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Growth Dynamics of Major Mangrove Species in the Sundarbans Reserve Forest of Bangladesh

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Abstract— To conduct the present study, data was collected from 33 Permanent Sample Plots with a view to observing the growth dynamics of important mangrove species with a multistage sampling technique in the Sundarbans Reserved Forest (SRF), Bangladesh. The salinity of the soil varies from 5 to 28 ppt and P^H ranges from 5.0 to 6.0. There were 25970 ha^{-1} of seedlings in the LSWZ (>5 ppt), 32212 ha^{-1} in the MSWZ (5-18 ppt), and 26424 ha^{-1} in the SSWZ (>18 ppt). The chronology of the total number of seedlings in each salinity zone were 43%, 24%, and 33% respectively. Total numbers of regeneration for *H fomes* 9303, 5970 and 4818; *E agallocha* 7273, 12970, 3091; for *C decandra* 2303, 636, 11242; for *X moluccensis* 879, 909,233; for *B sexangula* 2788, 1303, 152; for *S apetala* 333, 1273, 0; for *A officinalis* 697, 636, 30; for *C ramiflora* 758, 30,0; for *A corniculatum* 242, 30, 4576; for *R apiculata* 121, 606,0; for *A cucullata* 394, 394, 182; for *P paludosa* 485, 0,0 and for *N fruiticans* 485, 455,0 in less, moderate and strong salinity zones consecutively. Total regeneration percentage with average annual increase of growth (DBH, cm and Height, m) of each species of *H fomes* 27.5%, 0.025 and 0.020; *E agallocha* 7.0%, 0.023 and 0.012; *C decandra* 39.2%, .033 and 0.034; *B sexangula* 13.6%, 0.156 and 0.055; *X mekongensis* 3.1%, 0.029 and 0.028; *A officinalis* 4.6%, 0.024 and 0.053; *S apetala* 0.8%, 0.146 and 0.348; *A corniculatum* 0.6%, 0.019 and 0.156 in different saline zone of Sundarbans.

Keywords— Growth Dynamics, Mangrove, Permanent Sample Plots, Regeneration, Sundarbans.

I. INTRODUCTION

The Sundarbans form an impenetrable salt swamp of lakes and rivers, and are the largest forest in the world [34], [52]. This natural productive system is very important for both floral and animal resources. It is one of the world's largest productive mangrove forests [13], [25] located south of the Tropic of Cancer at the northern tip of the Bay of Bengal and may be classified as tropical forests, covering an area of about 10,029 km^2 in Bangladesh and India [30]. It is located in the southwest corner of Bangladesh, between $21^0$30" to $22^0$30" north and 89°00" to 89°55" in the east [28]. The total area of Bangladesh Sundarbans is approximately 6,017 km^2 (62% of the total) covering 4,143 km^2 of land [41] and 1874 km^2 water bodies through complex network of rivers, canals and streams [57], [33].
The Sundarbans mangrove forest is remarkable for its flora and fauna, wildlife habitat, and natural resources as a result of which it was declared by UNESCO as the 560^{th} Ramsar Wetlands Site and the 798th World Heritage Site in 1992 and 1997, respectively [29]. Increasing land use patterns, positive perceptions of Social Forests especially women's employment opportunities, firewood facilities and rapid economic choices quickly change livelihoods and increase social and economic status directly or indirectly in the Sundarbans coastal belt [35] , [52]. The mangrove forests of Bangladesh provide important ecosystem goods and services to the environment [26], [53], [34] and to the densely populated coastal population including shoreline stabilization, storm protection, water quality maintenance, micro-climate stabilization, groundwater recharge and discharge, flood and flow control, sediment and nutrient retention, habitat protection and biodiversity, biomass, productivity and resilience, recreation and fishing, forestry products, and water transport [5], [25], [27].

Increasing land use pattern, positive perception towards Social Forestry especially employment opportunity for female, fuel wood facilities and selection of economically viable species accelerate to change the livelihood as alternate pattern and also increase socioeconomic condition directly or indirectly in coastal belt of Sundarbans [52] , [38], [16]. Bangladesh's largest mangrove forest-Sundarbans provide a wide range of environmental services and contribute to the social and economic development of neighboring communities [14]. Timber, fishing and other non-timber forest products (NTFP) are the main forest products [25]. The Sundarbans Reserve Forest (SRF) in Bangladesh is an ideal destination for tourism development [15], [52]. Also, the Sundarbans act as coastal protection and reduce winds and storms, coastal floods and coastal erosion [47], [26], [34]. More than 3.5 million people living near Sundarbans rely directly or indirectly on natural resources. People close to the Sundarbans use small-scale forest products directly and indirectly [34]. In addition, the forest has regional and global significance for its natural resources. UNESCO declared Sundarbans a "World Heritage Site" in 1997 [37].

