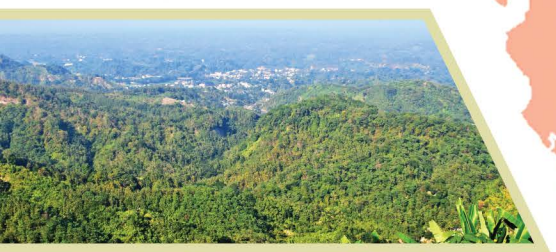
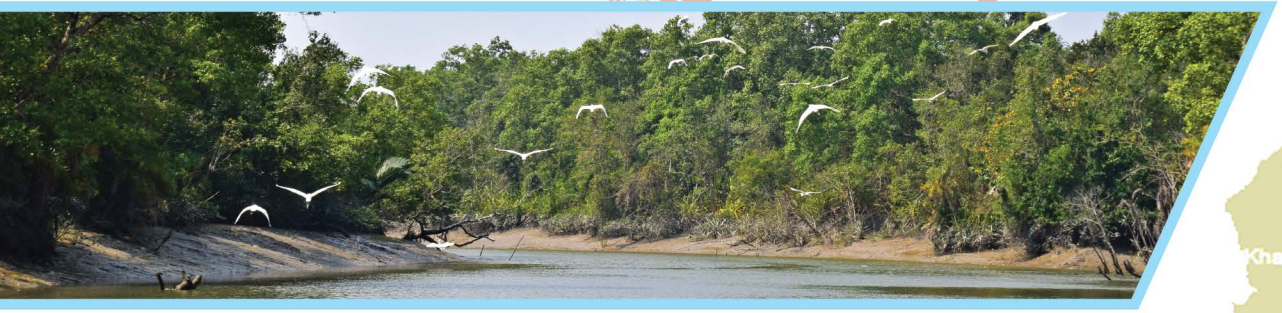
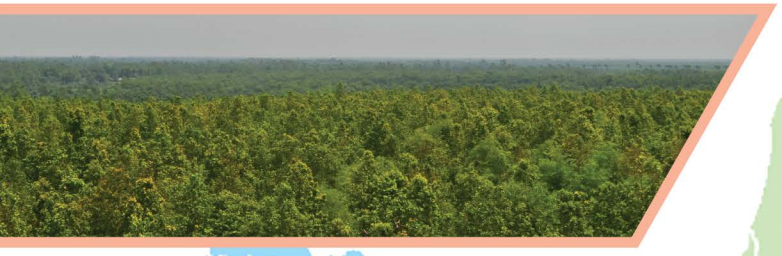
Understanding tree and forest resource change in Bangladesh

A literature review to support the preparation of the socioeconomic survey







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The Forest Department of Bangladesh leads actions to improve forest management and conservation, adopting forward thinking, innovative approaches in its management of approximately 1.55 million hectares of land across the country.

In 2015, the Forest Department began a process to establish a National Forest Inventory and Satellite Land Monitoring System for improved forest and natural resource management. The process supports national objectives related to climate change mitigation and provides information in support of the UN-REDD programme aimed at Reducing Emissions from Deforestation and Forest Degradation (REDD+). The process also addresses domestic information needs and supports national policy processes related to forests and the multitude of interconnected human and environmental systems that forests support.

The activities implemented under the Bangladesh Forest Inventory process are collaboration between several national and international institutions and stakeholders. National partners from multiple government departments and agencies assist in providing a nationally coordinated approach to land management. International partners, including the United Stated Agency for International Development (USAID) and the Food and Agriculture Organization of the United Nations (FAO) are supporting the development of technical and financial resources that will assist in institutionalizing the process.

The results will allow the Forest Department to provide regular, updated information about the status of trees and forests for a multitude of purposes including for assessment of role of trees for firewood, medicines, timber, and climate change mitigation.

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Disclaimer

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EXECUTIVE SUMMARY

Tree and forest resources are essential for our societies for basic needs such as food security, energy, climate regulation, medicinal, timber and so on. To better management plan and protection of our forests, we need to better understand the relationships between our social and economic activities, and our trees and forests. However, available resources and their demand are not known. The socio-economic survey to be carried out under the Bangladesh Forest Inventory is essential to understand the linkages between household welfare, livelihoods and the trends in sustainably managing the provision of ecosystem services from forest and tree resources in the country. These data are essential to inform natural resource decision making and planning process.

This literature review provides a comprehensive overview of zone-specific drivers of tree and forest resource change in the country, and lays the foundation on which the national scale socioeconomic survey is being designed. Both underlying and direct drivers have been identified under the three processes of change (forests converted to other land use, degradation of trees and forests and increase of tree and forest resources), in the five forest zones (hill, Sal, Sundarbans, village and coastal). The analysis of drivers is based on the framework provided by Kaimowitz, D., & Angelsen, A. (1998). Direct drivers include encroachment, over-extraction, pollution, etc., while for the underlying drivers, analysis is provided across social, political, economic domains, and governance and forest tenure. An analysis is also provided on the impact of tree and forest resources on various socioeconomic dimensions, including food security and nutrition, livelihoods and resilience of ecosystems to climate change.

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ACRONYMS

BBS	Bangladesh Bureau of Statistics
BFD	Bangladesh Forest Department
BFI	Bangladesh Forest Inventory
CEGIS	Center for Environmental and Geographic Information Services
CHT	Chittagong Hill Tracts
CPD	Centre for Policy Dialogue
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IUCN	International Union for Conservation of Nature
MOEF	Ministry of Environment and Forests
NFA	National Forest Assessment
NTFP	Non-Timber Forest Products
REED+	Reducing Emissions from Deforestation and Forest Degradation
ToF	Tree Outside Forests
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
VCF	Village Common Forests
WRI	World Resources Institute

1. INTRODUCTION

Trees and forest resources are recognized as one of the most important natural resources to human which contribute food, energy, health and income. About 1.6 billion people in the world are dependent on forests for their livelihoods (Bank, 2004; Programme, 2012; SRDI, 1998; WRI, 2005). In Bangladesh data related to socioeconomic benefits from trees and forests is lacking although forest covers around 15.78% of the total land area (M Akhter & Costello, 2016; FRA, 2015). However, it has been estimated that about 3.5 million people are directly and Indirectly dependent on Sundarbans forests (Abdullah, Stacey, Garnett, & Myers, 2016). The tree and forests in Bangladesh has been faced several environmental and anthropogenic challenges which impact on the forestry sector particularly climate change, soil erosions, deforestation and forest land encroachments, forest degradation, biodiversity loss and so on. According to FAO (2015), it has been estimated that area of forest resource is continuously declining and has retracted 0.2% since 1990. The continued downward trend in tree and forest cover has negative implications for food security (Pimentel, McNair, Buck, Pimentel, & Kamil, 1997a), water quality, tropical disease and global climate.

To address this trend, it is important to identify the drivers of change, the dynamics of those changes in terms of land use conversion, the socio-economic implications of these changes and to allow informed and well-targeted policy decisions and outcomes. In 2015, the Bangladesh Forest Department (BFD) operationalized the Bangladesh Forest Inventory (BFI) aimed at assessing the state and trends of the country's tree and forest resources. One component of the BFI is to analyze the socio-economic interactions with tree and forest resources which in fact, is a critical approach to fill the gap in data on the human dimension of forest and tree use. Moreover, this component is intended to encourage participatory process with forest dependent people[1]. This means a move towards integrated policy formulation for improved forest management, which aims to improve socio-economic benefits from forests through employment and income generation, enhanced provision of carbon sequestration, water, soil and biodiversity conservation (Ministry of Environment and Forest, 2016).

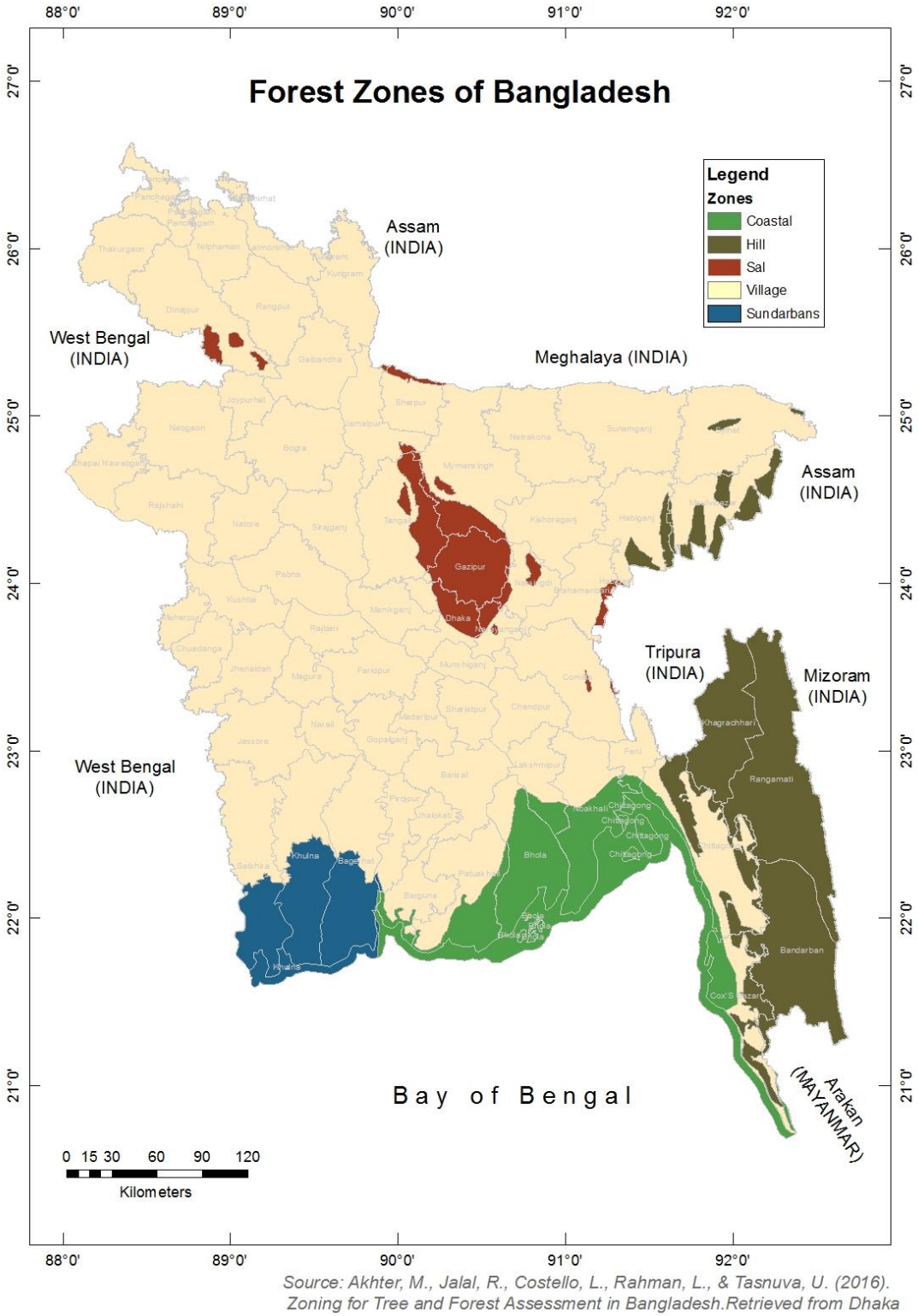
The literature mainly focused on to find out a question: *What are the drivers and impacts of changing tree and forest resources*? To identify and understand the processes and drivers of forest and tree cover change resulting into different adverse impacts, an analytical framework has been outlined (Figure 2). It elaborates

[1]FAO estimates suggest that around 13% of people directly dependent on forest resources (around 0.43 billion) in the Asia Pacific region. For a clear understanding of the relationships that people hold with forests, it is important to formulate a typology on different types of users, or else "forest dependency" will largely remain a vague term. FAO broadly categorizes three types of "forest dependent people", which may also overlap.

1. People who live inside forests - hunter-gatherers or shifting cultivators, their livelihood primarily depends on forest and tree resources (may be indigenous people or people from minority ethnic groups)
2. People who live near forests (likely to be involved in agriculture outside the forest, and regularly use forest products (timber, fuelwood, bush foods, medicinal plants etc) partly for subsistence purposes and partly for income generation.
3. People engaged in commercial activities as trapping, collecting minerals or forest industries (e.g logging). These people depend on income from forest-dependent labour rather than from direct subsistence use of forest products (Fisher, Srimongkontip, & Veer, 1997)

on the direct and indirect drivers of tree and forest resources. A review of the impacts of these changes on various socioeconomic dimensions is followed by the conclusion. This information serves as the foundation for the design of the socio-economic survey assisting the development of questionnaires for the defined zones (Figure 1) in the BFI. It will act as a key instrument to guide policies and measures for different purposes including food security, energy access, resilience to environmental crisis including climate change, support activities for climate change mitigation etc.

