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Ecosystem Services of the World Largest Mangrove Forest Sundarban in Bangladesh

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ABSTRACT: Sundarban is the largest productive contiguous mangrove forest in the world, located in the south-western part of Bangladesh. UNESCO declared three wildlife Sanctuaries of the Sundarban as 522nd World Heritage Site in 1997. The unique and a house of diverse biodiversity of the Sundarban is not just a good to be conserved for its intrinsic value, but has a critical role in ecosystem processes that provide essential services to the country and the community living nearby. Species level traits were found to benefit a number of ecosystem services, with species abundance being particularly important for pest regulation, pollination and recreation, and species richness for timber production and freshwater fishing. It is also the hub of natural resources and beauties with several types of tourist destination which may be used as a potential tool for sustainable ecotourism promotion in future aiming one hand to protect the natural environment and cultural diversity, and on the other hand, generating a source of revenue for the local people without harming the nature. A new paradigm of management should look forward to considering climate change, ecological integrity, sustainable harvesting and ensuring continuity of the ecosystem services of the Sundarban. This paper, therefore, attempts to examine ecosystem services of the selected sites of the Sundarban in context of exploring their sustainable uses for both enhancing livelihood and promoting ecotourism.

KEYWORDS: Sundarban, Mangrove, Ecosystem, Ecosystem services, Ecotourism, World Heritage.

1 INTRODUCTION

The significance and value of ecosystem services for human well-being is well known. Among the different ecosystem in the world, mangroves ecosystems, lying along the coastlines in the tropics and subtropics, provide a number of ecosystem services such as provisioning services (e.g. typical forest products, food), cultural services (e.g. tourism, worship, educational research), regulatory services (e.g. protection from cyclones and storm surges, climate regulation, pollination) and supporting services (e.g. nursery ground of Fish, nutrient cycling, habitat of biodiversity) [1]. However, the ecosystem services concept is used to focus on management of natural assets for their values to wellbeing and the complex inter linkages of ecosystem processes for designing adaptive management strategies [2]. Likewise other Reserve Forests in the world, the world's largest mangroves, the Sundarban, covering 6000 km^2 in Bangladesh provides a variety of ecosystem services [3]. It is a unique mangrove ecosystem of considerable ecological and real contributions not only to the local and national economy but also the forest dependent livelihoods are greatly influenced by this mangrove forest. However, the Sundarban, covering about one million hectare in the delta of the rivers *Ganga*, *Brahmaputra* and *Meghna* is shared between Bangladesh (~60 %) and India (~40 %), and is the world's largest coastal wetland. The 'Sundarban Reserve Forest' (SRF) of Bangladesh part houses 300 species of flora and 425 species of fauna [4] including 291 fish species. Royal Bengal Tiger (*Panthera tigress*) is the iconic flagship species of this forest. More than 3.5 million people living around the Sundarban are directly or indirectly dependent on the ecosystem services of the forest [5]. But unfortunately, the Sundarban is to be threatened by a growing human

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population that not habitat of many rare and endangered animals especially the Royal Bengal tiger. Other species like Javan rhino, wild buffalo, hog deer, and barking deer are now extinct from the area. Large areas of the Sundarban mangroves have been converted into paddy fields over the past two centuries, and more recently into shrimp farms. But having the world's densest population, like Bangladesh, it is difficult to protect the flora and fauna unless there are economic benefits to the country as well as to the local people [6]. However, a mangrove is often considered a way to minimize losses incurred from their decline and to provide additional services to coastal communities.

There is an increasing trend to integrate ecosystem service arguments within the management plans and strategies of protected areas [7] as well as the wider landscape. However, ecosystem service-related argumentation is not undisputed [8]. Much recent works have focused on functional relationships between biodiversity and ecosystem services. In addition to a number of broader scale syntheses [9], some studies have tended to examine a small selection or individual ecosystem services [10] with few spanning multiple ecosystems [11]. Elsewhere researches showed to be useful in identifying specific links between species, ecosystem processes and ecosystem service delivery [12] [13] and can demonstrate the complexity of processes and interactions which occur in ecosystems [14] [15]. Therefore, the importance of further research is deemed essential to understand how different services interact with each other which can be critical in mediating the delivery of other services. Taking this notion, the present study explore the ecosystem services of the selected sites of the Sundarban in context of their sustainable uses in promoting wellbeing of the surrounding community, biodiversity conservation and ecotourism development. Therefore, the objectives of the study were basically in twofold; at first to identify the different ecosystem services in the selected sites of the Mangrove Forest Sundarban, and secondly to find out the major characteristics of identified ecosystem services.

