'natural protector' of the forest resource, given that some individuals are reluctant to enter and exploit the forest being afraid of the tiger. Given its role as a protector and given its inherent value, management efforts should be made to conserve the species. On the other hand, management is complicated given the desire of some locals to hunt the tiger to near extinction and by the continuing depletion of its habitat (Loucks et al., 2009).

2.2 Evolution and development of forest policy in Bangladesh

The history of forest policy in Bangladesh has received considerable attention in the literature, notably from Istiaque and Chhetri (2016), Mohammad (2013), Sadath and Krott (2012), Muhammad et al. (2008) and Iftekhar and Islam (2004). Valuable reviews of policy trends are provided by Alam (2009), Choudhury (2008), Millat-E-Mustafa (2002) and others. In addition, ITTO (2017), Abdullah (2014), Jashimuddin and Inoue (2012), Getzner and Islam (2013), Mukul (2007), Iftekhar and Islam (2004) provide overviews of forest management practices and strategies. More specifically, Roy et al., (2013) discuss property rights and their relevance to sustainability of the Sundarbans. The Bangladesh National Forest Policy (1994) (GOB, 1994) and the National Forest Policy (Draft) (2016) describe the evolution and development of forest policy in Bangladesh (GOB, 2016). The following provides a historical forest sector context for Bangladesh.

2.2.1 Maurya period (321-226 BC)

Evidence of a human-Sundarbans interaction, in the form of proto-urban settlements, date back to the Mauryan period. Pandit (2013) noted that from 321-226 BCE, the Mauryan Empire encompassed most of the Indian sub-continent and placed significant emphasis on management of forests classifying them based on their intended use. The Sundarbans were included in the forest area managed by the empire. Writing about 300 BCE, Chanakya, traditionally identified as Kauṭilya, authored the Arthashastra*,* an ancient Indian political treatise, to advise of king Chandragupta Maurya on matters of politics and strategy. Under the rule of the king, a superintendent (called as kupadhyaksha) was employed for the management of forest resources. Under the supervision of the kupadhyaksha, forest

guards carried out their duties according to the law (Kamal et al., 1999). This period represents the first formulation of official forest policy in the Indian sub-continent (Iftekhar and Islam, 2004). The forest was classified into three categories- reserve forests which were sub-categorized as reserve forest for the king and reserve forests for the state, forests for the brahmins (highest caste in Hinduism) and public forests. The reserve forest for the king was used for hunting purposes. Under the Maurya empire, setting fire in the forest, and trapping of birds and animals were recognized as offences (Millat-e-Mustafa, 2002).

2.2.2 Gupta period (320-673 AD)

Following the Maurya period, the empire was ruled by Kushans and then succeeded by Guptas. During this period, the forestry sector was a main source of revenue for the state; however, land was also reallocated to agriculture. Employees were appointed for the management of the forest resources and revenue collection (Millat-e-Mustafa, 2002). In this period, different administrative rules and regulations were developed by the forestry sector (Iftekhar and Islam, 2004; Millat-e-Mustafa, 2002). However, Pandit (2013) argued that the management system of the Maurya period was not followed during the Gupta Dynasty, when extensive tracts of land were cleared and converted into agricultural land.

After Guptas, Indo-Bangladesh was subdivided into states and forestry management was the responsibility of the respective states. During this period (800-1400), the forestry lands were mainly used for providing timber, natural fibers and medicinal herbs (Millat-e-Mustafa, 2002). It is also noteworthy that throughout this period, the effects of over-harvesting of timber, conversion of forests to alternative land uses (agriculture) and the

impact of feudal battles in the form of fire and tree felling for defense together contributed to widespread forest destruction.

2.2.3 Mughal period (1526-1700)

In this period, the states were unified and administrated centrally by Mughal emperor. Forestry lands had been turned into agricultural lands in this period. During the Mughal period, the forests were reserved for timber and hunting purposes. Dhaka based ship-building industry had been developed depending on timber from Chittagong Hill Tracts (Millat-e-Mustafa, 2002).

2.2.4 British period (1757-1947)

In 1864, the systematic management of forest resources has been started (Jashimuddin and Inoue, 2012). In 1865, the forest law was enacted (FD, 2015). The first British forest policy was enacted in 1894 (Jashimuddin and Inoue, 2012; Alam, 2009). The main objective of this policy was revenue generation and maximum exploitation for ship building and railway sleepers production (Mohammad, 2013). The Sundarbans was classified as 'production forest' by this rule and the main forest management was to manage the *Heritiera fomes* according to diameter (Iftekhar and Islam, 2004a). In the British period, Sir William Schanlich was appointed as the forest conservator of Bengal (Jashimuddin and Inoue, 2014; Millat-e-Mustafa, 2002).

2.2.5 Pakistan period (1947-1971)

After petition in 1947, Bangladesh was recognized as East Pakistan and the Chittagong Hill Tracts, forests of Dhaka, the Sundarbans and a small part of Assam were under the supervision of East Pakistan (Millat-e-Mustafa, 2002). In 1955, Pakistan enacted a rule

emphasizing the conservation of habitat and wildlife which has been changed to commercial purposes in 1962 (Ishtiaque and Chhetri, 2016). Timber based industries like the Khulna newsprint mill, Khulna hardboard mill were established to ensure maximum use of resources from the Sundarbans (e.g. *H. fomes*) (Iftekhar and Islam, 2004b).

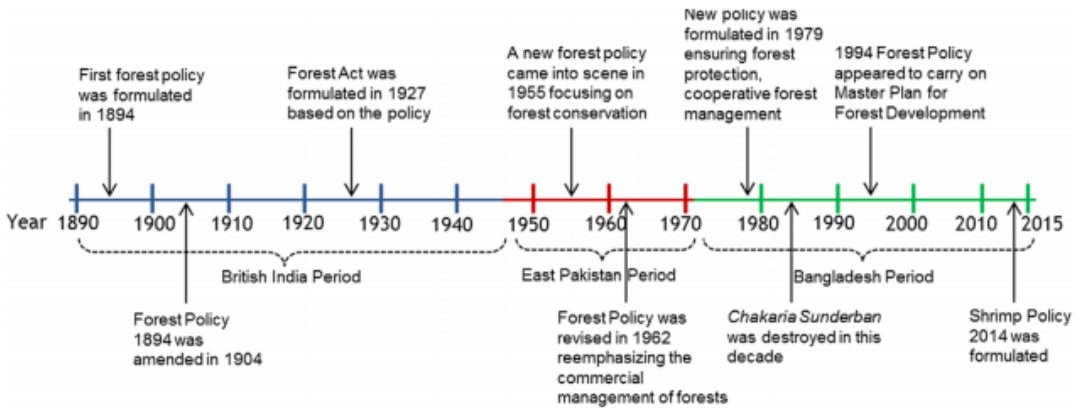

Figure 4. Evolution of forest policy of Bangladesh (Adapted from: Ishtiaque and Chhetri, 2016)

2.2.6 Evolution of Bangladesh forest policy (1971-present)

The Bangladeshi period of forest policy started with limited harvesting of timber on specific species and familiarized participatory approach. Followed by the independence of Bangladesh in 1971, a new concept was adopted by the government as “Forestry for all”. The government of Bangladesh imposed new rules that fallow lands and village groves were under the coverage of tree plantation (Mohammad, 2013) which lead to the first national forest policy of Bangladesh in 1979 (Gazette Notification No. 1/For-1/77/345, 8 July 1979) (Ishtiaque and Chhetri, 2016; Jashimuddin and Inoue, 2014; Iftekhar and Islam, 2004b). The aim of the first policy was ‘careful preservation’ and ‘scientific management’ for ‘qualitative improvement ’ of forest resources (Mohammad, 2013). No clear distinction

between ‘preservation’ and ‘conservation’ was provided by Mohammad, however conservation of forests for environmental purposes received priority over commercial exploitation (Ishtiaque and Chhetri, 2016). The policy also encourages education and research on forestry. Unfortunately, the policy lacks proper guidelines, and contains few ‘generalized and somewhat vague directions’ (Alam, 2009). The forest policy was revised in 1989 and more protective policy was recorded in 1994 by keeping the provision of punishments for offenders. In this policy revision, the forest department of Bangladesh gave special attention to biological diversity and protected areas. The 1994 forest policy also emphasizes horizontal expansion of the forest sector by considering fallow lands, embarkments, railway tracks and roadsides. For the first time, this policy introduced the concept of ‘social forestry’ which encourages the participation of local communities (GOB, 2016). In Bangladesh, the concept of social forestry aims at ensuring economic, ecological, and social benefits to citizens, most notably to the rural masses and those living below the poverty line. Despite this progress, the policy failed to significantly address the climate change effects on forestry. However, the policy did seek opportunities to encourage forest research. Unfortunately, corruption of forest officers, competing policies, lack of collaboration between government and NGO’s, continue to be threats to the forest sectors (Alam, 2009; Choudhury, 2008).

> The main aim of the policy is to manage all existing forests, wildlife and other forestry resources, adhering to the principles of sustainable management and climate resilience; enrich degraded forest areas; and enhance land areas under

> forest/tree cover; to produce a wide array of goods and ecosystem services for the benefit of Bangladesh's present and future generations. (GOB, 2016b, p. 3)

Significantly, the national forest policy (draft) (2016) introduced climate change activities focusing on conservation of the forest (Appendix 2).

2.3 Present forest management practices in Bangladesh

The BFD is responsible for the management of forests in Bangladesh. The forest policy (1994) had 'strong language' (Ishtiaque and Chhetri, 2016) but Food and Agriculture Organization (FAO), (1998) found that improvements were needed at the operational level. According to FAO (1998), the eco-friendly management of natural forests and wildlife conservation have been neglected. One positive step taken by the government in 2003 was to reduce the dependency of communities on the forest resource by introducing 'alternative income generating activities.' The current forest policy draft (2016) is more encouraging and attempts have been made to overcome past policy weakness. The aim of present forest management practices has been changed from 'sustained yield' to 'sustainable and integrated management' (Rahman, 2017). The policy focuses on climate change issues, more participation of stakeholders, sustainability of the forest, and natural resource management, rather than on timber production (yield) of the forests. To achieve the sustainability of forest resources, the Bangladesh government has implemented a system of 'Criteria and Indicators' introduced by the ITTO (International Tropical Timber Organization) in 1990. As such, ecosystem services get priority over revenue generation. Afforestation, including coastal plantation, is also a priority of the government. Furthermore, the FD has taken a 'two-tier system of co-management' which is constituted

by the members of different groups (FD, 2017). As well, the government gives special consideration to the management of protected areas. Rahman (2017) reported that the mangrove forest is getting special focus by the FD. For example, recent forestry related policy and legislation helps the FD to improve the forestry of Bangladesh in a sustainable way (Table 3). The Bangladesh government also collaborates closely with international organizations. Indeed, the 'UN-REDD+ Programme (United Nations Collaborative Initiative on Reducing Emissions from Deforestation and Forest Degradation [REDD+])' supports the BFD technically and financially (FD, 2017).

Although there have been several laws and pieces of legislation enacted to protect the mangroves, it is apparent that serious shortcomings in policy still exist. For example, as noted by Ishtiaque and Chhetri (2016), the national shrimp policy (2014), aims to (i) increase shrimp production through planned shrimp culture, considering economic, social, and environmental development, geographical location, climate-change feasibility, along with inventing environment and eco-friendly technology, (ii) maintain environmental balance, biodiversity conservation, and public health in shrimp-culture areas, (iii) shrimp production and sustainable management, (iv) establish shrimp-culture infrastructures ensuring environmental balance. Ishtiaque and Chhetri (2016) noted that sometimes ill-minded political leaders and the corrupt officials may take advantages of these shortcomings. Currently, there are many forest related plans and projects under the auspices of the FD and NGO's (FD, 2017b). Rahman (2017) points out a number of management limitations associated with policy implementation, including gaps between management plans within the forest department and other ministries, demographic pressure

on forest land, developing new laws without assessment of the old plans, and conflicts between international and national plans.

Table 3. The forest related acts, legislation, and laws in Bangladesh

Act/Rule	**Issue**
Bangladesh Wildlife preservation Act, 1973 (P.O. 23 of 1973)	Legal protection of wildlife
Environmental Conservation Act, 1995 (ECA 1995)	Conservation and improvement of the environment, and control and mitigation of environmental pollution
Social Forestry Rules, 2010	Complete rules regulating social forestry in Bangladesh
Section 12 of the Constitution (Fifteenth Amendment) Act, 2011 (Act XIV of 2011)	Provide safeguards of the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens
Forest Produce Transit (control) Rules, 2011	To regulate transit of forest produce all over Bangladesh
Wildlife (Protection and Safety) Act, 2012 (Act No. 30 of 2012)	provide legal protection of forests and wildlife
The Bangladesh Biological Diversity Act, 2012	An act to regulate conservation of biological diversity and their sustainable use
The Sawmill Rules, 2012	Laws regulating the setup, operation and control of sawmills

Source: Rahman, 2017; Jashimuddin, 2012 and Alam, 2009.

Chapter 3 Conceptual Framework

3.1 Sustainable livelihood approach

The Sustainable livelihood approach (SLA) was introduced by Robert Chambers and Gordon Conway in 1991. It is recognized as one of the most promising development concepts by researchers and NGO's such as the United Nation's Development Programme (UNDP), Department for International Development (DFID), as well as Care and Oxfam (Knutsson, 2006; Chambers and Conway, 1991).

SLA, as an integrated concept, is recognized as one of the best-suited frameworks to facilitate the development of rural communities. Mohammed (2006) and Castro (2002) contend that research on community development requires attention to the complex relationship between human and natural resources. This relationship is based on the interaction between five types of capital: human, natural, financial, social and physical, which makes development and satisfaction of basic human needs possible. In this regard, DFID has developed the Sustainable Livelihoods Framework (SLF) (Figure 5) to understand the livelihood of poor people and to analyze existing livelihood policy. Like other frameworks, it is a simplified concept, which does not offer an exact illustration of the reality but stimulates a way of thinking about the livelihood of deprived people. The aim of this framework is to alleviate poverty and promote the sustainability of livelihoods among unprivileged people by promoting basic needs (DFID, 1999). Both quantitative and qualitative data within the framework provide opportunity to better understand the lifestyle of local people (UNDP, 2017).

