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Prospective Livelihood Opportunities from the Mangroves of the Sunderbans, India

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ABSTRACT

World's largest contiguous mangrove forest Sunderbans has a human population pressure of more than one million apart from dense mangrove and its biological diversity. These made the area ecologically fragile having frequent anthropogenic interferences with the forest environment. These populations mainly consist of marginal farmers and fishermen who are entirely dependent on the natural resources of the area including mangroves. This study aims to elucidate the existing livelihood opportunities as well as alternative sustainable natural resource using options in this area which will be beneficial for this huge population. Appropriate community based natural resource management as well as processing technology and its mass dissemination are the most important aspects in this regard to sustain the ecological and socio-economic balance in the Sunderbans.

Key words: Sustainable livelihood, community mangrove management, forest dependent people

INTRODUCTION

Mangroves are among the biologically most productive ecosystems on earth and occupy approximately 75% of the world's tropical coastlines (Spadling *et al.*, 1997). Mangroves support more than 80 species of flora and 1300 species of fauna and act as nursery habitats for fish and crustacean of commercial value. In addition, mangrove swamps are effective in sediment trapping, nutrient recycling and protection of shorelines from erosion as well as provide a large number of socio-economically essential goods such as food, fuel wood, timber, honey, wax and tannin (FAO, 1997; Kathiresan and Alikunhi, 2010). However, in recent years, mangroves are declining globally in both biodiversity and extent-wise at an alarming rate. According to FAO (2005), a sharp decline in worldwide mangrove coastlines from 198000 km in 1980 to 146530 km in 2000 had been observed. Increasing population pressure, unsustainable harvesting methods of fish and prawn, mixing of wastewater effluents from urban industrial areas and coastal oil spill are the major factors responsible for degradation and destruction of mangrove (Reddy and Roy, 2008; Datta *et al.*, 2010). Sunderbans, world's largest mangrove forest is no exception and it is also experiencing the same predicament (Gopal and Chauhan, 2006).

The mangrove forest of Sunderbans is world's largest halophytic formation situated on the estuary created by the combined flow of the Ganges and the Brahmaputra (Muhibbullah *et al.*, 2007). It was declared as a World Heritage Site by IUCN in 1987 and Biosphere Reserve by UNESCO in 1989 (Chaudhuri *et al.*, 1994). The area consists of about 106 deltaic islands with a maze of innumerable rivers, rivulets and creeks. Continuous diversion of land from mangroves to other land uses, mainly agriculture, shrimp ponds, habitation and consequential deforestation from 18th century onwards resulted in gradual drop of forest area (Datta, 2010). The Indian part of Sunderbans is of 9630 sq. km in area comprising 54 inhabited and 52 forested islands (WBFD, 2007). Gayen (1995) identified 4 distinct zones for management purposes in the Indian Sunderbans, namely (1) Core zone (1700 sq. km) of the well conserved Tiger Reserve, (2) Manipulation zone (2400 sq. km) of mangroves surrounding the core areas, (3) Restoration zone (200 sq. km) of degraded and disturbed mangroves and (4) Balance zone of non-forest land uses. The last three zones are transitional in nature and need special attention in case of afforestation activities, soil-water-tidal resource management, agriculture, aquaculture and human resource development to reduce the magnitude of anthropogenic interference and gradual destruction of mangroves in the core areas and to minimize the probabilities of potential man-animal conflicts in the buffers. For these reasons, community based mangrove management in the name of Joint Forest Management (JFM) was initiated in the Sunderbans in the early 1990s by the Forest Department (FD).