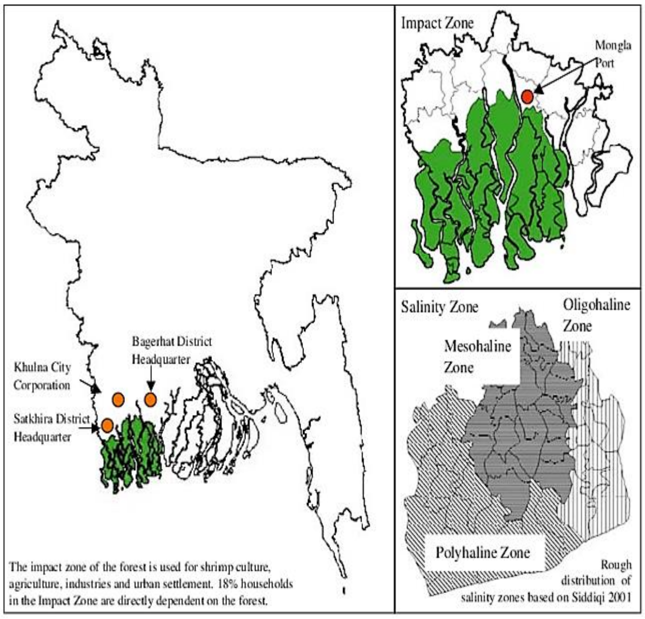

Figure 1: Map of the Sundarbans showing different zones.

Currently, Sundarbans are threatened by both anthropogenic and environmental factors. Natural threats include climate change that has increased sea levels. It is expected that the greater diversity in the Sundarbans will be reduced from 60% to 30% by 2100 by sea levels of 88 cm compared to 2001, which will ultimately reduce the production of forest products and livelihoods [8]. Rapid climate change is expected to have various impacts on coastal Bangladesh. Nearly 39 million people have lost their homes as a result of major natural disasters such as floods and hurricanes from 1970 to 2009 [56]. Despite the deterioration, the Sundarbans contribute 3% to the country's total domestic production of the 5% contribution to the forestry sector [50]. According to MEA [44] (2005), about 60 percent of the world's natural resources have been damaged or misused. Mangroves are widely known as the sub-tropical tidal wetland ecosystems that provide a variety of environmental services including provision, e.g. Wood Production [46], regulatory, e.g. collection and storage of material [17] and spiritual activities, e.g. sacred forest [45].

The soil of the forest is of recent origin. Depending on the soil salinity, three different salinity zones-oligohaline (2 dsm^{-1}), mesohaline (2-4 dsm^{-1}) and polyhaline (4dsm^{-1}) can be identified [53]. Depending on the volume of the oceans, the forest can be divided into four (1) saturated surfaces (new, non-oxygenated accretion), (2) saturated with normal high tides (covering most of the area), and (3) full spring only high waves (especially) in the northern part), and (4) flooded by high waves (northeastern part) [53]. It supports more than 330 species of plants representing 245 generations, more than 400 species of fish, 35 species of reptiles, more than 300 species of birds, and 42 species of mammals [39] , [36]. Of these, 2 amphibians, 14 reptiles, 25 birds and 5 mammals are extinct in other parts of the world [39]. *Heritiera fomes* of Sterculiaceae and *Excoecaria agallocha* of the Euphorbiaceae are two species of large trees [39]. *Heritiera fomes* of Sterculiaceae and *Excoecaria agallocha* of Euphorbiaceae are the two major tree species [39]. Besides, Goran (*Ceriops decandra* (Griff). Ding Hou), Kankra *(Bruguiera sexangula (*lour.) Poiret) , Passur (*Xylocarpus mekongensis* Pierre) , Baen (*Avicennia officinalis* L) , Keora (*Sonneratia apetala* Buch.-Ham) Golpata (*Nypa fruticans* Wurmb.) , Jhana (*Rhizophora apiculata* Lam.) , Khalsi *(Aegiceras corniculatum (L.)* Blanco), Amoor *(Amoora cucullata* Roxb.) , Hantal *(Phoenix paludosa* Roxb.) , Singra (*Cynometra ramiflora* L.) etc. grow here. Establishment of plantation in the poorly regenerated areas of the Sundarbans is essential for the enrichment of ecosystem and biodiversity of the Sundarbans to mitigate the climate change issues [26], [52].