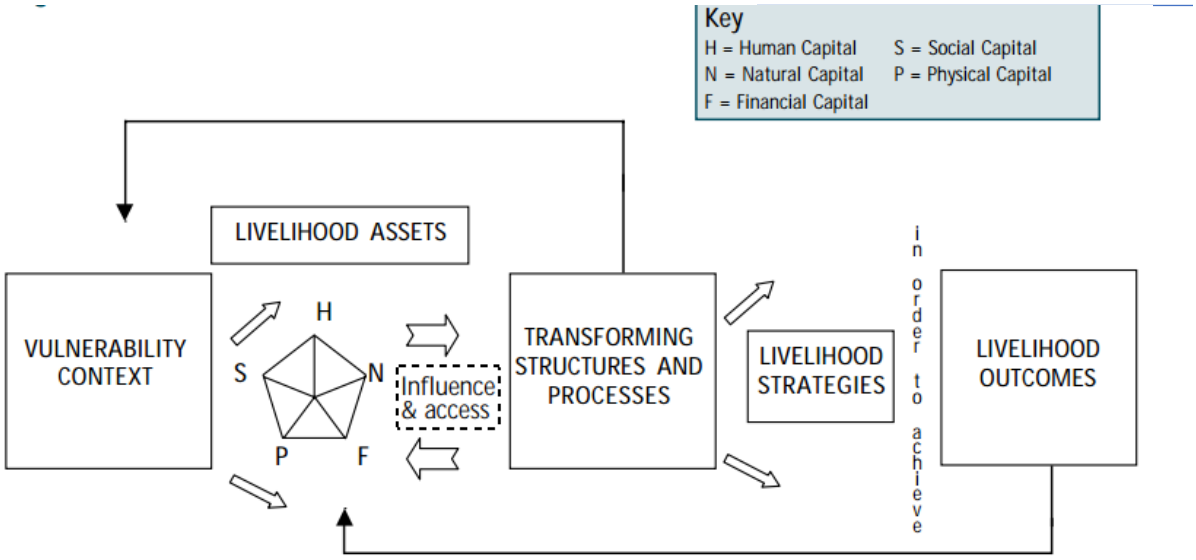

Figure 5. Sustainable livelihoods framework (Adapted from DFID, 1999)

To ensure sustainable management of mangrove forests, it is important to understand the livelihood of the local people. Moreover, participation of local people is considered as one of the best ways to conserve natural resources. Presently, policy makers encourage collaborative and participatory methods as a means to promote integrated resource management. A wide variety of participatory approaches exist (Van der Eijk, 2014; Badola et al., 2012) to increase stakeholder participation in decision making. Participation by local stakeholders is considered of prime importance given that these individuals are the primary users of the resources. In this regard, the diversified practice of SLF can be conceptualized for mangrove management.

3.2 Property rights in natural resource management

Attitudes of local communities towards the use and management of resources is a key determinant in the success or failure of any conservation project (Badola et al., 2012).

Studies on ‘attitudes’ reflect the needs and aspirations of local communities in terms of their ideas, values and opinions on management and conservation issues (Roy, 2016). Vo et al. (2012) argues that management and conservation of natural resources are highly dependent on environmental protection and on the economy of the local people. Policies implemented by governments and consequences of decisions are the main factors regulating the management and conservation of natural resources (Oudenhoven et al., 2015). For example, in a case study of the Mahakam Delta in Indonesia, Baten (2009) argues that insufficient policy responses relating to mangrove conservation, combined with the lack of property rights, are important reasons for the decline and loss of mangroves. Unclear or ill-defined property rights are also responsible for the mismanagement of common resources, often referred to as Hardin’s ‘tragedy of the commons’ (Hardin, 1968). Accordingly, appropriate property rights on the commons, as well as monetary valuation of ecosystem services, may strongly influence local people in the co-management of natural resources (Roy et al., 2013; Kuenzer et al., 2012; Coleman, 2011). Schlager and Ostrom (1992) developed a typology for property rights to adopt the management activities by the government and the local people collectively. Schlager and Ostrom (1992) classified four categories as*:* authorized user, claimant, proprietor and owner. Under this typology, the authorized users have access and withdrawal rights. With those rights, a claimant enjoys management rights. The proprietors also have the right to decide who will access the resources and how can this right be transferred to others. The owners have the ultimate right to sell, exploit or manage the property (Roy et al., 2013). This well-defined property rights framework may help decision makers to achieve their goals towards sustainable

management and conservation of mangrove forests, where co-management by government and local people can be the key to success.

3.3 Assessing the linkage between livelihoods and biodiversity conservation

In the early 1990s, conservationists started to develop new approaches that matched the financial needs of local people with the need for conservation. These methodologies influence the link between different livelihood activities of communities and biodiversity conservation (Salafsky and Wollenberg, 2000; Western, Wright and Strum, 1994). In this regard, different well-designed strategies have been studied for successful conservation activities. To assess the linkage between livelihood and conservation activities, Salafsky and Wollenberg (2000) described a framework depending on the experience of the six years project of the BCN (Biodiversity Conservation Network). BCN was established to conserve the biodiversity sites across Asia and the Pacific. BCN works on the effectiveness of community-based conservation strategies to ensure the economic benefit of the local people. Salafsky and Wollenberg (2000) developed three approaches for describing the linkages between conservation and livelihood activities: a. no linkage b. indirect linkage and c. direct linkage (Figure 6). However, each of the approaches has advantages and disadvantages.

a. No Linkage between Conservation and Livelihood Activities: Protected areas represent a model where no linkage exists between conservation and livelihood activities. To conserve biodiversity, the state or government of a country may declare a central area (reserve) protected by a border to exclude everyone except authorized personnel (Figure 6 a). However, sometimes it is hard to define the area

for lack of proper incentives and legal systems: lack of efficient people, lack of financial incentives, lack of proper instruments, remote areas and in the deep ocean (Rao and Geisler, 1990). Considering the limitations of protected areas, for a few decades, ecologists started to involve community people with the conservation activities. For example, the government of Tanzania started allowing limited rights to local users of the natural resources surrounding parks or protected areas (Wells and Brandon, 1992).

b. Indirect Linkage between Conservation and Livelihood Activities: In some countries, in order to limit access and usage of the protected areas, the practitioners offer policy instruments such as economic incentives within the buffer zone of core areas (Figure 6 b). The aim is to meet the livelihood activities of the local people while still protecting the core area. For example, to decrease the dependency on biodiversity, conservationists sometimes offer alternative financial activities to decrease harvesting of resources in protected areas. However, this policy instrument does not always significantly decrease the risk of increasing pressure on the core reserve (Salafsky and Wollenberg, 2000).

c. Direct Linkage between Conservation and Livelihood Activities: The third model involving a direct linkage between livelihood activities and conservation is a comparatively modern model (Salafsky et al., 1999). This model allows local people to be dependent on the natural resources. Community stakeholders get

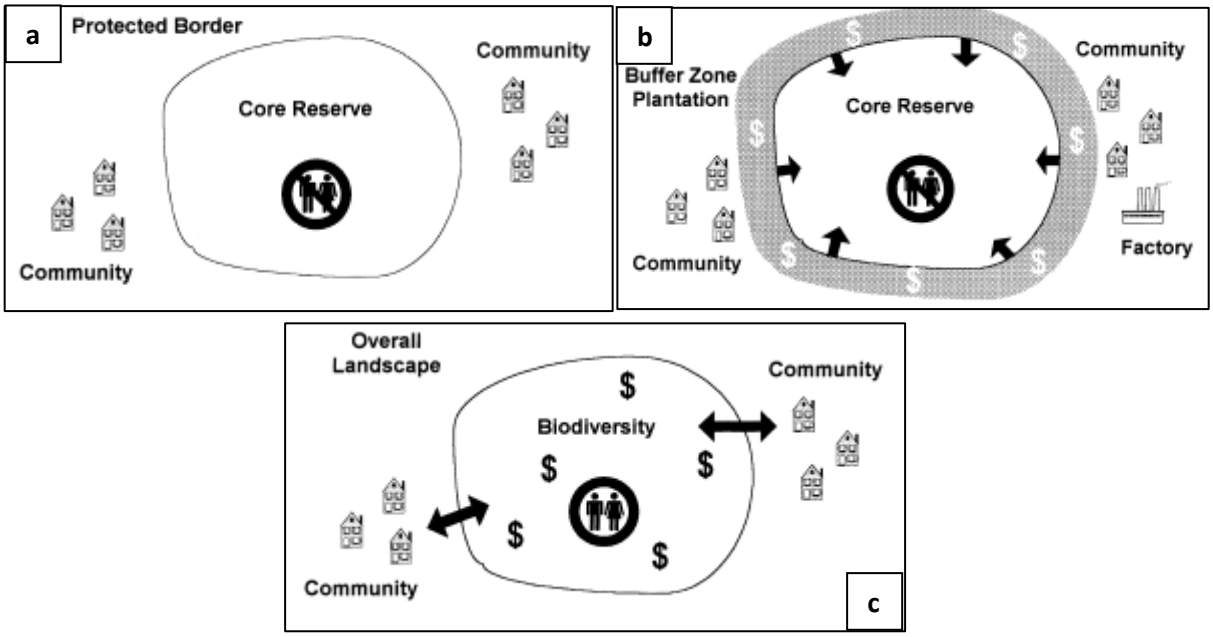

Figure 6. A trend towards linking conservation and livelihood. a) No linkage: Protected area strategy b) Indirect linkage: Economic substitution strategy; c) Direct linkage: Linked intensive strategy. (Adapted from BCN 1997 and Salafsky, 1998)

opportunities to derive resources and at the same time perform some duties in maintaining biodiversity (Figure 6c). Depending on the location and livelihood activities of the stakeholders, the practitioners decide the suitable management (stewardship) approach for any given ecological region (Salafsky and Wollenberg, 2000).

Salafsky and Wollenberg (2000) have subsequently produced a generalized model for conservation projects (Figure 7), where it is assumed that biodiversity activities are affected by anthropogenic activities. This framework describes indirect threats caused by human interventionwhich is further subdivided into internal and external direct threats. Overexploitation of natural resources is an example of internal direct threat and construction of roads, pollution from factory are the examples of external threats. To

mitigate these threats, the previously described three approaches (no linkage, indirect and direct linkage between conservation and livelihood) can be considered for different biodiversity areas according to the suitability of the approaches of that region (Salafsky and Wollenberg, 2000).

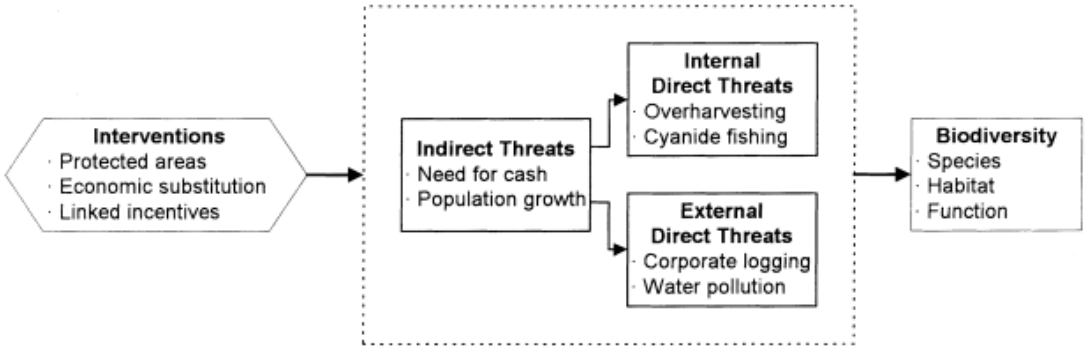

Figure 7. A general model of conservation project. Note: Rectangles indicate condition of the project site. Hexagons indicate interventions by the project team. (Adapted from Salafsky and Margoluis, 1999)

3.4 Community-Based Mangrove Forest Management (CBMFM)

Similar to the theoretical models presented by Salafsky and Margoluis (1999), the CBMFM is a people-oriented mangrove management concept that benefits both community people and the environment. The direct resource users play an important role in the process of mangrove management (Aheto et al., 2016). Different studies (Aheto et al., 2016; ELAN, 2011) have revealed that mangrove resources can be sustainably managed if '*customary rules'* can be imposed at a local level. Customary rules refer to as a result of these customary rules, the new rights and opportunities motivate local people to get involved with new responsibilities that results in conservation activities (ELAN, 2011).

3.5 Proposed conceptual framework for mangrove management

Taking into account the conservation models noted above, and a people-oriented approach, this thesis presents five key ideas as a means to strengthen conservation of mangrove forests: a. International initiatives, b. State government policies and NGO's, c. Local communities, d. Benefits, and e. Threats and vulnerabilities (Figure 8). The framework attempts to identify linkages and feedbacks among factors that influence decision-making in support of mangrove conservation. It will be argued that guidelines required to effectively manage mangroves must take into account the interactions and dependencies implicit in the proposed framework.

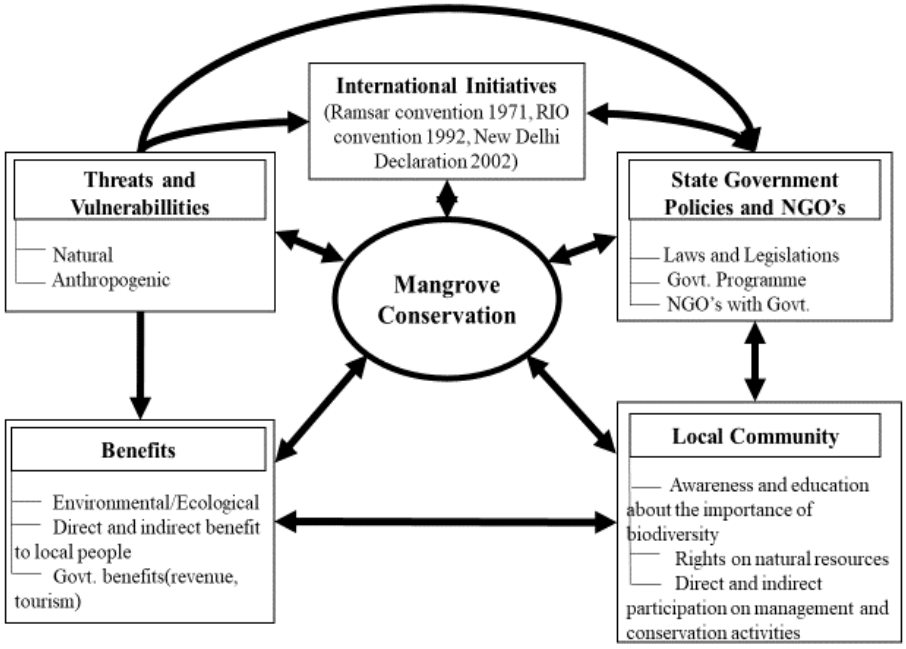

Figure 8. Proposed conceptual framework for mangrove conservation

a. **International initiatives:** For the betterment of humankind, world leaders periodically participate in international initiatives as a means of achieving a common (global) vision to address conservation issues, including the loss of biodiversity. Through discourse and consensus building, delegates seek solutions to address the degradation of natural systems. Over the last decades, several conferences linked directly and indirectly to conservation provide a basis for assessment, response, and strategic approaches to conservation, including the formulation of future policy regimes. These include: Ramsar Convention (1971), Rio Conference (1992), Kyoto Protocol (1997), New Delhi declaration (2002), Copenhagen Climate Conference (2009), United Nations Climate Change Conference at Durban (2011), Doha Amendment (2012), the 3rd International workshop for conservation genetics of mangrove (2016), and the International conference on sustainable mangrove ecosystem (2017) (Korhola, 2014; ITTO, 2017). Considering the importance of mangrove forest, in 2016 UNESCO declared 26th July of each year as the "International day for the conservation of mangrove ecosystem" (UNESCO, 2016). In 2017, world leaders joined an international conference on sustainable mangrove ecosystem in Bali, Indonesia. The objective of the conference was to "identify ways in which mangrove restoration and sustainable management could contribute to the achievement of Sustainable Development Goals 13, 14 and 15 and the Paris Agreement on climate change" (ITTO, 2017, p.3). The representatives of different countries shared their views on sustainable mangrove management while they focused on livelihood of resource dependent communities, adaptation and mitigation of climate change, strengthening good

governance, laws and policies, payment method for environmental services and increasing research and awareness (ITTO, 2017; Islam, 2014).

