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Structure and Functions of Social-Ecological Systems: A Case Study from Indian Sundarbans

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STRUCTURE AND FUNCTIONS OF SOCIAL-ECOLOGICAL SYSTEMS: A CASE STUDY FROM INDIAN SUNDARBANS

Sneha Biswas*

Abstract

The term social-ecological system (SES) is used to define the interactions or interlinkages between the social system and the ecological system of an area. Indian Sundarbans, which can be considered as an integrated SES, is rich in biodiversity and is also home to more than 5 million people. The present study is a micro-level analysis of the above-mentioned SES. Therefore, four villages (Madhya Gurguria, Debipur, Satjelia and Rangabelia) from two blocks (Kultali and Gosaba) of Indian Sundarbans were selected and a primary survey was conducted with the help of a suitable questionnaire. Results from the study show that there is a high dependency here on agricultural, fishing and livestock resources. Dependence on multiple resources for income generation is the norm in the village ecosystem. But this, in turn, is increasing the pressure on existing resource base. Thus, the paper tries to analyse the micro-level perspective of resource use and resource flow in Indian Sundarbans. The present paper suggests that there is need for a robust framework endorsing inclusive and participatory role of all the stakeholders in resource management which will ensure the sustainability of both resources and livelihood of people living in the SES of Indian Sundarbans.

Introduction

Natural sciences, with their sole focus on natural phenomena, have been trying to understand ways of protecting nature, while social sciences include the study of society and the economy and how to extract economic benefits even from natural resources. The demarcation between natural and social sciences was clear and distinct in the earlier centuries. But being a part of the larger ecosystem, ecology, economy and society do not work separately. Efforts to merge natural sciences and social sciences started in the 1970s with the emergence of subjects like ecological economics, political ecology, traditional ecological knowledge etc. Human beings are part of an interlinked world where the biological world and the cultural world prevail simultaneously. Hence, the concept of social-ecological systems (SES) tries to combine both the natural and social systems in which human beings live. Change in either of the two systems will inevitably have an effect on the other. For example, among people depending on natural resources for their livelihood, any changes in the natural environment will have an effect on the livelihood of the people. On the other hand, resource exploitation and pollution will bring in changes in the natural ecosystem. Hence SES tries to analyse the interdependence of two systems i.e. ecology and society. In other words, SES is an integrative framework that considers two-way interactions between social and ecological systems, has an anthropocentric perspective and is analysis-oriented (Bots *et al* 2015). Similarly, the present paper tries to focus on the interactions between natural resources and people dependant on them in the distinct social-ecological system of Indian Sundarbans. Indian Sundarbans is situated on the eastern part of India. It is an important coastal ecosystem which is home to more than 5 million people, and provides livelihood support to them in the form of agriculture, forest, riverine and marine resources and tourism. This research tries to assess the

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functioning of this complex SES with the help of primary data. Primary data was collected following a testified structured questionnaire and focus group discussions from the two blocks of Indian Sundarbans i.e. Kultali and Gosaba (out of 19 blocks which consist of Indian Sundarbans).

Review of Literature

Social-ecological system (SES) as a concept emerged in the late twentieth century. The term was popularised majorly by two scholars i.e. F. Berkes and C. Folke in the 1980s. Since the concept's inception, researchers have tried to define SES as a holistic framework which views both the ecological and social systems as parts of a larger system and majorly focuses on the interactions between the two subsystems. Some authors have tried to explain the natural system and social system as separate components (Berrouet *et al* 2018) while some others have tried to explain SES as a whole system (Anderies *et al* 2004; Ostrom, 2009). One of the important definitions is provided by Bots *et al* (2015). According to them, "SES is an integrative framework that considers two-way interactions between social and ecological systems, has an anthropocentric perspective and is analysis-oriented." On the other hand, Folke *et al* (2010) define SES as an "integrated system of ecosystems and human society with reciprocal feedback and interdependence." Although it is argued that there is a lack of a clear unifying definition, the scope of the subject seems to expand over the decades.

As the SES framework provides scope to analyse the system as a whole, some other concepts related to ecosystem or ecology have also become part of SES study. For example, the concept of resilience, adaptive capacity, robustness, vulnerability etc. have been intricately related to the study of SES. The interdisciplinary nature of the concept of SES have led to the usage of the term with multiple topics. For example, the concept of resilience is intricately related to an SES. The concept of resilience which is borrowed from natural science and brought to social science thus tries to assess the ability of an SES to remain within a stable condition but with changing and adapting strategies (Folke *et al* 2010; Cote and Nightingale, 2012; Xu and Marinova, 2013).