The forest canopy rarely exceeds 10m in height and is slightly open [19] (FAO, 1994). The forest has been systematically managed for more than 130 years [7] and is divided into 55 administrative units or rooms and 8 blocks. Planting can be done by taking into account medicinal values, aesthetic values, biodiversity, and dynamic coastal forests, increasing vegetation coverage and, of course, accelerating the ongoing subsistence pattern closer to local communities in Sundarbans [25]. Four detailed vegetation survey [11], [20], [9], [49] have been developed. Temporary environmental research suggests that the structure and structure of the forest has changed for a variety of reasons and that the forest is declining in terms of growing livestock capacity and ecosystem [40], [53]. However, the effects of plant growth power have not been compared. Information on seedlings' recruitment, structure, and composition and growth of trees indicating their ecological significance that may be considered in future decision making processes for management of the SRF However, Therefore, it is important to know the regeneration status, changes of seedlings to saplings to trees in understating potential responses of the mangrove ecosystems to their management practices. This study was conducted to study changes in the vegetation potential of Sundarbans and to develop a more complete understanding of the dynamics of forest vegetation. At the same time this research will help to determine the plant, intrusion of vigorous plant to cope with salty environment in different parts of Sundarbans. This study has been undertaken to analyze the changes in the vegetation dynamics of the Sundarbans and to develop a comprehensive understanding of vegetation dynamics of the forest. At the same this research study will help to know the vegetation status, seedling and sapling recruitment status with relation to salinity in different zones of Sundarbans. This will help to know growth increment of different species and finally to manage the ecosystem of Sundarbans.

II. Related Work

Study on the natural regenerations of the major mangrove tree species in the Sundarbans of Bangladesh were conducted by Faizuddin, M.; Rahman, M. M. and Shahidullah, M. (1996) [18], and then Rahman, M. M. (2017) [48] conducted related research entitled Regeneration status of major mangrove species in the Sundarbans. However present study was conducted after a certain period of time to know the species regeneration of seedlings, saplings and growth of trees.

III. METHODOLOGY

Study area

Climatic conditions of the Sundarbans is humid with annual rainfall of about 200-2100 mm. Highest temperature in the Sundarbans occur in April and May up to 40^0c and lowest temperature is 12^0c in December and January [4], [53]. The mean annual rainfall is about 1700 mm in most of the Sundarbans area. Maximum and minimum average relative humidity (RH) in the Sundarbans is 100% and 23% respectively. The soils of the Sundarbans are alluvial in nature, no distinct profile and hydromorphic with varying degree of gluing in the sub-soil horizon [4]. In general soil fertility decreases from east to west and from north to south [10].The soil of the Sundarbans is slightly saline, silty clay loam and sub-soil consists of alternate layers of clay and sand, and it is uniform throughout the forests. The mean organic matter content in the top soil is 0.62% and pH range is 5.0-8.0 throughout the Sundarbans. Hasan *et al*., (1988) [23] have classified soils having <2.0 mmhos of electrical conductivity as less saline, 2.0-4.0 mmhos of electrical conductivity as moderate saline zone and > 4.0 mmhos of electrical conductivity as strong saline zone. The study was conducted on three natural habitats in Sundarbans such as the less saline water zone (LSWZ), moderate saline water zone (MSWZ) and strong saline water zone (SSWZ). The Mangrove Silviculture Division of the Bangladesh Forest Research Institute has been researching growth patterns since 1980 by establishing Permanent Sample Plots (PSPs) in three different salt marshes. Permanent Sample Plots (PSPs) are managed by the Mangrove Silviculture Division.

Table-1: Water salinity and P^H basis PSPs locations in the Sundarbans.

