

Chapter 5

Traditional Knowledge, Institutions and Human Sociality in Sustainable Use and Conservation of Biodiversity of the Sundarbans of Bangladesh



Rashed Al Mahmud Titumir, Tanjila Afrin, and Mohammad Saeed Islam

Abstract This chapter attempts to (a) identify the drivers of biodiversity degradation of the Sundarbans of Bangladesh, (b) present an alternative understanding on the measures for sustainable utilisation and conservation of resources and (c) suggest actions and policy alternatives to reverse the process of degradation and to move towards transformative harmonious human–nature interactions. While it is documented that the size of the Sundarbans of Bangladesh reduced and several floral and faunal species of the forest have been facing threat of extinction, the causes of continuous and unabated loss of the resources of this forest region have not been rigorously demonstrated. By challenging the mainstream approaches, the chapter theoretically and empirically exhibits that the exclusion of indigenous peoples and local communities (IPLCs) in the conservation and management process has contributed to the losses of biological diversity and suggests that the IPLCs have been practising several unique production methods based upon their traditional knowledge which can significantly contribute to the sustainable management of resources through symbiotic human–nature relationships. Following multiple evidence base (MEB) approaches, it is found that human sociality-based conservation practice positively impacts on resilient indicators and helps achieve Aichi Biodiversity Targets.

Keywords Human sociality · Traditional knowledge · Conservation · Biodiversity · The Sundarbans

R. A. M. Titumir (✉)

Department of Development Studies, University of Dhaka, Dhaka, Bangladesh

Unnayan Onneshan, Dhaka, Bangladesh

e-mail: rt@du.ac.bd; rtitumir@unnayan.org

T. Afrin · M. S. Islam

Unnayan Onneshan, Dhaka, Bangladesh

Department of Development Studies, Faculty of Arts and Social Sciences, Bangladesh

University of Professionals, Dhaka, Bangladesh

e-mail: tanjila.afrin@bup.edu.bd; saeed.islam@bup.edu.bd

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O. Saito et al. (eds.), *Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia*, Science for Sustainable Societies, https://doi.org/10.1007/978-981-15-1133-2_5

5.1 Introduction

The chapter considers the case of the Sundarbans of Bangladesh, the largest mangrove ecosystem of the world and a hotspot of biodiversity resources, to explore the underlying causes behind the continuous and unabated losses of its biodiversity resources and to seek viable means (policy) or measures (action) through which the process of degradation can be halted, the conservation process can be revitalised, and the sustainability of the resources can be ensured. It accordingly maps and finds out the key stakeholders and the agents dependent on the Sundarbans biodiversity resources and presents an alternative analysis to the sustainability of natural resources management integrating traditional knowledge (TK) systems to the socio-ecological production landscapes and seascapes (SEPLS) and draws on actions as regard to sustainable management of natural resources by means of harmonious human–nature nexus. Such an alternative analysis developed here can be used in other countries that are facing the same type of problems in biodiversity loss.

It is well documented that biodiversity resources have been declining at an alarming rate across different regions of the world posing threat to the future of humanity as well as to the other species (Higgins et al. 2013). Means and measures drawn on different school of thoughts are yet to find out the solutions of sustainable natural resource management which would lead to sustainable conservation process, secured livelihood options for the stakeholders and balanced ecosystem. Selfish resource exploitation, in fact, threatens societies as well as livelihoods contributing to a serious imbalance of the ecosystem (Battersby 2017). The situation is even worse in developing countries where the continuous pressures have already caused the extinction of numerous biodiversity resources. Bangladesh is no exception in this case. The Sundarbans of Bangladesh, known as the lung of the country, can now be identified as an important case of ecologically vulnerable area in terms of degradation of biodiversity resources. Several studies conducted on the Sundarbans have concluded that the resources of the Sundarbans have been declining gradually (e.g. Iftekhar and Islam 2004; Gopal and Chauhan 2006; Giri et al. 2007, 2014; Rahman et al. 2010; Rahman and Asaduzzaman 2010; Uddin et al. 2013; Islam 2014; Aziz and Paul 2015; Sarker et al. 2016). These studies have identified the external causes of forest degradation (e.g. conversion to other land use, over-harvesting, pollution, coastal erosion and climate change) or quantified the reduction in forest coverage area. Those studies, however, have not been able to provide solid theoretical foundation to analyse these problems and hardly propose an alternative suitable conservation and sustainability framework. Against this backdrop, this chapter critically explores the major theoretical underpinnings of neoclassical economics, institutional economics and political ecology to analyse the major drivers, including property rights instability, fragile institutions, lax regulatory regimes, unequal power sharing arrangements and political settlement. By employing such analyses of the state-of-the-art, the research exhibits that the exclusion of indigenous peoples and local communities (IPLCs) in the conservation and management process has contributed to the losses of biological diversity of the

Sundarbans. The chapter argues that the IPLCs have been practising several unique production methods based upon their TK which can significantly contribute to the sustainable management and conservation of natural resources through symbiotic human–nature relationships. It reveals, as a whole, that the well-being of SEPLS essentially depends on human sociality constructed by norms, values and other formal and informal institutions.

The next section presents a brief profile of the Sundarbans by identifying this mangrove ecosystem as a perfect case of SEPLS. The third section provides a conceptual framework that helps identify the major drivers of biodiversity resource degradation of the Sundarbans as well as examine the alternative means and measures for the conservation and sustainable utilisation of those resources. In the analyses parts of sections four and five, the empirical evidences have been discussed by juxtaposing the existing policy and institutional set up into the developed conceptual framework to reveal the major drivers of resource degradation and show alternative options which can be applied as viable means to manage the resources in a sustainable way. The penultimate section discusses the current resilience capacity of the Sundarbans based on the major findings of the study. The final section ends with concluding remarks.

5.2 A Brief Profile of the Sundarbans: A Socio-Ecological Production Landscape and Seascape (SEPLS)

This chapter uses three elements, here, in the form of *structure, benefits and changes* (Ichikawa, 2013) to present the Sundarbans as a perfect case of SEPLS.

5.2.1 Structure: Dynamic Mosaics of Habitats and Land Uses

The Sundarbans is located at the great delta of the Ganges, Brahmaputra and Meghna (GBM) rivers at the edge of Bay of Bengal and is the largest contiguous single-tract mangrove ecosystem in the world (Fig. 5.1). This mangrove ecosystem lies within both India (the State of West Bengal) and Bangladesh. The Bangladesh part is larger compared to the portion in India, with an area of 6071 km² (62% of the total area), which constitutes 39.5% of the total forest area of Bangladesh (Roy and Alam 2012). Of this Bangladesh part, 70% is land area and the rest (30%) is water (Kabir and Hossain 2008). The wetlands of the Sundarbans consist of about 200 islands separated by about 400 interconnected tidal rivers, creeks and canals (Rahman et al. 2010). The Sundarbans was recognised as a Natural World Heritage Site in 1997 by UNESCO and as a Ramsar Site of international importance in 1992 (IUCN Bangladesh 2014).

