

# Is co-management a double-edged sword in the protected areas of *Sundarbans* mangrove?

Md. Mizanur Rahman

Deputy Secretary, Information and Communication Technology Division, Government of the People's Republic of Bangladesh, Dhaka 1207, E-mail: [mizan\\_peroj@yahoo.com](mailto:mizan_peroj@yahoo.com)

## Abstract

The overall objective of the study was to examine the pros and cons of the participatory approach adopted in natural resource management in the ecologically protected areas of the *Sundarbans* mangrove of Bangladesh. A comparative study was done between the people who are involved and non-involved in this approach. Empirical data was collected through personal interviews with a structured questionnaire. The *Gini* coefficient was measured first and then embedded with the Lorenz curve to draw a line between perfect equality and inequality vis-a-vis. The study revealed that the co-management built awareness in favor of biodiversity conservation and the efficient use of natural resources. Contradictorily, a segment of different hierarchical committees was involved in destructive activities like poisoning the wetlands for fishing. Therefore, a mixed outcome was found. The findings will help the policymakers in identifying the pitfalls and bottlenecks rooted in co-management. Hence, the study recommends revising the approach to ensure the community's active participation on an equal basis and take action against them who degrade those resources. Exploring profitable alternative income-generating activities is warranted to narrow down the dependency on the *Sundarbans* mangrove's natural resources. In order to address the tragedy of the commons, the study advocates for the unity of all knowledge ranging from science to humanistic scholarship for sound policymaking.

**Keywords:** *Sundarbans*; co-management; common's tragedy; inequality and ethics; ecosophy and ecofeminism

## 1. INTRODUCTION

The structure and composition of *Sundarbans*, the largest single halophytic mangroves unit in the world, are undergoing significant changes due to anthropogenic climate change effects (Payo *et al.*, 2016; Rahman, 2020). The mangroves of *Sundarbans* are subject to multiple anthropogenic-environmental stressors originating from a rapidly changing climate and socio-economic context (Mitchell *et al.*, 2015). These stressors act simultaneously and degrade the function and services of the mangrove ecosystems. Local pressures originate from the human, while global pressures from climate change (Mitchel *et al.*, 2015). The global problems exacerbate the local pressures (Hoegh-Guldberg *et al.*, 2017). The destruction of mangrove forests occurs faster than ever before (Mohammed *et al.*, 2010). After independence, Bangladesh followed the British and Pakistani Regimes' traditional forest management approach (Iftekhhar, 2006), where the state-owned Forest Department enjoyed the full authoritative power. The top-down forest management approach from the colonial and post-colonial regimes could not help with nature conservation (Rashid *et al.*, 2016). Traditional forest management experienced an increasing trend of habitat loss and fragmentation (Nath *et al.*, 2015; Rahman, 2009; Rahman *et al.*, 2009; Rahman and Vacik, 2010); consequently, it failed to maintain the status quo in ensuring sustainability (Biswas and Choudhury, 2007). Similarly, this centralized management system (Giessen *et al.*, 2016) could not heighten the community's active participation, which resulted in incremental encroachment,

degradation, and deforestation (Millat-e-Mustafa, 2002). By realizing the negative impacts of traditional management, the emphasis was given to adopting a decentralized forest policy to protect against further degradation (Nath *et al.*, 2015). Accordingly, the policy discussions underlined the importance of sustainable use of forest resources. Bangladesh formulated the first national forest policy in 1979, embracing the provision of adopting the participatory approach in the state-owned forest (Muhammed *et al.*, 2008). Even after formulating the policy mentioned above, the protected areas could not safeguard their natural resources due to stakeholders' passive participation in the planning and implementation processes, which resulted in ineffective programs (Rashid *et al.*, 2016).

Community's active participation in the participatory management can be ensured by making clear peoples' rights, incentives, and responsibilities (Rahman and Akter, 2020). Later on, the international donor-funded projects highlighted society's harmonization with natural conservation (Giessen *et al.*, 2016). On the other way round, Rashid *et al.* (2016) revealed that the donor-funded projects coupling their prescriptions do not result in positive outcomes always. Bangladesh introduced co-management in targeted forests and wetlands of *Sundarbans* in 2008 with the financial and technical support of different international organizations, notably the United States Agency for International Development (USAID) (Cunningham *et al.*, 2013). This co-management's objective was to manage *Sundarbans'* natural resources sustainably by maintaining ecological balance, promoting green growth, and engaging the community in the governance (Fox and Mustafa, 2013). There is compelling evidence that co-management achieved its objectives (Carlsson and Berkes, 2005). Some studies examined the positive outcomes of co-management in Bangladesh, overlooking the negative consequences. In-depth research is required for understanding and scoring both positive and negative effects. Therefore, the study aimed to evaluate the recently introduced co-management identifying both challenges and opportunities. These findings will also contribute to bridging the gaps between what was and what was supposed to be.

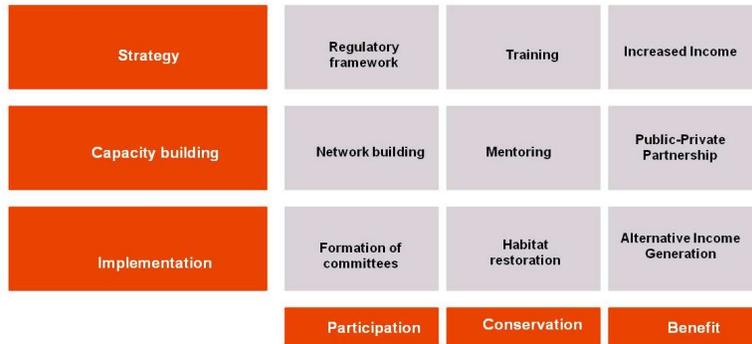
On the other hand, Bangladesh is one of the front-runners in institutionalizing the Sustainable Development Goals (SDGs). The country adopted the aspiration of the "whole society approach" to ensure all stakeholders' participation (VNR, 2020). Contrarily, both the *Gini*-coefficient and Palma ratio has been increased (Osmani *et al.*, 2015), though the core value of SDG 10 is to reduce income inequality. The increased income inequality thwacks poverty reduction accelerating relative deprivation. Wealthx (2019) reported that the number of high net-worth individuals in Bangladesh is increasing. Therefore, the study examined the efficacy of co-management in ensuring the "whole society approach" and reducing income inequality. An alignment between the co-management and SDGs will help realize the importance of this participatory approach in meeting SDGs.

The survivability of *Sundarbans* also depends on anthropogenic and non-anthropogenic perturbation and all those impacts on the ecology (Rahman, 2020). *The Sundarbans* are chaotically complex and continuously changing due to anthropogenic-climatic dynamics (Rahman, 2020). Ecosystems are highly complex where biotic, abiotic, and anthropogenic components and activities go hand in hand (Gaucherel *et al.*, 2020). The abiotic forces, the inborn part of both biophysical and socio-economical entities, shape the ecological dynamics through various activities (Frontier *et al.* 2008; Gaucherel, 2014; 2018; Gaucherel *et al.*, 2021). Multiple actors have interests in the *Sundarbans*, which remain unrevealed until they mobilize material or non-material resources

against conflicting uses (Khan *et al.*, 2020). Now a logical question arises about the synergies and trade-offs between conservation and unavoidable conflict. Hence, a philosophical understanding of *Sundarbans'* ecology is crucial. "Biohumanities," the nexus of biology and humanities discipline, fosters experience and knowledge of biology (Stotz and Griffiths, 2008). "Public ecology" can go beyond biology to gain an understanding for effective decision-making (Robertson and Hull, 2001). Ecological and social science cannot solve the existing multiplex problems of the *Sundarbans*. Ethical issues, regulatory framework, ecology, and management schemes have become inevitable for formulating sound policies that can support conservation management (Schwartz *et al.*, 2012). The conservation biologists evaluate the success of conservation decisions by the validity, acceptability, and accuracy. Similarly, the policymaker tries to that make the decision successful in the political realm. Environmental humanities can work in many fields by positioning the human in various forms and analyzing it from the ethical point of view (Robin, 2018). The bridge between ecology and science's philosophy can set the agenda for future betterment (Colyvan *et al.*, 2009). Additionally, Sloterdijk (2004) urged for creating an "ontological constitution" to incorporate all beings, widely recognized as post-humanism. The increased complexity of biological individuality set off the necessity of under-recognized philosophical aspects and discussions to enrich the existing knowledge (Kaiser and Trappes, 2021). There is an obligation to advocate on behalf of biodiversity for its inherent value and the incapability of nonhuman beings to do that for themselves (Chan, 2008; Odenbaugh, 2003). Thereupon, the study also strived to find out the possible solutions through the lens of biology's philosophy and social aspects.

