Forest Coverage and Local Community Involvement in Sustainable Forest Management in the Central Coastal Area of Bangladesh

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ABSTRACT: This study analyzed the changes in coastal vegetation cover of recent times and explored effective ways of integrating local communities in coastal forest management program for the future sustainability of coastal forestry. Changes in coastal forestry have been identified through the NDVI operation using satellite images from 1991-2021. Results show that a total of 4105.3 $km^2$of coastal vegetation cover decreased at a rate of 0.342% per year in the last 30 years where afforested lands are being converted to various land uses. This loss is mainly due to the rapid expansion of human settlements and agricultural activities. Focus group discussions and key informant interviews were conducted to collect primary data about the integration of the community in the central coastal areas of Sandwip, Nijhum Dwip, and Char Kukri Mukri. Study findings reveal poor participation of local people in coastal forest management practices and identified several challenges as the main hindrance to integration. Finally, the study developed a framework for better forest management practices useful to protect afforested areas, especially in the central coastal area of Bangladesh.

Keywords: Coastal Forest; Community; Management; Participation; Sustainability

INTRODUCTION

The coastal area of Bangladesh is characterized by a low natural resource base and frequent occurrences of natural disasters (e.g. cyclones, storm surges, floods, etc.) (Jashimuddin and Inoue, 2012). About one-third of the country falls under the coastal area which consists of 19 coastal districts (Parvin et. al, 2010). Coastal forests afford protection against different types of natural calamities. The coastal area of Bangladesh is very dynamic from a geomorphological point of view, with land erosion and accretion occurring at varying rates (Brammer, 2014; Ahmed et al., 2018). The changes in land are rapid in the coastal area, which is home to 44.8 million people (i.e.26.73 percent of the total population of the country) (Ahmed, 2011). As a result, many people lose their lands due to erosion every year. Coastal forests are being used to stabilize these lands and to increase coastal soil fertility (Ahammad et al., 2013; Salim and Shameem, 2016). The demand for basic human needs (especially food and shelter) are higher in the coastal area, so the inhabitants directly and indirectly depend on forest cover for their survival. Coastal forests contribute to meet these demands and provide a livelihood to the coastal community (Aheto et al., 2016). As greenhouse gasses are increasing i consequence of global warming, the sea level is rising and a one-meter rise in sea level would engulf 17.5 percent of the country's large coastal and floodplain zones (Sarwar and Khan, 2007). Coastal forest is also important for mitigating greenhouse gases (e.g., CO_2) as forests take part in carbon sequestration (Ximenes et al., 2012).

Bangladesh has only 17.62 percent of vegetative area whereas the total amount of forest area is quite insignificant (DoF , 2018). To mitigate the adverse effects of coastal hazards, and to ensure a better use of coastal lands for sustainable livelihood, the coastal afforestation program was started in 1966 (Das and Siddiqi, 1985). After the initiation of the program, the forest authorities carried out several afforestation projects with different time frames especially in Cox's Bazar, Chattogram, and Feni districts. Mangrove afforestation was initiated in the same year in the coastal districts of Chattogram, Noakhali, Patuakhali, and Barisal covering an area of approximately 320 ha (800 acres) (Saenger and Siddiqi, 1993). With time, the coastal afforestation program

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has shown that it not only enhances the amount of forest cover but also raises the rate of land accretion from the sea and stabilizes the 'char' lands. After the political independence of Bangladesh, more attention was given to the coastal afforestation program in 1973. Intending to plant approximately 8100 ha (20000 acres) of mangroves annually, the World Bank has funded Mangrove Afforestation Project-I from July 1980 to December 1985, and another Mangrove Afforestation Project-II was planned to generate a further 8100 ha (20 000 acres) of new afforested area annually from 1986 to 1990. By implementing these projects approximately 192,395 ha of mangrove and 8,690 ha of non-mangrove forest coverage were grown till 2013 (Hasan, 2013). Moreover, a large-scale coastal afforestation program in the country was started in 1966. According to the Forest Department the amount of forest built under this program was about two lakh hectares (DoF, 2018). The amount of afforested area is increasing after the adoption of diverse plantation projects. Despite these initiatives, forest are decreasing at an alarming rate. FAO (2011) estimated only 1.44 Mha (11 percent) as effective forest cover in Bangladesh (Kumer, 2016). However, to combat forest degradation in the country, policy and management regimes have been updated to reflect the shift away from centralized government control and toward more participatory management systems (Biswas and Choudhury, 2007).

The concept of engaging the local community in coastal forest management practices was not initiated at the beginning of the large-scale coastal afforestation program except for some social forestry practices in the coastal areas of Bangladesh. Moreover, the idea of benefit sharing mechanism with the local community was not in practice until 1995. It was first observed through the program called Coastal Greenbelt Project 1995-2000 (Jashimuddin and Inoue, 2012). After that many programs had taken place in the coastal area and many of them included the participation of the local community. However, in practice, the involvement of the local community was not so effective in the coastal area for various reasons. In some places, the participation of local people was high initially but eventually community lost their interest in integrated management practices. As a result, the main aim of community involvement remains unfulfilled. Moreover, there is no official report or data about the successful involvement of the local community, which limits research on community-based coastal forestry in the area.

By integrating the local community in coastal forest management more resources can be extracted and also livelihood can be created for native people. It is possible to accelerate land accretion through proper afforestation programs. Various participatory approaches and decentralized policy frameworks have been used to manage local forest resources through the transfer of authorities to local people throughout the last few decades in the tropics (Claude et al., 2008). However, more research is needed on these issues so that various aspects of integration of local community in coastal forest management can be identified and further steps can be taken to ensure sustainable forestry in the coastal area of Bangladesh. The present study intends to identify the trends of vegetation coverage in the coastal area of Bangladesh and the situation of community involvement in the central coastal area. Moreover, the study identified the challenges of participation for poor local people as well as the reason responsible for less integration of the communities in the central coastal area.

METHODOLOGY OF THE STUDY

Study Area

The study considers the whole coastal area (19 coastal districts of Bangladesh) for assessing the trends of coastal forest, subdividing into three coastal zones, i.e., western coastal zone, central coastal zone, and eastern coastal zone (Fig. 1). The central coastal area consisting of Chattogram, Bhola, and Noakhali districts was considered to assess the involvement of local community in sustainable forest management practices. The survey sites include Sandwip upazila from Chittagong, Hatiya from Noakhali and, Char Fasson from Bhola were selected from the central coastal area of the country.