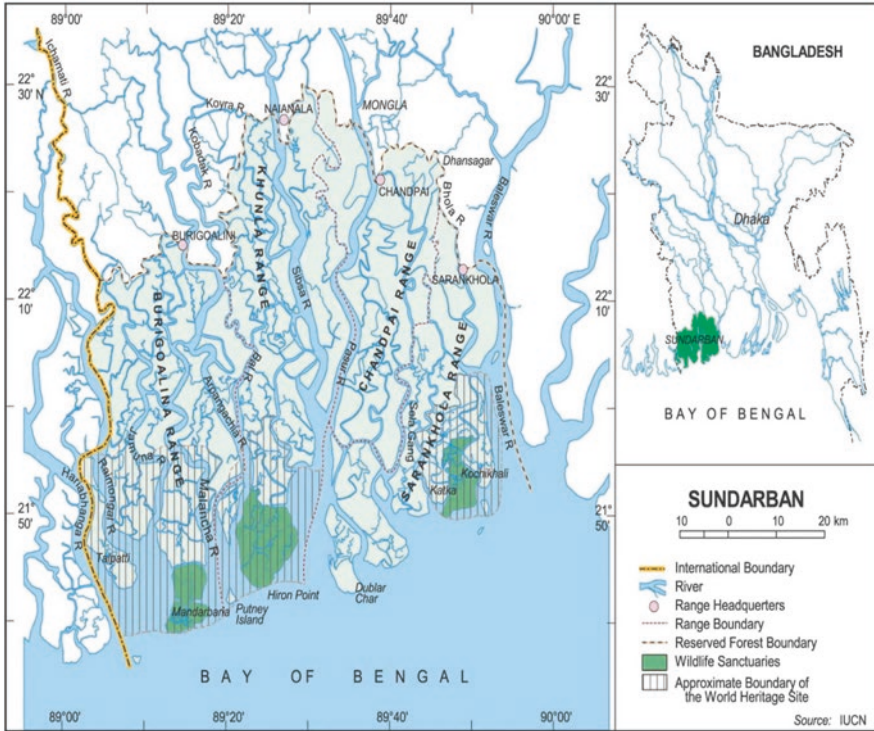


Fig. 5.1 Location of the Sundarbans. (Source: IUCN n.d as cited in Rahman et al. 2010)

5.2.2 Benefits: Maintaining Biodiversity and Providing Humans with Goods and Services

The Sundarbans harbours 334 species of trees, shrubs, herbs and epiphytes and about 400 species of wild animals (Behera and Haider 2012). Sundri (*Heritiera fomes*) is the most important floral species. Other prominent species are: gewa (*Excoecaria agallocha*), baen (*Avicennia officinalis*), passur (*Xylocarpus mekongensis*), keora (*Sonneratia apetala*), goran (*Ceriops decandra*), ora (*S. caseolaris*) and hental (*Phoenix paludosa*). It also offers high value non-timber forest products like honey, wax, fish and crabs. This forest is also rich in its faunal diversity. There are 448 species of vertebrates including 10 amphibians, 58 reptiles, 339 birds and 41 mammals (Department of Environment [DoE], Government of Bangladesh [GoB] 2015). It provides habitat for diverse aquatic wildlife such as estuarine crocodile (*Crocodylus porosus*), turtles (*Lepidochelys olivacea*), dolphins (*Platanista gangetica* and *Peponocephala electra*) and molluscs like the giant oyster (*Crassostrea gigas*). Nevertheless, the Royal Bengal Tiger (*Panthera tigris*) is the most magnificent animal. According to the census of 2004, around 440 tigers resided in the Bangladesh part while the most recent estimate puts such to around 106 tigers

(Bangladesh Forest Department [BFD], 2015 and The Guardian, 27 July 2015). It is also home to thousands of spotted deer (*Axis axis*) and barking Deer (*Muntiacus muntjak*).

These *biotic* along with other *abiotic* resources of the Sundarbans contribute directly or indirectly to the economy both at local and national levels. Fig. 5.2 shows how the resources of the Sundarbans have been utilised for different purposes, contributing both to the lives and livelihoods of local people and to the economy of the country. The livelihood pattern in the Sundarbans area varies with seasons and supports an estimated 3.5 million people directly or indirectly (Sarker et al. 2016). Wood and *golpata* collectors (*Bawalis*), fisherman (*Jele*), honey and wax collectors (*Mouals*), shell collectors (*Chunary*) and crab collectors are among the major occupational groups of the adjacent forest region. The lives and livelihoods of the local people are mainly related to the physical and biological (or biodiversity) resources as depicted in Fig. 5.2.

5.2.3 *Changes: Shaped by the Interactions Between People and Nature*

The Sundarbans has experienced major ecological and physiographical changes due to anthropogenic pressures and climatic disorder, which have taken a heavy toll on the regenerative capacities of the forest and its ability to maintain sustainability. Such pressures have resulted in the continuous decline of the forest coverage and of its biodiversity resources. In 1776, the size of the Sundarbans was 17,000 km². At present, it is only almost half of this total area (Islam and Gnauck 2009). A recent report shows declining trends in forest areas both in India and Bangladesh (Fig. 5.3).

The reduction of volume of important tree species of the Sundarbans can also be analysed through forest inventories prepared by different agencies (Table 5.1). The trend in growth of trees in each case is found to be declining.

The degradation of floral diversity also yields negative impacts on faunal diversity. As many as 20 globally threatened species inhabit in the Sundarbans. The most endangered species are *Batagur baska* (turtle), Ganges River dolphin and the Irrawaddy dolphin. Other threatened wildlife species include pythons, king cobras, adjutant storks, white-bellied sea eagles, clawless otters, masked fin-foots, ring lizards, river terrapins, fishing cats, spoon-billed sandpipers, and eagles (Department of Environment [DoE], GoB 2015). The most important faunal species, the Royal Bengal Tiger, is also enlisted as an endangered species by the IUCN. Table 5.2 provides a summary of the characteristics of the Sundarbans as regards SEPLS.¹

¹The two major indicators for identifying SEPLS have been specified here based on the definition by the *Satoyama Initiative* and illustrated by others (e.g. Gu and Subramanian 2012; Ichikawa 2013; Bergamini et al. 2013).