### ***1.1. Background of co-management in Sundarbans***

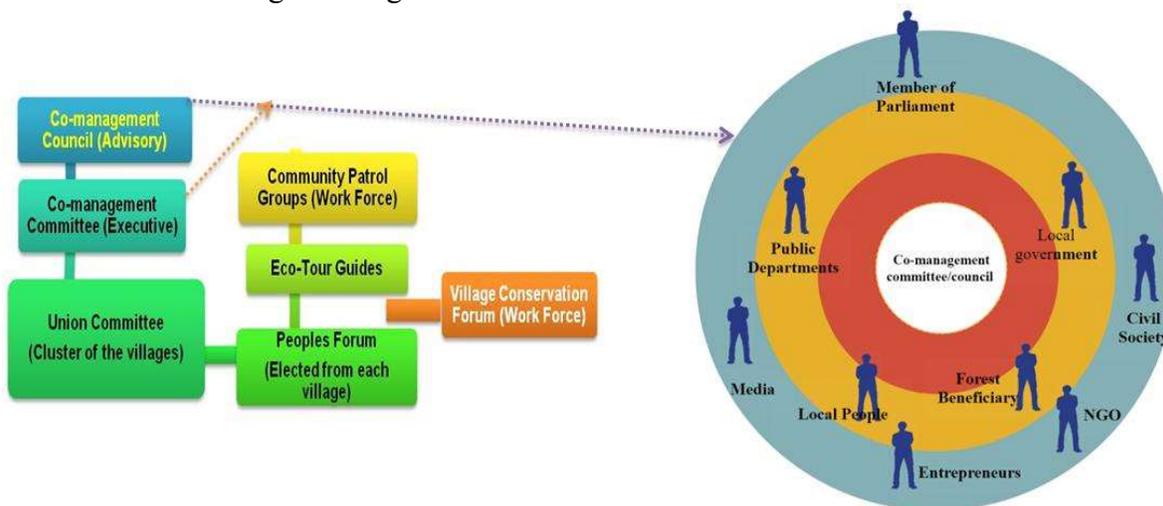
The Forest Department (*FD*) launched the "Nishorgo Support Project (2003-2008)" in 2003 with the support of the USAID. The project's objective was to enhance biodiversity conservation in the Protected Areas (*PAs*) by formally engaging the local people in forest management's decision-making process (Khan, 2008). The community's participation, inclusiveness, transparency, accountability, and poverty reduction were the crucial dimensions (Rahman and Akter, 2020). Hence, the community gained its legitimized voices in the management process for the first time (Lostarnau, 2011). The community also benefited from the protected areas and played a role against illegal logging, poaching, and encroachment of forest lands and water bodies. The Integrated Protected Area Co-Management (*IPAC*) project (2008-2012) clustered the *Sundarbans* into 1) East Wildlife Sanctuaries; 2) West Wildlife Sanctuaries; 3) South Wildlife Sanctuaries, and 4) Ecologically Critical Areas (*ECA*) in 2008. It followed a matrix-based approach in planning, capacity building, and field-level conservation (**Figure 1**).



**Figure 1:** Co-management matrix in the *Sundarbans* (USAID, 2013)

The matrix incorporated three components: a coherent strategy, capacity building, and site-specific implantation to ensure sustainability. A constituency was developed for expanding the network and forming committees to ensure the participation of multi-stakeholders. Conducting training on ecological restoration was another strategy to enhance knowledge and build leadership so that the stakeholders can contribute to conservation. Emphasis was given on alternative income generation activities and public-private partnerships to scale up the community's benefit through increasing income.

Different committees were formed hierarchically (**Figure-2**), followed by business allocation for each committee (Rahman and Laskar, 2016). After completion, IPAC was replaced by another USAID-funded “Climate-Resilient Ecosystems and Livelihoods (CREL) project (2012-2017),” keeping the same organizational structures. CREL scaled-up the model of IPAC to protect the *Sundarbans* from further degradation and increased the resilience to climate change through more participatory planning and livelihood diversification (Winrock International, 2015). It also provided training on climate adaptation and resilience, sustainable natural resource management, and alternative income-generating activities.



**Figure 2:** The hierarchy of participatory organizations for each protected area (Rahman and Laskar, 2016)

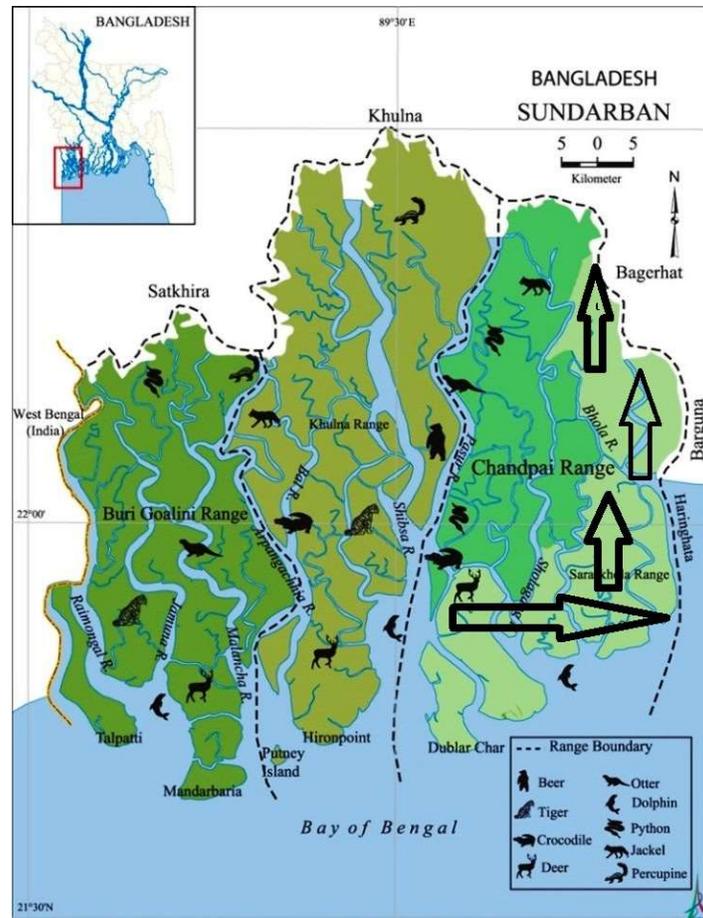
According to the Forest Department guidelines, co-management committees were responsible for managing PAs through stakeholders’ consultations. Each Village Conservation Forum (VCF)

comprised of 30-100 villagers reserving one-third quota for female members. Each VCF elected one male and one female as “Peoples Forum” (PF). “Community Patrol Groups” (CPG) and “Eco-Tour guides” were selected by the VCF (Islam, 2013). The co-management committee performed activities in PAs following the guidance provided by the Council. All activities were supported by a group of local motivators named “*Nishorgo Shahayaks*” (NSs). The co-management council/committee and the VCFs were registered by the Social Welfare Department of the government. IPAC provided financial support for imparting training on integrated farming, aquaculture, homestead forestation, seed production, van driving, vegetable production, nursery management, eco-tourism, and waste management. As part of creating alternative income-generating activities, it provided financial support to the members of VCF for aquaculture, pond re-excavation, and buying sewing machines and rickshaws. The co-management committee held a monthly meeting to discuss the progress and ongoing activities. It strengthened forest governance by adopting more informed, transparent, and inclusive approaches. It involved various stakeholders like public departments, public representatives, non-government organizations (NGOs), donors, grass-root level community, and a broad spectrum of civil society. Co-management attracted young people to foster the next generation who were aware of and committed to conservation and coping with climate change challenges. Different occasions were observed to motivate the local people towards conservation. The CPG worked with the forest rangers to protect the natural resources from the loggers, poachers, and encroachers. Co-management also stressed responsible tourism, networking, and nature-loving campaign. The co-management committee demonstrated field-level activities like establishing billboards; distributed posters, charts, and leaflets among the mass people; presented cultural shows; and participated in the fairs highlighting biodiversity conservation.

## 2. MATERIAL AND METHODS

### 2.1. Study Area

Primary data was collected from the ecologically critical areas of *Chandpai*, one out of four ranges of the *Sundarbans*, which is surrounded by the *Sarankhola* range to the east and south, mainland to the north, and *Khulna* range to the west (**Figure-3**).