At present, more than one million people live in Sunderbans and most of them are primarily marginal farmers and fishermen (Census of India, 2001). Despite the presence of such a large population, this area still has considerable mangrove cover. This is mainly due to the protection and surveillance by the FD for being a part of the Biosphere Reserve at one hand and the Forest Protection Committees (FPCs) functioning under the JFM programme as a community endeavor on the other. Although the FD had mandated a 20-year felling cycle for Sunderbans in general, traditionally felling and thinning of mangroves remained as an annual practice before the creation of Biosphere Reserve and inception of JFM. For many years, open mangrove covers had been exploited by both the deprived and elite sections of rural masses alike, for either subsistence or commercial timber production, without any notable management initiative. As mangrove resources depleted, people gradually shifted towards brackish water aquaculture and paddy monoculture (University of Calcutta, 1992). Only in the last 10-15 years, community based management of mangroves had been initiated in this area and the impacts were found to be optimistic (Datta *et al.*, 2010).

To achieve sustainable productivity of natural resources through proper management regimes, comprehensive knowledge on the condition of these mangrove dominated ecosystems and their patterns of utilization are needed. An attempt had been made in this study to identify and explore environmentally sustainable as well as economically feasible prospective livelihood opportunities for the local communities of Sunderbans keeping in mind the restrictions and constraints of the mangroves ecosystem. Creation of new mangrove belts and increase in the quantum of non-timber forest products in the afforested areas had been given supreme importance in this study.

LIVELIHOOD OPPORTUNITIES IN THE SUNDERBANS

The mangrove ecosystems remained indispensable in the lives of the people of Sunderbans for ages. To postulate synchronized livelihood options with respect to ecology and society of the Sunderbans, thorough understanding of the existing livelihood activities and associated landscape

or land use changes are necessary. For this, the local livelihood patterns along with their scope for improvement had been discussed first followed by the assessment of prospective sustainable resources.

Existing livelihood options: problems and prospects: The different kinds of livelihoods as observed in the Sunderbans can be classified into four broad groups, viz. (I) Agriculture, (II) Fishing and prawn-seed collection, (III) Wood collection, handicrafts and others, (IV) Honey and other Non Timber Forest Products (NTFP) collection.

Agriculture: The agricultural activities practiced in the Sunderbans are complex, diverse as well as risk prone (Saha, 1999). Paddy monoculture dominates the entire landscape along with small pockets of seasonal vegetables (e.g., watermelon) and oilseeds. Growing of salt tolerant varieties of rice is the only option left in most of the areas. The low lying saline lands, absence of micro-irrigation facilities and lesser success of HYV paddy contribute to the ever decreasing rate of agricultural returns (Biswas *et al.*, 2006). The wide spread destructions of embankments and consequent inflow of saline water into the agricultural fields during *Aila* made the lands more unproductive by accumulating salt on the top soil. Hence, traditional agriculture is not conducive here and alternate farming systems have to be introduced in accordance with the required environmental conditions. The Sundarban Development Board (SDB) under the Government of West Bengal had already introduced the paddy cum fish culture with rainwater harvesting facilities in which 2/3 land is devoted to agriculture and 1/3 to aquaculture or water storage. Similarly, orientation towards salinity tolerant rice varieties and vegetables should be given priority in the post-*Aila* scenario. In the severest salinity affected places of Satjalia island, Basanti and Hingalganj, fodder cultivation in the form of native Dhani grass (*Portersia coarcatata tatecoa*) may be practiced in the fallow lands which have, in turn, remained as permanent wastelands since *Aila*. With financial assistance from micro-finance institutions, this type of fodder cultivation along with selective animal husbandry can effectively lead to a whole new realm of sustainable agriculture in the Sunderbans as these grasses are integral parts of the mangrove ecosystem.