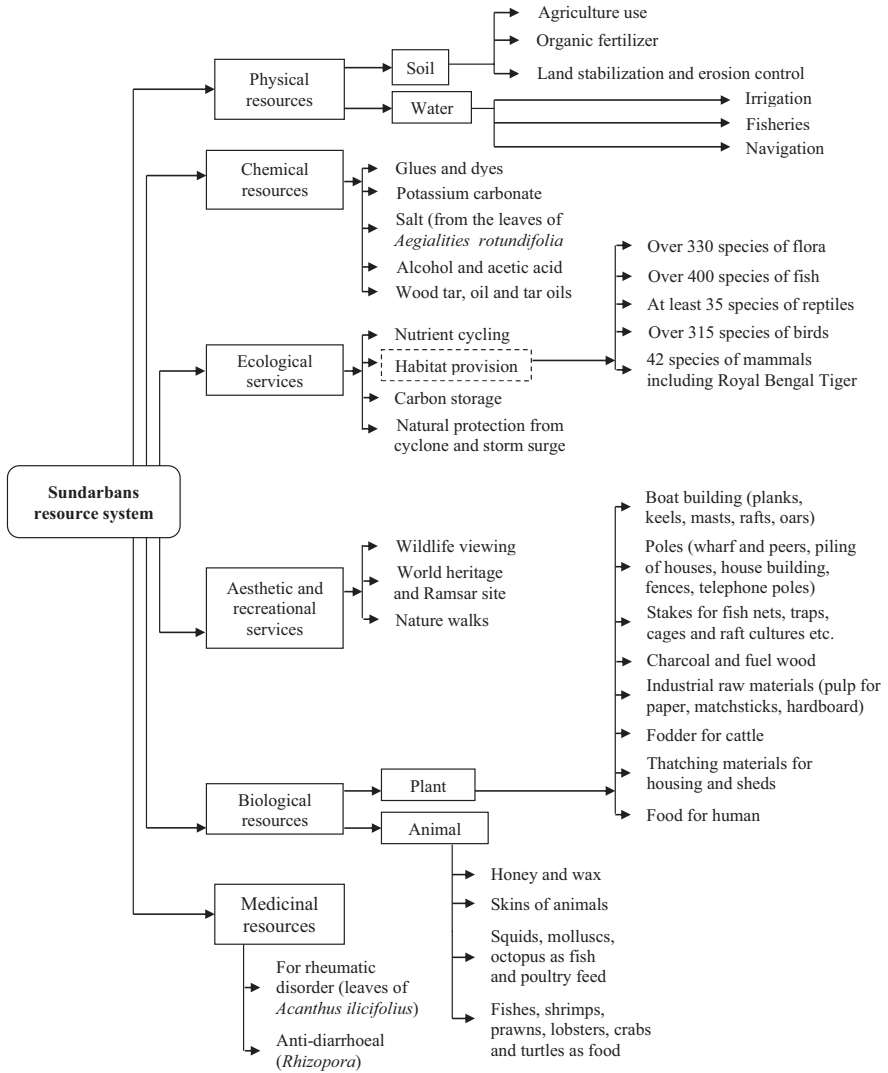


Fig. 5.2 Sundarbans resource system. (Source: Titumir and Afrin 2017)

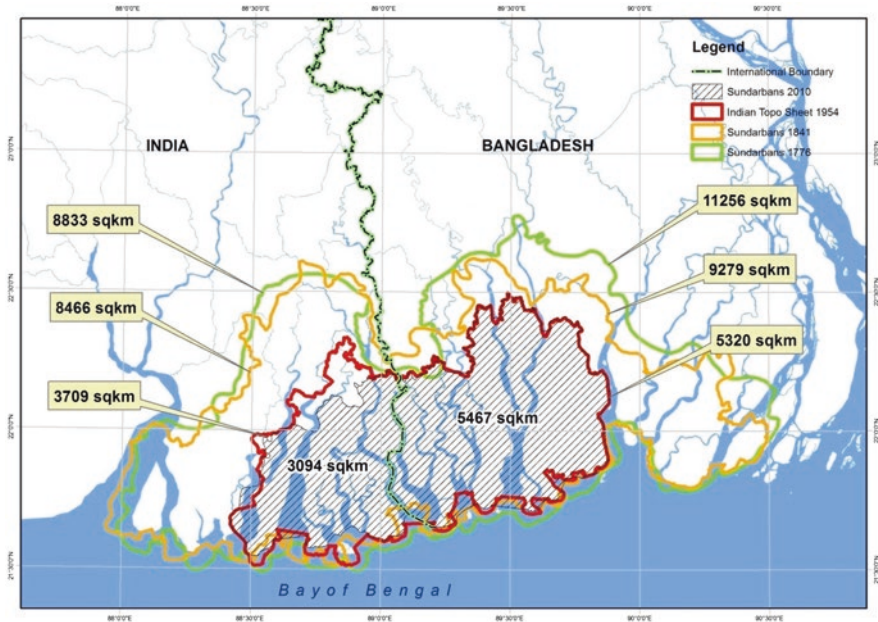


Fig. 5.3 Mangrove forest change of the Sundarbans from 1776 to 2010. (Source: Joint Landscape Narrative by India and Bangladesh, CEGIS 2016)

Table 5.1 Growing stock of the Sundarbans (Source: FAO 2011)

Year	Inventory done by	Sundri (number of trees per hectare)	Gewa (number of trees per hectare)	All tree species (number of trees per hectare)
1959	Forest and Forestal Engineering, Canada	211	61	296
1983	Overseas Development Authority	125	35	180
1996	Forest Resource Management Project, FD, GoB	106	20	144

Table 5.2 The Sundarbans as a SEPLS (Source: Titumir and Afrin 2017)

Indicators	Relevant to the Sundarbans? (yes/no)	Why relevant?
Mosaic of production landscape/seascape	Yes	It is a mangrove forest that includes forest, coastal and wetland ecosystems, supporting diverse production activities
Harmonious interaction between humans and nature and well-being of both	Yes	It provides the IPLCs different options for maintaining livelihoods and the IPLCs provide protection to the forest and its resources through traditional livelihood practices

It should, however, also be noted that the balance of such a SEPLS has continuously been threatened as has been found in the above discussion.

5.3 A Conceptual Framework: SEPLS, Human Sociality and Sustainability

Means and measures employed for the natural resource management are primarily drawn from market centric theoretical underpinning as a part of the intellectual project of neo-liberalism. This school of thought suggests that the biodiversity resources degrade primarily because of the non-existence of market and negative externality (Sadmo 2015; Perrings et al. 1992). It argues that valuation techniques can provide useful insights to support policy initiatives by quantifying the economic value of the resources and to devise exchange rule associated with the protection of biological resources (Costanza et al. 1997; Pearce 2001; Bräuer 2003; Kumar 2005; Barbier 2007; McAfee and Shapiro 2010; Hahn et al. 2015). This understanding has been complemented by the institutional economists as establishing a formal property rights regime can efficiently manage the natural resources where the absence of property rights results in resources degradation (Ostrom 2000; Vatn 2009, 2010; Ituarte-Lima et al. 2014).

A section of the political economy analyses, on the contrary, contend that the existence of overlapping property rights regime contributes to the conflicting resources management and degradation. It sheds light on the political elements in resources management regime and highlights the hierarchical relationship that exists in society. It argues that institutional arrangements (property rights) are vulnerable to some political economic factors stemming from accumulation by different agents in presence of non-cooperative solution. It further stresses upon the roles of the formal political institutions and emphasises on the narratives about the changes of the ecosystem services (Robbins 2012).

Such literature provides a lens to describe the bio-environmental relationship in the presence of distribution of power to production activities and its link to ecological analysis (Greenberg and Park 1994). It emphasises on the claim that the degradation of natural resources is not only about the non-existence of market but also about unequal power sharing by the stakeholders over the management of resources (Fig. 5.4). Existence of vertical relations in society and upward enforcement of rules

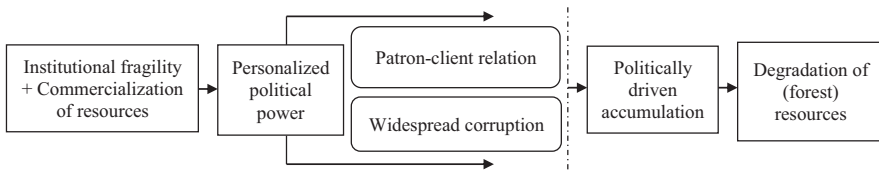


Fig. 5.4 Political economy factors inducing biodiversity resources degradation. (Source: prepared by the authors)

enable the powerful group to capture resources with impunity (Adhikari and Goldey 2010). The process prioritises the rule of individuals over the rule of law which ultimately results in institutional fragility, enlarging rent dissipation, rent seeking and seizure of property rights.

