# INCEPTION REPORT

## Consultancy Services for Valuation of Ecosystem Services (Wealth Accounting) and Assessment of Payment for Ecosystem Services

**Submitted to:**

**Project Director, SUFAL Project, Bangladesh Forest Department, Dhaka, Bangladesh**

**Date: 15 September 2022**

**Submitted by:**

**Ernst & Young (EY) LLP and The Energy and Resources Institute (TERI)**

The better the question. The better the answer.
The better the world works.

Building a better working world

# Table of Contents

## Disclaimer

*This document is being submitted to "Project Director, SUFAL Project, Bangladesh Forest Department" for the purpose of describing Ernst & Young's ("EY") qualifications. In order to describe its capabilities, Ernst & Young has disclosed certain proprietary and other sensitive information. In consideration of receiving the disclosures, we request "Project Director, SUFAL Project, Bangladesh Forest Department" to treat this document as confidential material. The information in this document and any oral presentations made by EY contains trade secrets and confidential and proprietary information of EY, the disclosure of which would provide substantial benefit to competitors. As a result, this document should not be disclosed, used or duplicated – in whole or in part – for any purpose other than "Project Director, SUFAL Project, Bangladesh Forest Department" evaluating EY for the purpose of awarding a contract or assignment.*

*If an engagement is awarded to EY, the right of "Project Director, SUFAL Project, Bangladesh Forest Department" to duplicate, use or disclose the information in this document will be to the extent authorized in the resulting formal agreement between EY and Bangladesh Forest Department. If an engagement is not awarded to EY, this document and any duplicate copy thereof should be returned to EY or destroyed.*

# 1. Introduction

## 1.1 Background

Gross Domestic Product (GDP) is the sum of the value of all services and products which are produced by a country or region in a certain period, and it is a key indicator to evaluate the economic development level for a country or region. For a long time, people have overestimated the positive effect of GDP on promoting economic and social development. However, the pursuit of GDP growth has also caused great waste of natural resources and environmental damage. Natural Wealth Accounting is the practice of incorporating principles of natural resource management and conservation into reporting practices and cost/benefit analyses. Such accounting allows a sector to see the impact of ecologically sustainable practices in everything from their value chain. It allows accountants to report on the economic impact of those decisions to stakeholders to allow for proactive decision making about processes that simultaneously meet environmental regulations while adding to the bottom line.

The population of Bangladesh is more than 166 million people. Forests contribute a significant portion of the economy (46%) at local and national levels, followed by crop/fruit production in the region[1]. The communities residing near the forest in Bangladesh depend on the forests for the collection of NTFPs such as medicinal bark of Menda, Taragota (a substitute of cardamom), bamboo, honey, fruits and tendu leaves, along with the collection of fuel wood and timber. However, over the years, as suggested by multiple literatures, the forest condition in Bangladesh has deteriorated considerably. The pathways of causation of forest decline in Bangladesh are closely related to poverty, overpopulation, and an inability to govern natural resources in a properly planned manner[2].

The above-mentioned threats have had a significant impact on the natural wealth of the country over the years. In addition to that, there is no current mechanism of natural resource accounting in the country which has resulted in poor decision making and lack of institutional support. Institutional and capacity gaps have exacerbated the impact on these forests which are also the reason behind the low annual budgetary allocation for conservation and preservation of natural resources.

Till now, Bangladesh has calculated its GDP mostly based on income and production and there is no integration of natural capital and the provisioning, cultural, supporting and regulating value of the ecosystem services in GDP accounting in their systems. Thus, due to this rationale the current assignment is aimed at developing the natural wealth accounting system for Bangladesh and identifying PES schemes for conservation and preservation of natural resources. The study is targeted towards igniting cognizance among policy and decision makers on the economic value of the ecosystem services provided by forests and Protected areas by unveiling the ecosystem's economic worth.

[1] Adapting Land Degradation and Enhancing Ethnic Livelihood Security Through Fruit Production: Evidence from Hilly Areas of Bangladesh | SpringerLink

[2] UN-REDD Bangladesh National Programme | United Nations Development Programme (undp.org)

## 1.2 Forests of Bangladesh

Bangladesh is located in the largest deltaic plain in the world, the Ganges-Brahmaputra delta, in the north-eastern part of South Asia. It lies between 20°34/ and 26°38/ North latitude and 88°01/ and 92°41/ East longitude and is mostly composed of floodplains with some hilly areas and has a sub-tropical monsoon climate. Around 80% of the country's land is low-lying and prone to flooding, especially during the monsoon season, making it the largest flood-basin in South Asia. The majority of the land is formed by river alluvium from the Ganges and Brahmaputra rivers and their tributaries. Despite facing a challenging period that has negatively impacted its biodiversity and ecosystem, Bangladesh is situated in a unique geophysical location and has a suitable climate, making it rich in biodiversity with a variety of endemic plant species, believed to be over 7,000, in the Indo-Burma region, which is a global biodiversity hotspot. The detailed biogeographic features of Bangladesh are provided as Annexure 1.

Bangladesh is home to the world's largest continuous mangrove forest, the Sundarbans, which harbors the largest surviving population of the Royal Bengal tiger. The country also has evergreen to semi-evergreen hill forests in the east and wetlands, known as haors, in the northeast that support a diverse array of aquatic plants, migratory birds, and freshwater fish species[3]. The forests of Bangladesh cover three major vegetation type occurring in three distinctly different ecosystems, that is, hill forests (evergreen to semievergreen); plain land Sal (*Shorea robusta*) forests and mangrove forests.

Even in a small land area, Bangladesh hosts four major types of forests: (a) Hill Forests (Tropical/mixed-evergreen forest), (b) Sal Forest (Moist deciduous forest), (c) Mangrove Forest (Natural Mangrove), and Mangrove Plantation. Few other types of forest also exist with substantial biodiversity: (d) freshwater swamp forests, (e) homestead forest, or village common forest, which is a natural forest conserved by communities for their uses[4].

1. **Tropical evergreen or mixed evergreen Hill forest** - The total Area of Hill Forests is 6, 70,000 hectares, which is 4.65% of country's area and 44% of total forestland managed by the Forest Department. Hill Forests are spread over the hilly areas of Chittagong, Cox's Bazar, Sylhet and Chittagong Hill Tracts[5]. Based on the topography, soil and climate, the Hill Forests can be further classified into:

   (a) Tropical Wet Evergreen Forests

   (b) Tropical semi–Evergreen Forests.

   The Hill Forests are rich in diverse variety of flora and fauna. Champa (*Michelia champaca*), Chapalish (*Artocarpus chaplasha*), Chickrassi (*Chickrassia velutina*), Garjan (*Dipterocarpus spp*.), Telsur (*Hopea odorata*), Dhakijam (*Syzygium grande*), Mangium (*Acacia mangium*), Lohakat (*Xylia dolabriformis*), Sal (*Shorea robusta*) are some of the species found in hill forests. Besides, bamboo, cane, climber, fern are also found in this forest type. Some of the common bamboo species are:

[3] Khan, M. A., Uddin, M. B., Uddin, M. S., Chowdhury, M. S. H., & Mukul, S. A. (2007). Distribution and status of forests in the tropic: Bangladesh perspective. *Proceedings of the Pakistan Academy of Sciences*, *44*(2), 145-153.
[4] *Reza, A. A., & Hasan, M. K. (2019). Forest biodiversity and deforestation in Bangladesh: the latest update. Forest degradation around the world, 1-19.*
[5] Khan, M. A., Uddin, M. B., Uddin, M. S., Chowdhury, M. S. H., & Mukul, S. A. (2007). Distribution and status of forests in the tropic: Bangladesh perspective. Proceedings of the Pakistan Academy of Sciences, 44(2), 145-153.

Bariala (*Bambusa valgaris*), Daloo (*Neohuzeaua dullooa*), Mitenga (*Bambusa tulda*), Muli (*Melocana baccifera*) and Orah (*Dendrocalamus longispathus*)[6].

Plantation has been a regular activity in the Hill forests of Bangladesh since 1871, these plantations play a major role in ths upply of tropical timber. Important plantation species include Teak (*Teaktona grandis*), Sal (Shorea robusta), Chickrashi (*Chichrassia velutina*), Gamar (*Gmelina arborea*), Mehogony (*Swietenia spp*.), Chapalish (*Artocarpus chaplasha*), Jarul (Lagerstroemia speciosa), Koroi (Albizia spp.), and Telsur (*Hopea odorata*).

