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ECOSYSTEM SERVICES OF MANGROVE ASSOCIATE FLORAL SPECIES INHABITING INDIAN SUNDARBANS

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ABSTRACT

The mangrove ecosystem of Indian Sundarbans in the lower Gangetic delta region sustains a number of mangrove associate floral species whose ecosystem services have not been properly evaluated. We present here few ecosystem services of *Porteresia coarctata* and *Ipomoea pes-caprae* in the sphere of environment upgradation and alternative livelihood. Recent advancements in these two sectors have opened up a new horizon, which has high potential to improve the economic profile of the people living in this mangrove dominated lower Gangetic delta region.

INTRODUCTION

The planet Earth sustains a rich spectrum of biodiversity because of its congenial temperature, water availability and other natural resources necessary to sustain life on this planet. This spectral band of biodiversity encompasses a wide range of flora and fauna starting from bacteria to blue whale. Even the microbes of the hydrothermal vents are also the components of biodiversity spectrum. Each and every component of biodiversity provides and contributes services to mankind both directly and indirectly. Scientists are still unaware of the number of species in the biodiversity band of the planet Earth, neither the services provided by them have been identified so as to estimate the economic valuation of the service providers. Covering about 71 % of the Earth's surface, the marine and estuarine ecosystems sustain numerous flora and fauna of which mangrove and associate species have special importance as service providers in the sectors like disaster management, fisheries, timber and wood-based industries, bioremediation, education, tourism *etc*. However very few literatures are available on the ecosystem services of mangrove associate floral species. We present here a comprehensive overview and summary of studies undertaken to investigate the direct and indirect benefits of mangrove associate floral species with particular reference to Indian Sundarbans.

MANGROVE ASSOCIATE FLORAL SPECIES: A PROBABLE DEFINITION

The floral species in mangrove ecosystem can be categorized into true mangroves and mangrove associates (Selvam, 2007; Wang et al., 2011). The species which are adapted to mangrove habitat and do not extend into other terrestrial plant communities are referred to as true mangrove species. On contrary, plants that occur in the coastal environment and also within the mangroves are referred to as mangrove associate species. Example of mangrove associate species are *Porteresia coarctata*, *Ipomoea pes-caprae*, *Sesuvium portulacastrum* and several seaweeds like *Enteromorpha intestinalis*, *Ulva lactuca*, *Catenella repens etc*. A list of mangrove associate species commonly available in Indian Sundarbans is highlighted in **Annexure 1**.

ECOLOGICAL SERVICES

a) Beach stability

The mangrove associate floral species play important roles in minimizing the action of waves, accretion of sediment and dune formation. All these processes increase the density of vegetation and also the depth of the water. *Porteresia coarctata* belonging to family Poaceae is a pioneer

species in the sequence of ecological succession during island formation in Indian Sundarbans (Fig. 1). Similarly *Ipomoea pes-caprae* with very long stem and root systems act as sediment binders and stabilize the sand dunes on the coastal zone (Fig. 2). The mangrove associate species trap the sediments by their long root system and thus serve as land expanders.

Figure 1: *Porteresia coarctata* bed on the mudflats of Indian Sundarbans

Figure 2: *Ipomoea pes-caprae* plantation

b) Bioremediation

Mangrove ecosystems have survived the onslaught of man by using them as waste-dumping sites. However, the potential of mangrove associate species as agents of bioremediation is basically because of three reasons (i) flow through the floral bed disperses wastes from a point source over vast areas, (ii) the floral community filters nutrients and absorbs heavy metals from the water and sediment, (iii) the substratum/soil, microbes attach to the root system absorb large amount of pollutants. Researchers have documented that *Porteresia coarctata* and *Ipomoea pes-caprae* can accumulate considerable amount of Fe, Zn, Cu, Pb and even Hg in their body tissues (Mitra et al., 1992; Mitra et al., 2014a; Das et al., 2014). Recent studies (Banerjee et al., 2014; Mitra et al., 2014b) reveal considerable amount of heavy metals in their vegetative parts and the order of accumulation is stem > leaf > root in case of *Ipomoea pes-caprae* (Figs. 3a, 3b, 3c and 3d). In case of *Porteresia coarctata* highest concentrations of Zn was observed in the vegetative parts followed by Cu and Pb (Figs. 4a, 4b and 4c).