Market centric analysis does not recognise that if particular species of ecosystem of a special kind are being traded for monetary gain, they might not be replaced. It, however, fails to offer a sustainable solution regarding the distinct characteristics of interdependent relationship among humans, biodiversity resources and ecosystem services. Exchange based on economic valuation is found to be faulty (Kosoy and Corbera 2010; Gomez-Baggethun and Ruiz-Perez 2011; Muradian et al. 2013; Turnhout et al. 2013; Neuteleers and Engelen 2015). It reduces biodiversity into a number of quantifiable parts, subjecting to the utilitarian usage and reducing social-natural relations to market transactions (Turnhout et al. 2013). Such measures provide a narrow conception of ecosystem services and are potentially detrimental to the conservation of resources. Alongside, the political ecology does not provide any measures but a broad understanding of the contributing elements of the degradation of natural resources.

Human beings are part of the ecology not merely the exclusive agents who extract resources. The long-standing embeddedness of the human beings into the ecology and the roles they play into the system remains unexplored and sometimes has been identified as external to the system. Being a part of this system, human beings have been maintaining an interwoven, intimate and reciprocal nexus with the nature. This nexus can be explored from 'human sociality' perspective. Human sociality refers to the human beings, as a collective organisation, and is part of the larger ecosystem, which possess distinct knowledge and practices that systematically and sustainably contributes to the conservation and regeneration of the resources along with maintaining provision of ecosystem services. It stresses upon that societies in harmony with nature contribute to the biodiversity conservation through revitalisation and supporting SEPLS where informal institution plays a crucial role. Informal institutions which include norms, values and traditional knowledge not only contribute to the SEPLS but also conserve and regenerate the resources for making a more resilient ecological system and society.

A sustainability conservation framework constructed in this chapter exhibits that inter-institutional pitfall stemming from exclusion of informal institutions and community ownership causes degradation of the natural resources, contrary to the market-centric perspectives. It argues that the earlier practices of fencing off pieces of nature as a means to 'mitigate' anthropogenic intervention have been proved costly, unsustainable, and dubious in terms of socioeconomic and conservation processes (Liu et al. 2012). This alternative framework has taken the political economy premise to identify the causes of degradation with emphasising on the complementary relations between human beings and nature in ensuring the sustainable utilisation and distribution of the resources. It claims that conservation requires acknowledging a diversity of values, knowledge and framings of SEPLS which build the cooperation and incentivise conservation for long-term sustainable use of those resources (Fig. 5.5).

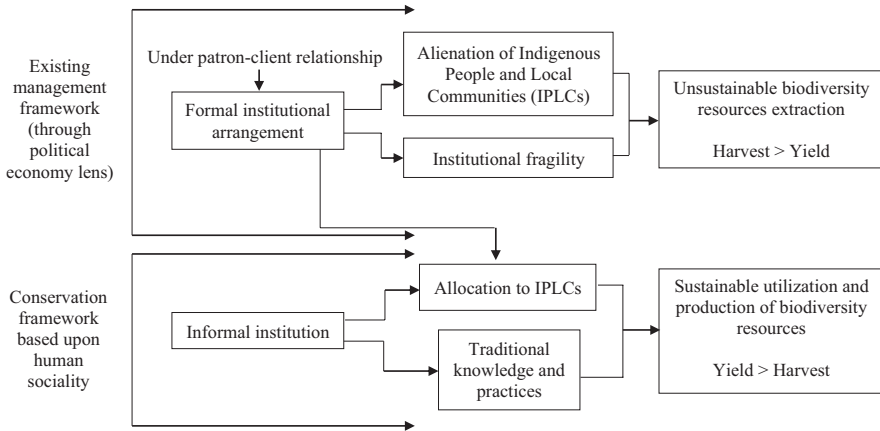


Fig. 5.5 Conceptual framework. (Source: prepared by the authors)

This framework argues that in the presence of neo-liberal means and measures, the exchange process constitutes a patron–client relationship. In this process, the IPLCs become the external agents to the ecological milieu, and it brings institutional fragility because of unequal power sharing between political elites and IPLCs. Such exchange relationship culminates into primitive accumulation of the resources and unsustainable extraction of resources (where, harvest is greater than the yield due to maximum realisation of the resources rent). Alternatively, the sustainable conservation framework based upon human sociality suggests that allocation of resources regime to the IPLCs is sustainable. IPLCs together with their traditional knowledge and practices constitute a socio-ecological production network. IPLCs contribute to sustain this production network because of its symbiotic nature to the stock of resources. This incentivises IPLCs to invent knowledge to conserve the resources and to practice the knowledge for ensuring a sustainable value chain. Thus, altogether the IPLCs and their TK practices make the biodiversity resources more resilient (where yield is greater than harvesting) and sustainable.

5.4 Drivers of Biodiversity Resource Degradation of the Sundarbans²

It is necessary to define the nature of property rights of a particular type of resources in order to identify the drivers of degradation of those resources through the lens of political economy. The reason is that fragile institutional arrangement (e.g. instable property rights) is at the root of resource degradation which results from the influ-

²The empirical sections (Sects. 5.4 and 5.5) discuss these results drawn from different studies, conducted by the *Unnayan Onneshan* (e.g. Kabir and Hossain 2008; Baten and Kumar 2010; UO 2010; Titumir 2011, 2015; Titumir and Afrin 2017; Titumir et al. [in progress]).

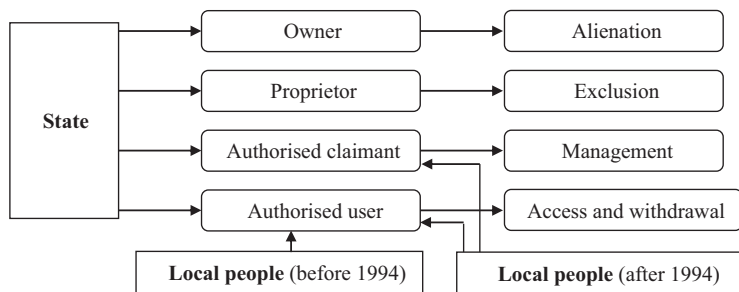


Fig. 5.6 Property rights structure of the Sundarbans. (Source: prepared by the authors)

ence of many political economic factors. A brief overview has been provided here firstly on the current structure of property rights of the Sundarbans. The major drivers of resource degradation have been identified thereafter.

5.4.1 Structure of Property Rights of the Sundarbans

The nature of property rights of the Sundarbans was ambiguous since formulation process. It was treated as open access forest for harvesting and conversion for agriculture particularly during Mughal period. The British colonisers ruling over Indian subcontinent became aware of the importance of this mangrove forest and declared it as Reserve Forest (RF) in 1878. The right over the forest was, thus, kept in the hands of the government. After the independence of Bangladesh in 1971, the forest of Bangladesh part was declared as RF again under the Forest Act 1927. Then, the Forest Policy of 1994, however, recognised the community participation in the management process and accordingly recognised the rights of the local people. The property rights structure of the Sundarbans now, therefore, cannot be defined in terms of specific type of property rights (common or public) rather the rights are being distributed among the state authority and local people. The overall structure of property rights can be explained through a diagrammatic representation based on Schlager and Ostrom's (1992) typology of bundle of property rights (Fig. 5.6).

