

# Biotechnology-Based Socio-Economic And Environmental Development Program – A Possible Intervention For Sustainable Growth In Sundarbans Region, West Bengal, India

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## Abstract:

Sundarbans is a unique ecosystem with signature biodiversity. It flourishes under inhospitable environmental conditions and though fragile, is able to sustain itself by means of a robust pattern of energy flow. It is a rich ground for bio-resources and has critical implications in regulating local and global climate patterns. However, recent tremendous anthropogenic stress engendered by uncontrolled and unsustainable exploitation has led to the following concerns: A) Led to a vicious cycle of irreversible ecological damage, B) Created a marginalized population of poor migrants, and indigenous people who mainly depend on fishing and economically non-viable monocrop, and silviculture, C) Altered climate pattern in alarming proportion threatening the existence of the land and life itself. In order to identify specific problems and their mitigation, data on the Sundarbans is which is scanty and whatever available data is there, lacks proper analysis of biodiversity vis-a-vis patterns of geographical distribution and environmental factors, needs to be addressed in the right way. Earnest studies to assess human needs has also not done in this biosphere. Whole ecosystem studies to reveal trends in habitat degradation and biodiversity loss is also lacking.

This article shall constitute sustainable use for poverty alleviation in – (I) Understanding sustainability parameters of the region (its inhabitant humans and the biodiversity and what it has to offer, the biosphere's ecology and environment); (II) Explore biodiversity for bio-resources and characterize them using advanced science and technology for translation into applicable forms (medicine, healthcare products, food supplements, cosmetic use, bioremediation etc.); (III) Apply it in the daily lives of the local people for economic benefit and empowerment with the help of the government's translational mechanisms of institutional network to generate economic impetus for conservation of the biosphere.

**Key Words:** Sundarbans, Biodiversity, Energy, Ecology, Economy

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## I. INTRODUCTION:

The Bengali name 'Sundarban' means 'beautiful forest' and there is a reason on this mangrove forest got this name. A UNESCO World Heritage Site and Ramsar Site, Sundarban the mangrove forest is the world's largest continuous mangrove forest covering an area of 10,000 km<sup>2</sup> that straddles India and Bangladesh. With an area of over 6,000 square kilometers of Bangladesh, the Sundarbans is a region of great importance to India and Bangladesh<sup>1,2</sup>.

The Sundarbans is a unique ecosystem due to its inherent biodiversity. Due to their difficult access, ecosystems have preserved a unique diversity of globally important animal species. For example, this is the last remaining habitat of the endangered Bengal tiger in Bangladesh. There are 334 species of plants, 400 species of wildlife, over 290 species of fish, 315 species of birds, and 35 species of real mangroves.

In addition to their unique value for global biodiversity, millions of people living in the Sundarbans fringes depend, directly or indirectly, on mangroves, which function for survival and protection from extreme weather and ecosystem dependence. Indeed, mangrove forests support income generation and food security well beyond their immediate boundaries. Mangrove forests act as highly effective carbon sinks and can absorb 97.57 tons of carbon per hectare.

This is more than three times the absorption capacity of non-mangrove forests. More importantly for Bangladesh's coastal communities, mangroves provide physical protection and an reverse the effects of sea-level rise as they rapidly trap sediment within their complex root structures. Mangrove forests therefore play a role in nature conservation and livelihoods for climate-sensitive coastal inhabitants<sup>2,3</sup>.

## II. ENVIRONMENTAL CORRELATION WITH PUBLIC HEALTH:

Mangroves are productive ecological communities. It protects coastal areas against natural disasters such as hurricanes and tsunamis<sup>4</sup>. They retain land sediments and recycle nutrients, which maintains clear ocean water and promotes phytoplankton photosynthetic activity and the growth and sustainability of coral reef, seagrass, and reef fish communities<sup>5</sup>. They are important habitats, nurseries and refuges, providing food for countless organisms, including humans<sup>6</sup>. These ecosystems are also important carbon sinks, storing carbon temporarily in organic peat or as dissolved organic carbon in deeper marine sediments and producing greenhouse gases that affect the climate in the long term. Over the past two and a half centuries, the Sundarbans have been a public health focus on how direct human impacts, upstream development, slow climate change and extreme weather events have affected the health and structure of this ecosystem. and public policy analysis.