Adaptive capacity which is defined as the ability to adjust to disturbances is considered to be a part of resilience (Folke *et al* 2010). Institutions play an important role in adaptive capacity or adaptation as it provides support (Cote and Nightingale, 2012; Berkes *et al* 2000; Seixas and Berkes, 2003). However, SES is mostly used in framing resource management or resource use. "All humanly used resources are embedded in complex, social-ecological systems (SESs)" (Ostrom, 2009). Holling's concept of resilience and 'adaptive cycle' is important in this context. It includes four stages of resource management e.g. Exploitation, Conservation, Release and Reorganisation which operates in a cyclical manner instead of linear progression (Holling and Gunderson, 2002) of resource use. Some researchers (Seixas and Berkes, 2003; Anderies *et al* 2004) have worked on co-management or community management as a resource management tool in a particular SES. These studies show that major factors contributing to strengthening SES are strong institutions, monitoring process and rule implementation, cross-scale communication, equity, collective choice and use of ecological knowledge as inputs for resource management. On the other hand, Berrouet *et al* (2018) suggest that there is a necessity to do interdisciplinary research on the impact of globalisation on the functioning of SES. Communities' world view reflects on their practices of resource management (Cote and Nightingale, 2012). Therefore, local

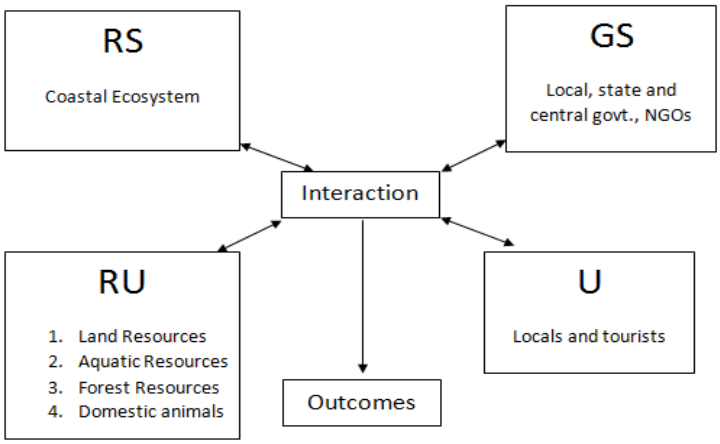
knowledge or traditional ecological knowledge should be used as one of the crucial instruments for social-ecological adaptation. All of the above concepts and their link with SES imply that SES itself as a system is not stable, it is susceptible to change (either internal or external). Hence, it is necessary to keep in mind the fragility or vulnerability of an SES before studying it. The present paper takes Indian Sundarbans as a broader SES, under which there are multiple subsystems such as resource units, resource users, governance system etc. Although there are several studies on Indian Sundarbans (Sarkar and Padaria, 2011; Das and Tripathi, 2012; Mukhopadhyay and Roy, 2015), they tried to study different ecosystems, for exmple agriculture, aquaculture, fishing or the natural vegetation as individual sectors. Hence the present paper tries to analyse the functioning of an SES from a micro-level i.e. village level. The main objective of the paper is to analyse the structure and functioning of a social-ecological system.

Analytical Framework for Understanding the Social-Ecological System (SES)

Some of the researchers have referred to SES as an integrated system of ecosystems and human society with reciprocal feedback and interdependence, consisting of multiple subsystems and internal variables (Folke *et al* 2010; Ostrom, 2009). So, in a broader term, SES tries to explain the interdependence or the reciprocity between nature and society, regarding humankind as the key subject. The concept of SES has been used by several researchers to analyse the system of resource management (Berkes *et al* 2000; Berkes *et al* 2003; Ostrom, 2009). They tried to distinguish between the westernised concept of resource management i.e. conservation with the local resource management system and argue the latter is more sustainable and thus should be desired. Colding and Barthel (2019) reviewed 20 years' research papers on social-ecological systems and concluded that there is a lack of comprehensive analytical frameworks for understanding or analysing the SES framework. However, there are a few frameworks which have been used to understand the concept of SES, namely Holing's concept of 'adaptive cycle' which includes four stages i.e. Exploitation, Conservation, Release and Reorganisation (Holling and Gunderson, 2002) and Ostrom's general framework for analysing the sustainability of SESs (Ostrom, 2009). As the present paper aims to study the structure and functioning of the social-ecological system of the area, Ostrom's framework of SES is being used.

According to Ostrom (2009), there are many subsystems and internal variables inside a larger and complex SES. Her concept of SES describes the interlinkages of resource management which vary across space and time. The following figure includes the first level four core systems i.e. Resource Systems (RS), Resource Units (RU), Governance Systems (GS) and Users (U).