This review contextualizes these changes under three processes: conversion of forest land to other land uses, degradation of forest and tree resources and increase of tree and forest cover and assess the dynamics of these processes in relation to zones of Bangladesh. Five zones (Figure 1) have been defined to reflect the broad forest types of the country based on geographic location, edaphic factors, such as soil type and altitude (M. Akhter, Jalal, Tasnuva, Vollrath, & Iqbal, 2016). The zones are Hill, Coastal, Mangrove, Sal and Village. A focus on only negative impact on tree and forest resources ignores local best practices that can be scaled to enhance the drive for afforestation (Leach, 2015). Thus, both the increasing and decreasing trends of change in these resources is also considered in this literature review. The direct and underlying causes, impacts of resource change on food security and nutrition, livelihoods of forest dependent people and local climate regulation and resilience of ecosystems to environmental changes are then discussed.



Source: Akhter, M., Jalal, R., Costello, L., Rahman, L., & Tasnuva, U. (2016). Zoning for Tree and Forest Assessment in Bangladesh.Retrieved from Dhaka

Figure 1: Zones for the Bangladesh Forest Inventory

2. FRAMEWORK FOR TREE AND FOREST RESOURCES CHANGE

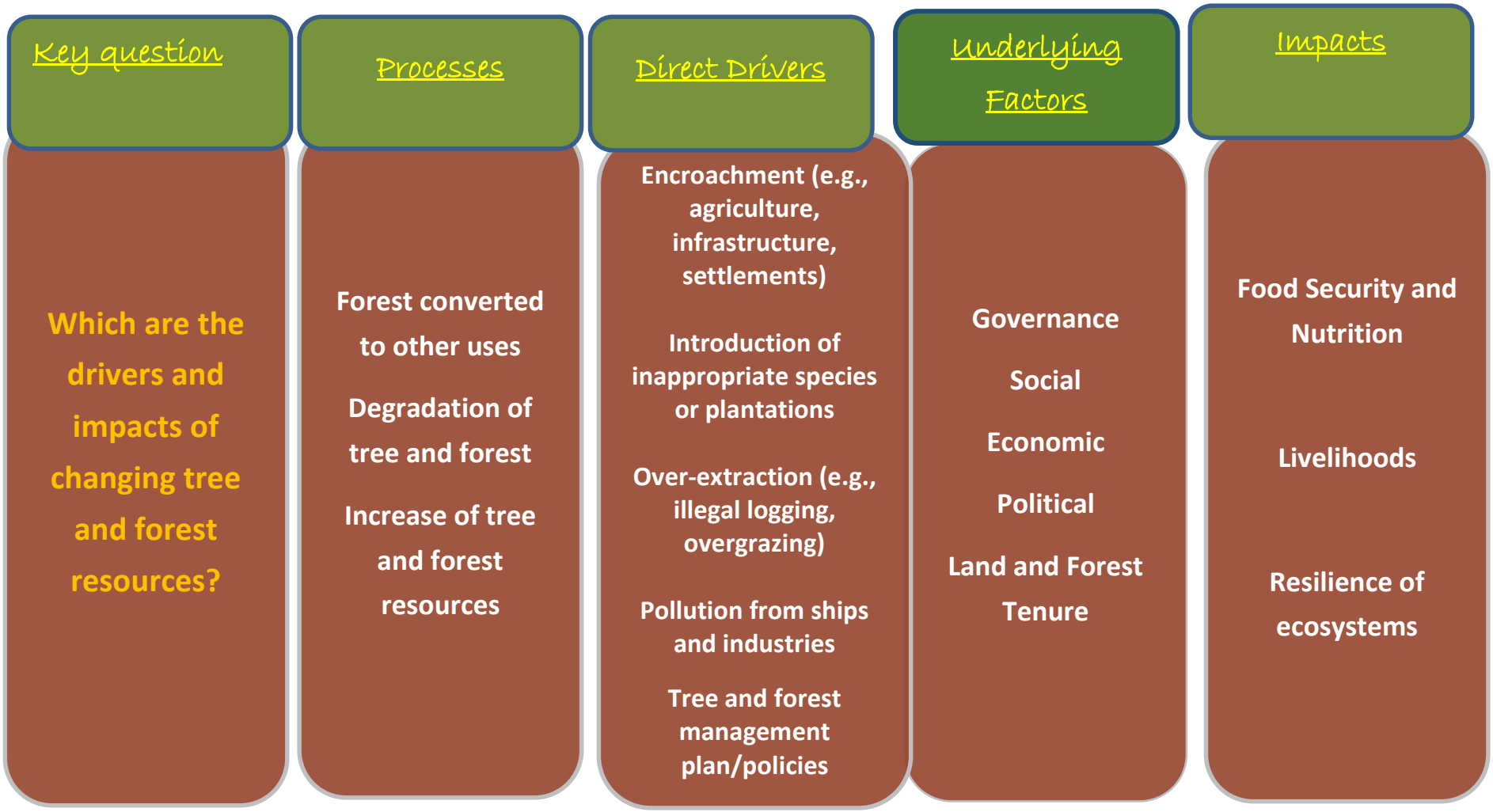
There are several direct and indirect drivers responsible for the tree and forest resources change. The major direct drivers include encroachment (e.g., agriculture, infrastructure, settlements), introduction of inappropriate species or plantations, over-extraction (e.g., illegal logging, overgrazing), pollution from ships and industries and indirect drivers (underlying factors) include- Governance, Social, Economic, Political, Land and Forest Tenure. Apart from these tree and forest management plan also influence the tree and forest resources change. These drivers are categorized into three processes that responsible for the tree and forest resources change (Figure 2): The processes are:

(1) Forests[2] converted to other land use (e.g., agriculture, industrialization),
(2) Degradation of trees and forests and
(3) Increase of tree and forest resources (e.g., other land converted to forest land).

These processes, explained below, form the basis of Greenhouse Gas (GHG) Inventory reporting to the UNFCCC for the land use, land use change and forestry sector (LULUCF) (Penman et al., 2003) and are a central component of the United Nations (UN) Reducing Emissions from Deforestation and Forest Degradation (REDD+) Program. Analysis of the impact of tree and forest changes through these processes allow better understanding of the drivers behind carbon stock changes in different zones. The socio-economic survey is designed in a way that will seek answers in both the national context and also on specific regions.

A complete understanding of the tree and forest cover change should follow a sequential process that will elaborate the causes and effects of the changes both spatially and temporally throughout the country. This section presents an overview of the framework that is followed to have a comprehensive knowledge on change in tree and forest resources of Bangladesh.

[2] There are different definitions of forests. FAO defines forest as Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. Falling under this definition, there is today just under 4 billion ha of forest in the world, covering about 30% of the world's land mass. The United Nations Framework Convention on Climate Change (UNFCCC) threshold values for forest are a minimum area of 0.01-1.0 ha, a minimum tree height of 2-5m and a minimum crown cover 10-30%, while the United Nations Environment Program (UNEP) defines forest based on a minimum crown cover of 40%(Chao, 2012)



(Source: Understanding tree and forest changes: An Analytical Framework (Kaimowitz, D., & Angelsen, A. (1998)

Figure 2: Illustration of the framework for understanding change in tree and forest resource in Bangladesh. This study is structured as per the structure of this framework. The next section elaborates on the framework of analysis used in this review.

2.1 FORESTS CONVERTED TO OTHER LAND USES

The first process considered for analyzing change is the conversion of forest or tree cover to other land uses. In fact, it is a not only a significant driver of land cover changes in Bangladesh but also is a major issue in global extent. The most significant conversion process globally is that of agricultural expansion to crop or pastures. In the tropics, more than half of this conversion has been at the expense of intact forest and a further 28% from disturbed forests (Lambin & Meyfroidt, 2011). (Gabrielle Kissinger, 2012) estimated that worldwide agriculture is the direct driver for about 80% of deforestation. There are six broad IPCC[3] classes for land use categories and in Bangladesh, these categories are further granulated to more subclasses specifically to reflect the country context. Bangladesh is also in the process of defining a national land representation system where any type of land use can be assigned to a class thus land use information from different times and different organizations can be compared more accurately in assessing change and other issues(Gregorio, Akhter, & Islam, 2014).

Deforestation is the mechanism that converts forests to another land use, such as agriculture, settlements or other use. There are many drivers of deforestation in Bangladesh. According to the remote sensing based time series analysis done by University of Maryland (FAO-UMD) the total tree cover loss in Bangladesh has been estimated to be approximately 74,000 ha from 2000 to 2014. There are different causes those are accelerating this loss. The direct causes are conversion for agriculture purpose, population pressure and development interventions such as the construction of dams which are often associated with indirect causes like profitmaking and insufficient or corrupt forest management (A. Ahmed, 2008). In Bangladesh, population pressure means conversion to settlements and industrial expansion is also a significant consideration (M. R. Islam & Hassan, 2011). However, the catalyst for these drivers is often a complex set of factors that may stem from government policy, climatic events or external economic influences. Drivers of deforestation therefore cannot be deduced to a single process, but considered in the context of changing economic opportunities which are in turn influenced by secondary elements of social, political or infrastructural changes (Lambin et al., 2001).

2.2 Degradation of tree and forest resources

Degradation of the existing forest quality is the second process which is rather difficult to define (Lund, 2009) and therefore measure (FAO, 2011a). Forest degradation is a process that erodes the ecosystem services of the forest. It is observed by reduction of biodiversity, erosion, reduced canopy cover, fragmentation, increased presence of invasive species, soil fertility, reduction of carbon stock and sequestration and others (FAO, 2011a). In Bangladesh, frequent natural disasters are a driver of degradation of land area of which erosion, cyclonic storm surges and saline intrusion in coastal areas becoming increasingly apparent. However, uncoupling these from manmade climate change against 'natural' events is becoming increasingly difficult (Miah, 2010). Data from NFA 2005-07 shows that the percentage of forest land area, in the major land use classes, is impacted by various environmental problems (Table 1). The same area may have multiple environmental problems.

It has been found that the most common environmental problems in Bangladesh are loss of soil fertility, erosion and flooding, but also poor water and drought (Table 1). In "Forest", the most common environmental problems are erosion, over exploitation and loss of soil fertility. In "Cultivated land" and "Villages" the most common problems are loss of soil fertility, flooding, poor water and drought. In "Inland water" erosion, flooding, poor water and loss of soil fertility are the most common environmental problems (BFD, 2007).

Table 1: Percentage of major land use classes impacted by various environmental problems (Source: BFD, 2007)

Environmental problems	Major land use class				
	Forest (%)	Cultivated land (%)	Village (%)	Built up area (%)	Inland water (%)
Not existing	9	44	40	55	40
Loss of water	-	2	2	-	2
Drought	-	9	9	1	2
Flooding	-	18	17	5	16
Poor water	9	5	11	-	16
Pests	10	7	2	-	-
Erosion	60	8	2	-	20
Loss of soil fertility	24	20	17	14	11
Burning	5	3	2	-	-
Wind throw	2	-	-	-	-
Over exploitation	28	4	-	1	-
Overgrazing	2	-	-	-	-

2.3 Increase of tree and forest resources

Tree and forest cover gains are also observed in Bangladesh, particularly in village or peri-urban areas (M. A. Salam, 2000).The Global Forest Change dataset by Hansen *et al.* 2013 shows that overall national gain in tree cover from 2001 to 2012 was 6750 ha (Derived from UMD time series analysis). The BFD have long recognized the value of forest and have established an ambitious target of 20% forest cover under the draft National Forestry Policy of 2016 (Bangladesh Forestry Department, 2016). Recent policy initiatives recognize the importance of biodiversity conservation, climate resilience, food security and nutrition and propose strategies for their improvement (Forest Department, 2016). Improved management of trees and forests requires an understanding of the biological resources, the historical changes and of forest condition, trends in changes to management objectives and relevant policy and a critical understanding of the interrelationships between ecosystems and local people within a socioeconomic context. Social forestry is one of the important strategy to increase tree coverage as well as improvement of socioeconomic condition of the community people (L. M. Rahman, 2016). The social forestry has been executed in the newly accreted land (locally called char), drained tracts, ponds and tank boundaries. Up to 2014-2015, 51389 hectares of woodlot plantation, 10626 hectors of agroforest, 64834 km of strip plantation and 9007 hectares of other plantation have been raised and about 605566 beneficiaries are involved in social forestry programmes. An amount of Taka 2362 million has been distributed to 120413 participants as benefit of social forestry (BFD, 2016 cited at (L. M. Rahman, 2016)).