Fishing and prawn-seed collection: The whole of Sunderbans is characterized by a variety of fishing and aquacultural activities comprising coastal fisheries, brackish water aquaculture, estuarine and riverine fisheries, riverside prawn seed collection, shrimp farming and several freshwater aquaculture variants (Muhibbullah *et al.*, 2005). Although coastal and estuarine fishing and riverside prawn seed collection engage most of the workforce of the Sunderbans comprising men, women and children, the shrimp farms and brackish-water paddy cum prawn culture systems are also becoming one of the major sectors of instant cash income for owners of large landholdings. As found out by the researchers, most of these fishing systems are environmentally unsustainable and aimed for short term growth (Chakraborty, 1986; Ray, 1993). On one hand, indiscriminate fishing in the coastal areas throughout the year is reducing the natural fish stock and hindering the reproduction processes of several anadromous species like *Hilsa ilisha* and on the other, use of fine nets and gross wastage of fin fish seeds at the time of prawn seed catching along the riverbanks are becoming direct threats to the aquatic biodiversity of Sunderbans. Similarly, brackish-water fish and shrimp farms, locally known as '*Bheris*', are inducing salinity on the top soil of nearby agricultural fields. This harmful effect of in-situ shrimp culture gave birth to strong socio-political protest in the forest-fringe villages since the late 1990s and thus the trend of overnight conversion of open mangrove stands to shrimp ponds have become relatively slower.

However, what is needed for the fishing industry of Sunderbans for long term is not the business as usual sectoral planning but a comprehensive spatial planning coupled with proper zonation for different types of fishing activities and mixed land use patterns for shrimp culture. Complete ban on fishing in the breeding season and use of fine and small gap nets as well as protection against coastal oil-spills are the other measures to be followed stringently.

Wood collection, handicrafts, tourism and others: A relatively small number of people of Sunderbans are still engaged in wood collection. Mostly, these people belong to the few indigenous population groups still surviving in the immigrant dominated rural society of the Sunderbans. The collection of wood is oriented more towards fuel wood gathering than on timber harvesting. In reality, large scale timber based logging is done under the direct control of state FD and hence, scope for direct livelihood earning from legal timber harvesting is almost nil for the ordinary people. However, plantations raised under Social Forestry do have the provisions for timber harvest from *Eucalyptus* (*Eucalyptus grandis*) and Akashmani (*Accacia auriculiformis*) trees although these are not favourable for the mangrove environment. Few people are also engaged in tourism, handicraft making and associated activities.

Honey and other Non Timber Forest Products (NTFPs) collection: Considerable numbers of people in the forest-fringe areas of Sunderbans earn their livelihood from honey and wax procurement as well as from other NTFPs collection. Honey, collected from both wild (*Apis indica*) and artificial captive boxes, is treated as a nutritious food and has high market demand. Similarly wax is also a valuable commodity. Every year, especially in the months of April-May, hundreds of people with or without valid permits issued by the FD enter the reserved forests to collect honey and wax. Many of them were killed by tiger in the wild in this process. These high risks associated with wild honey collection have compelled many to turn towards artificial cultivation of *Apis dorsata* in the bee-hives along the village embankments opposite to the forests. Although huge amount of labour is exerted in both these processes, the collection of honey and wax per person are still not satisfactory. Moreover, the primary honey collectors or 'Mouleys' do not get sufficient payments for such life risking efforts when compared to the final market prices of these products. In addition, various NTFPs like tannin, gum, resin, wild fruits, leaves and tree parts as primary medicines are collected by the marginal forest dependent people mainly for subsistence and sell in the local markets. The creation of National Park and Wildlife Sanctuaries in the Sunderbans has drastically reduced the scope of legal procurement and harvest of these products from the wild due to total or partial bans. As a result, many of the forest dependent people had either switched to prawn seed collection or engaged themselves as agricultural labours.

Prospective sustainable resources: In the view of present circumstances in which most of the existing livelihood practices are proving to be harmful to the mangrove ecosystem, a well structured inventory for prospective sustainable resources and associated livelihood opportunities can essentially become beneficial both for the people and the environment of the Sunderbans. A detailed discussion of some of these prospective resources, therefore, had been made in the following section on the basis of feedbacks given by the forest dependent people, forest guards and beat officers as well as mangrove experts through participatory appraisals.