Since 1994 the Forest Department (FD) on behalf of the state took the responsibility to ensure the efficient use of resources of the Sundarbans as the owner, proprietor, authorised claimant and authorised users. The resource users have the right to access and use resources by obtaining permission from the FD. On the contrary, the local people had got management rights along with the access and withdrawal rights. The practical scenario, however, signifies that this formal institutional arrangement is not stable. They have to face many barriers to exercise their rights to have access inside the forest and to use the biodiversity resources. Moreover, the FD is also found to be inefficient to exercise its legal rights in a stable way. Such instability is apparent through several legal and quasi-legal interventions by different powerful agents into this resourceful region as will be clarified in the below discussions.

5.4.2 Increasing Habitation and Illegal Encroachment

The existence of instable and ill-defined property rights creates scope for the politically and economically powerful groups to encroach into the forest of the Sundarbans in illegal ways. The Sundarbans, particularly, locates within the three districts of Khulna, Satkhira and Bagerhat. The density of settlement across these three regions has been increasing over the years, and the trend will continue as the projection indicates (Fig. 5.7). Shear dependence on natural resources of the Sundarbans, therefore, is also increasing. Such increasing habitation is largely an outcome of fragile property rights regime by the community over this ecological landscape. A significant number of migrated people find it possible to encroach into the forest and, therefore, intend to live in the nearby districts of the Sundarbans.

They are not the indigenous local people, and therefore, they do not respect the local customary practices to conserve the forest resources and always intend to extract the resources as much as possible and thus enhances the process of degradation. Moreover, politically and economically powerful groups are also found to continuously encroach into the forest region by making coalition at different levels.

5.4.3 Rent-Seeking Tendency and Extra-Legal Management

The government agencies, officials and functionaries are alleged to be rapacious in their own right too. There are irregularities in fishing and collection of honey, timber and *golpata* (*Nypa fruticans*). For instance, in every case the traditional collectors have to get access right (BLC—Boat License Certificate) from FD to enter into the forest by paying extra tolls in form of bribe. To cope with such excessive tolls, the

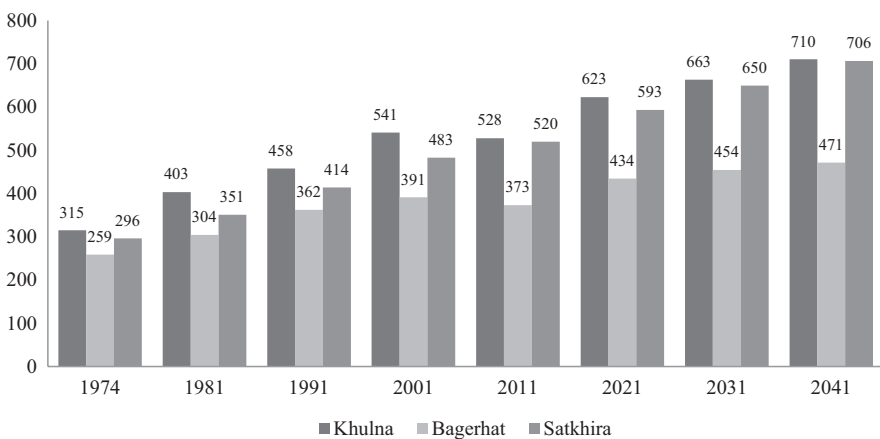


Fig. 5.7 Population density in the districts encompassing the Sundarbans (in number). (Source: Authors' calculation based on population census of 2001 and 2011 by BBS (2011))

resource collectors have to collect resources more than they are permitted to which adversely affects the reproduction capacity of the forests. Moreover, the illegal encroachment into the forest, as described in the previous subsection, by the politically powerful ones has been possible with the direct cooperation of forest officials through bribery and other illegal means such as embezzlement and misuse of power. Going against its own policy, the government over the last few years permitted setting up of 190 industrial and commercial units in the ecologically critical area (ECA) of the Sundarbans, which poses a serious threat to the biodiversity (Fig. 5.8). The government declared the 10-km periphery of the mangrove forest as the ECA in 1999, after the UNESCO listed it as a natural world heritage site. As per Bangladesh Environment Conservation Act 1995 (amended in 2010), no one is allowed to set up any factory in the ECA.

Most of these agents and interest groups of land grabbers are businessmen and industrials units who have powerful political linkage. The most recent and controversial project is the ‘Rampal Power Plant Project’, a coal-based power plant, fraught with triple jeopardises in the three domains of environment, economic and technical feasibility, which may cause dangers to the integrity of the Sundarbans. The project is under the process of implementation.

5.4.4 Land Reclamation and Shrimp Cultivation

Conversion of land into commercial shrimp farming is the largest human threat to the Sundarbans mangrove ecosystem. The increase of the farms is mainly caused through quasi-legal intervention. The farms are put in place by the powerful local stakeholders, specifically, by the rich fishermen (not part of the indigenous people), connected with political and administrative structures at local and national levels.

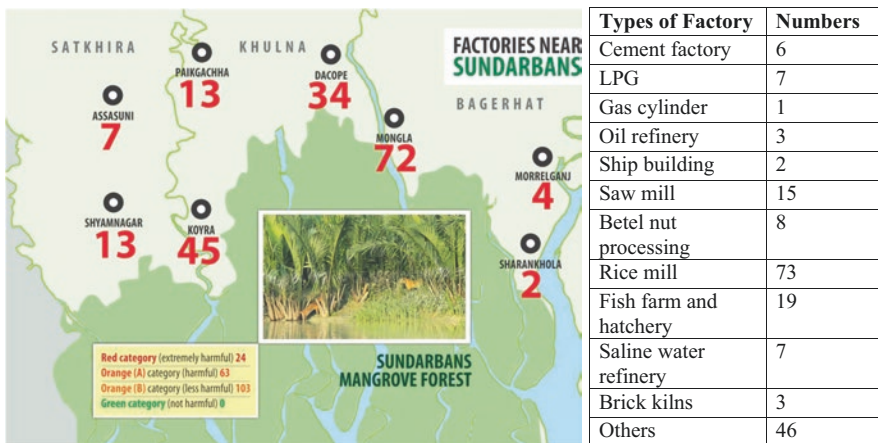


Fig. 5.8 Factories near the Sundarbans. (Source: The Daily Star, 6 April 2018)

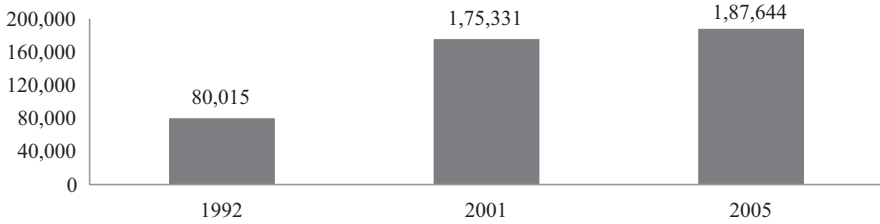


Fig. 5.9 Bagda shrimp cultivated areas adjacent to the Sundarbans (in hectares). (Data Source: Hussain 2014)

There is an increasing trend of shrimp (Bagda, *Penaeus monodon*) cultivated areas adjacent to the Sundarbans (in hectares) from 1992 to 2005 (Fig. 5.9). The constructions of shrimp ponds contribute to the degradation and loss of mangrove habitats in several ways. For instance, a shrimp-cultivating pond exhausts its usefulness within 3–6 years of construction.