2 THE SUNDARBAN

The Sundarban comprises essentially of numerous islands formed by the sediments deposited by three major rivers, the Ganga, Brahmaputra and the Meghna, and a dense network of smaller rivers, channels and creeks (Figure 1). The maximum elevation within the Sundarban is only 10 m above the mean sea level. The mangroves are the dominant geomorphic agent in the evolution of tidal shoals and their accretion to the main landmass. A new Khulna Forest Circle to preserve the forest was created in 1993 and a Conservator of Forests has been posted. The basic unit of management is the compartment. There are 55 compartments in four Forest Ranges and these are clearly demarcated mainly by natural features such as rives, canals and creeks. There are three wildlife sanctuaries established in 1977 under the Bangladesh Wildlife (Preservation) Order, 1973 (P.O. 23 of 1973):

2.1 EAST WILDLIFE SANCTUARY

Extends over an area of 31,227 ha. Freshwater and Sundri (*Heritierafomes*) dominated interspersed with Gewa (*Excoecariaagallocha*), Passur (*Xylocarpusmekongensis*) with Kankra (*Bruguieragymnorrhiza*) occurring in areas subject to more frequent flooding. There is an understory of Shingra (*Cynometraramiflora*) where soils are drier and Amur (*Amooracucullata*) in wetter areas and Goran (*Ceriopsdecandra*) in more saline places.

2.2 SOUTH WILDLIFE SANCTUARY

Extends over an area of 36,970 ha. where Gewa is the dominant woody species. It is often mixed with Sundri. It is also frequently associated with a dense understory of Goran and sometimes Passur.

2.3 WEST WILDLIFE SANCTUARY

Extends over an area of 71,502 ha. includes areas which support sparse Gewa and dense stands of Goran and discontinuous patches of Hantal palm (*Phoenix paludosa*) on drier ground and river banks and levees.