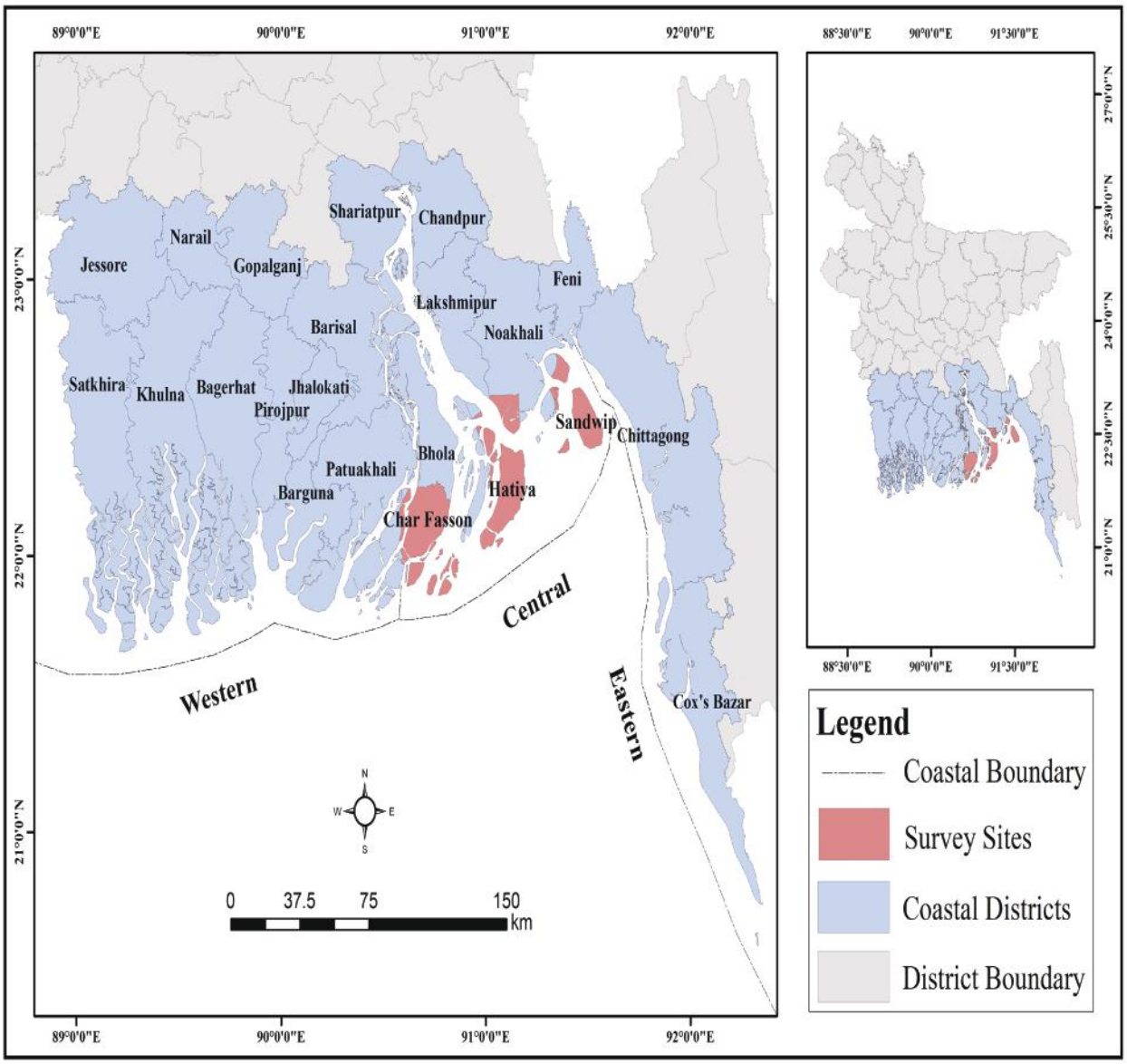

Figure 1: Location of the Study Central Coastal Zone of Bangladesh

Methods of the Study

The study conducted a rigorous review of existing literature on community-based coastal forest management in Bangladesh to identify the research gaps. Using GIS, remote sensing techniques, and based on satellite images (Fig. 2), the vegetation of the coastal area of Bangladesh was analyzed. To identify the current practices of community involvement and forest management practices in the coastal area, the study conducted three Focus Group Discussions (FGDs). The study selected three survey sites from the afforested areas in the central coastal zone to conduct FGDs and KIIs based on the assessment of the trends of afforested areas. Two sets of checklists were prepared for FGDs and KIIs: one is for local people, and the other for forest authorities. Finally, a sustainable forest management framework was developed through the integration of knowledge from the literature, collected field data from stakeholders, and the opinions of the experts.

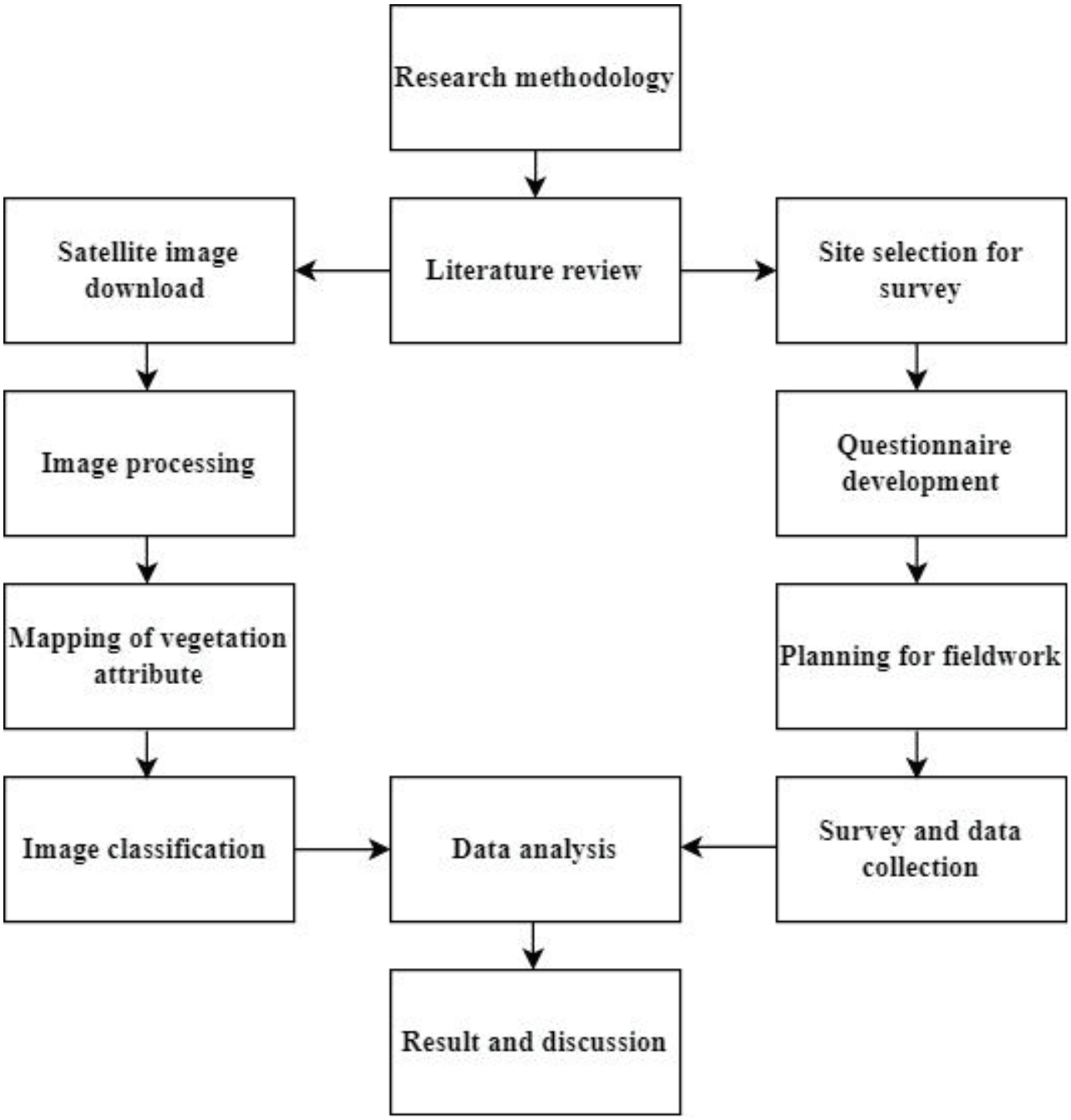

Figure 2: Overview of Methods Followed for the Present Study

Acquisition of Satellite Imagery

Satellite images were collected from USGS source to assess the trends of vegetation cover in the coastal area for the years1991, 2001, 2011, and 2021. Such images are easily available free of cost but have a limited spatial resolution of 30m (Raja, 2012). A total of 7 separate image tiles were required to cover 19 coastal districts for each of the years. Images from 1991, 2001, and 2011 were collected from Landsat 5 and images from 2021 were from Landsat 8 sensor. All the images were from the same season but have little seasonal fluctuations (Table 1).

