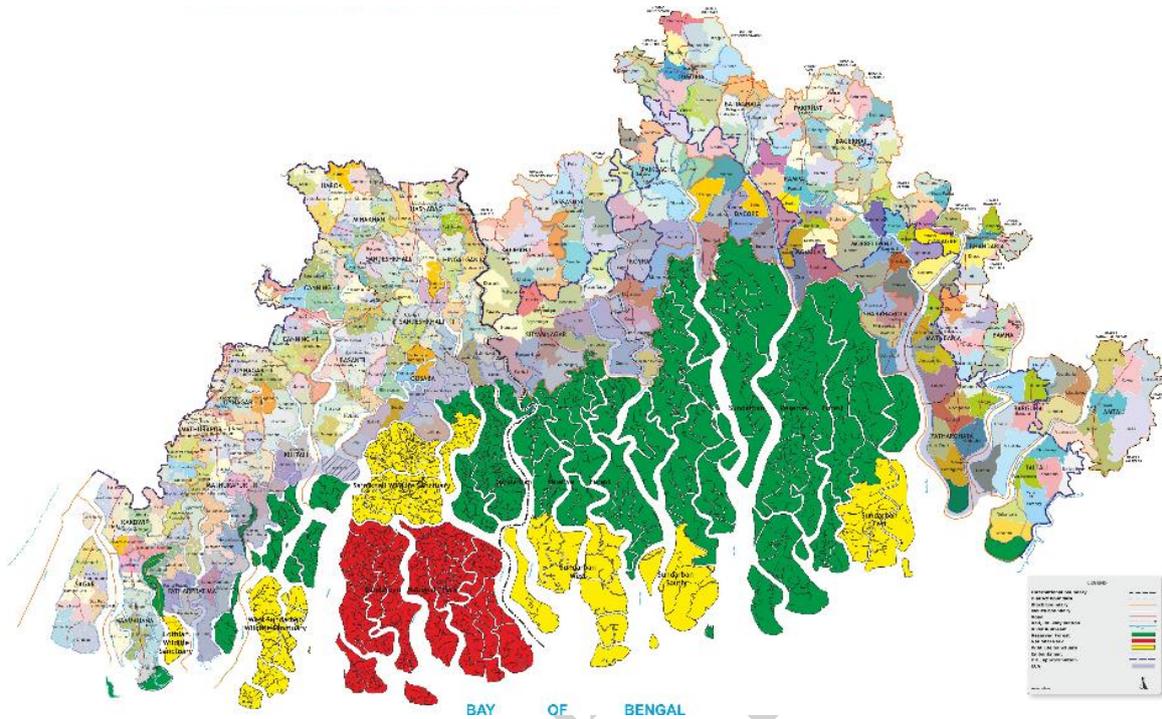


Benefits of Cooperation: Focus on the Sundarban

Identification and Assessment



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December 2018



THE WORLD BANK

Prepared for and Discussion

Acronyms and Abbreviations

BAU	Business-as-usual	MLD	Million Litres per day
CD	Community Development	MoEFCC	Ministry of Environment, Forest & Climate Change
CEM	Choice Experiment Method	MoU	Memorandum of Understanding
CESM	Centre for Ecological Services Management	MP	Market Price
CVM	Contingent Valuation Method	NCA	Natural Capital Accounting
ECA	Ecologically Critical Area	NGO	Non-Governmental Organization
EPA	Environmental Protection Agency	NPV	Net Present Value
ES	Ecosystem Services	NTCA	National Tiger Conservation Authority
FGD	Focus Group Discussions	NTFP	Non-Timber Forest Product
FSI	Forest Survey of India	PA	Protected Area
GDP	Gross Domestic Product	PES	Payment for Ecosystem Services
GSDP	Gross State Domestic Product	PF	Production Function
HP	Hedonic Pricing	PIWTT	Protocol on Inland Water Transit and Trade
IIFM	Indian Institute of Forest Management	PIWTT	Protocol for Inland Water Transit and Transport
INR	Indian Rupees	RC	Replacement Cost
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs	SIZ	Sundarbans Impact Zone
ISD	Indian Sundarbans Delta	STR	Sundarbans Tiger Reserve
IUCN	International Union for Conservation of Nature	TCM	Travel Cost Method
IWA	International Water Association	TEV	Total Economic Value
JRC	Joint River Commission	UNECE	United Nations Economic Commission for Europe
JWG-CoS	Joint Working Group on Conservation of Sundarbans	UNESCO	United Nations Educational, Scientific and Cultural Organization
KII	Key Informant Interviews	USD	United States Dollar
Lpcd	Litres per capita per day	WWF	World Wildlife Fund
MEA	Millennium Ecosystem Assessment		
UNITS			
Ha	Area in hectares	m ³	Volume in cubic metres
km ²	Area in square kilometres	kg	Weight in kilogram

Table of Contents

Section I – Introduction	1
Section II – Historical Accounts of Cooperation between Bangladesh and India	3
2.1 Historical Accounts of Cooperation	3
2.2 Cooperation on the Sundarban.....	4
2.3 Envisioning the Future of Sundarban.....	5
Section III – Models of Cooperation on Basin Management: A Worldwide View	8
3.1 Factors Behind Cooperation	8
3.2 Stages of Cooperation.....	8
3.3 Case-Studies of Co-operation and Benefit Sharing.....	10
Section IV – Review of Literature of Ecological, Economic and Socio-Cultural Issues in the Sundarban Landscape	13
4.1 Sundarbans Tiger Reserve (India)- Case Study.....	13
4.2 Economic Valuation in Bangladesh Sundarban.....	15
Section V – Framework on Economic Case for Cooperation on Sundarban	20
5.1 Types of Benefits.....	20
5.2 Perception on Benefits and Costs of Cooperation.....	22
5.3 Identification of Benefits: Focus Sundarban.....	23
Section VI - Estimation of Benefits of Cooperation on Sundarban	28
Fisheries	29
Storm Protection.....	31
Tourism	32
Cost of Non-Cooperation	34
Environmental Protection Agency (EPA), USA Benefit Categories	34
Section VII: Suggestions and Way Forward	35
7.1 Gap Areas.....	35
7.2 Way Forward.....	35
References	38

List of Figures

Figure 1: Sundarbans Eco-Region (Courtesy: Dr. Anurag Danda, WWF India)	1
Figure 2: Treaties Signed Between India and Bangladesh	3
Figure 3: Types of Cooperation (after Sadoff and Grey (2005) and UNECE (2015))	10
Figure 4: Stock and Flow Benefits from STR	14
Figure 5: Benefit Pyramid (after ten Brink, 2008).....	28

List of Tables

Table 1: Summary of Case Studies that Employed the Benefit-Sharing Mechanism	11
Table 2: Ecosystem Services Matrix of STR.....	13
Table 3: Bundle of benefits in STR	14
Table 4: Economic Values of Bangladesh Sundarban	15
Table 5: Studies on Economic Valuation of Ecosystem Services in the Sundarban Region.....	16
Table 6: Typology of Benefits.....	20
Table 7: Perception on Benefits and Costs of Cooperation on Sundarban	23
Table 8: Range of Benefits of Cooperation Across Various Sectors in the Sundarban	24
Table 9: Framework for Analysis of Economic Benefits of Cooperation	25
Table 10: Perception benefits categories for three sectors.....	28
Table 11: Economic Value of Fisheries in the Sundarban Region.....	29
Table 12: Economic valuation of fisheries for current scenario	30
Table 13: Perceived benefits of cooperation in fisheries sector	30
Table 14: Economic Value of Storm Protection in Sundarban Region.....	31
Table 15: Economic valuation of storm protection for current scenario	31
Table 16: Perceived benefits of cooperation in storm protection sector.....	32
Table 17: Economic Value of Tourism in the Sundarban Region	32
Table 18: Economic valuation of tourism for current scenario	33
Table 19: Perceived benefits of cooperation in tourism sector.....	33
Table 20: Comparison of economic benefits of current scenario and perceived benefits of cooperation.....	33
Table 21: EPA Benefit Categories.....	34

Section I – Introduction

The Sundarbans mangrove forests in Bangladesh and India are the largest continuous mangrove stretch in the world (Figure 1). It covers an area of about 9,630 km² of deltaic flood plains and is home to rich biodiversity. The Sundarban National Park in India and the Sundarban Reserve Forest in Bangladesh have been declared World Heritage Sites by UNESCO. The Bangladeshi Sundarban has also been listed as a Wetland of International Importance in the Ramsar Convention. The unique ecosystem is a delicate balance between the freshwater flows of the tributaries and distributaries of the Ganges-Brahmaputra riverine system and saline waters of the Bay of Bengal. While the Sundarbans landscape is celebrated for its ecological attributes, nearly 0.1% of the global population, amongst the poorest in the region, is directly dependent on the Sundarbans for their livelihood.

Defining the landscape of Sundarbans will aid in identifying the regions appropriately. The Sundarban region has been defined as the Sundarban Reserve Forest and the Ecologically Critical Area next to the Sundarban in Bangladesh and Sundarban Biosphere Reserve in West Bengal, India. While there is no human habitation within the Sundarban Reserve Forest, the population residing around the forest are dependant on the Sundarban. The population of the 11 upazilas in Ecologically Critical Area who are directly dependant on the Sundarban for their livelihood is around 515,718 (~ 0.5 million, BBS 2011). However, the livelihood of nearly 2 million people which mainly include fishing and allied activities from the rivers and creeks as one of the major sources of income is dependent on the Sundarban (Winrock International, 2014). Across the border, nearly 5 million in West Bengal, India, live in the buffer zone of Sundarban Biosphere Reserve. Other ways of defining the Sundarbans landscape are given in the Annexure.

As the Sundarbans region are shared ecosystems between the two countries, they provide an ideal opportunity for strategic cooperation and joint actions resulting in simultaneous poverty reduction and sustainable ecosystem management. Developing a co-management policy and implementing it jointly or individually seems to be an appropriate solution, given that 7.5 million inhabitants face similar dimensions of poverty and environmental threats.



Figure 1: Sundarbans Eco-Region (Courtesy: Dr. Anurag Danda, WWF India)

The South Asia Water Initiative (SAWI) of the World Bank has been facilitating multi-stakeholder consultations to facilitate dialogue and confidence building activities for strategic cooperation and joint actions between Bangladesh and India. Supported by SAWI, the Bangladesh-India Sundarban Region Cooperation Initiative (BISRCI) has been conceived with the explicit objective of evidence-based policy advocacy towards integrated management of the Sundarban Region resulting in economic growth through sustainable development and ecosystem management. Comprising institutions from Bangladesh and India, along with international organizations, it is a joint initiative of the International Water Association (IWA); the Observer Research Foundation (ORF), New Delhi; the Institute for Defence Studies & Analysis (IDSA), New Delhi; the Policy research Institute (PRI), Dhaka; EnGIO; and the Worldwide Fund for Nature, India (WWF)

As a part of the policy advocacy of BISRCI, a white paper outlining the economic benefits of cooperation in the Sundarban, including the costs of non-cooperation is being developed by Indian Institute of Forest Management (IIFM), with contribution from the International Water Association. The paper is based on a series of meetings and consultations involving the participation and contribution of civil society organizations, research organizations, government officials, private sector representatives and local inhabitants from in Khulna and Dhaka, Bangladesh and Kolkata, Kakdwip and New Delhi, India held over a period from January 2015 - December 2018.

The main objective of this paper is to develop a framework on the Economic Case for Cooperation on the Sundarbans and qualitative and quantitative assessment of benefits of cooperation (or costs of non-cooperation) based on literature and secondary information. The paper identifies several past interventions on Sundarban where the areas for cooperation between two countries have been carved out and also identifies gaps in economic valuation of different ecosystem services of Sundarban. Thus evaluating these less understood services will create opportunities for broadening the areas for bilateral cooperation. In addition, the report reveals that economic cases for cooperation in the Sundarban regions can initially be explored in tourism, fisheries and storm protection sectors. It also enlists various issues on which extensive research is required in future so as to develop a judicious management plan for the said ecosystem.