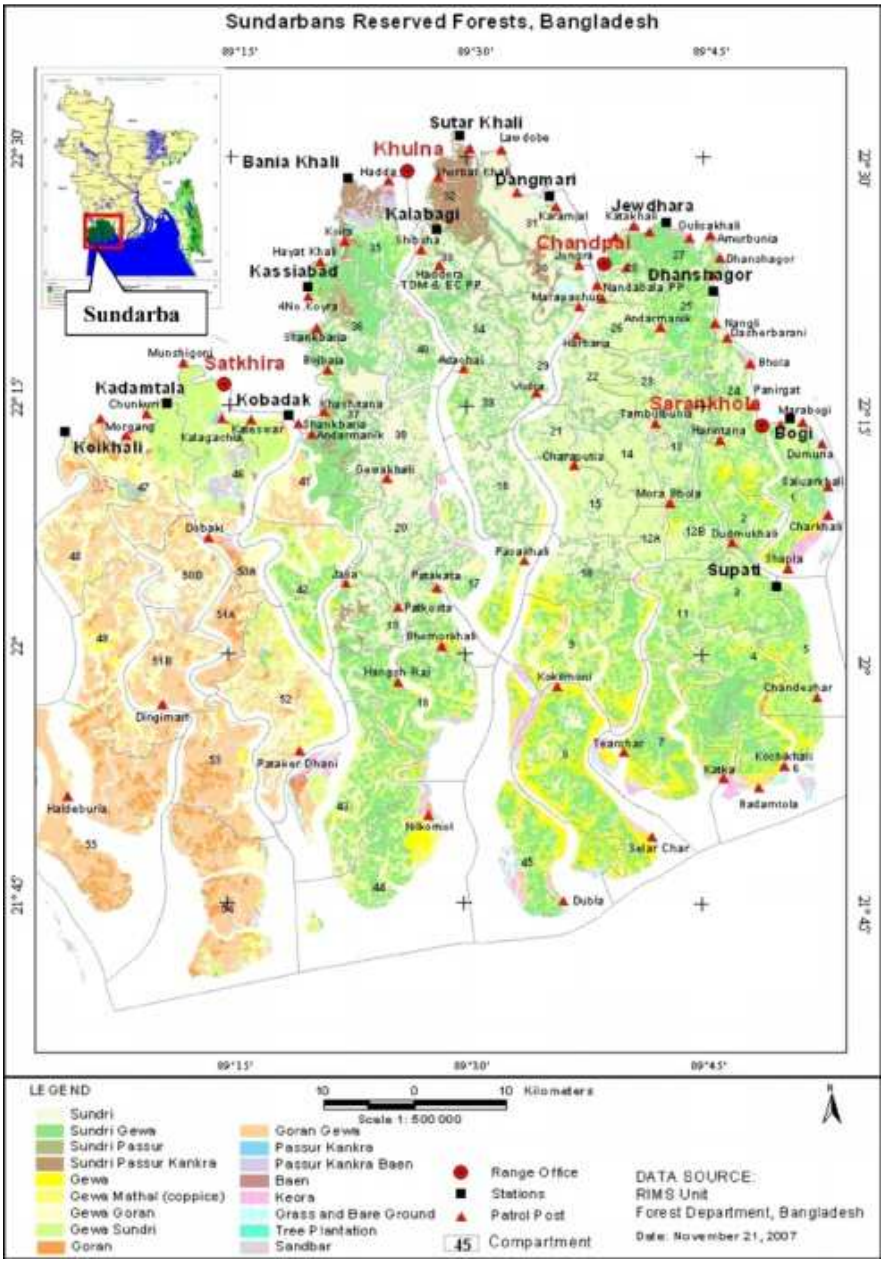

Fig 1. Location of the Sundarban Reserve Forest, Bangladesh (Source: Bangladesh Forest Department)

3 MATERIALS AND METHODS

This research employed mix method approach of both quantitative and qualitative methods and data. Ecosystem services indicators have been selected based on the study framework, data availability, measurability and current environmental concerns. A one month long field survey was conducted in three sanctuaries of the Sundarban (figure 1) in the winter period in January 2016 as this time is best for going very inside in the Sundarban. Data was collected through direct observation, photograph taking, and formal and informal discussion on the community mainly from the people whose livelihood are completely depended on different provided ecosystem services of the Sundarban. Formal discussions were also carried out with the officials of the Forest whose long experiences provided excellent insights of the raised issues of this research. Data were analyzed to prepare the list of ecosystem services along with uses and their potentiality.

4 RESULTS AND DISCUSSION

Millennium Ecosystem Assessment (2005) [16] defines ecosystem services as benefits people obtain from ecosystems. Ecosystem components include resources such as surface waters, oceans, soils, flora and fauna, etc. Ecosystem process and functions are the biological, chemical and physical interactions between ecosystem components. As stated earlier that ecosystems provide four types of potential services such as supporting services, provisioning services, regulating services, and cultural services [17], therefore, this study examined the ecosystem services on top of that classification. However, economic valuation of the provisioning services of the Sundarban has been considered for the services got by the community in general and also in exceptional cases from the forest. The observed ecosystem services found in the selected sites of the Sundarban is given in Figure 2.