Table 1: Information about the Landsat Images Used in the Study

Year	Acquisition date	Sensor	Weather	Resolution	Cloud cover	Remarks
1991	26/01/1991 to 06/03/1991	Landsat 4–5 Thematic Mapper (TM)	Normal	30m	None	Low seasonal variation
2001	21/01/2001 to 19/03/2001	Landsat 4–5 Thematic Mapper (TM)	Normal	30m	None	
2011	02/02/2011 to 07/04/2011	Landsat 4–5 Thematic Mapper (TM)	Normal	30m	None	
2021	04/02/2021 to 17/03/2021	Landsat 8 Operational Land Imager (OLI)	Normal	30m	None	

Image Processing

The collected images were processed by using ERDAS IMAGINE software (version: 2014). The collected images (tiff) were first stacked by bands for creating multiband composite images from a panchromatic image. This was done for all seven images of individual years. The seven composite images of each year were mosaicked on their overlapping parts to create one whole multiband image. Some radiometric corrections such as noise and haze reduction were performed for making the image quality better. Finally, the coastal areas (i.e., 19 coastal districts) was extracted from the mosaic images through the use of a masking command.

Mapping Vegetation Index

In order to quantify vegetation density and canopy closure, a variety of spectral vegetation indicators are commonly utilized (Datta and Deb, 2012). Among all of these measures, the normalized difference vegetation index (NDVI) is the most widely employed (Morawitz et. al., 2006). The underlying principle of NDVI is that the rates of reflection differ for the picture's band 4 (band 5 in case of Landsat 8) near-infrared (NIR) and band 3 (band 4 in case of Landsat 8) (Red), and that these discrepancies can provide an image the status of green plants while being unaffected by topography. The following equations (equation I and II) were used to calculate the NDVI:

$$\text{For Landsat 5, NDVI} = \frac{(Band\ 4 - Band\ 3)}{(Band\ 4 + Band\ 3)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(I)}$$

$$\text{For Landsat 8, NDVI} = \frac{(Band\ 5 - Band\ 4)}{(Band\ 5 + Band\ 4)} \ldots\ldots\ldots\ldots\ldots\ldots\text{(II)}$$

Image Classification

Images were classified into 4 different land use and land cover types for each year by following the supervised classification method of satellite images. The classification was mainly focused on vegetation coverage. However, the details of the land cover types are mentioned in Table 2.

Table 2: Details of the Land Cover Types Considered for the Present Study

Land Cover	Description
Waterbody	River, permanent open water, lakes, ponds, canals, permanent/ seasonal wetlands, low-lying areas, marshy land, and swamps
Land	All infrastructure- residential, commercial, mixed use and industrial areas, villages, settlements, road network, fallow land, construction sites, developed land, excavation site, open space, bare soils, and the remaining land cover types
Sparse Vegetation	Shrubs, grassland, homestead garden, vegetated lands, agricultural lands, and crop field
Dense Vegetation	Trees, natural vegetation, mixed forest, gardens, parks and playgrounds.

Accuracy Assessment and Change Detection

To evaluate a classified image's performance and to measure its accuracy, it is imperative to compare it against reference data presumed to be accurate (Foody, 2002). The preprocessing and classification of the images underwent a comprehensive analysis and accuracy assessment was calculated separately using the kappa coefficient. The result showed that for the year 1991, 2001, 2011, and 2021 the overall accuracy was 83.12%, 81.34%, 87.41%, and 91.72% while its kappa coefficient was 82.40%, 78.85%, 85.33%, and 89.64% respectively. Finding out which land-use class is shifting to another is crucial in change detection analysis. Although there are several methods for detecting changes, 'classification comparisons of land cover statistics' were employed in this study. Comparison of areas occupied by each type of land cover over time and direction of changes (e.g. positive or negative) were established.

Field Data Collection and Analysis

Focus Group Discussion (FGD) and Key Informant Interviews (KII) were conducted to ensure the highest possible inclusion of people from every sphere of the community in the study area. In case of selecting the participants, the aim was to involve all the major stakeholders and to take an integrated opinion from them. The three FGDs incorporated the local people and the stakeholders in the respective areas that are very close to the forest. At Sandwip, the number of participants for FGD was 12, and their average age was between 40 to 50 years old. At Nijhum Dwip, the number of participants was 9 and their average age was between 35 to 45 years. In the case of Char Kukri Mukri, the number of participants was 9 and their average age was between 40 to 50 years old. A total number of 15 KIIs were conducted in the three sites to explore the views on forest management authorities in the respective areas. Moreover, local union parishad members, chairmen, local journalists, and NGO workers were also interviewed as key informants. The KIIs mainly contained open-ended questions. After collecting data, they were documented in a Microsoft Word file, cleaned for redundancy, and processed. It was then analyzed for extrapolating facts, patterns, and thus developing explanations.

RESULT

Land Use and Land Cover Pattern

The analysis of land use and land cover for 1991 depicts that the total amount of water body covers 2613.41 km^2 that is 6.53%, built-up and other land area covers 13072.9 km^2 that is 32.67%, sparse vegetation 9765.98km^2 that is 24.40% and dense vegetation covers14564.3 km^2 that is 36.39% area of the total coastal area respectively (Fig. 3A). The dense vegetation or forestry occupied a significant portion of the coastal land which is more than one-third of the total land area. However, built-up areas and sparse vegetation covered the maximum land of the coastal area.

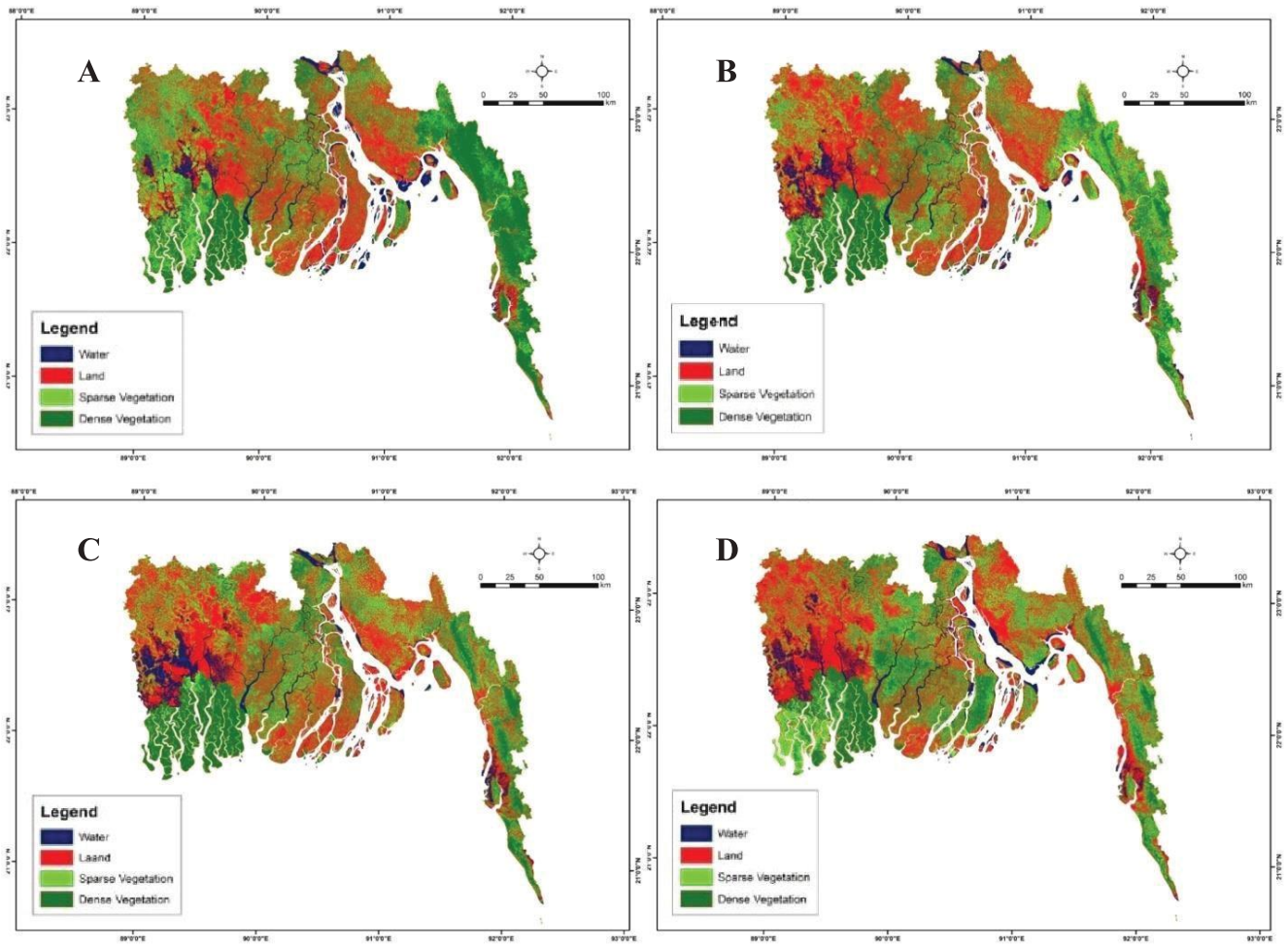

Figure 3: Landuse/ Landcover Map of the Coastal Area of Bangladesh: (A) 1991, (B) 2001, (C) 2011, (D) 2021