Honey and wax: On average, 200 quintals of honey, both from wild and bee-boxes as well as 1000 kg of wax are collected every year from the Sunderbans. Processing and marketing activities of these products begins after they were being transported to Kolkata in their raw form under the control of FD. As the primary collectors are not associated with any type of value addition in these products, they earn meager amounts of money. Honey and wax processing and bottling plants are, therefore, of prime need in the rural Sunderbans as these can bring some extra money in the moribund grass-root rural economy. Production of honey candies from the collected materials can further boost up the economy by attaching more surplus values. For initiating a successful honey candy making venture, analysis and characterization of honey, quality control of produced candy as well as storage capacity studies and evaluation of shelf life of the product have to be performed first.

Tannins and dyes: Tannins as NTFP are widely used in the leather and chemical industries. The fishermen of the Sunderbans also apply tannin in their fishing nets and other tools. Although the use of artificial tannin due to its easy availability and ready to use form is becoming more common in the industrial sectors, the local fishermen still use natural mangrove based tannins for their purposes. Barks of many mangrove species, notably *Ceriops decandra*, are good sources of tannins. As the processing chain of natural tannin in the Sunderbans continued to be underdeveloped, hence a great scope for establishing tannin processing industry exists over there. Similarly, natural dyes can also be generated from mangroves with proper extraction techniques. A list of some tannin producing mangrove plants is given in Table 1.

Medicinal plants: Throughout the last century, migrants from Bangladesh and south-west Bengal gradually settled in the reclaimed areas of the Sunderbans and the population began to expand. As a result, the indigenous population became marginalized and segregated. With their segregation, the traditional knowledge about the medicinal and other values of mangrove resources also started to sink into alienation and obliteration. The immigrants are still not totally familiar with all the possible uses of mangroves and hence, mangroves have been treated as mere forests without any substantial livelihood values. However, mangroves do have important medicinal properties as pointed out by local resource persons as well as scholars worldwide (Lakshmanan *et al.*, 1984; Naskar *et al.*, 2002). A preliminary list has been prepared to demonstrate some basic medicinal qualities of selected mangrove plants (Table 2). If properly cultivated and processed, these can fetch significant livelihood opportunities to the local marginal forest dependent population.

Table 1: Tannin percentages in some selected mangrove plants

Name of the plant	Frequency	Tannin percentage
<i>Bruguiera cylindrica</i>	Occasional	17.8
<i>Bruguiera gymnorhiza</i>	Common	36.0
<i>Ceriops Decandra</i>	Common	29.0
<i>Rhizophora apiculata</i>	Common	29.0
<i>Sonneratia apetala</i>	Common	11.0
<i>Sonneratia griffithii</i>	Occasional	9.0
<i>Xylocarpus granatum</i>	Common	25.0
<i>Xylocarpus moluccensis</i>	Common	24.0
<i>Lumnitzera racemosa</i>	Occasional	19.2

Source: Chaudhuri *et al.* (1994)

Table 2: Selected mangrove plants and their medicinal qualities

Name of the plant	Common medicinal uses
<i>Tamarix diocia</i>	Tonic, skin disease
<i>Tamarix gallica</i>	Astringent in dysentery
<i>Thespiea lampus</i>	Fruits for syphilis
<i>Derris indica</i>	Seed powder in bronchitis
<i>Ceriops tagal</i>	Root as substitute of quinine
<i>Acanthus ilicifolius</i>	Asthma, snake bite
<i>Rhizophora apiculata</i>	Root for blood pressure
<i>Casuarina equisetifolia</i>	Bark in diarrhea
<i>Derris trifoliata</i>	Antispasmodic and stimulant

Gums and resins: Traditionally, the coastal fishing communities living near mangroves in India have always used mangrove plants as the local sources of cheap gums and resins. In the Sunderbans only few fishermen have been found to be still using the plant extracts as gums in their fishing and boating gears along with artificial gums. Among the mangrove plants, Dhundhul (*Xylocarpus granatum*) and Kala Bien (*Avicennia marina*) have been reported for extracting gum making saps. These can also be treated as potential sources for making resin from their barks and sap. Well maintained mangrove plantations hence can be a satisfactory source for eco-friendly gums and resins if proper production chains are established.