b. **State government policies and NGO's:** Regarding the outcomes of international initiatives, state governments are encouraged to incorporate recommendations into their existing national and regional policies and to set appropriate goals to promote conservation. For example, recommendations to sustain mangrove forest have emerged from several international fora, most notably, from the International conference on sustainable mangrove ecosystems at Bali, Indonesia; the key message was 'prioritizing the conservation and sustainable management and use of mangrove ecosystems in national policies, laws and regulations at all levels of government, and strengthen law enforcement to reduce the continuing loss and degradation of mangrove ecosystem'(ITTO, 2017, p.53). The conference also focuses on land-use planning, effective mangrove restoration, financing mechanisms and generating and disseminating of knowledge. In most countries government forest policy guides the mangrove forest management activities. In Bangladesh the guidelines for mangrove forest management lie under the national forest policy which is largely designed to alleviate poverty by involving NGO's and local stakeholders by enhancing biodiversity management activities (GOB, 2016b).

c. **Local community:** Toit (2002) argued that success or failure of natural resource conservation highly depends on local people. Conservationists are particularly concerned with the rights of local people to the commons and therefore often focus their research on strategies to involve the resource users (stakeholders) into

environmental services (e.g. guard of the common resources, replanting etc.) (Roy, 2016). Providing economic support to community people for conservation activities is one of the means to improve mangrove management (ITTO, 2017). Moreover, education and awareness of citizens about sustainable mangrove management, helps defined property rights and responsibilities of stakeholders on commons.

d. **Benefits:** Both government and local people benefit from conservation activities. In many developing countries a sustainable forest could be the most promising economic resource for forest dependent people. State governments, like those in Bangladesh, are also aware they get more revenue from a well-managed forest. In both economic and ecological terms, the benefits of a mangrove forest are many: timber, fuel, value-added products, carbon sequestration, water filtration and protection of coastal communities from natural hazards. Indeed, mangrove forests are noteworthy for biodiversity richness and productivity given their abundant and unique flora and fauna that span both terrestrial and aquatic environments (Mazumder et al., 2018; UNESCO, 2016; Alam, 2009). On the other hand, the local community would increase their benefit by preserving the forest resources: maintaining proper rules and regulations, prohibiting overexploitation and illegal approach, helping in management programme and increasing awareness about conservation activities.

e. **Threats and vulnerabilities:** Mangroves are facing two major types of threats: natural and anthropogenic. Naturally, the plants of mangrove forests are sometimes affected by diseases or destroyed by natural hazards. For example, during the last 30 years the Sundari trees of Sundarbans are disappearing due to top-dying diseases

and salinity (The Daily Star, 2018; Mondal, 2017). The forest also fought the cyclone Sidr in 2007 and Aila in 2009. Globally, the mangrove forests are facing threats because of overexploitation, establishment of infrastructures around the buffer zone, fisheries or other economic activities. Deforestation due to agricultural activities remains a major anthropogenic cause for mangrove degradation (Ghosh et al., 2015). These kinds of threats and vulnerabilities have serious negative impacts and reduce benefits to local communities (Valiela et at., 2001). By assessing threats and vulnerabilities state governments could incorporate guidelines in their forest policies while international organizations could better assist in developing and implementing state policy.

Potential threat for the Sundarbans: Bangladesh is planning to implement a 1320 MW coal-based power station only 14 km away from the border of the Sundarbans (Banktrack, 2019) and within the SIZ. Typically, a 500MW power plant produces 125,000 tons of ash and 193,000 tons of sludge each year which contains elements of toxic chemicals (Chowdhury, 2017). Moreover, the process of producing electricity in a coal-based power plant is deleterious to the surrounding biodiversity. The plant produces electricity by burning coal to produce water-steam which under tremendous pressure turns turbine(s) to generate electricity. To bring the coal to the power plant a river channel will be used which poses a hazard to aquatic life and creates traffic in the riverways. Moreover, untreated air (there is no air treatment plant in the design) produced by the power plant will contain nitrogen and sulphur gases (NO_2 and SO_2) which contribute to acid rain. Failure of proper disposal of waste products from the power plant could potentially pose threats to water, air and

soil and be a risk to residents. Finally, noise produced by the power plant might add a further disturbance or risk to biodiversity (Chowdhury, 2017; SAHR, 2015). UNESCO has described the situation as a 'potential threat' for the Sundarbans (UNESCO, 2017).

Herein, the proposed framework for conservation of mangrove forests represents a unified model of conservation by linking those points discussed above (a, b, c, d and e). It can be argued that as world leaders continue their efforts to solve global problems and produce guidelines and targets for consideration by state governments, it is critical that all countries, including Bangladesh, take into account principles of sustainability, with particular emphasis on SESs and the concepts of resilience, adaptability and transformability. Taking into account issues of sovereignty and national priority, Bangladesh must also agree to binding and nonbinding international agreements, and at multiple levels (national, regional, district) to try to fulfill their commitments by involving local stakeholders in decision-making and local conservation management activities.

Charter 4 Methodology

4.1 Rationale for method selection

To provide a complete and wide-ranging understanding of the research questions, a mixed methodology approach is used encompassing both qualitative and quantitative methods. , described the necessity of a mixed method as "….in a study that is primarily qualitative, there is some aspect of the study that can be measured quantitatively, and the measurement will enhance our descriptive understanding of the phenomenon" (p. 91). The exploratory design of mixed method research approach supports to generalize the results of different samples to understand better the attitude of the people in a selected area. Nightingale (2003) and Pratt (2009) also support this argument. Schutt (2006) suggested that the goal of exploratory design is "to learn 'what is going on here' and to investigate social phenomena without explicit expectation" (p. 23).

Willig (2016) argued that "Qualitative research is an approach to research that is primarily concerned with studying the nature, quality, and meaning of human experience. It asks questions about how people make sense of their experiences, how people talk about what has happened to them and others, and how people experience, manage, and negotiate situations they find themselves in" (para. 1). In qualitative research, a researcher experiences the personal views of an individual as a part of collective experience of the group (Willig, 2016). A qualitative method is "used to describe an approach to research than stresses; 'quality' not 'quantity', that is, social meanings rather than the collection of numerate statistical data" (Brewer, 2003, para. 1). To fulfill the aim of the research a survey

questionnaire was designed where an open-ended questionnaire serves the qualitative purpose followed by close-ended quantitative questions. Different sections of the questionnaire were used to survey the attitudes of villagers on property rights, policy, and management of the Sundarbans.

4.2 Study Area

The Sundarbans is located at the south-western geographical corner of Bangladesh (Figure 9). There are three wildlife Sanctuaries in Sundarbans- south wildlife sanctuaries, east wildlife sanctuaries and west wildlife sanctuaries - which cover 139700 ha area of land. These sanctuaries are recognized as protected areas and the core area for the diversity of flora and fauna. The Bay of Bengal is situated at the south of the Sundarbans while the western part the forest extends to India. The eastern and northern part of the Sundarbans are bounded by different agricultural lands and shrimp farms (Abdullah, 2014). This mangrove forest is interconnected by numerous rivers and was recognized as a Ramsar wetland site in 1992. UNESCO declared 139700 ha (13%) of this diversified mangrove forest as World Heritage site in 1997 (Ishtiaque and Chhetri, 2016; Abdullah, 2014).

The Sundarbans is situated at the southern part of Satkhira, Khulna and Bagerhat districts (FD, 2015). Around 3.5 million people in 17 subdistricts live within the buffer zone of the Sundarbans known as Sundarbans Impact Zone (SIZ). These local people are highly dependent on the Sundarbans for their livelihood. They collect resources both from forestland and waterways (Islam, 2011). Local people are called bawali (wood cutters), mowali (honey collectors), jele (fishermen), chunery (snail and oyster collectors) and golpata (*Nipa frutican*) collectors (Roy et al., 2013; Islam, 2011).

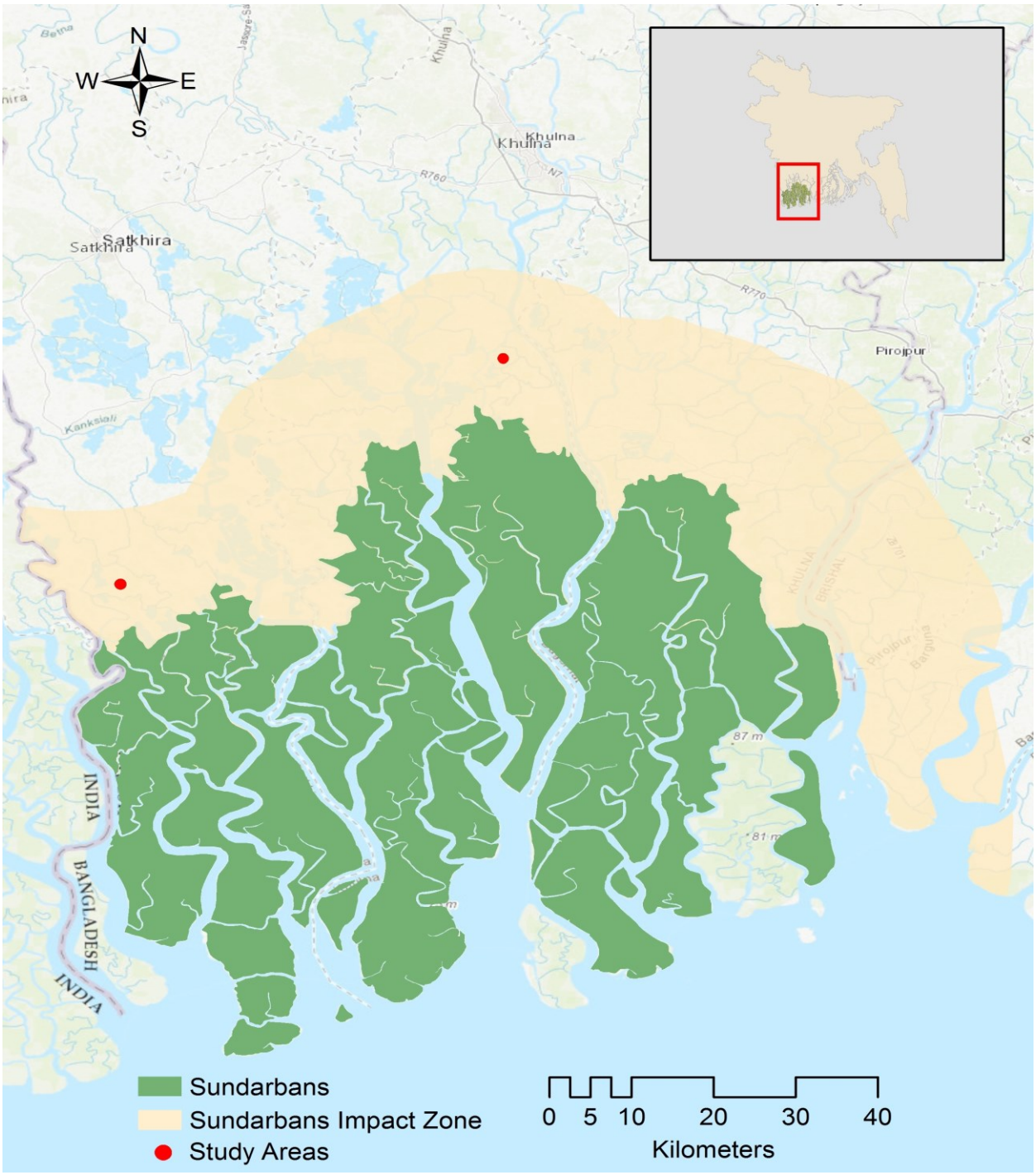

Figure 9. Map of the Sundarbans area (Bangladesh part), SIZ and study areas

Within Bangladesh, there are eight geographical divisions. Each division is subdivided into a number of districts and subdistricts. The latter are further divided into unions with their concomitant villages. This study focuses on the districts of Khulna and Satkhira, both of which are located within the Khulna Division. Among 14 subdistricts of the Khulna district, Dacope district was selected based on proximity to the SIZ and on accessibility to the researcher. There are nine unions in the Dacope subdistrict, however only five were within the SIZ, and therefore met the selection criteria for the study. Each village was assigned a unique number and placed in a jar. Following mixing, two numbers (unions), Laudove and Pankhali, were randomly selected without replacement. Among the seven villages located in Laudove union, two villages, Harintana and Khutakhali, were selected using the method described above. In Pankhali union with its 18 villages, two villages, Katabunia and Moukhali were selected as described above.

In the Satkhira District, this study focused on Munshigong union, 1 of 12 unions within the Shyamnagar subdistrict. Two villages, Harinagar and Dhankhali, were selected from 20 villages of Munshigong union using the methods described above.

4.3 Data Collection

A survey questionnaire was prepared to collect data from the six villages noted above: Harintana, Khutakhali, Katabunia, Moukhali, Harinagar and Dhankhali. The questionnaire was designed to meet the specific objectives of the research initiative (Appendix 1). Besides demographic information, the survey examined the attitudes of villagers on the

issues of management, access to the resource, conservation, education levels, property size and rights and on their relationship with the Sundarbans. These data were then used to identify pressing policy issues and to assess how policy might be improved. Three collaborators from Bangladesh helped this researcher gather data. These individuals were working with different NGO's located near the Sundarbans and had valuable experience in survey work. The data collection process began with a discussion of the questionnaire with the collaborators. Collection of data started from the center of the villages. Data were collected from the head of the household because they are likely the resource collectors (Roy, 2014). Sixty samples were prepared from the villages. Data were collected from mid-July to August.

4.4 Data Analysis

After collecting data, all hardcopies were compiled and entered into an excel spreadsheet. The quantitative data were analyzed using Microsoft Excel software. Descriptive statistics were compiled in tabular and graphic forms to examine data trends. Qualitative data were analyzed by selecting key words of the respondent's answers to generate categories (Creswell, 2013). To fulfill the objectives of this study, six categories were generated based on the views of the respondents. The categories are described below:

1. **Demographic information of respondents:** According to Lee and Schulee (2010) "Demographic information provides data regarding research participants and is necessary for the determination of whether the individuals in a particular study are a representative sample of the target population for generalization purposes" (p. 2). Demographic information of a region reflects the overall quantifiable

characteristics of a population. Analysis of demographic data offers insight into the social status of a population which reflects their thinking and attitudes towards life and surroundings. This study deals with six demographic trends including age of the respondents, educational qualifications, employment and sources of income, family size, land size, and access and frequency of entry into the mangrove forest. Close-ended questions were developed to survey the trends. Demographic data from the questionnaire were analyzed by using Excel and presented as percentage data in tabular format and in pie chart.

2. **Attitudes of the respondents to the resources of the Sundarbans:** Demographic and socio-economic characteristics often dominate attitudes towards livelihood and resources. In this study, the relationship of the respondents with the Sundarbans was evaluated by survey questionnaires. Close-ended questions were designed for the survey. Responses of the respondents were analyzed using Excel and presented in percentage data using graphical chart. Views of the respondents towards sustainable management of the forests were evaluated by the survey.
3. **Current status of the mangrove forest:** Attitudes toward the current status of the mangrove forest were measured with specific questions directed to management practices. Open-ended questions and a Likert Scale ranging from 1-10 were developed to examine respondent's views on the forest resource. The average scoring of the respondents to the respective variables were presented by using the Likert Scale. Mangrove spatial-temporal change impacts of recent cyclones and attitudes of respondents on the status of the Sundarbans were studied to evaluate the present situation of the Sundarbans Reserve Forest (SRF) and SIZ.