In 2001, the total amount of water body was 2634.18 km^2 that is 6.58% area, built-up area or land area was 15163.1 km^2 that is 37.89% area, sparse vegetation was 10849.5 km^2 that is 27.11% area, and dense vegetation was 11369.8 km^2 that is 28.41% area of the total coastal land cover (Fig. 3B). The land or built-up area occupied the maximum area and dense vegetation or forested area covered the second highest area of the total land use. Sparse vegetation occupied slightly less area than dense vegetation whereas water bodies covered the least portion of total coastal land use in the same year. However, figure 3C reveals that water body covers 3217.78 km^2 which is 8.04% area of total land use, built up or land area covers 15592.8 km^2 that is 38.97% area, sparse vegetation covers 10495.5 sq. km that is 26.23% area and dense vegetation covers 10710.5 sq. km that is 26.77% area of the total coastal land use in 2011. Built-up and other land areas covered the maximum portion of the coastal area in 2011 whereas dense vegetation is second and sparse vegetation is the third most occupied land use types and both covered almost the same portion of land area.

The map of 2021 in figure 3D and figure 4 elicit that the total amount of water body covers 2958.16 km^2 that is 7.39% area, built up and other land area covers 15500.2 km^2 that is 38.73% area, sparse vegetation covers 11099.1 km^2 that is 27.74% area and dense vegetation covers 10459 km^2 that is 26.14% area of the total coastal land use. Most of the coastal area in 2021 is occupied by built-up and other land areas. Second most area is occupied by sparse vegetation whereas dense vegetation or forested area occupies the third position which is slightly less than sparse vegetation.

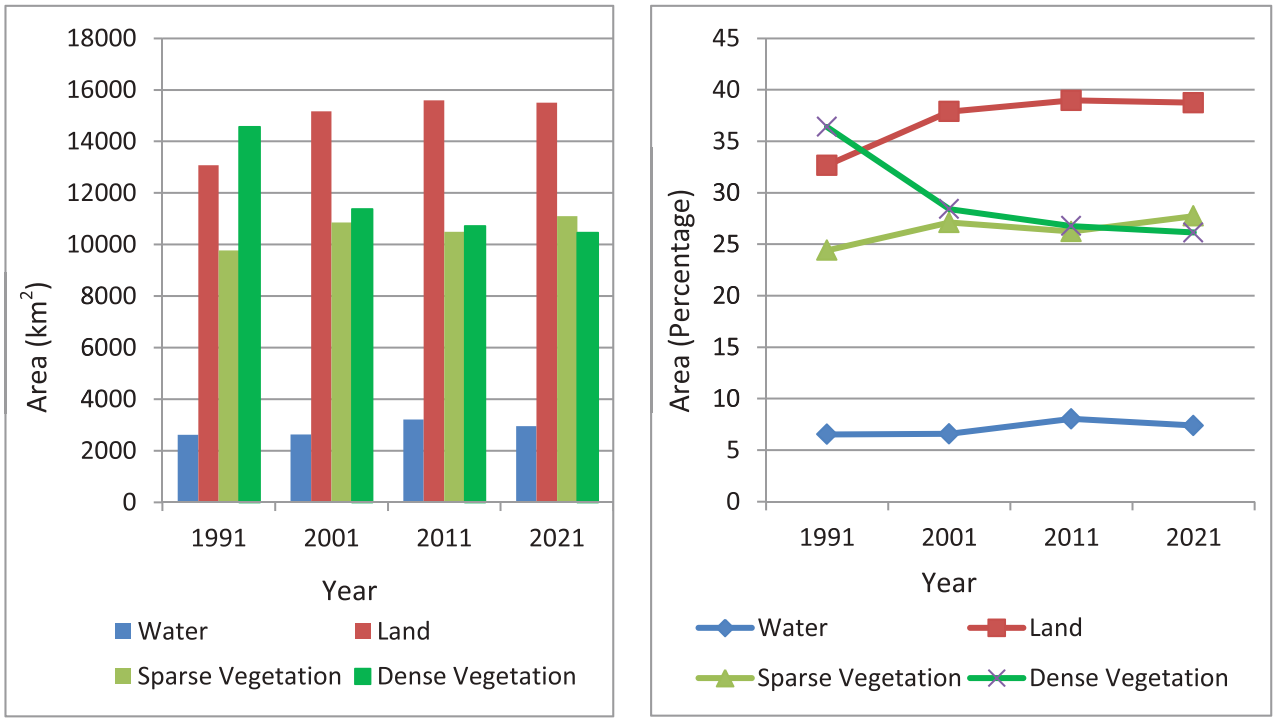

Figure 4: Amount and Percent of Area Covered by Each Land-Use Type Intervening Every 10 Years

Community Involvement

The results of FGDs and KIIs reflect a variety of responses on the involvement and role of the local community in coastal forest management activities. The study reveals a poor involvement of the local community in forest management programs. Local people are not properly engaged either in the afforestation program or in management practice by the forest department. The community wants to participate in the plantation program as they want to get benefit from the forest but they are being deprived of scope or opportunities to involve themselves in the afforestation program. Some of the respondents mentioned that they are not even aware of the schedules of the plantation or afforestation program. In some cases, only the political personalities including the mayor, chairman, members, and government officials are notified of the program except the marginal group of local people. Local people also mentioned that previously, there was no such communication and collaboration between the forest department and the local community. However, recently a new program called the SUFOL project is ongoing in the coastal areas of Bangladesh including the fieldwork sites where local communities are started to get involved in the afforestation program and management mechanism. Local people who are extremely poor and directly depend on the forest for their livelihood are getting financial support from the Government under this project. The concept is that this financial support will reciprocate their loss because of the depletion of forest and help them to take care of the forest. Another program facilitated by the Bangladesh Water Development Board (BWDB) in collaboration with the Forest Department is ongoing where the plantation is being done outside of the embankment area and the forest department is involving the local community in the plantation where local people are the major stakeholders of this project. The communities who have been evicted from the area where the embankment has been constructed or the communities close to the embankment area where the plantation program is operational, only get a share of benefits and involvement in the plantation and management program.

Findings of KIIs at Sandwip reveal that the forest department welcomes people who want to participate in the afforestation program. The participation process is open to everyone and is much expected and appreciated by the forest department. Initiatives such as meetings, seminars, or workshops to enhance the participation

of the community are not taken yet but attempts were made to engage the local community as much as possible during various afforestation programs. It is assumed that both the community and forest officials had biased responses and were blaming each other. However, it was noted from the field observation that the local people seemed to not even know the necessity of the integration between the forest department and the community and they are not aware of their rights and benefits from these kinds of afforestation projects. Due to a lack of necessary knowledge and information on the matter, the local people lose their interest and do not participate in the afforestation program.