This document is arranged in five sections. Section II describes different stages of cooperation between countries who share an ecosystem as defined by different experts. The section also shares brief case studies on transboundary cooperation across the world. Section III gives a summary of literature on economic valuation of the Sundarban ecosystem. Section IV identifies the different benefits of cooperation and puts together a framework for benefits of cooperation on the Sundarban. The last segment, section V estimates the benefits of cooperation of the Sundarban.

Section II – Historical Accounts of Cooperation between Bangladesh and India

2.1 Historical Accounts of Cooperation

Cooperation between India and Bangladesh started with the first treaty 'India-Bangladesh Treaty of Friendship, Cooperation and Peace' signed in 1972. This paved the way for building further relations in various sectors including trade, water allocation and transportation. There are around 100 MoUs between Bangladesh and India and some of those relevant to Sundarban are mentioned below (Figure 2) and their brief summaries of agreements.

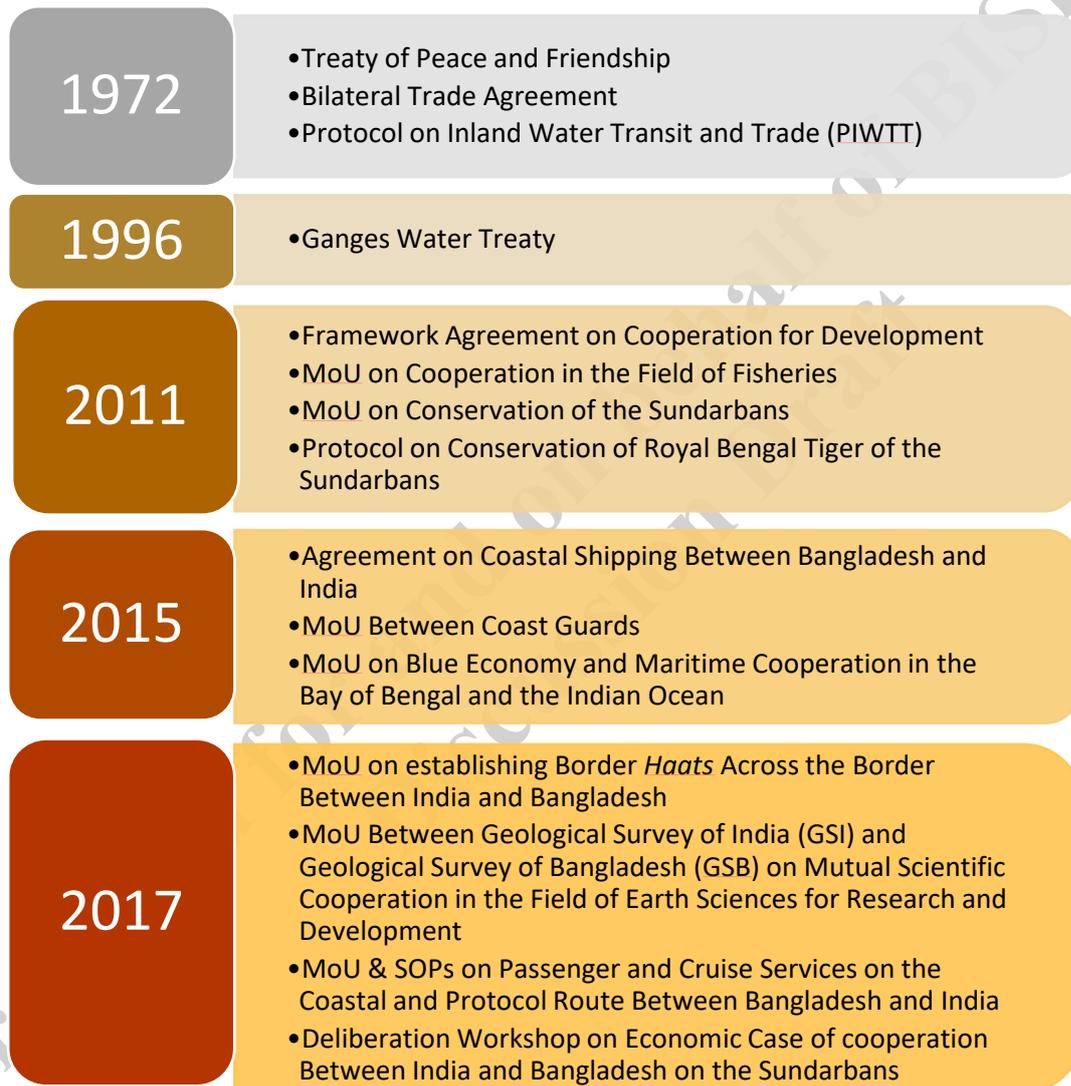


Figure 2: Treaties Signed Between India and Bangladesh

The **Treaty of Peace and Friendship** was signed between the Government of India and the Government of the People's Republic of Bangladesh in March 1972 to promote the ideals of peace, secularism, democracy, socialism and nationalism. The **Trade Agreement Protocol** was signed in 1972 with the objective of organizing trade on a state-to-state basis as far as possible. The agreement was part of efforts for mutual cooperation, achieving desired strength in economic relations between the two countries.

In December 1996 both the countries signed the **'Treaty on Sharing of the Ganges Waters'** at Farakka. The mutual agreement provided an arrangement for sharing of the Ganges waters at Farakka in a spirit of mutual accommodation and the need for a solution to the long-term problem of augmenting the flows of the Ganges. The Memorandum of Understanding for increasing **'Cooperation in the Field of Fisheries'** was signed in 2011. Additionally, in 2011 both the countries have agreed on a **'Framework Agreement on Cooperation for Development'**. This framework reiterates their common objective of promoting trans-border cooperation in the management of shared water resources, hydropower potentials and ecosystems and in the areas of connectivity and trade and economic cooperation.

The trade agreement of 1972, led in turn to the signing of the Indo-Bangladesh Protocol on Inland Water Transit and Trade, this was a big step in the revival of inland water transport in eastern and north-eastern India. During the June 2015 visit of the Indian Prime Minister to Bangladesh, the two countries renewed the Protocol. The MoU of 2015 in the field of **'Blue Economy and Maritime Cooperation in the Bay of Bengal and the Indian Ocean Region'** was to reinforce neighbourly relations recognizing that both countries border the Bay of Bengal and are littoral states of the Indian Ocean. In 2015, an agreement was signed on **'Coastal Shipping'** to carry out coastal movement of goods between the two countries. Another relevant MoU is on **'Judicial Training, Navigation and Earth Sciences'** for training and capacity building programme for Bangladeshi judicial officers in India. An MoU was signed between the Geological Survey of India (GSI) and Geological Survey of Bangladesh (GSB) on **'Mutual Scientific Cooperation in the Field of Earth Sciences for Research and Development'**. India and Bangladesh have set **'Standard Operating Procedures (SOPs) for Passenger and Cruise Services on the Coastal and Protocol Route'** between the two countries. The SOPs are in pursuance of the MoU signed between the two countries in 2015 with a view to make mutually beneficial arrangements for the use of their waterways. Further, the "Neighbourhood First" and "Act East" policies of the Government of India place strong emphasis and accord priority to development of stronger economic ties with neighbouring countries and beyond, both bilaterally and regionally.

The most prominent for Sundarban was the MoU signed in 2011 that seeks to facilitate **'Cooperation in the Areas of Conservation of Biodiversity'**. The MoU addresses joint management of resources, livelihood generation for poverty alleviation and development, documenting local biodiversity including both flora and fauna and studying the impacts of climate change.

A MoU for **'Conservation of the Royal Bengal Tiger of the Sundarbans'**, MoU was signed in 2011, it provides for bilateral cooperation in undertaking scientific research, knowledge and sharing. It also includes patrolling of Sundarban waterways on the respective sides of each country to prevent poaching or smuggling of derivatives from wildlife and bilateral initiatives to ensure survival and conservation of the Bengal Tiger in the unique ecosystem of the Sundarban. This protocol also provides for cooperation to further promote understanding and knowledge of Royal Bengal Tigers, exchange of personnel for the purpose of training and promotion of education.

2.2 Cooperation on the Sundarban

With multiple treaties signed between the two nations, the shared Sundarban region has a possibility where it is developed sustainably and managed as one ecosystem. signed by both countries in 2011. The MoU's "Conservation of the Sundarban", and a "Protocol on Conservation of the Tiger in the Sundarbans" are anchored within the Ministry of Environment, Forest and Climate Change (MoEFCC) of Bangladesh and India. As a first step towards implementing this MoU, the 1st meeting of the Joint Working Group on Conservation of Sundarban comprising officials from India and Bangladesh took place on Thursday, July 21, 2016, at New Delhi, India. The Joint Working Group of the Sundarban has also discussed a set of nine activities that the two countries can perform together. These are:

They are:

1. Sharing of knowledge of flora and fauna in both parts of Sundarbans through a biodiversity mapping and evaluation study
2. Water quality monitoring of important rivers terminating in the Sundarbans region and ultimately to the Bay of Bengal for both countries through a standard methodology and standard parameters solely for the management of the Sundarbans ecosystem
3. Siltation trend analysis of rivers terminating in the Sundarbans region of both countries and generation of timeline data for future studies and assessments solely for the management of the Sundarbans ecosystem
4. Discussion on
 - i. Sharing of intelligence on smuggling of animals and wildlife products
 - ii. Inviting forest officials to regularly attend meetings on security issues held by forces
 - iii. Officials of India and Bangladesh holding periodic meetings on either side of the Sundarbans alternately, to share management strategies and create common approaches as envisaged in the MoUs
5. Discussion on reserving seats for personnel from Bangladesh in the nine months Diploma course in the Wildlife Institute of India, Dehradun
6. Illegal exploitation of marine biodiversity using harmful gears
7. Measuring the scale of dependency of the adjacent community on the Sundarban ecosystem
8. Study on the Sundarban dependent community and their alternative livelihood
9. Joint identification of research need, joint research and incorporation of research findings in the Sundarban management practice for the whole Sundarban ecosystem

More recently, during a three-day state visit to New Delhi from April 7–10, 2017, the Prime Ministers reiterated their commitment to regional cooperation through signing of different agreements and MoUs which support the vision for greater connectivity and integration in the South Asian Region.

2.3 Envisioning the Future of Sundarban

The Sundarban landscape is under rapid changes due to major drivers such as climate, sea-level rise, temperature change, changes in precipitation and cyclone activity, population and market growth. It is important to identify the host of drivers that lead to mangrove degradation as this will aid in developing sustainable management goals.

Climatic Change: According to the Global Climate Risk Index (2015), both Bangladesh and India were amongst some of the worst impacted countries by climatic events like floods, droughts and cyclones in the last decade. Within both countries the Sundarban region is the most vulnerable to global climate change and sea level rise in addition to other anthropogenic and natural disasters.

Over-Exploitation: The areal extent of the forest has remained more or less unchanged over the last few decades. However, a substantial decline in *H. fomes* has been reported – around 76 per cent since 1959 – and about 70 per cent of the remaining *H. fomes* trees are affected by the top dying disease. Additionally, the use of destructive fishing practices in both countries has impacted other species and juvenile species that use the mangroves as nursery grounds thus affecting the fish stocks.

Land Use Change Related to Shrimp Farming: Over the last few decades, shrimp farming has emerged as an important industry in the coastal region of Bangladesh and India. However, unplanned and unregulated practices in shrimp aquaculture have led to land degradation. This is mostly due to the

nature of shrimp culture which requires letting in saline water into empoldered shrimp beds. The practices of shrimp farming have caused increased water and soil salinity, massive loss of crop production, loss of fruit, loss of indigenous floral species and freshwater crisis for drinking.

Coastal Development Activities: Coastal development activities such as seaport construction and transportation of cargo and movement of vessels destroy the natural waterways. Numerous ships containing cargo such as goods, coal, fly ash, heavy oil have been reported to have collided and sunk thus polluting the waterways and affecting the benthic flora and fauna.

Reduction of Freshwater Flow: The Ganges river which provided freshwater to the system has been reduced drastically due to the Farakka barrage. This has resulted in increased salinity in forest regions and high salt deposition in lower reaches (Anirban et al., 2018). Along with this, continuous cultivation of crops has led to increased salinity in the land and rendered it unsuitable for further crop cultivation.