2.3 Analyzing tree and forest change processes in the different zones of Bangladesh

It is important to focus at the sub-national level by analyzing the different zones and the socio-economic elements that are relevant within the context of land use change. The zones of Bangladesh will be considered in the context of both the BFI's biophysical survey and the socio-economic component to effectively monitor the different pathways of change depending on demographic factors and the different human activities that occur within them (M. Alam, 2009).

Table 2 below highlights the changes of land use within the period 2005-2009 as extracted from Globcover. The Table 2 shows that the forest land is decreasing in trend particularly coastal, Hill, Sal and village area except Sundarbans. On the other hand, crop land is in increasing trends. That means forest land are converted in different land use particularly crop land. Conversion of forest land to other types of land (cropland, grassland, settlements and wetland) is marked (*), while the other types of land to forest land is marked (**).

Table 2: Increase/Decrease of forestland by zone (Source: Globcover)

2005

	Type of Land/Zone	Cropland (in ha)	Forest land (in ha)	Grass land (in ha)	Other land (in ha)	Settlements (in ha)	Wetland (in ha)	Grand Total (in ha)
2009	**Coastal**	**358,892**	**99,588**			**511**	**27,640**	**486,631**
	Cropland	351,771	14,925*			56	1,897	368,650
	Forest land	7,068**	84,653			18**	1,981**	93,720
	Other land	53	9*				53	115
	Settlements	0				438		438
	Wetland	0	0				23,709	23,709
	Hill	**146,213**	**1,503,379**	**44**		**3,520**	**44,592**	**1,697,748**
	Cropland	132,204	23,224*	0		29	983	156,440
	Forest land	14,009**	1,480,155	0		657**	6,332**	1,501,154
	Grass land		0	44			0	44
	Settlements	0	0			2,834		2,834
	Wetland	0	0				37,276	37,276
	Sal	**476,734**	**17,196**			**36,248**	**2,636**	**532,814**
	Cropland	475,910	2,659*			43	70	478,682
	Forest land	798**	14,459			61**	26**	15,343
	Other land	26	78*			9		113
	Settlements	0	0			36,135		36,135
	Wetland	0					2,540	2,540
	Sundarbans	**7,079**	**390,452**				**24,556**	**422,088**
	Cropland	5,805	1,637*				2,030	9,472
	Forest land	1,274**	388,815				3,343**	393,432
	Other land						9	9
	Wetland	0	0				19,175	19,175
	Village	**8,707,321**	**1,560,759**	**3,427**	**14,055**	**55,934**	**392,792**	**10,734,288**
	Cropland	8,628,408	603,866*	103	427	310	8,711	9,241,825
	Forest land	74,620**	934,910	199**	769**	176**	9,343**	1,020,018
	Grass land	0	0	3,125			0	3,125
	Other land	4,293	21,984		12,859		408	39,543
	Settlements	0	0			55,447	0	55,447
	Wetland	0	0	0	0	0	374,330	374,330
	Grand Total	**9,696,240**	**3,571,374**	**3,471**	**14,055**	**96,214**	**492,216**	**13,873,569**

* Conversion of forest land to other types of land

** Conversion of other types of land to forest land

Using Globcover, data on land cover change from 2005 to 2009 show that 14,925 ha of forest land was converted to cropland for the coastal region, while only 9067 ha of other type of land was converted to forest land showing great decrease in resources. Decrease of forest land in the hill region is less significant with overall decrease of 2226 ha of forest land. For the Sal, the overall decline in forest land is 1774 ha. Data suggests an increase of forest land in the Sundarbans by 2980 ha, mainly through conversion of wetland into forests. Globally, agriculture is highlighted as one of the most significant drivers of land use change and in particular forest land conversion. This holds true for Bangladesh, as the data suggests that in the village zone, net conversion of forestland to other use, mainly cropland, is at 518759 hectares. Overall, this suggests a significant level of overall decline in tree and forest resources in the country. (S. Rahman, 2010) has documented six decades of land use change in Bangladesh and suggests land use intensity has increased significantly since the 1960s on the back of widespread adoption of a rice-based Green Revolution technology extension packages, such as high yield crop varieties and increased fertilizer availability.

3. DIRECT DRIVERS OF CHANGE ACCORDING TO ZONES

Direct or immediate drivers impact tree and forest resources directly and are relatively easier to identify, monitor and quantify as they are related to specific events (Gabrielle Kissinger, 2012). This section provides an overview of the direct factors that impact tree and forest resources by zone. A short summary of these drivers is provided below in Table 3.

Table 3: Specific Drivers of Tree and Forest Resource Change by Zone

Zones	Conversion of forest to other land uses	Degradation of tree and forest resources	Increase of tree and forest cover
Sundarbans	- Competing land use for agriculture, shrimp farming and other (M. R. Islam, 2006) - Fire damage (MAP, 2010)	- Pollution: oil spillage, heavy metals, agrochemicals, pesticides from ships, industries and agriculture (M., Chongling Y., & K.S., 2009) - Salt intrusion due to construction of Farakka barrage (Kibria et al., 2010) and development of sea ports in Khulna and Chittagong (M. M. Rahman, M. Rahman, & K. S. Islam, 2010) - "Top-dying" disease of mangroves (M. M. Rahman, M. Rahman, & K. S. Islam, 2010) - Natural calamities (Sidr (2007), Aila (2009) - Over exploitation of resources (illicit removal of timber) (M. M. Rahman, M. Rahman, & K. S. Islam, 2010)	- National forest management plan and policies (BFD,2016)
Hills	- Illegal possession and uncontrolled logging (BFD, 2007) - Jhum cultivation and agricultural conversion (Kibria et al., 2010) - Settlements (Chakma, Khisa, & Chakma, 2008) - Industrialization	- Heavy reliance on tree and forest resources (firewood, material for building houses) (Misbahuzzaman, 2007) - Soil erosion - Natural calamities	- Plantation of trees (Acacia, Teak etc.) - Community based forest management and conservation - Forest management plan and policies (e.g., co-management)

	- Development intervention (e.g. road) -		
Sal	- Illicit occupation and removal of timber and firewood (Kibria et al., 2010) - Industrialization - Encroachment	- Introduction of invasive species such as *Acacia* and Eucalyptus - Overgrazing - Excessive use of pesticides for pineapple and banana plantations (Rahman, Rahman et al. 2010) - Soil erosion - Heavy reliance on tree and forest resources for construction materials, fuelwood, fodder and recreation of surrounding population (Rahman, Rahman et al. 2010)	- Rubber plantation - Teak plantation - National forest management plan and policies (BFD, 2016)
Coastal	- Unauthorized cultivation and occupation - Devastation from cyclones and storms (Kibria et al., 2010)	- Pollution from shrimp farming (GESAMP, 1991) - Soil erosion - Flood - Salinity intrusions - Unplanned shrimp cultivation (Rahman and Begum, 2011)	- Management plan (Coastal afforestation)
Village	- Encroachment - Infrastructure development (buildings, roads, industries etc.)	- Natural hazards (Flood, drought, etc.) - Heavy reliance on fuelwood	- Smallholder homestead forestry for subsistence (B. Roy, Rahman, & Fardusi, 2013) - Homestead forestry or agroforestry by large homeowners for commercial purposes (M. A. Salam, 2000) - Social Forestry (Rahman, 2016)

3.1 Sundarbans

The Sundarbans is an area of mangrove forest located in the south-west region of Bangladesh, extending to India. It is the world's largest mangrove forest tract and is an important habitat for the critically endangered Bengal Tiger (Gopal & Chauhan, 2006), and supports a myriad of floral and aquatic diversity. The Sundarbans were declared a world heritage site by UNESCO in 1987 (Kibria, Sunderland, Rahman, & Imtiaj, 2010). Sundarbans forest has depleted 35% over 25 years (from 717 million m cft in 1960 to 542 m cft in 1985) (S. A. Chowdhury, 2004). Although the data suggests, net increase in forest land in the Sundarbans, as highlighted in Section 3, but there is a decreasing trend that is offsetting the potentially larger positive effects. The Global Forest Change Dataset also support the fact showing a decreasing trend in tree cover of Sundarbans. According to a newspaper report, around 300 conglomerates, businesses and individuals bought about 10 thousand acres of land in the villages adjacent to the Sundarbans to establish industries and other infrastructure that possess the potentiality of forest over loss to a great extent (M. Iftekhar, 2016). These decreases in resources is occurring for a large number of specific factors as highlighted below.

3.1.1 Forests converted to other land use

Fire threats to Sundarbans

Fire is one of the major threats to Sundarbans forest in recent years, mainly due to human activities, including fires set to clear forests for fuel wood and carelessly disposed cigarettes. On March 20, 2010, around 250 ha of the forestland were damaged by fire and is not uncommon in the Sundarbans, with 12 fire incidents in the 3 years leading to 2010 (MAP, 2010). According to publised report 21 fire incidents have been reported in Chandpai and Sharankhola ranges of Sundarbans in the 14 years (Star, 2016a). In 2016, four fire incidents have been reported in the Sundarbans forests. Many precious plant speceis like Sundari, Goran and Gewa burnt into ashes resulting fresh grasses were observed and Sundari plants were not growing in the affected areas (Star, 2016b).

Shrimp farming leads to ecosystem disturbances

Sundarbans forests, the most notable ecosystmes, fall under the prey of shrim pond construction with its massive destruction. A number of shrimp ponds developed along the periphery for catching shrimp fry shrinks the reserve area of the Sundarbans (M. M. Rahman, M. Rahman, & K. S. Islam, 2010). The extreme fishing pressure grasps shrim fries as well as other important revering species that spawn in the coastal areas. It destroys the environment of the coastal area ecosystem as well (Md Mizanur Rahman, Giedraitis, Lieberman, & Akhtar, 2013). It has been found that manjority number of people are engaged in galda shrimp fry (24.3%) collection, followed by collection of bagda shrimp fry in the Sundarbans zones (IUCN, 2014). In 2005, the total area under Bagda farming was about 187,644 ha (CEGIS, 2006 cited at (IUCN, 2014)). Although shrimp cultivation contribute to the national economy of Bangladesh, it has been causing severe threats to local ecological systems, such as-deterioration of soil and water quality, depletion of mangrove forest, decrease of local variety of rice and fish, saline water intrusion in ground water, local

water pollution and change of local hydrology (M. A. Chowdhury, Shivakoti, & Salequzzaman, 2006; A. W. R. Hasan, 2016).

3.1.2 Degradation of Tree and Forest Resources

Illegal logging and poaching

Illicit removals of timber are caused by large gap between the demand and supply of wood and persistent unemployment in rural areas, which results in continued dependence on gathering of wood for livelihoods and subsistence. Organized groups of mongers who illegally cut and remove valuable trees, even from the inner regions of the forest, are a major cause of deforestation in the region (Mohammed M. Rahman, Motiur Rahman, et al., 2010). Illegal poaching of wildlife, are leading to loss of mangrove forest and as a result biodiversity of the area is reducing at an alarming rate (Saif, 2016).

Seaports

Degradation has also been exacerbated with the development of two main seaports at Khulna and Chittagong, which handle most of Bangladesh's imports and exports, respectively (Mohammed M. Rahman, Motiur Rahman, et al., 2010). Increasing population with limited alternative livelihood opportunities pose a serious threat to the mangroves, leading to excessive exploitation and neglect in restocking (M. Ali, Kabir, & Hoque, 2006).

Overgrazing

Degradation due to overgrazing is also common, as mangrove leaves are used as food for domestic animals such as goat, cattle, sheep and cow. Livestock access to the mangroves is relatively easy (Mohammed M. Rahman, Motiur Rahman, et al., 2010).

Pollution

Oil spillage, heavy metals, agrochemicals, pesticides and nutrient enrichment have significantly changed the mangrove ecosystem's biogeochemistry (M., Chongling Y., & K. S., 2009). Huge amounts of garbage, waste water, pollutants and other effluents is discharged to the mangrove wetland due to industrial development, agriculture and aquaculture near the river basins, and population increase. The Mongla port is a major source of oil pollution situated at the north edge of the mangroves. Numerous large shipping vessels pass through the Sundarbans everyday though the north-east shipping route (ESCAP, 1988). These vessels release lots of pollutants, including waste oil, spillage, ballast water and bilge washings. The most dangerous pollutants are crude oil and its derivatives which enter the mangrove forest due to oil transportation (M. S. Iftekhar, 2004). It has been reported that about 350000 liters of furnace oil crashed in the Shela river of Sundarbans and polluted Sundarbans ecosystem (Star, 2016a).