At Nijhum Dwip, the local people are not involved in the coastal forest management program by the forest department. Due to the abundance of saltwater here, the survival rate of plant species is quite low in that area and thus the forest department is reluctant to take up plans for plantation programs. Rather, some specifically selected mangrove species are planted in the coastal area which needs special care during and post plantation. As there are no commercial species, and thus less chance to create profit, local people lose their interest to participate. The only interest in this case seems to be for firewood. Another reason behind the poor participation of local people is the requirement of special care and training for mangrove cultivation, which the local people are not very accustomed to.. Another issue is forestry being done on *Khas* land. As there is no fixed owner of these kinds of land, the number of participants, the list of beneficiaries, assurance of getting a fair share after participation, and other uncertainties push the participants to a point of demotivation to participate in the afforestation programs. Though there are clear guidelines about all these issues which are mentioned in Social Forest Rules- 2004, local communities are not that knowledgeable and conscious about these rules, and also these rules are not always followed.

The respondents were asked about the mechanism of involvement of the local community, and the process of selecting beneficiaries from the local community. It was noted that all these were done according to the Social Forest Rules-2004. The Forest Department involved the local communities by following some criteria and resolving some issues when the plantation program was done. The enrolled local communities are considered the future beneficiaries. The beneficiaries' selection criteria are- the people who are living within a 1 km area of forestry and have less or equal to 50 *satak* (i.e., 1 decimal) of land. If no people are living within a 1 km area from the forestry then the nearest communities get the opportunity of being beneficiaries. In that case, the consideration for a beneficiary are landless people, women deprived of their rights, backward communities, poor dwellers, poor forest villagers, and the poor freedom fighter or their heiress. These categories of people are involved with the forest department, take care of the forest, and get benefits from the forest. An agreement between the beneficiaries and the forest department has been formulated in which the duration of the contract would be a minimum of 10 years to a maximum of 20 years. This contract can be renewed for 2 to 3 times and the highest duration would be 40 years. However, this agreement was not properly practiced in the areas for most of the cases. It was known from the FGDs that the politically powerful people, financially stable people, and associations of government officials get preference while selecting the stakeholder of afforestation projects.

Benefit Sharing Mechanism

Local people get benefited from the forest by collecting firewood, timber, and by cattle ranching but are not allowed to cut down any trees from the afforested area. For getting these benefits, permission from the forest department is required but it was not properly followed by local people. Immediately after the plantation, there would be an agreement between the forest department and the beneficiaries. According to this agreement, local people could get a certain portion of benefits if any trees are being sold. Also, no one will allow cutting down any trees while the trees are growing but they can collect firewood, fruits, and other dead branches of trees. However, these agreements are not properly followed in the area and local people claimed that they are not getting their fair share. The local people claimed that sometimes the staff of the forest department sell trees without informing other stakeholders. On the other hand, the forest department claimed that benefits were shared among stakeholders according to Social Forest Rules- 2004. Local people can collect stalks and fruits first two years without sharing any portion with the forest department. From the third year, local people and the forest department shared the benefits equally among them. This sharing is only about stalks and fruits but cutting down trees is not allowed at that time. According to Social Forest Rules- 2004 when the trees will be sold then the benefits will be shared in the following way (Table 3):

Table 3: Current Benefit Sharing Mechanism Exists in the Study Sites

Forest Types	Stakeholder	Share of Benefits (%)
Strip plantation in the private or public lands other than forest department-owned lands	Forest department	10
	Land owning agency	20
	Beneficiaries	55
	Local Union Parishad	5
	Tree Farming Fund	10
Char land and foreshore plantation	Forest department	25
	Beneficiaries	45
	Landowner or tenant	20
	Tree Farming Fund	10

DISCUSSION

Land Use - Land Cover Dynamics

The classified images of 1991, 2001, 2011, and 2021 revealed the dynamics of land use/ land cover change and helped to analyze the changing scenario of coastal forestry between each of the consecutive years. A comparison between the map of 1991 and 2001 reveals that in 1991 the amount of water body was 2613.41 km^2 which increased slightly (2634.18 km^2) in 2001 (Table 4). Within these 10 years, the amount of area covered by the water bodies shows a very little increase. In case of built-up and other land area in 1991, the amount of area was 13072.9 km^2 which expanded to 15163.1 km^2 in 2001. Within these 10 years, a significant change has been took place in built-up and other land area (5.22% land area increased). However, in 1991, the amount of sparse vegetation was 9765.98 km^2 which increased to 10849.5 km^2 in 2001, amounting to an increase of 2.7%. In 1991, dense vegetation occupied most of the land cover type which covered 14564.3 km^2 but reduced to 11369.8 km^2 in 2001. In these 10 years, the amount of dense vegetation area decreased by 7.983% which is 3194.5 km^2 with a rate of 319.45 km^2 reduction each year. These reduced areas are occupied mostly by built-up areas and sparse vegetated. Between 1991 to 2001, dense vegetation or forest area decreased rapidly and these reduced areas are occupied mostly by built-up areas and some areas were occupied by sparse vegetation.

Table 4: Dynamics of Land Use Land Cover and Changes in Vegetation

	Area in different years (km^2)				**Changes in an area in different years (km^2)**			
Land use Types	1991	2001	2011	2021	1991 to 2001	2001 to 2011	2011 to 2021	1991 to 2021
Water	2613.41	2634.18	3217.78	2958.16	20.77	583.6	-259.62	344.75
Land	13072.9	15163.1	15592.8	15500.2	2090.2	429.7	-92.6	2427.3
Sparse Vegetation	9765.98	10849.5	10495.5	11099.1	1083.52	-354	603.6	1333.12
Dense Vegetation	14564.3	11369.8	10710.5	10459	-3194.5	-659.3	-251.5	-4105.3

Comparison between the classified images of 2001 and 2011 reveals that in 2001 the amount of water body was 2634.18 km^2 which increased to 3217.78 km^2 in 2011. The amount of area occupied by water bodies which increased within these 10 years is 583.6 km^2 which is 1.46% area. The amount of land was 15163.1 km^2 in

2001 which increased to 15592.8 km^2 in 2011. Between these 10 years, 429.7 km^2 areas increased which is 1.07% land area. In the case of sparse vegetation, the amount of the area in 2001 was 10849.5 km^2 and reduced to 10495.5 km^2 in 2011. Approximately 354 km^2 area which is 0.88% sparse vegetation area reduced in these 10 years. The amount of dense vegetation or afforested area that was 11369.8 km^2 in 2001 dropped to 10710.5 km^2 in 2011. In these 10 years, about 1.65% area had been reduced, that is 659.3 km^2 of forest area reduced with a rate of 35.93 km^2 area each year. Both sparse and dense vegetation were reduced in these 10 years and the reduced area is mostly converted to other land uses. The scenario of overall land dynamics from 2001 to 2011 shows that both sparse and dense vegetation decreased whereas built-up area increased.