Salinity Zone	Sl no.	Location	PSP No.	C.N.	Water salinity (ppt)	Soil p^H
Less Saline Zone	1	Nandabala	1	26	16.0	6.6
	2	Jongra	3	30	17.0	6.4
	3	Supoti (East)	4	3	6.0	5.2
	4	Supoti (West)	5	5	6.0	6.4
	5	Sarankhola	26	24	6.0	5.7
	6	Mirgamari	25	28	13.0	6.2
	7	Bagi	6	1	5.0	5.6
	8	Dhangmari	13	31	17.0	6.5
	9	Koramjol	14	31	18.0	6.6
	10	Mora bhola	28	2	5.0	5.6
	11	Supoti Khal	33	04	6.0	6.4
Moderate Saline Zone	12	Charaputia	2	15	19.0	5.2
	13	Baniakhali	7	35	27.0	6.6
	14	Kashiabad	8	36	25.0	6.6
	15	Alkidives (East)	15	17	25.0	6.6
	16	Alkidives (West)	16	17	25.0	6.2
	17	Bosboja (East)	22	37	27.0	5.9
	18	Bosboja (West)	23	37	27.0	6.0
	19	Kalabogi	24	32	23.0	6.5
	20	Katka	27	7	15.0	5.0
	21	Bhadra	29	29	18	5.6
	22	Charaputia	32	21	17.0	6.3
Strong Saline Zone	23	Gewakhali	11	38	27.0	5.7
	24	Sonamukhi	12	41	27.0	5.0
	25	Ball River	17	41	26.0	6.0
	26	Kadamtala	18	46	27.0	6.1
	27	Chunkuri	19	47	27.0	6.6
	28	Chunkuri	20	47	27.0	6.6
	29	Kateshor	21	46	17.0	6.0
	30	Koikhali	30	47	27.0	5.2
	31	Burigoalini	9	46	28.0	6.2
	32	Gewakhali	10	20	19.0	5.0
	33	Andermanik	31	41	26.0	6.6

Data collection

There are currently 33 Permanent Sample Plot (PSPs) sites in three natural areas in Sundarbans. The multistage sampling process is used to collect data from each PSP. The area of each PSP is 400 m^2 and each PSP is divided into three sites each with an area of (2.5m × 4m = 10 m^2). Data collected on each PSP covering an area (10 m^2 × 3) $30m^2$. Therefore, the total area ($30m^2$ × 33) $990m^2$ was considered as data recording for the study. A pattern of mangrove regeneration was observed. Average number of seedlings / ha, seedlings / ha were managed and identified annually. At the same time the increase in the average age in the Breast Height (DBH) (in cm), increased in height (in m). A number of trees (with a width of > 5 cm at a height of 1.33 m) and seedlings (with a width of <5 cm) of all major species were recorded in each building. Lease of mangrove seedlings was recorded in May and November each year. Growing seedlings and particles of different species have been identified by experience. PSP locations are shown in **(Table 1)**. The saline water data was recorded by the Automatic Refractometer. In all salinity zones, classes of various diameters were selected for data collection. Trees were lined with metal sheets and marked at DBH level (1.3 m) with a red ribbon with their paint. New numbers and repainting were done once a year.

Data analysis

Survival and growth data (Height, m and DBH, cm) were collected twice a year. Microsoft's advanced software is used to process all collected data. At the same time, Microsoft Excel programs were used to prepare tables, charts, and graphs.

IV. RESULTS AND DISCUSSION

Mangrove species present (seedlings, saplings and trees in terms of increment of height, DBH) in the study area of

SRF are presented in Table 2. A total of thirteen mangrove species belonging to nine families were present in the all stand layer (seedlings, saplings and trees) in the Sundarbans, Bangladesh. The species present in this study were presented in Table 2. At the same time, family name and IUCN conservation status with global population trend are presented in the table 2. Most of the species (Total 8 species) present in this zone are in Least concern (LC) which belongs to nine families according to IUCN conservation status. On the contrary, only two species are Near Threatened (NT) (family-Rhizophoraceae and Arecaceae), two species are not abundant (NA) (family-Fabaceae and Meliaceae) and only one species are Endangered (EN) (family-Malvaceae) in the study area of Sundarbans, Bangladesh (Table 2). Besides according to global population trend, two species are Not Abundant (NA) (family- Fabaceae and Meliaceae) and the rest species global population trend are decreasing which belongs to family of Euphorbiaceae, Malvaceae, Meliaceae, Rhizophoraceae, Avicenniaceae, Myrsinaceae, Lythraceae, Arecaceae in SRF, Bangladesh (Table-2).

Table- 2: Taxonomy, global conservation position, and ecological distinctiveness of the species in the study area of SRF, Bangladesh.