The mangrove forests of the Sundarbans Delta have excellent ecosystems as they are both highly dynamic coastal areas and important freshwater outlets from the Ganges-Brahmaputra Delta. Several natural and anthropogenic processes affect the physicochemical parameters of estuaries, including rainfall, weathering, soil erosion, urban development, industrial and agricultural activities, and human use of water resources<sup>7</sup>.

Despite being one of the most diverse mangrove settlements in India, ethnopharmacological practices in the Sundarbans are sparse compared to other mangrove regions of India. Information on the therapeutic potential and ethnopharmacology of mangrove species can raise social awareness among mangrove inhabitants. This also helps in promoting the application of folk remedies using mangrove plants that have enormous potential as a complementary step to enhance community health. At the same time, extensive bioprospecting studies of key mangrove plants can provide principles for conservation, management and public policy<sup>8</sup>.

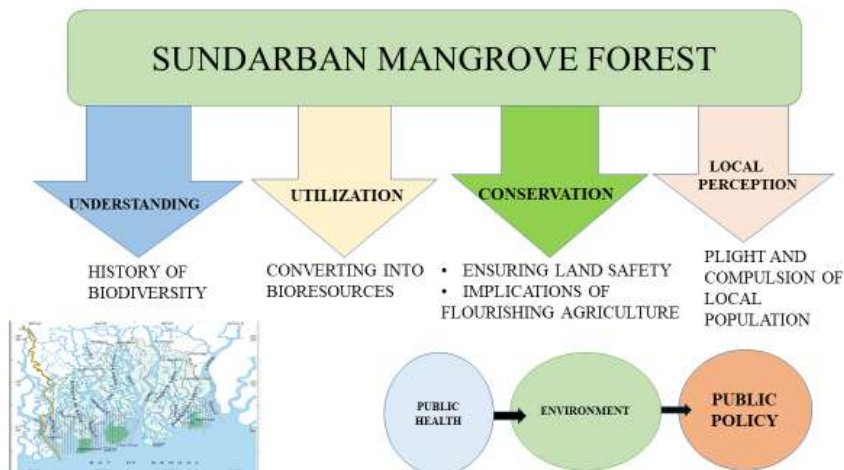


Figure 1 : How Environment is related to Public health

### Presentation Of The Collected Data From Field Visits In Verbatim As Understanding Biodiversity-

Little is known about Sundarbans biodiversity in changing environment and under anthropogenic influences. The generation of bio resources in translatable form for tangible socio-economic benefits to local populace and ensuring conservation will be of great benefit. It will work by establishing biodiversity-development linkages, i.e. by identifying sources of bioactive compounds that can be sustainably utilised in order to alleviate poverty. Compounds which are effortlessly cultured in the area include: *Piper betle* leaf (antioxidants), mangrove trees *Heritiera fomes* and *Ceriops decandra* (biocides, antioxidants, antidiabetics, anticancer), gastropods *Anadara granulosa*, *Thais lacera*, and *Crassostrea sp.* (anti-inflammatories), barnacles *Balanus*, *Lepas* (barnacle cement as therapeutic scaffold); anemones *Paracondylactis nensis*, *Edwardsia jonesii*, flatworms *Convulata sp.*, sipunculids *Phascolosoma arcuata*, and tintinnid ciliates (various bioactive molecules). Bioactive compounds are potent inducers of pharmaceutical or nutraceutical moieties for

ommercialization. For successful translational outcomes, the systematic evaluation of bioactive compounds and their molecular nuances is key. Patenting of such powerful molecules with health benefits shall provide long-term economic benefits to the local population by providing alternative livelihoods and encouraging ancillary industries (eco-tourism) thus addressing one of the key objectives of the Nagoya Convention<sup>9</sup>.