Cyclonic Impact on Forests: A total of 525 cyclonic storms have been recorded from 1877 – 2016 (S. Bandyopadhyay et al., 2018). Such recurring events have caused constant damage to livelihood activities and driven fishers to a state of poverty. The recent Cyclone Aila caused immense damage where 80% of regional workers lost their jobs and villagers were forced to change their professions (Mallick et al., 2011).

Governance Issues: Both Bangladesh and India, have in place progressive policies and regulation for conservation and management of the Sundarban. However, the study done by Islam et al. (2018) highlighted that illegal and destructive fishing practices, illegal logging, and poaching of wildlife was prevalent.

Tourism: The natural beauty of the Sundarban has been attracting a steadily growing number of visitors in both countries. Tourism has brought some revenue for the forest department and the local people have benefited from the opportunity (Uddin et al., 2013). Some work as tour guides, boat men, sell groceries and commodities (Salam et al., 2000). It was also found that there is unregulated tourism where tourists do not adhere to rules and regulations and this causes disturbances to the natural settings of the forests.

In order to develop strategies to ensure a long-term sustainability of the Sundarban ecosystem, both countries have developed vision documents. The goals envisage issues pertaining to governance structure, biodiversity conservation, management of human settlement and development of alternative livelihoods, sustainability of the delta's ecosystems, water availability and climate security. The Indian vision document focuses on the well-being of the communities and their economic activities, improvement of the forest ecosystem and encouragement of a phased-out migration through creating economic zones outside the Sundarban. Whereas, the Bangladesh visions aims at the sustainability and conservation of the natural resources, their ecosystem services and the well-being of the community in the existing mangrove forest.

The country-specific visions for Sundarban have been briefly mentioned below:

Indian Sundarbans Delta Vision 2050

To restore the mangrove forests to conserve ecosystems and ensure ecosystem services, including biodiversity, serious alterations in the strategy for the management of the Indian Sundarban Delta (ISD) are needed. A four phase approach will improve the human development, prevent avoidable loss of life and livelihood due to high intensity weather events, partial reversal of ecosystem degradation and improvement in ecosystem services (Danda et al., 2011). These are:

1. Identification of the 19 Community Development blocks as a single administrative unit aka 'Biosphere District' and accountability of the roles by the various stakeholders leading to a formation of improved governance structure for the region.
2. Development of physical infrastructure to allow the younger generation to secure opportunities for growth of human capital and allow restoration of mangrove forests that are delineated up to the tidally active creeks.
3. Provide strong financial inducements and compensation for the population migrating to newly developed areas and make use of the infrastructure there to enhance their human, social, political, financial and physical capital. Additionally, the population or sections thereof could continue to live at their current locations should they choose to.
4. Unused land by current access right holders should be restored as mangrove forests (about 1190 km² of restored forests by 2050). Beyond 2050, investments should only be made for ecosystem restoration.

Bangladesh Sundarbans Delta Vision 2050

The growing human activities, shrimp farming and deforestation of the mangroves had called for a long-term vision backed by integrated management. The vision goal of Bangladesh Sundarban is that "by 2050, the Sundarban delta is rich in biodiversity and highly capable of extending sufficient ecosystem goods and services, to provide sustained social, economic and environmental benefits to the neighbouring communities, nation and beyond, for present and future generations, under a changing climatic scenario."

The strategies to achieve these goals are:

1. Improvement in governance structure
2. Enhancement of appropriate mechanisms and information systems for sustainability of the Sundarban ecosystem services
3. Increase freshwater availability
4. Reduce pollution threats from all sources
5. Implementing suitable measures to reduce climate change impacts
6. Enhance alternative livelihood options

Both countries need a multi-level institutional framework to implement the Sundarban vision and subsequent management of resources and ecosystem services. There is also a need for strengthening the capacity of government agencies, augmenting mechanisms for collaboration and knowledge exchange between Bangladesh and India.

Section III – Models of Cooperation on Basin Management: A Worldwide View

Cooperation of countries with transboundary ecosystems and resources presents complex challenges due to varying interests, population behaviour, and management strategies. Most shared ecosystems relate to issues in shared river basins, mostly regarding water allocation aspects. In theory, cooperation seems obvious. However, cooperation in the real world is difficult (Dinar, 2004). Apart from the tragedy of the commons and power asymmetry, there also exist other financial, institutional, psychological and political barriers to cooperation. Cooperation is affected by economic capabilities of the riparian nations. Poorer the riparian, less are the resources to devote to cooperative initiatives. Additionally, the costs of implementation of transboundary institutions are high and it might be difficult to raise funds or divide the costs of the collaborative or joint activities among the riparian nations (Mirumachi and Allan, 2007). Domestic political necessities and commitments often restrict options for countries regarding transboundary water cooperation (Turan and Kut, 1997). Also, in case of transboundary cooperation, perceptions are of major importance. Perception about benefits and benefit-sharing may be distorted by historical tensions, suspicions and inaccurate and asymmetric information which can hinder the cooperation process (Grey, 2016).

3.1 Factors Behind Cooperation

Even with so many hindrances, sustainable efficient outcome can be achieved through joint cooperation or collaborative actions among countries on multiple issues with reciprocal benefits (Allan, 2002, Just and Netanyahu, 2004, Dinar, 2004). Cooperation may also be influenced by the following factors, which are mostly political:

- Image a country wishes to have,
- International laws,
- Linkages as agreement on the river may be used to gain concession for other issues,
- Reciprocity and
- Sovereignty of the riparian nations (LeMarquand, 1976)

Significance of the ecosystem within a country also influences cooperation and greater the significance, the more likely is the cooperation (Dinar, 2004).

3.2 Stages of Cooperation

Sadoff and Grey (2005) stipulate a four-mode continuum of the cooperation process. These are: (shown in Figure 3)

- i. Unilateral action (independent, non-transparent national plans),
- ii. Coordination (communication of information on national plans),
- iii. Collaboration (adaptation of mutually beneficial national plans through consultation),
- iv. Joint action (joint plans and project development and management)

On similar lines, UNECE Policy Guidance Note on Benefits of Transboundary Cooperation, 2015 has set out four stages of development of the transboundary cooperation process, namely;

- i. Pre-Initial Phase
- ii. Initial Phase

- iii. Intermediate Phase
- iv. Advance Phase.

Unilateral Action

Unilateral action refers to non-cooperation. Unilateral action has the potential to harm other nations and may result in serious international tension (Mostert, 2005). For example, Farakka Barrage, built by India in the 1960s, restricted natural water flow to Bangladesh resulting in adverse effects (Wolf et al., 2003). This corresponds to the pre-initial phase in the UNECE framework.

Coordination

The coordination stage starts with collective gathering and sharing of information among the countries involved in the process. In the UNECE framework, it corresponds to the initial phase. The focus at this stage should be identification of the full range of the benefits of cooperation. The examples include cooperation between Azerbaijan and Georgia in Kura River Basin, Estonia and the Russian Lake Peipsi Area (UNECE, 2015; Barnes et al, 2009).

Collaboration

When national plans and actions are adopted to generate mutually beneficial gains or mitigate harm, the process is at the collaboration stage. This stage is referred as the intermediate phase and is characterized by ongoing negotiation process or agreement. Examples includes, the Niger Basin Water Charter and the Sustainable Development Action Plan (SDAP) and its associated investment programme (Tignino, 2016), Cooperation on Great Lakes between Canada and USA (UNECE, 2015).

Joint Action

Joint action occurs when countries work as partners to design, invest and implement the transboundary project and characterized by development of institutional bodies and correspond to the advance stage in the UNECE framework. One of the leading examples is the International Commission for the Protection of the Rhine. Today, as a result of joint action, 96% of population in the river basin is connected to water treatment plants, animal and plant species have increased and so have the migratory fishes, flood plains have been reactivated (UNECE, 2015).

For each basin or ecosystem, the optimal mode may differ as it mainly depends on a mix of factors including: hydrologic characteristics, the economics of cooperative investments, number of riparian and relationships among them, and cost of cooperation.

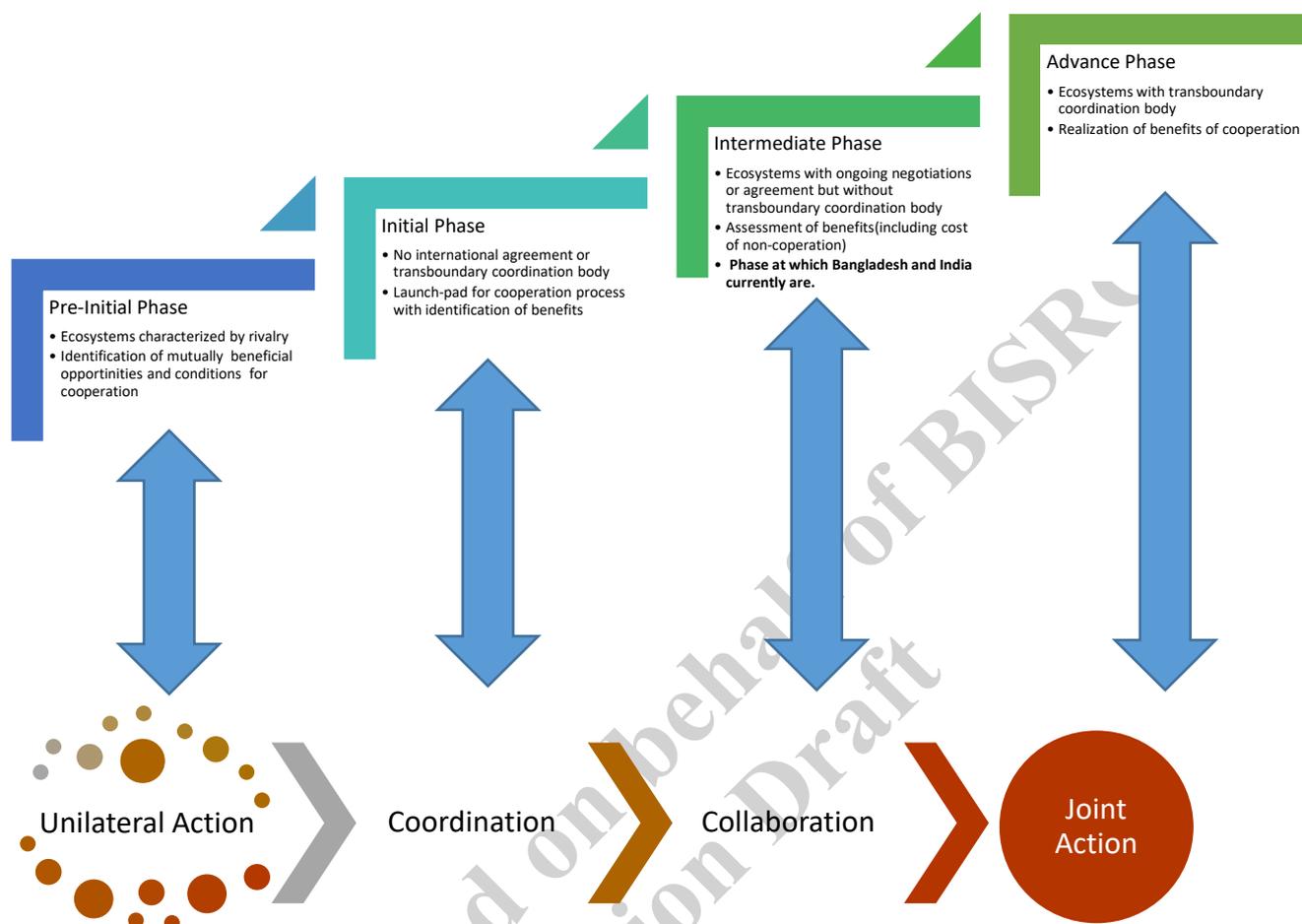


Figure 3: Types of Cooperation (after Sadoff and Grey (2005) and UNECE (2015))

The cooperation on Sundarban between Bangladesh and India is at the intermediate stage with some level of coordination. Although some progress has been made, the two countries present one of the least integrated parts in the world with regard to policy, trade, and infrastructure. This lack of integration directly affects economic development and hampers management of shared natural resources, such as forests and cross-boundary river basins. Given the cases of cooperation across the globe, there is considerable hope and scope for bilateral coordination or joint action on the Sundarban. The Sundarban spread across Bangladesh and India needs to be visualized as a single biogeographical entity and that bilateral research and cooperation be promoted to inform joint action for sustainable development and conservation of the Sundarban landscape. However, thus far, the pattern of governance at the national and especially regional level in the Sundarban region has struggled to keep up with the management and development challenges posed by this complex system. Fostering cooperation in the Sundarban needs to be based on the understanding that the benefits of cooperation are seen to outweigh those of unilateral action.