This forest region also has a rich faunal diversity. Important mammals include Elephant (*Elephas maximus*), Rhesus Macaque (*Macaca mulatta),* Wild Pig (*Sus scrofa*), Barking deer (*Muntiacus muntjak*), Sambhar (*Cervus unicolor*) and Indian Leopard (*Panthera pardus*). Of the reptiles, King Cobra (*Ophiophagus hannah*), Monitor Lizard (*Calotes versicolor*) and Bengal Monitor Lizard (*Varanus bengalensis*) are common[7].

2. **Mangrove Forests –**Bangladesh is gifted with both natural and planted mangrove forests. Their natural mangrove forests include The Sundarbans and Chokaria Sundarbans. The Sundarbans is the largest continuous productive mangrove forests of the world, spreading over the southern part of Bangladesh and West Bengal state of India. The total area of Sundarbans is 6,01,700 hectares, which is 4.16% of the total area of Bangladesh and 40% of the forest land is managed by forest department[8].

   There are 25 true mangrove species in the Sundarbans; Sundri (Heritiera fomes) is the most important one, which occupies 73% of Sundarbans. Sundri is followed by Gewa (Excoecaria agallocha), Baen (Avicennia off cinalis), Passur (Xylocarpus mekongensis) and Keora (Sonneratia apetala). There are numerous minor forest products such as Golpata (Nypa fruticans), honey, bee's wax, fish and others[9].

   Besides the Natural mangrove forest, Bangladesh also has the extensive mangrove plantation along the 710 km long exposed coastal areas facing the Bay of Bengal[10].

   Besides the Natural mangrove forest, Bangladesh also has the extensive mangrove plantation along the 710 km long exposed coastal areas facing the Bay of Bengal.

3. **Sal Forests -** the Sal forests are classified as tropical moist deciduous forests has a total land cover of 1, 20,000 hectares, which forms the 0.83% of country's land cover and 7.9% of forestland managed by the Forest Department. Sal forests spread over the Central and Northern districts of Bangladesh. These forests are scattered in nature and intricately mixed with habitations.

---

[6] *Chowdhury, M. S. H. (Ed.). (2014). Forest conservation in protected areas of Bangladesh: policy and community development perspectives (Vol. 20). Springer*

[7] *Roy, M. K. (2004, August). Designing a co-management model for protected areas in Bangladesh. In international seminar on protected area management, University of Montana, USA.*

[8] *Khan, M. A., Uddin, M. B., Uddin, M. S., Chowdhury, M. S. H., & Mukul, S. A. (2007). Distribution and status of forests in the tropic: Bangladesh perspective. Proceedings of the Pakistan Academy of Sciences, 44(2), 145-153.*

[9] *Khan, M. A., Uddin, M. B., Uddin, M. S., Chowdhury, M. S. H., & Mukul, S. A. (2007). Distribution and status of forests in the tropic: Bangladesh perspective. Proceedings of the Pakistan Academy of Sciences, 44(2), 145-153.*

[10] *Khan, M. A., Uddin, M. B., Uddin, M. S., Chowdhury, M. S. H., & Mukul, S. A. (2007). Distribution and status of forests in the tropic: Bangladesh perspective. Proceedings of the Pakistan Academy of Sciences, 44(2), 145-153.*

The biodiversity of Sal forests includes a wide variety of flora and fauna. The dominant tree species found in the Sal forests is Sal (*Shorea robusta*). Other species include Banyan (*Ficus bengalensis*), Ashwath (*Ficus religiosa*), Lemon (*Citrus spp*.), Sharifa (*Anona squamosa*), Grapefruit (*Citrus decumana*), Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), Guava (*Psidium guajava*), and Pineapple (*Ananus sativa*). A total of 36 families including 63 common plant species are present in the Sal Forests. Important mammals include Jackal (*Canis auveus*), Bengal Fox (*Vulpes bengalensis*), and Jungle Cat (*Felis chaus*). Of the reptiles, Bengal Monitor Lizard (*Varanus bengalensis*) and Common Cobra (*Naja naja*) are important. A total of 220 species of wildlife including 12 amphibians, 25 reptiles, 148 birds and 35 mammal species are available in the Sal forests[11].

4. **Reed Land Forests –** These forests are also classified as the Freshwater Swamp Forests. The reed land forests are situated in the Sylhet Division of the country comprising a total area of 23571.39 hectares.[12] These forests are dominated by the reed swamp association known as Pajuban and consist of tall grass namely Nal (*Phragmites kakra*), Khagra (*Saccharum spontaneum*), and Ekra (*Eranthus ravannae*). Meadow grasses such as Binna (*Vetivera zizaniodes*) dominate the open areas. The main tree species include Hijal (*Barringhtonia acutangula*), Bhuri/Pitali (*Trewia nudifl ora*), Barun (*Crataeva nurvata*), and Karach (*Pongamia pinnata*).

   The reed land areas are also very rich in faunal diversity. A survey reported 27 mammals, 49 birds, 22 reptiles and 9 amphibians from the reed-land forests. All of them are used as food, medicine, bait, for commercial trade and recreation. The reed-land flood plains are also rich in fisheries resources[13].

5. **Village Forests -** Village groves or village forests play a very important role in the economy of the country. The tree cover of village forest is 2,70,000 hectares. These provide a significant portion of the wood and firewood supply of the country. Besides wood production, village forests have several important uses. They provide fruit, fodder, fuel, raw material for small and cottage industries, house construction materials, agricultural implements, cartwheel, etc. The area covered by village groves or forest is estimated to be about 0.27 million ha[14]. This is not forest as per definition. However, in the Bangladesh context this tree cover is very significant in many ways[15].

**Table 1: Major forest types and areas of Bangladesh**

| Forest type | Location | Area | Remarks |
|---|---|---|---|
| **Hill forests** (Evergreen to Semi Evergreen) | Eastern part of the country (Chittagong, Chittagong Hill Tracts and Sylhet) | **0.67** | Highly degraded and managed by the Forest Department |

[11] *Chowdhury, M. S. H. (Ed.). (2014). Forest conservation in protected areas of Bangladesh: policy and community development perspectives (Vol. 20). Springer.*
[12] https://www.usfsbd.org/forest-in-bangladesh-242367
[13] Bangladesh Centre for Advance Studies, (1997), *Sicio-economic Survey in Reed-land Forest Areas*, Vol.1, Dhaka.
[14] *Roy, M. K. (2004, August). Designing a co-management model for protected areas in Bangladesh. In international seminar on protected area management, University of Montana, USA.*
[15] https://en.banglapedia.org/index.php/Forest_and_Forestry

| | | | |
|---|---|---|---|
| **Unclassified state forest** (USF) | Chittagong Hill Tracts | **0.73** | Under the control of district administration and denuded mainly due to faulty management and shifting cultivation. Mainly scrub forest. |
| **Plain Land Sal Forests** (Tropical moist deciduous forests) | Central and north-western region (Dhaka, Mymensingh, Tangail, etc.) | **0.12** | Mainly Sal Forest but now converting to exotic short rotation plantations. Managed by the Forest Department. |
| **Mangrove forests** | | | Managed by the Forest Department. |
| Sundarbans | Southwest (Khulna, Satkhira) | **0.57** | Mangrove plantations along the shoreline of 12 districts. Managed by Forest Department |
| Coastal plantation | Along the shoreline of twelve districts | **0.10** | |
| **Village forests** | Homestead forests all over the country | **0.27** | Diversified productive system. Fulfill majority of country's domestic timber, fuel wood and bamboo requirements. |
| **Tea gardens and rubber plantations** | Chittagong Hill Tracts and Sylhet | **0.07** | Plantations of tree and rubber with various short rotation species as shade tree |
| **Total** | | **2.53** | 17.49 % of country's landmass |

***Source: Mukul et al. (2014): Khan et al. (2007)***

## 1.3 Demographic and Economic Status of Bangladesh

Bangladesh is the eighth most populated country in the world with almost 2.11% of world's population. As per 2022 Census of Bangladesh, the population of country is about 169.25 million. Bangladesh has a total land area of 13.01 million hectares and based on the 2020 United Nations Data on population and land mass, Bangladesh is among the highest populated country with 1265 per square km. Bangladesh population is evenly distributed throughout its landscape, only the three hill tracts districts are sparsely inhabited. There are four metropolitan cities and 119 municipalities in the country and only 39.4% of the population resides in urban areas. About 91.04% of Bangladeshis are ethnic Bengalis, while rest 2% of the population is made up of other minorities and ethnic tribes. These minorities include indigenous people in northern Bangladesh and the Chittagong Hill Tracts, which have 11 ethnic tribal groups such as the Tanchangya, Chakma, Bawm, Kuki, and Marma. The Mymensingh region is home to a large Garo population, while North Bengal has a large population of aboriginal Santals[16].