**Figure 3:** The arrows showing the landscape area of the *Chandpai Range* (Banglapedia, 2020)

The site’s landscape area is about 50 km in length and 5 km in width, covering two districts named *Khulna* and *Bagerhat*. One sub-district (*Dacope*) from *Khulna* district and two sub-districts (*Mongla* and *Morrelgonj*) from *Bagerhat* districts are under this area, including 05 unions, 29 villages, 24,440 households, and 134,420 people in the landscape. The Forest Department has 04 station offices, 22 patrol camps, and about 200 staff to manage this range. A Co-management Council, an equal number of Co-management Committee (CMC), 05 union committees, and 29 VCFs were functioning in this range. Additionally, other relevant platforms like PF, Federation of Resources User Groups (FRUG), *Nishorgo* (to cherish the sanctity of nature) Clubs, CPG, *Nishorgo Sahayaks* (local motivators), and Eco-Guides worked as the supporting forces. The characteristics of the *Chandpai Range* are given below (**Table-1**):

**Table 1:** Characteristics of the study area

<i>Attributes</i>	<i>Chandpai Range</i>
Status	a wildlife sanctuary, an ecologically critical area, a crocodile breeding center, a dolphin sanctuary, and two tourist spots
Ownership	Government
Management	Mostly top-down management and partly co-management

---

Coordination with academia and researchers	No
Year established	a Wildlife Sanctuary in 1977, an Ecologically Critical Area (ECA) in 1999, a Dolphin Sanctuary in 2012
Forest area (ha)	760
Main plant species (Rahman, 2020)	<i>Sundri (Heritiera fomes)</i> , <i>Keora (Sonneratia apetala)</i> , <i>Kankra (Bruguiera gymnorrhiza)</i> , <i>Khalshi (Aegiceras corniculata)</i> , <i>Passur (Xylocarpus moluccensis)</i> , <i>Dhundul (Xylocarpus granatum)</i> , <i>Hantal (Phoenix paludosa)</i> , and <i>Golpata (Nypa fruticans)</i>
Main Wildlife Species (Rahman and Asaduzzaman, 2010)	The river terrapin ( <i>Betagur baska</i> ), Indian flap-shelled turtle ( <i>Lissemys punctata</i> ), Peacock soft-shelled turtle ( <i>Trionyx hurum</i> ), Yellow monitor ( <i>Varanus flavescens</i> ), Water monitor ( <i>Varanus salvator</i> ), Indian python ( <i>Python molurus</i> ), the Bengal tiger ( <i>Panthera tigris</i> ), Spotted deer ( <i>Axis axis</i> ), Rhesus monkey ( <i>Macaca mulatta</i> ), Gangetic Dolphin ( <i>Platanista gangetica</i> ), Irrawaddy Dolphin ( <i>Orcaella brevirostris</i> ), King cobra ( <i>Naja naja</i> ), Honeybee ( <i>Apis dorsata</i> , <i>Apis cerena</i> , and <i>Apis florae</i> ) and Marsh Crocodile ( <i>Crocodylus palustris</i> )
Projects	Integrated Resource Development of the <i>Sundarbans</i> Reserve Forest (1992-1995), <i>Sundarbans</i> Biodiversity Conservation Project (1999-2005), Forest Resources Management Project (1992-2001), <i>Nishorgo</i> Support Project (2003-2008), Integrated Protected Areas Co-management (2008-2012), Sundarban Environmental and Livelihoods Security (SEALS) Project (2012-2014), Climate-Resilient Ecosystems and Livelihoods (2012-2017)
Community involvement in decision making	Partially
Tourism facilities	Yes
Community benefits from forests	Yes
Human-wildlife conflict	Loss of livestock and human lives
Compensation for losses from wildlife	No compensation
Local languages	Bengali

---

## ***2.2. Data collection***

The respondents were classified as 'people involved in co-management' (PICM) and 'people not involved in co-management' (PNCM). Twenty VCFs out of 29 were considered for data collection. Ten respondents from each VCF were selected with a combination of purposive and simple random sampling for face-to-face interviews. A total number of 200 PICM were examined in this study with a structured questionnaire comprising 25 closed-ended questions between March and May of 2015. Female respondents were selected purposively, where the male was interviewed by drawing a lottery from the name list to reduce potential biases associated with convenience sampling. The nearest neighbor of each PICM who was not involved in co-management was selected as PNCM so that the social attributes remain the same. The total number of respondents and gender ratio also remained the same in both PICM and PNCM. The questionnaire underlined questions regarding the awareness level, occupation, natural resources dependency, and annual income. Some suspected respondents involving in illegal professions were cross-interviewed by their neighbors and relatives very carefully. Their market chain and supply chains, along with financial transactions, were strictly observed and monitored intelligently to be confirmed about their real annual income and profession. The questionnaire was prepared in the *Bengali* literature and translated into English in the latter part.

## ***2.3. Data analysis***

Comparative data analysis was done based on the feedback of the interviewees. Most of the questions had a rating scale ranging from 01 to 05 that weighted the performance levels, with 01 being "strongly disagree," while 05 being "strongly agree." Descriptive statistics were used to tabulate the data. *Gini* coefficient was calculated based on the respondents' annual income, which was embedded with the Lorenz Curve to understand the line of equality better. The SDGs were aligned with co-management considering its activities, objectives, and aspirations.

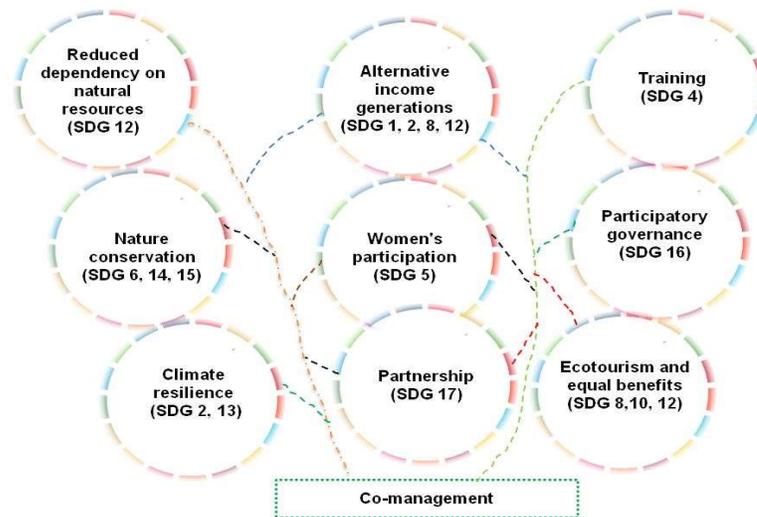
# **3. RESULTS**

## ***3.1. Mapping with SDGs***

The study revealed that co-management is resonated with 13 SDGs out of 17, highlighting nature conservation, climate resilience, responsible consumption of natural resources, women's empowerment, participatory approach, equitable share of benefits, ecotourism, alternative income generations, and training (**Figure 4**). Capacity development through imparting training is a core issue of SDG 4, which stresses non-formal education eyeing on employment generation (SDG 8). Additionally, employment opportunities can help in meeting SDG 1 (no poverty) and SDG 2 (zero hunger). Alternative income generation can reduce poverty (SDG 1) and generate more jobs (SDG 8). This participatory approach aimed to empower the rural women in the planning and management process linked to SDG 5. Narrowing the income inequality is implanted with achieving SDG 10, which can ensure parity and inclusiveness. The concept of eco-tourism is embedded in SDG 8 and SDG 12, endorsing the necessity of branding local products and culture. Participatory governance can ensure transparent, accountable, inclusive, and competent governance at the grass-root level, which are the basic principles of SDG 16. The co-management culminates in partnership building, notably public-private, the cornerstone of SDG 17. The projects strived to build a resilient society to cope with emerging climatic stressors, the foundation of SDG 13. Therefore, it can be argued that all elements of the "whole society approach" are deep-rooted

in the co-management. Proper implementation of co-management can ensure that no one is left behind.

Co-management aimed to use natural resources responsibly and efficiently, which is the core theme of SDG 12. The *Sundarbans* mangrove has diverse ecosystems like freshwater, brackish water, benthic, estuarine, littoral, terrestrial, and marine ecosystems coupled with SDG 6, SDG 14, and SDG 15. The goals related to nature conservation are implanted with the Convention on Biological Diversity, *Ramsar* Convention, *Nagoya* Protocol, and *Paris* Agreement. Twenty SDGs' targets relating to biodiversity conservation are to be achieved by 2020 as they were agreed initially under "*Aichi* Biodiversity Targets." Until and unless co-management functions correctly, Bangladesh cannot meet those targets.