Figure 1: Author's Adaptation from Ostrom's (2009) Analytical Framework for Social-Ecological Systems (SESs)



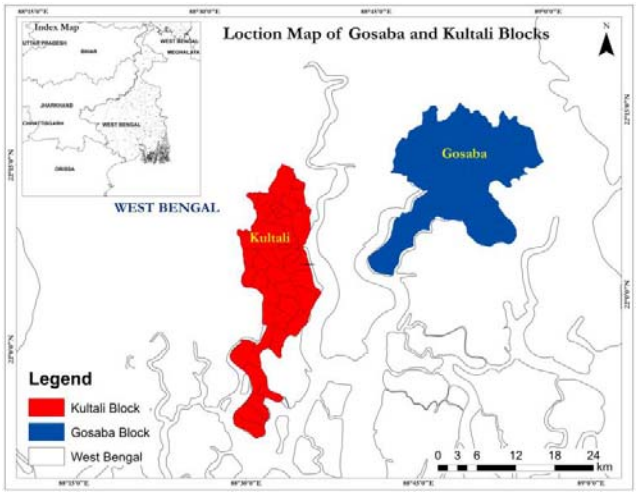
In the case of the present study, the resource system (RS) refers to the larger coastal ecosystem of Sundarbans. Sundarbans which is situated in the Ganges-Brahmaputra-Meghna Delta consists of an area of around 10000 square km. Only 40 per cent of its total area falls in the Indian part of Sundarbans. Indian Sundarbans is situated within the geocoordinates of $21^{0}32'$ to $22^{0}40'$ N $88^{0}05'$ E to $89^{0}00'$ E and covering an area of around 9600 sq. km out of which 4230 sq. km is reserved forest. The forest area falls under the Sundarbans Biosphere Reserve which consists of one national park and three wildlife sanctuaries.The area is also recognised as a wetland of international importance viz. Ramsar site. In the present research, the Indian part of Indian Sundarbans is considered as the broader resource system (RS).

According to Ostrom, Resource Units are the subcomponents of the broader component i.e. resource system. Within the broader resource system (RS), we looked at the resource units which are part of the village ecosystem and are used by the inhabitants. Resource units (RU) of the study area can be divided majorly into four categories viz. (1) Land resources - agricultural land, pastoral land and common fields (2) Aquatic resources (river and pond) – fish, crabs, shrimp, shells (3) Forest resources (mangroves) – wood, honey, leaves, medicinal plants (4) Livestock – cow, hen, duck, goat, sheep. Governance System includes the state policies, bureaucrats, government officials working in the area and other non-governmental organisations who actively or passively participate in resource management of the concerned area. People themselves constitute a part of the governance system (GS) when they manage the resources themselves. Users (U) include the locals, tourists and all others involved in the usage of the resources.

Study Area and Climate

The present study aims at understanding the social-ecological system working at the village level of Indian Sundarbans. To achieve this goal, two blocks i.e. Kultali and Gosaba (in South 24 Parganas district) were purposively selected from the review of literature (DasGupta and Shaw, 2015). However, a further selection of four villages (Madhya Gurguria, Debipur, Rangabelia and Satjelia) were done again following purposive sampling (based on their accessibility). The researcher made several field visits which extended from December 2018 to February 2019. After entering into the field, she explored the village boundary, made a social map and then went for geographical cluster sampling.

Figure 2: Location of the Study Area



Source: CEENR

The study area has a hot and humid climate throughout the year, temperature ranging from 36.3^0 C (maximum) to 13.6^0 C (minimum) and an average annual rainfall of 1750 mm to 1770 mm. May is the hottest month while January is the coldest. Relative humidity remains always high as the area is situated near the coasts of Bay of Bengal.

Methodology

A household survey was conducted to collect authentic primary data from the study area. Hence, the household has been considered as a unit for analysis. Fifty households from each village were chosen, thus contributing to two hundred samples in total (N=200). Household heads were preferred to be chosen as respondents. In the case of absence of the household head, adult members of the households were chosen. Structured questionnaire schedule, participant observation, discussions with subject experts and locals were used as tools and methods to achieve the research objective. Descriptive statistics were used to analyse the primary data. A comparative analysis approach was taken to find out if there were any differences in the socio-economic structures of two blocks i.e. Kultali and Gosaba. While explaining the functioning of the SES as a system, two blocks were merged together to have a holistic view.