The economic performance of a country is assessed by its gross domestic product (GDP); it is the measure of goods and services in monetary terms produced within the borders of a country indicating its overall economic health. An increase in the GDP is interpreted as a sign of economic development. According to the World Bank data 2021, Bangladesh was worth 416.36 billion US dollars representing 0.19% of the world economy and is expected to grow its GDP by 5.35% in Fiscal Year (FY) 2023[17]. Though GDP is widely used to track economic development, it may not provide the most relevant

[16] https://worldpopulationreview.com/countries/bangladesh-population

[17] Asian Development Outlook(ADO) April 2023, http://dx.doi.org/10.22617/FLS230112-3

aggregation of all the various economic performances present in the country. As different country uses different approach, methods and standards to estimate their GDP, it becomes difficult to compare the economic growth of different countries. Unlike the other measures of economic productivity, GDP per capita measure the overall well-being and the prosperity of a country by taking its average population size into consideration and allowing easy comparison between the countries with different sizes. GDP per capita is estimated by dividing the nation's GDP with its mid-year population[18]. Bangladesh has witnessed a continuous rise in its per capita GDP. In 2000 the per capita GDP of Bangladesh was 413 US$, which augmented to 2758 US $ in 2021. There is a 9% CAGR increase in GDP per capita from 2000 to 2021.

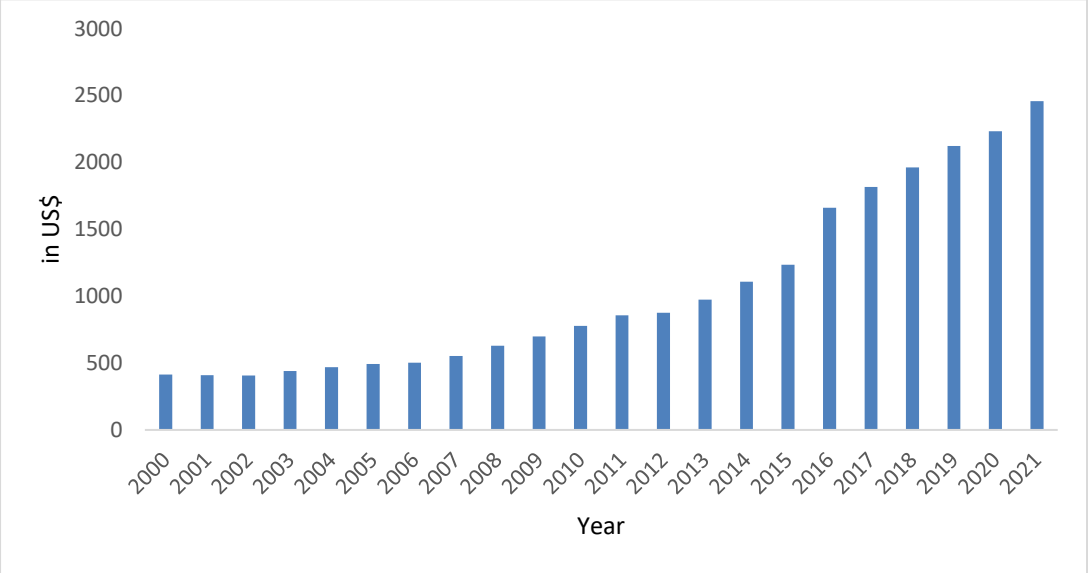



**Figure 1: GDP per capita (current US$) of Bangladesh**

Source: World Bank

Developing countries like India, Vietnam, Pakistan, and Indonesia all have witnessed an average growth rate of 5-6% from 2000 to 2021. In absolute terms, the GDP of Bangladesh is comparable with GDP of Vietnam and Pakistan, while the GDP of Indonesia and India far exceed that of Bangladesh as shown in figure below.

[18] https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/gross-domestic-product-GDP

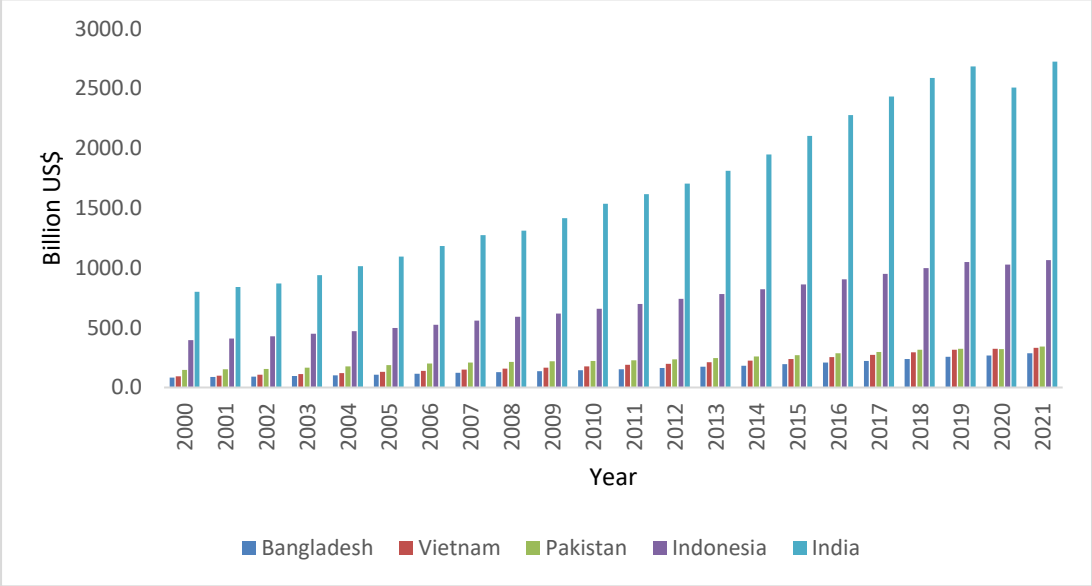



**Figure 2: GDP (constant 2015 US$) of different developing countries**

Source: World Bank

Economy of Bangladesh is dominated by service sector, followed by industry. The service sector contributes to more than half to its GDP. In 2000, the service sector contributed to almost 50% of the GDP which increased to 54% in 2015. Contribution of manufacturing sector has increased from 14% in GDP in 2011 to 21% in 2021-22. Share of agriculture sector in GDP has dwindled from 22% in 2000 to 11% in 2021.

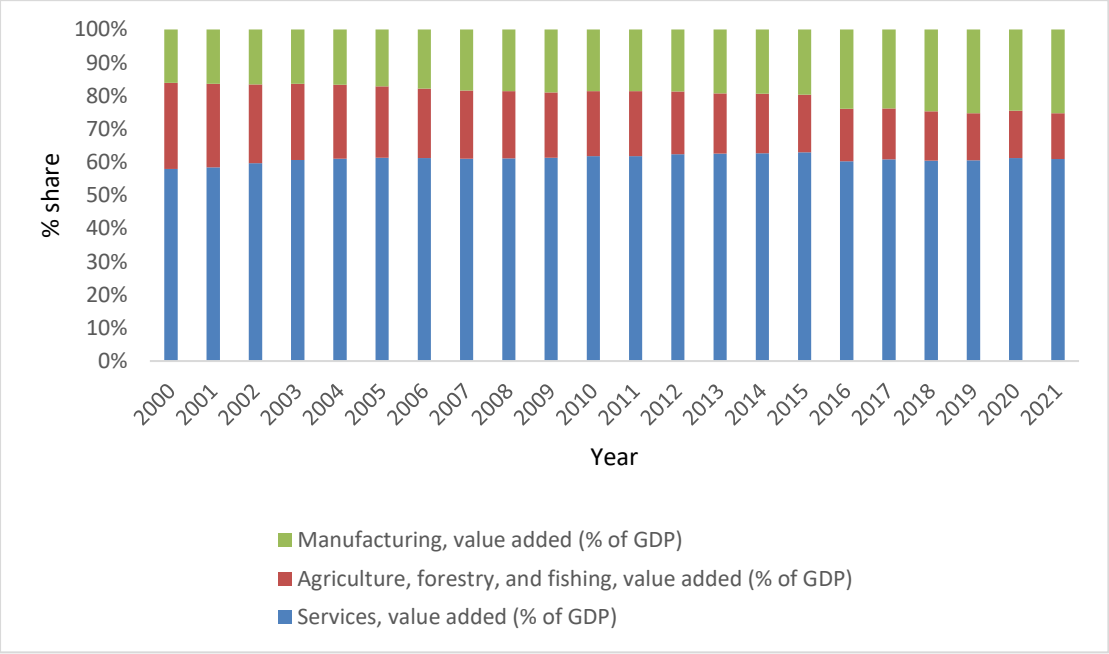



*Figure 3: Sectoral contribution (as a percentage of GDP)*

Source: World Bank

Bangladesh exhibited a steady and high GDP growth, averaging 7.4 percent per year during FY 2015-16 to FY 2018-19 before the COVID-19 pandemic, and reached a record 8.15 percent growth rate in FY 2018-19[19][20].