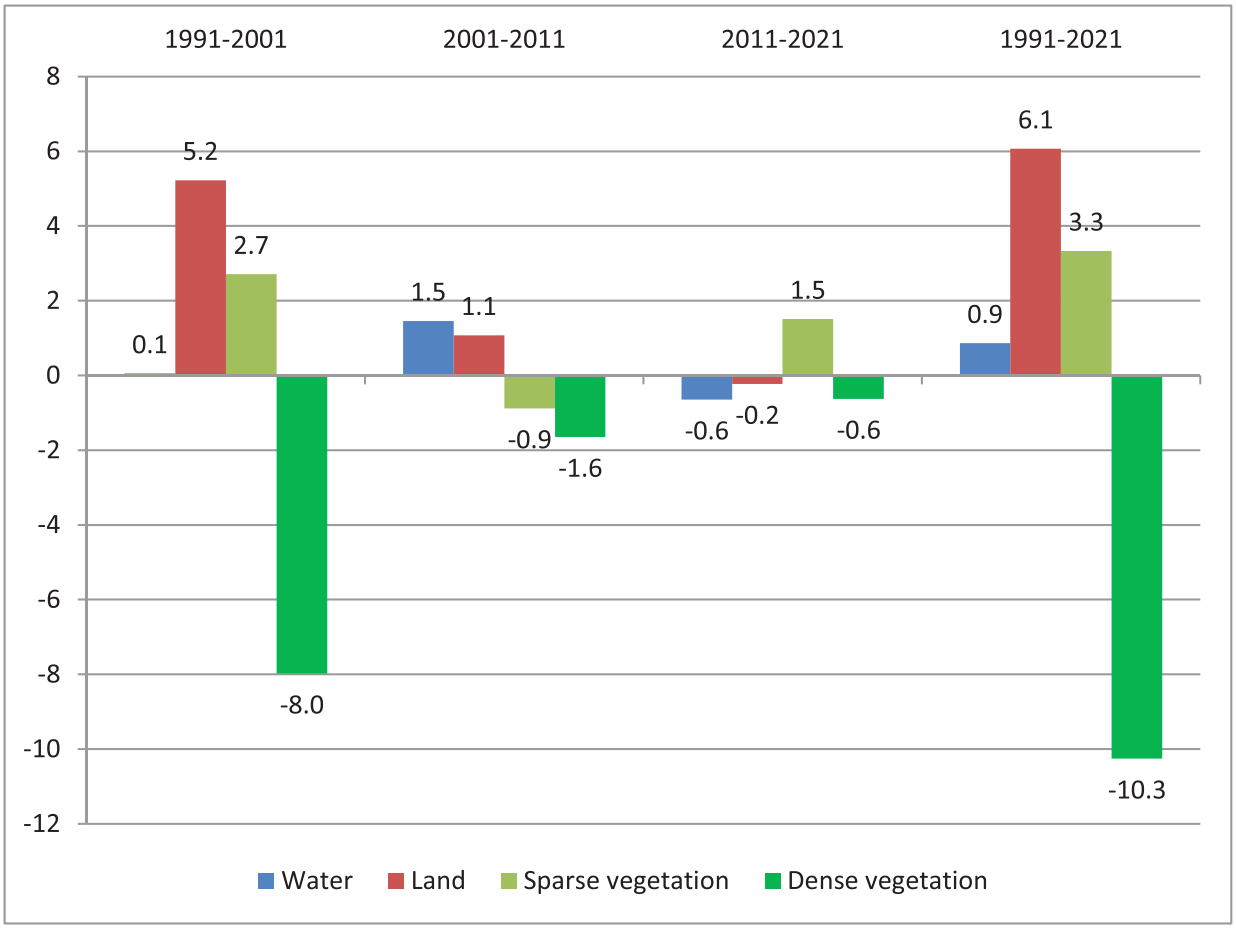

Figure 5: Percent of Change in Area by Every 10-Years Interval from 1991 to 2021

A comparison of the classified image of 2011 and 2021 reveals that the water bodies which were 3217.78 km^2 in 2011 reduced to 2958.16 km^2. That means, about 259.62 km^2 area which covers 0.65% area of water reduced and converted into other land use types (Fig. 5). In the case of other land and the built-up area in 2011, the amount of land cover was 15592.8 km^2 which remained almost the same in 2021. By these 10 years, no significant changes in the built-up area took place. The amount of sparse vegetation was 10495.5 km^2 in 2011 which became 11099.1 km^2 in 2021. In these 10 years, the amount of sparse vegetation increased by 1.5% covering almost 603.6 km^2 area. In 2011, the amount of dense vegetation was 10710.5 km^{2}which reduced to 10459 km^2 by 2021. That means, about 0.63% of forest area was reduced by these 10 years with a rate of 25.15 km^2 area each year which occupied 251.5 km^2 area. The overall scenario from 2011 to 2021 indicates that the amount of water body and dense vegetation cover area reduced, amount of land area remained almost the same whereas the amount of sparse vegetation cover area increased in this period.