Salt intrusion

Construction of the Farraka barrage over upstream Ganges by India in West Bengal has led to reduction of the water flow significantly during the dry season. The reduced flows, that are now one third of pre-construction rate, once flushed the accumulated salt from the system is leading to increased salt intrusion from the sea and is altering the ecosystem in terms of stocking rate and floristic composition, most notably

of two major species *Heritiera fomes* and *Nypa fruticans.* Coupled with reduced sediment supply and over extraction of the main fuel wood *Ceriops decandra* (MS Iftekhar & Islam, 2004), the multitude of stresses affects the vulnerability and access to livelihoods assets at the household scale of local people (Shameem, Momtaz, & Rauscher, 2014). However, the damaging accumulation of salt water has been a boon for shrimp farmers - a practice that has brought a suite of negative environmental outcomes.

Mismanagement and resulting poor drainage of polders established in the 1970's and 80's caused water-logging, which lead to salination and reduced the profitability and subsequent viability of rice production in the region. The steady expansion of shrimp farms in the region, that followed a trend of global demand since the 1980'shas resulted in dissatisfaction among local people due to the perceived influence of shrimp farming on land fertility, health and biodiversity loss (T. Islam, Navera, & Mahboob, 2011). This conflict stems from the fact that comparatively poorer locals rarely have the capital to enter the market, meaning wealthy businessmen engage external labour that limits the distribution of wealth throughout local area. A study by the Soil Resource Development Institute revealed that 50, 000 hectares of mangroves located predominantly in the Sundarbans, has been deforested. This coincides with a 50,000 ha increase in aquaculture in Khulna division over the same period. In 2010, the area of shrimp Ghers was 96,283 hectares, having risen from zero in 1973 (M. N. Hasan et al., 2013). Over 9000 shrimp farms are currently in operation and is well in excess of the sustainable level (S. Akhter, 2010).

Natural calamities and climate change

Natural calamities such as cyclones, floods, storms, coastal erosion, naturally shifting hydrology, climate change and sea level rise lead to further destruction of trees (Rahman et al., 2010). The most notable natural disasters in last decades were cyclone Sidr in 2007 and Cyclone Aila in 2009 (Saif, 2016). It has been estimated that about 8-10 percent of forest has been damaged completely, while 15 percent has been partly damaged (Manik & Khan, 2007). Cyclone Sidr caused the death of 3,363 individuals around the Bangladesh Sundarbans (GoB 2008, cited at (Saif, 2016). Additionally, as a result of cyclone Aila, around 500,000 people were displaced from their homes (cited at (Saif, 2016).

Climate change further threatens biodiversity of the Sundarbans, increasing immersed areas and salinity of water in coastal areas. Higher temperatures, sea level rise and changing rainfall patterns, and increase in intensity and frequency of extreme events due to global warming, such as floods, storm surges and cyclones and sea level rise, further threatens these mangroves (Mohammed M. Rahman, Motiur Rahman, et al., 2010).

Other causes

Large causes of deterioration in the forest include "top dying", a common disease for Sundari trees and also rising salinity in rivers, canals and other water bodies in the mangrove forest (M. M. Rahman, M. M. Rahman, & K. S. Islam, 2010). Other aspects that threaten the mangroves in the Sundarbans are diseases and natural disasters, such as, storms, floods, cyclones, coastal erosion and natural changes in hydrology, e.g. sea level rise and inadequate regeneration (Mohammed M. Rahman, M. Motiur Rahman, et al., 2010).

3.2 Hills

3.2.1 Forests converted to other land use

Encroachment

The hilly regions of greater Chittagong, CHT and Sylhet comprise of tropical moist, evergreen and semi-evergreen forests represent 38.2% of the country's total forest (Kibria, Rahman, Imtiaj, & Sunderland, 2011). The area is subject to unregulated logging which is leading to increased landslides and soil erosion (BFD, 2007). This process is now considered one of the main causes of deforestation in the CHT (S. Rahman et al., 2010). Different government development initiatives (like, construction of Kaptai hydroelectric dam, Bangladesh Airforce base, roads and highways etc.) directly lead to conversion of forestland (M. Iftekhar & A. Hoque, 2005) (MS Iftekhar & Islam, 2004). In Sylhet region, gas exploration by the multinational corporation has contributed to the destruction of forestry and environment (A. I. M. U. Ahmed, 2008).

Population pressure and poverty are the main two factors stimulating forestland encroachment. Forests provide new areas for agriculture and a range of subsistence products. With increasing population, more families search land for agriculture or look for fuelwood or timber. Larger number of people also means more labor is available for agricultural activities. Forest encroachment results in forest degradation and forest degradation results in land degradation, and this leads to agricultural stagnation and even a lowering of productivity, which in turn promotes further encroachment and completes the vicious cycle (Angelsen & Kaimowitz, 1999; M. Iftekhar & A. Hoque, 2005; M.S Iftekhar, Hoque, & I.M.).

Jhum (shifting) cultivation

Deforestation is also caused by conversion of land to other land use, particularly for slash-and-burn cultivation or shifting cultivation (locally called jhum cultivation) in the Chittagong Hill Tracts. Shifting cultivation is a traditional type of agriculture practice by the resource poor communities with a rotation of cultivation and fallow in the same unit of land (S. A. Rahman, Rahman, & Sunderland, 2012). It has been estimated that about 80,00 families practice shifting cultivation in CHT (Banik, 2003, cited at (Banik & Kunda, 2013). With increasing population pressure, the jhum cycle is accelerated leaving little insufficient fallow period that previously allowed forests to regenerate (Kibria et al., 2010).

Settlements

The hill forest area located in the international boundary between Myanmar and Bangladesh, have sheltered Rohynga refugees of up to 1 million since the 1990s (G. Rasul, Thapa, & Zoebisch, 2004). These people have become very much dependent on forest resources. This has led to forest land being converted to other land use, with establishment of plantations in clear felled areas, encroachment of land for agricultural conversion, particularly swidden agriculture, and human habitation and livestock grazing in the forest areas. All this has led to increased pressure on tree and forest resources of the region (Kibria et al., 2010).

Hill deforestation in the CHT was significantly accelerated because of the Karnaphuli hydro-electricity project (Global Forest Coalition, 2010). The people–forest relationship in CHT was further impacted by the creation of the Kaptai Reservoir in the 1960s. The dam inundated two fifths of total plough lands of the region and a large part of adjacent forests, displacing an estimated 100,000 indigenous people. The majority of the displaced people took refuge in the forest areas in the region that has caused significant population pressure and encroachment in the forest areas (Adnan & Dastidar, 2011).

The population transfer programme under the government was initiated in 1978 with settlement of hundreds of Bengali migrant families in the Kassalong reserve forest and this further exacerbated the problem. Before independence, commercial leasing of forestlands for plantation to supply industrial raw materials created severe pressure on forest resources. After independence in 1971, forest degradation was further exacerbated by the unpopular population transfer project which started in 1978 (Chakma, Khisa, & Chakma, 2008). According to the literature, 400,000 Bengalis were settled in the CHT between 1980 and 1984 (Adnan & Dastidar, 2011; Barkat et al., 2009; Bhumitra, 2010).

3.2.3 Degradation of trees and forests

Over-extraction

An estimated 17% decline in the resource base has been observed in the forests of CHT over the last 21 years (S. A. Chowdhury, 2004). The loss of the forest resource is affecting local people who rely on the diminishing supply of forests for bamboo poles, canes etc. to repair their houses, firewood for domestic consumption, medicinal plants for their health, and many other minor forest products as part of their daily diet. Large demand for these resources creates pressure on the already declining resource base (Misbahuzzaman, 2007).

Fire

Forest fire is also particularly significant in the context of CHT, where jhum or slash and burn cultivation is practiced. This practice is particularly risky in terms fire spreading out of the farmers' control, which burns up huge areas of forest land. NFA 2005-7 highlighted that 56000 ha of land destroyed by fire in the hill region, in that current year.

3.3 Sal

The Sal forest are mainly located in the Gazipur, Dhaka, Mymensingh and Tangail districts and cover an area of 369000 ha of forest land (BFD, 2016). The Sal forests are in patches, intermingled with private agricultural lands and habitation, and are surrounded by small blocks of forest. More than half of the total Sal forest has been depleted, while remaining patches are in poor condition, degraded and in the process of being lost (Kibria et al., 2010).

3.3.1 Forests converted to other land use

Encroachment

Sal forests were felled for timber followed by coppice regeneration, when the Government recognizing the practice was no longer sustainable introduced prohibitive policies against it. Policy measures, however, did not stop felling and land clearance for agriculture and forest land encroachment continued (BFD, 2007). Particularly in the Sal forests, lack of clear boundary demarcation and weak tenure arrangements leads to continued encroachment and a precipitous decline in the quality and extent of the Sal forest ecosystem (BFD, 2007). It has been reported 77,000 ha of forest land involving 12,200 families are estimated to be encroached (FMP, 1993). Out of 46,000 acres in the Tangail part of the Modhupur forest, 1,000 acres (2%) to the Air Force, 25,000 acres (54%) have gone into illegal possession and the FD controls only 9,000 acres (20%) (A. I. M. U. Ahmed, 2008).

Conservation of forest land into Agricultural land

Rapid conversion of forests into agricultural land, encroachment and denudation of forests through illegal occupation is common (M. S. Iftekhar & A. K. F. Hoque, 2005). Social forestry programmes that were initiated in 1989-1990 was preceded by rubber monoculture plantation, which played a huge role on destruction of Sal (Mohammed Mahabubur Rahman, Rahman, Guogang, & Islam, 2010). However, even with the introduction of social forestry, plantation forestry still remains one of the most significant threats to biodiversity in the Sal forests. Growing rubber monoculture and expanding commercial fuelwood plantations has led to growing threats for the Sal(Mohammed Mahabubur Rahman et al., 2010). Under reforestation programmes, new plantations of exotic species, such as Akasmoni and Eucalyptus, which are also considered invasive species, have been introduced in many areas of the Sal, and is leading to further loss of biodiversity, species extinction and forest degradation (P. Gain, 1998). Out of 46,000 acres in the Tangail part of the Modhupur forest, 7,800 acres (17%) have been given out for rubber cultivation (A. I. M. U. Ahmed, 2008).

Infrastructure development

Industrialization (illegal possession) and militarization are reported another cause of deforestation of Sal forest in Greater Mymensingh District(A. I. M. U. Ahmed, 2008) (Ahmed, 2008). It has been reported that local people are selling their lands to outsiders for industrialization as it requires vast area of land. About1,000 acres (2%) forest lands converted into Air force base and training ground that contributed to the deforestation ((A. Ahmed, 2008).

3.3.2 Degradation of trees and forests

Over extraction

Various ethnic groups such as the Garos and Hajongs, who live near the Sal forest, are highly dependent, on its resources to satisfy many of their basic needs, such as food, fuel, medicinal herbs, raw materials for construction of houses, boats, furniture, and many other items of trade and commerce (Mohammed Mahabubur Rahman et al., 2010). The forests provide resources such as timber, fuelwood, bark tannin, animal fodder, native medicines and food (e.g, fruits, honey and wildlife) for centuries. Illegal cutting, encroachment of forest areas, and illegal poaching of wildlife, is leading to increasing loss of biodiversity at an alarming rate (Mohammed Mahabubur Rahman et al., 2010).

Illegal cutting and overgrazing

Lucrative timber trade provides one of the few income-generating opportunities for people in Sal forests leading to illegal cutting (P. Gain, 1998). Poaching also presents major threats to the Sal forests (Mohammed Mahabubur Rahman et al., 2010). Overgrazing presents a significant problem in the Sal forests. Constant trampling largely contributes to the erosion of surface soils, which impacts forest longevity (Gautam & Devoe, 2006).

3.4 Coastal

The coastal zone extends from the eastern edge of the Sundarbans to the border of Myanmar and includes mudflats, chars, new accretions and offshore islands within the Bay of Bengal. The area is a highly dynamic ecosystem with river and tidal flows continually changing its extent and area. The area is very densely populated indicative of an area that comprises approximately 20% of land area yet contributes 30% of cultivatable land (Haque, 2006). This is particularly concerning for a country that is regarded as the most vulnerable to sea level rise (SLR) And people living in this area are likely to be most affected considering their dependence on vulnerable industry such as agriculture, fisheries and salt production for (M. M. Islam, 2006).

3.4.1 Cyclones and natural events

Periodic cyclone damage affects the coastal zone most significantly and in the context of climate change the severity of these events is likely to increase. Around 16.84 million trees were recorded to be uprooted from the coastal areas during the devastation Sidr in 2007 (M. M. Hasan & Jaima, 2012). Storm surges are a common aftermath from cyclones which have potentially more pervasive and long lasting effects stemming from salt water intrusion, exacerbated by reduced freshwater flow from the Padma that are required to flush accumulated salt from the system (Kibria et al., 2010).