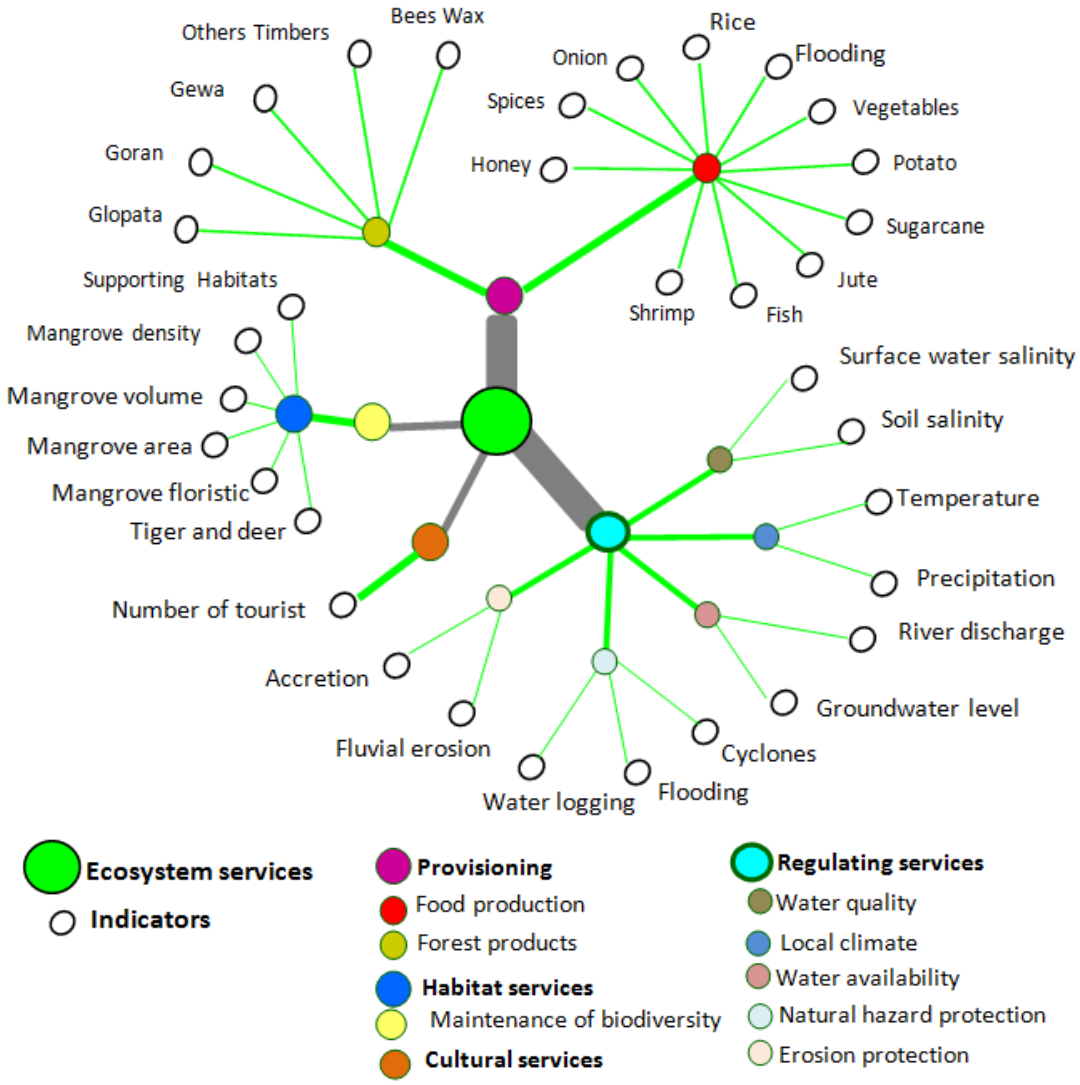

Figure 2: Ecosystem services of study area

The list of ecosystem services and their major functions and characteristics are given in Table 1. Major provisioning services of Sundarban were timber, fish, thatching materials, fuel wood, crab as well as honey and wax. Bangladesh forest department collects revenue from peoples harvesting those products. It was found from forest officials that the total revenue collection slightly decreased from Sundarban over the last few years, mostly from timber and fuel wood. However, revenue from fish, dry fish and thatching materials were increased over the period. The forest officials stated that annual extractions of thatching materials fluctuated very much in recent years and the revenue collection from thatching materials sharply increased in 2010-15. In recent years, crab collection has been increasing due to high market price. A number of crab

collectors, mainly nearby community people including women and children are involved with crab collection in the muddy areas. As a result annual revenue from crab has increased. Increasing number of crab collectors ultimately showed how the livelihoods dependent on the ecosystem services of the Sundarban. Revenue from honey and wax remained the same over the years.