Results and discussion

Socio-demographic profile of the study villages

Basic socio-demographic characteristics include religious, gender, caste and landholding compositions. These socio-demographic characteristics help us understand the structure of the social-ecological system. While coming to religious categorisation, it was found that in both the blocks, more than (or equal to) 87 per cent of the total households belonged to the Hindu category. Only 4 per cent of the households surveyed belonged to Muslim category while 13 per cent of the households belonged to other religious category, mainly tribals (although they practice Hindu rituals mostly). There was a clear separation in the habitation of people belonging to other religions. Coming to the social category, General constituted the highest percentage (47.5%) in total, followed by SC (29.5%), OBC (17%) and ST (6%). The share of SC families was much higher in Gosaba block constituting 39 per cent of the total sample. ST category (Mundas) were found in Kultali block only. Coming to income level, we can see that more households in Gosaba block (55 per cent) belonged to BPL (Below Poverty Line) category while less than half the households in Kultali block belonged to the same. However, the categorisation of APL and BPL was not necessarily always accurate. It was observed that many were eligible to be considered to be as BPL category, but according to the government survey, they were enlisted as APL category. Although, the monthly income ranged between Rs. 3,000 (for a small fisherman) to Rs. 40,000 (for a medium landholder), there was not much difference in the average monthly household income in both the blocks.

Table 1: Socio-demographic Characteristics of the Study Area

Block Names		Kultali	Gosaba
Median age of respondents (in years)		42	41
Respondent	Male (%)	34	36
	Female (%)	66	64
Religion	Hindu (%)	87	96
	Muslims (%)	0	4
	Others (%)	13	0
Caste	General (%)	54	41
	OBC (%)	14	20
	SC (%)	20	39
	ST (%)	12	0
Average household size		5.47	4.77
Head of the household	Male (%)	85	86
	Female (%)	15	14
Proportion of literate household heads		58	70
Highest level of education	Post Graduation and above (%)	10	3
	Graduation (%)	10	10
	Higher Secondary (%)	18	12
	Secondary (%)	38	29
	Upper Primary (%)	20	30
	Primary (%)	4	16
Income category	BPL (%)	42	55
	APL (%)	58	45
Average land holding	Agricultural (bigha)*	4.18	3.57
	Non-agricultural (bigha)*	0.275	0.57
Mean monthly income		10228.5	12062.5

*1acre = 3 bigha

Average sizes (modal value) of the households were 5.47 and 4.77 respectively. Household sizes ranged between 2 being the smallest number of members referring to a nuclear family to 11 referring to a joint family. An average nuclear family consists of a husband, wife and their children, while the joint family consists of grandparents living with their son, daughter-in-law and grandchildren. In general, it was observed that people preferred to be considered to belong to a nuclear family rather than to a joint family even if the extended family was residing in the same courtyard. This trend may be due to the introduction of government welfare schemes which allot money or ration goods per family rather than per capita. For example, the distribution of rice for the cyclone (Aila) affected families is 16 kg and a one-time amount of Rs. 10,000 was allotted to each family. It may be noted that a previous study (Jalais, 2014) suggests that nuclear families were common in the study area. Average landholding (agricultural) was a little more than one acre in both cases.

While coming to analyse the educational attainment of the sample population, the highest educational level achieved by any member of the household was considered. In most cases, the highest level of education was secondary and upper primary level (constituting around 58 and 59 per cent combined together), followed by higher secondary (18% and 12%) education. Around 26 per cent of the households in Gosaba could reach primary schools and very few number of households consisted of graduates and post-graduates. The highest level of education attained by a household and the literacy of the household head is important for resilience and decision-making process. In all the villages, it was observed that the female members (daughter or daughter-in-law) were more likely to attain the highest degree of education in the household. Girls, in general, were more likely to finish their schools than the boys. As a result, drop-outs are more prevalent among among boys in the area. In the case of literacy of the household head, it was found that the household heads were literate in 58 and 70 per cent of the cases.

A profile of the economic activities of the study villages

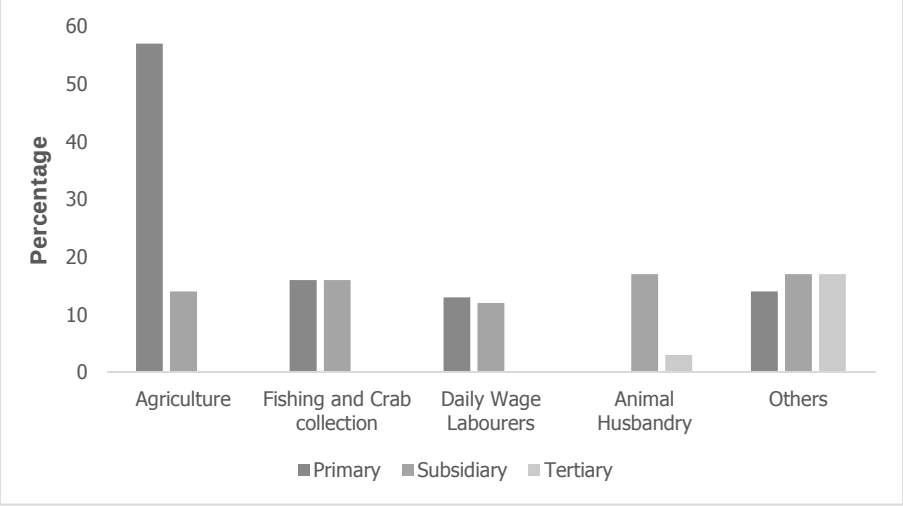
Although Indian Sundarbans economy is generally a rural-based economy, it provides multiple livelihood options for its inhabitants. To understand the livelihood diversity of the study area, respondents were asked to name three sources of their household income based on the activity's importance. For example, if the major portion of income of a household was coming from agriculture, then agriculture would be the primary occupation for that particular household. Thus, livelihoods were categorised as Primary, Secondary and Tertiary based on their relative importance and five major types of occupation were identified i.e. agriculture, fishing and crab collection, daily wage labour and Others. The Others category includes small business, shopkeeping, boat making, honey collection, driving, remittances, public services etc.