3.4.2 Forests converted to other land use

Encroachment

The destructive presence of salt water for some presents opportunities for others. Shrimp farmers have actively tried to retain saline waters for their aquaculture practices, much to the detriment of crop farmers. In Cox's Bazar, 15 tons of waste from shrimp farming are added to the water on a daily basis (GESAMP, 1991). Particularly, in Mohesh Khali of Cox's Bazar, conversion of forest land for salt production is also a major issue (Mohammed M. Rahman, M. Motiur Rahman, et al., 2010). The most affected area are in the coastal belts of Noakhali and Chittagong, where much of the land has been lost to unauthorized cultivation and occupation (M. Alam, 2009).

3.4.3 Increase of tree and forest resources

Accretion

The coastline of Bangladesh has always been undergoing several changing phases caused by radical accretion and erosion of lands along the coastal zone. Huge sediment supply by the Ganges-Brahmaputra-Meghna river system contributes significantly for land accretion. Focus of development projects has been on rapid accretion via mangrove plantations, which can have negative impacts on the land, that can no longer support mangroves. This practice of mangrove plantations to accelerate accretion of land does not support objectives for optimal timber production, which can hinder forest cover growth in the long term (Saenger & Siddiqi, 1993).

Coastal Afforestation

The coastal zone covers 32% of total land area of Bangladesh and coastal forests cover 11% land area of coastal zone (Banik & Kunda, 2013). The coastal forests protect lives and property from natural calamities as well as play an important role in socioeconomic development of coastal people (Banik 2011 cited at (Banik & Kunda, 2013). Since 1960, The Bangladesh Forest Department has been implemented coastal afforestation on the coastal embankments, newly accreted coastal char lands and offshore island along with 710 km of coastline. Man-made coastal forests cover about 212,334 ha of lands up to 2013 and represent as green-belt along the coastline (Banik & Kunda, 2013).

3.5 Village

Douglas (1981) describes village forests or homegardens as "a multi-storied vegetation of shrubs, bamboos, palms and trees surrounding homesteads that produce materials for a multitude of purposes in the village areas of Bangladesh". The management practice for maintaining homegardens or village forests is described as agroforestry (KP, 2006). Human dominated landscapes which are tree covered are significant to conserve biodiversity. Village forests also play key roles in providing ecosystem services such as carbon sequestration, biodiversity conservation, soil quality, and preserving air and water quality (Bardhan, Jose, Biswas, Kabir, & Rogers, 2012). Homegardens are particularly helpful to reduce pressure on public forests for biomass fuel and wood products (Mukul, Tito, & Munim, 2014).Homesteads and their appropriate management, including intercropping practices, have been recognized as an important

strategy for enhancing tree cover, and also to meet the basic needs of forest-reliant people and to maintain environmental balance(B. Roy et al., 2013).

3.5.1 Increase of tree and forest resources

Smallholder homestead forestry for subsistence

Small and medium household owners usually produce variable homestead garden products, such as seasonal fruits, firewood, medicinal plants, timber, and vegetables and spices. Farmers show a particular preference to fruit trees because fruit trees provide immediate cash return; contribute largely to household food and nutrition requirements; support livestock; and can also be used as "gift" item on socio-religious occasions(B. Roy et al., 2013).Mainly, homestead gardens in Bangladesh comprise of fruits, timber and bamboo species. Contribution of homestead to subsistence is large in terms of food security and other necessary household materials. Proximity to natural forests and local market demand of timber also influences the propensity to plant timber and fuelwood in home gardens. At times, inability to access fuel-wood in the local market due to financial constraints may encourage marginal or smallholder farmers to grow fuelwood, as well as non-timber forest products and vegetable gardens. (Md. Motiur Rahman, Furukawa, Kawata, Rahman, & Alam, 2005).

Homestead forestry for commercial purposes

Decisions on whether or not to plant more trees around the homestead depends on economic reasons, i.e whether the produce can be sold at a profitable price and market access (M. A. Salam, 2000). Market access in an important determinant for these large household owners to maintain homestead gardens. Large land owners usually produce less diverse products, which they sell in the markets (B. Roy et al., 2013). This also largely depends on the price of tree and forest products, particularly timber, in markets.

Social forestry/Community forestry

Social forestry plays an important role in reducing poverty among the resource poor communities as well as increasing tree cover, rejuvenate the degraded ecological climate condition ((N. Muhammed, Koike, Sajjaduzzaman, & Sophanarith, 2005; Nur Muhammed, Koike, Sajjaduzzaman, & Sophanarith, 2016). Since 1979 Bangladesh Forest Department has been implementing Social Forestry /community forestry programmes in the country and playing a vital role in the expansion of forest cover (40,387 ha of new forest cover and 48,420 km new strip plantation since the mid-1980s) benefiting thousands of poor people (N. Muhammed et al., 2005). Currently 500,000 beneficiaries are engaging in the on-going SF programmes and 44,408 ha woodlots, 10,626 ha agroforestry and 61739 KM strip plantation have been established (BFD, 2014). It has been reported that BDT 2066.86 million has been distributed among 102800 participants as part of their benefit sharing (Banik & Kunda, 2013).

This section presented an overview of specific drivers of resource change in each zone. The next section highlights the main underlying drivers of these changes.

4. UNDERLYING CAUSES OF CHANGE

Geist and Lambin (2001) defines underlying drivers as “forces (or social processes) that underpin the more obvious or proximate causes of tropical deforestation. They can be seen as a complex of social, political, economic, technological, and cultural variables that constitute initial conditions in the human-environmental relations that are structural (or systemic) in nature. In terms of spatial scale, underlying drivers may operate directly at the local level, or indirectly from the national or even global level.” Kaimowitz and Angelsen (1998, p. 95) as cited in (Geist & Lambin, 2001) highlight that “it is more difficult to establish clear links between underlying factors and deforestation than between immediate causes and deforestation [since the] causal relationships are less direct“.

4.1 Governance

The good governance dictates whether forest resources are used efficiently, sustainably and equitably, and whether countries achieve forest related development goals. On the other hand, poor forest governance has ripple effects and reflects overall weakness in governance within a country (FAO, 2011c). In preparing the draft National Forest Policy, the Forest Department (2016) have acknowledged the deleterious implications of a reduced and degraded forest resource and have a mandate to improve management over and “increase and stabilize its forest cover to at least 20% of the country's geographical area”. “Forest Land’’ or land under management of the BFD is comprised of reserve forest, protected forest, acquired forest and crosses over various land types and geographic regions. However, the nation’s tree and forest resources are not confined to these areas alone. Indeed approximately 67% of the country’s woody biomass exists outside of recognized state forests(Bangladesh Forest Department, 2007). Trees Outside of Forests (ToF) are therefore a fundamental component of the forestry resource and are becoming increasingly recognized for their contribution to biomass, carbon stocks and livelihoods (Hubert de Foresta et al., 2013; Schnell & Kleinn, 2015).In this context, various socioeconomic (SE) dimensions are embedded under the objectives of the Forest Department **(Box 1)** as per its draft National Forestry Policy 2016.

Lack of reliable data on forest-dependent peoples, including their numbers, livelihoods and other socioeconomic linkages with forests (food security, nutrition, water supply, etc), itself demonstrates their marginalization in forest policy making (Chao, 2012). These objectives need contextualization by means of primary data collection, in order to support implementation of policies and plans at the local level.

As mentioned before, major policies and plans in the forestry sector (National Forest Policy, Master Plan and Country Investment Plan) are being revised, with re-emphasis on drawing on more rigorous understanding of socio-economic dimensions of forest-dependent people to inform tree and forest management policies. Looking at how the forestry sector contribution of the forestry sector to the economy can be improved is important, while also making sure that growth in the sector is pro-poor to ensure sustainability of policies. This means public involvement within various policies and departmental manuals of the Forest Department needs to be improved (S. A. Chowdhury, 2004). Focusing on integration

of the needs and vulnerabilities of the people through the Bangladesh Forest Inventory project will allow a more participatory approach to policy formulation.

Significant to sustainability of forests is the requirement of policies to address how the rich are accessing and using forests. This means that status quo of vested groups such as how local political leaders and social elites end up influencing such policies needs to be challenged. This means access to resources are very much defined with a bias for the elite, who can influence major changes in these resources through over-extraction (Biswas, 2007).

Box 1: Key Objectives of Forest Department (as per Draft National Forest Policy 2016)

The draft National Forestry Policy 2016 of the Forest Department identifies the following key areas for improved resource management in Bangladesh:

- Biodiversity conservation through sustainable management of forest ecosystems
- Control conversion of forestland to non-forest use
- Sustainable management of protected areas and wildlife corridors
- Engage in a more participatory process with local people to enhance forest productivity, reduce poverty rate, and enhance socio-economic benefits of local people
- Sustainable management of degraded and marginal areas, including coasts and wetlands and reduction of greenhouse gases through enhanced forest carbon sequestration
- Launch and sustain country-wide conservation movement with engagement with different stakeholders
- Meet requirements of all relevant international agreements, conventions and protocols to which GoB is signatory
- Monitor state of forest, biodiversity and ecosystem services to provide relevant information to GoB and agencies, and other stakeholders by building forestry research, analysis and institutional capacity

The policy also highlights:

"Intensify efforts to ensure that 20% of the country's area is under forests and tree cover, including 100% of state forests, 80% of hill land areas, 30% of terrain land areas, and 10% of plain land areas, by 2035 through afforestation, reforestation, social forestry, and ecological restoration and sustainable forest management programs involving the government, conservation and natural resources management non-governmental organizations (NGOs), and the private sector in partnership with local communities".

M. Alam (2009) suggests that policy is not backed up by sufficient legislative provisions, and is not followed up by program and strategy development, action plans and operational tactics. His study highlights that although the 1994 forest policy encourages people's participation in forestry activities, but the Forestry Act was only amended in 2000 to incorporate social forest. The study also highlights that many policies which are formulated are met with little practical action in terms of implementationM. Alam (2009).

Poor management direction, particularly in terms of logging bans implemented without any real strategy have failed to secure forests (S. Sarker, Deb, & Halim, 2011). Lack of coordination among other significant sectors, increases pressure on tree and forest resources. For instance, various land laws and land reforms are formulated with a bias towards agriculture or industries, while remaining contradictory to forest policy. Solutions need to be formulated in collaboration with other key sectors which have key influences on these resources, i.e. agriculture and land (Sunderland, Kibria, Rahman, & Imtiaj, 2011).

Regulatory policies need to take account of forest dependent livelihoods and sustenance practices. Established safeguards need to be maintained in forest policy. For instance, in the Sundarbans, extraction of certain forest products has been banned by the government, but this impinges on the traditional rights of forest-dependent people that was established in Bangladesh Wildlife Protection and Safety Act, 2012. Some species, such as the Golpata, require regular extraction, and banning all extraction may actually harm the mangrove ecosystem ("Ban slapped on some Sundarbans resources," 2014). Local people living nearby forests develop unwritten rights which become especially relevant when they participate in forestry operations under social forestry or co-management programs (D. Z Hassan, 2011). Issue of rights and land tenure and how these impacts on resources is further explored in the next section.

4.2. Forest Tenure

Clear and secure forest tenure is a prerequisite for sustainable forest management. According to World Resources Institute (2013) “forest tenure is a broad concept including forest ownership rights and other secondary rights to access, use, and manage forest resources.” Forest tenure shapes the relationship between people with respect to forests by defining who can use what resources, for how long, and under what conditions (ibid). **Box 2:** Different types of forest tenure (BFD, 2016) presents the different categories of tenure that are formally recognized. However, for the purpose of this review, the main distinction in tenure, are the *de jure*(formal) and *de facto* (prevalent due to customary practice) rights of forest dependent people, as these define access, conflict and resulting impacts on these resources.

Tenure is defined by ownership. Ownership of forest land can be of two types private and government. While private ownership is clear and is fully favourable of the individual or organization named in the land record (eg. homesteads, rubber gardens, and tea estates), but government ownership may have some contention, due to user interests. However, people may also accrue user rights over forest land that is owned by Government (FD) and can share in the benefits through agreements (D. Z. Hassan, 2011). Land tenure among ethnic populations, (e.g. CHT) is different than other regions. Rights over land in the CHT is divided into two broad categories - common rights and private rights. Around 2.025 million ha of this forest land is under the government as classified or nonclassified forests. 0.27 million ha is owned privately, commonly known as village forests (Bangladesh Forest Department, 2007).

Box 2: Different types of forest tenure (BFD, 2016)

Reserved Forest (RF): RFs fall under the management of the FD and are governed/protected under the Forest Act. Although these areas are titled "forest", in many cases they may not present canopy cover in line with national definitions of forest.

Protected Forest (PF): PFs are also fall under the management of the FD and are governed/protected under the Forest Act. PF are mostly found in Chittagong and Cox's Bazar districts and in patches in Noakhali, Nilphamari and Naogaon districts (Bangladesh Bureau of Statistics, 2016).