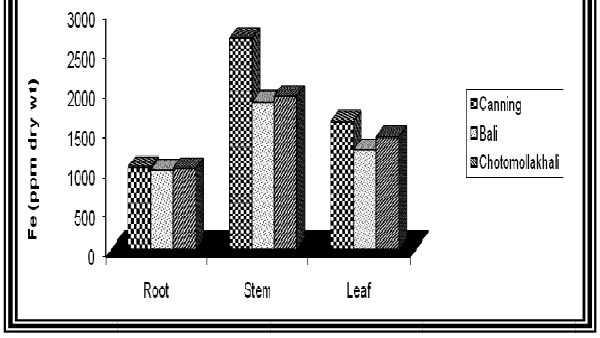


Figure 3a: Fe concentration of *Ipomoea pes-caprae* in 3 selected stations

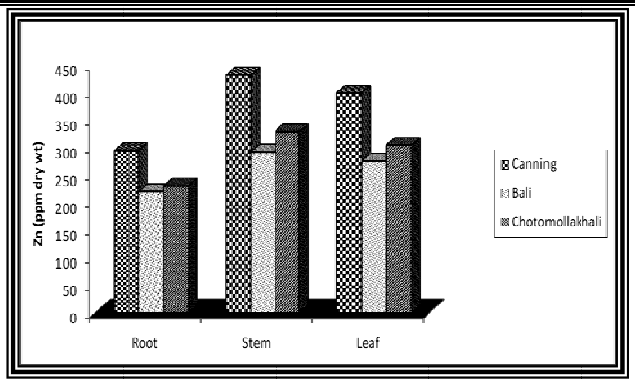


Figure 3b: Zn concentration of *Ipomoea pes-caprae* in 3 selected stations

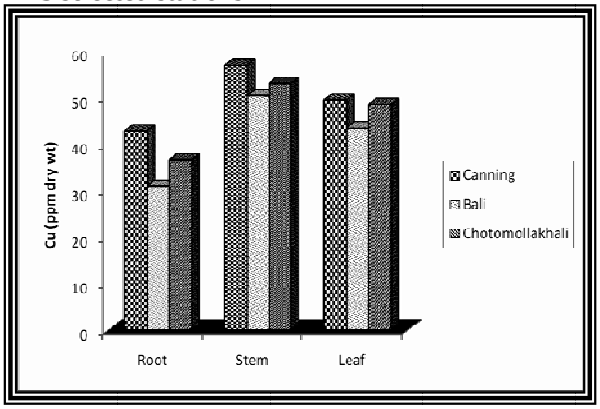


Figure 3c: Cu concentration of *Ipomoea pes-caprae* in 3 selected stations

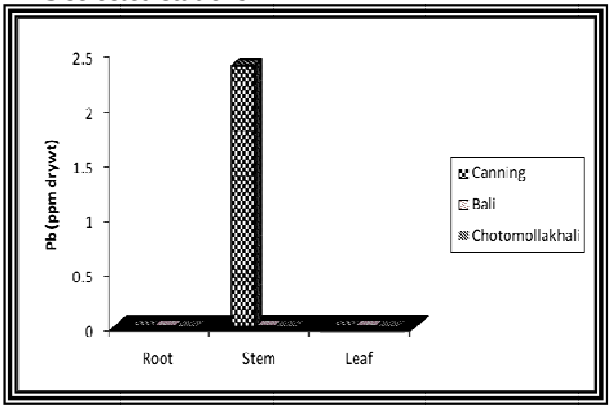
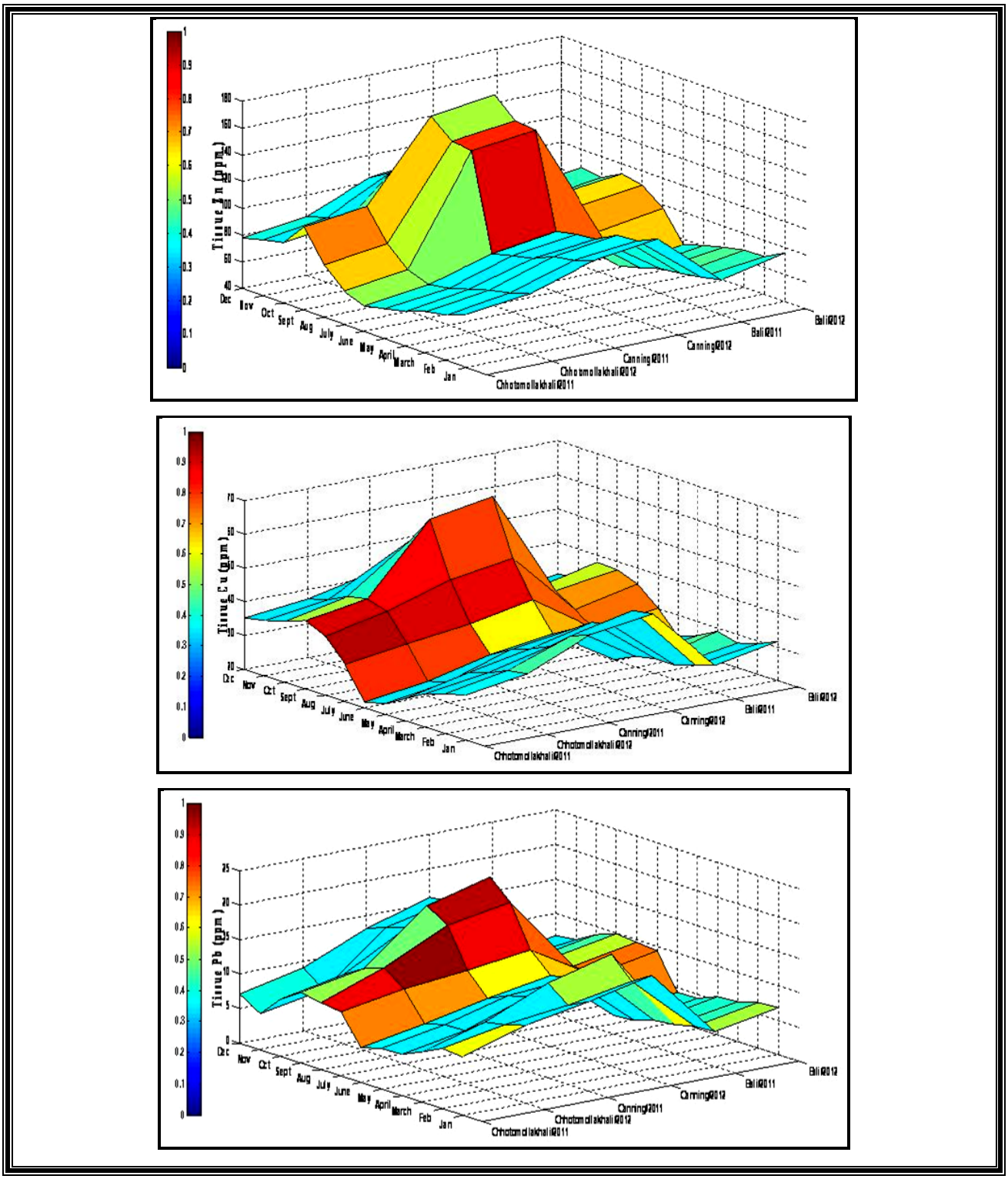


Figure 3d: Pb concentration of *Ipomoea pes-caprae* in 3 selected stations



Figures 4a, 4b, 4c: Bioaccumulation of Zn, Cu and Pb in *Porteresia coarctata* tissue

c) Carbon sequestration

The recent thrusts on global warming phenomenon have generated tremendous interest in the carbon sequestration potential of coastal vegetation. The mangrove associate species *Porteresia coarctata* that can withstand a wide range of salinity (Jagtap and Untawale, 1999) has been found to be a unique store house of carbon. A 12 - year study conducted in the Hooghly and Mandovi estuaries shows that the Above Ground Carbon (AGC) of the species in the Hooghly estuary contains 58.33g/m^{2}C to 104.30 g/m^{2}C whereas in Mandovi estuary the value ranges from 32.57 g/m^{2}C to 63.82 g/m^{2}C (Fig. 5). The Below Ground Carbon (BGC) ranged from 47.81 g/m^{2}C to 63.49 g/m^{2}C in *P. coarctata* of Hooghly estuary, whereas in Mandovi estuary mudflats the value ranged from 26.79 g/m^{2}C to 54.41 g/m^{2}C (Fig. 6). Such difference may be due to edaphic factors and salinity variation (Jana et al., 2013).