Sl no.	Local name	Latin name	Family	IUCN conservation status	Global population trend
1	Gewa	*Excoecaria agallocha* L.	Euphorbiaceae	LC	D
2	Sundri	*Heritiera fomes* Buch. -Ham	Malvaceae	EN	D
3	Goran	*Ceriops decandra* Griff. Ding	Rhizophoraceae	NT	D
4	Passur	*Xylocarpus moluccensis* Pierre	Meliaceae	LC	D
5	Baen	*Avicennia officinalis* L	Avicenniaceae	LC	D
6	Kankra	*Bruguiera sexangula* lour. Poiret	Rhizophoraceae	LC	D
7	Khalshi	*Aegiceras corniculatum* L. Blanco	Myrsinaceae	LC	D
8	Keora	*Sonneratia apetala* Buch.-Ham	Lythraceae	LC	D
9	Singra	*Cynometra ramiflora* L	Fabaceae	NA	NA
10	Jhana	*Rhizophora apeculata* Lam	Rhizophoraceae	LC	D
11	Amur	*Amoora cuculata* Roxb	Meliaceae	NA	NA
12	Hantal	*Phoenix paludosa* Roxb.	Arecaceae	NT	D
13	Golpata	*Nypa fruticans* Wurmb	Arecaceae	LC	D

*EN = Endangered, LC = Least concern, D = Decreasing, and NA=Not abundant
Compiled from- Sarker et al., (2016) [51]; Iftekhar and Saenger, 2008 [33] and Mahmood, *et al., (2019)* [43].

Percentage of mangrove regeneration in different parts of the Sundarbans varies from year to year. Due to pests, diseases and other disturbances the trees do not produce enough fruit and seeds (propagules) so regeneration is affected. There are significant differences in the rental of Sundarbans species and habitats.

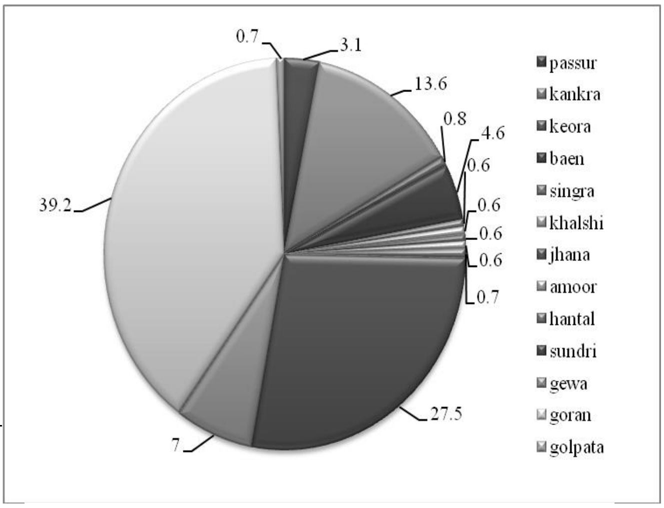

Figure 2: Regeneration status of Sundarbans in the study area

The regeneration pattern of mangrove species in the Strong Saline Water Zone (SSWZ) moderate Saline Water Zone (SSWZ) and Less Saline Water Zone (LSWZ) of the Sundarbans varies from place to place. The regeneration pattern in the PSPs was detected and the percentage was Sundri 27.5%, Gewa 7.0%, Goran 39.2%, Kankra 13.6%, Passur 3.1% , Baen 4.6%, Keora 0.8%, Golpata 0.7%, Jhana 0.6%, Khalsi 0.6%, Amoor 0.6, Hantal 0.7%, and Singra 0.6% in various saline areas of Sundarbans (Figure-2). The number of seedlings per hectare in the low-salt area (> 5ppt) was 25970, in a moderate salt area (5-18 ppt) 32212 and in a high salt area 9> 18 ppt) 26424 (Figure-3).