***Converting into bioresources-***

Initial exploratory studies on *Piper betel* leaves, a brackish mudflat creeper grown by the poorest farmers, shows certain varieties to sequester potent anti-inflammatory molecules. All upstream environmental and anthropocentric factors for its growth must be intact for sequestration of this chemical. Powerful drugs or nutrition supplements from local biodiversity may form nucleus for green industrialization. This also spawns ancillary industries and means of livelihood leading to the local people's socio-economic upliftment. Quantitative and qualitative assessment of inadvertent biodiversity depletion (habitat loss, introduction of exotic variety with disastrous results etc.) is urgently needed. In short, Sundarbans is a data-starved region. Thereby a detailed correlate such as bio resource damage and its economic implications through thorough study and implementation is very much of a necessity.

***Ensuring land safety-***

River embankment failure destroys habitable agricultural land jeopardizing the very existence of the people of the land. Geo-textiles such as geojute and mechanical strengthening of embankments with ecologically sustainable environment-friendly advanced civil engineering techniques should be implemented as a means for poverty reduction.

***Environment correlation with agriculture-***

Environmental correlation shall provide data such as long- and short-range aerosols due to airborne sea salt that have pronounced effects on ecology and biodiversity of the Sundarbans and which induce climate change precursor events as well as have health and agronomical implications as well as public health concerns.

***Plight and compulsion of local population-***

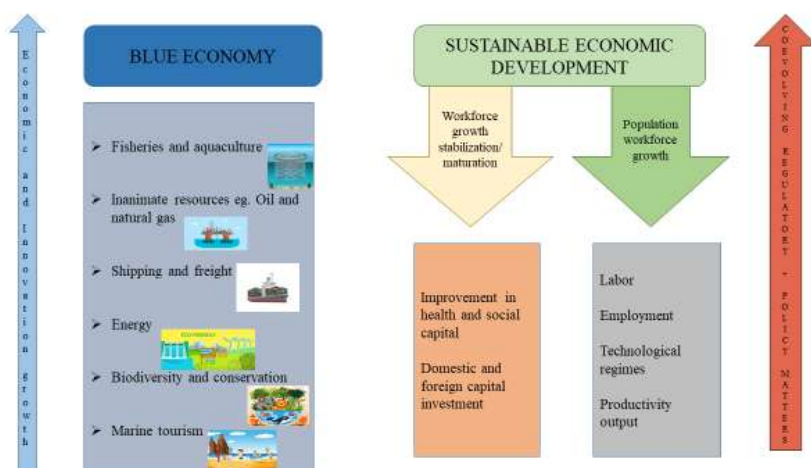
In recent times, external market forces have generated demands which has created undue pressure on local inhabitants, especially women and children who struggle for a sustainable livelihood. In addition, uncontrolled and irreparable damage to the marine ecosystem has devastating effects on the local land (a sudden increase in river bank embankment failure, and hitherto unknown super-cyclones very far inland) but it also has serious direct and indirect implications on Kolkata, the state capital of Bengal, and the socio-cultural and politico-economic lifeline of the state.

### **III. APPLICATION OF BIOTECHNOLOGY PRINCIPLES FOR ECONOMIC GROWTH**

The natural resources of the Sundarban mangrove ecosystem offer a wide range of opportunities. Jobs and livelihoods related to the blue economy in the region, most relevant to India's Sundarban region, where mangroves dominate are

- (i) fisheries and aquaculture;
- (ii) inanimate resources such as oil and natural gas;
- (iii) shipping and freight;
- (iv) unconventional energy;
- (v) biodiversity and conservation; and
- (vi) estuarine/marine tourism.

The "blue economy" is the ocean economy that strengthens the backbone of the economy. The aim to develop the country through the rational use of marine resources is an integration of resource bases of seas, oceans, bays, and estuaries that are involved with society. Development and environmental sustainability linked to innovative business model<sup>10,11,12</sup> assures a sustained growth of the economy.