3.3 Case-Studies of Co-operation and Benefit Sharing

There are many examples of cooperation around the world. Table 1 shows the summary of case studies highlighting the important aspects of benefit-sharing.

Table 1: Summary of Case Studies that Employed the Benefit-Sharing Mechanism

Case Study	Area	Highlights
Mekong River Basin	South East Asia	<ul style="list-style-type: none"> • Emphasis on hydropower generation, agriculture and trade • Development gap between China and countries • Benefits included improved water quality, biodiversity conservation, energy and food production, economic integration
Amu Darya Basin	Central Asia	<ul style="list-style-type: none"> • Tajikistan’s proposed hydropower plant’s impact on downstream agriculture • Model for scenario development based on interests of 5 countries • Cooperative schemes based models and country priorities • Compensation mechanisms need to be developed for downstream countries
Advancing Local Benefit-Sharing in West Africa	Western Africa	<ul style="list-style-type: none"> • West African countries have over one hundred large dams and they aim to build more. In the context of sustainable development, benefit-sharing helps to address the frequent disconnect between national and local development • Benefit-sharing mechanism for dams among 16 countries • Benefit-sharing through legal and policy framework • Multi-stakeholder dialogue platform • Linking to existing initiatives promoting dam planning and management in IWRM river basin management context and knowledge-sharing with other West African states
The Guiding Principle for the Wadden Sea: Advantages of a Dynamic Approach in a Changing World	Wadden Sea	<ul style="list-style-type: none"> • “Wadden Sea Network” playing a key role in its restoration consisting of local people, scientists and non-scientists, governmental and non-governmental organizations, professionals and amateurs who have worked for more than a century for its protection • Guiding Principles of the Trilateral Cooperation acting as an umbrella for management activities • Set of regulations and management framework developed specifically for the Wadden Sea
Joint Infrastructure and the Sharing of Benefits in the Senegal and Niger Watershed	Senegal Basin and Niger Basin in West Africa	<ul style="list-style-type: none"> • International agreements signed to establish transboundary cooperation in the basin among riparian states • Internalizing regional cooperation in policy, institutional and legal framework and adopting several international treaties • Sharing of benefits was kept in focus to put interests of community into concrete practice • Shared Vision approach incorporated along with principles of integrated water resources management • Community of interests and rights through “common works” around shared resources and embracing a communal, integrated approach to managing them • In the Senegal basin, joint ownership of the dams through the OMVS substantiate transboundary cooperation on the management of water infrastructure • Innovative techniques for management of collective water infrastructure and to be co-owned and co-managed as works of common interest

Case Study	Area	Highlights
Benefit-Sharing Opportunities in the Nile Basin (Nile Basin Initiative)	Nile Basin (Eastern Africa)	<ul style="list-style-type: none"> • Shared Vision: Sustainable socio-economic development through the equitable utilization and benefit from, the common Nile Basin Water Resource. Facilitating regional cooperation and Water Resources Management and Development • The Subsidiary Action Programmes has a three-point agenda: • Power Interconnection between riparian countries • Food security: irrigated agriculture • Livelihood centred watershed management • Through policy framework, water resources analysis, data-sharing, and basin-monitoring • Manifold advantages of cooperation: reducing costs, optimization of resources and planning, better financing options, fostering cordial relations between neighbours and increase intra-regional trade
Denmark and Baltic Sea Cooperation	Baltic Sea (Europe)	<ul style="list-style-type: none"> • Two priorities: to protect the environment and climate, as well as to create growth in a broad sense. Aims at reinforcing cooperation within this large region by working together, as well as promoting a balanced development in the area. • The strategy also contributes to the implementation of major EU policies and reinforces the integration within the area. • Implemented by means of Flagship Projects and contributing projects, which have a macro-regional impact and are based on joint initiatives involving partners from different countries.

Section IV – Review of Literature of Ecological, Economic and Socio-Cultural Issues in the Sundarban Landscape

As Sundarban mangrove forest has been widely studied by numerous stakeholders and institutional set ups in various sectors including socio-economic development, landscape research, cultural and political aspects. These studies have been done by academic and research institutions, international agencies mostly at the national level. Thus most of this literature focuses on only one part of the forest. Though the complete picture across the Sundarban landscape is not available but a few independent sites have been conducted across the Indian and Bangladesh side on various ecosystem services which are presented below:

4.1 Sundarbans Tiger Reserve (India)- Case Study

(Case study adapted from: Economic Valuation of Tiger Reserves in India, Verma et al. (2015))

Sundarbans Tiger Reserve (STR) is situated in the state of West Bengal (India), about 100 kilometres from the city of Kolkata. All the services emanating from STR are vital for maintaining the ecological balance and human well-being. STR forests also provide active carbon pools which perform a storage and sequestration function. They are a habitat for a plethora of species and recreation value to tourists. Apart from these mentioned services, STR provides crucial services which reflect the uniqueness and significance of the area (Verma et al., 2015).

Valuation Estimates from Ecosystem Services Emanating from STR

Following is the ecosystem service matrix of the ecosystem services (Table 2) emanating from Sundarbans Tiger Reserve (India).

Table 2: Ecosystem Services Matrix of STR

Ecosystem Service	Annual Flow Values in Million USD/Year and (million INR/Year)	Importance for the Landscape
Employment Generation	0.06 (3.75)	Livelihood linkages and supporting local economy
Fishing	25.10 (1600)	Livelihood linkages and food provisioning
Non-Wood Forest Produce (NWFP)	0.09 (5.50)	Livelihood linkages and food provisioning
Gene-Pool Protection	45.02 (2870)	Biodiversity protection (insurance value) and provisioning of local medicines
Carbon Sequestration	7.25 (462.08)	Active carbon sinks
Nutrient Retention	46.59 (2970)	Sustaining the nutrient cycle
Biological Control	1.59 (101.51)	Regulation of diseases, pests and pathogens
Moderation of Extreme Events	4.31 (274.83)	Prevention of damages from potential disasters
Pollination	4.34 (276.84)	Providing a habitat to pollinator species, can be associated to crop production in the region
Nursery Function	81.10 (5170)	Providing breeding grounds to sustain fish population

Habitat For Species	5.65 (359.89)	Providing unique bio-geographic features for floral and faunal species
Recreation	0.58 (37)	Boosting tourism of the area, supporting local economy
Gas Regulation	1.74 (110.74)	Maintaining air composition (preventing pollution) and oxygen production
Waste Assimilation	23.53 (1500)	Waste assimilation function for nearby areas/cities like Kolkata

*average 2015 USD rate,1 USD = 63.75 INR

Ecosystem Benefits Bundle

The Sundarbans Tiger Reserve contains ecosystem stock which perform vital ecological functions. The benefits of these functions play an essential role in the maintenance of human well-being. The quantum of flow benefits (Figure 4) (ecosystem services) generated spreads to various spatial scales. Approximately 16 per cent of flow benefits accrue at the local level, 39 per cent at the national level and 44 per cent at the global level.

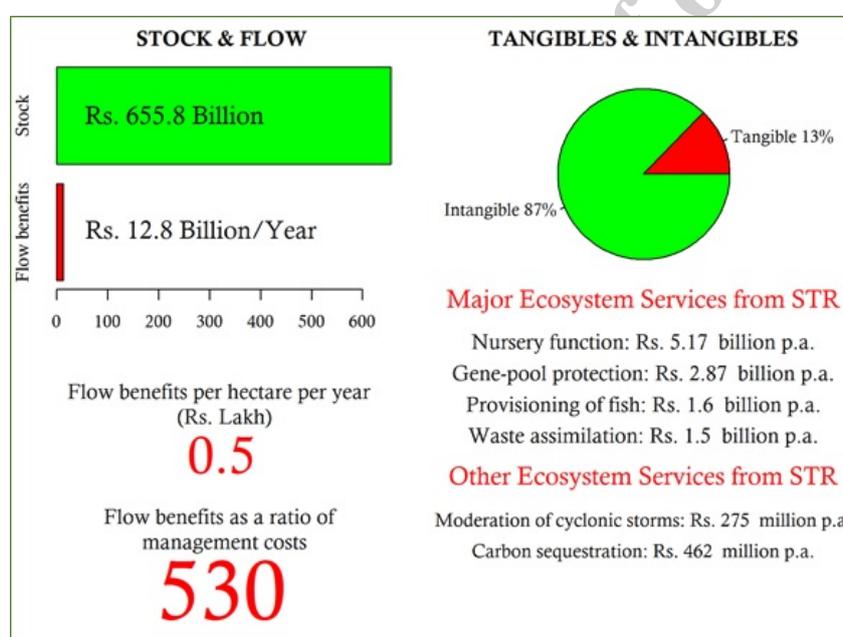


Figure 4: Stock and Flow Benefits from STR

Ecological functions provide complex benefits. These benefits come in bundles and can be categorized into different frameworks. As per the Millennium Ecosystem Assessment Classification bundle of benefits can be represented as:

Table 3: Bundle of benefits in STR

Type of Value	Value	
	Million USD/Year	Million INR/Year
Provisioning Services	70.77	4511.72
Employment Generation, Fishing, Non-Timber Forest Produce, Gene-Pool Protection		
Regulating Services	129.50	8255.89

Carbon sequestration, Nutrient cycling / retention, Biological control, Moderation of extreme events, Pollination, Nursery function, Habitat / refugia, Gas regulation, Waste assimilation		
Cultural Services	0.58	37.00
Cultural heritage, Recreation, Spiritual tourism, Research, education and nature interpretation		

4.2 Economic Valuation in Bangladesh Sundarban

A few studies in Bangladesh Sundarban on economic valuation have been done. Studies by Uddin et al. (2013), Khanom and Buckley (2015) and Rahman et al. (2018) have tried to estimate the values of provisioning services (mainly fisheries, timber, fuelwood, honey, fodder, wax and construction, thatching materials), regulating services (storm protection, erosion control), supporting services (nursery and habitat function) and cultural services (tourism). Table 4 shows the estimated values of ecosystem services from these studies.

Other studies in ecosystem services were based on perception on the benefits of mangroves, influence on livelihoods, assess climate change effects on deterioration of ecosystem services, value chain of marketed products and remote sensing assessment of Sundarban reserved forest.

Table 4: Economic Values of Bangladesh Sundarban

Ecosystem Services	Economic Value (Million USD/Year)
Provisioning Services	
Fisheries (fish, crab)	0.2 –356
Timber	0.4
Fuelwood	0.06 –29
Honey	0.011 - 19.25
Fodder	9.51
Wax	0.004
Construction materials	0.06
Regulating Services	
Storm protection	4.59
Erosion	0.75
Supporting Services	
Nursery and habitat function	3.27
Cultural Services	
Ecotourism	0.042 - 5

Table 5 further summarises different studies of ecological, economic and socio-cultural issues in the Sundarban.