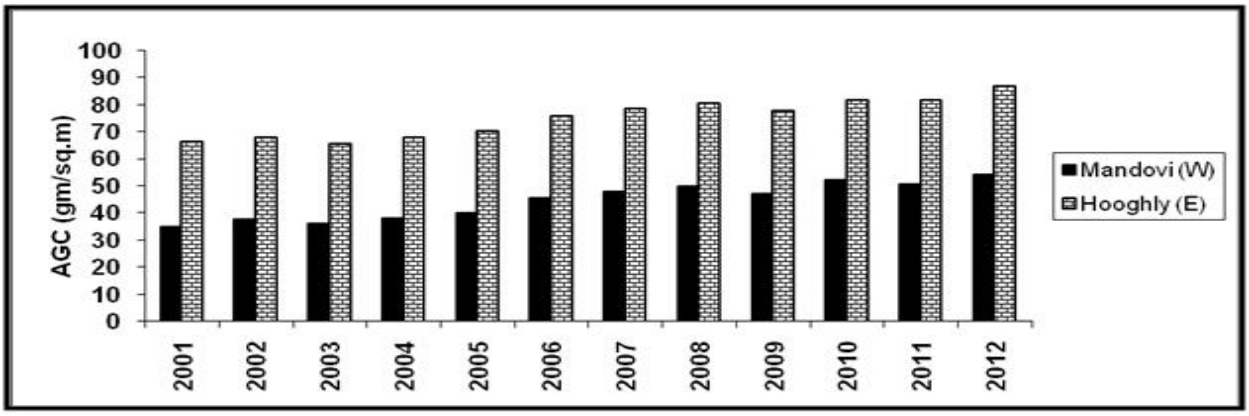


Fig. 5: AGC in *P. coarctata* samples from the Hooghly and Mandovi estuary

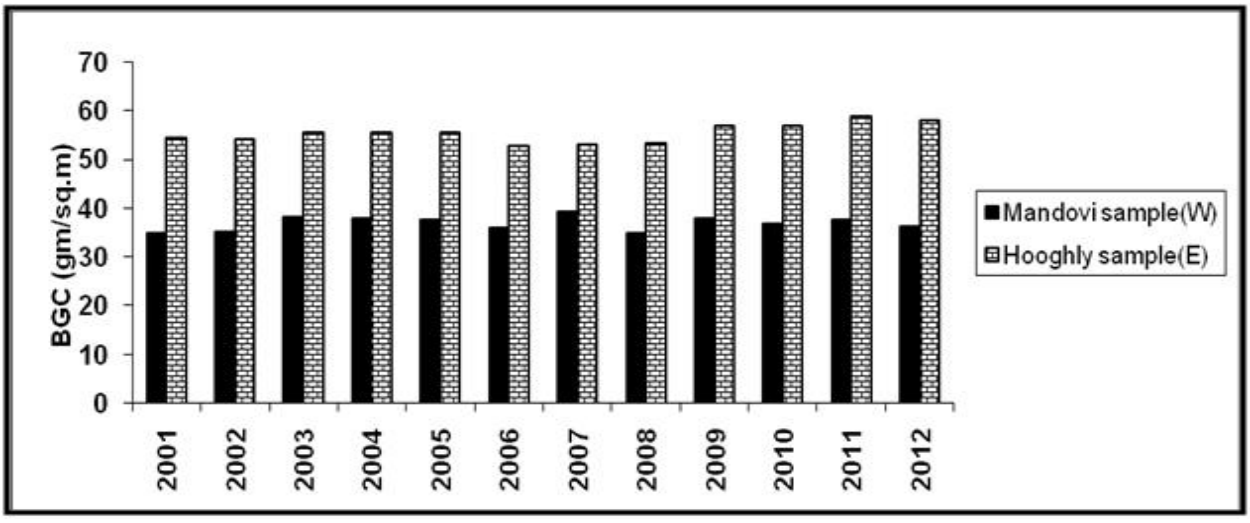


Fig. 6: BGC in *P. coarctata* samples from the Hooghly and Mandovi estuary

d) Industrial application

Health care

Several mangrove associated seaweeds are used for manufacturing cosmetics (Table 1) due to presence of nutritional elements, antioxidant and iodine in their thallus body.