Edible forest products: Mangrove ecosystem, as a whole, is treated as one of the most bountiful sources of edible products, both floral and faunal origin, among all the major forest ecosystems. Apart from honey, tender leaves, buds and fleshy fruits of *Avicennia marina*, *Pluchea indica*, *Bruguiera gymnorhiza*, *Avicennia officinalis*, *Oncosperma tigillaria* and *Sonneratia apetala* are frequently used as vegetables in the daily diets of many marginal families of mangrove-fringe villages worldwide. Moreover, fruits of Sundari (*Heritiera fomes*), Hental and Golpata were sold in the local markets of the Sunderbans even 10-15 years ago. At present, these activities have almost ceased to exist due to overexploitation primarily and finally as a result of imposition of successive forest protection laws by the FD. However, sustainable and controlled harvesting can be performed in the newly created mangrove plantations which can become a potential source for eco-friendly diet for the local people as well as reduce possibilities of illegal harvesting of protected mangroves. Wild mushrooms and other fungal flora growing across the forests can also be a potential source of income generation for the rural population in this area (Das *et al.*, 2002a, b). In addition, litter woods and remnants of timber parts after controlled logging by the FD in some areas of mangroves can be used for producing cheaper salts than those packaged ones available in the markets (Bandaranayake, 1998). The major benefit of this activity is that these litters and remnants, especially of *Avicennia* varieties, were by any chance going to be wasted without any other usage and as a result, marginal people can easily procure these raw materials for subsistence based salt production.

Grass and leaf based products: Golpata (*Nypa fruticans*) and Hental (*Phoenix paludosa*) leaves were once widely used for thatching of hut roofs, making ropes and handicrafts in the Sunderbans. With the establishment of National Park and Biosphere Reserve, commercial harvesting of these plants from the wild is totally banned by law. However, these plants along with the Dhani grass variety found around the embankments and riversides as well as Hogla (*Typha elephantina*) found

in more inland areas have remarkable potential for small scale handicraft, straw, plate, rope and mat making industries in the rural areas if proper technological and marketing interventions are performed. For the collection of raw materials for these industries, open vested lands, saline wastelands, riversides around inhabited islands can be safely used under the Social Forestry plantation schemes in the Sunderbans. This can serve the dual purposes of livelihood improvement and environmental protection by creating healthy mangrove belts around the islands.

CONCLUSION

It is evident from the above discussion that although the Sunderbans mangroves are well endowed with natural resources which can be effectively utilized for generating sustainable livelihood for the forest fringe villagers, little efforts have been taken till now. Proper exploration of NTFP based rural enterprise generating opportunities in the Sunderbans is thus, in turn, dependent on the judicious application of technological intervention in natural resource management which will be both economically feasible and ecologically sustainable. Transfer of appropriate technology in this regard becomes the most crucial aspect as this includes development of technology, testing of it for financial feasibility, public dissemination, capable enterprise creation and sustenance and finally establishment of a comprehensive market information system (Chattopadhyay and Datta, 2010). All these matters can be realized and implemented in the poverty stricken Sunderbans if only adequate attention from both public and private stakeholders are channelized towards tackling these matters through a holistic community based natural resource management programme in the long run.