Table 5: Studies on Economic Valuation of Ecosystem Services in the Sundarban Region

Author (Year)	Experts Involved / Region of Study	Study Objectives	Economic Value	Domain / Sector	Ecosystem Services (Provisioning - P, Regulating - R, Supporting - S, Cultural - C) - Ecosystem Function
Islam et al. (2018)	Bangladesh, International / Bangladesh Sundarban	The natural and anthropogenic drivers of change that affect the ES of Sundarban were identified. 90 interviews, 6 FGDs and 15 KIIs were done in three fishing communities on the following themes: socio-economic profile, extent of their perceived dependency on mangrove ES, perceptions of natural and anthropogenic environmental changes in the forest and their influence on livelihoods	Not assessed	Economics	P- Timber, fuelwood, fish, crab, thatching materials, honey, wax; C- Tourism
Rahman et al. (2018)	Bangladesh, International / Bangladesh Sundarban	Eighteen ES provided by Sundarban mangroves as perceived by local coastal communities in three villages (100 households) and their monetary value were estimated through different contexts (resource use, land use, socio-economic status, natural disasters, drivers of change)	Fishery (USD 976 per ha), fuel energy (USD 80 per ha), honey (USD 53 per ha), fodder (USD 26 per ha), storm protection (USD 13 per ha), erosion control (USD 2 per ha), nursery function (USD 9 per ha)	Economics	P- Fishery, fuel, honey, fodder, brackish water supply, Construction materials; R- storm protection, erosion, flood & flow control, gas & climate regulation; S- nursery, habitat for wildlife; C- aesthetic, ecotourism, heritage, spiritual
Suckall et al. (2018)	India, International, Bangladesh / Sundarban	The study presents a framework to identify trade-offs between long-term adaptation strategies in deltas using a three-step process, 1. identify current policy-led adaptations actions, 2. develop future adaptation policy directions, and 3. explore trade-offs that occur with each policy direction. The broad objective of adaptations were to reduce socio-economic vulnerability, address disaster risk reduction and actions that affect landscape/ecosystem resilience	NA	Policy development	NA

Author (Year)	Experts Involved / Region of Study	Study Objectives	Economic Value	Domain / Sector	Ecosystem Services (Provisioning - P, Regulating - R, Supporting - S, Cultural - C) - Ecosystem Function
Uddin et al. (2013)	Bangladesh, International / Reserve Forest - Bangladesh Sundarban	The study estimated the values of provisioning (USD 744,000 per year) and cultural (USD 42,000 per year) services between the year 2001-2002 to 2009-2010. The study used the data from the forest department to arrive at the annual economic revenue generation for the services	Timber (USD 0.4 million), fisheries (USD 0.2 million), fuelwood & thatching materials (USD 0.06 million), honey (USD 0.011 million), wax (USD 0.004 million), crabs (USD 0.02 million), tourism (USD 42,000)	Economics	P- Timber, fuelwood, fish, crab, thatching materials, honey, wax; C- Tourism
Ekka and Pandit (2012)	India / Indian Sundarban	The study spanning 10 villages and 432 households tries to analyse people's perception about the importance of mangroves and their willingness to pay for its conservation. About 64.7% respondents were willing to pay for mangrove conservation at different bid levels	Not assessed	Economics	Fishery
Kibria et al. (2018)	International / Mangrove Forest - Bangladesh Sundarban	The study aims to understand the influence of livelihood capitals (natural, financial, human, physical, social) on access to provisioning services. The study was conducted in 104 households in 9 villages. The study recommends that interactions between livelihood capitals and access to provisioning services should be addressed to avoid over exploitation of natural resources	Not assessed	Economics	Honey, crab, shrimp fry, shrimp, mixed fish and fuelwood
Danda (2017)	India / Indian Sundarban	The study is a comprehensive compendium of the biodiversity in Indian Sundarban, threats faced by biodiversity and provides broad policy perspective on sustainability of Sundarban	NA	Taxonomical studies	Genetic resources
Payo et al. (2016)	India, International, Bangladesh / Coastal -	The study developed a model to estimate mangrove area loss in Sundarban by 2100 based on sea-level rise and erosion scenarios	NA	Remote sensing	Erosion control

Author (Year)	Experts Involved / Region of Study	Study Objectives	Economic Value	Domain / Sector	Ecosystem Services (Provisioning - P, Regulating - R, Supporting - S, Cultural - C) - Ecosystem Function
	Bangladesh Sundarban				
Abdullah-Al-Mamun et al. (2017)	Bangladesh, International / Bangladesh Sundarban	Ecosystem services of Sundarban were identified and the various benefits to the local communities and to compare the impacts of climate change and other anthropogenic factors on deterioration of ecosystem services provided by the Sundarban. The ES were evaluated using Total Economic Value framework.	NA	Development	P- Timber, golpata (Nypafruticans), honey, beeswax, fish, shrimp larvae; R- Carbon storage, protection from cyclones and tidal surges; S- Breeding and nursery grounds for the aquatic species, biodiversity conservation; C- Tourism
Khanom and Buckley (2015)	Bangladesh, International / Bangladesh Sundarban	Annual tourist expenditure was estimated at USD5 million. The study was conducted based on 25-item surveys from 70 tourists. The study recommended ways on ecotourism development and improvements in the existing tour facilities and operation structure to attract more visitors and subsequently more revenue generation.	USD 5 million	Economics	Tourism and recreation
Ghosh T. (2014)	India / Indian Sundarban	Time-series analysis using multi-temporal satellite imageries was done to identify island erosion. Migration patterns of locals were evaluated based on the economic status.	NA	Remote sensing	Erosion control
Islam (2010)	Bangladesh / Bangladesh Sundarban	The study investigated the economics of Sundarban reserve forest in Bangladesh through value chain analysis of marketed products.	Not assessed	Economics, value chain	Fish production and exports

Author (Year)	Experts Involved / Region of Study	Study Objectives	Economic Value	Domain / Sector	Ecosystem Services (Provisioning - P, Regulating - R, Supporting - S, Cultural - C) - Ecosystem Function
Salam et al. (2000)	Bangladesh, International / Coastal - Bangladesh Sundarban	The study uses GIS tools to map regions for developing ecotourism options which can bring economic incentives to locals and protect the region. The study investigated the structural and institutional set up that exists in the region in addition to the benefits and threats to the Sundarban region.	NA	Remote sensing	Tourism
(Verma et al., 2017)	India / Indian Sundarban	The study estimated the quantitative and qualitative value for 25 ecosystem services from six tiger reserves in India. Various methodologies of total economic value framework and value+ approach was used. Primary and secondary data was used. The ecosystem services values and the investment multiplier values per hectare basis was estimated.	Employment generation (USD 0.6), fishing (USD 24.6), standing stock (USD 9672.3), NWFP (USD 0.1), gene-pool protection (USD 44.2), carbon storage (USD 370.8), carbon sequestration (USD 7.1), nutrient cycling/retention (USD 45.7), biological control (USD 1.6), moderation of extreme events (USD 4.2), pollination (USD 4.3), nursery function (USD 79.5), habitat (USD 5.5), recreation (USD 0.6), gas regulation (USD 1.7), waste assimilation (USD 23.1)	Economics	P- Employment generation, fishing, NTFP, gene-pool protection timber; R- carbon sequestration, nutrient cycling/retention, biological control, moderation of extreme events, pollination, nursery function, habitat/refugia, gas regulation, waste assimilation; C- Recreation
(Ghosh, 2011)	India / Indian Sundarban	The study compares the value of benefits and economic cost of non-intervention in business-as-usual scenario to that of WWF vision 2050. The values of benefits are estimated from 2050 to 2100. The study was conducted using secondary literature values in 6 blocks of the Indian Sundarban region.	Shrimp farming (USD 5.253506 million), Agriculture (USD 7.214363 million)	Economics	P- Fishing (shrimp), agriculture

Section V – Framework on Economic Case for Cooperation on Sundarban

Transboundary cooperation has the potential to generate significant benefits to the countries involved. If an ecosystem is treated as a single unit, its physical integrity is maintained and externalities are internalized resulting in enhanced ecosystem services and benefits (Qaddumi, 2008, LeMarquand, 1976). According to LeMarquand (1976), the combined effort will also have economies of scale which means net benefits through cooperation will be more than independent action. On the other hand, the cost of non-cooperation is inefficient resource management leading to decreasing water quantity, quality, and environmental health. Higher the level of cooperation, higher the benefits realized and benefit assessment exercise helps to realize the potential value of cooperation (UNECE, 2015). For benefits assessment, UNECE Policy Guidance Note on Transboundary Cooperation stipulates the following three phase benefit assessment exercise (only the first two are discussed in this paper):

- i. Identification of benefits
- ii. Assessment or estimation of benefits
- iii. Communication of benefits

5.1 Types of Benefits

Identification of benefits is essential as benefits vary from basin-to-basin or ecosystem-to-ecosystem based on economic, social, environmental and geopolitical characteristics and level of cooperation stage (UNECE, 2015). In order to ensure benefits of common pool resources in shared ecosystems, the concept of benefit-sharing and developing a benefit-sharing framework aids in bringing about sustainable management and human development.

In their comprehensive framework, (Sadoff and Grey, 2002, Sadoff and Grey, 2005) identify four types of benefits from cooperation on the transboundary river basins. The first two can be summarized as “sustainable development” and the last two as preventing or resolving international conflicts and promoting cooperation (Mostert, 2005, UNECE, 2015). As Sundarban is a waterscape and the lowest part of the Ganges Delta, the theories of basin cooperation can be applied to a waterscape or ecosystem like the Sundarban. Types of benefits of cooperation are shown in Table 6.

Table 6: Typology of Benefits (Adapted from Sadoff and Grey (2002))

Category of Benefits	Specific Benefits
Type I Benefits for the Transboundary Waters	
Environmental benefits	Avoided habitat degradation and biodiversity loss (i.e. non-use value of improved river ecosystem health)
Type II Benefits from the Transboundary Waters	
(a) Improved human satisfaction and health	-Improved satisfaction from increased recreational opportunities and protection of cultural values -Improved human health (reduced incidence of water-borne diseases as a consequence of improved water quality)
(b) Direct (micro)economic benefits/economic productivity benefits	-Increased economic production (aquaculture, irrigated agriculture, industrial production, nature-based tourism) -Reduced cost of carrying out productive activities (avoided costs of supplying water from more expensive sources, lower cost of

Category of Benefits	Specific Benefits
Reduced costs and improved benefits as a consequence of managing water better (e.g. improved water allocation from integrated water planning at the transboundary scale)	<ul style="list-style-type: none"> treating raw water for human consumption and economic uses, lower cost of energy inputs from using hydropower, savings from using river transport) -Reduced risks: avoided human and economic losses from floods, avoided catastrophic losses from drought (e.g. loss of perennial crops), avoided food shortages, avoided energy shortages -Increased value of property thanks to improvements in riparian ecosystems
Type III Benefits to the Transboundary Waters	
Reduced costs and improved benefits as a consequence of building trust between countries	<ul style="list-style-type: none"> -Reduced cost of managing water (e.g. from more efficient water monitoring, more efficient responses to pollution accidents, etc.) -Reduced cost of complying with international treaties -Reduced defence spending and avoided costs of dispute/military conflict -Benefits gained from cooperating in other policy areas after trust has been built in the water area
Type IV Benefits Beyond the Transboundary Waters	
Indirect (macro)economic benefits	<ul style="list-style-type: none"> -Economic growth, employment generation and poverty reduction, generated by more investment across borders and more open markets for goods, services and labour, which are in turn generated by the combination of the microeconomic benefits of managing water better (Type II benefits) and the improved economic climate generated by the improved trust between countries (Type III benefits)

The analysis shown in this report focuses on the economic benefits of cooperation. However, benefits also have environmental and socio-political implications, together known as triple bottom line. Economic benefits can be referred as quantifiable material and financial benefits from cooperation. Socio-political benefits consist of tangible and intangible benefits such as poverty reduction, improved health outcomes, food and energy security, cultural exchange and integration. The socio-political benefits also include foregone costs of disputes, conflict and military expenditure. Intangible benefits such as improved trust and understanding, peace and stability, regional integration, enhanced value and pride due to ecological integration also fall into this category. Environmental benefits correspond to benefits to the environment and ecosystem.

The cooperation on Sundarban between Bangladesh and India has been discussed in detail in Section II. The integrated resource management promotes sustainable development and management of water, land and related resources by looking at the ecosystems as a management unit maximizing economic and social welfare (UNECE, 2015). As shown in Figure 5, the higher the cooperation, the larger are the benefits (Qaddumi, 2008) and joint action represents the greatest form of cooperation (Sadoff and Grey, 2005; UNECE, 2015).