Table 1: use of mangrove associated species in health care products

Product Name	Company Name	Country	Seaweed Used
Super Moisturizing Hand Cream	Balance Me	UK	*Chondrus crispus*
Pacific Seaweed Soak	Beauty through Balance	Canada	*Macrocystis integrifolia*
Gentle Foaming Facial Cleanser	Be Natural Organic	U.S.	*Ascophyllum nodosum*
Your Best Baby Bump Duo (containing Elasticity Belly Oil & All Moisture Body Lotion)	Belli Skincare	U.S.	*Chondrus crispus*
Detoxifying Soap Bar with Grapefruit, Lemon & Seaweed	Bentley Organic	UK	*Fucus vesiculosus*
Brow Boost	Billion Dollar Brows	U.S.	*Laminaria digitata*,
Bliss Fabulous Every Day Eye cream	Bliss World LLC	U.S.	*Laminaria digitata*
Beeswax & Royal Jelly Eye Cream	Burt's Bees	U.S.	*Chondrus crispus*
Scottish Intensive Seaweed Conditioner	Diana Drummond	UK	*Laminaria digitata, Chondrus crispus, Ascophyllum nodosum, Ulva lactuca,*
Sea Plus Renewal Night Cream	Alba Botanica	U.S.	*Chondrus crispus, Laminaria digitata, Macrocystis pyrifera, Ulva compressa, Ulva lactuca*

Organic fertilizer

Organic fertilizers are compounds that contain variety of organic matter. The ingredients may be of floral or faunal origin. Several types of naturally available biotic components can be used to manufacture organic fertilizer. Rotten products, bone meal and even the decomposing plants removed at the end of the harvest season are chopped into small pieces for their inclusion in the organic fertilizer. Marine and estuarine flora like seaweeds, seagrass, saltmarsh grass are rich in

nitrogen, phosphorous, sulphur, potassium and trace elements like iron, zinc, copper *etc*. Hence, these floral species are also used as ingredients of organic fertilizer. The marine and estuarine floral ingredients are extremely useful components of organic fertilizer. They enhance seed production and promote thicker maturation of roots. Also the iron level of the marine and estuarine flora stimulates the production of chlorophyll, which is the prime photosynthetic machinery of plants. Addition of marine and estuarine floral components in the organic fertilizer also helps in improving the quality of the soil. When the extracts of seaweeds and saltmarsh grass are added to compost; it breaks down faster and thus enriches the soil with macro- and micro-nutrients.

Fish feed

Mangrove associate floral species are also used for preparing fish feed. Feed prepared from *P. coarctata* and *Enteromorpha intestinalis* have been found to boost up the growth *Macrobrachium rosenbergii* (Mondal et al., 2014a; Mondal et al., 2014b). Such fish feed not only increase the growth of the cultured species, but it also upgrades the water quality in terms of dissolved oxygen and organic load (Mitra and Zaman, 2014)**.**

Future vision

The real utilities of species get unlocked only when their benefits to mankind are established and can be linked with the livelihood sector. Under this situation the species are considered as service provider and their economic valuation can be forecasted. Most of the literatures available till date focus on the benefits of mangroves and only very few research works have been conducted to link up mangrove associate species with the societal benefit. In this paper we have summarized the benefits of mangrove associate species particularly *Porteresia coarctata* and *Ipomoea pes-caprae*. Apart from the ecological benefits, these species can be a unique source of organic fertilizer (due to their rich elemental composition) and can open a source of alternative livelihood for the poor island dwellers of Indian Sundarbans. The present authors have translated this dream into reality by developing a unique mangrove associate based organic fertilizer “SABUJIMA” (Fig. 7), which has generated employment to the people thriving Below Poverty Line (BPL) in the districts like 24 Parganas, Purulia and Bankura of the maritime state of West Bengal. The liquid organic fertilizer developed from the saltmarsh grass (Fig. 8) is rich in micro- and macro-elements required for the growth of cash crops and vegetables.

Fig. 7: SABUJIMA: A marine floral based organic fertilizer

Fig. 8: Liquid organic fertilizer developed from saltmarsh grass extract

It is expected that such products may not only develop the economic profile of island dwellers of Indian Sundarbans, but may also upgrade the environmental quality due to their floral base and absence of any synthetic chemicals.