**Figure 2:** The impact of bio based economic development in Sundarbans area

**Presentation Of The Collected Data From Field Visits As Ergonomics For Economic Impetus-**

Rigorous advanced technology for lab-based translation of bio resource into pharmaceutical and nutraceutical green industries, and revenue generation from the health products produced are expected to improve the local economy, minimise anthropogenic environmental damage, and underpin the sustainable use of this ecosystem. Sundarban ecosystem also harbors bacterioplankton communities which play key role in ecosystem processes including carbon cycling. However, understanding of their structure and function with respect to carbon cycling along temporal spatial scales is poor. Moreover, many of the Bacterioplankton species that may be present in this ecosystem could be potentially novel and can be explored for bioremediation from oil pollution, thus contributing to overall carbon cycling.

**Local population empowerment and protection of childhood-**

Socio-economic studies on women empowerment requires an ‘empowerment-index’ and/or index for income or consumption to measure the ‘success’ of various interventions aimed at empowering rural population. But most of these studies had been carried out in rural areas that are ecologically insignificant. In an internationally important ecological site like Sundarban, such a study remains grossly incomplete if the economic aspects are not intertwined with the ecological aspects. The ‘value’ generated by an intervention to empower women cannot be measured solely by the additional monetary income it can generate. The ‘value’ of saved ‘ecological resources’ must also be added to properly evaluate the success of such an intervention.

**Resurgence of traditional knowledge -**

Traditional knowledge (TK) is an important aspect that has been neglected for far too long. This has to be brought back. Anthropologists shall weave in traditional knowledge with data on biota, environment and their inter-relationship for whole ecosystem mapping. ‘Matla’, ‘Hamilton’, ‘Nona Bokra’, ‘Talmugur’, ‘Dudheswar’, ‘Lal Getu’ and ‘Sada Getu’ are some traditionally known salt tolerant paddy variety raised over here from ancient past. These would be reintroduced and local people trained to sustain their agriculture. Climate-resistant cultivars can ensure food security as local soil is otherwise uncultivable. Trainings should be imparted to local population in ecologically sustainable cultivation of both the climate resistant as well as reintroduced indigenous varieties.

**Climate-resistant cultivars & reintroduction of traditional varieties of crops-**

Food security can also be ensured by: (i) characterization and reintroduction of traditional knowledge based medicinal plants, edible crops with inimitable flavor, aroma and nutraceutical benefits including but not limited to rice, daal; (ii) lab-developed resilient varieties of salt-resistant legume cultivars that can mitigate loss of potential food crops for indigenous people.

Ecotourism- Sundarban Reserve Forest contributes approximately USD 53.14 million annually to the economy and what it offers is huge opportunity for ecotourism development tourism resources, economic effects, etc. employment and ecological protection. Unfortunately, Government and private sector organizations are not doing this in a well organized, informative and developed manner which is one of the biggest drawbacks to tourism growth. Information about nature, cultural importance of Sundarban mangrove forests, traditional festivals can encourage tourists to pay attention and leave ecological footprint and enable a unique ecosystem and improve the experience of ecotourism<sup>13,14</sup>.

#### IV. CONCLUSION

This study aims to provide long- and short-term changes to sustainable development of the Sundarban area. The incentives expected from this study for similar future research are- (a) mitigation of shortfalls in data to guide policy; (b) provide much-needed scientific information on this critical mode of energy flow for the planet; (c) socio-economic leverage to local people through bio resource exploration, conservation and application of traditional knowledge in a high-return economic model; (d) In course of the environmental surveys, we expect to correlate environmental markers with professional and public health concerns and suggest means for redressal. It is expected that it will give the local people of South Bengal necessary impetus to preserve ecosystem and alleviate poverty through alternative livelihood and ancillary eco-friendly industries that does not require them to work under hostile conditions, have access to education and basic healthcare, thus pre-empting destructive and subversive ways that a lack of proper livelihood induces. Awareness generated from biodiversity conservation shall benefit global scientific community, and form the basis of formulation of sustainable economic growth through preservation and not destruction of the unique biosphere.