**Figure 4:** Mapping of SDGs by co-management

### 3.2. Socio-economic Challenges

#### 3.2.1. Demographic profiles

The study showed that the social status of both PICM and PNCM was identical in terms of household size, educational level, age, and family size (**table-2**). The average family size was higher than the national average of 4.09 in 2017 (BBS, 2017). In another study, Quasem (2011) found a similar average family size (5.1) in Bangladesh's rural areas. The average household size revealed that the people residing in the *Sundarbans*' ecologically areas were functionally landless (< 0.5 acres). The household size was petite, where one-third of the landless population was dependent on forest lands (Getzner and Islam, 2013). The education level was abysmal, as half of the people had no formal education. According to Getzner and Islam (2013), only 14–23% of the population in the *Sundarbans* achieved secondary school. Sarkar and Bhattacharya (2003) focused on the necessity of increasing education levels in the mangrove forest areas. Therefore, it can be argued that achieving SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 4 (quality education) are at a far-flung distance in the coastal areas. During data collection, it was observed that the allocated quota for the female was not maintained, and the ratio was around 10%. So, the concept of ensuring women's full and active participation and equal opportunities for leadership at all levels (SDG 5.5) was not reflected accurately. From birth to death, the rural community in the remote

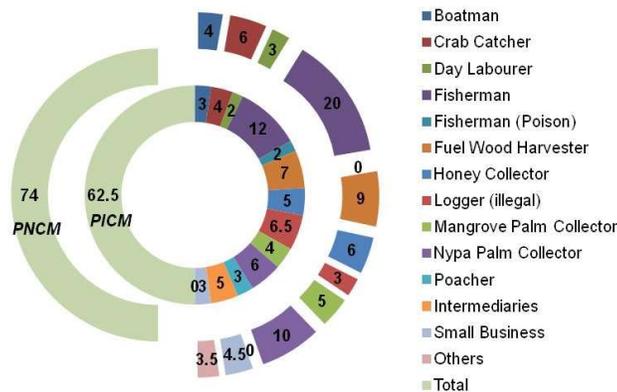
areas faces onslaught challenges emerging from circadian tropical cyclones and increased salinization. Hence, they remain busy with struggling hunger, ignoring the necessity of education enrolment. The rich and influential people in that area accelerated brackish shrimp culture by grabbing ordinary peoples' land either forcefully or making them bound to lease at the minimum cost. Consequently, the marginal landers are turned into landless heightening the vulnerabilities.

**Table 2:** Demographic profiles of the respondents in the study area

<i>Description</i>	<i>Mean ± SD</i>	
	PICM	PNCM
Household Size (Decimal)	16.74±6.85	15.48±6.63
Education Level (class)	2.65±2.77	2.58±2.68
Family Size (N)	5.29±0.95	5.25±0.97

### 3.2.2. Dependency on mangrove resources

Comparing to PICM, the dependency on the *Sundarbans'* natural resources was more in PNCM (Figure 5). According to the Forest Department guideline, a resident can extract resources like fish, crabs, honey, and *Nypa* palm with prior permission. Beforehand, they have to pay a prescribed fee. But logging, poaching, and destructive fisheries are strictly prohibited. The guideline outlines the duration, area, and quantity of the resources to be harvested. Fishing and crab catching is allowed throughout the year excluding in the *Ramsar* Sites, while honey and *Nypa* palm can be collected seasonally (Getzner and Islam, 2013). The fishery is the dominant occupation, followed by fuelwood collection, folk apiculture, crab catching, *Nypa*, and Mangrove Date Palm harvesting. Some incentives like training, micro-credit, and other support provided by the projects helped the people take the edge off dependency on natural resources slightly. With this, the co-management contributed to the responsible consumption and the efficient use of natural resources to some extent; consequently, the maxim of SDG 8 was partially fulfilled.



**Figure 5:** The occupational distributions of PICM and PNCM

In PICM, the respondents imparted practical training on alternative income-generating activities to find other jobs. The respondents argued that training could not maximize the output as Training Need Assessment (TNA) was not done earlier. Business management, entrepreneurship development, modern and scientific technology, and cost-benefit analysis were not encompassed in the curricula. Diversely, the respondents did not show many interests to replace the resource exploitation by the alternative income generations on account of a dearth of motivation. It was

reported that the emphasis was given to spend the allocated money on the training head within the timeframe. Appropriate training contents and interactive modes of delivery can enhance knowledge, understanding, skills, and conceptualization.

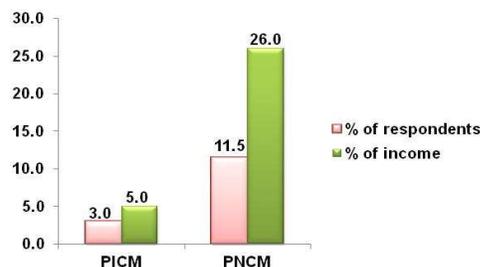
### 3.2.3. Income and Inequality Vis-a-Vis

The study found that the mean annual income of PICM was better than PNCM (Table 3), but it was identical, excluding the degraders' earnings.

**Table 3:** Annual Income of PICM and PNCM

<i>Activities</i>	<i>Number (N)</i>		<i>Annual Income in Bangladesh Taka (Mean)</i>	
	PICM	PNCM	PICM	PNCM
Legal extraction of resources	177	194	63751	62957
Illegal extraction of resources	23	6	172375	112564
Total	200	200	76243	64445

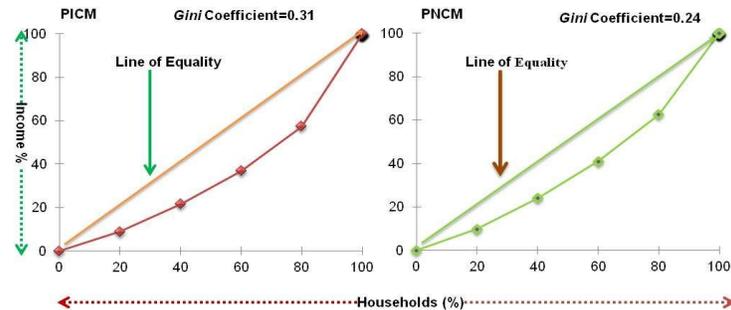
A more significant portion compared to PNCM was involved in destructive activities like clear felling (6.5%), wildlife poaching (3%), wetland poisoning (2%), and other unethical activities (**Figure 5**). Chemical pesticides, including cyanide, were being sprayed on the canal's water bodies, notably *Ramsar* Canals, to harvest a chunk of fishes, spending the quickest time for making the highest return. The poachers commonly used *Chhitka* (leg snare) to hunt spotted deer, wild boar, red junglefowl, and poisoned baits to kill the Bengal Tigers. The loggers always targeted the pioneer tree species, *Sundari* (*Heritiera fomes*), a high-value timbering tree species. The meat of spotted deer is sold at a higher price, contrasting to domestic animals. Hence, the degraders can earn many times of people involved in the legal profession. The findings showed that 11.5% of respondents of PICM engaged in illegal activities contributed to 26% of the total income. In contrast, 3% of PNCM propagated 5.24% of the total income (**Figure 6**).



**Figure 6:** Proportion of illegal professions and their contributions (%) to the total income

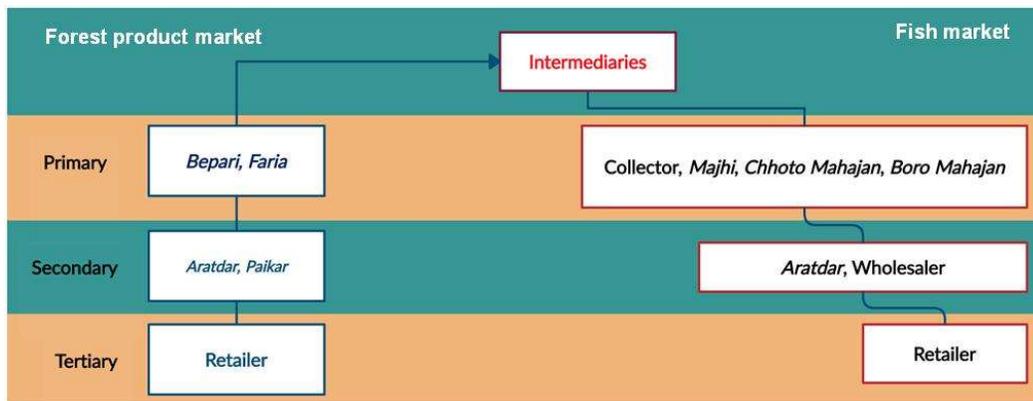
It was evident that a portion of the CPG having the legacy of access to natural resources abused the opportunities with some local elites, important folios of co-management, and few overseers'

support. The *Gini*-coefficient was greater in PICM than PNCM (Figure 7), which indicates that the abusers made a difference in propelling income inequality.