In FY 2020-21, the current account balance deficit stood at US$ 3,808 million on the back of robust remittance inflows compared to a US$ 4,724 million deficit in the previous year. Financial accounts and capital accounts showed surplus during this time. Therefore, the overall balance recorded a surplus of US$ 9,274 million in FY 2020-21 compared to US$ 3,169 million surplus in the previous year. As a result, the foreign exchange reserves increased to a record US$ 46.39 billion on 30 June 2021. During this period, a marginal (0.05%) depreciation in the exchange rate of Taka with the US dollar is being observed.

## 1.4 Legal Instruments for Forest Conservation

Lists of forest Acts of Bangladesh include[21]:

1. **Forest Act, 1927** - Integrates the law relating to forests, the transport of forest produces and the duty accountable on timber and other forest-produce.[22]
2. **Forest Act (Amendment), 1989** - Provides authority over any government-owned land suitable for afforestation and to strengthen forest protection by providing stiffer penalties and restricting the discretionary powers of forest officials and local magistrates. This act empowers the government to regulate the felling, extraction, and transport of forest produce in the country.
3. **The Bangladesh Private Forest Act (PFA),1959** - Regulate private forest land that allows the Government to take over management of improperly managed private forest lands, any private lands that can be afforested, and any land being uncultivated for more than three years. The government managed lands under this act are called "vested forests". The Forest Department manages approximately 8,500 hectares in the country as "vested forests".
4. **State Acquisition and Tenancy (SAT) Act, 1950** - Eradicated the landlord system and provided title of the land to its tillers and set limits on extent and kinds of private land holding. Allow retention of the homesteads and agricultural lands up to a specified limit but did not entitle a tenant to retain forested lands. During the period SAT Act became operative, many people illegally cleared their forests and hastily erected settlements so that government is not able to claim that land. The private forest lands acquired by the government under this Act are called "acquired forests".

[19] https://www.adb.org/countries/bangladesh/economy

[20] *Bangladesh Economic Review, 2021. Refer: Bangladesh-Economic-Review - Finance Division, Ministry of Finance-Government of the People\'s Republic of Bangladesh (portal.gov.bd)*

[21] https://www.slideshare.net/ShamimAlrazi/forest-acts-of-bangladesh

[22] https://www.researchgate.net/profile/Mohammed-Jashimuddin/publication/283732074_Forest_conservation_in_Bangladesh_Legal_measures_and_policy_support_in_relation_to_landscapes_and_land_use_issues/links/57dcd63808ae4e6f1846bae2/Forest-conservation-in-Bangladesh-Legal-measures-and-policy-support-in-relation-to-landscapes-and-land-use-issues.pdf

5. **The Acquisition of Wasteland Act, 1950** - Provide the acquisition for public purposes of waste land and authorizes the Government to acquire private lands that have been uncultivated from the last five years for any public purpose including afforestation, production of food, for carrying out waterworks, etc. The Government shall notify and declare in the official gazette that any waste land is needed for public purposes and then direct the collector to take order for the acquisition of the land. The Act further provide principles for determining compensation, penalties to shut off the acquisition of land, rulemaking powers of the Government, etc.
6. **The Private Forest Ordinance, 1959** - Provide the conservation of forests and the afforestation in certain cases of waste lands where such forests or lands are not the property of the Government or where the Government have no proprietary right over such forests or lands.
7. **Brick Burning (Control) (Amendment) Act, 1992** - The Brick Burning (Control) Act, 1989 as amended in 1992 and 2001 outlaws the use of wood fuels in brick making. It provides fines, imprisonment, and loss of license if anyone finds to make bricks from fuelwood.
8. **The Bangladesh Wildlife (Preservation) (Amendment) Act, 1974** - Regulates the preservation and safety of biodiversity, forest, and wildlife of the country.
9. **The Protection and Conservation of Fish (Amendment) Act, 1984** - Amends the Fisheries Ordinance to raise penalties for illegal fishing. Provides the conservation, development, propagation, protection, exploitation and disposal of inland fish and fisheries.
10. **Bangladesh Environment Conservation Act, 1995** - Provide conservation and improvement of environment; and provides environmental standards for pollution control and mitigation.
11. **Land Reforms Act, 1984** - Reform the law relating to land tenure, land holding and land transfer with a view to maximising production and ensuring a better relationship between landowners and sharecroppers.
12. **Cattle Trespass Act, 1871** - Consolidate and amend the law relating to Trespasses by Cattle which states that any owner, keeper, or attendant of cattle, who neglects/damages/causes or permits to damage any land/any crop/land produce by allowing such cattle to trespass will be on conviction before a Magistrate.

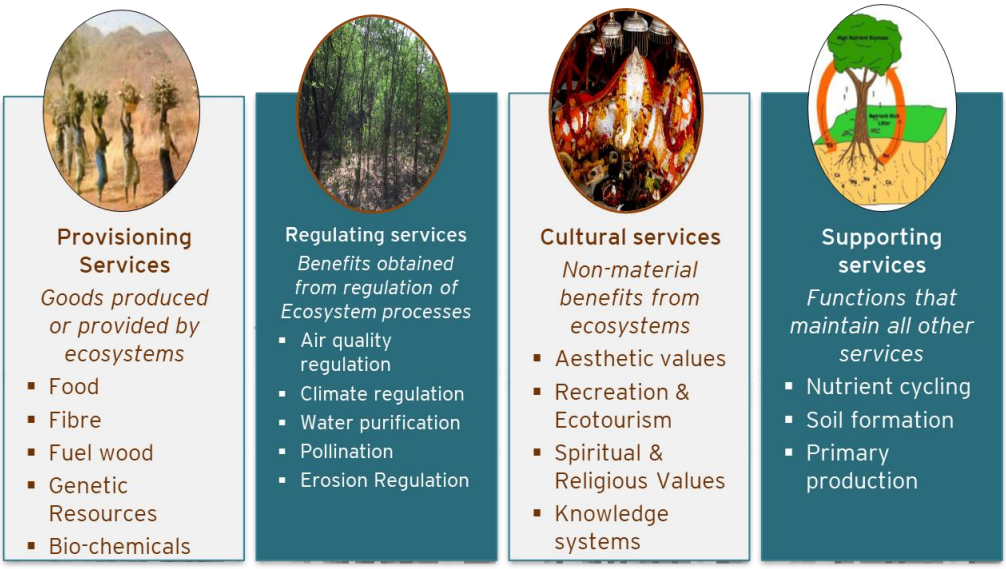
**Conventions ratified by Bangladesh**:

1. The Ramsar Convention
    - Adopted in 1971 in the Iranian city of Ramsar and came into force in 1975.
    - The Ramsar Convention on Wetlands of International importance (especially as Waterfowl Habitat) is a treaty for the conservation and sustainable use of wetland.
2. Convention on the Protection of the World Cultural and Natural Heritage
    - Adopted in 1972 by General Conference of UNESCO that promotes an international perspective on cultural heritage by inviting state members to submit an inventory of properties forming its national cultural and natural heritage that is to be included in a list of World Heritage sites.
3. Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
    - Introduced in 1973 and entered into force in 1975.
    - It is an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

4. United Nations Framework Convention on Climate Change (UNFCC)
    - Entered into force in 1994.
    - An International environmental treaty whose objective is to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with climate system.