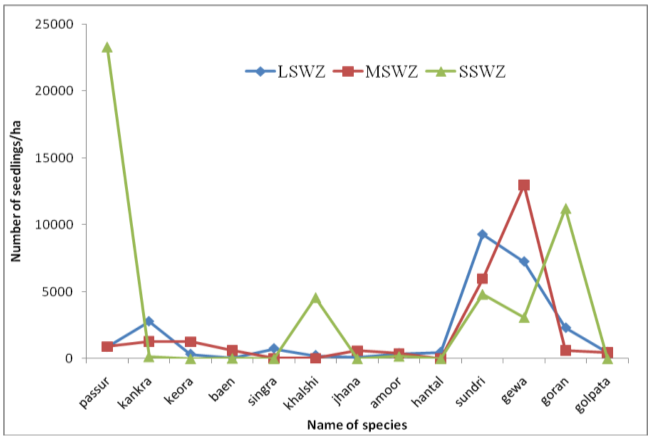

Fig. 3: Number of seedlings/ha in the study area

Among them the number of seedlings per hectare in the less saline water zone are Sundri, Gewa, Goran, Kankra, Passur, Baen, Keora, Golpata, Jhana, Khalsi, Amoor, Hantal and Singra was 9203, 7273, 2303, 2788, 879, 697, 333, 485, 121, 242, 394, 485 and 758 respectively (Figure-3) for PSPs. The number of seedlings per hectare in the moderate saline water zone are Sundri, Gewa, Goran, Kankra, Passur, Baen, Keora, Golpata, Jhana, Khalsi, Amoor, and Singra was 5970, 12970, 636, 8303, 909, 636, 1273, 455, 606, 30, 394 and 30 respectively in the study area. The number of seedlings per hectare in the strong saline water zone are Sundri, Gewa, Goran, Kankra, Passur, Baen, Khalsi, and Amoor was 4818, 3091,11242, 152, 2333, 30, 4576 and 182 respectively in the Sundarbans (Figure-3).

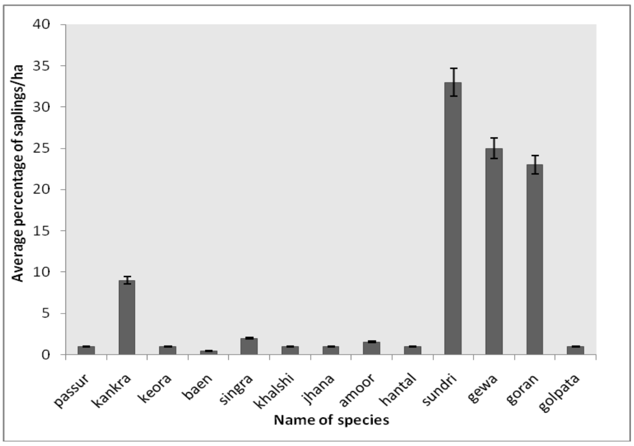

Fig. 4: Percentage of saplings/ha in the study area

Average saplings percentage in the PSPs of Sundri (*Heritiera fomes*) 33%, Gewa *(Excoecaria agallocha*) 25%, Goran (*Ceriops decandra*) 23%, Kankra *(Bruguiera sexangula*) 9% , Passur (*Xylocarpus moluccensis*) 1%, Baen (*Avicennia officinalis*) 0.46% , Keora (*Sonneratia apetala*) 1%, Golpata (*Nypa fruiticans*) 1% , Jhana (*Rhizophora apeculata*) 1% , Khalsi *(Aegiceras corniculatum*) 1% , Amoor *(Amoora cucullata*) 2% , Hantal *(Phoenix paludosa*) 1% and Singra (*Cynometra ramiflora*) 2% (Figure-4). In the Permanent Sample Plots (PSPs) of the Sundarbans the total number of saplings in low-salt, moderate saltwater areas with 43%, 24% and 33% saltwater respectively (Figure-5).

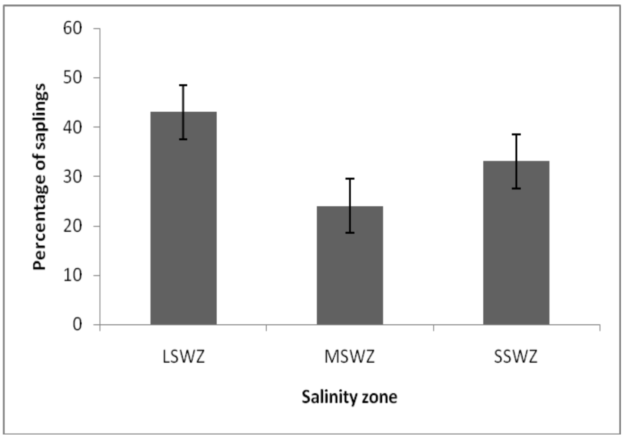

Fig. 5: Percentage of saplings in the study area

In addition to the increase in the annual average of height (m) of Sundri, Gewa, Goran, Kankra, Khalsi, Amoor, Passur, Keora, Baen and Singra in Sundarbans were 0.020m, 0.012 m, 0.034 m, 0.055 m, 0. 156m, 0.283 m, 0.028 m , 0.348 m, 0.053 m and 0.067 m respectively (Fig 6).