**Figure 7:** Lorenz Curve and *Gini* Coefficient for both PICM and PNCM

Howbeit, a significant portion of PICM was found working as intermediaries in the market chain (Figure 8), exploiting their local influences. The respondents identified five intermediaries groups in the market chain of forest products: *Bepari* (collector), *Faria* (assembler), *Aratdar* (storekeeper), *Bepari* (wholesaler), and the retailer. Contrastingly, the fish market chain was embroidered by the presence of collector, *Majhi* (captain of the boat), *Chhoto Mahajan* (small moneylender), *Boro Mahajan* (Big moneylender), *Aratdar*, wholesaler, and retailer. It was revealed that the incendiaries made 4-5 times the return of the source or producer. In Bangladesh, the intermediaries control the agricultural market and supply chain making higher returns without any investments (Alam *et al.*, 2021; Rahman *et al.*, 2020). The intermediaries groups in PICM also helped in income inequality. Usually, income inequality stipulates the symmetry or asymmetry of individuals' incomes of a society, analyzing the economic conditions at the individual or collective level. The co-management could not underscore reduced inequalities; instead, it helped to creep.

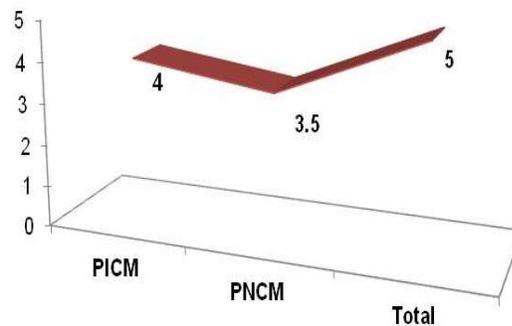


**Figure 8:** Intermediaries in the market chain

### 3.2.4. Awareness about conservation

The PICM scored better than PNCM in terms of awareness about nature conservation (Figure 9). The respondents treated the *Sundarbans* like their mother and acknowledged that they could not survive without it. They were also happy to know that they were an integral part of it, making them proud. According to their perceptions, it is essential to protect the existing plant community,

spotted deer, wild boars, birds, Bengal Tigers, and other animals. All respondents of both PICM and PNCM showed the highest score for punishing the criminals and tiger conservation though some of them were involved in poaching. The Bengal Tiger's role in ensuring equal justice and protecting this unique ecosystem was entrenched in their belief. The respondents stressed controlling loggers, poachers, land grabbers, fire orchestrators, and forest robbers. The degraders should be punished by enforcing laws neutrally and adequately. They urged for declaring the people involved in poisoning as the social, local, and national enemy. Contradictorily, the respondents show their neutral stand on catching fingerlings and juvenile fishes using gill nets interconnected with their livelihood. The arrival of more tourists, notably foreign tourists within the framework of ecotourism, was much appreciated. The respondents did not express more interest in donating funds for conservation purposes and voluntary activities. The co-management positively contributed to awareness building for nature conservation, which can be considered the highest favorable co-management outcome. Participation in nature-loving networks and various campaigns helped a little bit in increasing awareness.



**Figure 9:** Scoring for the awareness level

#### 4. DISCUSSIONS

By examining the co-management through a lens of broader environmental governance, it can be argued that co-management efforts represented mere nibbling at the edges of much more significant issues. Individualism overran there due to the community's lack of a legacy for analyzing their rights. Campbell (1990) revealed that individualism dominates when the community is not adequately legitimized to access their rights. Despite awareness-raising, the degraders' crimes showed a multi-colored picture full of confusion. Under community management's rhetoric, the degradation, notably wetland poisoning, posed an onslaught threat to the aquatic, terrestrial, amphibians, and benthic ecosystems. The destructors and the market intermediaries created "The Tragedy of the Commons" in the *Sundarbans* areas. Garrett (1968) revealed that degradation of nature caused "The Tragedy of the Commons". Therefore, the question was raised about its effectiveness in the *Sundarbans*. Poison fishing is causing severe damage to wildlife and human health hazards as it flows into the rivers and freshwater ecosystem (Hoq, 2007).

Professor Christopher Stone from the University of Southern California acknowledged the *locus standi* of nature to defend itself against damages (Stone, 1972). Progressively, many countries' legal systems have granted the right to nature for standing in court for protection. The G77 recognized the Earth and its ecosystems as is our home to live well (UN, 2014). The *Paris Agreement* has recently undertaken a shifting paradigm, where humans will live in harmony with

nature. Co-management could not restrain the poisoners, poachers, and loggers from their destructive activities. The heinous crimes against these mangrove ecosystems expound a hefty set of reasons why the legal puzzle should accept *Sundarbans*' right to stand in court. A collective effort of the majority can check the bullying and self-aggrandizing behaviors of a smaller portion. Otherwise, they will become the main selective force in human evolution (Boehm, 2011).

Since biodiversity conservation is a human effort, it depends on social actors' commitment and the level of 'open-minded localism.' Usually, biodiversity conservation relies on a vague dichotomy between the community and nature (Brechin *et al.*, 2002). The community's passive participation in planning, implementation, financing, and overall management cannot ensure participatory forest governance (Rashid *et al.*, 2016). The co-management could not bring any breakthroughs in the top-down management approach. The top-down approach cannot help avoid the commons' tragedy (Ostrom 1990, 2010). Besides, the community was also confused with the prospect of continuity of these donor-funded projects. The dearth of full and active involvement of the communities can be considered the significant loophole of co-management in Bangladesh. According to Ostrom (1990, 2010), the community must have legal jurisdiction, equal burden-sharing, and collective choice. The polycentric governance can be followed where the members must know that they are part of a group and group's objective. The community members have to agree upon decisions so that Forest Department cannot be a boss around. In monitoring and gradual restrictions, the community will detect disruptive activities and impose restrictions.

The NGO was responsible for the beneficiary selection, conducting training, offering incentives, and building awareness. The *FD* did not let NGOs go of very much control for meaningful community participation. Rashid *et al.* (2016) reported that the members of VCF were nominated based on local influences and *FD*'s desires. Likewise, the wishes and interests of *FD* was the critical determinant in NGOs' selection. Sometimes, the NGOs endorsed the prearranged decisions and directions of the department. The NGOs could always be fair in selecting the right people during the formation of committees at the implementation level. In the real sense, the co-management committee functioned as per the framework and guidelines set by *FD* (Fox and Mustafa, 2013). Therefore, both the conservation volunteers and degraders were blended simultaneously in different hierarchical committees. Other studies revealed that vested interest groups occupied various committees' key positions on many occasions, who rarely respect the laws (Chowdhury, 2013; Belal, 2013). The vested group significantly affected participatory governance's notion and zeal (Rashid *et al.*, 2016). The orchestrators remain behind the scenes but force others to fulfill their desires through illegal activities (Rahman and Alam, 2020; Rahman, 2021c, 2022). They are locally elite persons who control local politics and the economy.

It was also reported that few committee members remained absent very often in the meeting and were very reluctant to take initiatives until their interests were guaranteed (Rashid *et al.*, 2016). The formal procedures were mostly maintained just by informing and receiving approval from the chairperson (Rashid *et al.*, 2006). The avoidance of selection within groups (favoring non-cooperation) can avert the common's tragedy. The top-down approach cannot help avoid the commons' tragedy (Ostrom, 1990, 2010). Therefore, different committees' revisions to expel the

degraders and intermediaries and to include the volunteers are highly warranted. The NGOs should be selected based on their previous history, performance record, commitment, capacity strength.

Women's participation in the whole process, including planning and decision-making, was downplayed through not maintaining the preserved quota. Creating a free, fair, and neutral environment for all stakeholders is essential for effective participatory governance. Biasness overshadows the aspiration of any novel initiative. In the school of 'ecofeminism', it is believed that the woman is 'closer to nature', naturally caring for the environment. The mother may transmit 'environmental care' onto her daughters, and the women having trading capital may reduce the dependency on natural resources (Leach, 2007). Equal women's participation should be ensured by establishing a local women leader's forum and equalizing women's quota in various committees, which is cardinal for ensuring gender parity and welfare of nature.

Poor resource governance is considered one of the major bottlenecks in many forestry projects in Bangladesh. Though most of the projects somehow achieved the physical targets, they could not ensure equitable distribution of rights and share (Rahman and Akter, 2020). Land grabbing and encroachment are also significant challenges in the *Sundarbans*. By watching the incremental degradation, the community people are not confident enough to participate in the governance (Rashid *et al.*, 2016). Restoring the confidence of the community along with motivating them should be the paramount importance of *FD*.

Only co-management cannot be considered as the panacea in sustainable natural resource management. Proper enforcement of existing legislative measures and ensuring environmental justice on an equal basis may curb the degradation. Differently, violations of the laws are rampant due to the enforcer's laxity and the tendency of non-compliance (Islam *et al.*, 2018). The penalties incorporated into legislation are not imposed due to a lack of monitoring, surveillance, and lack of human resources. Weak enforcement of laws created the perception among the community that violations of the regulations punish them rarely. The core focus of management practices is accelerating revenue earning, which jeopardizes the world's unique ecosystem. The activation of the Monitoring, Control, and Surveillance (MCS) system is much more important to track the legal extraction of the resources. Forest guard lacking adequate logistics and workforce should be considered as the primary law enforcer there. The well-equipped Bangladesh Coast Guard can be assigned as the primary force for patrolling. Other forces like Bangladesh Navy, Bangladesh Police, Rapid Action Battalion, and Forest Guard may work as the supporting or auxiliary forces.