Therefore, the cultivators have to move along the coast, destroying mangroves to make room for more ponds. Moreover, it increases salinity in the soil and thus alters the soil composition of that region. Southwest coastal region of Bangladesh is already facing increasing salinisation, especially between October and May. Laboratory analyses of water and soil samples show an increase of salinity over time in the region. Climate change induced sea-level rise will further intensify the problem of river and soil salinisation (World Bank 2016).

5.4.5 Marginalisation of Traditional Forest Users

The current management framework of the Sundarbans excludes the traditional forest resource users in the management process. Here exclusion means that the communities cannot apply their customary knowledge to resource management. Their exclusion from managing this forest led them to undermine the process of conservation because of inadequate representation of their interests. Moreover, the current management practice does not include alternative livelihood options for them.

5.5 Informal Institutions, Traditional Knowledge and Human Sociality: Towards Sustainable Conservation of Biodiversity Resources

The IPLCs sensibly believe that the forest provides their livelihoods, and it must be protected from all sorts of misuse and abuse for the present and future generations. They, therefore, follow some rules according to which they harvest the resources with utmost care and love for the nature (Fig. 5.10).

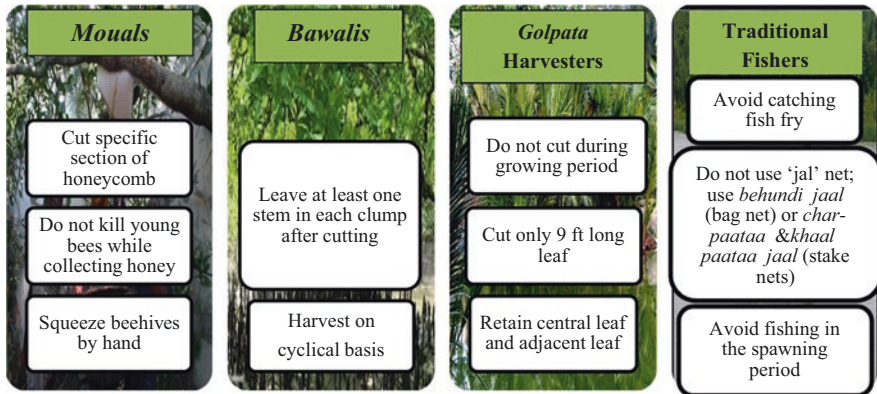


Fig. 5.10 Traditional rules and practices followed by IPLCs occupational groups at a glance. (Source: prepared by the authors)

5.5.1 Traditional Rules and Practices Followed by IPLCs

5.5.1.1 Rules Followed by the Mouals (Honey/Wax Collectors)

Honey is considered as an important non-wood forest product. The *Mouals* (honey/wax collectors), while collecting honey from the honeycombs, usually during the months of April, May and June, cut a specific section (about two thirds) of the honeycomb and leave the rest for reproduction. They also try to make sure that no young bees are killed while collecting honey and squeeze beehives by hand and never use metal tools. They revisit the colonies after a period of 1 month or more depending upon the size of the colony and flowering condition of nearby vegetation. When collecting the honey, the *Mouals* produce smoke using dry leaves but never put fire on beehive.

5.5.1.2 Rules Followed by Bawalis (Wood Collectors)

The *Bawalis* (wood collectors) follow several rules to ensure sustainable harvests of wood. They leave at least one stem in each clump of trees after cutting. Once the *Bawalis* have harvested wood from a compartment, in the following year they will not use this compartment for harvesting but will harvest on a cyclical basis so that there is an adequate re-growth of plants. They usually cut wood where there is abundance. They do not cut young and straight trees. The *Bawalis* believe that this tidal forest is a sacred place and the Creator washes the forest twice a day and maintains its sanctity and, therefore, try to maintain sustainable use of forest.

5.5.1.3 Traditional Practices of Golpata (*Nypa fruticans*) Harvesters

According to the rules followed by *Golpata* harvesters, exploitation in any area is not allowed more than once in a year and is not allowed during June to September specifically as it is the growing period of *Golpata (Nypa fruticans)*. They cut only the leaves that are approximately 9 ft long, and the leaves are cut in a way so that the central leaf and the leaf next to it in each clump are retained. They maintain the rule that the flowers and fruits shall in no way be disturbed when cutting leaves. They also maintain that young plants with only one utilisable leaf should not be cut.

5.5.1.4 Customary Rules Followed by Jele (Traditional Fishers)

The *Jele* (traditional fishers) knows that catching fish fry will ultimately deplete the number of fishes in the water bodies and thus they try to avoid doing so. They do not use ‘*jal*’ net (very small-meshed net) usually. They use nets like *behundi jaal* (bag net) or *charpaataa* and *khaal-paataa jaal* (stake nets)—which are innovated and customised scientifically to benefit the Sundarban’s unique waterscape. They use big-meshed net for rivers and small-meshed net for closed water bodies. They do not catch all species of fish and also avoid fishing in the spawning period.

5.5.2 Innovation and Diversification of Livelihood Patterns

In addition to the above-discussed traditional rules and practices which have been practiced through generations, the IPLCs in recent times have also diversified their livelihoods options by innovating different production methods and techniques as responses to the continuous deterioration of their livelihood opportunities due to man-made pressures (e.g. degradation of forest resources, loss of agricultural lands) and anthropogenic pressures such as climate change. These techniques are innovative as the IPLCs came up with these for enriching their adaptation capacity to the changed situation.

5.5.2.1 Innovative Techniques in Agriculture

The local small farmers have developed some innovative techniques in agriculture that are adaptive to local biophysical conditions while ensuring environmental sustainability. In the face of climate change and increased salinity in soil and water in that coastal region, the farmers grow their rice seedlings in raised land to reduce the risk of saline water contamination for ensuring maximum survival and then these seedlings are transplanted in the main agricultural land. For instance, they harvest rice plant at 8–12-in. high from the ground to respond to high salinity contents in soil and water (Fig. 5.11a). Practically this saline contaminated rice straw is decom-

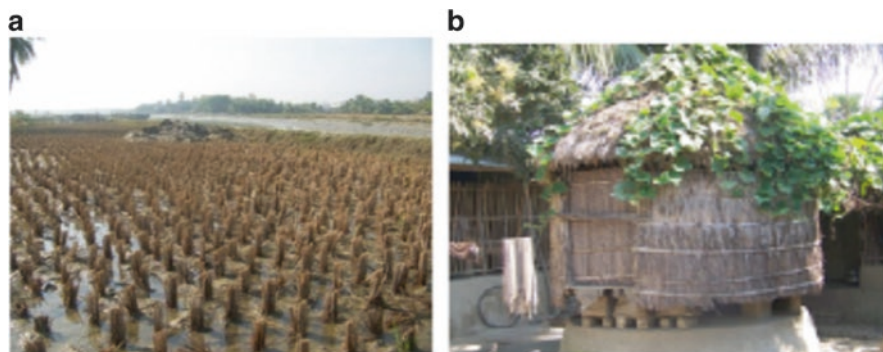


Fig. 5.11 (a) Rice harvesting in raised lands and (b) cultivating vegetables on roof

posed within very short time if these are used as roofing materials. They, therefore, let those to be decomposed in the field which in turn add organic matter, mainly nitrogen, in soil and also reduce saline intensity, which is beneficial for the growth of their next crop. Moreover, those who are landless, grow vegetables on sheds or roofs, yard or back yard of their houses (Figure 5.11b).