Vested Forests (VF): The Private Forests Ordinance, 1959 (E.P. Ordinance No. XXXIV of 1959) allows the Government to take over management of improperly managed private forest lands, any private lands that can be afforested, and any land lying fallow for more than three years. The Private Forest Ordinance was originally enacted in 1945, as the Bengal Private Forest Act, and was re-enacted by the Bangladesh (Erstwhile East Pakistan) in 1949. These government managed lands under this Ordinance are called "vested forests". This area is relatively small, but the area historically affected by this law is much larger.

Acquired Forests (AF): The private forest lands acquired by the government under the State Acquisition and Tenancy Act (SAT), 1950 (E.B. Act No. XXVIII of 1951) are called "acquired forests". The government has reserved many of these acquired lands under the Forest Act, 1927 (Act XVI of 1927) and those areas are now counted with the reserved forests. Under the SAT Act, the government has also acquired full ownership of many of "vested forests" (under Private Forest Act) and reserved them. The small area that is still managed as "vested forests" are largely lands that the government could not acquire under the SAT Act.

Un-classed State Forest Land (USFS): The USF are located in the Chittagong Hill Tracts (CHT). The USF were until recently under the control of the Deputy Commissioner and now have been placed under the control of CHT District Councils where they are used as jhum (slash and burn agriculture) by indigenous communities.

Protected Areas (PAs): PAs are defined under titles of Reserved, Protected and Vested Forest. Each have different management status. PAs include all sanctuaries, national parks, conservation areas, safari parks, eco-parks, botanical gardens, national heritage, kunjavan, and special biodiversity conservation area notified under the provisions of wildlife laws. Currently there are 21 Sanctuaries, 17 National Parks, 2 Safari Parks, 10 Eco-parks, 2 Botanical Gardens and one special biodiversity conservation area established in the country. PAs cover an area of 265,981 hectares and are governed and managed by the Forest Department. PAs represent some 1.8% area of the country and 11% of the designated forest land of the country.

Many assume that among the most important factors to protect forests is ensuring land tenure security (Robinson, Holland, & Naughton-Treves, 2011).(Angelsen, 1999) argues that clearly defined forest tenure does not necessarily protect forests and giving farmers land rights may translate to further deforestation. However, (Robinson et al., 2011) reviewed 130 empirical cases that suggest that land tenure security is associated with less deforestation, regardless of the form of tenure. (S. Rahman et al., 2010) found that positive forest outcomes have been related more to protected areas relative to private, communal and public land. Illegal possession of forest land resulting from unclear land tenure and rapid industrialization and urbanization are leading to fast depletion of forests. As a result, secure tenure is seen to be fundamental for success from long-term investments and future intensification of efforts.

Moreover, for REDD+ initiatives to be effective, clear and secure tenure is one of the enabling conditions. Tenure reform without effective enforcement may threaten success of future REDD+ implementation, and at the same time accelerate existing inequality in tenure arrangements as well as future REDD+ benefits (Tulyasuwan, Henry, & Karsenty, 2015).

4.2.1. Tenure and Ethnic Rights

Land reform strategies must incorporate consideration of the rights of indigenous people who depend on forests for such reforms to endure (Colchester & Lohmann, 1993). Under the UN Declaration on the Rights of Indigenous Peoples and the International Labor Organization Convention on Indigenous and Tribal Peoples No. 107, indigenous people have rights to their traditional forestlands (R. Hasan, 2014b). Recognition of traditional laws of the indigenous peoples as indigenous rights is needed to address conflicts between customary and statutory laws and regulations related to forest ownership and natural resource use in order to ensure conservation of forest resources by the indigenous people (Chakravarty, Shukla, Malla, & Suresh, 2008).Involvement of local/indigenous populations more closely in the decision-making process will contribute to better understanding of interactions between 'societies' and forest resource are understood in policy-making (Chakravarty et al., 2008).

4.2.2. Direct management by government

Reserved forests are under the direct management of the government, and use of these forest resources is controlled by the government. Successive governments have declared increasingly large tracts of forest land to be reserved. Government control of these forested areas has not necessarily enabled sustainable management of these resources (USAID, 2010). Forestland that does not have the legal status of reserved forests is highly susceptible to conversion (M. Alam, 2009).

In some forest land, the right to practice slash and burn agriculture in unclassified state forests, and the right of conversion of forest land to farm land (as in many Sal forestlands) have been provided. **Box 3**

highlights the tenural aspect of resource use for the CHT. Conflict between unwritten land rights of local residents and people and formal land regulations can largely define how tree and forest resources are impacted. These unwritten rights become particularly significant during implementation of social forestry and co-management schemes (D. Z Hassan, 2011). Impacts of management practices such as social forestry are covered in Section4.5.1.

Box 3: Forest management and tenure in the Chittagong Hill Tracts

Since 1900 in the Chittagong Hill Tracts (CHT), customary rules guided access to and use of forest land (CHT manual 1900). However, gradual introduction of new administrative systems and changes in forest management practices has influenced new ownership patterns in the region (Golam Rasul & Thapa, 2006). Traditionally, ownership of settlement and cultivation areas in the CHT were under common property systems. This type of *de facto* ownership allowed local ethnic people to enjoy rights of land and forest use for subsistence livelihood activities (Golam Rasul, 2007).

In recent times, there has been increasing legal or *de jure* arrangement for accessing land, but still only around one-third of the total population in CHT have legal registered rights to land. There are dual arrangement of customary and formal administrative process for accessing and ownership of lands in the CHT (Ahammad & Stacey, 2016). By tradition people accessed forest areas for different forest product collection and shifting cultivation (i.e. subsistence farming). However, these rights have reduced with increasing government control on management of forests and land-use systems. People may have access to government owned forests in some cases, but their secure tenure rights has not been properly addressed (Khan et al. 2012). Overlapping jurisdiction of resource use and ownership between customary land and government reserves creates complexities in the management of traditional common property (i.e. forests and shifting cultivation lands).

4.3. Social drivers of tree and forest resource change

The poor compete for resources and opportunities in an uneven playing field in terms of class, ethnicity, social inequities and economic opportunities, and also gender(Khan, 2001). Lack of education also has effects through lack of alternative livelihoods or reducing their dependence on forest resources. This is particularly true for the Sundarbans periphery areas, where the rate of literacy is extremely low. Few people own agricultural land, while rice paddy cultivation is not suitable for the area. Thus, people are forced to extract resources from the mangrove forests for income (Global Forest Coalition, 2010).

Poor people living in forests risk marginalization, exclusion and rights abuses. Largely the wealthier sections have more access to forest resources and access to opportunities in social forestry programmes than the poorer sections (Khan, 2001). Policies that enable some to profit (from timber, firewood and charcoal), while leaving others marginalized lead to exacerbation of poverty, and thus, need to be revised

to negate structural asymmetries. Relationship between religion, ethnicity, gender and income and the interaction with forest and forest resources have been identified, and are presented below. These social identities may intersect leading to grater vulnerabilities to access resources. The following sections present how different social drivers, ethnicity, gender, religion and patronage-client system create any change in tree and forest resources.

4.3.1. Ethnicity

Many ethnic minority groups depend on forests and shifting cultivation for their subsistence. This is particularly evident in the Hill and Sal region. Ethnic people largely depend on forests for their food cycle, medicine and building materials, and also other requirements. Vested interests measure and cut down trees for timbers, extract mines, minerals, and other resources in the pursuit of profit, leading to an overall decline of forest and tree resources. They nurture a spiritual connection with forests, which many urban people fail to observe, rather than interacting with forests by measuring value proportions of resources (Hasan, 2014).

Degradation of forest lands, encroachment by Bengali settlers and new government policies have worked towards deterioration of such religious/cultural values which enabled forest protection. Many ethnic people have migrated to nearby towns in search of employment after selling their land to new settlers (CPD, 2008). Historically, arrival of different civilization has translated to drastic change in the traditional life-style of indigenous people, breakdown of their social institutions and even displacement from their ancestral lands. Outside intrusion also affects customs and religious beliefs, and changes are further exacerbated by infrastructure development, eg. construction of roads which often result into social and land conflicts (Schmink & Wood, 1992).

A study by (R. D. Roy, 2004) shows that indigenous people in CHT only enjoy customary forest rights to the extent that they do not conflict with state law. Only some customary rights to resources have been formalized and recognized in practice, such as indigenous people's rights to minor forest produce (e.g., seeds, honey). Indigenous people execute legal rights based on generations of use of forest products and forest access (R. D. Roy, 2004). Therefore, conflicts between indigenous people and the state over forest land and accessing forest resources remains common. This makes access to resources more difficult for the poorer and more marginalized sections (USAID, 2010).

Ethnic interests must be incorporated into consideration of sustainable management options. In this way, indigenous people would be able to entitle a tenural ownership on the planted trees, and hence develop responsibilities to protect these resources (Hasan, 2014). This suggests that the survey should be aimed at collection of related data on ethnicity and resource use.

4.3.2. Gender

Forests are particularly significant for women, as women perform in a number of crucial roles related to forests that include, as farmers, harvesters, users of firewood, collectors, sellers of minor forest products,

and tenders of livestock (Baten & Khan, 2010). According to (Baten & Khan, 2010), gender refers to "the social roles and relations between women and men, which include different responsibilities of women and men in a given culture and location." Women and men have different roles in the use of tree and forest products and services. Men are more likely to be involved in extraction of timber and non-timber forest products. Women are likely to depend on forests for their household energy needs, and non-timber forest products, that serve nutritional, health, and cultural benefits for households (Otzelberger, 2011). Women generally gather forest products for fuel, fencing, food for the family, fodder for livestock and raw material to produce natural medicines (U. a. G. IUCN, 2010). These roles and needs, of course, largely vary according to context(Otzelberger, 2011).

Women's relationship with trees may ease or accentuate their seasonal burden), especially in terms of firewood and fodder collection (Chambers & Longhurst, 1986). Women, as primary managers of household energy, have knowledge on how to use firewood resources efficiently, including adoption of fuel-saving techniques (Mahat, 2003). Understanding gendered differences in knowledge and utilisation of forest products and services is integral to understand what drives change in these resources (Otzelberger, 2011). It is now recognized that excluding gendered knowledge will negatively affect the efficiency and effectiveness of response to climate change (Mahat, 2003). This means that the gendered roles of how men and women participate in the household energy system and their use and benefits from tree and forest resources need to be strongly contextualized by means of data collection to inform policy.

Forest and forestry related activities are traditionally viewed as male dominated, which has made it difficult to include women's voices in forest management and decision-making. This is also because most profits from forestry come from timber extraction and management, which traditionally has received major emphasis in forest policy. This activity is generally viewed as male dominated, leading to less attention being paid to gendered implications related to the activity (Mahat, 2003). A local forestry project in Thailand, which distributed seeds for plantation, failed due to negligence in consideration of women's knowledge, who normally take care of seeds (Mahat, 2003).

Women can be major players in afforestation and reforestation programmes, and also contribute to slowing down the process of deforestation and thereby, reducing carbon emission. Women's role as nurturers and preserving characteristics make women more fit to work in nurseries as part of afforestation programs than men. This is why women play a large role in planting trees, in afforestation programmes in home gardens of rural areas (Baten & Khan, 2010).

Social and political issues, particularly issues of gender equality have been neglected in carbon-market oriented approaches[3]and focus has been more on a natural science-based approach(Terry, 2009). However, REDD+ initiatives increasingly offer excellent opportunities through targeted and effective institutional response, to reward women for their biodiversity stewardship, with regard to saving seeds

[3]The REDD+ mechanism provides developing countries financial incentives for reduced deforestation, and increased afforestation and reforestation, intended to increase amount of carbon stored in trees, as opposed to the atmosphere (Otzelberger, 2011). The mechanism has been criticized for not providing sustainable benefits and neglecting the importance of women's roles and needs in tree and forest management(U. a. G. IUCN, 2010).

and nurturing trees in crisis periods (Baten & Khan, 2010). Inadequate policies and implementation may in fact create unequal gender roles which were not present before (Otzelberger, 2011). The Forest Act 1927 was only amended in 2000 to include social forestry and women's participation in SF. The Social Forestry Rules (SFR) was framed in 2004 and only last amended in 2011 to provide equal rights and benefits to women. Ethnic women in CHT have traditionally been formal land owners. However, many development programmes have ignored women as participants, resulting in most new land titles owned by male settlers hand benefit-sharing (CPD, 2008).

4.3.3. Religion

Categorizing local forestry practices as degraded, denuded and less productive, ignores the immense social, cultural, traditional, educational, medical and environmental values in local practices. Inherited knowledge, passed through generations among ethnic people contributes to the preservation and maintenance of hills and forests, e.g. religious practice such as Bodha Poja (R. Hasan, 2014a).