According to the existing laws, ordinary people cannot seek environmental justice without the Department of Environment's written reports and inquiry (Rahman *et al.*, 2021). Legal reform is required to build the perception that none is above the law, and anyone can seek the degraders' verdict. Departmental proceedings should be increased to deter corruption at any level as it is deeply rooted in integrity, service delivery, and performance (Mauro, 1998). Additionally, ethical education can be included in the departmental training to heighten the aspiration of patriotism and commitment to the country.

In Bangladesh, the institutional and legal framework for regulating natural resources is characterized by a fuzzy and complex arrangement (Rahman, 2021a, b, c, d, e). There are many overlapping jurisdictions among the public departments on various issues. The Department of Fisheries (*DOF*) has the overall responsibility to regulate aquaculture in the wetlands. But in the

protected areas, FD has sole authority to manage all resources, including fisheries. Therefore, a conflict of interest over wetland management between *FD* and *DOF* is more prominent. *DOF* should play the nodal role in managing the fisheries in the *Sundarbans* to balance exercising power. On the other hand, co-management empowered *FD* to restrict the change in the land category based on usage, which is an inherent legacy of the collector (Deputy Commissioner of a district). Bangladesh Tourism Board is empowered to regulate tourism in critical areas, while *FD* controls tourism in the *Sundarbans*. The conflict of interests among public departments and overlapping jurisdiction are the key challenges in coordination development and cementing cohesion. Resultantly, non-compliance with the existing laws is widespread due to a lack of coordination (Rahman, 2021). In addition, the coordination and integration mechanisms with the public departments, researchers, academicians, and NGOs are not well developed. Henceforth, establishing strong coordination among different stakeholders is a crying need to save the *Sundarbans*. The *FD* should strengthen the coordination with the *DOF*, Bangladesh Coast Guard, and Bangladesh Police to regulate the rational extraction of resources, end over-extraction, and stop illegal, unreported, unregulated, destructive extraction practices. On the other hand, SDGs' target 1.3 states, "by 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services, including microfinance. The alternative income generations like crab caging, giant freshwater prawn (*Macrobrachium rosenbergii*) culture, mixed prawn-rice culture, *nypa*-shrimp-crab culture, multi-trophic aquaculture, apiculture, and small entrepreneurship development may be testified to solve employment centric problems. The policy barriers hindering the society's full and active participation on an equal basis with others (Rahman, 2021; Akter and Rahman, 2018) should be decoupled for saving this mangrove.

It can be argued that the philosophical roots for *Sundarbans*' ecological crisis deeply rooted in the value dichotomy, where moral obligations and ecological rationality are unbefitting. Moral education among the key role players followed by meditation can pursue a great virtue creating a consensus of co-existence with nature. The concept of 'ecosophy' recognizes nature's fundamental value and resists hegemony over nature, and does not treat it as a resource (Næss, 1977). The 'Bawalis' (wood collector), 'Moualis' (honey collector), and 'Jeley' (traditional artisanal fishers) is an isolated segment from the mainstream who treat the forest as a very holy place. They also believe that God washes the forest twice a day and maintains its sanctity through tidal inundation. They consider the forest and its biological resources as part of their life and extract the resources that do not contradict sustainability and conservation principles (Titumir *et al.*, 2020). Their beliefs and values are deeply implanted with today's 'ecosophy'. Future policy initiatives should stress the application of their traditional knowledge for biodiversity conservation.

## 5. CONCLUSIONS

*Sundarbans* also acts as a "last resort" for the neighboring people's immediate needs, survival, and income. As a UNESCO world heritage and *Ramsar* site, the *Sundarbans* has become a global interest. The co-management could neither heal the common's tragedy nor check the hegemony of the degraders. According to Sullivan (2012), monetizing ecosystems unfolded from ideology, 'selling nature in order to save it' or 'saving nature in order to trade it'. In the case of *Sundarbans*, the actors' doctrine can be defined as "selling nature in order to be wealthy". The *Sundarbans* must

be legitimized to seek a verdict against the degraders together with ensuring environmental justice for all on an equal basis. Legal, policy, and institutional bottlenecks on the way to environmental justice should be cleared.

The institutional framework is not built on a solid ethical foundation. The greed, sin, and unethical thinking and practices of the actors are considered the main determinants of degradation. Therefore, only the knowledge of conservation science or sociobiology cannot help in making the right policy. Wilson (1999) emphasized the fundamental unity of all knowledge ranging from science to humanistic scholarship, known as ‘consilience’. Deep penetration of ethical scholarship and political economy is indispensable. The ideology of the traditional people can be incorporated into the policy to disseminate the concept of ‘ecosophy’. Some research works on different social aspects can be found, but the ethical crisis was rarely studied in the *Sundarbans*’ context. Further studies on different schools of humanity can help the policymakers for a deep understanding of interlinkages.

The growing commons’ awareness of conservation needs further and long-term nourishment. The creation of common-pool resource groups (CPR) can protect the *Sundarbans* and ensure polycentric governance and local autonomy. Ostrom (2010) defined local autonomy as the group having the elbow room to deal with its own affairs. CPR can restore ecological diversity and foster economic diversity to cope with the rapidly changing socio-ecological context. Co-management in Bangladesh draws attention to be rectified for responsible use of natural resources and community development. The embedded challenges should be transformed into opportunities to heal this global heritage.

## 6. REFERENCES

Akter, A. and Rahman, M. (2018),”Women with disabilities in Bangladesh: Accessibility in the Build Environment”, *Proshikhyan, A Journal of Training and Development*, Vol. 26 No. 2, pp. 1-12.

Alam, S., Rahman, M.M. and Arif, A.A. (2021) “Challenges and opportunities in artisanal fisheries (Sonadia Island, Bangladesh): The role of legislative, policy and institutional frameworks”. *Ocean & Coastal Management*, Vol 201, 105424, <https://doi.org/10.1016/j.ocecoaman.2020.105424>.

Banglapedia (2020), Sundarbans, National Encyclopedia of Bangladesh, <http://en.banglapedia.org/index.php?title=File:Sundarbans.jpg>.

BBS (2017), “*Statistical Pocket Book*”, Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Government of Bangladesh.

Belal, M.A.H. (2013), “Effectiveness of Co-management committees in Teknaf Wildlife Sanctuary”, in Fox, J., Mustafa, M.G., Bryan, R.B., Stephen, M.B., Laurie, D. (Eds.), *Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh*, USAID, Bangladesh, pp. 10-23.

Biswas, S.R. and Choudhury, J.K. (2007), “Forests and forest management practices in Bangladesh: The question of sustainability”, *International Forestry Review*, Vol. 9 No. 2, pp. 627–640.

Boehm, C. (2011), “Moral Origins: The Evolution of Virtue, Altruism, and Shame”, New York: Basic Books.

Brechin, S.R., Wilshusen, P.R., Fortwangler, C.L. and West, P.C. (2002), “Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as social and political process”, *Society & Natural Resources*, Vol. 15, pp. 41–64. doi:[10.1080/089419202317174011](https://doi.org/10.1080/089419202317174011).

Campbell, D.T. (1990), “Levels of Organization, Downward Causation, and the Selection-Theory Approach to Evolutionary Epistemology.” In: G. Greenberg & E. Tobach, editors, *Theories of the Evolution of Knowing*, 1 – 17. Hillsdale, NJ: Lawrence Erlbaum Associates.

Carlsson, L. and Berkes, F. (2005), “Co-management: Concepts and methodological implications”, *Journal of Environmental Management*, Vol. 75, pp. 65-76. <https://doi.org/10.1016/j.jenvman.2004.11.008>.

Chan, K. (2008), “Value and Advocacy in Conservation Biology: Crisis Discipline or Discipline in Crisis”? *Conservation Biology*, Vol. 22 No. 1, pp. 1-3.

Chowdhury, R.I. (2013), “Attitudes towards co-management: Is Satchari National Park a sui model for Bhawal National Park?” in Fox, J., Mustafa, M.G., Bryan, R.B., Stephen, M.B., Laurie, D. (Eds.), *Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh*, USAID, Bangladesh, pp. 24-43.