4. **Economic value of the Sundarbans:** The unique characteristics of the Sundarbans make them economically valuable to users. Stakeholders derive significant income from both terrestrial and aquatic resources within the mangrove resource. Attitudes of stakeholders on the economic value was assessed using a Likert Scale. The respondents were asked their opinions on government revenue, employment opportunities in the Sundarbans, value of resources, negative impact of agriculture and fish farming on the forest, and the role of natural resources. Thus, the study aimed to assess how the participants value the resources of the mangrove forests.
5. **Property rights of the Sundarbans:** According to Ostrom, (2000)

> A property right is an enforceable authority to undertake particular actions in specific domains. The rights of access, withdrawal, management, exclusion and alienation can be separately assigned to different individuals as well as being viewed as a cumulative scale moving from the minimal right of access through possessing full ownership rights. All of these rights may be held by single individuals or by collectivities (p. 332).

Local people holding government permits have certain rights to access the resources from the SRF (Roy, 2016). An open-ended questionnaire examined their opinions on the rights to the resources of the Sundarbans and was summarized as percentage data. This study gathered views on privatization of property rights, advantages and disadvantages of privatization of property rights and queried whether privatization would help to improve management.

6. **Present forest policy and management of the Sundarbans:** To assess the level of participation in management decision-making, specific questions were included in the survey to explore if respondents had any voice in forest planning and/or management. Open ended questions were developed to find out their views on current policy and management and results were tabulated as percentage data.

4.5 Ethical Considerations

This thesis involves human participants which requires ethical consideration. The questionnaire was ethically approved by the Grenfell Campus Research Ethics Board (GC-REB). To ensure the privacy of the respondents, there was no option for the respondents to include their name on the questionnaire. There was no physical, psychological or financial risk for the respondents. The participation in the questionnaire was completely voluntary. A respondent could skip any questions if s/he did not want to answer the question or could leave the interview at any time. A consent form was provided to each participant for this purpose (Appendix 1). The collected data will be preserved for at least five years in a secured file as per Memorial University's policy, then it will be destroyed.

4.6 Limitations of the study

Sample size dictates the amount of information collected and therefore, in part, determines the precision or level of confidence derived from sample estimates. As such, increasing the sample size can give greater power to detect differences in responses. Although biasness and error of a study can be reduced by increasing sample size (Taherdoost, 2017), they also cost more time and money. In this study, sample size was limited by resources; future

studies may help expand the geographical scope and sample size. Moreover, a few respondents did not feel free to answer a number of demographic questions (e.g. income). This reluctance to disclose information further limits the database. Further, because of the short period available to conduct the survey, data were collected during one point in time. Repetition of the surveys would further elucidate many of the issues addressed in the study. Finally, the survey data for this study were collected during the monsoon period in Bangladesh. In some instances, it was a challenge to reach the respective stakeholders because some areas in the SIZ were flooded.

Chapter 5 Results and Discussion

The proposed theoretical framework was used to guide the collection and analysis of qualitative data and to assist in exploring the relationships among those elements within the proposed model. As such, the framework acted as an analytical tool with several variations and contexts. Further, it was used to make conceptual distinctions and organize ideas. Strong conceptual frameworks capture something real and often do this in a way that is easy to remember and apply.

Findings of this study are presented and discussed under the following sections: (1) Demographic information of respondents, (2) Attitudes of the respondents to the resources of the Sundarbans, (3) Current status of the mangrove forest, (4) Economic value of the Sundarbans, (5) Property rights of the Sundarbans, (6) Forest policy and participatory governance of the Sundarbans.

5.1 Demographic information of respondents

Demographic information collected from respondents reflects the socio-economic condition of individuals and their family unit. In this study, selected characteristic such as age, educational qualification, employment, annual income, sources of income, size of family and size of lands allow for inferences concerning the villagers' socio-economic condition.

5.1.1 Age of the respondents

Quality of survey work significantly depends on the age of the respondent (Andrews and Herzog, 1986). The data provided in Table 4 offer an age profile of the respondents

indicating that young, middle age and older individuals form the basis for most attitudes reported in the survey. By design, survey responses were limited to individuals who serve as the head of the households, as it was assumed that the members who usually serve as decision-makers within the family unit putatively contribute more to sustainable forest management practices. Because the head of the family (usually men) has decision making power in the family, they also exert a degree of influence on community decision-making. Such individuals have considerable experience in extracting a livelihood from the Sundarbans and have operated under various management regimes and policy guidelines for extended periods. Therefore, with respect to the role of the Sundarbans in providing adequate livelihood, it can be expected that the knowledge base of most respondents is high. However, as discussed below, there are many constraints such as education and income that may limit sustainable practices.

Table 4. Distribution of the respondents according to their age

Category (age)	**Number (n=60)**	**Percentage (%)**
Young (up to 30)	8	13.33
Middle aged (30-50)	38	63.33
Old (>50)	14	23.34

5.1.2 Educational qualification

Education is an important prerequisite to meeting the many challenges surrounding ecosystem sustainability. Vare and Scott (2007) pointed out the strong relationship between education and sustainable development. In this study, the educational qualification of the respondents was categorized on a scale ranging from illiterate to those with a university

degree. The distribution of respondents according to their educational qualification is shown in Table 5. Given that most respondents (80%) have a level of literacy, there is high potential that many are aware, or are in a position to become more aware, of sustainability issues and to better understand and contribute to mangrove forest policy and management. However, among those literate respondents, only 48.33% of the respondents had a primary level of education and fewer (18.33%) had secondary education. Very few of the respondents had a post-secondary degree. In a similar study, Abdullah (2014) reported that the head of households in the Sundarbans region had on average 3.7 years of schooling. This study also supports findings by Sarkar and Bhattacharya (2003) who emphasized education as a means to reduce dependency of farmers on the mangrove forest and to manage it sustainably. Similarly, Badola et al. (2012) who studied the Indian Sundarbans mentioned the importance of education for engaging people in conservation and sustainable management activities. These works are also supported by Getzner and Islam (2013) and Roy et al. (2013). Paradoxically, Roy (2014) also noted that education may negatively affect the conservation of natural resources because an educated workforce knows the pros and cons of conservation activities better than illiterate people and may easily find loopholes in existing policy. That is, to increase their income, they might practice illegal ways to exploit more resources and use loopholes to protect themselves. Despite Roy's findings, there is general agreement in the literature (Vare and Scott, 2007; Sarkar and Bhattacharya, 2003; Wals and Jickling, 2002) that education is seen as central to economic competitiveness, the reduction of poverty and inequality, and environmental sustainability.

Table 5. Educational qualification of the respondents

Category (grade)	Number (n=60)	Percentage (%)
Illiterate	12	20
Primary (1-5)	29	48.33
Secondary (6-10)	11	18.33
College (11-12)	6	10
University degree (>12)	2	3.34

5.1.3 Employment and sources of income of the respondents

The employment of subjects in this study varied within three major categories: (i) employed for wages, (ii) self-employed and (iii) part time or seasonal worker. The status of employment for each category of workers is shown in Table 6. Results indicate that 60% of the respondents are involved with part time or seasonal work (collecting fishes, honey, crabs, golpata (*Nipa frutican*). Those employed for wages worked as day laborers on agriculture fields, shrimp farms (gher), fishing boats, or in the boat making industry, and others were self-employed. It is significant that some workers in the Sundarbans find it necessary to participate in multiple jobs. A day laborer might collect honey seasonally (April to June) from the forest and also occasionally participate in the collection of fish. Indeed, rather few (31.67%) of the respondents have full time or permanent jobs usually as self-employed work in agricultural, shrimp farms or wood based small industries (like boat making). Most respondents in this study derived their sources of income directly from the Sundarbans (Table 7). Fewer have government and NGO positions within the SIZ. The annual family income of the respondents ranged from US $700 - $4550 (1 USD = 84.48 [Bangladesh Taka] BDT) and the average income for 60 respondents was US$1138 which

is below the national average income (US$1466) (GOB, 2016; The Daily Star, 2016) in Bangladesh. In a livelihood study on the Sundarbans, Abdullah et al. (2016) found the annual family income of US$1122 which is similar to findings reported herein. In 2019, the Gross Domestic Product (GDP) per capita was US$ 1827 in Bangladesh. The poverty line is estimated by the availability of food for the family. Among many developing countries there is evidence that poor and underprivileged people live adjacent to forest resources (Isbell et al., 2017; Langat et al., 2016). In a study in China, Hogarth et al. (2013) also found that the poor income groups were more reliant on forest income than relatively rich households, due to lack of alternative income sources. Despite the reliance of many poor people on the forest resource, Mondal (2017) reported a negative impact on conservation activities. This suggests a serious lack of concern for forest sustainability and calls for policies that protect and sustain valuable forest resources. This finding has particular relevance for the Sundarbans, because many forest dependent people live their life at or below the poverty line and can barely meet their minimum demands.

Table 6. Distribution of the respondents according to their occupation

Category	**Number (n=60)**	**Percentage (%)**
Employed for wages	23	38.33
Self-employed	14	23.33
Part time/seasonal worker	36	60.00
Government Officials	4	6.67
NGO worker	1	1.67

Table 7. Sources of income of the respondents

Category	Number (n=60)	Percentage (%)
Agricultural activities	8	13.33
Employment (Government/ Non-Government)	5	8.33
Day labor	16	26.67
Collect fish and crab from rivers of Sundarbans and sell in local market	49	81.67
Selling Non-Timber Product (honey, golpata, etc.) in local market	7	11.67

5.1.4 Family size

The family size of the respondents was categorized as nuclear, joint, or extended family. A nuclear family represents a family consisting of parents and their unmarried children whereas a joint family represents a number of siblings and their wives and unmarried children living together. An extended family means parents with children, grandparents and/or other relatives. The distribution of respondents according to their family size is shown in Table 8. Data indicate that 76.67% of the respondents had a small sized or nuclear family while only 18.33% of respondents were classified as an extended family. Surprisingly, very few joint families were found in the study area. The results in this study reflect data reported in 2011 by the Bangladesh Bureau of Statistics (BBS) indicating the family size in SIZ ranged from 3.8-4.24, a figure below the national average (4.44). While the reasons for this may be multiple, one reason proposed for the lower family size is that

many people in the SIZ are killed by wild animals. Chakrabarti (1984) noted that estuarine tigers of Sundarbans are popularly called “inherent man-eaters” having a high degree of cunningness. They may take a heavy toll of human lives. Moreover, in the event of such tragedies, the widow of most of the victims are often considered a curse to the family and is sometimes disowned by the family. However, in some circumstances, the widow may remarry and make a new family with her new husband and young children (Abdullah, 2014). Thus, the family unit increases and the unit may again find their means of livelihood in the forest by fishing, collecting firewood or other NTPs (Non-timber forest products). Tracing the demographic and socio-economic profiles of households and their interactions with the Sundarbans is beyond the scope of this study, however it is apparent that family size places demands on resource use and should be considered in any long-term management regime for mangrove forests.

Table 8. Distribution of the respondents according to their family size

Category	**Number (n=60)**	**Percentage (%)**
Nuclear family	46	76.67
Extended family	11	18.33
Joint family	3	5

5.1.5 Land size

Costanza et al. (2014) and other researchers commonly consider livelihood capitals to include natural, human, financial, physical and social capital. In practice, these interact to influence how and when resources are accessed. For example, Bhandari (2013) contends that the size of cultivated land and livestock ownership are paramount in influencing the

livelihood activities of forest dependent people. Natural capital (e.g., land area) significantly increases access to resources and therefore production potential and livelihoods are inherently linked to land ownership. In the case of the Sundarbans, landlessness is particularly associated with a greater dependency on the mangrove forests. The size of land owned by respondents in the study area varied from landless (>0.02 ha) to large (<3 ha). Based on their land size, respondents were classified into 5 categories as presented in Table 9.

Table 9. Distribution of the respondents according to their land size

Category	Number (n=60)	Percentage (%)
Landless (<0.02 ha)	29	48.33
Marginal (0.02-0.2 ha)	16	26.67
Small (0.21-1.0 ha)	11	18.33
Medium (1.01-3.0 ha)	3	5
Large (>3 ha)	1	1.67

These data disclosed that the majority (48.33%) of the respondents were landless as compared to marginal (26.67%), small (18.33%), medium (5%) and large (1.67%) land holders. Islam et al. (2018) reported that climate change and natural disasters like cyclones are mainly responsible for significant number of landless people around the Sundarbans. During natural disasters, dwellers may lose their house, agricultural land or shrimp farms and consequently many migrate from the Sundarbans. However, most landless people stay on the embarkment of rivers and remain highly dependent on the Sundarbans for their livelihood (Kibria et al., 2018). Abdullah et al. (2016) provide an excellent review of the

value of mangrove resources to local communities adjoining the Sundarbans in Bangladesh. These workers note the important role of mangroves in the local economy, particularly in poverty alleviation. Santiphop et al. (2011) reported that land size, either owned or rented, significantly and consistently influences the livelihood of marginalized people around natural ecosystems. Thus, it can be anticipated that nearly 50% of stakeholders in this study will remain highly dependent on the Sundarbans because little opportunity exits to develop alternate enterprises. The findings of this research also highlight two major constraints associated with stakeholder livelihoods, notably access to provisioning services (PS) and frequency of use, both of which are influenced by policies underpinning property rights as well as economic policies. PS, as used herein, represent material benefits, a type of ecological service described by Kibria et al. (2018).

5.1.6 Access and frequency of entry into the mangrove forests

In Bangladesh, Sundarbans mangrove forest and water bodies are controlled by the state government. Traditionally, the right of access to Sundarbans is through membership in village communities dominated by the local elites. These rights are not formally regulated but are considered the birthright of the community. Results from this study confirm the high dependence of locals on the mangrove forests. Indeed, most people surrounding the Sundarbans require access to the forest for their livelihood. Findings (Figure 10) indicate that 47% of the respondents think they have adequate accessibility to the Sundarbans. However, 35% and 18% of respondents stated that they lacked adequate access or had no access, respectively.

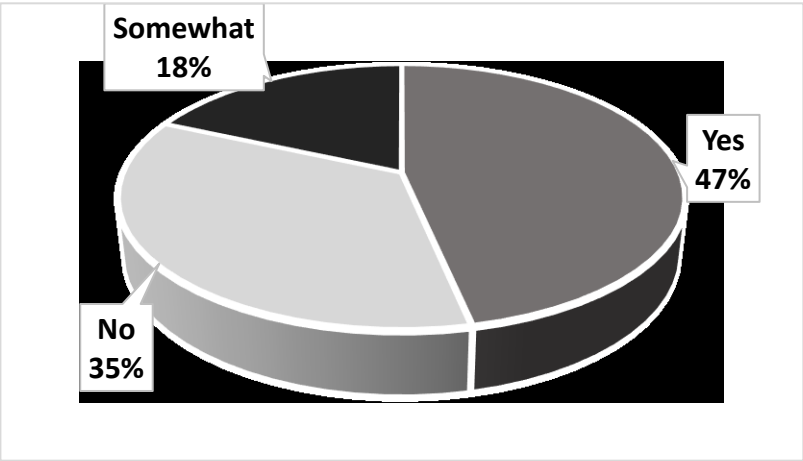

Figure 10: Access to the Sundarbans

Regulation of accessibility of the local people to the common Sundarbans property is very difficult because local people contend that they have a traditional right to use the property. Moreover, within local communities, accessibility is controlled by political and elite leaders. Indeed, political power may assist special or higher interest groups to allow greater access to the resource.