In the case of CHT, Buddhism is the most prominent religion. Buddhists practice *ahimsa* or non-injury towards all beings. Buddhist ideals focus on living in harmony with the environment, and when nature is degraded people suffer as a result. As a result, a spiritual relationship is maintained in Buddhism between people and trees. Particularly during the "*Bodhi Poja*", respect is paid by Buddhists to the Bodhi tree by pouring water onto the root of the tree. Nowadays, this practice has also been extended to other species of trees (Barua & Wilson, 2005).

The Hindu religion also have practices that include using different plant parts as offerings to different Goddesses and to the souls of the lately departed persons; beliefs to protect and conserve naturally regenerated indigenous seedlings; and beliefs to retain indigenous trees and shrubs in the home and religious compounds. A study by Narsingdi floodplain area of Bangladesh(Mohammad Moshiur Rahman, 2006) showed that these practices have larger positive impacts of tree and forest resources in the homestead, in comparison to other neighboring households. Access to good quality seeds/seedlings of proven species made available through development programmes enable improved vegetation/homestead, and this can be further build on through actions by the government and development partners (S. A. Islam, Miah, Habib, & Moula, 2015). A focus on economic growth fails to account for psychological, social, cultural and religious impacts of such policies. In many cases, these have led to local people being displaced from their traditional ways of life and belief systems. Indigenous knowledge of resource generation and sustainable development, must be regarded into policies (Barua & Wilson, 2005), and this can be better contextualized through data collection.

4.3.4. Patronage-client system

The social aspect of patronage-client network also defines people-forest relationships. This may be in the form of a patron or *murubbi* who has sufficient social power to enable or hinder access to forest resources (Khan, 2001).Complex patronage-client relations and structures in many Bangladeshi villages cuts across social and economic groups and impacts access to resources, mainly by smallholders. These relationships also largely shape the impact and performance of implementing programmes, and resulting impact on resources (Khan, 2001). **Box 4** provides the case study on such relationship in the context of Betagi and Pomora.

Box 4: Patron-client system at Betagi and Pomora model of social forestry

In his paper on "Social Forestry Versus Social Reality: Patronage and Community-Based Forestry in Bangladesh", Khan (2001) looks at the patron-client system in social forestry in the two project areas of Betagi and Pomora, under the Rangunia Thana subdistrict. Patrons are commonly known as "*Murubbi*", and the term for labourer in Bangla is "*Kamla*". These patrons are able to exercise discretion over local political scene. They usually have musclemen, commonly known as "*mastans*", to support them. These characteristics of patron-client system is quite common in most regions of Bangladesh.

Farmers are usually affiliated with a single patron, with whom they have a dual relationship. Patrons may both be supportive or oppressive, in terms of farmers' access to resources. Political and physical protection is provided to clients by their designated local patron. However, patrons may extract unpaid labour, food, rent, and interests from farmers/clients, leading to gross structural oppression. This gives them sufficient influence on whether smallholders may be able to access resources.

The patron-client system is another social dimension that influences how farmers access tress and forest resources, defining how these resources change. Patrons also have influence on who gets access to benefits from various projects. In some cases, fake "landless" people have been included under project activities by patrons due to favoured relationship. Patrons can be powerful to the extent that government attempt to evict fake "landless" farmers failed largely due to "patronage protection and factional politics". Punishments by patrons to their respective farmers include both physical and mental harassment, including loss of additional income earning opportunities. Conformity is usually the only option for smallholders.

Smallholders are aware of these inequalities in power, which is why they try to stay affiliated to their patrons to withhold some form of protection, albeit limited (at least from exploitation and oppression from other patrons and their mastans).

Illegal logging is commonly led by patrons and executed by poor villagers and even SF farmers, as it provides limited, critical source of income for them, especially in off-peak agricultural season. Seasonality in livelihoods may also influence tree and forest resource change, depending on- and off-peak agricultural seasons.

4.4. Economic

Trees and forests provide significant economic benefits to the people. However economic benefits from tree and forest resources are not significantly reflected. Data from BBS (2014) states that the forestry sector contributes to 1.74% of total national GDP. The most important products are: timber, fuelwood, poles, plant food and construction material (MoEF 05-07). Harvesting of timber and fuelwood is increasing in majority of the areas (MoEF 05-07). Major forestry sector industries produce furniture, hardboards, particle boards, chipboards and paper (e.g., pulp, newsprint, packaging paper, and other specialty paper products). Other major forestry industries are match factories, cottage industry handicrafts from wood, bamboo and cane. The government's ban on felling has declined the contribution made by forestry to the Gross Domestic Product. However, contribution of the Bangladesh forestry sector to the national economy remains significant, in the form of timber, electric poles, posts, cross arms, anchor logs, railway sleepers, fuelwood (BFD, 2016).

Poverty is often highlighted as the primary reason for resource destruction linked to the adoption of strategies which yield immediate results rather than long-term considerations in resource use. However, findings suggest that the poor may depend more on common resources in relative terms, but in absolute terms their dependency is lower, particularly for resources with good market opportunities (Adhikari, 2003).Limited year-round employment in rural areas also results in greater dependence on collection of wood from forests for subsistence; and exploitation activities by organized groups who conduct illicit cutting and removal of valuable trees of the forests (BFD, 2007).While the poor may attempt to minimize risks by using forest resources to counter shortfalls in consumption levels, the rich or less poor may be interested in enhancing their earning by selling these resources, particularly when there are good market opportunities, which present greater threats to forest resources (S. Rahman et al., 2010).

(Kaimowitz & Angelsen, 1998) highlighted that population increase may also indirectly affect tree and forest resources via effects on labour markets, demand for agricultural and forest products, and induced technological or policy/institutional change. Huge gap between the demand and supply of wood and lucrative value of wood leads to illicit removal of wood, contributing to high prices of wood. There is dearth of data on demand of tree and forest resources and their supply (which is either poor or very much localized)(M. Ali et al., 2006). Data collection on this gap is integral to inform sustainable resource management and will certainly need to be integrated into the SEM survey.

4.5. Political

4.5.1. Management practices

Under the previous Forestry Master Plan of the government, fundamental reform was highlighted by means of forest land allocation. Strategies highlighted were people-based forest management, integrated social forestry and forest land management, to equalize present tenure structure for the advantage of

people and people living on forest lands. Maintaining the forest resource base, supporting sustainable wood supply for both direct users and industries, while providing supply of long term forest products and security for new investment were highlighted as important areas in the 1993 Master Plan for the forestry sector. These strategies and objectives remain relevant today, as per the draft National Forest Policy 2016 (**Box 1**). The aim of all management practices, such as social forestry, agro-forestry and village common forests, is to enhance tree and forest resources. However, in reality these practices have mixed impacts on resources. **Box 5** elaborates on these different types of management practices.

In practice, Bangladesh has now seen over three decades of social forestry and over a decade of co-management practices (M. Y. Ali & Uddin, 2015). Social Forestry (USFS) has been a widely promoted solution against deforestation under the notion that if local people act as saver through some benefit sharing agreement then the level of deforestation will largely diminish (S. A. Chowdhury, 2004). Social forestry programs are intended to create sustainable employment in the forestry sector, meet needs of fuel and other minor forest products, promote soil and water conservation and make forest areas accessible for recreational activities. Modest success has been demonstrated by these programmes with some net reforestation in the 1990s, but overall outcomes have been mixed as some social forestry programmes have not achieved what they were intended(Nur Muhammed et al., 2016).

Overall, social forestry has played a vital role in the expansion of forest cover in the country, leading to expansion of 40387 ha of new forest cover and 48420 km new strip plantation since the mid-1980s(Nur Muhammed et al., 2016). Results from a study by (Nur Muhammed et al., 2016) show that from 2000 –

Box 5: Forest management by community people

Social Forestry

Social forestry is described to mainly include forest lands, village woodlots, farm forestry, strip plantations beside railways, highways and embankments, plantation on public lands with joint management and benefit-sharing arrangement between the Government and local communities" (Alim, 1998). Social forestry policy in Bangladesh was designed to achieve various objectives, such as participation of women, youth and other disadvantaged sections of the society. It is also intended to support the creation of people's organization, reorientation of the values and practices of state foresters, and the creation of a participatory environment for people and government officials within which to cooperate meeting the needs of local people, increased living standard and social status of the participating farmers, fostering social equity etc (S. A. Chowdhury, 2004).

Co-management

Co-management, meaning the joint management of the commons, is the arrangement of power sharing between the State and local resource users. In practice, there is often a number of local interests and government agencies at play, and co-management involves more actors, such as civil society, as well as the interaction of a unitary State and local people (Carlsson & Berkes, 2005).

Agroforestry/Home Gardens

Maintaining trees (either natural or cultivated) beside agricultural croplands is a common practice. Planting trees near or between shelters and agricultural land in rural areas is common. This is known as agroforestry, which is common as it readily provides food, timber, NTFPs and fuelwood (Rahman et al. 2014). Agroforestry programs involve integrated agricultural and forest production on same land and has been implemented in both plains and hill areas(USAID, 2010). Home gardens are also popular measures to protect forest resources as this shifts the dependency for fuelwood and other forest products from forest to home gardens. Beyond this, home gardens also provide benefits in terms of livelihoods and nutrition (Uddin & Mukul, 2007).

Village Common Forests

Access to the forest and use of the forest products is governed by customary law in areas where the local forestry officials are not present. Right to occupy homestead land and take forest products for domestic use is codified in legislation applicable to the Chittagong Hill Tracts (CHT) region. However, often formal laws based on customary principles remains unacknowledged in practice (USAID, 2010).Village Common Forest (VCF) are traditional bodies and are an influential model of forest management, serving multiple functions indigenous people in the CHT. VCFs are enriched with more biodiversity than that of Government managed forests and demonstrate a fair balance between exploitation and conservation (Baten, Khan, Ahammad, & Missbahuzzaman). Attempts by government agencies to formalize management systems of traditional bodies, such as Village Common Forests has been scarce. As a result, their number has been declining due to various factors and this has also affected the hill peoples' livelihoods (Misbahuzzaman, 2016).

2003 more than 23 000 individuals benefitted from the final felling of different social forestry plantations (woodlot, agroforestry and strip plantation).One of the most prominent success stories is the first large integrated social forestry project in Bangladesh, which informed the Social Forestry Manual 2004. Details of the project are highlighted below:

Betagi Pomora Social Forestry Project

The Betagi-Pomora Social Forestry project was located in the two *mouzas* (administrative divisions based on government revenue collection) of Betagi and Pomora, in Rangunia Thana of Chittagong district. The project followed an integrated approach with focus on initial leasing land and eventual provision of land permit, and also education and awareness raising. Largely the project objectives were to regenerate denuded hills through tree plantation, rehabilitate the landless farmers and protect the forest from the illegal felling. By the end of the project, income of project beneficiaries rose up to three times, and more than half of the income came from agroforestry products (S. A. Rahman et al., 2010).

Drawback of Social Forestry

Major criticism of social forestry programmes have emerged in terms of ineffective engagement with local people. Social, people or participatory forestry[4] on public forest land present large cash deals, with loans coming from international financial institutions. This is largely experienced in the Sal forests, in the Greater Mymensingh District, as these management practices promote extension of plantations via people participation. Resultantly, forests are cleared to make space for plantations and contribute to the rapid destruction of biodiversity in public forests. For instance, in Modhupur, medicinal plants were once very popular, but can hardly be seen anymore due to the popularity of such practices. This means that traditional species (*Gandhi Gazari, Ajuli, Dud Kuruj, Sonalu* , *Sesra, Jiga, Jogini Chakra, Kaika, Sidha, Sajna*, or *Amloki)* are being lost as these practices are promoted. Large scale cultivation of some crops (e.g ginger cash crop in the CHTs) put pressure on forest land (Global Forest Coalition, 2010).

Critics of social forestry programs suggest that much of SF programmes consisted of commercial and industrial plantations in the name of social and industrial plantations, which were passed off as social forestry. Industrial plantations are monoculture in nature, with one or two exotic species promoted, which the industrial countries can purchase at a cheaper price or can sell pulp and paper technologies to Bangladesh. These species do not necessarily benefit the local economy, and may even pose serious threat to the local environment and economy (Philip Gain, Salam, & Moral, 2001).

[4]Centralized management regime creates lack of ownership by forest dependent people or people adjacent to the forest resulting in massive illicit felling and forest encroachments. Participatory forestry has evolved with the broad aim to involve forest dependent poor peoples in managing forest resources so that people have ownership of and feel the need to protect these resources. It also allows understanding of how local practices are enabling the process of afforestation. Efforts towards afforestation or conservation are likely to collapse as soon as the programme is over, unless genuine participation of local people is drawn(Biswas, 2007).