Table 2: Occupational structure of the study area

Type of Occupation	Kultali			Gosaba		
	Primary	Subsidiary	Tertiary	Primary	Subsidiary	Tertiary
Agriculture	57	14	0	45	12	2
Fishing and Crab collection	16	16	0	19	8	2
Daily Wage Labourers	13	12	0	7	10	4
Animal Husbandry	0	17	3	0	22	16
Others	14	17	17	29	36	7
N.A.	0	24	80	0	12	69
Total	100	100	100	100	100	100

People of Sundarbans are mostly dependent either on agriculture or fishing as their main livelihood sources. More than half of the sample households in Kultali block depend on agriculture as their main source of income, while in the case of villages in Gosaba, it's less than half of the sample (45%). Cultivators, sharecroppers and agricultural labourers were all included under this category. Practising agriculture is a problem as the soil is prone to salinity and the area is also deprived of proper irrigation facility and thus the majority of the land is mono-cropped. Paddy is the main crop which is usually cultivated once in a year and sometimes twice in a year. Vegetables like bitter gourd, radish, potato and chilli are the other crops grown here. Chilli production was reduced considerably according to the locals after the severe supercyclone Aila in 2009. The islands of Gosaba used to see a good yield of chilli. Vegetable gardens or kitchen gardens are a common practice in Gosaba block, where a small piece of land (around one katha) in front of the house is used to grow vegetables like cabbage, radish, greens etc. for household consumption. In some other cases, vegetable gardens are cultivated for income generation.

Figure 3: Occupational structure of people living in Kultali block of Indian Sundarbans

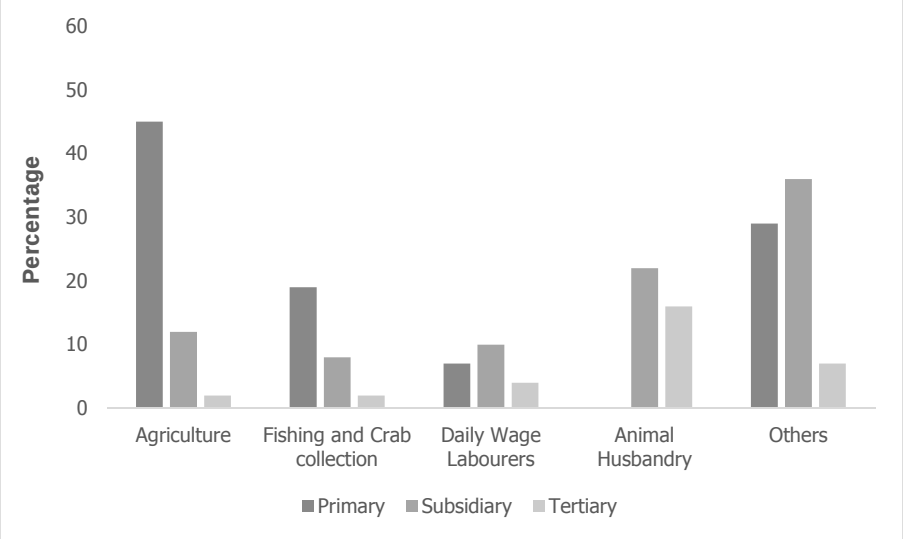


Although fishing and crab collection cover a smaller percentage of the total occupational structure, it is an integral part of the larger social-ecological system. Fishermen require a boat licence certificate (BLC) which allows fishing only in the buffer area of the tiger reserve. The number of BLCs being limited (923 in total) and the job being riskier, fewer people opt for fishing and crab collection as an occupation. Apart from it, clashes with the forest department (FD) are also frequent. People are fined by the FD on the grounds of illegal entrance.