## 1.5 Ecosystem Services of Bangladesh

Millennium Ecosystem Assessment (MEA) defines ecosystem services as the benefits people obtain from ecosystems which include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (MEA, 2003)[23].




If the value of these services is not clearly defined, they may be overused. Valuation measure how important the service is to the people and why they should be used in a sustainable manner.

Total Economic Value (TEV) framework assumes that individuals hold multiple value for ecosystem which ensures that all values are given recognition and no double counting of values occur in the valuation process. Economists classify ecosystem values into two types-

1. Use values.

    These are generally grouped into two types, direct, indirect or option values, that refers to consumptive and non-consumptive uses. Direct consumptive use values involve the extraction of an environmental asset for anthropocentric purpose, whereas non-consumptive direct use values

[23] The Millennium Ecosystem Assessment (MEA, 2003)

include the services that are provided directly without extraction- such as in aquatic ecosystems, use of water for transportation and recreational activities. Option use values involve the genetic material that are unknown today but could be useful in the future.

2. Non-use values

Most of natural environments are thought had significant values and the people do not make use of these values rather wish to see them preserved "in their own right" (Bishop and Welsh, 1992). Non-use values does not concern with our use, either direct or indirect use of the environment. It is further categorized into existence and bequest value. Existence value is the benefit reflected as a sense of wellbeing or simply knowing that the biodiversity exists, even if it is never utilised or experienced. Bequest value determined by the individual concern that future generation should have access to functional ecosystem and its resources.

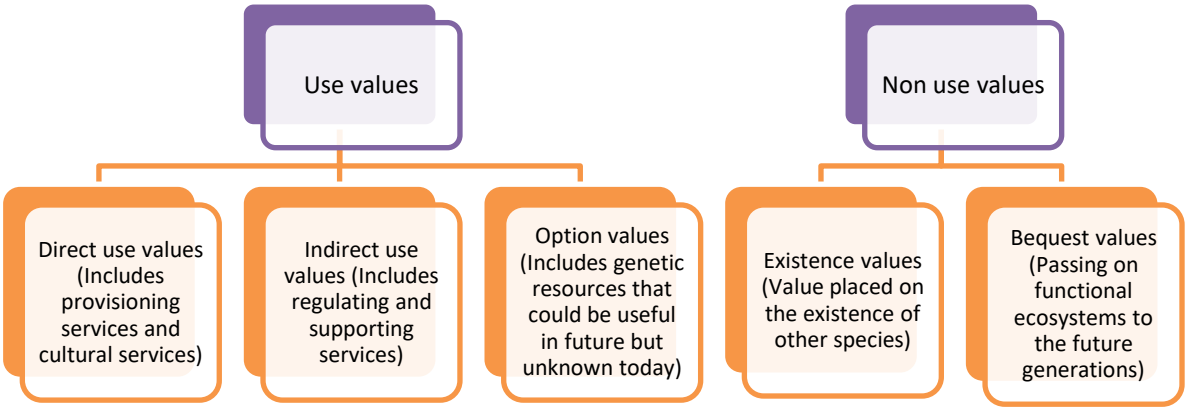



**Figure 4: Classification of Ecosystem Services based on Use and Non-use values.**

There have been a several studies since 2002 to document the ecosystem services provided by the forests and its value in Bangladesh. Although the major focus of the studies has been on the Sundarban habitat, terrestrial landscapes such as Chittagong Hill Tract and Sylhet hill have also been studied. The list of detailed studies conducted has been provided as Annexure 1.

Based on the secondary literature reviewed, the below mentioned services are identified for ecosystem evaluation of Bangladesh forest ecosystem in three protected areas i.e., **Teknaf Wildlife Sanctuary**, **Madhupur National Park**, and **Ramgarh-Sitakunda Reserve Forest.**

1. Provisioning services
    - Timber, Bamboo, fodder, NTFPs.
    - Fuel wood
    - Fish and other aquatic produce
2. Regulating and Supporting services
    - Carbon sequestration and storage
    - Water purification and Soil conservation
    - Biodiversity and conservation
3. Cultural services
    - Tourism and recreation
    - Education, Science and Research

In consultation with Bangladesh Forest Department (BFD), the services will be revised based on the relevance and importance to the study region.

It should be kept in mind that the ecosystem services provided by the two PAs and one reserve forest would be identified based on the preliminary scrutiny of the existing literature. However, this may alter during the study.

# 2. Objectives and Scope of the Project

The specific objectives of the study include:

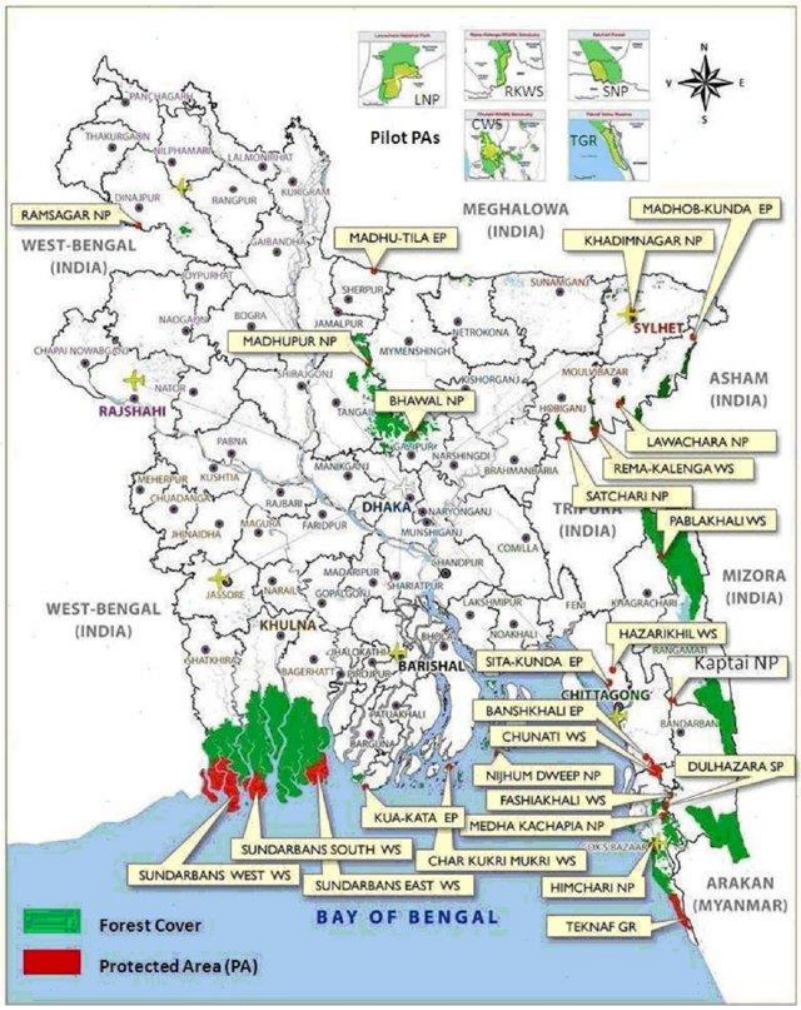
- To devise a methodological approach for compiling forest accounts for Bangladesh that is in alignment with System of environmental- economic Accounting Central framework (SEEA CF) and compliments the standard national accounts of country.
- Compiling a draft National Capital Account for forest and Protected Areas of Bangladesh.
- Application of developed framework for detailed valuation of National Capital in Teknaf Wildlife Sanctuary (TWS), Modhupur National Park (MNP) and Ramgarh-Sitakynda Forest Reserve (RSRF).
- To carry out feasibility study for setting up Payment for Ecosystem Services in Ramgarh-Sitakunda Reserve Forest
- Dissemination of results of National NCA framework

The specific tasks and scope of the work for the study are:

- Devise a methodological approach for compiling forest accounts for Bangladesh that is aligned to the System of Environmental-Economic Accounting Central Framework (SEAA CF) and compliments the standard national accounts of the country.
- Compile Natural Capital Accounts for the forests and Protected Areas of Bangladesh
- Apply the developed framework to make more detailed valuation of Natural Capital in Teknaf Wildlife Sanctuary (TWS), Modhupur National Park (MNP) and Ramgarh-Sitakunda Reserve Forest (RSRF)
- Undertake scoping assessment/ feasibility study for setting up Payment for Ecosystem Services (PES) scheme in the RSRF.
- Conduct a workshop to disseminate the results of National NCA framework, Forests and Protected Area accounts, application in selected PA's and PES feasibility.