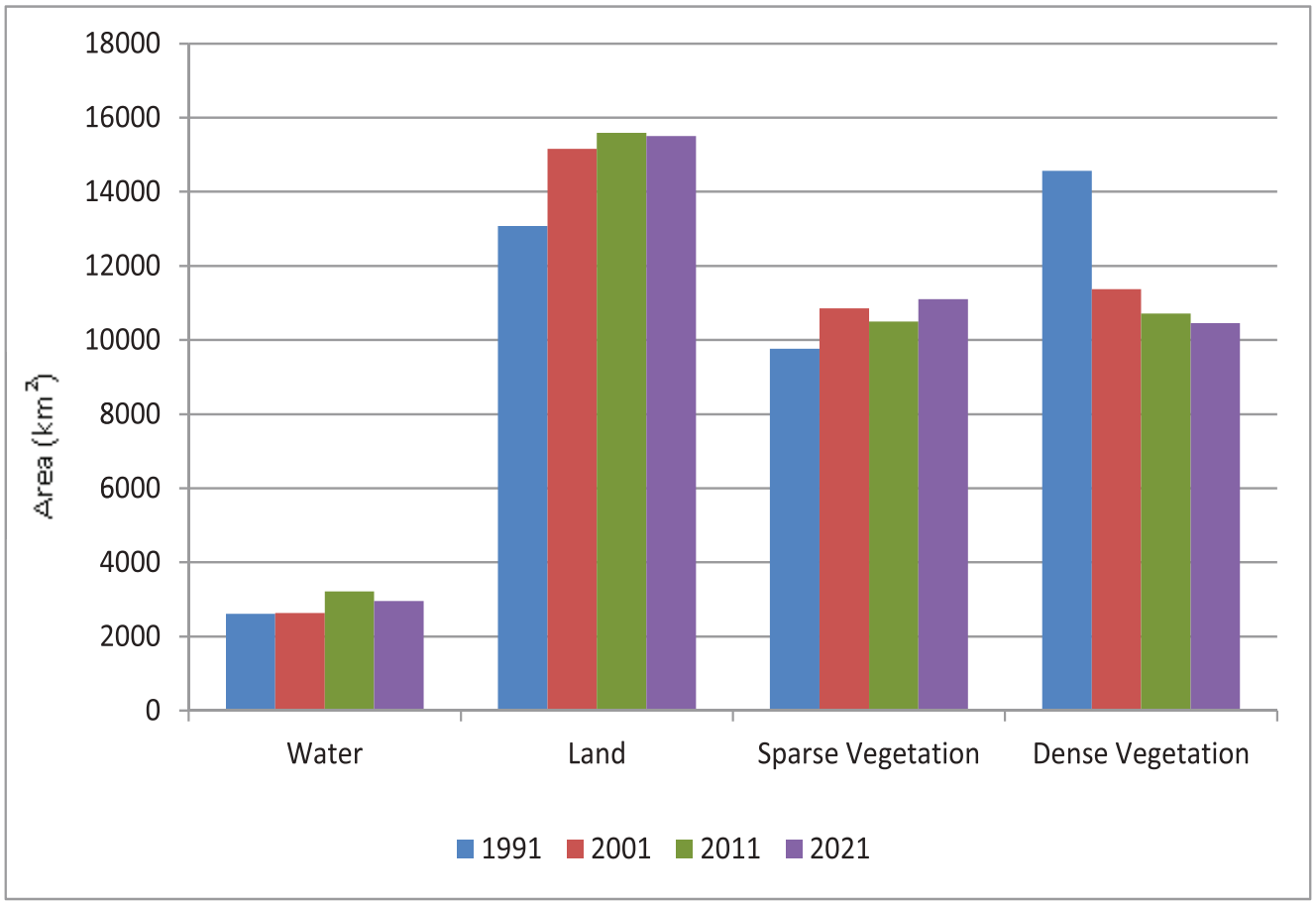

Figure 6: Change of Area for Every 10-Years among Each Land-Use Type

The overall change from 1991 and 2021 of 30 years indicates that the amount of water bodies was 2613.41 km^2 in 1991, increased to 2958.16 km^2 in 2021 (Fig. 6). In these 30 years the amount of area covered by the water bodies increased by 344.75 km^2 which is 0.86% of the land. This shows a changing rate of 11.49 km^2 per year which means every year 11.49 km^2 area of water bodies increases. The cause of this could be the coastal area of Bangladesh being highly dynamic and some areas are experiencing a rapid rate of erosion. The most dynamic land use type is the built-up and other land use area that has significant impacts on both sparse and dense vegetation. In 1991, the amount of built-up and other land use area was 13072.9 km^2 which rapidly increased to 15500.2 km^2 in 2021. This is a notable change in the land area that took place within the last 30 years and the amount of land increased is 2427.3 km^2 which is 6.07% increase in the area with a changing rate of 80.91 km^2 per year. Every year, about 80.91 km^2 of other land use types changed into built-up area, and the amount of built-up and other land area had been increased. The most probable reason behind this change is the population pressure of the coastal area. With time, the population in the coastal area increases at a faster rate and this extra population creates pressure on the land for food, habitation, and other needs. Creation of new land is not possible so people mostly resort to areas with vegetation cover to meet their demand. As a result, land use in the coastal area has changed rapidly during the mentioned period and the amount of built-up area increased. With the population rise, the demand for food and other crops also increases which demands more agricultural land. In the last 30 years, the amount of sparse vegetation areas had increased by 3.33%. In 1991, the sparsely vegetated area was 9765.98 km^2 and in 2021, it increased to 11099.1 km^2. About 1333.12 km^2 of the sparsely vegetated area increased in these 30 years with a changing rate of 44.44 km^2 area per year. However, the dense vegetation or forested areas, which is constantly reducing for the last 30 years. The amount of forestry in 1991 was 14564.3 km^2 which is 36.3957% of the total coastal area, and reduced to 10459 km^2 in 2021 which

is only 26.1367% of the total coastal land use. In these 30 years, 10.26% of forest area which is 4105.3 km^2 has been reduced with a changing rate of 136.84 km^2 per year. That means, every year, about 136.84 km^2 of forest cover decreases and has changed to other types of land use. The annual rate of the reduction of forested area is 0.342% which means, per year 0.342% of the densely vegetated area has been reduced from the coastal area of Bangladesh. This rate is very high and alarming for a disaster-prone country like Bangladesh. The primary reason behind this reduction of the coastal forest is the huge population of the country. Besides this, a large portion of people directly or indirectly depend on this forest for their livelihood which causes overexploitation of forest resources, and as a result, forest areas are reduced. However, the government is taking various steps to stop the depletion of the coastal forest.

Factors Affecting Community Involvement

There are some factors came out from the discussion that directly affect the participation of the local community in afforestation and forest management programs. The study indicates that the current condition of community involvement is not strong and the factors are acting as a catalyst behind these problems.

Lack of Knowledge about Integration

The findings from the group discussion revealed that the local communities are not familiar with the concept of integrated forest management. According to them, forest areas are state property, planting trees and protecting the forest areas are the duty of the forest department and government. They also think that there is no duty of local people except resource extraction from the forest. Moreover, the forest is a renewable resource that generates resources, and cutting down a small number of trees by them might not reduce the forest area that the community people perceive. Respondents who were less educated and can only understand the concept of integration are not optimistic since, they did not find any successful integration projects in their areas for previous times.

Sharing of Benefits

Though the forest department claimed that benefits from the forests are being shared fairly among the stakeholders, local people denied this claim and opined that they did not get even half of their allocated share. From the field observation and interview it was clear that profit from the forest resources is not rationally shared among the stakeholders and local people are losing their interest in any kind of integrated forest management program and are not taking care of the forest properly. These inconsistencies in benefit-sharing issue are making integrated forest management more challenging in that areas.

Problem with Cattle Ranching

Local people opined that if the cattle enter into forest areas then the cattle and animals are sent to corrals as a penalty for the owners. Moreover, they are harassed, humiliated, insulted in inaudible language, and charged greatly for the redemption of their cattle. According to the response, the forest department appoints some people who keep guard of the animals and seize them for any destruction of the forest areas. This causes problems for the owners of the cattle. A totally different opinion was given by the forest department which stated these corrals are built by local politicians, especially by the union chairman, and the people who caught the animals are appointed by the chairman/ members and are the supporters of local politicians. The forest department doesn't get any share from the payments taken as redemption and the forest department is not connected with this system, as they stated.

Political Influence

The respondents argue that the local political leaders influence the government projects and in most cases, they misuse their power for personal benefits and involved in corruption. The forest department hardly can take any steps against them despite their good intentions as they have limited manpower. Therefore, the local people have had realizations from practical experience that these projects though intended for them will not bring any positive changes for them. Only the influential local political leaders and elites are being benefitted from the projects.

Corruption

The Bangladesh government supports with various grants and funds to the poor marginal group but due to the corruption in relevant sectors, the poor marginal group

of people is simply deprived of the benefits of social forestry. Instead, local powerful people and relatives of them are benefiting from these funds. Moreover, due to corruption, local people are not getting their fair share of the forest resources. People who deserve to be part of beneficiaries are often excluded from benefit sharing. Hence, the marginalized people are not receiving their rights and as a result, they are becoming less interested in this type of afforestation project.

Mistrust between Forest Department and Local People

Forest departments claim that local people are responsible for the reduction of forest area and they cut down trees for their purpose whenever they get the chance and overexploit forest resources. On the other hand, the local community claim that people of the forest department cut down trees and sell them for profit and save themselves by diverting this allegation to local people. As a result, the relationship between local communities and the forest department stands on mistrust. The forest department does not agree that much to involve the local community whereas local people want full ownership rather than being a stakeholder in the forest department.

Population Pressure on Forest

The Forest Department mentioned that people are converting forest areas into agricultural lands. They also added that resourceful lands are also converted for housing purposes; people are using both forest land and forest products (i.e. wood, bamboo) by uprooting trees. This extra pressure on land is acting behind the depletion of the forest in the central coastal area of the country.

Land Ownership

The owner of the land becomes the stakeholder of the forested area and receives the benefit from the forestry. Though the Social Forest Rules- 2004 indicated the ownership of land and beneficiaries of newly accreted lands in the coastal area but in reality, that is not maintained properly in previous times. The most deserving marginal local people are deprived of being part of the beneficiaries. Politically powerful, associations of the forest department's staff, government officials, or rich people usually get the lease of the newly accreted lands and eventually the forest areas.

Protection of the Seedlings and Forests

After plantation, it is essential to take care of the seedling areas as these areas might be destroyed by any kind of domestic animal. However, protection of a large forest area from animals is not solely possible for the forest department with their limited manpower. Local people have to come forward to protect the forest by keeping their cattle away from forest cover.

Lack of Monitoring

Forest department stated that they regularly follow the process of monitoring from higher authority but according to the local people, monitoring is not regularly conducted in the surveyed sites. The reason behind this irregular monitoring is that the study areas are remote places and not easily accessible. The only routes to these places are waterways which are also very risky for non-native people. That's why continuous monitoring is deemed improbable in the study areas and the locals assumed that lack of monitoring is the reason behind corruption and other unethical activities. Some respondents narrate that as there is less monitoring, forest departments don't have to give any explanation for their transgression to other government officials.

Framework for Sustainable Forest Management

Bangladesh government is running several coastal afforestation projects for many years ago under the supervision of the forest department by involving the coastal community. But the problem is that the existing practices are not improving the condition of the forest as well as the livelihood of poor people. Several drawbacks were identified from field visits and a new mechanism is needed which is expected to overcome existing challenges and bring better results. However, the present study devised a new framework that is expected to be more effective for managing forest areas in the coastal area of the country sustainably. In this new framework, five elements/ actors are identified which together prepare a house of sustainable forest management. It is an inter-depended framework where each element has a close connection to each other and also depends on one another for better workability.