4.5.2. Role of Actors/Institutions

The Forest Department is the most powerful and influential actor among all the stakeholders. There have been strong criticisms of forest management in Bangladesh in terms of management remaining more "tree-oriented" rather than "people-oriented". This translated to local staff playing a policing role by trying to maintain control over forests, which at times led to marginalization and harassment of the poorer villages(S. A. Chowdhury, 2004). Forest policies have generally been implemented with the aim to maximize and extract profit[5]. As a result, policies on environment remain biased against the rural poor. Even if policies are fair, the rural poor face significant biases when projects or programmes are implemented. They compete for resources and opportunities on various levels, such as in terms of social inequalities and economic hurdles. This types of structural asymmetries and widespread regressive policies need to be considered in forestry policy design and programmatic action (Larson & Ribot, 2007).

There have been some measures taken by the government, and also non-governmental organizations, to involve farmers in forestry i.e., agroforestry and people woodlot plantations. However, such measures remain ineffective to halt the process of deforestation and encroachment (Kibria et al., 2010). Certain projects have been unsuccessful in terms of delivering promises as farmers who participated in certain forestry programs did not get their share from harvesting timber crop as promised in initial agreement. Inability to engage with farmers in this case led to farmers not taking care of plantations. This inactivity from farmers allowed loggers to illicitly fell away mature trees. Consequentially, there have been growing conflict between the government and local people (S. Rahman et al., 2010).

It is critical to draw on the participation of forest and tree users and their interest to plant and restore homestead biodiversity with those species, particularly the indigenous varieties(Kibria et al., 2010). In order to attain a more participatory approach, the forest department and other state actors must become facilitators to empower local people. Sustainable participatory programs depend largely on strong commitments from important actors together with effective forest policy and management plan (K. K. Islam, Kimihiko, H., Tani, M., Krott, M., & Sato, N., 2014). Given resource constraints, the Government has been unable to prioritize the forestry sector. Donor preferences to fund larger projects in other sector have also hindered forestry sector initiatives (FAO, 2011b).

Merely awareness raising activities will not ensure participation of the local people to conserve forests. Complimentary long term efforts towards empowerment and short term efforts to support key livelihood issues are pertinent for sustainable management of forest resources. These may include updating forest villagers' certificates, forest village mapping, participatory forest in critical areas, NFP restoration in core areas, privileged representation in local government, establishment of governmental primary schools, water conservation, agricultural and vocational training, supplying of fertilizer, etc (M. A. Rahman, 2011).

[5]Discussions over drivers of deforestation and degradation may be largely influenced by people, both globally in terms of climate change, and at the national level in terms of forest management techniques(Global Forest Coalition, 2010).

5. IMPACTS OF CHANGING FOREST AND TREE RESOURCES

This section provides an overview of the impacts of changing tree and forest resources on various socioeconomic dimensions including, food security and nutrition, livelihoods and resilience of ecosystems to environmental change.

5.2. Food Security and Nutrition

Tree and forest resources provide both direct and indirect benefits for food and nutrition security of forest dependent people. In terms of direct benefits, trees provide fruits, oil, seeds, nuts, roots, and other materials(Pimentel, McNair, Buck, Pimentel, & Kamil, 1997b).Following is an overview of some of the key areas where forestry, food security and nutrition intersect.

5.2.1. Non-timber Forest Products (NTFPs)

People depend on forests for medicine, fodder, supplemental fruits and timber, as well as honey, fish, and edible leaves and shoots. Particularly people in the Hill areas or poor rural households with limited agricultural land or homestead areas are highly dependent on essential vitamins, minerals, protein, and calories, available from forest resources (M. Y. Ali & Uddin, 2015). NTFPs include food, plant products, medicine and aromatic products which contribute to food and nutrition security (UNEP, 2011). Forests also contribute to food security by providing non-timber forest products (NTFPs), such as fruits, nuts, honey, and mushrooms. Loss of biodiversity affects supply of medicinal plants and herbal remedies, impacting the health of rural people, as well as their income and employment opportunities (M. Y. Ali & Uddin, 2015).

In Bangladesh, malnutrition and hunger are particularly prominent. However, the data needed for decision-makers to make informed choices is quite limited at both national and local level. Further research is integral to identify:

- actual extent of most systems
- numbers of people who rely on these systems to meet their household food and/or income needs,
- relative value of different forests and tree-based systems on the diets and health of those who manage them

These information are critical for policymakers, planners and development agencies seeking to improve the lives of populations suffering from food insecurity and malnutrition(Bhaskar Vira, 2015). The SEM survey can incorporate elements on these dimensions to close this gap in data.

5.2.2. Fuelwood

People depend on fuelwood collected from forests to cook their food (M. Y. Ali & Uddin, 2015). According to the FD, 65% of forest products are consumed as fuelwood (FAO, 2011b). Firewood still acts as the most important biofuel used as rural domestic fuel. Number of people depending on firewood and other traditional biofuels are expected to increase over time. Efforts to economise on firewood can induce shifts to less nutritious foods which need less fuel to cook, raw or partially cooked food that may be toxic, or leftovers which rot if left unrefrigerated, or the poor may even miss meals altogether (Uddin & Mukul, 2007). Use of improved cooking stoves in rural areas, mitigates excessive use of using fuelwood in traditional cooking stoves to some extent. However, majority of households in urban and semi-urban areas are still dependent on traditional cooking stoves, which requires use of fuelwood(M. N. Alam, Kaneko, & Rahman, 2012).An overall decline in tree and forest resources impacts people's access to fuelwood.

5.2.3. Soil fertility

Forests also play important roles in food security, through soil formation, nutrient cycling and provision of green manure, water provisioning, pollination and microclimate regulation(Uddin & Mukul, 2007). Soil erosion due to deforestation reduces soil productivity, increasing water runoff and decreasing water infiltration and water-storage capacity of the soil. During the erosion process, organic matter and essential plant nutrients are lost from the soil and soil depth is reduced, resulting in inhibited vegetative growth. Valuable biota and overall biodiversity in the soil is reduced inducing lower productivity and increased risks of food insecurity and malnutrition (Pimentel, 2006). Natural nutrient cycling from forest to plain arable land has declined due to clearing of forests and increasing use of chemical fertilizers and toxic pesticides. Soil degradation due to nutrient deficiency has also become common in the plain lands (Kibria et al., 2010).Agroforestry can be a good way to increase soil fertility, reduce salinity, alkalinity, acidity and desertification, and improve soil health which keep the land suitable for agricultural production(M. K. Hasan & Alam, 2006).

5.3. Livelihoods

Persistent poverty combined with lack of alternative livelihoods has also been cited as a key underlying cause contributing to forest loss (Global Forest Coalition, 2010). Around 2% of the national labour force is employed in the forestry sector (Ministry of Finance 2004). NFA 2005-07 highlights that approximately ¼ of the population in forest areas depend on forestry as main activity. This means changes in these resources significantly impact the livelihoods of these people, while availability of sustainable livelihood strategies influence change in resources. Major livelihood activities from trees and forest include production of wood, production of bamboo, production of fire wood, rubber production and other naturally grown forest productions like honey, mushroom etc (Bangladesh Bureau of Statistics, 2011-12).

Trees also provide contingencies (both seasonal and or on one-off basis) for the poor. Trees are significant sources of food, fodder and other useful material, and can help poor households to get through lean periods. These meet the seasonal requirements of poor households. Firewood for feasts, poles and timber for huts and house building, replacing a lost boat or canoe or broken plough require tree and forest resources on a one-off basis. Trees can be source of cash (via mortgage) or a means of savings and security for the future (Chambers & Leach, 1989).

Timber harvesting has not been traditionally very pro-poor, but there is potential to improve this with the current trends of increased local ownership of natural forests, growing tree commercialization and small scale wood processing. There is rapid emergence of ecological service payments, but it remains uncertain how much the poor will benefit from these non-timber forest products (NTFPs) have important functions which include, providing regular cash income, gap filling or safety net functions(Angelsen & Wunder, 2003). Measures for adapting to climate change, e.g. construction of water reservoirs, afforestation through people partnership, and development of pest- and disease-resistant varieties remain significant. These provide integrated opportunities for better livelihood opportunities and mitigating the impacts of climate change(Md. Giashuddin Miah, 2013).

5.4. Resilience of ecosystems to environmental crisis

Bangladesh is a low-lying country and about two-thirds of the country is just around 5 meters above sea level. Particularly low land coastal areas are vulnerable to sea level rise and saline water intrusion. Natural disaster like tropical cyclones, storm surges, floods, tornadoes and droughts are common almost every year. Climate change has further exacerbated frequency and intensity of these natural disasters. Forests act as sentinels to mitigating negative impacts of environmental change through enhancing resilience of ecosystems via various functions, including carbon sequestration, protection of biodiversity, and acting as watersheds (FAO, 2003).

5.4.1. Carbon sequestration

Forests function as carbon sinks as they absorb carbon dioxide from the atmosphere and store it as carbon. Carbon sequestration by forests is a popular mitigation approach, as it is relatively inexpensive, while also functioning as a climate regulation measure in terms of reduced global warming. Conversion of forest land to non-forested use has significantly impacted accumulation of greenhouse gases in the atmosphere. This is also exacerbated by forest degradation caused by over-exploitation of forests for timber, fuelwood and intense grazing which reduce forest regeneration(FAO, 2003).

Forest management practices can increase carbon sequestration through:

- afforestation, reforestation and forest restoration;
- tree cover increase through agroforestry, urban forestry and planting trees in rural landscapes;
- enhancement of forest carbon stocks (in both, biomass and soils) and sequestration capacity through changes in forestry management practices (FAO, 2011d)

5.4.2. Forests help protect biodiversity

Forests also provide habitats for biodiversity and host a large variety of genetic resources (UNEP, 2011). Removing natural high forests severely alters the habitat of many other plant or animal species. As a result of excessive illegal logging, biodiversity has declined rapidly and many animal species face risks of extinction. The Forest Department has marked some areas as protected areas for conservation and established plantations for agroforestry and woodlot as sustainable production system in the encroached and degraded forest area. However, present management remains unsustainable. An intensive management policy integrating with other policies with consideration to socio-economic factors (e.g, alternative livelihood strategies), is essential to restore the forest ecosystem (S. K. Sarker & Ahmed, 2008). Natural regeneration strips enable to mitigate these changes somewhat (Asian Development Bank 1993). There is evidence of homegarden agroforestry (AF) systems has demonstrating success for biodiversity conservation (Bardhan et al., 2012).

The most immediate social impact of deforestation is at the local level with loss of ecological services provided by forests. Forests provide important services such as erosion prevention, flood control, water treatment, fisheries protection and pollination functions. These functions are particularly important to the world's poorest people who rely on natural resources for their everyday survival. Forest destruction risks quality of life, by destabilizing climate and local weather, threatening the existence of other species and undermining the valuable services provided by biological diversity (Schmink & Wood, 1992).

5.4.3. Forests as watersheds

Forested watersheds are important as they capture and store water, contributing to the availability of water. Forests have a function of purifying water by stabilizing soils and filtering contaminants. Water flowing from forested watersheds are important to agriculture, generation of electricity, water supply, and recreation and habitat for fish and other wildlife species (Kreiger, 2001). As natural catchments for water, forest vegetation helps prevent flooding and erosion. However, currently there is no programme for catchment management in any of the reserved areas (FAO, 2011b). Watershed forests situated on steep slopes are especially important in ensuring water flow and inhibiting erosion. There is some concern from the government regarding increased sedimentation and soil erosion in the CHTs (Misbahuzzaman, 2016). However, promotion of watershed management still receives limited attention from policy makers and major international development partners.

6. CONCLUSION

This literature review has been conducted in preparation to the national scale socioeconomic survey under the Bangladesh Forest Inventory. The review highlights existing national research to understand tree and forest changes in Bangladesh using the 5 zones that are considered for the BFI, which are hills, Sal, village, coastal and mangroves. Direct and underlying drivers have been identified for the zones under

that impact tree and forest resources through the processes of forests converted to other land use (e.g. agriculture, industrialization, etc), degradation of trees and forests, and increase of tree and forest resources (e.g. other land converted to forest land). Among the specific drivers highlighted for the zones were encroachment, over-extraction, and pollution. Underlying drivers revolve around issues related to governance and policies, social aspects, such as ethnicity and gender, economic factors, that include widening demand and supply gap, and political, that includes role of different actors and various management practices. This comprehensive overview of the various drivers is followed by impacts of these changing resources on livelihoods, and food security and nutrition of forest dependent people, and resilience of ecosystems to climate change. By building on existing research and knowledge the BFI will contribute to better guide actions and measures in the forestry sector and for natural resources management.

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