Traditionally, people from Scheduled Caste category used to opt for fishing as a profession, but with the increasing demand of employment, people from other categories are also joining the profession. The fishing season is generally for 9 months *Ashwin* to *Falgun* (June to February). Fishing is generally done in groups. Usually, groups of 4 to 5 people twice in a month sail to the rivers in a small boat for 7 to 8 days continuously while carrying minimum supplies such as food, net etc. The profit is shared equally among the fishermen, pump owner, boat owner and net owner.

Crab collection is riskier than just fishing as it involves the threat of tiger attack. There are instances of tiger attacks on crab collectors in Madhya Gurguria, Debipur and Satjelia villages; still, the economic profit derived from selling the crabs is an incentive that makes people risk their lives in this task.

Figure 4: Occupational Structure of People Living in Gosaba Block of Indian Sundarbans



Daily wage labourers are mostly Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) workers who are generally employed in the protection of embankments of their respective villages. Sometimes woman MGNREGS workers are provided with saplings as a part of the afforestation programme and to reduce soil erosion. The daily wage of a MGNREGS worker is Rs.180 per day for both genders. In both the blocks, animal husbandry has been opted for as either a subsidiary or tertiary source of income. People of the study area mostly prefer domestication of cow, hen, duck and goat.

Places like Rangabelia which may be considered as the entrance of the archipelago have scope for business and other professions. This may be the reason for a significantly higher percentage of households belonging to other occupational categories in Gosaba than Kultali (X^2= 4.8, df =1, p < 0.05). However, it can be observed that a large portion of people of Kultali have a maximum of two sources of income, while in the case of Gosaba, people have more sources of income. Hence, it can be said that the livelihood of the people of Gosaba is more diversified than that of the people of Kultali. Others category also includes remittances sent by family members who are working as labourers in other parts of the country. Lack of enough income generation has pushed the people of Sundarbans to move out of the area (which ranges from working in the nearby metropolitan city Kolkata to the farthest parts of the country like Chennai, Bangalore or even Andaman and Nicobar islands).

Women of the study area mostly opt for collecting '*meen'* or 'prawn seeds' as a source of livelihood. Women even work side by side with men in the agricultural fields. But women are paid less than the male agricultural labourers. A visible gap of Rs. 100 is there between male (Rs 300) and female (Rs 200) agricultural labour. It was encouraging to notice that in every village (except Satjelia), there were women SHGs working for financial empowerment of women.

Diversified livelihood: A case study of Madhya Gurguria

Kanailal Jana's (age 58) house has 7 members in total. He is head of the family. He is an illiterate person who has spent most of his life practising agriculture and fishing, and in MGNREGS for a short time. Kanailal also collects honey from the forest after collecting a pass (BLC) from any of the BLC owners. The rule is that they have to sell the honey back to the forest department at Rs 110 per kg. Thus a person can undertake several livelihood strategies during his whole lifetime.

Table 3: Functioning among different subsystems of SES

Resource Unit	Governance System	Users	Interaction	Outcome
Land resources	Farmers' association and impacted by policies of Revenue dept., Irrigation dept.	Farmers, share croppers, agricultural labourers	Mixed kind of cropping dominated by paddy	Pressure on land, less agro-biodiversity
Aquatic resources	Forest Department, Govt of WB, NGOs	Fishermen, locals, outsiders	Limited number of licence (BLCs) limit extraction	Less exploitation of fish stock
Forest resources	Forest Department, Govt of WB	Locals, outsiders	Sale of NTFP checked by Forest Department	Less exploitation of forest resources. But theft and poaching continue to threaten forest resources
Livestock	Locals (women especially) and farmers	Locals	Local women learn to rear livestock	Economic benefit of selling milk, eggs and meat. But sometimes invite predators.

Land resources: The most important usage of the land resource is for agricultural purpose, contributing more than sixty per cent of the livelihood of the Indian Sundarbans (Das and Tripathi, 2012). The area being largely monocropped, the saline nature of the soil and lack of enough irrigation facility poses larger difficulty for the farmers of the area. Apart from that, the dominance of a marginal

landholding pattern puts pressure on the land use pattern. Paddy is generally cultivated only for sustenance. Kitchen gardening is usually done in the courtyard of the houses and bitter gourd seeds are sown on the side of the paddy fields to get maximum utilisation of the land. However, in the past one decade, the yield of chilli and paddy has decreased due to a decline in the soil quality.