Numerous reports suggest that discrimination of rights based on gender, financial condition of the resource collectors, or offers of political support are familiar phenomena at play in getting access to common property. For example, corruption is claimed to be a major constraint to successful implementation of many of the stated mangrove conservation practices in the SMF (Islam and Wahab, 2005). Understandably, malpractice or corruption represent a threat to the sustainability of the Sundarbans, given it can undermine fairness, and ultimately the participatory process itself, thereby compromising conservation efforts. Roy et al. (2013) bring attention to corruption within government and note that it was

assumed that wider community participation in the planning and decision-making process would prevent corruption in the BFD. However, these workers further note that the BFD has maintained a conservation policy which excluded Forest Dependent Community (FDCs) from management and policy formulation. For those respondents who gain access to the Sundarbans, 70% of them enter into the forest weekly while 23.33% of the respondents enter into the forest biweekly (Figure 11). The local people frequently enter into the Sundarbans because they are fully/partially dependent for their fuelwood and fish on the mangroves. In addition, government officials enter into the forest for management purposes, while tourists and a few local people also use it for recreational purposes.

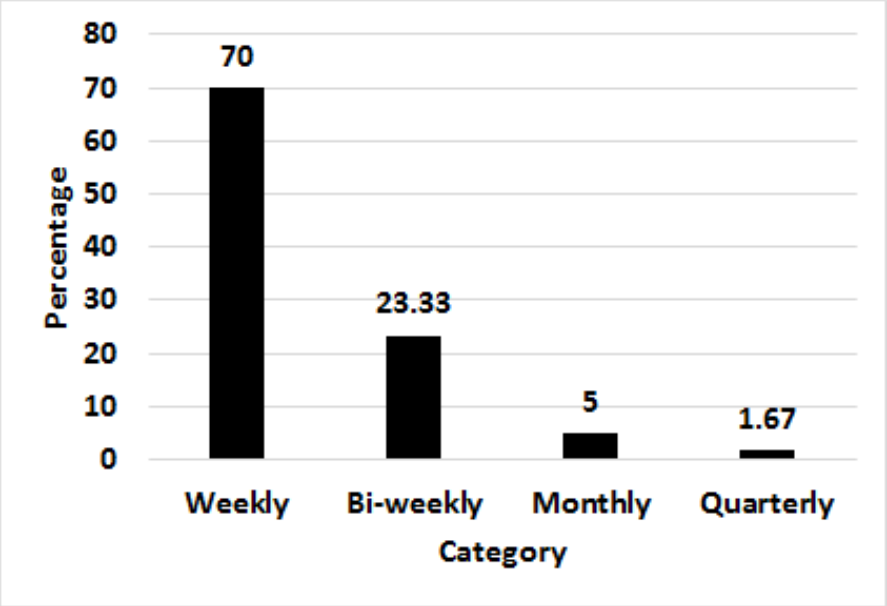

Figure 11: Frequency of respondents entering the mangroves

5.2 Attitudes of the Respondents to the Resources of the Sundarbans

To respond to the challenge of mangrove sustainability, it is important to know the attitudes and concerns of respondents about the resources of the Sundarbans and how they benefit from the forest. Similarly, it is important to promote participatory approaches to decision-making if the livelihood of local communities is to be secured. Ultimately, sustainable management of the Sundarbans is dependent on stakeholder's attitudes towards the forest resource and their involvement in the decision-making process. Khan (2001) noted that in an effort to expand and conserve Bangladesh's natural forests, the government of Bangladesh has recognized the need for developing adequate policy and framework planning, including appropriate institutional reforms to promote people's involvement in forest management and conservation. It can be argued that one prerequisite to successful management and to a sustainable future for residents of the Sundarbans (SIZ) is the need for them to recognize more fully the contribution of ecosystem services to their livelihood. Under the conceptual framework proposed in this thesis, there is a local community link that requires residents to have a significant appreciation of the benefits (value) of the Sundarbans. Moreover, stronger interactions with the government, NGOs and conservation efforts should elevate participation levels and ensure mangrove forest policies reflect the priorities and aspirations of local communities. Thus, the discussion below focuses on the relationship between residents and the Sundarbans. A measure of the attitudes and dependency of local communities on Sundarbans' natural resources is needed if mangrove forests are to stay high on the political agenda and if conservation strategies are to be developed in harmony with local livelihoods (Riddell, 2013).

5.2.1 Relationship of Respondents with the Sundarbans

To conserve the Sundarbans, it is necessary to assess, and where possible, improve the attitudes of stakeholders towards natural resources. Stakeholders who are closely associated with the forests are in the best position to understand the full value of the resource and to contribute to formulation of policies designed to effectively manage the forest. In the proposed conceptual framework for mangrove conservation (Figure 8), the local community is the interactive component that bridges benefits and government policy. This assumes that deliberative democratic processes are desirable and possible. An effective participatory approach in community-based management is thought to represent peoples' empowerment (Mathur, 1997). As Benhabib (1996) argues:

> According to the deliberative model of democracy, it is a necessary condition for attaining legitimacy and rationality with regard to collective decision making processes in a polity, that the institutions in this polity are so arranged that what is considered in the common interest of all results from processes of collective deliberation conducted rationally and fairly among free and equal individuals (p.69).

While it can be argued that democratic legitimacy is not necessarily related to the success of conservation policies, most respondents agree that for conservation success, local participation is desirable. In the case of Bangladesh, the historical record indicates local participation is weak or ineffective. It should therefore be strengthened. Despite weak participation, data from this study indicate very significant relationships between respondents and the Sundarbans. Among the 60 respondents, most (93.33%) were community members as the respondents were within the SIZ. The respondents were within

the range of 0.25 km to 5 km from the border of the forest. Most of the community members are dependent on the Sundarbans for their livelihood. In this study, 3.33% of the respondents worked in the wood-based industry. Findings (Figure 12) disclosed that 1.67%, 10% and 51.67% of the respondents are involved with hunting, honey and beeswax collection, and firewood collection, respectively. This study also found that 80% of the respondents collect fishes and crabs from the rivers of the Sundarbans.

Most of the respondents collect forest products either occasionally or professionally. In this study the collected products are categorized in four groups: firewood; honey and beeswax; fishes, crustaceans and mollusks; golpata. A significant number (81.67%) of local people collect fishes, crustaceans and mollusks from the water resources (figure 13) of the

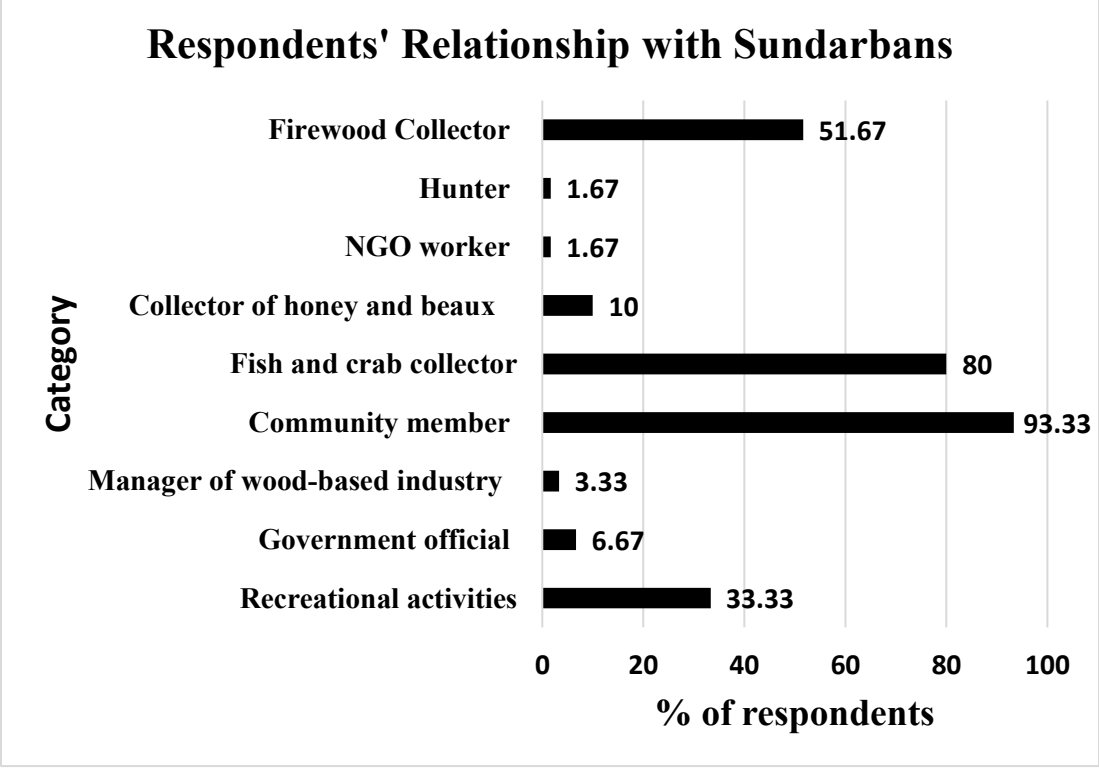

Figure 12: Relationship of respondents with the Sundarbans based on selected categories

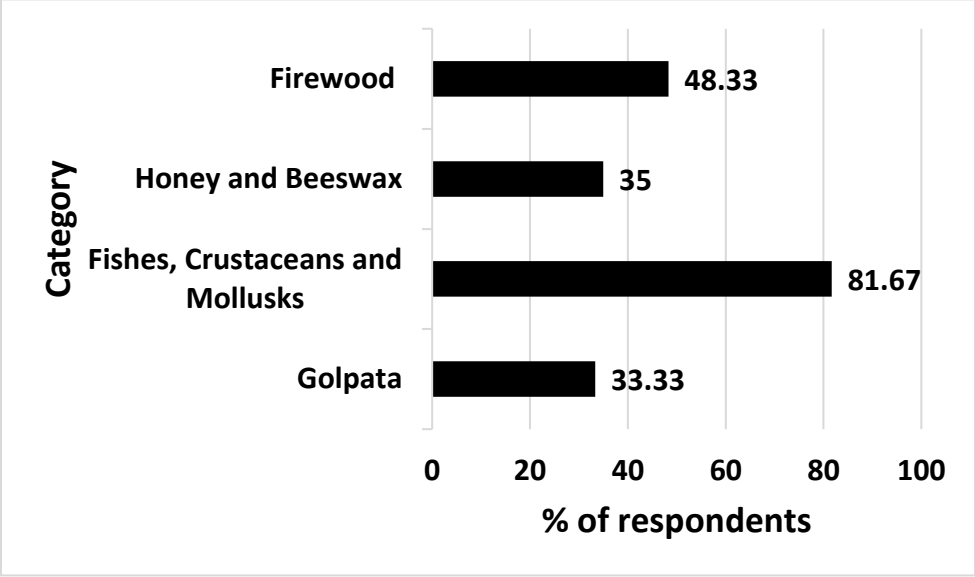

Figure 13: Types of collected natural resources from the Sundarbans

Sundarbans, which is similar (85%) to findings reported by Roy et al., (2013). Getzner and Islam (2013) also noted that most of the households (67%) in the Sundarbans collect fish resources followed by crab harvesting (14%) which supports the findings of this survey. However, this study also revealed that 33.33% of the respondents also collected golpata (*Nipa frutican*) from the forest.

Most (80%) of the local people use the harvested product for household consumption (figure 14). They use golpata (*Nipa frutican*) as a roof material of their house. Some of the NTP's (e.g. fish, honey) are used for consumption and medicinal purposes. A significant number (58.33%) of people use harvested products to generate income by selling the collected products in the local market. According to a respondent "We are completely dependent on Sundarbans for our livelihood. Day by day the resource collectors are

increasing and the availability of resources are decreasing". Given that the Sundarbans are highly productive wetlands characterized by halophytic mangrove forests, it is not surprising that Getzner and Islam (2013) found that the household consumption of fishes is much higher than honey and crab.

However, live crabs have a great export value. Because of higher consumer demands, crabs are exported in around 23 countries as Malaysia, Japan, China, and Korea (Islam and Hossain, 2017). To meet up the demand of protein, the households consume more fishes while honey collectors can earn cash from selling the honey because there is a special demand for honey from Sundarbans. Islam et al., (2018) indicated that about 50% of the produced honey of Bangladesh comes from Sundarbans.

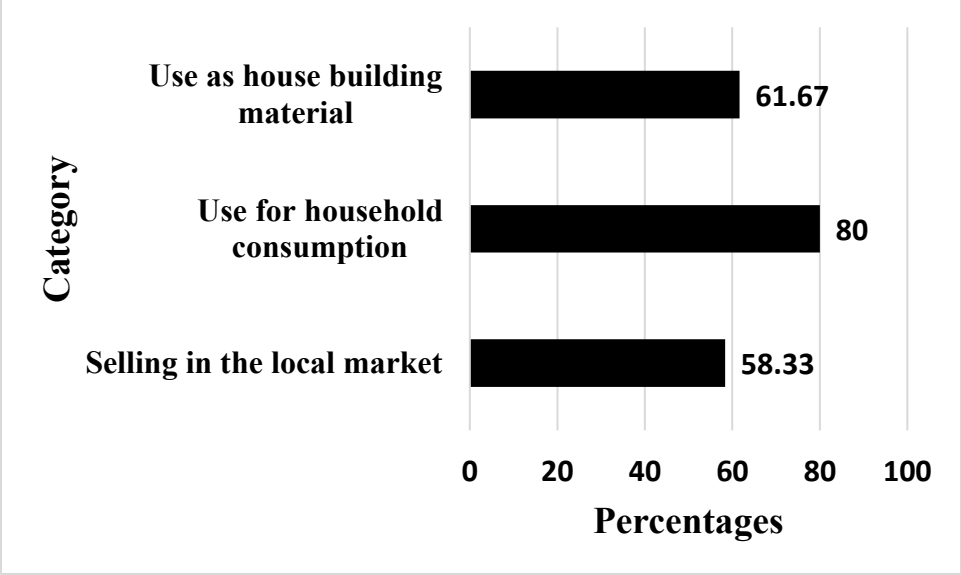

Figure 14: Use of collected products from the Sundarbans

In a recent study, Roy (2014) reported that 74% of the households surveyed were dependent on the mangrove forest for their livelihood. Roy (2016) also noted similar rates of participation in the collection of fishes and crabs from the rivers of the Sundarbans. Many residents within the SIZ collect golpata (*Nipa frutican*) illegally during fishing (Islam et al., 2018; Roy, 2014; Getzner and Islam, 2013). Few of them might have other full-time work (agriculture, shrimp farm) or business, but are still directly involved with the Sundarbans through hunting, collecting firewood and recreational activities. Other residents also collect crab and shrimp fry from fishermen or are involved in boat building, which means indirect involvement with the forest. Mondal (2017) found that resource collection depends on the population size and poverty level. He reported that 57% of the people in the SIZ collect fuel wood from the mangrove forest. Mozumder et al. (2018) reported that people closer to the Sundarbans collect more firewood than people relatively away from the border of the forest. As expected, in most instances poor people are more dependent on the forest than those considered wealthy (Mondal, 2017).

It is clear from this study and from works cited above that there is a strong relationship between local communities and the Sundarbans with its concomitant resources. Local communities depend on the resources for food, housebuilding material, fuels, and recreation. To meet their needs, local communities harvested resources from forest either legally or illegally. Consequently, sometimes they overexploit the resources, occasionally neglect government rules and regulations, and at times mistreat the ecosystem. Not surprisingly, there is also strong competition among users for limited resources. These types of practices and attitudes offer a real threat to the ecosystem and complicate efforts

to advance sustainable management of the Sundarbans. Therefore, it is essential that policymakers carefully consider stakeholders' attitudes towards sustainability in any decision-making approach.