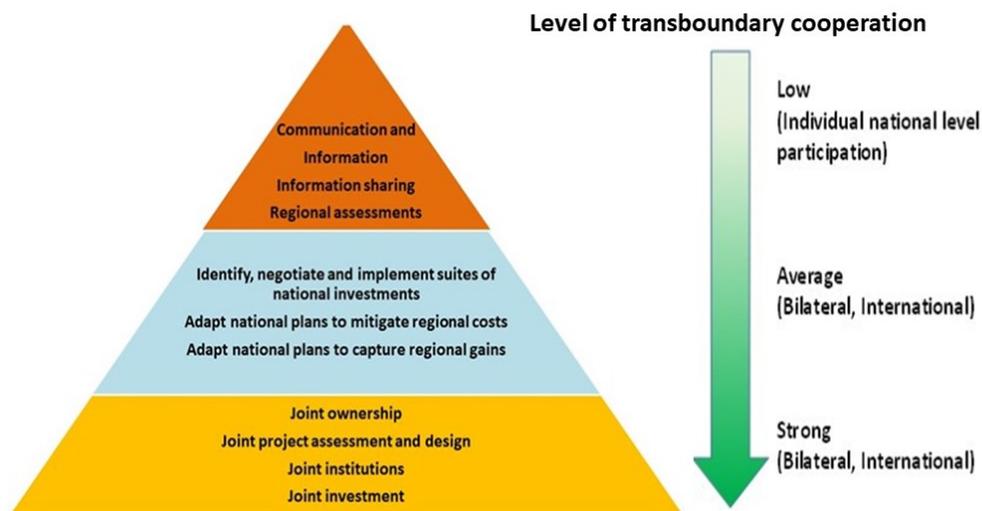


Figure 5: Benefit associated with Levels of Cooperation (after Sadoff and Grey, 2005)

As shown in section III, there are many examples all around the world where large benefits have resulted from joint action. Successful cases include the Lower Danube Green Corridor Initiative with focus on restoration and sustainable management of marsh and wetlands in the Danube delta has enhanced natural resources productivity (fish, reed, grasslands) and tourism. Cooperation on Wadden Sea through the Common Wadden Sea Secretariat has improved nature-based tourism in the area (Brandt and Wollesen, 2009). The Organization for the Development of the Senegal River (OMVS) has facilitated water management, drinking water, irrigation, fishing and energy generation with increasing environmental protection and public participation (Tignino, 2016).

There are also cases where joint actions have not been as successful as conceived. The main factors which decide success or failure of a project are origin of the initiative, the agents or stakeholders and their interest and motivation and how strong the institutional mechanism is developed (Hensengerth, 2009). However, even in transboundary basins where there is lack of institutional coordination and implementation of actions like the Lake Chad basin, transboundary cooperation has resulted in the improvement of monitoring, countries are focusing on reforestation in the watershed and according to a 2007 image there has been a slight improvement over previous years in the surface area of the lake (Scheumann and Neubert, 2006; Braun, 2010). In the Emerald Triangle Protected Forests Complex between Thailand, Cambodia and Laos, where the legislative framework and institutional commitment still needs to be strengthened considerably, deforestation scale is much lower in transboundary protected areas compared to unprotected areas in some of the countries (ITTO, 2014).

5.2 Perception on Benefits and Costs of Cooperation

Countries do not cooperate because they are morally or politically compelled to do so. They cooperate when perceived benefits of cooperation outweigh benefits of non-cooperation and distribution of benefits seems to be fair (Grey, 2016, Qaddumi, 2008). When the number of countries is small such as in case of the Sundarban, the incentive for cooperation is greater as incremental cost felt by each riparian due to externalities are larger and more apparent (LeMarquand, 1976). Riparians are also more likely to cooperate to mitigate and manage common risks (Jagerskog et. al, 2009; Grey et. al, 2009). For instance, Cooperation on Rhine was mainly driven by poor water quality (UNECE, 2015). Cooperation in the Sundarban makes a lot of sense due to high hydraulic variability in the region as cooperation would decrease vulnerability owing to hydraulic shocks (Sadoff and Grey, 2002).

In order to thrash out various issues and seek a response from a varied set of stakeholders, IWA in association with the World Bank conducted a workshop on the Economic Case for Cooperation on the Sundarban on November 3, 2017 in New Delhi, India. During the workshop, experts deliberated and provided feedback on the areas of (i) benefits of cooperation including cost of non-cooperation within the Sundarban ecosystem and (ii) framework for this cooperation.

Besides a questionnaire survey with experts from both Bangladesh and India was done to understand their perception on benefits of cooperation. The questionnaire for this was developed using feedback from several meetings organized by IWA where both Indian and Bangladeshi experts entered into a dialogue on cooperation. In total, 18 experts were interviewed using both emails and face-to-face interviews in some cases. According to experts, cooperation will significantly increase both countries' ability to manage shared resources. It will also increase global accountability in managing endangered species living in Sundarban. Perceived benefits are listed in Table 7.

Table 7: Perception on Benefits and Costs of Cooperation on Sundarban

No	Benefit/Cost of Cooperation	Changes in Benefits/Costs will be		
		More Than 50%	Less Than 50%	No Benefits/Costs
1	Enhance capacity to manage similar resources	83%	17%	0%
2	Improve accountability of managing endangered species	78%	17%	6%
3	Promote one voice for mangrove protection globally	78%	22%	0%
4	Enhance nature based tourism	72%	22%	6%
5	Reduce poaching	72%	22%	6%
6	Build trust between countries on transboundary resource management	67%	33%	0%
7	Improve mangrove protection	61%	33%	6%
8	Reduce transboundary resource management cost	53%	41%	6%
9	Promote harvesting of new resources like seaweeds	50%	39%	11%
10	Livelihood improvement of local people	50%	39%	11%
11	Increase fisheries protection	44%	56%	0%
12	Reduce management cost of protection	44%	22%	33%
13	Increase cyclone and storm protection ability	39%	50%	11%
14	Energize harness of marine resources	39%	56%	6%
15	Promote sustainable development	33%	61%	6%
16	Enhance rights of indigenous people	28%	39%	33%
17	Reduce pressure on forests	22%	67%	11%
18	Enrich local culture	22%	67%	11%
19	Enhance pests and diseases in local agriculture	12%	41%	47%
20	Create conflicts in boundaries	11%	33%	56%

5.3 Identification of Benefits: Focus Sundarban

Based on the above process and through expert interviews and recommendations from the expert panel meeting held in November 2017, sectors have been identified that presents a feasible option

for joint management of Sundarban. This was adapted from the draft report “Economic Case for Cooperation on the Sundarban” prepared by IWA as part of the deliverables of the project – Consensus Building and Development of Action Plans for Joint Bangladesh-India Sundarban Management (Nishat and Jha, 2017). Further to this, based on consultative multi-stakeholder processes in Bangladesh and India involving the participation and contribution of different stakeholders and literature review, a range of benefits of cooperation on the Sundarban have been identified (Table 8).

Table 8: Range of Benefits of Cooperation Across Various Sectors in the Sundarban

Sector	Opportunities
Forest Conservation	<ul style="list-style-type: none"> • Enhanced capacity to manage similar resources • Optimized data and information collection • Increased ecological integrity and reduced habitat degradation and biodiversity loss • Reduced poaching • Natural regeneration
Fisheries	<ul style="list-style-type: none"> • Improved fisheries management • Livelihood generation • Transboundary movement of fish/ restoration of migration routes • Common spawning ground • Cooperation between fishery federations
Nature Based Tourism	<ul style="list-style-type: none"> • Income generation • Integrated tourism • Diverse option of routes and circuits • Cultural services • Growth of hospitality industry • Improvement of infrastructure and services (water supply, sanitation, electricity supply)
Navigation	<ul style="list-style-type: none"> • Integrated routes • Improved transportation services • Effective patrolling
Disaster Management	<ul style="list-style-type: none"> • Information sharing and joint assessment • Regional early warning and dissemination system • Post-disaster relief and rescue efforts • Regional capacity building
Transboundary Trade Development	<ul style="list-style-type: none"> • Border haats • Regional trade and market access • Income generation
Adaptation and Mitigation to Climate Change	<ul style="list-style-type: none"> • Carbon sequestration

Understanding the dynamics of conflicts and cooperation on shared ecosystems is a complex process. The proposed framework (Table 9) developed by Sadoff and Grey (2002) approaches the benefits of cooperation from multidisciplinary facets. The framework has been implemented by many countries that depend on transboundary ecosystems for development.

Table 9: Framework for Analysis of Economic Benefits of Cooperation (Based on Sadoff and Grey (2002))

Benefits Typology	Opportunities	Present Level of Cooperation	Desired Level of Cooperation	Applicable Valuation Technique	Economic Value of Benefits
From the ecosystem (socio-economic)	1) Ecosystem services	JWG – CoS	Joint economic valuation studies	MP, RC, TEV, MEA	Refer Section VI
	2) Enhanced livelihood and economic opportunities	JWG – CoS	Joint scoping and training programmes	MP	*
	3) Improved fisheries management	Indian Forest Act 1878, Hunting and Fishing Rules 1959, Major Fisheries Regulations for SRF, Wildlife Sanctuary Regulations 1999	Joint stock-taking of fisheries resources	MP	Refer Section VI
	4) Infrastructure development	Framework for cooperation and development	Joint infrastructure planning and decision-making	NA	NA
	5) Enhanced capacity to manage similar resources	JWG – CoS	Effective resource management	RC	*
	6) Navigation development	PIWTT, Transport of goods and materials	Improved communication to prevent collision events	MP	*
	7) Nature-based tourism development	JWG – CoS	Ecolodges and education centres	CVM, TCM, HP, CEM	*
	8) Transboundary trade development	PIWTT	Promoting border <i>haats</i>	NA	NA
	9) Poverty alleviation	Framework for cooperation and development	Promoting border <i>haats</i>	NA	NA
	10) Cultural exchange	India-Bangladesh Treaty of Friendship, Cooperation and	Indo-Bangladesh Cultural Centre	NA	NA

Benefits Typology	Opportunities	Present Level of Cooperation	Desired Level of Cooperation	Applicable Valuation Technique	Economic Value of Benefits
		Peace, Cultural Corporate Agreement			
To the ecosystem (environmental)	1) Integrated water management (IWM)	1997 Sharing of Ganges Water	Basin-wise IWM	RC	*
	2) Optimized data and information collection	JWG – CoS	Joint monitoring, surveillance and research	NA	NA
	3) Increased ecological integrity, reduced habitat degradation and biodiversity conservation	JWG – CoS	“	MP, CVM, CEM	*
	4) Storm protection and disaster management	JWG – CoS, Joint Rivers Commission (JRC)	Joint cyclone shelters and rehabilitation measures	RC, PF	Refer Section VI
	5) Wetland and marine resource conservation	JWG – CoS, MoU – Ministry of Agriculture and Farmers’ Welfare (India) and Bangladesh Government, Blue Economy and Maritime Cooperation	Formation of Sundarban Conservation Group	PF, RC	*
	6) Erosion control and management	JRC	Reforestation and restoration	PF, RC	*
	7) Natural regeneration	JWG – CoS	Joint monitoring, surveillance and research	RC	*
	8) E-flows	JWG – CoS, JRC, 1997 Sharing of Ganges Water	Joint monitoring, surveillance and research	RC	*
	9) Carbon sequestration	JWG – CoS	Reforestation and restoration	PF, RC	*

Benefits Typology	Opportunities	Present Level of Cooperation	Desired Level of Cooperation	Applicable Valuation Technique	Economic Value of Benefits
Because of ecosystem (political)	1) Peace and security	India-Bangladesh Treaty of Friendship, Cooperation and Peace	Effective joint patrols and institutional mechanism	NA	NA
	2) Enhanced trust and cooperation	"	Promoting regional integration	NA	NA
	3) Policy shifts to food/energy security and poverty alleviation	"	Establishing joint expert working groups	NA	NA
Beyond the ecosystem (indirect economic)	1) Regional integration	India-Bangladesh Treaty of Friendship, Cooperation and Peace		NA	NA
	2) Regional investment and development	"		NA	NA
	3) Regional trade and market access	"		NA	NA
	4) Improved satisfaction due to preservation of cultural resources or access to recreational opportunities	"		NA	NA
	5) Promote one voice for mangrove protection globally	"	Mangrove conservation trust	NA	NA
	6) Climate change mitigation and adaptation	JWG-CoS	Science research and renewable energy cooperation	RC	*

* Primary data needed, NA - Not Applicable

Section VI - Estimation of Benefits of Cooperation on Sundarban

After identification of benefits, nature and level of detail of the benefit assessment phase will depend on the issues, the cooperation stage and political will of the parties involved (UNECE, 2015). Issues and political will are subjective in nature and largely depend on context, time and stakeholders involved. In case of the cooperation stage, it mostly follows an objective pattern and can be identified based on the stage characteristics.