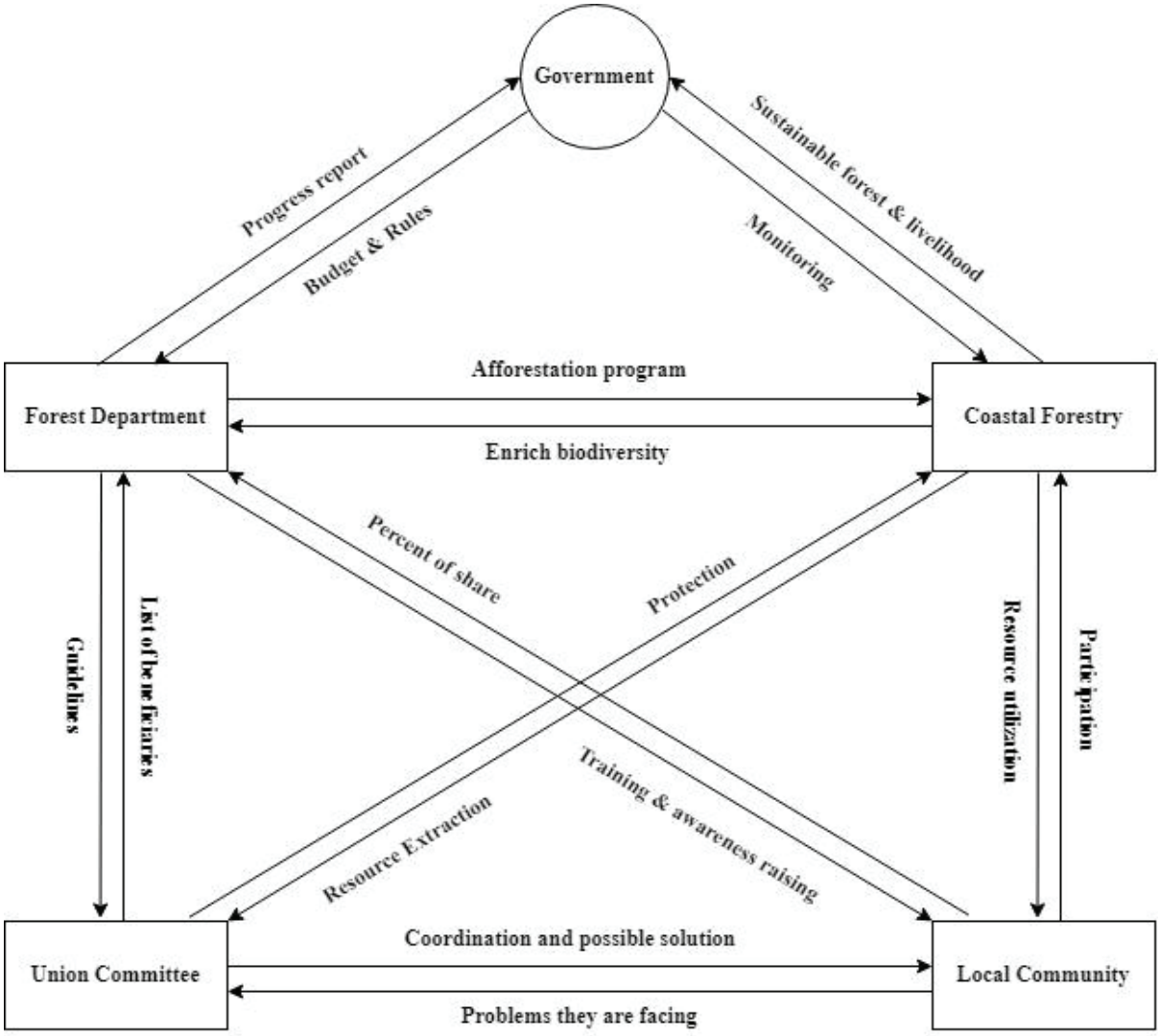

Figure 7: Suggested Framework for Sustainable Forest Management in the Central Coastal Area of Bangladesh

Government

The first essential element of the framework is the central/ local government which can be considered the roof of the sustainable forest management house. Basically, the government will construct rules and policies and these are to improve the forest conditions and livelihood of the local community. Besides, government authority is the source of maximum financial support for any kind of afforestation project. Hence, the authority will make a budget and give funds to the forest department so that they can run various programs associated with forestry. On the other hand, Forest Department has to submit a progress report to the government describing the condition of the forest, an explanation and reason behind the progress of the forest, and further suggestions to improve and increase the forest areas. This will increase the process of transparency and accountability of the forest department towards the government will be ensured. Moreover, the central government will monitor the improvement of the forest condition after a certain period and based on the monitoring report, further policies might be formulated for the forest department.

Forest Department

The most active element of this framework for achieving sustainability is the forest department. A strong positive connection between the forest department and the local community can reduce the challenges by increasing integration which ultimately influences sustainability. There is a lack of collaboration between the local

community and the forest department. To minimize this gap, the forest department can arrange seminars, workshops, and other collaboration programs to raise awareness among local communities. Moreover, the forest department can arrange training opportunities for the local communities so that they can learn more about species selection, plantation, and taking care of the seedling. This will not only enhance forest-related knowledge among the local community but also will build a good relationship between these two parties which is necessary for sustainable forest management.

Local Community

The most influential element of this framework is the local community. They are the central element of implementing plans, policies, and rules related to coastal afforestation. For enhancing the sustainability of the forest, the participation of local people in forest management is important. It is expected that the local community will inform the union committee about the problems they are facing whereas, the committee will give the possible solutions to those problems of the local community by discussing with the forest department. Besides this, the committee will work for enhancing the positive relationship between the forest department and the local community. The committee will arrange various collaboration programs between all the stakeholders to accelerate coastal afforestation program.

Union Committee

The present study suggests that a union/ ward level committee is necessary for sustainable forest management practices in the areas. Local people do not have a good relationship with the forest department and they cannot inform their issues to the local forest department. Hence, a union-level committee is required that will act as a bridge between the forest department and the local community. The Union committee can prepare the list of beneficiaries and to provide the list to the forest department. Forest department can provide guidelines to union committee for sustainable forestry. These guidelines will be prepared based on the condition of the forest and the involvement scenario of the local people in the forest management mechanism.

Coastal Forestry

Coastal forestry is the only dependent element of this framework and all other elements work for the betterment of this component. The local community contributes to coastal forestry by participating in the coastal afforestation program. In exchange for participation, coastal forestry will give the local community the right to resource utilization. But the use of the forest resource should be sustainable. Coastal forestry also has a connection with the local union committee. This union committee act as a bridge between the forest department and the local community. Coastal forestry will allow resource extraction by a committee member. On the other hand, coastal forestry needs the protection of the forest area from domestic animals. The union committee will give protection of the forest and will save the seedling from the attack of any kind of animal.

CONCLUSIONS

Community involvement in coastal forest management can improve the condition of forest resource and also can ensure livelihood for the locals. The study result shows rapid depletion of coastal forestry and poor integration of local community in coastal forest management practices. A proper guideline should be prepared for both the forest department and local communities for the betterment of coastal forestry and enhancing community involvement. The gap between the local people and the forest department can be reduced by constructing a ward committee and transparency and accountability of the forest department's activities can be ensured by continous monitoring. Spontaneous participation of local communities will be ensured if the fair share of benefits from the forest is given to them. Involvement of merginal group of people in forest management program can be increased by giving them aid. Local communities have to be facilitated by giving them chance to do agriculture in relatively stable char areas and plantation/ afforestation should be done in newly raising char lands. Otherwise, local people will start harvesting crops by clearing the forest area as most of the local people are engaged with agriculture. Special workshops and seminars can be arranged for local communities by the forest department focusing on the benefits of integrated forest management. This study adopts a framework considering all these issues for sustainable forest management. A sustainable coastal forest management practice can be seen only by ensuring the responsibilities of every parties in the framework. Further research is needed to operate in other coastal areas of Bangladesh to ameliorate the condition of coastal forestry.

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