The long-term thriving of mangrove forests in Bangladesh rests and will depend on effective policies needed to ensure sustainability. The current protection measures and management system show major deficiencies and it is unlikely that the ecological integrity inherent in the Sundarbans can be maintained over the long-term. The government of Bangladesh and the FD recognize the dependency of human populations on the Sundarbans for subsistence and livelihoods (UNESCO, 2011). Yet, the need to develop better relationships with local people in order to reduce illegal activities remains. Ideally, local people should be a part of planning and managerial activities. Local voices that can resonate with the BFD, and the Department of Environment would help set priorities and assist in the full implementation of an effective integrated management system. Unfortunately, most of the respondents (80%) in this study said they have no voice on the management policy of the Sundarbans (figure 15). Most contend that more local input into planning and decision-making is needed and that attention to traditional knowledge should be incorporated into current policy. Furthermore, more effort should be made to implement policy. The former will demand increased engagement between stakeholders and decision-makers; the latter requires increased resources and more formal assessment to ensure policies guidelines are followed.

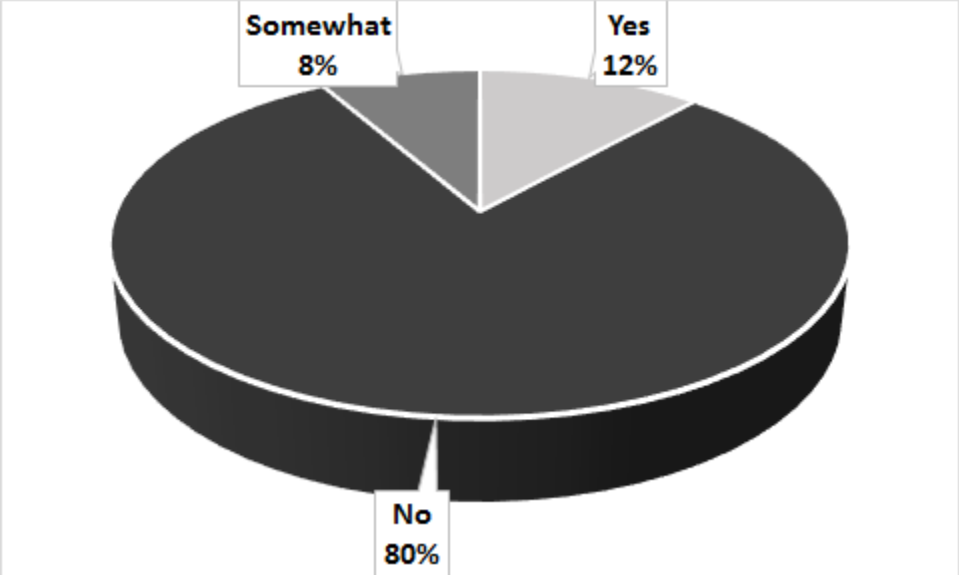

Figure 15: Attitude of respondents in the extent to which they have a voice on management policy of the Sundarbans.

5.2.2 Relationship between Sundarbans wildlife and villagers

Among the many complex relationships that exists between villagers and their mangrove environment, the interaction between villagers and wildlife is paramount. There exists a delicate balance between the inherent value of biota, especially larger wildlife species, and the need to avoid the risks to human lives. Almost all the respondents indicated they are aware of the risks of selected wildlife. According to a respondent, "We should not move to and from in the dark, should not keep our domestic animals in open places, and if we notice any wild animal anywhere in the village, immediately we should inform the forest office". Some of the respondents think they can, through teamwork, guard the villages. In particular, the villagers are afraid of wildlife such as tigers, crocodiles, snakes, and foxes. In the question related to conservation of the mangrove forest, the tiger drew most attention. Villagers are afraid of entering into the forest because of carnivorous tigers.

However, killing of the endangered tiger is also a threat to an endangered species (Goodrich et al., 2015). The human-tiger conflict is a common phenomenon in this region of Bangladesh. Similarly, in the Indian Sundarbans human-crocodile conflict is highlighted by Badola et al. (2012). Among the respondents, 85% know that there is some compensation by the government if they are injured or killed by the wild animals. Though the compensation is very small (Inskip, et al., 2014), poor villagers are compelled to collect natural resources to maintain their livelihood. From the demographics data of this study it is evident that the livelihood of the people surrounding Sundarbans is below the national standard. In this study, 86.67% of the respondents provided information about their income. A few of the respondents did not feel free to express their income. Legally and/or illegally, many in the SIZ benefit from the forest. In view of the high dependence of users of the resource and given that conservation is a pillar of sustainable management, policymakers of Bangladesh should give careful attention to future policy formulation as a means to conserve the Sundarbans.

5.2.3 Ranking of the Sundarbans as a resource

Despite current practices and the neglect of conservation efforts, 67% of the respondents ranked the mangrove forest extremely high as a resource in terms of economic, social and environmental benefits. Twenty-three% and 10% of the respondents ranked the Sundarbans as high and medium in value, respectively (figure 16). Significantly, no one ranked the mangrove forest as low in value which implies that the local people place high value on the mangrove forest as an asset. According to a respondent, “It is a resource from where I can collect fishes, crab, golpata, firewood, honey etc. and by selling them I can

earn money for livelihood". The ecosystem services of mangrove forests offer more potential than any other natural resources. Besides the ecosystem products (e.g. fish, timber, honey etc.) mangroves also serve regulatory functions such as water purification, erosion control, climate regulation, carbon sequestration and nutrient cycling (Barbier et al., 2011). The sustainability of the ecosystem depends to a large extent on biodiversity. Biodiversity, defined as a measure of variation at the genetic, species, and ecosystem levels, indicate a healthy ecosystem and therefore a more sustainable ecosystem. Healthy ecosystems can better deal with environmental pressures such as climate change, and in a long run will serve humankind and the environment in a sustainable way.

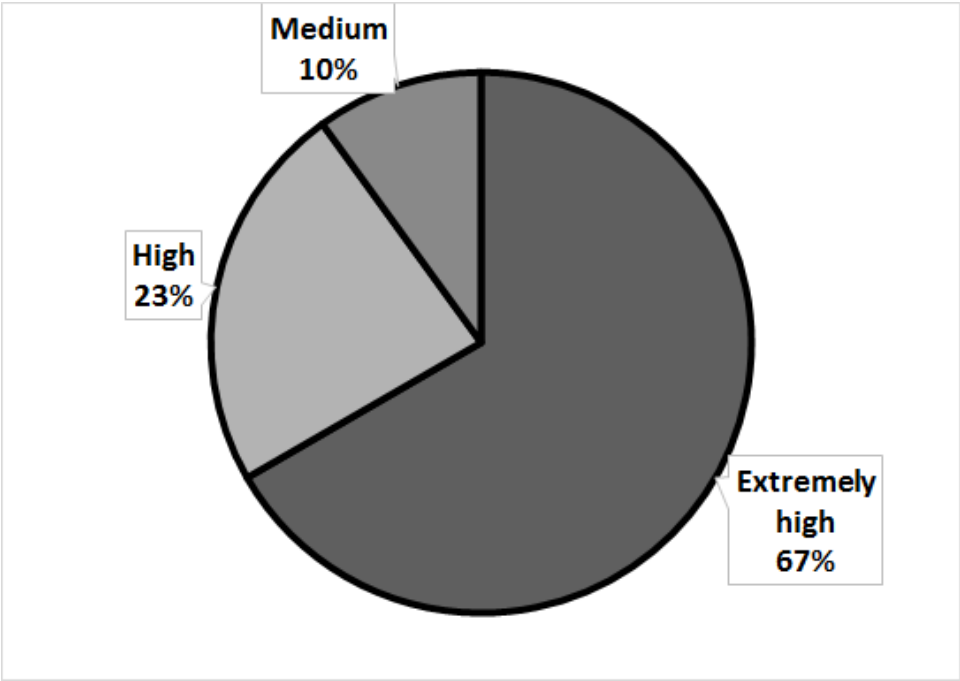

Figure 16: Ranking of Sundarbans as a resource

5.3 Current status of the mangrove forest

The present status of the mangrove forest is evaluated based on a review of the most recent literature and on respondents' answers when surveyed in this study. Attention is given to environmental characteristics and biodiversity of the Sundarbans in general and to issues ranging from mangrove spatial-temporal changes, protection, economic value, property rights, and related policy issues.

5.3.1 Mangrove spatial-temporal changes and impacts of recent cyclones

The Sundarbans of Bangladesh, like many of the world's mangrove forests, continues to lose its ecological diversity and productivity due to natural and anthropogenic causes (Islam, 2016). Worldwide, the major cause of mangrove decline is related to land conversion for agriculture and aquaculture, urbanization, timber extraction, and natural disasters such as cyclones, sea level rise and salinity changes. Complicating the trends is the uncertainty associated with climate change. Several respondentshave documented the spatial and temporal changes in land cover (forest cover area) of the Sundarbans (Ghosh and Mukhopadhyay, 2016; Mondal and Debnath, 2017; Abdullah et al., 2019). Over the last 40 years, significant changes in forest composition and forest cover have occurred. In particular, government has taken afforestation and reforestation projects and/or programs through the coastal belt of Bangladesh to save the region from natural disasters. However, the cyclones Sidr in 2007 and Aila in 2009 caused extensive damage to the mangrove forest and significantly altered the ecosystem. During these disasters many people died, and infrastructures and embankments were damaged. Moreover, agricultural and cultivated-fish land (gher) suffered loses. The total economic loss from disaster Aila was estimated at

USD 269.28 million (Xinhua, 2009) and from the cyclone Sidr at USD 1521million (Haque and Jahan, 2016).

5.3.2 Attitudes on the status of the Sundarbans

Attitudes of the respondents towards natural resources reflect their way of thinking about the value of natural resources. In this study, respondents were surveyed to view their opinion on the status of the Sundarbans based on selected criteria: Sustainable to unsustainable, healthy to unhealthy, protected to unprotected, productive to unproductive, managed badly to managed well and attractive to unattractive. These criteria were chosen to reflect measures of satisfaction with sustainability issues and to gauge attitudes towards current management practices. Table 10 shows the attitudes (based on average scores) of the respondents on the respective criteria. A preponderance of interviewees think that the forest is sustainable and productive. This may be because many generations have been able to subsist on the mangrove resources. Also, the resilience of the mangroves is noticeable to many locals. For example, after the devastating cyclones Sidr in 2007 and Aila in 2009, the Sundarbans appeared to recover with new biota reestablishing. Also, after these cyclones, new trees have been replaced (growing) and to some extent look attractive. However, with reference to the question of protection, half of the respondents said the mangrove forest is not protected and most of the people think the forest is badly managed. So, it can be argued from the survey results that people of the SIZ highly value the mangrove forest as a resource. Moreover, villagers are highly dependent on the mangrove resources for their livelihood and are concerned that the mangrove forest is threatened by human exploitation and natural hazards like cyclones, salinity, disease and sea level rise

(SLR) (Aziz and Paul, 2015). Realizing the value of the resource to local communities, government has established three wildlife sanctuaries in the Sundarbans designated as protected areas. Entering in the forest to exploit resources without the permission of FD is completely illegal. Moreover, in this study, a number of respondents raised concerns of increasing salinity causing a degradation of their property. Similar concerns of increasing salinity in the Sundarbans has also have been reported by Sarker et al., (2016).

Table 10. Responses of the respondents' ranking from 1 to 10 scale based on different categories of Sundarbans

Unsustainable	1	2	3	4	5	6	**7**	8	9	10	**Sustainable**
Unhealthy	1	2	3	4	5	**6**	7	8	9	10	**Healthy**
Unprotected	1	2	3	4	**5**	6	7	8	9	10	**Protected**
Unproductive	1	2	3	4	5	6	7	**8**	9	10	**Productive**
Managed Badly	1	**2**	3	4	5	6	7	8	9	10	**Managed Well**
Unattractive	1	2	3	4	5	6	7	8	**9**	10	**Attractive**

*The green marking showing the average scoring of the respondents on ranking scale 1 to 10

5.4 Economic value of the Sundarbans

The Sundarbans offers direct employment opportunities to fishermen, boatmen, timber and NTPs collectors and tourist guides. Indirectly, it supports many downstream enterprises employing workers in the sawmill, fishery, and tourism industries who are dependent on the mangrove forest. Many of these workers are aware of the importance of the Sundarbans to the local economy. Worldwide, there is a common tendency that underprivileged people are relatively more dependent on natural resources, given there are few alternatives for livelihood maintenance (Heubach et al., 2011; Assan and Kumar, 2009). This study directly

addressed the attitudes of respondents towards the economic value of the Sundarbans. Not surprisingly, poorer and marginalized families are highly dependent for their income on the mangrove forest and view the mangrove resource as their only livelihood option. The majority of respondents viewed the Sundarbans as an important source of employment and indicated that government also derives significant revenue from the resource. Seventy percent of those interviewed realized the economic importance of the mangrove resource, and 62% recognized that natural products offer high economic potential. Such findings point to the critical need to conserve and sustain the natural mangrove ecosystem. These findings align with studies by Abdullah et al. (2016). In a livelihood study, these respondents also found that both legal and illegal exploitation of resources from Sundarbans is higher in lower income (24%) households than in the middle (19%) and higher (11%) income households. More problematic is the knowledge reported by Islam and Hossain (2017) that forest harvesters have to pay 10 to 15 times higher fees to get a permit to enter into the forest than what is required under the standard government fee. These illegal approaches (higher fees) increase the expectations of users who may overexploit the resources. Interestingly, most of the stakeholders (67%) disagree, some strongly, over the impact of agriculture and fish farming on Sundarbans (Figure 17). This response may be because the detrimental effects of agriculture and fish farming are less apparent or because the heavy dependence on such activities strongly influences opinions and there is a reluctance to take into account the known impacts of agriculture on sensitive mangrove ecosystems.