Table 1. The different ecosystem services function in study area

Ecosystem Function Category	Ecosystem Service Function	Major Characteristics of Ecosystem Services in Sundarban
Provisioning Services	Food and fiber	Food products derived from plants, animals, and microbes
	Fuel	Wood and other biological materials serve as sources of energy
	Provision of Shade and Shelter	Related to vegetation those used for shade and shelter like *Golpata*
	Genetic resources	Many places are used for animal and plant breeding
	Pharmacological Resources	Natural materials used to maintain improve health
	Natural medicines	Many biocides, food additives such as alginates, and biological materials
	Ornamental resources	Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined
	Fresh water	Fresh water is another example of linkages between provisioning and regulating services
	River Transport	River is used for transporting and connecting place and people
Regulating Services	Gas Regulation	Influencing many aspects of air quality,
	Climate regulation	Ecosystems influence climate. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases.
	Water regulation	The timing and magnitude of runoff, flooding, and aquifer recharge are strongly related
	Erosion control	Vegetative cover plays an important role in soil retention
	Water purification and waste treatment	Sundarban is a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
	Pollination	Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators
	Soil Retention	Minimizing soil loss through having adequate vegetation cover, root biomass, retaining rock and soil biota.
	Nutrient Regulation	The Sunderban is works as transportation, storage and recycling of nutrients.
	Storm protection	The presence of coastal ecosystems such as mangroves and coral reefs can dramatically reduce the damage caused by hurricanes or large waves
	Spiritual and religious values	The diversity of ecosystems is one factor influencing the tourists. Many religious and festival are now occurring here. Many people value the "sense of place" that is associated with recognized features of their environment, including aspects of the ecosystem. Ecosystems influence the types of knowledge systems developed by the learners.
	Educational values	
	Aesthetic values	
	Recreation and ecotourism	
	Cultural heritage values	
Supporting Services	Supporting Habitats	Preservation of natural and semi natural ecosystems as suitable living space for wild biotic communities and individual species.
	Soil Formation	The transportation and accumulation of inorganic and organic matter in the surface through tide, litter fall etc.

Source: Field survey and Literature review

Sundarbans has vital role in protecting coastal communities. As the coastal areas of Bangladesh are very prone to natural calamities like cyclone and tidal surges, the Sundarban is reducing damage of properties and lives of coastal communities

from cyclone, tidal surges and other natural disasters. For example, the cyclone that blown over non-Sundarbans (Chittagong, Bangladesh) area on November 12, 1970 had a speed of 224 Km per hour and had a death toll of 0.5 million lives. On the other hand, another cyclone 'SIDR' had a speed of 210 to 230 Km per hour and crossed Sundarban (Khulna, Bangladesh) first and then passed over the human habitations on November 15, 2007, had a death toll of 3363 human lives. Though it is very difficult to estimate the protective value of the mangrove forests it could be easily realized its great protective services. Along with other services, cultural services of the Sundarban include tourism, education, and world heritage site, ethnic festivals, and worship by local people. All these cultural services could not be valued in monetary term. However, growing tourism in Sundarban can be the indicator of the importance of cultural services of Sundarbans. There are some special events and festivals that annually are celebrated in Sundarban and they have the potential to attract tourists. Some important attractions in Sundarban are river cruising, fishing, beach relaxation, walking, bird watching, jungle trails, wildlife watching, dolphin watching, boat trip experiences etc. Being part of the World Heritage Site as well as for unique and diversified ecosystem, Sundarbans is also attractive for international communities.

5 CONCLUSION

The Sundarban is internationally recognized as heritage site for many years could be the easy getaway for the economic development of Bangladesh. From the above discussion this paper argued that the value of diversified ecosystem services of the Sunderban is very much important for the country for its economic uplifts and environmental sustainability. However, as from the observation and also from formal and informal discussions with the community and forest officials it was found that the ecosystem services are now under threat due to anthropogenic influences and climate change impacts on natural resources, therefore, an urgent policy should be taken by the concern authority for its protection and simultaneously to take the benefits from the services these are provided by the Sundarban. As the cultural service has a great potentiality for promoting ecotourism, the country has to focus particularly on this issue in urgent context as it may be an important driving force in a socio-economic growth for the country. Finally this paper concludes that ecosystem services of the Sundarban can be a basis for sustainable development by integrating our natural resources for people and for nature with a growing population and hence an ever-increasing demand for the people.

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