The concerted outcome of the multidisciplinary studies will be translated for the improvement of health, education and livelihood of the local people which will be effected through the institutional mechanism of the district administration as well as the local institutions. In this regard, economic valuation is often viewed as a useful support tool for conservation policy-making and governance<sup>15</sup>.

#### REFERENCES

- [1]. UN General Assembly. Seventieth Session Agenda Items 15 And 116 UN General Assembly; UN General Assembly: New York, NY, USA, 2015.
- [2]. Ghosh A, Schmidt S, Fickert, T., Et Al. The Indian Sundarban Mangrove Forests: History, Utilization, Conservation Strategies And Local Perception. *Diversity* 2015;7, 149-169. <https://doi.org/10.3390/D7020149>
- [3]. Nicholls R.J, Hutton C.W., Lázár, A.N., Et Al. Integrated Assessment Of Social And Environmental Sustainability Dynamics In The Ganges-Brahmaputra-Meghna Delta, Bangladesh. *Estuary Coast. Shelf Sci.* 2016 : 183, 370–381.
- [4]. Dahdouh-Guebas, F, Jayatissa, L.P, Di Nitto, D., Et Al. How Effective Were Mangroves As A Defence Against The Recent Tsunami? *Curr. Biol.* 2005;15, 443–447.
- [5]. Mumby P.J, Hastings A. The Impact Of Ecosystem Connectivity On Coral Reef Resilience. *J. Appl. Ecol.* 2008: 45, 854–862.
- [6]. Nagelkerken I, Blaber S.J.M, Bouillon S., Et Al. The Habitat Function Of Mangroves For Terrestrial And Marine Fauna: A Review. *Aquat. Bot.* 2008 : 89, 155–185
- [7]. Shefat M, Chowdhury, F Haque, J. Hasan., Et Al. Assessment Of Physico-Chemical Properties Of The Pasur River Estuarine Water. *Ann. Bangladesh Agric.*, 2021: 24 Pp. 1-16, 10.3329/aba.v24i1.51932
- [8]. Simlai A, Roy A. Biological Activities And Chemical Constituents Of Some Mangrove Species From Sundarban Estuary: An Overview. *Pharmacogn Rev.* 2013 : 7(14):170-8.
- [9]. Doi: 10.4103/0973-7847.120518. PMID: 24347925; PMCID: PMC3841995.
- [10]. The Convention On Biodiversity And The Nagoya Protocol: Intellectual Property Implications, 1992.
- [11]. Ellison AM, Farnsworth EJ, Merkt RE. Origins Of Mangrove Ecosystems And The Mangrove Biodiversity Anomaly. *Global Ecol Biogeogr.* 1999: 8(2):95-115.
- [12]. Hamilton RS, Snedaker SC (1984) Handbook For Mangrove Area Management. Gland, Switzerland. Commission On Ecology, IUCN.
- [13]. Chaudhuri AB, Choudhuri A. Mangroves Of The Sundarbans. Vol.1: India. IUCN, Bangkok, Thailand. 1994.
- [14]. Zacarias D, Loyola R. How Ecotourism Affects Human Communities. In: Blumstein D, Geffroy B, Samia D, Bessa E (Eds.) *Ecotourism's Promise And Peril.* Springer, Cham, Pp. 2017 :133-151.
- [15]. Alam M, Furukawa Y, Akter S. Forest-Based Tourism In Bangladesh: Status, Problems, And Prospects. *Tourismos.* 2010 : 5:163-172. Available At: <https://mpa.ub.uni-muenchen.de/id/eprint/25212>
- [16]. Mitra, Abhijit. Prospect Of Blue Economy In Indian Sundarbans. Pdf. 2022