REFERENCES

- Bandaranayake, W.M., 1998. Traditional and medicinal uses of mangroves. *Mangroves Salt Marshes*, 2: 133-148.
- Biswas, H., S.K. Mukhopadhyay, T.K. De, S. Sen and T.K. Jana, 2006. Methane emission from the wetland and rice fields in Sagar Island, the coast of Bay of Bengal, India. *Int. J. Agric. Res.*, 1: 76-84.
- Census of India, 2001. Primary Census Abstract: West Bengal and Orissa. Office of the Registrar General, Govt. of India, New Delhi, India..
- Chakraborty, K., 1986. Fish and fisheries resources in the mangrove swamps of Sunderbans, West Bengal-an in-depth study. *Indian For.*, 112: 538-542.
- Chattopadhyay, R.N. and D. Datta, 2010. Criteria and indicators for assessment of functioning of forest protection committees in the dry deciduous forests of West Bengal, India. *Ecol. Indicators*, 10: 687-695.
- Chaudhuri, A.B., A. Choudhury, M.Z. Hussain and G. Acharya, 1994. *Mangroves of the Sunderbans: India*. Vol. 1, IUCN, Bangkok, Thailand, ISBN-13: 9782831702094, pp: 247.
- Das, N., S.C. Mahapatra and R.N. Chattopadhyay, 2002a. Some edible fungal flora of tribal areas of Midnapore District. *J. Non-Timber For. Prod.*, 9: 154-155.
- Das, N., S.C. Mahapatra and R.N. Chattopadhyay, 2002b. Wild edible mushrooms: Non-wood forest products for livelihood generation. *Indian For.*, 128: 445-455.
- Datta, D., 2010. Development of a comprehensive environmental vulnerability index for evaluation of the status of Eco Development Committees in the Sunderbans, India. *Int. J. South Asian Stud.*, 3: 258-271.

- Datta, D., P. Guha and R.N. Chattopadhyay, 2010. Application of criteria and indicators in community based sustainable mangrove management in the Sunderbans, India. *Ocean Coast Manage.*, 58: 468-477.
- FAO, 1997. *State of the World's Forests 1997*. Food and Agriculture Organization of the United Nations, Rome, Italy..
- FAO, 2005. *Forest Resource Assessment 2005: Progress Towards Sustainable Forest Management*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Gayen, K.C., 1995. Prospect of Participatory Management of Forests in the Sunderbans. In: *Experiences from Participatory Forest Management*, Roy, S.B. (Ed.). Inter India Publications, New Delhi, India..
- Gopal, B. and M. Chauhan, 2006. Biodiversity and its conservation in the Sunderbans mangrove ecosystem. *Aquat. Sci.*, 68: 338-354.
- Kathiresan, K. and N.M. Alikunhi, 2010. Tropical coastal ecosystems: Rarely explored for their interaction. *Ecologia*, (In Press).
- Lakshmanan, K.K., J. Rajendran and T. Ravignanam, 1984. Importance of mangroves-raw material function and role in environment. *Indian J. For.*, 7: 201-207.
- Muhibbullah, M., S.M. Nurul Amin and A.T. Chowdhury, 2005. Biol some physico-chemical parameters of soil and water of sundarban mangrove forest, Bangladesh. *J. Biol. Sci.*, 5: 354-357.
- Muhibbullah, M., M.A.T. Chowdhury and I. Sarwar, 2007. Floristic condition and species distribution in Sundarban mangrove forest community, Bangladesh. *J. Boil. Sci.*, 7: 384-388.
- Naskar, K., R. Mandal and A. Ghosh, 2002. Important medicinal plants from Indian Sunderbans. *Proceedings of National Seminar and Workshop on Indian Systems of Medicine and Homoeopathy*, Dec. 25-27, Ramakrishna Mission Ashrama, Narendrapur, West Bengal.
- Ray, P., 1993. *Aquaculture in Sundarban Delta, its Perspective: An Assessment*. International Books and Periodical Supply Service, New Delhi, India..
- Reddy, C.S. and A. Roy, 2008. Assessment of three decade vegetation dynamics in mangroves of Godavari delta, India using multi-temporal satellite data and GIS. *Res. J. Environ. Sci.*, 2: 108-115.
- Saha, D., 1999. Alternative livelihood for coastal communities in Sunderbans. *J. Indian Soc. Coastal Agric. Res.*, 17: 292-296.
- Spadling, M., F. Blasco and C. Field, 1997. *World Mangrove Atlas*. International Society for Mangrove Ecosystem, Okinawa, Japan.
- University of Calcutta, 1992. *Mangrove ecosystem of Sunderbans in virgin and reclaimed areas with special reference to productivity*. Department of Marine Science, University of Calcutta, Kolkata, India.
- WBFD, 2007. *Annual report of Sunderbans tiger reserve 2006-2007*. West Bengal Forest Department, Govt. of West Bengal, Kolkata.