In previous sections the identified benefits of cooperation on the Sundarban are different in nature, so assessment approaches will necessarily be different (shown on Figure 5). For most of the identified benefits, a qualitative assessment will at least be possible. This can be done through a combination of expert assessment, participatory assessment and literature review. For example, in assessing peace and security benefits, the focus should be on qualitative assessment. For some benefits, it will be possible to provide a quantitative assessment. And only for a small number of benefits it will be possible to provide a monetary valuation.

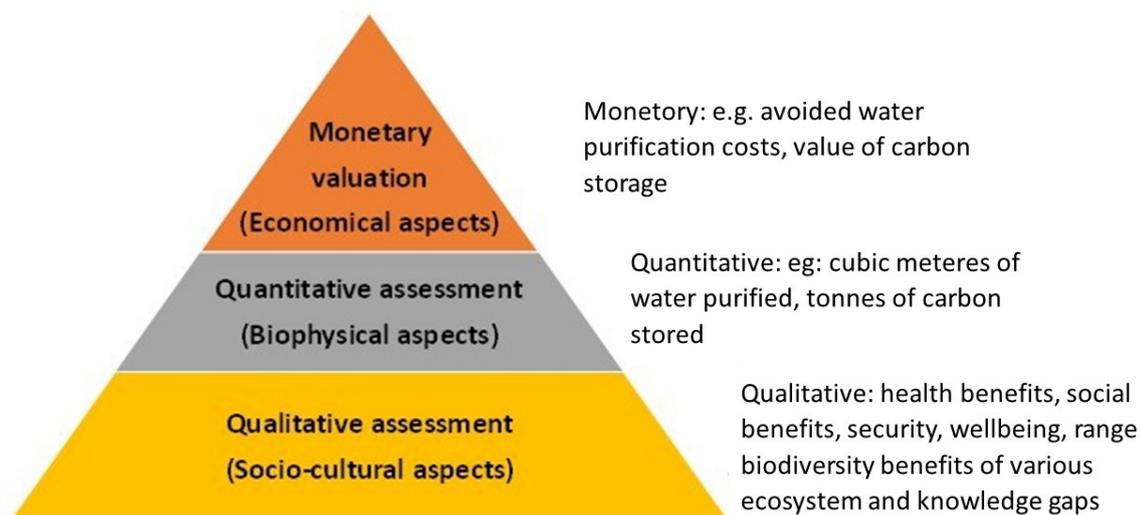


Figure 5: Benefit Pyramid (after ten Brink, 2008)

Estimating the benefits of joint cooperation is crucial for sustainable resource utilisation, therefore, trying to address these benefits, a questionnaire for perception of benefits was conducted (see Table 10). Based on the questionnaire survey, we have grouped certain benefits into three categories for evaluating benefits of cooperation. Table 10 highlights the three categories and perception of benefits grouped in them. The exercise improves understanding of perceived benefits to the stakeholders which helps to advance the process further.

Table 10: Perception benefits categories for three sectors

Category	Perception of benefits / cost of cooperation	Changes in Benefits/Costs		
		More Than 50%	Less Than 50%	No Benefits / Costs
Fisheries	Promote harvesting of new resources like seaweeds	50%	39%	11%
	Increase fisheries protection	44%	56%	0%
	Energize harness of marine resources	39%	56%	6%
	Average	44%	50%	5%
	Improve mangrove protection	61%	33%	6%

Storm protection	Reduce management cost of protection	44%	22%	33%
	Increase cyclone and storm protection ability	39%	50%	11%
	Average	48%	35%	16%
Tourism	Enhance nature based tourism	72%	22%	6%
	Reduce poaching	72%	22%	6%
	Improve accountability of managing endangered species	78%	17%	6%
	Average	74%	20%	6%

Change in benefits / costs

As there was no fixed class, we divided the change in benefits into three classes of benefits viz. 'More than 50%', 'Less than 50%' and 'No benefits/costs'. Therefore, we assume that there is an increase of 75% in benefits/costs for *More than 50%* class. Similarly, we fix for other categories at 25% increase in benefits/costs for *Less than 50%* class and 0% for *No benefits/costs* class.

With known percentage increase in each class, we estimated the economic benefits for the three sectors as discussed below.

Fisheries

Fishing in Sundarban is one of the major livelihood activities and it contributes to 3.61% of the Bangladesh GDP (DoF, 2017). Studies that estimated the economic value of fishing activities have been conducted in different localities. Kibria et al. (2018) conducted a study close to the north of Bangladesh Sundarban Mangrove Forests in 104 households. The survey identified that the majority of households (about 75%) make less than USD 255/year in crab catching, mixed fish collection, shrimp fry / shrimp collection. Very few families made between USD 765/year to USD 1020/year. Therefore, for this study an average value of USD 255/year was considered. The study by Rahman et al. (2018) considered 100 households from three villages. The capture fisheries occupation generated about USD 1086/year and the calculated economic value was USD 976/ha.

The economic value of provisioning services study done by Uddin et al. (2013) for the Bangladesh Sundarban Reserve Forest was USD 7,44,000/year during 2001 – 2010. Fishing generated an average of USD 0.2 million/year. This value was for the entire Sundarban region which covers an area of 6000 km² and since fish is of direct market value, the value was estimated using the market price method.

In Indian Sundarban, Verma et al. (2017) presented a value of USD 24.6 million/year. The study used the production estimates and local market price value to arrive at the economic value of fishing in the buffer zones of Sundarban Tiger Reserves (STR). The quantity of fish caught from the STR was estimated to be 8000 tonnes/year.

A national level study done on coastal mangroves in India by Anneboina and Kumar (2017) showed that fish production in 2014 in West Bengal state was 73,297.84 tonnes/year. Fish production for the region of Sundarban could not be estimated from this study.

Table 11: Economic Value of Fisheries in the Sundarban Region

Study	Year of Study	Area	Value	Unit
Kibria et al. (2018)	2018	Shyamnagar Sundarban (Bangladesh)	255	USD / year
Rahman et al. (2018)	2018	Shyamnagar Sundarban (Bangladesh)	1086 (976)	USD / year (USD / ha)

Uddin et al. (2013)	2013	Sundarban Reserved Forest (Bangladesh)	0.2	USD million / year
DoF (2017)	2016-2017	East and West Sundarban (Bangladesh)	18086.04	Metric tonnes
Anneboina and Kumar (2017)	2014	West Bengal (India)	73297.84	Tonnes / year
Verma et al. (2017)	2015	Sundarban Tiger Reserve (India)	24.6	USD million / year

Benefits of cooperation

Fisheries is the major sector of revenue generation in Sundarban region. The economic value of fisheries in India as per Verma et al. (2017) study was USD 40.553 million (at 2017 prices). The study by Rahman et al. (2018) found out that provisioning of fisheries in Shyamnagar was USD 976/ha. We used this value after price adjustment for the year 2017 and, it is about USD 1156.4/ha. Due to paucity of information, this value was used to calculate for the entire Bangladesh Sundarban water area and it produced about USD 216.71 million for Bangladesh (Table 12).

Table 1: Economic valuation of fisheries for current scenario

	Value	Unit	Scenario	Source
India	40.553	USD million (2017)	Current Scenario	Verma et al (2017)
Bangladesh	0.1156	USD million/km ²		Rahman et al (2018)
	216.71	USD million (2017)		
Total	257.26	USD million (2017)		Calculated

Perceived benefits in fisheries sector

We use the average value of perception from Table 9 to calculate the potential benefit of cooperation. Therefore, the different perceived benefits in fisheries is averaged out to reveal that 44% of participants perceive there might be an increase of benefits of up to 75%, 50% of participants perceive there is 25% benefit and 5% perceive there is no benefits in the current scenario. These values were used for fisheries to estimate the increase in benefits and these are shown below in Table 13.

Table 2: Perceived benefits of cooperation in fisheries sector

Benefits class	Assumed increase in benefits	Perception value	Calculated Perceived Benefit	Perceived benefit based on current scenario (USD million)	Fisheries value for Sundarban (USD million)
More than 50%	75%	44%	33% (0.75*0.44)	84.896	342.16
Less than 50%	25%	50%	12.5% (0.25*0.50)	32.158	289.42
No benefits/costs	0%	5%	0%	-	257.26

The table above shows that fisheries can generate up to USD 342.16 million if it is jointly managed as against USD 257.26 million without cooperation.

Storm Protection

Storm surges from cyclonic events are a major threat across the Sundarban. The cyclonic events bring catastrophic losses in terms of damage to houses and material property, agricultural lands and impacts biodiversity. Mangroves in Sundarban protect and subdue the impacts from such events thus providing valuable regulating services (Sandilyan and Kathiresan, 2015). A household level willingness to pay (WTP) study done by Rahman et al. (2018) in Bangladesh Sundarban showed that 89% of households were willing to pay USD 10/year for storm protection and the value extrapolated for villages in the SIZ was USD 13/ha.

The study by Verma et al. (2017) shows that the total economic value of mangroves for moderating extreme events in STR was USD 4.2 million/year. This was calculated assuming that every five years a cyclone of 'Super Cyclonic Storm' category hits the region.

It has been estimated that the recent financial damage and loss caused by the most recent 10-year return period cyclone in Bangladesh was about USD 1.67 billion (S. Dasgupta et al., 2010). In Ghosh (2011) study, the storm protection value of the Sundarban for the period 2050–2100 was USD 5046.81 billion. With such high economic benefits due to the mangroves highlights the need to conserve and stress the importance for restoration activities. Based on the studies available, a conservative value of USD 4.59 million/year in Bangladesh Sundarban and USD 4.2 million/year for Indian Sundarban can be used (Table 14).

Table 3: Economic Value of Storm Protection in Sundarban Region

Study	Year of Study	Area	Value	Unit
Rahman et al. (2018)	2018	Shyamnagar Sundarban (Bangladesh)	4.59 (13)	USD million/year (USD / ha)
Verma et al. (2017)	2015	Sundarban Tiger Reserve (India)	4.2	USD million/year
Ghosh (2011)	2011	Indian Sundarban	5046.81	USD billion (2050-2100)

Benefits of cooperation

The study by Verma et al. (2017) showed that storm protection value of mangrove area of Sundarban was USD 1920.49/km² (2017 prices). In Bangladesh, Rahman et al. (2018) highlighted a storm protection value of USD 1540.29/km². The total protection value calculated for both the regions is USD 3460.78/km² (Table 15).

Table 4: Economic valuation of storm protection for current scenario

	Value	Unit	Scenario	Source
India	1920.49	USD/km ² (2017)	Current	Verma et al. (2017)
Bangladesh	1540.29	USD/km ²	Scenario	Rahman et al. (2018)
Total	3460.78	USD/km ² (2017)		Calculated

Perceived benefits of storm protection

The increase in storm protection value in the three classes based on perceived benefits using the survey results are shown in Table 16.

Table 5: Perceived benefits of cooperation in storm protection sector

Benefits class	Assumed increase in benefits	Perception value	Calculated Perceived Benefit	Perceived benefit based on current scenario (USD/km ²)	Storm protection value for Sundarban (USD/km ²)
More than 50%	75%	48%	36% (0.75*0.48)	1245.88	4706.66
Less than 50%	25%	35%	8.75% (0.25*0.35)	302.82	3763.60
No benefits/costs	0%	16%	0%	-	3460.78

From the above table, we can observe that undertaking joint cooperation on the Sundarban region between the two countries can generate storm protection value up to USD 4706.66/km² as against USD 3460.78/km² without cooperation.

Tourism

Cooperation in tourism can generate economic benefits for the local people and also contribute to the economic growth at national level. In Bangladesh, it is a growing sector and contributes to 4.4% to the GDP. Various studies have been conducted in tourism in Bangladesh and the Indian Sundarban region.

The study done by Khanom and Buckley (2015) revealed that most of the tourists are domestic (98%) and the total annual tourist expenditure was USD 5 million. However, the sector has high potential for tourism revenue generation. Uddin et al. (2013) conducted the study between the years 2001-2002 and 2009-2010 and found that the tourists have doubled in number and revenues have increased four times. The total revenue generated was about an average of USD 42,000 per year. The values vary as the studies in Bangladesh were conducted on a smaller scale, e.g. at village level.