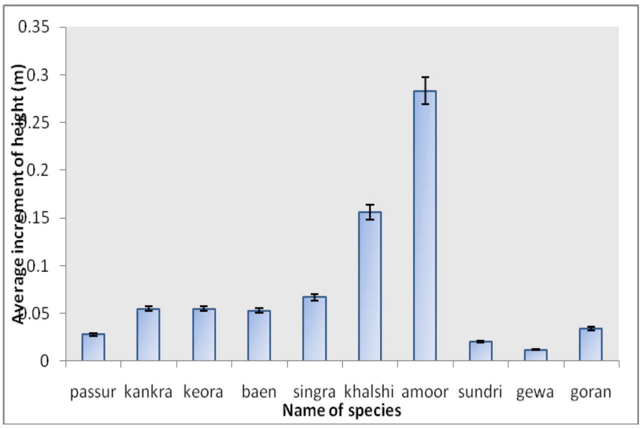

Fig 6: Average increment of height (m) in the study area

In the PSPs fields of all saline areas the annual increase of DBH was taken respectively. The DBH (in cm) dimensions of Sundri, Gewa, Goran, Kankra, Khalsi, Passur, Keora, Baen, Singra and Amoor were 0.025 cm, 0.023 cm, 0.033 cm, 0.156 cm, 0.019 cm, 0.029 cm, 0.146 cm, 0.024 cm, 0.108 cm and 0.133 cm respectively in the Sundarbans. At the time of taking the data from the experimental PSP, DBH was taken more than 4 cm for each species (Fig 7).

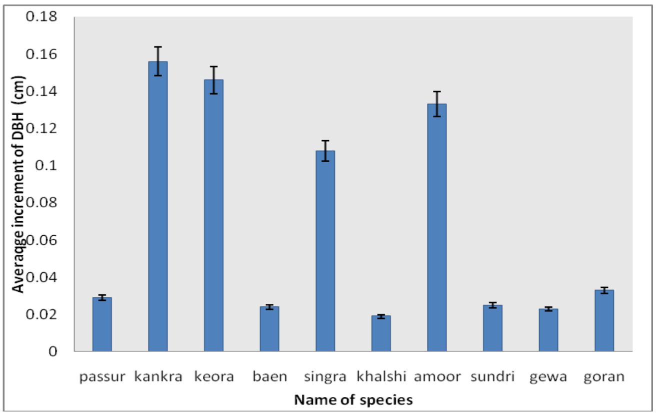

Fig 7: Average increment of DBH (cm) in the study area

Discussion

Total 13 species recorded in the study area of SRF and most of the species (8 species) present in this zone are in Least concern (LC) according to IUCN conservation status. Besides, only two species are Near Threatened (NT), two species are not abundant (NA) and only one species are Endangered (EN) in Sundarbans, Bangladesh. Again, according to global population trend, most of the species population is decreasing (11 species) and two species are Not Abundant (NA) (Table-2). So IUCN conservation status and global population trend indicates the necessity of this species in the context of global climate change issues, species conservation strategy, sustainable management planning and so on

There are several consecutive systems designed to define vegetation dynamics in Sundarbans [53]. From a detailed data analysis in the PSPs, the highest number of seedlings was observed in the event that *Heritiera fomes* (9,303ha^{-1}) were followed by *Excoecaria agallocha* (7,273ha^{-1}) in an area with low salt water. *Heritiera fomes* and *Excoecaria agallocha* species are prominent species in the Myyarwady (AYWD) Delta of Myanmar where wild mangroves [55] show similar findings in this study. At the same time the highest number of seedlings was observed in the case of *Excoecaria agallocha* L. (12,970 ha^{-1}) followed by *Bruguiera sexangula* (8,303ha-1) in moderate salt water and in the 11,242 ha^{-1} saltwater area of *Ceriops decandra* followed by *Heritiera fomes* (4,818 ha^{-1}) (Figure-3). Among the three salt marshes the highest number of seedlings was observed in the area with moderate salt water (5-18 ppt) 32,212 ha^{-1} (Figure-3). Seedling recruitment and survival mainly drive human growth [6], [42] and thus determine the plant quality and production of forest stands [54]. In order to adequately rehabilitate the environment at least 2,500 seedlings are proposed that are well distributed per hectare [54].