Colyvan, M., Linqvist, S., Grey, W., Griffiths, P., Odenbaugh, J. and Possingham, H. P. (2009), “Philosophical issues in ecology: recent trends and future directions”, *Ecology and Society*, Vol. 14 No. 2, Art. 22., [http:// www.ecologyandsociety.org/vol14/iss2/art22/](http://www.ecologyandsociety.org/vol14/iss2/art22/).

Cunningham, E.J., Chassels, M., Fox, J. and Mustafa, M.G. (2013), “Introduction: Tailoring collaborative conservation in Bangladesh”, in Fox, J., Mustafa, M.G., Bryan, R.B., Stephen, M.B., Laurie, D. (Eds.), *Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh*, USAID, Bangladesh, pp.204.

Fox, J. and Mustafa, M.G. (2013), “Introduction: Co-management initiatives implemented by IPAC in wetlands and forests of Bangladesh”, in Fox, J., Mustafa, M.G., Bryan, R.B., Stephen, M.B., Laurie, D. (Eds.), *Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh*, USAID, Bangladesh, pp.1-9.

Frontier, S. P.-V., D., A. Lepêtre, D. Davoult, and C. Luczak. (2008), “Ecosystèmes. Structure, Fonctionnement”, *Evolution: Sciences SUP*. Paris, Dunod.

Garrett, H. (1968), “The Tragedy of the Commons”, *Science*, Vol. 162, pp.1243-1248.

Gaucherel, C. (2014) “Ecosystem Complexity through the Lens of Logical Depth: Capturing Ecosystem Individuality”, *Biological Theory*, Vol. 9, pp. 440–451. <https://doi.org/10.1007/s13752-014-0162-2>.

Gaucherel, C. (2018), “Physical concepts and ecosystem ecology: a revival?” *Journal of Ecosystem and Ecography*, Vol. 8 No. 2.

Gauchere, C. Pommereau, F. and Hély, C. (2020), "Understanding Ecosystem Complexity via Application of a Process-Based State Space rather than a Potential Surface", *Complexity*, Article ID 7163920, <https://doi.org/10.1155/2020/7163920>.

Gauchere, C., Carpentier, C., Geijzendorffer, I.R., Noûs, C. and Pommereau, F. (2021), "Discrete-event models for conservation assessment of integrated ecosystems", *Ecological Informatics*, Vol. 61, 101205, <https://doi.org/10.1016/j.ecoinf.2020.101205>.

Getzner, M. and Islam, M.S. (2013), "Natural resources, livelihoods, and reserve management: a case study from Sundarbans mangrove forests, Bangladesh", *International Journal of Sustainable Development and Planning*, Vol. 8, pp.75–87.

Giessen, L., Sarker, P.K. and Rahman, M.S. (2016), "International and domestic sustainable Forest Management policies: Distributive effects on power among state agencies in Bangladesh", *Sustainability*, Vol. 8, pp. 335. <https://doi.org/10.3390/su8040335>.

Hoegh-Guldberg, O., Mumby, P.J., Hooten, A.J., Steneck, R.S., Greenfield, P. and Gomez, E. *et al.* (2007) "Coral reefs under rapid climate change and ocean acidification", *Science*, Vol. 318, pp. 1737–1742. DOI: 10.1126/science.1152509.

Hoq, M.E. (2007), "An analysis of fisheries exploitation and management practices in Sundarbans mangrove ecosystem, Bangladesh", *Ocean and Coastal Management*, Vol. 50, pp. 411–427. <https://doi.org/10.1016/j.ocecoaman.2006.11.001>.

Iftexhar, M.S. (2006), "Forestry in Bangladesh: An overview", *Journal of Forestry*, Vol. 104 No. 3, pp. 148–153.

Islam, M.M., Sunny, A.R., Hossain, M.M. and Friess, D.A. (2018), "Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh", *The Singapore Journal of Tropical Geography*, Vol. 39, No. 2, pp. 244–265.

Islam, M.T. (2013), "People's participation in Protected Areas of Bangladesh", a paper presented at First Asia Park Congress, 13-17 November, Sendai City, Japan (Available at: <http://www.env.go.jp/nature/asia-parks/>).

Kaiser, M.I., and Trappes, R. (2021), "Broadening the problem agenda of biological individuality: individual differences, uniqueness and temporality", *Biology and Philosophy*, Vol. 36, No. 15. <https://doi.org/10.1007/s10539-021-09791-5>.

Khan, M.F.A., Rahman, M.S. and Giessen, L. (2020), "Mangrove forest policy and management: Prevailing policy issues, actors' public claims and informal interests in the Sundarbans of Bangladesh", *Ocean & Coastal Management*, Vol. 186, No. 105090, <https://doi.org/10.1016/j.ocecoaman.2019.105090>.

Khan, N.A. (2009), "More Than Meets the Eye: Re-Reading Forest Policy Discourse in Bangladesh", *QEH Working Paper Series*, No.177, University of Oxford. pp. 40.

Leach, M. (2007), "Earth Mother Myths and Other Ecofeminist Fables: How a Strategic Notion Rose and Fell", *Development and Change*, Vol. 38, pp. 67-85. <https://doi.org/10.1111/j.1467-7660.2007.00403.x>.

Lostarnau, C. *et al.* (2011), “Stakeholder participation within the public environmental system in Chile: Major gaps between theory and practice”, *Journal of Environmental Management*, Vol. 92, pp. 2470-2478.

Mauro, P. (1998), "Corruption and the composition of government expenditure," *Journal of Public Economics*, Vol. No.2, pp. 263-279.

Millat-e-Mustafa, M. (2002), “A review of forest policy trends in Bangladesh”, *Bangladesh Policy Trend Report*, pp. 114–121.

Mitchell, S.B., Jennerjahn, T.C., Vizzini, S. and Zhang, W. (2015), “Changes to processes in estuaries and coastal waters due to intense multiple pressures—An introduction and synthesis”, *Estuarine, Coastal and Shelf Science*, Vol. 156, pp. 1–6. <https://doi.org/10.1016/j.ecss.2014.12.027>.

Mohammed, M.R., Rahman, M.M. and Islam, K.S. (2010),”The causes of deterioration of Sundarban mangrove forest ecosystem of Bangladesh: conservation and sustainable management issues”, *AAFL Bioflux*, Vol. 3 No. 2, pp. 77-90.

Muhammed, N., Koike, M. and Haque, F. (2008), “Forest policy and sustainable forest management in Bangladesh: An analysis from national and international perspectives”, *New Forests*, Vol. 36, pp. 201.

Naess, A. (1977), “Spinoza and ecology”, *Philosophia*, Vol. 7, No. 1, pp. 47–54.

Nath, T.K., Jashimuddin, M. and Inoue, M. (2015), “Bangladesh: Do Changes in Policy Ensure Good Forest Governance?” in Inoue, M., Ganesh, P. and Shivakoti (Eds.), *Multi-level forest governance in Asia: concepts, challenges, and the way forward*. SAGE, Los Angeles, pp. 21-39.

Odenbaugh, J. (2003), “Values, Advocacy and Conservation Biology.” *Environmental Values*, Vol. 12 No. 1, pp. 55–69.

Osmani, S.R., Akhter, A., Tahmeed, A., Naomi, H., Saleemul, H. and Asif, S. (2016), “Strategic Review of Food Security And Nutrition In Bangladesh”, *World Food Program*, Dhaka.

Ostrom, E. (1990) “Governing the Commons: The Evolution of Institutions for Collective Action”, Cambridge, UK: Cambridge University Press.

Ostrom, E. (2010), “Polycentric Systems for Coping with Collective Action and Global Environmental Change”, *Global Environmental Change*, Vol. 20, pp. 550 – 557.

Payo, A., Mukhopadhyay, A., Hazra, S., Ghosh, T., Ghosh, S., Brown, S., Nicholls, R., Bricheno, L., Wolf, J., Kay, S., Lazar, A.N., Haque, A. (2016), “Projected changes in area of the Sundarban mangrove forest in Bangladesh due to SLR by 2100”, *Climatic Change*, Vol, 139, pp. 279-291. <https://doi.org/10.1007/s10584-016-1769-z>.

Quasem, M.A. (2011), “Conversion of Agricultural Land to Non-agricultural Uses in Bangladesh: Extent and Determinants”, *Bangladesh Development Study*, Vol 34 No 1.

Rahman, M.M (2021), The rhetorical blue economy in Bangladesh: Analyzing the inborn regulatory bottlenecks, *Acta Aquatica: Aquatic Sciences Journal*, 8 (2): 66-73. <https://doi.org/10.29103/aa.v8i2.4775>.