In India, the only study was done by Verma et al. (2015) in the Sundarban Tiger Reserve. The region generates services with an estimated value of 0.6 million USD annually. The other study was done by Kavi Kumar et al. (2016) for the entire state of West Bengal where tourism generated an average value of 704 million USD per year in 2013. Therefore, a conservative value of USD 42,000/year in Bangladesh Sundarban and USD 0.6 million/year for Indian Sundarban can be used (Table 17).

Table 6: Economic Value of Tourism in the Sundarban Region

Study	Year of Study	Area	Value	Unit
Khanom and Buckley (2015)	2015	Bangladesh Sundarban (Bangladesh)	5	USD million
Uddin et al. (2013)	2010	Bangladesh Sundarban (Bangladesh)	42,000	USD / year
Iqball et al. (2010)	2009	Sundarban Reserved Forest (Bangladesh)	24	USD / ha
Verma et al. (2015)	2014	Sundarbans Tiger Reserve (India)	0.6	USD million / year
Kavi Kumar et al. (2016)	2012-2013	West Bengal (India)	703.7	USD million / year (USD 1 = INR 54)

Benefits of cooperation

The tourism value generated by India as per Verma et al. (2017) was price adjusted for the year 2017 and it is USD 0.94 million and for Bangladesh, it is USD 0.10 million (Khanom and Buckley, 2015).

Thus, the total tourism value of Sundarban of both countries for the year 2017 is estimated at about USD 1.04 million (Table 18).

Since there are more tourists visiting the Indian Sundarban, the revenue value was utilised for estimating the potential for Bangladesh Sundarban region and it was estimated to generate USD 1.56 million.

Table 18: Economic valuation of tourism for current scenario

	Value	Unit	Scenario	Source
India	0.94	USD million (2017)	Current Scenario	Verma et al. (2017)
Bangladesh	0.10	USD million (2017)		Khanom and Buckley (2015)
Total	1.04	USD million (2017)		
Per km ²	0.0002595	USD million/km ²		
Bangladesh	1.56	USD million		Potential revenue calculated using Indian data

Perceived benefits of tourism sector

The likelihood of increase in tourism revenue in the three classes based on perceived benefits using the survey results are shown in Table 19.

Table 19: Perceived benefits of cooperation in tourism sector

Benefits class	Assumed increase in benefits	Perception value	Calculated Perceived Benefit	Perceived benefit based on current scenario (USD million)	Tourism value for Sundarban (USD million)
More than 50%	75%	74%	55% (0.75*0.74)	0.572	1.612
Less than 50%	25%	20%	5% (0.25*0.20)	0.052	1.092
No benefits/costs	0%	6%	0%	-	1.04

From the above table, we can observe that joint cooperation on the Sundarban region can generate tourism revenue up to USD 1.612 million as against USD 1.04 million without cooperation.

The below table shows the comparison of economic benefits with current scenario. It clearly highlights that there are significant benefits if cooperation between the two nations exist.

Table 20: Comparison of economic benefits of current scenario and perceived benefits of cooperation

Cooperation sector	Current Scenario	Perceived benefits of cooperation
Fisheries	USD 257.26 million	USD 342.16 million
Storm protection	USD 3460.78/km ²	USD 4706.66/km ²
Tourism	USD 1.04 million	USD 1.612 million

Cost of Non-Cooperation

Cost of non-cooperation will include the cost of unilateral opportunities (benefits) foregone. This is because development often supports and amplifies national development. For example, fish do not maintain borders, and coordinated activities strengthen the management of fisheries. The costs of non-cooperation in the case of Sundarban would pertain to costs involved in fisheries, tourism and disaster management sectors. The costs in these sectors can be attributed to the various heads including administration, forest protection, wildlife management, infrastructure development, developing research and technology, rehabilitation and biodiversity conservation.

Environmental Protection Agency (EPA), USA Benefit Categories

The ecosystem benefits mentioned earlier in Table 8 are the identified benefits. However, there are other ecosystem benefits from Sundarban that have not been identified and/or those that might arise in the future and these benefits can be categorized based on the EPA benefit categories (EPA, 2009) (Table 21).

Table 7: EPA Benefit Categories

Type of Value	Description	Examples of Ecosystem Services
EPA Effect Category 1	Benefits which can be assessed and monetized using available ecological models and appropriate economic valuation methods, including benefits transfer	Carbon sequestration, carbon storage, water provisioning
EPA Effect Category 2	Benefits which cannot be monetized, but can be quantified in biophysical terms using available ecological models and for which some indicator(s) of economic benefits exist	Biodiversity, pollination services
EPA Effect Category 3	Benefits which can be quantified in biophysical terms but for which no indicators of economic benefits exist	Climate and gas regulation
EPA Effect Category 4	Benefits which can be qualitatively described even if they cannot be quantified	Cultural values
EPA Effect Category 5	Benefits which have important non-economic values	Spiritual and nature appreciation

The categories 1 to 4 assist in providing as much information as possible about economic benefits addressing the benefit-cost framework. Whereas Category 5 corresponds to supplemental information about other values that could be of interest to policymakers and the public but are not based on the principles that underlie benefit-cost analysis. Note that some effects might fall into multiple categories. Nevertheless, the assessment of ecosystem services of the Sundarban landscape will help in designing more cost-effective ecosystem management policies and therefore a more efficient allocation of natural resources. It will lead to the inclusion of ecosystem services within economic growth and development strategies encourages a more sustainable use of economic and natural resources thereby contributing to a more inclusive, sustainable global economy.

Section VII: Suggestions and Way Forward

7.1 Gap Areas

Gaps in research help in understanding the extent of our knowledge and Sundarban as a transboundary ecosystem has its own challenges. The framework that has been developed for this study has highlighted the areas where data on economic value of benefits is limited / non-existent. The gap areas include most of the benefits in the socio-economic and environmental sectors as the joint management of Sundarban are new initiatives and in the development phase.

The valuation techniques for estimating the economic values of benefits for various sectors have been mentioned in Table 8. These are the most appropriate techniques to evaluate the benefits and require cooperation between stakeholders including academic institutions, government agencies, civil society organizations and non-governmental organizations.

Majority of the gap areas such as fisheries harvest, infrastructure sharing in case of disasters, sharing of resources relies heavily on various information, such as willingness of tourists to participate in tourism that takes them across boundaries, the best cost-effective and scenic travel routes that ensure value for money options. Therefore, data collection that consists of social, economic, environmental and cultural aspects should be made a priority as this will enable true estimation of benefits of cooperation.

7.2 Way Forward

Joint management of ecosystems in transboundary countries presents complex problems in diverse forms but, nevertheless cooperation is possible at various levels. In Sundarban, cooperation between Bangladesh and India requires involvement of multiple stakeholders and it opens a window of opportunity to sustainably manage this complex ecosystem. We have identified some way forward solutions to help bridge the relations for joint management as per the following:

1. Defining Sundarban boundary

For building cooperation process on the Sundarban landscapes, the first step should involve defining the boundary of the Sundarban landscape as this not only helps in delineating areas for human development and ecosystem preservation but also aids in understanding the complementary relation between dependent people and the Sundarban ecosystems. To achieve this step, stakeholders of both sides including representatives of villages, farmer and fisherman unions, businesses, researchers, governmental agencies should participate to help define zones of economic development, conservation and human settlements.

2. Sustainable and Integrated Community Based Tourism

As mentioned earlier, sustainable tourism in the Sundarban is one of the most feasible joint economic opportunities that can be undertaken. Developing tourism activities in this complex and multi-connected navigable waterways is challenging but preliminary research on feasibility of tourism that involves transboundary movement should be possible due to the MoU signed for passenger and river cruise services between the two countries. In fact, community based river cruise Landscape beauty – Ecological –Cultural –historical tourism may be developed and promoted between Bangladesh and India, especially in and adjoining the Sundarban, which will have the prospective not only to popularise some of the existing tourism routes and locations in this part of the world, but also to identify new

destinations and routes for tourism that can help capture the ecological, cultural and historical uniqueness of the Sundarban.

3. Fisheries development

Information of total fish production, crab and other seafood, methods of harvesting, their current distribution and predicted future population estimation should be conducted to ensure sustainability. Additional activities such as long-term data collection for monitoring salinity, impacts of pollution on fisheries, geomorphological changes and assessment of benefits of fishing bans should be conducted. All these activities can be easily executed due to an existing MoU between Bangladesh and India in the field of fisheries.

4. Inland navigation

Sundarban with its interconnected network of river ways also serves as a conduit for navigation and provides cheap transport mechanism. Transboundary inland navigation also facilitates regional integration, production, trade and promotes economic growth. In order to safeguard the environment and also achieve safe and efficient navigation, alternate river ways within the existing protocol routes should be mapped. The investigations should consist of identifying routes that do not have adverse impacts on the morphological features of the river network and those that bypasses ecologically sensitive areas, implementing environmental security measures that ensures ship wrecks, spillages, discharge of ballast / bilge waters does not occur and developing socio-economic activities for improving the livelihoods along the river networks.

5. Storm protection

Storm protection and coastal erosion are other sectors where Bangladesh has been observed to project improved results. Infrastructure sharing especially of the disaster shelters can help save many poor lives, therefore, policies for sharing such setup should be emphasised by both governments. Timely response in case of disasters is important, therefore, communication systems between the two countries in this particular region should be eased. Data on strategically locating these shelters, accessibility of road networks and provisioning of relief materials including food and water should be determined.

6. Developing SEEA-AFF

The United Nations System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA-AFF) integrates information on the environment and economic activities of agriculture, forestry and fisheries using the structures and principles laid out in the SEEA Central Framework of 2012. These activities depend directly on, as well as have an impact upon, the environment and its resources. Integrating information about agriculture, forestry and fisheries in the Sundarban landscape would facilitate understanding of the trade-offs and dependencies between these activities and their related environmental factors.

7. Research education

The Sundarban has rich floral and faunal diversity unique to the ecosystem. Joint research between the two countries to map their floral and faunal diversity by way of constructing Biodiversity Index would enrich our current understanding and will enable knowledge transfer of the complex ecosystem. This would also bridge collaborations amongst the researchers providing opportunities to conduct studies in each country and pave future pathways on development of Sundarban such that in developing such economic activities and developing navigational pathways, the critical biodiversity hotspots can be avoided. Biodiversity indices can in turn be used to understand linkage between

Biodiversity loss in terms of habitat loss and fragmentation on account of climate change in Sundarban habitats. To successfully achieve this, information on experts, their contributions to Sundarban region, funding mechanism, type of collaboration such as student exchanges / fellowships / MoU's should be collected and analysed.

8. Transboundary trade development

Currently, there are four *border haats*, it has been proposed that more such *haats* should be developed. Joint research on demand of the type of products, quantity of supply, economic feasibility of production in the Sundarban region without adversely affecting the natural settings should be pursued.

9. Livelihood generation

Emphasis should also be given to develop the livelihoods of the people in Sundarban as they are the core users and patrons of the Sundarban ecosystem. Therefore, involving them in research monitoring and conservation measures will ensure measureable results in terms of economic benefits for the primary stakeholders and would also reduce costs of managing the Sundarban ecosystems.

10. Policy Strengthening and execution

All activities and projects should be based on much stronger policies and understanding between the two countries as the Sundarban landscape is influenced by both natural and anthropogenic forces. Furthermore, steps should be taken to build mutual cooperation, beyond the bilateral agreements, at the stakeholder-level. This will help in jointly developing unbiased solutions especially when two countries belong to different economic growth conditions.

The study has provided guesstimates of potential economic benefits, if Sundarban were to be jointly managed. It has been found out that clearly there are high economic benefits in terms of revenue generation as well as in terms of cost effectiveness. Therefore, studies should be conducted at a micro- and finer-scale involving different stakeholders and more importantly the fishing communities and villagers. These stakeholders are ultimately the end-users and stewards of this region, so their opinions and perceptions of benefits, keeping aside all differences between the two nations, will aid in identifying on what aspects are beneficial and what is required for collaborative work to be done is important.

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