## 2.1 About Study Area

The proposed work will be carried out in three Protected Areas of Bangladesh, i.e., Teknaf Wildlife Sanctuary (TWS), Madhupur National Park (MNP) and Ramgarh-Sitakunda Reserve Forest (RSRF). The Organization structure of Bangladesh Forest Department is given in Annexure 6.3.




**Source**[24]

The three protected areas are blessed with various ecosystem services which sustain livelihood of the local communities living around the forests and ensuring conservation of biodiversity.

1. **Teknaf Wildlife Sanctuary**

   It was designated as Teknaf Game Reserve in 1983. In December 2009, The Government of Bangladesh enhanced its status to a Wildlife Sanctuary protecting 11,615 ha. The sanctuary lies between 20°52' and 21°09'N latitude and between 92°09' and 92°18'E longitude. It is one of the few places in Bangladesh where Asian elephants can be seen in wild. It comprises a range of steep hills aligned north south. Teknaf range is bordered by 48 villages.

   Restoring forest here offers the scope to double carbon sequester 157 tons of CO2 per hectare for climate change mitigation. Local people, including Kuti, Marma and Chakma ethnic communities, are poor and depend on forest resources, threatening the biodiversity and ecology. Activities impacting on the protected area include wood cutting (mostly for fuel), cultivation (rice and betel leaves and nuts), and extracting earth from hills, fires, sun grass collection and salt production.

[24] (17) (PDF) An overview on the protected area system for forest conservation in Bangladesh (researchgate.net)

Tourism attractions include the Teknaf Nature Park, a Second World War bunker, ethnic handloom products, patches of mangroves and the Teknaf sea beach.[25]


**Figure 5: Teknaf Wildlife Sanctuary**

**Madhupur National Park, Madhupur, Tangail**

It is situated on Dhaka-Mymenshing Road, 125 km North of Dhaka. It covers an area of 8436 ha. MNP was established in 1982. The NP lies between 24.7038° N, 90.0773° E. The river Bangshai flows by the side of the forest. The Garo, Koch and Barman communities live in the surrounding area of MNP, comprising a total of 187 villages, with varied degrees of dependency upon the forest. The Natural Sal forests are found (tropical moist deciduous type). [26]

The major challenges faced by the park area include encroachment by the locals for agricultural purposes and extraction of natural resources. Fuel wood, herbs, and timber for commercial use. Locals

[25] https://nishorgo.org/project/teknaf-wildlife-sanctuary/
[26] http://koreascience.or.kr/article/JAKO201928951544114.page#:~:text=References-,Abstract,is%20tropical%20moist%20deciduous%20type.

cultivate the lands in the surroundings of the park area for pineapple, jackfruit and other commercially viable fruits. [27]

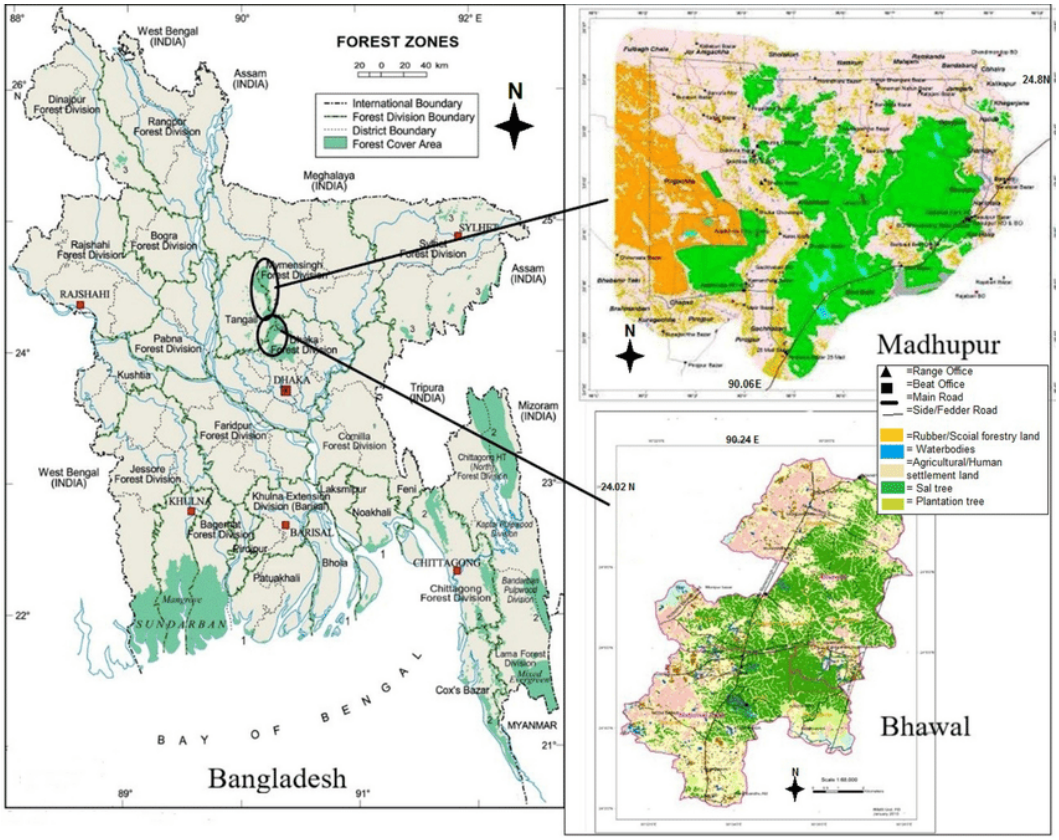



**Figure 6: Location map of Madhupur National Park**

**Ramgarh-Sitakunda Reserve Forest, Chittagong**

It was established in 2001. The botanical garden and eco-park area, comprising 808 ha. The forest covers an area of 72 square kilometres. Mostly tropical evergreen forest is found.[28] This reserve forest hosts the Baroiadhala National Forest and the Hazarikhil Wildlife Sanctuary.[29] It lies between Latitude- 22.70528° or 22° 42' 19"N and Longitude- 91.64972° or 91° 38' 59"E. It is surrounded by settlements of Bangali and Tripura communities, of about 14,612 households. They mainly engage in homestead gardening, horticulture, and aquaculture-based activities. During religious festivals, they are

[27] https://nishorgo.org/project/madhupur-national-park/
[28] https://www.usfsbd.org/forest-in-bangladesh-242367#:~:text=Tropical%20evergreen%20or%20mixed%20evergreen,Chittagong%2C%20and%20Cox's%20Bazar%20districts.
[29] https://www.tbsnews.net/environment/ramgarh-sitakunda-reserve-forest-stake

somewhat dependent upon the tourism generated from the visitors to the renowned Chandranath Mondir, a Hindu temple situated on the northern range of hills.[30]

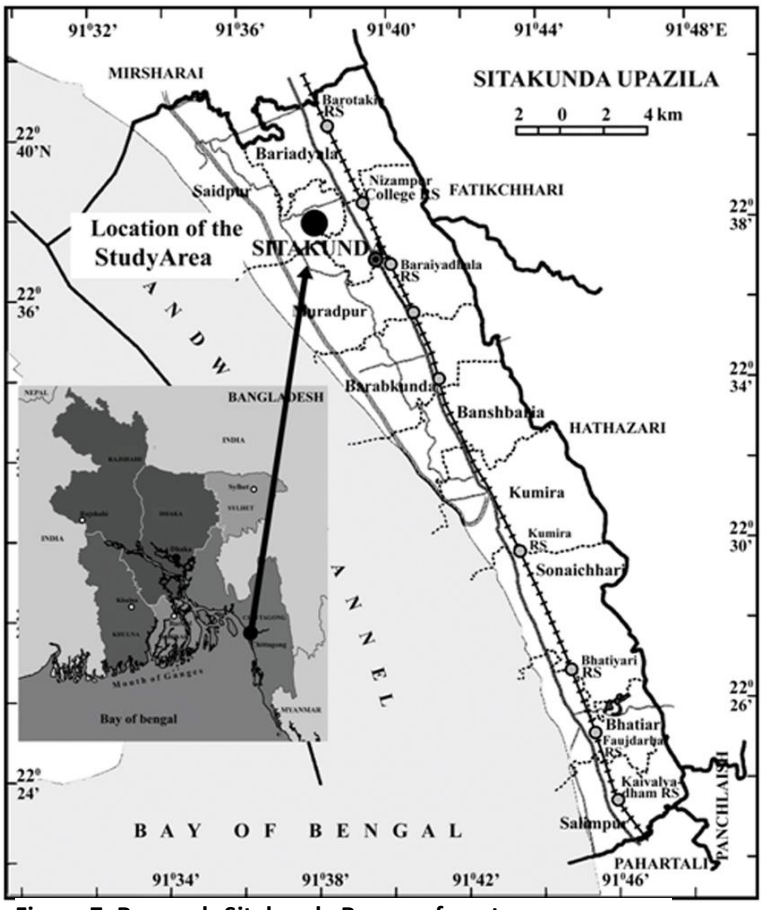



**Figure 7: Ramgarh-Sitakunda Reserve forests**

[30] https://nishorgo.org/wp-content/uploads/2017/06/7-7-15-Sitakunda-Eco-Park.pdf