Annexure 1: Herbs, grasses and sedges associated with true mangrove floral species of Indian Sundarbans

Species	Family	Species	Family
Aeluropus logopoides	Poaceae	*Myriostachya wightiana*	Poaceae
Aerva lanata	Amaranthaceae	*Panicum repens*	Poaceae
Ammania baccifera	Lythraceae	*Paspalum vaginatum*	Poaceae
Caesalpinia crista	Caesalpiniaceae	*Phragmites karka*	Poaceae
Canavalia cathartica	Caesalpiniaceae	*Porteresia coarctata*	Poaceae
Cyperus exaltatus	Cyperaceae	*Salicornia brachiata*	Chenopodiaceae
Fimbristylis halophila	Cyperaceae	*Sacobolus carinatus*	Asclepiadaceae
F. sub-bispicata	Cyperaceae	*Scirpus triquetra*	Cyperaceae
Heliotropium curassavicm	Boraginaceae	*Sesuvium portulacastrum*	Alizoaceae
Hoya parasitica	Asclepiadaceae	*Suaeda maritima*	Chenopodiaceae
Hydrophylax maritima	Rubiaceae	*S. nudiflora*	Chenopodiaceae
Ipomoea pes-caprae	Convolvulaceae	*Viscum orientale*	Loranthaceae
Lersia hemandra	Poaceae		

REFERENCES

1. Banerjee, K., Das, S., Pramanick, P., Ghosh, R., Fazli, P., Zaman, S., Biswas, P., Pal, N. and Mitra, A. 2014. Bioaccumulation pattern of heavy metals in saltmarsh grass (*Porteresia coarctata*) of Indian Sundarbans. STM Journal (In press).
2. Das, S., Mitra, A., Zaman, S., Pramanick, P., Ray Chaudhuri, T. and Raha, A.K. 2014. Zinc, Copper, Lead and Cadmium levels in edible finfishes from lower Gangetic delta. *Am. J Biopharmacol. Biochem Life Sci.*, 3 (1), 8 – 19.
3. Jagtap, T.G. and Untawale, A.G. 1999. Atoll mangroves and associated flora from republic of Maldives, Indian Ocean. Mangrove Ecosystem Technical Reports ISME, 5, 17–25.
4. Jana, H.K., Zaman, S., Chakraborty, S., Pramanick, P., Mondal, K.C. and Mitra, A. 2013. Spatio-temporal variation of stored carbon in *Porteresia coarctata* along the east and west coasts of India. Int. J Eng Manag. Sci., 4 (3), 377 – 381.

5. Mitra, A., Choudhury, A. and Zamaddar, Y.A. 1992. Effects of heavy metals on benthic molluscan communities in Hooghly estuary. Proc. Zool. Soc., 45, 481-496.
6. Mitra, A., Nayak, B., Pramanick, P., Roy, M., Chakraborty, S., Banerjee, K., Amin, G. and Zaman, S. (2014b) Heavy metal level in a mangrove associate species *Ipomoea pes-caprae* in and around the World Heritage Site of Indian Sundarbans. J Environ. Sci. Comp. Sci. Eng. Technol. (In press).
7. Mitra, A. and Zaman, S. 2014. Carbon Sequestration by Coastal Floral Community; published by The Energy and Resources Institute (TERI) TERI Press, India; Copyright The Energy and Resources Institute; ISBN- 978-81-7993-551-4.
8. Mitra, A., Zaman, S., Pramanick, P., Bhattacharyya, S.B., Raha, A.K. 2014a. Stored Carbon in Dominant Seaweeds of Indian Sundarbans Peternika J Trop. Agri. Sci., 37 (2), 263 - 274.
9. Mondal, K., Bhattacharyya, S.B., Mitra, A. 2014a. Marine algae *Enteromorpha intestinalis* acts as a potential growth promoter in prawn feed.World J Pharmaceutical Res.,3(5),764-775.
10. Mondal, K., Bhattacharyya, S.B. and Mitra, A. 2014b. Performances of green seaweed *Enteromorpha intestinalis*, salt-marsh grass *Porteresia coarctata* and mangrove litter as prawn feed ingredients. Res. J Anim. Vet. Fish. Sci, 2 (4), 17-26.
11. Selvam, V. 2007. Trees and Shrubs of the Maldives. RAP Publication 2007/12. FAO, Bangkok.
12. Wang, L., Mu, M., Li, X., Lin, P., Wang, W. 2011. Differentiation between true mangroves and mangrove associates based on leaf traits and salt contents. J Plant Ecol., 4, 292–301.