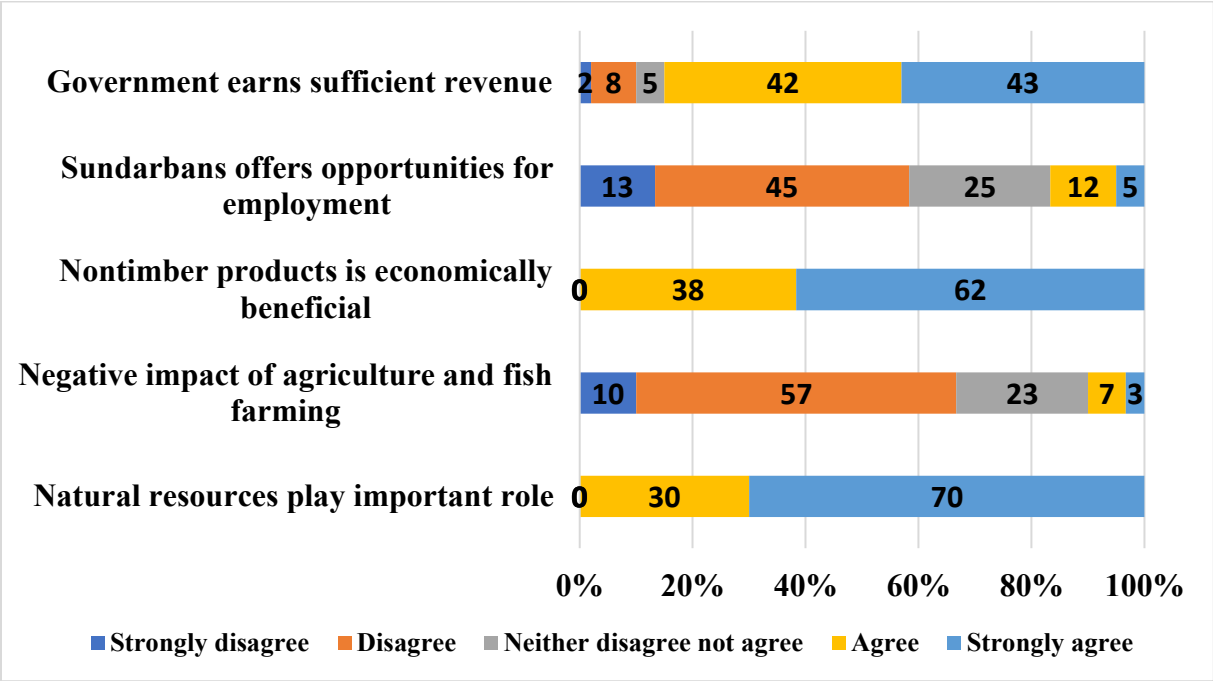

Figure 17: Economic value of Sundarbans by the respondents of SIZ

5.5 Property rights of the Sundarbans

Property rights means the right of an individual to a certain property. Most of the forests in Bangladesh are under legal government ownership. The government manages forests through the FD and through the Ministry of Land. According to Ostrom (2000), "Property rights define actions that individuals can take in relation to other individuals regarding some 'thing'. If one individual has a right, someone else has a commensurate duty to observe that right (p. 339)". Privatization of the property rights means to what extent an individual or group gets access to use the property, to what scale s/he can exploit resources from the property, and how much management rights an individual has. Privatization of the property is typically 'transferring of activities' from government to private sector with

certain ‘government regulations that limit individual rights’ (Alessi, 1987). Roy et al. (2012) critically evaluated past forest management policies and property rights regimes in achieving sustainability of the SMF in Bangladesh. These authors argue that the existing state property rights regime is inadequate and fails to secure the livelihood of 3.5 million people in marginalized and disadvantaged forest-dependent communities in the Sundarbans. They further argue that to achieve sustainability in the Sundarbans there is a need to reverse the trend of rapid reduction of forest resources. Property rights of the Sundarbans has been considered in this study. The central issue to be considered is whether people need permission or a pass to extract natural resources from Sundarbans and how can they get that permission, or whether some form of management rights or ownership is justified. Currently, it is mandatory to get permission to collect any natural resources from Sundarbans, so all the respondents (100%) answered that they need to go through certain process for gaining permission or to obtain a pass to enter the Sundarbans. Most of the respondents described the process as a lengthy one. They first need to apply to the FD for a Boat License Certificate (BLC). The BLC depends on the size of the boat and to obtain this certificate they need a copy of their national identity card, two copies of passport size photos and a citizenship certificate from the local chairman (elected leader of the community). They can collect a variety of products, according to the BLC. The extraction of natural resources is also time bound. Fishes and crabs extraction are allowed year round while honey can be collected from April to June and *Nipa frutican* can be collected from November to March (Getzner and Islam, 2013). Respondents see their current rights as being solely designed and controlled by insiders (e.g the BFD) and as being insufficient.

Thus, some argue that their current rights are unable to meet the livelihood needs of their community.

Findings from this study indicate that a form of property rights (e.g. privatization) may be a means to promote sustainability of the resource. About 62% of the respondents wanted privatization of the resources. Respondents maintained that privatization of property would influence them to take care of the resources in a sustainable way and would be more effective than treating the mangrove as a common resource. A number of respondents did not think privatization of the property would result in a sustainable mangrove forest. One of them argued "the privatization of property would create more problems and the beneficiaries might misuse the valuable resources".

A number of respondents commented on enforcement and its effectiveness. FD officials inspect the resources extraction activity from the Sundarbans but not on a regular basis. According to the survey, 78.33% of the respondents mentioned that FD inspects the extraction activity regularly (figure 18). A number of interviewees commented on the collaboration between government officials and resource collectors. Most of the respondents (71.67%) said that there is no conflict between government officials and resource collectors because of existence of Community Patrol Groups (CPG) within SIZ.

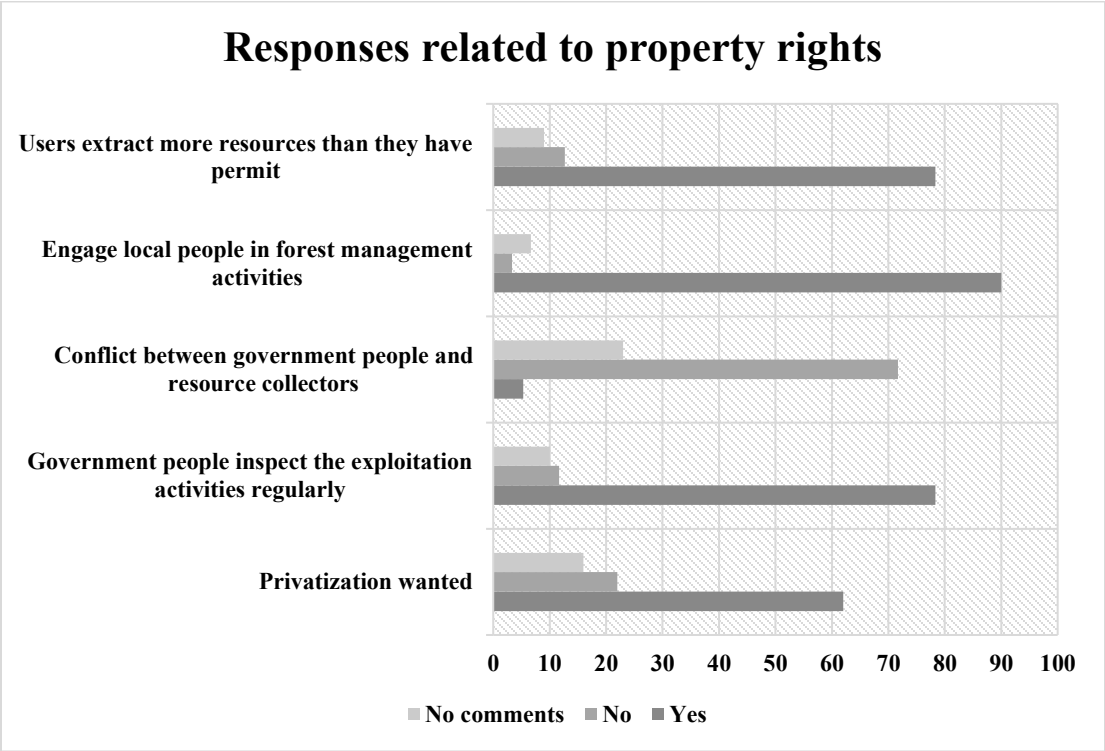

Figure 18: Attitudes of respondents toward property rights of the Sundarbans

The members of CPG are selected from the local stakeholders and they can participate in the management process by Co-management councils and Committee (CMC) programme of the government (Islam, 2014) which might decrease the conflict between FD and the local people. A few respondents raised concern about corruption and indicated that some stakeholders offer bribes called “bokhsis” to government officials during resource collection. Most of the respondents (70%) claimed that water hijackers (pirates) are a threat to the forest. These hijackers frequent the rivers of the Sundarbans and sometimes hijack (seize) food and money from fishing boats. More extreme events may include kidnappings or killings. In some instances, fishermen have to pay the water hijackers on a regular basis.

Ninety percent of the respondents believe that it is a good idea to engage local people and entrust them with more management rights. According to one respondent, “Sundarbans will be more protected if we can get more rights because the forest is the source of our income and everybody loves Sundarbans. But the FD should be careful about dishonest people”. Generally, respondents argued for increased collaboration between the leaders of the community and the FD. This mechanism seems reasonable given that the villagers always present their demands through the leaders. Surprisingly, 78.33% of the respondents think that users extract more resources than they have permission to extract. Indeed, according to the respondents, some of the users do not have valid permits. Further commentary suggested that if more rights were granted to the resources of the mangrove forest, there would be more incentive to manage the resources sustainably and follow laws imposed by the government of Bangladesh.

5.6 Forest policy and participatory governance

The concepts underlying participatory approaches to development and sustainability are underpinned by the roles of institutions and models of individual action. To promote a more integrated approach to the management of mangrove forests, a SLA calls for meaningful participation by local people. As noted above, various frameworks exist to facilitate increased participation and promote more sustainable approaches to resource management. The proposed framework presented herein (Figure 8) calls for direct and indirect participation by local communities to allow for wider input and debate. While different frameworks will have different trajectories, Figure 8 makes clear the need for local community linkages taking into account the need for more awareness (education), and

rights (property) of citizens. While Bangladesh, under the 2016 policy draft, has committed to more comprehensive and participatory approaches (e.g. the emergence of social forestry), it is clear from respondents that much is needed to effect full transformation of current forest policy. A significant number (56.67%) of respondents indicated the current management practices may result in a sustainable mangrove forest. However, 23.33% of the respondents think that current management practices might not result in a sustainable forest. More problematic was the finding that 20% of the respondents are unaware of current forest management policy.

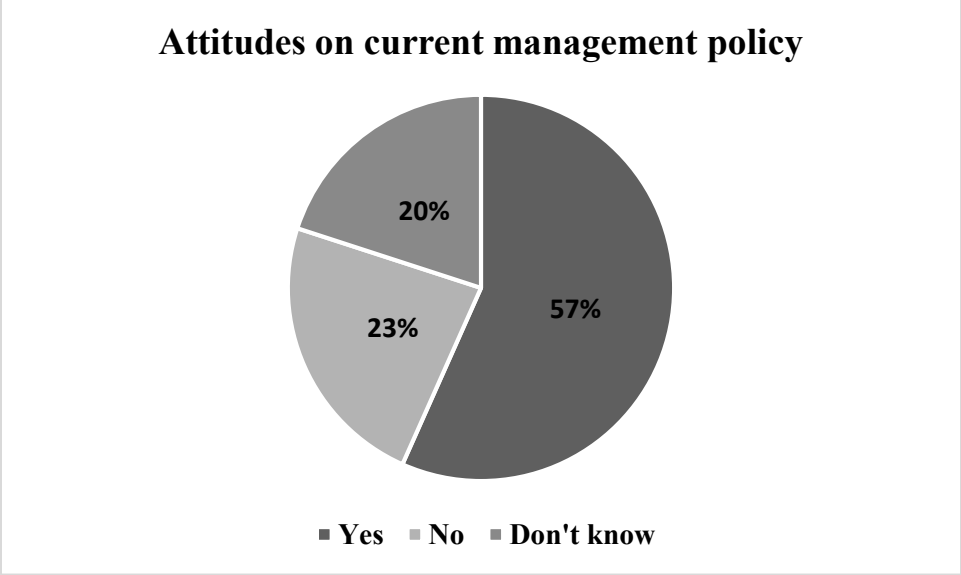

Figure 19: Respondents' attitudes towards current management policy

Findings from this research revealed that 88.33% of the respondents are involved with different government and nongovernment programmes including the VCF (village conservation forum), PF (peoples' forum), VTRT (village tiger response team) through meetings where they gather in a place with government officials or NGO's representatives

and discuss issues related to the Sundarbans. During these meetings, local people have an opportunity to try and improve their condition under the current policy. Early studies by Roy (2014) found that 83% of respondents maintained that sustainable management practices are not being followed. In a related study on the Indian Sundarbans, Badola et. al., (2012) found that the people around the forest value it and are willing to participate in conservation activities. In the current study, respondents mentioned three major issues - safety from water pirates, the process of getting access (passes) should be easy and lower in price, and more training on the conservation of wildlife and timetable of collecting resources. Respondents demanded that regulators impose stricter rules and regulations designed to protect them from pirates during collection of resources, and increase the number of forest camps and inspections. According to the respondents, increased collaboration and meetings among VCF, PF, and VTRT would strengthen management, given that insufficient and inefficient people are serious weaknesses of the current management policy.

The extent to which decision-makers respond to stakeholder needs including greater participation in management and policy processes requires a major paradigm shift involving a transition from a long-standing, top-down paradigm to a more diversified, bottom-up paradigm. In effect, this requires a transfer of power from the ‘elite’ which have dominated decision-making, to subordinates who utilize the resources on a regular basis and who have therefore, a vested interest in sustaining the resource. Thus, it can be argued that stakeholders in the SIZ, many of which are poor, need to be empowered to enable them to take command and act directly themselves. To a great extent, empowerment of the poor

requires reversals and changes of role and therefore a 'rethinking' of past practices. It also implies substantive changes in bureaucratic processes and cultures, and in particular the extent of local participation process. In recent years, a degree of consensus has emerged around the desirability of participatory democracy and is the subject of governance and policy reforms (Baiocchi and Ganuza 2016). Participatory democracy is, according to Baiocchi and Ganuza (2016), an imperative of our time and no longer a counterpoint but a part of the planning of power itself. Roy and Gow (2018) argue that planning targets cannot be met unless local participation is ensured through a deliberative framework. It is also noteworthy that participatory approaches have become an established orthodoxy among development agencies across the political spectrum. Within this context, there is a strong call for involvement of women in participatory strategies. The latter is highly relevant to Bangladesh where, to date, gender inequalities exist. Men (as head of households) most often influence strategic resource development priorities and decision-making processes. One possible means to ensure wider participation, including a role for women, is to involve women in the identification of criteria and indicators to monitor progress towards sustainability and environmental management goals established for the Sundarbans. Such empowerment could build capacity, involve marginalized groups, increase dialogue, promote open decision-making spaces, and incentives to participate. Inevitably, wider participation would promote diplomatic resolutions to management and/or policy conflicts.