# 3. Framework for Natural Wealth Accounting for Bangladesh

## 3.1 Review of existing national and international frameworks

**Millennium Assessment (MA) Report**

It was launched in 2001 and the principal report was published in 2005. The proposal for Millennium Assessment arose during a meeting held at World Resources Institute (WRI) on 17 May 1998 to discuss plans for biennial world resources. The meeting concluded with proposal of set of activities to create a new international assessment process, which includes the activities-

a) Conducting a 'Pilot Analysis of Global Ecosystems' (PAGE).
b) Focusing world resources from 2000-2001 on the condition of global ecosystem
c) Establishing a consultative process that could lead to creation of a full international science assessment.

The studies under Millennium Assessment Report underlines how humans have changed the environment and the consequences of changing environment on human well-being. The findings are compiled in five technical volumes and six synthesis reports, which provides information to decision-makers to manage ecosystem in more sustainable manner that maintain biodiversity and ecosystem. MA doesn't generate new primary knowledge, instead add value to existing information by clarifying-how ecosystems, human wellbeing and intrinsic values in nature are intimately connected.

**Natural Capital Accounting**

The conventional economic aggregates via national accounting such as GDP only measures the current income and production but tell us nothing about income for long-term. This underestimates the value of natural capital (such as energy/minerals, forests, agriculture lands, Protected Areas etc.) of a country. As natural capital provides a number of benefits and services, there is a need to valuate natural capital to recommend government for taking contribution into consideration of natural wealth into National Accounting System. Natural Capital Accounting (NCA) is a tool which measures the changes in the stock and condition of natural capital (ecosystems) at different scales to integrate the flow and value of ecosystem services into accounting and reporting systems in a standard way[31]. NCA gives a detailed statistics for the better management of natural resources which contribute to economic development. Natural Capital of a country provides outputs and outcomes that directly and indirectly effect human well-being and can be mainstreamed in development planning and national economic account. Natural Capital forms a large share of countries total wealth.

**The Economics of Ecosystems and Biodiversity (TEEB)**

This project started in 2007 by the group of Environment Ministers of G8+ 5 countries (which involves the group of leaders from G8 nations and heads of govt. of 5 leading emerging economies). It highlighted the urgent need of improving knowledge and awareness about the loss of biodiversity and helps policy makers in decision-making on nature conservation and sustainable economic

[31] https://environment.ec.europa.eu/topics/nature-and-biodiversity/natural-capital-accounting_en#:~:text=Natural%20capital%20accounting%20is%20a,systems%20in%20a%20standard%20way

development[3233]. To achieve this goal a structured approach was implemented for valuation of benefits provided by the biodiversity and ecosystem to demonstrate their value in economic terms, and wherever possible capture the monetary value in decision making process[34].

**Wealth Accounting and Valuation of Ecosystem Services (WAVES)**

It is a World-Bank global partnership that promotes sustainable development by mainstreaming natural resources in the economic system of the country for national economic accounts and development[35]. The major objective of the initiative is[36]:

a) Develop approaches and methodology for ecosystem accounting.
b) Aiding countries to adopt and implement accounts relevant for policy making and compiling the experience data.
c) Establishing a global platform for training and knowledge sharing
d) Building international consensus for natural capital accounting.

The United Nations Statistics Division, the United Nations Environment Programme, the Secretariat of the Convention on Biological Diversity, and the European Union launched the project "Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES). The accounts developed under WAVES program has demonstrated that for data poor and middle-income countries these ecosystem accounts can be used for formation of national development policies and plans. The World Bank Group leads a partnership to advance natural capital internationally. On the experience of WAVES, World Bank developed the Global Program on Sustainability (GPS) to expand the application of "sustainability" for decision making in developing countries.

[32] *TEEB (2010a) The Economics of Ecosystems and Biodiversity, Ecological and Economic Foundations. Earthscan, London and Washington*

[33] *TEEB (2010b) Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. TEEB*

[34] https://teebweb.org/

[35] https://seea.un.org/home/Natural-Capital-Accounting-Project

[36] https://www.wavespartnership.org/en/wealth-accounting-and-WAVES

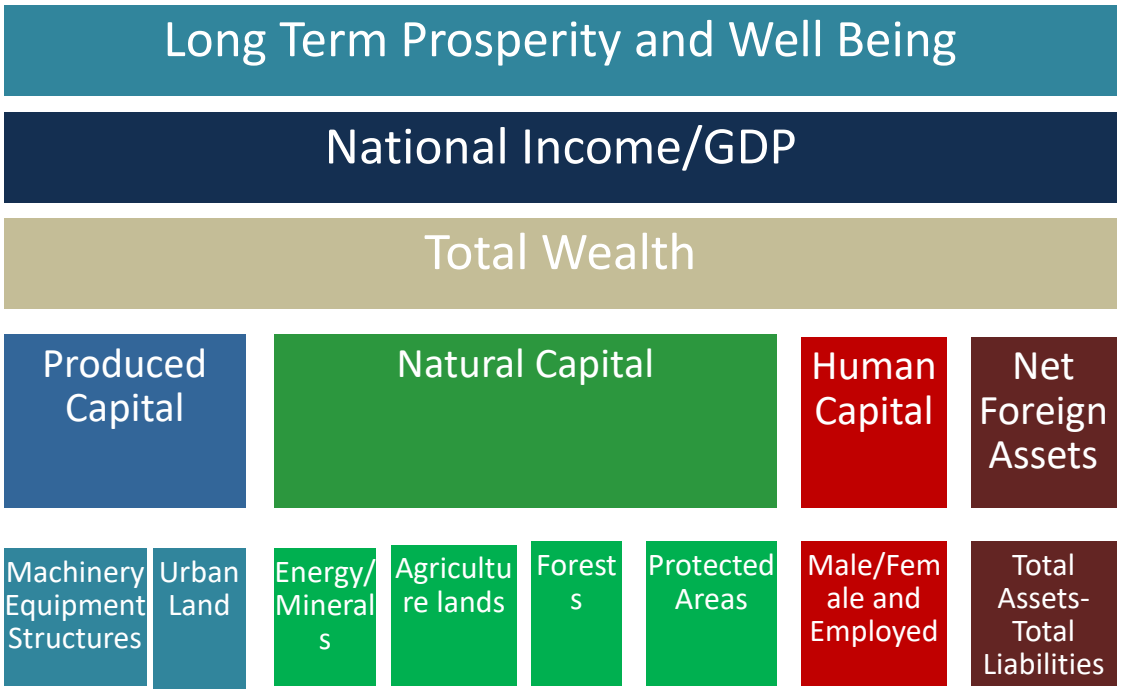



*Figure 8: Total wealth composition of a country*

***Source: Wealth Accounting and the Valuation of Ecosystem Services***

## 3.2 Current System of National Accounts of Bangladesh

The System of National Accounts (SNA) describes a consistent, integrated, and coherent set of macroeconomic accounting principles that are in line with the internationally agreed definitions, classifications, concepts, and accounting rules. The 1993, United Nations System of National Accounts version is used by Bangladesh, whereas the 2008 version is the latest SNA framework available[37].

The Accounting systems record financial transactions. The two major accounting systems are cash accounting and accrual accounting. Cash accounting systems recognize transactions and events when cash is received or paid; they do not recognize non-cash events. Accrual accounting systems, on the other hand, record payments and receipts when parties enter a commitment, not when cash changes hands. For instance, an accrual accounting system would record the purchase of naval helicopters when the government signs a contract to buy the helicopters, not when the helicopters are delivered and paid for (which would be the case in a cash accounting system). An accrual accounting system views the commitment, rather than the exchange of cash for goods or services, as the event that has economic significance[38].