5.5.2.2 Community-Based Mangrove Agro Aqua Silvi (CMAAS) Culture

The CMAAS culture refers to the practice of integrated cultivation of some mangrove faunal species—crabs, oyster or fishes (e.g. shrimps and bhetki [*Lates calcarifer*]) and floral species—golpata (*Nypa fruticans*), keora (*Sonneratia apetala*), goran (*Ceriops decandra*), etc. at the same time on any swampy land of brackish water. In addition, integrated cultivation of some mangrove floral species like golpata and a few faunal species like tengra (*Mystus tengara*), bails (*Awaous guamensis*), tilapia (*Tilapia nilotica*), etc. are practiced in a fresh water swampy land. The CMAAS culture is found to be profitable as is depicted in Table 5.3.

CMAAS culture is in fact an alternative practice to the commercial shrimp (CS) culture which has negligible or no adverse impact on the Sundarbans ecosystem. It has been pointed out already in the previous discussion that the commercial shrimp cultivation is leaving huge adverse impacts on the Sundarbans. Here, a comparative analysis of these two types of culture is provided in summary based on the findings of a research of Unnayan Onneshan.

The comparison in economic terms³ can be depicted in Table 5.4. In terms of net present value (NPV) and net benefit (NB), CMAAS culture looks more profitable than commercial shrimp (CS) culture. But the scenario is quite different when considering benefit–cost ratio (BCR). The BCR scenario implies that the cost effectiveness of CS culture is comparatively higher. Shrimp cultivation is, therefore, no

³The cost–benefit analysis (CBA) approach was used to compare the economic returns in this case.

Table 5.3 Economic return of CMAAS culture (Source: prepared based on findings of the research by UO 2010)

CMAAS culture		
Economic return (Benefits > cost)	Mangrove cultivation (flora): Total income (per 'Bigha'/per year): BDT 56,250 Total cost (per 'Bigha'/per year): BDT 1800 Net benefit: BDT 54,450 Cost–benefit ratio: 1:32	Mangrove aqua farming (fauna): Total income (per 'Bigha'/per year): BDT 1,83,000 Total cost (per 'Bigha'/per year): BDT 14,750 Net benefit: BDT 173,250 Cost–benefit ratio: 1:12

Note: A *Bigha*, a unit of land measurement, is 1600 yd² (0.1338 hectare or 0.3306 acre) and often interpreted as being 1/3 acre (it is precisely 40/121 acre). In metric units, a *bigha* is hence 1333 m²

Table 5.4 Value of cost–benefit analysis (CBA) measures of CMAAS and CS culture (Source: prepared based on findings of the research by *Unnayan Onneshan* 2010)

Measures of CBA	CMAAS culture(BDT/ <i>bighal</i> year)	CS culture(BDT/ <i>bighal</i> year)
Present value of costs (PVC)	16,550.00	8860.00
Present value of benefits (PVB)	217,500.00	177,272.72
Net present value (NPV)	202,454.54	169,218.18
Net benefit (NB)	200,950.00	168,412.72
Benefit–cost ratio (BCR)	13.00	20.00

doubt profitable. But beneficiaries are a selected group of people, and regrettably it has badly affected the livelihoods of landless and marginal farmers. Moreover, the ecological comparison (Table 5.5) proves that the CS culture is highly detrimental to the environment, whereas CMAAS culture has negligible or no harmful impact on the environment.

The ecological benefits resulting from the practice of CMAAS culture signify that the culture protects lands and soil from erosion, ensures better utilisation of fallow lands, protects environment from pollution, helps conserve biodiversity resources of the Sundarbans and most importantly provides alternative and sustainable livelihood options for the IPLCs.⁴

The CMAAS culture, as a whole, therefore, is a unique adaptation method to adapt to climate change in the coastal region. The local communities have invented this method, displaying a strong sense of ownership and a scope for scalability.

⁴The research, conducted by *Unnayan Onneshan*, focused only on a comparative analysis of CMAAS and CS culture based on economic and ecological indicators and has found it as a sustainable livelihood option for the IPLCs. More research can be conducted on a rigorous basis to assess its viability as an alternative income source for a wider context of coastal region for increased number of populations.

Table 5.5 Ecological Comparison between CMAAS and CS culture (Source: prepared based on findings of the research by *Unnayan Onneshan 2010*)

Criteria	CMAAS culture	CS culture
Salinity	No use of saline water; no salinity intrusion	Increases salinity in soil (in farmland and in adjacent lands)
Use of lands	Homestead adjacent fallow lands are used, and no conversion of forest lands into cultivation lands	Used ponds exhaust usefulness within 3–6 years of construction. So, destruction of mangroves occurs to make room for more ponds
Use of chemical fertiliser, pesticides, insecticides	No usage of chemical fertiliser or insecticides, natural feeding, and therefore no pollution	Chemical fertiliser, insecticides, etc. are used, causing pollution
Impact on agricultural productivity	Does not affect the agricultural productivity	Restricts crop production in agricultural land (by increasing salinity of lands) and conversion of agricultural lands to shrimp farming ponds reduces land availability
Impacts on the Sundarbans (in particular)	Eases and reduces the increasing anthropogenic pressures, making an alternative source of livelihoods for the local people who are dependent on the Sundarbans	Eradication of natural mangrove vegetation, and pollution of aquatic resources (negative)
Adaptation to climate change	An innovative adaptation method to climate change for the vulnerable	Increases the vulnerability to climate change

5.6 IPLCs, Resilience and Aichi Biodiversity Targets

As a Contracting Party to the Convention on Biological Diversity (CBD), Bangladesh is committed to implementing conservation and sustainable management of its biological diversity. The findings based upon empirical analysis, however, reveal that the most important biodiversity hotspot of this country, the Sundarbans, is under the threat of continuous degradation. In this process, the lives and livelihood conditions of the IPLCs are also being adversely impacted. Moreover, traditional knowledge-based livelihood strategies of the IPLCs are found to be effective in maintaining sustainable utilisation and conservation of this forest ecosystem. Yet, their knowledge has been neglected often under the formal institutional management system. Under the considerations of such major findings, this section *firstly* assesses the resilience capacity of the Sundarbans as a SEPLS based on some of the notable resilience indicators⁵ considering two scenarios: (a) resilience capacity under current management process and (b) change in resilience capacity under the alternative conservation framework (developed in Sect. 5.3). A multiple evidence-based approach for the

⁵A set of indicators of resilience of SEPLS has been developed by UNU-IAS to provide a tool for communities to understand their resilience and encourage the practices that strengthen it (UNU-IAS 2015). In total 20 indicators are developed so far, but here some of the important indicators have been used to assess the case of the Sundarbans.

assessment of the resilience capacity has been followed. The findings of the assessment have, then, been summarised in Table 5.6 through triangulation of conceptual framework (developed through critical analysis of available secondary literature on natural resource management), primary data collected from the IPLCs through numerous consultations and authors' own interpretations on the former. In this regard, a significant amount of primary data has been collected through participatory approaches (Focus Group Discussions—FGD, unstructured interview, Participatory Rural Appraisal—PRA tools like social mapping, impact assessment by the respondents, etc.) particularly drawing on from knowledge, views and understandings of IPLCs who are the members of the three cooperatives that the *Unnayan Onneshan* had helped set up—*Harinagar Bonojibi Bohumukhi Unnayan Samity*, *Koyra Bonojibi Bohumukhi Unnayan Samity* and *Munda Adivasi Bonojibi Bohumukhi Unnayan Samity* in the adjacent regions of the Sundarbans (Fig. 5.12).