Aquatic resources: The active part of delta (southern part of Sundarbans) having an average altitude lower than mean sea level has provided an opportunity for the people of Indian Sundarbans. Almost every household in the study villages either owns a pond or is able to share a neighbour's pond. Some use the ponds to cultivate fish (putting small fishes in the month of *Ashwin* and catch the matured fishes during *Poush*), some others create channels to cultivate shrimps. Shrimp seeds are generally collected by women of the area. After keeping a few weeks in the small water canal, matured shrimps are exported to the market in the nearby metropolitan city Kolkata. Another form of aquatic resources are shells which are used to make jewellery. Fishing and crab collection in the river channel can pose a high risk as well as fetch a high profit. The limited number of BLCs has restricted the number of fishermen entering the forest. As the Forest Department is vested with great responsibility, sometimes there are instances of misuse of their power. Although there are genuine cases of illegal entrance, many times fishermen are foisted with false cases out of grudge or for the sake of money. Some local NGOs like Sundarbans Jana Sramajibi Mancha (SJSM) and Dakhshinbanga Matsyajibi Forum (DMF) come forward to help fishermen gain their rights. Irrespective of restrictions, fishermen agree that there has been a depletion of fish stock over the last few decades. The reason for such depletion may be attributed to the dying river, mechanised fishing, increase in riverine transport etc.

Table 4: Quantified data of resource units (RU)

Resource Unit	Variables	Production or Extraction per household *
Land resources	Average size of agricultural land holding = 3.88 bigha	Paddy – 14 quintal in a year
Aquatic resources	River - Common property	Fish – 1.5 quintal in one trip Crab – 20 kilo in one trip Shells – 1 sack
Forest resources	Common property	Honey – 10 quintal in one trip
Livestock	Average number of livestock Cow = 2.46 Hen = 8.65 Duck = 11 Goat = 4	Milk – daily 3 litres Egg - daily 5 to 10 eggs

* Average does not include all the households. It takes into consideration only the households which utilise the respective resources.

Forest resources: The greatest resource of Sundarbans area is mangroves. The state of West Bengal has the highest cover of mangroves in India. The name of Sundarbans itself is derived from one of its mangrove species i.e. *Sundari*. Different forest Acts had an impact in changing the nature of the use of the forest by the locals. West Bengal State Forest Department (FD) is majorly tasked to look after the protected areas. People can only collect honey from the forest which they have to sell back fully or partially to the FD at a meagre amount (Rs 90-130 per kilo). The honey collection season is restricted to

only one to two months (March-April). Apart from it, people of Indian Sundarbans are not allowed to collect dried leaves and branches (although it is allowed according to the Forest Rights Act, 2006). Strict regulation was imposed on the Indian Sundarbans area after the declaration of Project Tiger in 1973. But this effort could not prevent the illegal entrance of people into the forest, indulging in poaching and illegal cutting of trees. In a recent incident in Madhya Gurguria, a tiger was killed in the net kept for catching wild deer by the illegal poachers.

Livestock: Livestock can work as an asset to a family when there is an emergency. They also provide a good alternative source of income. Animal husbandry is a more sought after subsidiary or tertiary practice of livelihood in the study area. Common livestock are cow, hen, duck and sheep (Satjelia). Livestock is majorly reared for use in the production of milk and eggs. There are initiatives from the government as well as non-governmental institutions to train one member of each family. Mostly female members of the family opt for such training to be able to rear their own livestock and in most cases, female members look after the livestock. Although animal husbandry provides a decent alternative source of income, it has some disadvantages. For example, during any hazard, people are unable to move or provide shelter to this livestock. Another problem is, sometimes the presence of livestock invites predators like tigers if the settlement is closer to forest and river.

People's participation and perception in resource management

People's participation as a community for managing natural resources is very significant. To assess how much the people of the area are aware of the resources, questions were asked about their participation in some aspects. These aspects were embankment repair, afforestation programme and prevention of illegal tree cutting.

The results show that a high proportion of people (76% and 82%) actively participate in repairing the embankment by the side of which they live. Earthen embankments are a very important aspect of the entire Indian Sundarbans region. They prevent the houses and the land which are built on the lower elevation, from being submerged by the river and channel waters. During monsoon season, people start to repair the banks either being recruited by the local government as a part of the daily wage scheme or driven by community need. Afforestation is another process which is promoted by local government and NGOs. The study shows that most people (64% and 58%) willingly participate in the afforestation process.