Rahman MM (2021a) Assessing the progress and pitfalls of the Ministry of Environment, Forest and Climate Change in achieving SDGs in Bangladesh. *Bangladesh J Pub Admin (BJPA)* 29(2):140–158

Rahman, M.M (2021b), “Can ordinary people seek environmental Justice in Bangladesh? Analyzing through the lens of legal, policy, and institutional framework. *Bangladesh Journal of Public Administration (BJPA)*, Vol. 29 No. (2): 15-34. DOI:[10.36609/bjpa.v29i2.226](https://doi.org/10.36609/bjpa.v29i2.226).

Rahman, M.M. & Akter, M. (2020) Effectiveness of Village-Based Organization (VBO) in improving the livelihood of the rural community in Bangladesh, *Bangladesh Journal of Public Administration (BJPA)*, 28(2), 145–166.

Rahman, M.M. (2009), “Plant diversity and anthropogenic disturbances in the Sal (*Shorea robusta* C.F. Gaertn) forests of Bangladesh”, *PhD Thesis*, University of Natural Resources and Life Sciences, Vienna, Austria.

Rahman, M.M. (2020), “Impact of increased salinity on the plant community of the *Sundarbans* Mangrove of Bangladesh”. *Community Ecology*, Vol 21 No 3, pp. 273-284, <https://doi.org/10.1007/s42974-020-00028-1>.

Rahman, M.M. (2021c). Achieving Sustainable Development Goals of Agenda 2030 in Bangladesh: the crossroad of the governance and performance, *Public Administration and Policy: An Asia-Pacific Journal* 24 (2) 195-211. <https://doi.org/10.1108/PAP-12-2020-0056>.

Rahman, M.M. Alam, M.A., Rahman, M.M., Mamun, M. & Alam, A. (2020) Challenges of Artisanal Fishermen: A Case Study from Sonadia Island, Bangladesh. In: Alam, M.A., Alam, F. & Begum, D. (Eds.), *Knowledge Management, Governance and Sustainable Development: Lessons and Insights from Developing Countries*. India: Routledge, pp. 261-275. <http://dx.doi.org/10.2139/ssrn.3773504>.

Rahman, M.M. and Alam, M.A. (2020) Regulatory and Institutional framework for the conservation of coral reefs in Bangladesh: A Critical Review. In: Alam, M.A., Alam, F. & Begum, D. (Eds.), *Knowledge Management, Governance and Sustainable Development: Lessons and Insights from Developing Countries*. India: Routledge, pp. 231-244. <http://dx.doi.org/10.2139/ssrn.3794550>.

Rahman, M.M. and Vacik, H. (2010), “Vegetation analysis and tree population structure of Sal (*Shorea robusta*) forests: a case study from the Madhupur and Bhawal National Park in Bangladesh”, in Polisciano, G. and Farina, O. (Eds.), *National Parks: Vegetation, Wildlife and Threats*, Nova Science Publishers, New York, USA, pp. 193-206.

Rahman, M.M., Nishat, A. and Vacik, H. (2009), “Anthropogenic disturbances and plant diversity of the Madhupur Sal forests (*Shorea robusta* C.F. Gaertn) of Bangladesh”, *International Journal of Biodiversity Science and Management*, Vol. 5 No. 3, pp. 162-173.

Rahman, M.R. and Asaduzzaman, M. (2010), “Ecology of Sundarban, Bangladesh”, *Journal of Science Foundation*, Vol. 8, No. 2, pp. 35-47.

Rahman, M.R. and Laskar, M. (2016), “Development initiatives of the Sundarbans of Bangladesh”, *Malaysian Forester*, Vol. 79 No. 1 and 2, pp. 77-88.

Rahman MM (2021d) Biologia Futura: can co-management protect Saint Martin’s corals of Bangladesh? *BIOLOGIA FUTURA* 72, 517–527. <https://doi.org/10.1007/s42977-021-00101-4>.

Rahman MM (2021e) Regulatory Framework of Small-Scale Fishers in Bangladesh: Safeguard or Jeopardy? In: Chuendagdee, R (ed.) *Visualizing Small-scale Fisheries of Bangladesh, Too Big To Ignore* (TBTI), Canada. <http://dx.doi.org/10.2139/ssrn.3939730>.

Rahman MM (2021f) Analyzing the institutional and regulatory framework for operationalizing the blue economy in Bangladesh: Lessons from Australia. Research Square; DOI:10.21203/rs.3.rs-1163138/v1.

Rahman MM (2022) Effectiveness of the coastal and marine conservation initiatives in Bangladesh: Analyzing the drawbacks of the legal, policy, and institutional framework. *Journal of Indian Ocean Region*.

Rashid, A.Z.M.M., Craig, D., Jeffery, M. and Mukul, S.A. (2016), “Shifting paradigm of governance in the natural resources management of Bangladesh: centralist to pluralistic approach in the forest protected areas management”, in Mukul, S.A. and Rashid, A.Z.M.M. (Eds), *Protected Areas: Policies, Management and Future Directions*, Nova Science Publishers, USA.

Robertson, D.P. and Hull, R.B. (2001), “Beyond Biology: toward a More Public Ecology for Conservation”, *Conservation Biology*, Vol. 15, pp. 970-979. <https://doi.org/10.1046/j.1523-1739.2001.015004970.x>.

Robin, L. (2018), “Environmental humanities and climate change: understanding humans geologically and other life forms ethically”, *WIREs Climate Change*, 9: e499. <https://doi.org/10.1002/wcc.499>.

Sarkar, S.K. and Bhattacharya, A.K. (2003), “Conservation of biodiversity of the coastal resources of Sundarbans, Northeast India: an integrated approach through environmental education”, *Marine Pollution Bulletin*, Vol. 47, pp. 260–264. [https://doi.org/10.1016/S0025-326X\(02\)00475-7](https://doi.org/10.1016/S0025-326X(02)00475-7).

Schwartz, M.W., Hellmann, J.J. McLachlan, J.M., Sax, D.F. Borevitz, J.O., Brennan, J., Camacho, A.E., Ceballos, G., Clark, J.R., Doremus, H., Early, R., Etterson, J.R., Fielder, D., Gill, J.L., Gonzalez, P., Green, N., Hannah, L., Jamieson, D.W., Javeline, D., Minter, B.A., Odenbaugh, J., Polasky, S., Richardson, D.M., Root, T.L., Safford, H.D., Sala, O., Schneider, S.H., Thompson, A.R. Williams, J.W., Vellend, M., Vitt, P. and Zellmer, S. (2012), “Managed Relocation: Integrating the Scientific, Regulatory, and Ethical Challenges”, *BioScience*, Vol. 62, No. 8, pp. 732–743, <https://doi.org/10.1525/bio.2012.62.8.6>.

Sloterdijk, P. (2004), “*Sphären III – Schäume, Plurale Sphärologie*”, Frankfurt-am-Main: Suhrkamp.

Stone, C.D. (1972), “Should Trees Have Standing? —Towards Legal Rights for Natural Objects”, *South California Law Review*, Vol. 45, pp. 450–501.

Stotz, K., and Griffiths, P. E. (2008), “Biohumanities: rethinking the relationship between bioscience, philosophy and history of science, and society”, *Quarterly Review of Biology*, Vol. 83 No. 1, pp. 37–45.

Sullivan, S. (2013), “Banking Nature? The Spectacular Financialisation of Environmental Conservation”, *Antipode*. Vol. 45 No. 1, pp 198–217.

Titumir R.A.M., Afrin T., and Islam M.S. (2020) Traditional Knowledge, Institutions and Human Sociality in Sustainable Use and Conservation of Biodiversity of the Sundarbans of Bangladesh. In: Saito O., Subramanian S., Hashimoto S., Takeuchi K. (eds) *Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia*. Science for Sustainable Societies. Springer, Singapore. [https://doi.org/10.1007/978-981-15-1133-2\\_5](https://doi.org/10.1007/978-981-15-1133-2_5).

UN (2014) General Assembly Resolution 07/208, Harmony with Nature, A/RES/70/208, Available online: [un.org/ga/search/view\\_doc.asp?symbol=A/RES/70/208](http://un.org/ga/search/view_doc.asp?symbol=A/RES/70/208) (accessed on 12 March 2021).

USAID (2013), “Performance Evaluation of the Integrated Protected Areas Co-management Project: Democracy and Governance Components”(Available at <https://www.climatelinks.org/resources/performance-evaluation-integrated-protected-areas-co-management-ipac-project>).

VNR (2020), “Accelerated action and transformative pathways: realizing the decade of action and delivery for sustainable development”, *Voluntary National Reviews*, Bangladesh.

Wealthx (2019), “High net worth handbook”, *Wealth-X* (Available at <https://www.wealthx.com/report/high-net-worth-handbook-2019/#downloadform>).

Wilson, E. O. (1999), *Consilience: The unity of knowledge*. Knopf.

Winrock International (2015), “Climate Resilient Ecosystems and Livelihoods: Overview”, (Available at <https://www.winrock.org/>).