Secondly, the section also illustrates how the alternative measures as suggested by this study for ensuring sustainability of biodiversity of the Sundarbans can help achieve the Aichi Biodiversity Targets⁶ envisioned by CBD.

A comparative analysis shows that human sociality-based alternative framework contributes significantly to the conservation of the Sundarbans biodiversity by making more resilient ecological system and society. This conservation practice directly impacts on 12 resilient indicators indicating a positive relationship (Table 5.6). It signifies that this framework is more ecologically responsive regarding the context of a SEPLS. For instance, under the current management approach, the ecosystem is hardly protected, and the regeneration capacity is hampered because of failure of checking anthropogenic pressures. On the contrary, the alternative framework tries to ensure the protection of the ecosystem at a higher level and revitalise the regeneration capacity at the fullest (indicator 1, 2, 3). This is possible as the alternative one puts high emphasis on the importance of the traditional knowledge system, whereas the current regime does not fully recognise the traditional knowledge (indicator 5, 6). In terms of the governance and equity indicators, the community-based governance is only envisioned in the policy paper, but in practice such governance system is undermined by agencies of the government. The alternative suggestions, on the other hand—the participation of the community in resource management—build a social capital that contributes to the cooperation, social equity and efficient governance (indicator 7, 8, 9, 10). Both the management frameworks (current and alternative) recognise that the livelihoods of the local people are based on biodiversity resources of the Sundarbans (indicator 12). The alternative framework, however, emphasises that this biodiversity-based livelihood pattern should be maintained in a sustainable way that conserves the biodiversity resources (indicator 4) as well as provides alternative livelihoods under the changed circumstances by diversifying their income sources (indicator 11).

⁶A set of 20 global targets under the Strategic Plan for Biodiversity 2011–2020 (CBD 2013; CBD Secretariat 2014).

Table 5.6 Comparative analysis of resilience capacity of the Sundarbans under two different scenarios (Source: prepared by the authors)

Resilience indicators	Scenario under current practice of management					Scenario under the alternative conservation framework				
	Very high	High	Medium	Low	Very low	Very high	High	Medium	Low	Very low
<i>Landscape and seascape diversity and ecosystem protection</i>										
1. Ecosystem protection				√			√			
2. Ecological interaction considered				√		√				
3. Recovery and regeneration					√	√				
<i>Biodiversity</i>										
4. Sustainable management of biodiversity resources					√	√				
<i>Knowledge and innovation</i>										
5. Traditional knowledge related to biodiversity			√			√				
6. Documentation of biodiversity-associated knowledge					√	√				
<i>Governance and social equity</i>										
7. Rights of the community in resource management				√		√				
8. Community-based governance				√		√				
9. Social capital as cooperation and coordination in resource management					√	√				
10. Social equity					√		√			
<i>Livelihood and well-being</i>										
11. Income diversity				√			√			
12. Biodiversity-based livelihoods	√					√				

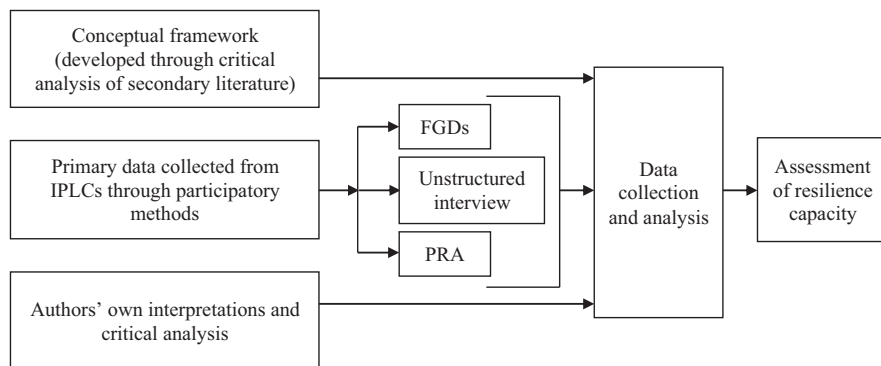


Fig. 5.12 Methods followed for the collection and analysis of data for the assessment of the resilience capacity of the Sundarbans. (Source: prepared by the authors)

Table 5.7 Achievement of Aichi Biodiversity Targets under the alternative conservation framework

Targets	Relevant indicators/issues	Contribution of this case study
Target 10: Pressures on vulnerable ecosystems reduced	<ul style="list-style-type: none"> • Trends in extent, of vulnerable ecosystems (here mangrove) • Anthropogenic pressures • Climate change 	<ul style="list-style-type: none"> • Multiple anthropogenic pressures identified on a mangrove ecosystem • Presenting and promoting the TK-based climate adaptation methods and sustainable agricultural methods
Target 15: Ecosystem restored and resilience enhanced	<ul style="list-style-type: none"> • Ecosystem resilience • Restoration 	<ul style="list-style-type: none"> • Traditional rules and methods followed by IPLCs promote the restoration process and enhances resilience capacity • Climate change adaptation methods like CMAAS innovated by the IPLCs enhances resilience capacity
Target 18: Traditional knowledge respected	<ul style="list-style-type: none"> • Traditional knowledge, innovations and practices • Customary use of biological resources 	<ul style="list-style-type: none"> • Promotes TK knowledge system practised by the IPLCs • Urges to recognise the traditional practices in the resource management framework • Emphasises on the participation of IPLCs in the resource management

The alternative conservation framework, accordingly, helps achieve some of the important targets under ‘Aichi Biodiversity Targets’ as is illustrated in Table 5.7. Firstly, it helps to contribute to the Target no. 10 by reducing pressures on vulnerable (here, mangrove) ecosystem. Secondly, it promotes restoration and enhanced resilience of that ecosystem and thus helps achieve Target no. 15. Finally, and most importantly, it contributes to achieve Target no. 18 by respecting the TK system practised by the local and indigenous communities (Table 5.7).

5.7 Conclusions

There is a significant number of anthropogenic pressures that cause the degradation of biodiversity resources of the Sundarbans. These anthropogenic pressures have mainly intensified with the advent of neo-liberalism as the sole strategy of accumulation of wealth, with profits being considered more important through commercialisation of forest products, neglecting intrinsic ecological value of biological resources. These commercial enterprises, formal and informal, are found to be highly organised in their extractions of resources, and most often being politically patronised and administratively supported. The chapter, thereafter, has scrutinised the livelihood strategies of the IPLCs, the resource-dependent communities of the Sundarbans, and the results show that their livelihood strategies (both traditional practices and innovative tools) are largely effective and beneficial for the protection and maintenance of natural mangrove ecosystem. The assessment of the Sundarbans on the basis of the resilience indicators of SEPLS also shows that the current resilience capacity can be improved by mainstreaming the traditional knowledge base and participation of the indigenous people into the resource management framework.

The lessons from this study can be applied with necessary modifications to improve policy decisions and management interventions of such type of SEPLS in different countries of the world. There is no denying of the necessity to revise laws, regulations, and policies relating to the use of resources and to secure the rights of the IPLCs.

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