Figure 5: People's Participation in Different Developmental Activities

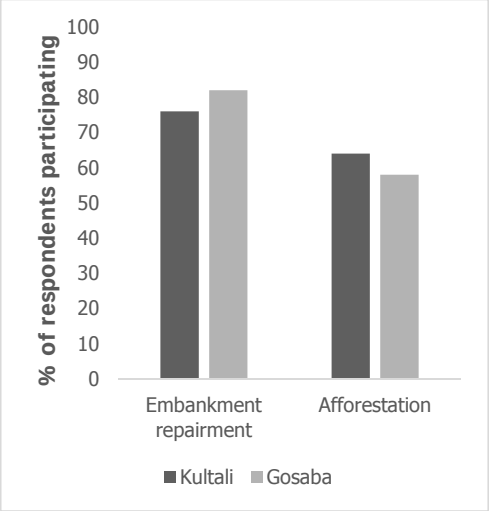
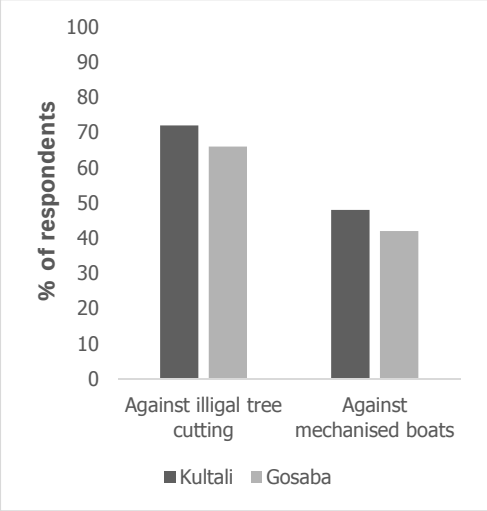


Figure 6: People's Perception about Protection of Nature



When asked about their perception of illegal tree cutting, most people (72% and 66% respectively) gave the strong view that illegal tree cutting should be stopped. But in the case of usage of mechanised diesel boats, a smaller proportion (48% and 42%) of the respondents felt that these boats should not be used. This is due to the fact that fishermen or ferrymen have to put a lot of physical effort while rowing the regular boats and also due to their lack of awareness about the harmful effects of mechanised boats.

Summary

Nature and society are inevitably linked with each other in the topography of the Indian Sundarbans. The districts of North and South 24 Parganas of West Bengal which constitute the Indian part of Sundarbans are densely populated going by the national average. The influx of people coming from surrounding areas which started during the British era continues. With the projected increase in population (Bhadra *et al* 2018), the pressure on resources is also intensifying. But the increased population pressure, limited access to resources on the one hand and the need for development on the other have created a dilemma among the stakeholders related concerning the area.

The present study found that dependence on water and land resources is high in the Sundarbans SES. The major sources of income are agriculture and fishing. Secondly, people opt for multiple sources of income, which encourages the usage of multiple resource units. Animal husbandry is the most preferred alternate source of income. Livelihoods are more diversified in Gosaba than in Kultali. But people seek diversified livelihood options due to poverty, threat of hazards and insecurity. The percentage of BPL category households was also higher in Gosaba block. Women's participation in economic activities was hardly seen and they were also paid less for their work, although it was evident from the researcher's observation that women put a lot of physical effort in several economic activities

which remained unnoticed. When it comes to observing the changes in resource use pattern, according to the elderly population of the area, the productivity of land is decreasing and fish stock is also being depleted with the passage of time. This indicates that pressure on land and resources is increasing. This is further causing many youths to migrate from the area to other parts of the country as unskilled labourers. To avert such a situation, assessment of the available Resource Units present in the area needs to be done. Additionally, we have to find a way in which these resources can be used sustainably. Furthermore, making local people aware of sustainable resource use is very much essential.

As Dr. Pranabes Sanyal, former director of Sundarbans Tiger Reserve says, while talking about the growing sector of tourism and developmental projects in Indian Sundarbans, "As long as it is within sustainable limits and does not exceed the carrying capacity, development can take place". This concept applies to other developmental sectors as well. The perspective of other stakeholders i.e. local people is also important in the aspect of resource management and development discourse. According to Ostrom (2009), people of a place, being aware of their resources, will willingly participate in a system of resource management which will be sustainable in the long run. Respondents from the field informed the researcher that people living in the area (Kultali and Gosaba) deliberately participate in the repair of the embankment, afforestation and protest against illegal tree cutting. It can be seen as a sign that they understand the significance of involvement of locals in resource management of the area that they live in.

The impact of culture can be observed in the worship of '*Bonbibi*', the forest goddess. Each time a fisherman or honey collector enters into the forest, they worship the goddess of the forest before entering, irrespective of their religious belief (Hinduism or Islam). Besides, people here know that their life is intricately related to nature as their life and livelihoods are majorly dependent upon nature and its resources. But the state plays a major role in managing resources by employing forest officials and implementing several environmental laws. As a significant number of the population depends upon forest resources, they encounter Forest Department officials. Often, these encounters between the Forest Department and the locals leads to clashes, which is a result of the difference in power hierarchies between them. It is a hierarchy which reflects in resource use and management and it is an issue which needs to be addressed. Therefore, a holistic and participatory approach towards resource management should be promoted to ensure participation by all the stakeholders. Furthermore, it will be imperative to strengthen the local governance system as well as the state governance system in order to retain the balance of the above-mentioned complex social-ecological system i.e. Indian Sundarbans.

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