Chapter 6 Summary and Recommendations

The Sundarbans mangrove forest, a UNESCO world heritage site, is the largest wetland forest in the world and is of great social, ecological and economic significance to the people of Bangladesh. The full value of the unique ecosystem cannot be monetized but with its array of forests and rich biodiversity, the mangrove ecosystem is a showpiece of natural history. It is also a center of economic activities where surrounding communities extract timber, fish, collect food (e.g. honey), to maintain their livelihoods. Despite their overwhelming importance, the Sundarbans, like many mangrove forests on earth, are under serious threat from natural hazards (e.g. sea level rise, cyclones) and from human activities such as human encroachment, illegal logging, tourism industries, unplanned development projects, forest clearing and related land use issues. Today, the area around the Sundarbans is densely populated and numerous people are engaged in the commercial exploitation of its resources. The challenge of conserving and managing the world's largest mangrove forest, is massive. During the past two decades, Bangladesh has improved its forest policy to help sustain the Sundarbans and to provide economic livelihoods to forest-dependent communities. Regrettably, the recent decision to establish a coal-based electric plant in proximity of the Sundarbans denotes lack of consistent concern for the conservation of this UNESCO protected area. As a protected area, the Sundarbans, is currently managed by the BFD under a state property rights regime. This study explores attitudes to sustainable forest policy and management of the Sundarbans. Particular attention is given to current policies with specific focus on livelihoods, access and property rights, and participatory approaches to forest management. Such factors are deemed important to consider if Bangladesh is to

sustainably manage the Sundarbans. Given that the sustainability and management of resources are so complex, Ostrom (2007; 2009), Mozumder et al. (2018), and others, suggest that a social-ecological system (SES) framework should be considered to better understanding processes of use, maintenance, regeneration, and destruction of natural resources. The proposed framework (Figure 8) with its respective elements (community actors, governance, threats//vulnerabilities, and benefits, indicate interactions and links to conservation priority located at the center of the conceptual framework. It is provided in an attempt to reinforce 'SES thinking' and ultimately to influence decision-making. Most developing countries have well written forest policies, but frameworks are lacking or deficient, and the implementation of forest policy is often difficult due to competing policies, lack of infrastructure, inefficiencies, and insufficient funding. Bangladesh is no different, suggesting an ecosystem-based approach to forest management is needed to address future threats and vulnerabilities. In Bangladesh the challenges are heightened because mangrove forest management policy is "top down" (Roy, 2016) where the community has little voice in the management of the Sundarbans. This study found that the socio-economic level of the people surrounding Sundarbans is generally very low. Traditionally, local farmers harvest natural resources from the forest for their livelihood. However, most of the participants are literate (80%) and willing to participate in the management activities in a sustainable way. The respondents (88.33%) have taken part in different government and non-government awareness programmes that help to increase their consciousness about the conservative management of the forest. However, villagers have very different reactions to the issue of sustainable forest management. Some (20%) of them have no knowledge about current forest policy. Others are not clear about their

current or potential role in the conservative and sustainable management of the mangroves. Most agree that there are serious threats to the resource, notably corruption (bribing of forest staff), illegal harvesting, political interference, rapid industrial growth, encroachment in the form of fish farms and agricultural activities. Findings from this research also indicate that many community members want more fair and well-defined property rights. As such, they can better engage in the management process and use traditional knowledge in management activities of the forest. Incorporating the villagers in the management activities with a form of co-management is one possible step to improving sustainable management of the Sundarbans. As such, the state could consider a shared benefit approach to ensure more stable economic conditions for the communities.

It should be noted that community-based management approaches that require strong participation by stakeholders has met with some resistance because it can be viewed by some as a form of political control. If progress is to be made, it must be recognized that a true participatory approach is one in which everyone's perspective is considered, as in participatory democracy. Equitable participation, trust, and respect among partners must serve as a foundation for improving the sustainability of the Sundarbans.

Recommendations

Formal national policy designed to protect the forests of Bangladesh continues to evolve along with aspirations for sustainable use of the Sundarbans resources. Establishing protected areas and promoting collaborative management approaches represent sound steps towards sustainability, however these have limitations; the Sundarbans continues to degrade. Good governance and favorable policies along with financial, administrative, and

institutional support are needed to ensure the resilience and ecological integrity of the Sundarbans. This is an urgent matter, given the Sundarbans are becoming more vulnerable to natural disasters and anthropogenic impacts. A change from oversight and monitoring only is needed, to one of proactive community engagement involving a SES approach. The latter can take into proper account all stakeholders in the SIZ, and will help build trust between forest officials and local users. Increased collaboration and sharing of information between government and stakeholders would facilitate planning, management, and ultimately, wise decision making. Based on data collected in this study, several specific recommendations follow:

- Government policy should strongly support and enhance educational opportunities for local people within the SIZ. More awareness of the *full value* of the Sundarbans would help to improve stakeholder attitudes towards sustainable management of the resource.

- Efforts should be made to advance coupled human–environment (socio-ecological) systems. These systems call for more participatory approaches to management that permit stronger voices from the local community. Wider participation would improve governance of the Sundarbans and address issues such as access, property rights, and illegal harvesting.

- Parallel efforts should be made towards local 'empowerment', to ensure common priorities and levels of agreement on both conservation and livelihood issues within well-defined and established form of participatory democracy.

- Introducing additional fuel sources such as biogas from cow dung or solar options as well as alternate income generation sources (e.g. handicrafts, goat farming, and fish cultivation) are recommended to reduce pressure on the mangrove.
- A number of policy instruments including financial incentives (subsidies or compensation), and regulations (access and allocations) should be considered to improve livelihoods that would in effect further reduce pressure on the mangrove resource. The government of Bangladesh should re-examine and foster the implementation of signed international conventions, treaties and protocols to protect the biodiversity of the Sundarbans, which in itself would promote sustainability.

- Information instruments, the political intervention that formally influences the social and economic action solely through "information", should also be better utilized. For example, communication strategies should be developed to better promote sustainability principles, ecosystem services, and to include local people in decision making.

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Appendices

Appendix 1: Consent form of the Questionnaire for the Survey

Dear Resident,

Thank you very much for participating in this study and taking time to answer questions related to policy and management issues associated with the Sundarbans. The author is a *graduate student of the "Environmental Policy Institute" at Grenfell Campus of Memorial University of Newfoundland, Canada. This survey is a part of her coursework.*

Please answer all the questions as completely as possible. Your views are important and will help guide future policy and management of the Sundarbans. Your answers will be grouped with those of others and you ***will not be identified by name or organization***. If at any point in the interview you wish to discontinue, please indicate your desire to do so.

If you have any questions about the study please don't hesitate to contact Mr. Ripon Kumar Ghose (Cell no.: +8801913-334606), or Mr. Md. Mosaddek Hossen (Cell no.: +8801716-009098) or H.M Majibur Rahman (Cell no.: +8801959-480530) or Md Abdul Hamid (Cell no: +880183999939). You are also welcome to e-mail Ms. Trishita Mondal (tmondal@grenfell.mun.ca). Your assistance with this project is greatly appreciated.

Thank you for your assistance.

Sincerely,

Trishita Mondal

Appendix 2: Key points of "National Forest Policy, 2016 (Draft)"

Aim of the policy

The main aim of the policy is to manage all existing forests, wildlife and other forestry resources, adhering to the principles of sustainable management and climate resilience; enrich degraded forest areas; and enhance land areas under forest/tree cover; to produce a wide array of goods and ecosystem services for the benefit of Bangladesh's present and future generations

Objectives

1. To arrest deforestation, and degradation of forest resources, enrich and extend areas under tree cover, through appropriate programmes and projects, to ensure that at least 20% of the country comes under tree cover by 2035, with at least a canopy density of 50%.

2 To ensure strict conservation, growth, increased ecosystem services and sustainable management of state forests. Introduce Forest Certification as a tool to improve forest management through market influence.

3. To significantly increase tree cover outside state forest, through appropriate mechanisms, in both public and private land including urban areas.

4. To encourage all types of participatory forestry activities and creation of off-forest job opportunities to reduce dependence of forest-dependent communities on forests.

5. To improve management and conservation practices of wildlife in Protected Areas and other important habitats.

6. To incorporate measures to deal with climate change impacts on forest ecosystems.

7. To delineate and designate catchments of rivers, lakes and other wetlands as strict nature reserves.

8. To ensure enhanced groundwater recharge and perennial stream flow, extend the coverage under Protected Areas to 30% of all notified forest land.

9. To strengthen the research, education and capacity building in forest ecosystem management practices to cope with the existing and emerging challenges including impacts of climate change, population pressure, and urbanization.

10. To include valuation and payment for ecosystem services in the planning and management of forest ecosystems.

11. To ensure effective implementation of the relevant programmes identified by the Bangladesh Climate Change Strategy and Action Plan, 2009.

12. To ensure that the policies prescribed herein, and the formulated programmes there under are properly implemented, and to establish a strong information management, monitoring and evaluation set up.

13. To facilitate the establishment of efficient wood and wood substitute-based industries, together with capacity building of rural communities and entrepreneurs, to enable them to setup wood and wood-based production facilities, small and large

14. To ensure fulfillment of the country's commitments under different Multilateral Environmental Agreements like CITES, CBD, UNCED, Ramsar etc.

15. To encourage community involvement, particularly, women's involvement in

forestry activities, wherever feasible.

16. To make plans for converting the policies outlined herein into actions by developing appropriate interventions backed by commensurate financial provisions and proper accountability.

Policy statements

1. General Statements

1.1. The Forest Department will be responsible for conducting all forestry activities on state owned forest land and will support, advise and guide tree planting activities in all other available land in the country;

1.2. Given the acute shortage of forest land, henceforth, no forest land will be released for any non-forestry activities without the prior approval of the Honourable Prime Minister with a vetting from the cabinet. In cases involving priority national interest, equal areas will be handed over to the Forest Department, with required fund for compensatory afforestation. Necessary rules will be formulated to that effect;

1.3. Coordination with all other relevant agencies on forestry related matters will be done by the Forest Department and the Ministry of Environment and Forests;

1.4. Adequate funds shall be made available from the national budget as well as external sources to address routine activities and emerging challenges;

1.5. Traditional rights of various ethnic-communities, living in and around state forest areas, will be recognized and maintained with due respect to their forest-related cultural values and religious beliefs. Conservation initiatives related to forest, wildlife and biodiversity by indigenous communities will be encouraged;

1.6. Undertake a credible valuation of the ecosystem services that the forestry sector

provides in Bangladesh.

1.7. Establish a properly staffed and equipped information management, monitoring and evaluation unit for information generation and assessment of the national forest programme under the Forest Department;

1.8. All forestry related programmes statements contained in the government's other sector policies will be implemented by the Forest Department;

1.9. Ensure fulfillment of relevant provisions of all Multilateral Environmental Treaties and

Conventions, including the Paris Climate Agreement, which Bangladesh has ratified;

1.10. Translate relevant forestry related recommendations from the Sustainable Development Goals as well as Bangladesh's Seventh Five-Year Plan into programmes and projects;

1.11. Enhance capacity for forestry research and education;

1.12. Promote and encourage community participation including women's involvement in forestry activities;

1.13. To ensure protection of the Sundarban Reserve Forest from pollution and oil spills, navigational routes inside the Sundarban will be strictly restricted. Access to any waterway inside the Reserve Forest, except the recognized routes between the Mongla Port and the sea, will be subject to prior permission from the Forest Department.

2. Enrich and extend forest cover

2.1. Manage all forest resources at an ecosystem level adhering to the principles of sustainable forest management;

2.2. Formulate and implement a strategy for the rehabilitation and enrichment of all degraded forest ecosystems, catchments and other fragile and ecologically sensitive areas located within forests;

2.3. Make an assessment of all available forest land and undertake large-scale plantation establishment programmes on all such land;

3. Protection of forests

3.1. Strengthen protection measures for all types of forested areas by providing adequately trained manpower, requisite tools, and logistics along with support from other law enforcement agencies;

3.2. Involve communities in forest protection activities and make provisions for the engagement of 'community patrol groups' in the law;

3.3. Ensure quick disposal of all forest cases through the establishment of separate courts for dealing with pilferage, encroachment and violation of transit rule related cases filed including title suits under the relevant laws of the country;

4. Trees outside forests

4.1. Strengthen and expand participatory forestry activities through the establishment of forest extension units in all upazilas with adequate resources and manpower to handle an effective advisory and support programme;

4.2. Formulate and execute extensive plantation programmes in suitable Unclassed State Forest (USF) land.

4.3. Extend the scope of agro-forestry across the country in government land;

5. Biodiversity and wildlife conservation

5.1. Ensure the implementation of the provisions laid out in the Bangladesh Wildlife

Master Plan 2015-2035 and the Bangladesh Forestry Master Plan 2017-2035 through appropriate mechanisms;

5.2. The Forest Department will implement relevant provisions of the National Biodiversity Strategy and Action Plan and also, ensure that the recommendations of the action plan are updated periodically to suit the needs of time;

5.3. Establish a fully resourced Bangladesh Wildlife Centre with a mandate to educate, train and build capacity of different categories of wildlife officials and other relevant stakeholders, conduct management and applied wildlife research and act as a depository of all kinds of documents and information on wildlife and its management.

6. Participatory Forestry

6.1. Empower communities, allowing them to have rights and responsibilities and devolved authority, to participate in forestry activities for socio-economic and environmental benefits, and increased forestry production;

6.2. Ensure that the benefits from participatory forestry activities accrue to an entire community and not to an influential few;

6.3. Ensue that Social/participatory forestry activities are extended to the entire country;

6.4. Promote and support the establishment and management of private nurseries all over the country.

7. National parks and recreational areas

7.1. Align the nomenclature of all Protected Areas with IUCN's Protected Area Management categories to improve management and facilitate access to international technical resources;

7.2. Promote low impact forest friendly and sustainable ecotourism in all forest areas as a

mainstream conservation activity;

7.3. Facilitate the creation of an enabling environment for the promotion of eco-tourism in forest areas and ensure accrual of the benefits to local communities;

7.4. Formulate and implement appropriate models with focus on conservation, values and functions of forest ecosystems to impart 'nature education' to visitors and the use of parks, botanical gardens, wildlife sanctuaries, safari parks and other notified protected areas for awareness raising;

7.5. Create recreational areas for the public in all regions of the country;

8. Forestry education and capacity building

8.1. Create a cadre of forestry officials through appropriate education, training and grooming, to ensure that they are familiar with modern management/conservation techniques and are able to face different emerging challenges;

8.2. Ensure entry level training for all new recruits in the Forest Department and upgrade and modernize curricula for basic training for entry level officials. Organize specialized training for forestry officials so that they can undertake jobs like handling information and knowledge management, climate change issues, forest economics related topics including valuation of ecosystem services and payment for ecosystem services, forest statistics, growth and yield forecasts, remote sensing and geographical information system, to ensure that the Forest Department has the required in-house capacity and is not dependent on external experts;

9. Climate change

9.1. Strengthen resilience of forest ecosystems and dependent communities to climate change;

9.2. Maintain maximum area possible under tree cover and ensure through proper actions that deforestation is totally arrested;

9.3. Translate relevant recommendations of the Bangladesh Climate Change Strategy and Action Plan 2009 into action plans to be implemented;

9.4. Develop and implement programmes and projects aiming at the mitigation and adaptation against adverse impacts from climate change;

9.5. Strengthen the capacity of the Forest Department to support climate resilience and low carbon development through integrating climate change issues into planning and implementation of strategies;

10. Forestry Research

10.1. Transform the Forest Research institute into an autonomous body with a major mandate to undertake forestry related applied researches.

10.2. Review, update and rationalize the Forest Research Institute to ensure the induction of staff with appropriate educational background, and facilities for further education and research should be made available to ensure development of appropriate capacity and know-how;

10.3. Tailor the research programmes of the Forest Research Institute to the needs of the forestry sector;

10.4. Ensure that there is no overlap in the roles, responsibilities and functions of the Forest Research Institute and the National Herbarium;

10.5. Forest Department will seek help from the Forest Research Institute and the National Herbarium for research and technical information generation;

11. Forest industries

11.1. Encourage and facilitate investment in forest industries;

11.2. Discourage the use of solid wood and promote processing of wood;

12. Non-timber Forest Products

12.1. Assess the availability of different Non-timber Forest Products (NTFPs) in the forests of Bangladesh;

12.2. Empower local communities to undertake income generating activities and, accordingly, define their access rights and responsibilities regarding NTFPs;

13. Forestry administration

13.1. Responsibilities for the implementation of all forestry related activities of the Government of Bangladesh will lie with the Forest Department;

13.2. Strengthen the Forest Department to ensure that it can undertake assigned responsibilities diligently;

13.3. Forest service cadre will be considered as a technical/professional service, similar to all other such civil service cadres. In view of the acute shortage of cadre service officers, to reduce the period of induction into the service, restrict temporarily recruitment in the Forest Service Cadre only to the graduates of forestry and wildlife disciplines;

13.4. Re-institute direct induction of officers at the Forest Ranger's level.