There is a strong rate of reforestation in small secondary areas, as seen by a high vegetable center in the first 10 years, exceeding the recommended amount of good regenerative energy in Matang Nature Reserve, Malaysia (5000- 10,000 saplings ha^{-1}) [21], [2]. The high concentration of samples and the growth rate show good regenerative potential indicating similarity and higher regenerative capacity and a moderate saline environment. The highest percentage of the species was observed in *Heritiera fomes* Buch. -Ham. (33%) followed by *Excoecaria agallocha* L. (25%) (Figure-4). High-yield lease was observed in the low-salt (43%) area but in the moderate and solid salt water areas it was 24% and 33% (Figure-5). The highest annual DBH rise (in cm) is 0.156 (Figure 7) of *Bruguiera sexangula* (Lour.) Poiret and the highest annual ht (m) increase was 0.348 (Figure- 7) of *Sonneratia apetala* Buch.-Ham. Haque *et al*. (2000) [22] found that growth in height was not related to the age of cultivation of these species. Another study conducted in the Mahanadi delta, Orissa, India has revealed that, *S. apetala* recorded high growth (3.0 m after 2 years) and *C. Decandra* showed low growth (0.5 m) [13]. The highest percentage of regeneration shown by *Ceriops decandra* (Griff.) Ding Hou (39.2%) was followed by *Heritiera fomes* Buch. –Ham (27.5%) (Figure-2). Helal Siddiqi (1998) [24] reported that *C. decandra, E. agallocha, H. fomes* are the dominant species in the various salt marshes in Sundarbans. All these findings have shown that Sundarbans flowers are characterized by an abundance of *H. Fomes, E. agallocha, C. decandra, S. apetala, A. officinalis*, Sundri (*Heritiera fomes*) are the most abundant tree species in the oligohaline area, followed by Gewa (*Excoecaria agallocha*) in the mesohaline area and in the Goran (*Ceriops decendra*) a common type of polyhaline zone. These three species occupy about 70% of the forest and the results of this study showed similar dominance in the case of seedlings, seedlings and regenerative conditions [31].

Several physiological factors - chemical (coastal structure, climate, waves, waves and currents, salt, dissolved oxygen, soil and nutrients) have been identified as key components of mangrove growth and development [1]. The major aspects of Sundarbans environmental management can be divided into four categories: climate (rain, temperature, humidity, evaporation, wind and storm); hydrological (water regime, quality of seawater and flooding); edaphic (soil salinity, nutritional status and aeration); and biotic (man and other organisms) [32]. These elements interact and contribute to the formation of the environment. In addition, the ecosystem is vulnerable to external changes such as climate change, sea level rise, landslides, inter-ethnic conflict and global trade [33]. Changes in any of these factors can affect the power of plants. Plant cultivation in Sundarbans can be enhanced by expanding the vast territory of Gewa, Khalshi, and Jhana by combining other mangrove species to reduce climate change in the delta and preserve the planting of Sundarbans ecosystems and biodiversity sustainability [26]. As with other plant species, *A. officinalis, E.agallocha, C. Decandra and B sexangula* are struggling, showing a variety of local growth effects along the coast. Therefore, deforestation of these mangrove species may be helpful, given their sequence of species, in order to produce high growth and coastal conservation [57]. This study suggests that mangrove species should be reintroduced to degraded and productive areas as suggested by [12], the distribution and regeneration of mangroves is necessary for conservation in scientifically controlled fields in a dry body. Mangrove species have therefore shown strong growth indicating that mangrove planting is unavoidable given its strong vegetarian status.

V. CONCLUSION AND FUTURE SCOPE

Mangroves are unique ecosystems that provide a variety of ecosystem services. Significant factors such as an increase in groundwater salinity, rainfall, temperature, wind, fresh water flow, wave eruptions, water flow, water intensity, landslides, water logging, etc. However, the findings of this study should be taken with caution due to a number of limitations. From research conducted it has been found that *H Fomes, C decandra and E Agallocha* seedlings were heavily rented at cost. But the seedlings per hectare were moderately high and the seedlings per hectare were very high in a low saline environment. On the contrary, *C. Decandra* has shown better renewal performance with *H fomes, B sexangula* showed the best annual increase of DBH (cm) and *Sonneratia apetala* showed the best annual increase in height (m) in the Permanent Sample Plots (PSPs) of Sundarbans. Despite this, *H fomes, C. Decandra and E agallocha* can be regenerated through B *sexangula* and reunited with *S apetala*. Therefore the above species should be expedited to take into account the current vegetation situation now and in the near future for the management of Sundarbans. Future forestry studies, temporal conservation planning, and biodiversity conservation and monitoring programs will indeed benefit from these. Improved species accumulation, higher productivity, and a large area of the residual mangrove communities spanning two nations (Bangladesh and India) are associated with higher dynamics vegetation of the stands in absolute terms; from the results of the study regarding this growth dynamics will accelerate ecology and ecosystem of Sundarbans, Bangladesh.

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