[37] https://www.worldeconomics.com/National-Statistics/GDP-SNA/Bangladesh.aspx
[38] https://www.cbgaindia.org/wp-content/uploads/2016/03/Information-Kit-on-the-Budget-of-Bangladesh.pdf

**Budgeting system of the country**

A new Budget and Accounting Classification System (BACS) has been introduced from FY 2018-19 with a view to upgrading government financial management to an international standard. In addition to civil administration, defense and railway budget and accounting process have been brought under the iBAS ++ software developed by local experts. To make this system more dynamic, activities will be undertaken for consolidation and integration among them. To simplify the development project fund release process, project directors have been given the full authority in FY 2019-20 to utilise project fund without seeking approval from any authority. For Budget Balance, the Government is conscious to keep the budget deficit within 5 percent of GDP. But in the revised budget of FY 2020-21, due to 'COVID-19' pandemic budget deficit crossed 5 percent of GDP. In the revised budget of FY 2020-21, budget deficit has been estimated at Tk. 1,83,466 crore (Including Grant) which is 5.9 percent of GDP. Of this deficit, Tk. 68,414 crore (2.22% of GDP) will be financed from external sources (including foreign grant) and Tk. 1,15,052 crore (3.73% of GDP) will be backed by domestic sources. To finance the deficit in the domestic sector, there is a plan to get Tk. 79,749 crore from the bank system and the remaining Tk.35,303 crore from the non-bank sector. As per iBAS++ provisional estimate the budget deficit excluding grants stand at Tk. 1,87,451 crore, which is 6.1 percent of GDP[39].

## 3.3 System for Environmental Economic Accounting Framework

System of Environmental Economic Accounting (SEEA) emerged from ongoing discussions on assessing and measuring the concept of sustainable development. It was adopted as an international standard by UN Statistical Commission at its 43 sessions in March 2012 and became the first international statistical standard for environmental-economic accounting.

SEEA Central Framework is a multipurpose framework for understanding interactions between economy and environment, and for describing stocks and changes in stocks of environmental assets which brings together information on water, minerals, energy, timber, fish, soil, land and ecosystems, pollution and waste, production, consumption, and accumulation- in a single measurement system[4041]. SEEA CF is complemented by 2 publications:

1. SEEA Experimental Ecosystem Accounting - describes the measurement of ecosystem in physical terms and valuation of ecosystems consistent with market principles.

During revision process, a need arises for material covering potential extensions and application of SEEA- based data sets which would fulfil the aim of promoting and supporting the widespread adoption of SEEA among official statisticians, researchers, and policy makers. To this end, SEEA Applications and Extensions were developed.

2. SEEA Applications and Extensions – presents several monitoring and analytical approaches that could be adopted and describes the way in which SEEA data can be used to inform policy analysis.

[39] https://www.adb.org/countries/bangladesh/economy

[40] *SEEA (2017) System of Environmental Economic Accounting 2012: Central Framework. International Monetary Fund*

[41] *SEEA EA (2021) System of Environmental-Economic Accounting—Ecosystem Accounting, Final Draft, Version 5,. Department Of Economic And Social Affairs, Statistics Division, United NationsISION, UNITED NATIONS*

**Key features of SEEA-CF[42]:**

1. Relationship of SEEA-CF to the System of Natural Accounting (SNA)

SNA is a measurement framework that has been evolving since 1950s as a distinguishable approach in the measurement of economic activity, economic wealth, and general structure of economy. SEEA-CF applies accounting concepts, structures, rules, and principles of SNA to environmental information with economic information in a single framework. Power comes from its capacity to present information in both physical and monetary terms.

2. Combining information in physical and monetary terms

It has capacity to organize physical and monetary data which have common scope, definition, and classifications into combined presentations (CP). Structure of presentations depends upon topic of measurement (water, energy, air emissions or forest products), the question of interests and availability of data.

3. Flexibility in implementation

It is a system emerged as an integrated, internally consistent series of accounts which is designed in such a way that it can be implemented equally well in a part or. Depending upon specific environmental issues faced by a country- it may choose only a selection of accounts to be implemented in SEEA-CF.

SEEA-CF integrates the information of various stocks and flows of economy and environment in form of table and accounts:

a) Supply and use tables in physical and monetary terms showing flows of natural inputs, products, and residuals.
b) Asset accounts for individual environmental assets in physical and monetary terms showing the stock of environmental assets at the beginning and the end of each accounting period and the changes in stock.
c) A sequence of economic accounts highlighting depletion-adjusted economic aggregates
d) Functional accounts recording transactions and other information about economic activities undertaken for environmental purposes.

## 3.4 Framework for Ecosystem Service Valuation

The SEEA framework covers the measurement of ecosystem services in three main areas[43]:

(a) the physical flows of materials and energy within the economy and between the economy and the environment.

(b) the stocks of environmental assets and changes in these stocks; and

(c) economic activity and transactions related to the environment

[42] https://seea.un.org/content/seea-central-framework
[43] https://seea.un.org/content/seea-central-framework

The economy functions through the production and import of goods and services which, in turn, are consumed by industries, government, households, export or are accumulated over time for future consumptions.

The economy is represented by both stocks and flows. The measurement of flows centers on the economic activities of production, consumption, and accumulation. The measurement boundary for production is the most significant since all goods and services (products) that are regarded as being produced are effectively considered to be "inside" the economy. Flows between the economy and the environment are determined by whether they cross the production boundary.

Stocks of economic assets provide inputs to production processes and are a source of wealth for economic units. While many economic assets are produced from economic activity (e.g., buildings and machines), many are non-produced (e.g., land, mineral resources, and water resources). Both produced and non-produced assets provide inputs to the production of goods and services[44].

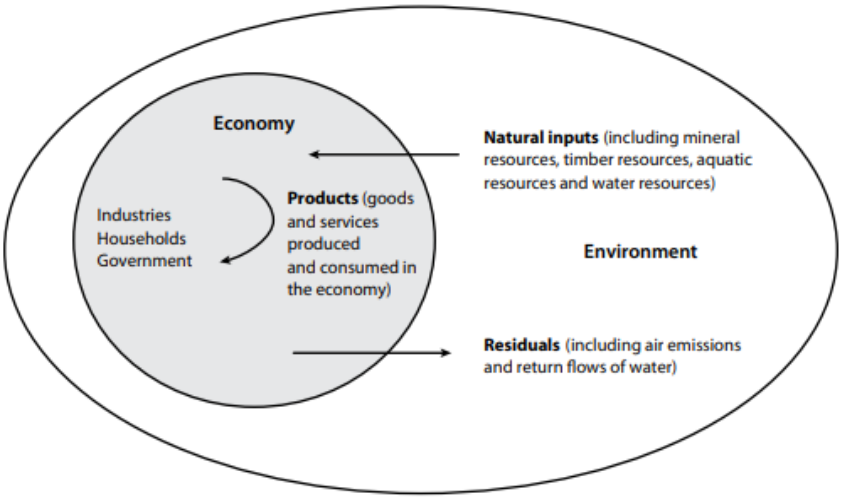



**Figure 6: Physical flows of Natural inputs, Products, and residuals**

***Source: SEEA CF Framework***

### Measurement of flows and stocks

### 1. Flow in physical terms

The use of physical units to record flows of goods and energy that enter and exit the economy as well as fluxes of materials and energy within the economy itself is a significant area of measurement. These measures are referred to as physical flows.

Natural inputs are all materials that are physically transferred out of their natural habitat as part of economic manufacturing processes or that are used directly in production. Natural inputs can be inputs from Natural resource, renewable energy resources, soil, and air. During the extraction of

[44] https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf

natural resources, not all the extraction is retained in the economy, these extractions which are not retained in the economy are returned to the environment immediately. These flows are thus named as natural resource residuals. The physical flows are recorded in assets accounts where they represent changes in the stock of assets between different time periods.

**2. Flow in monetary terms**

Two major types of economic flow are defined in SNA: transaction and other flows. A transaction is an interaction between economic units by mutual agreement such as the sale of timber products or the purchase of environmental protection services. Other flows relate to changes in the value of assets and liabilities that do not result from transactions, for example loss of assets due to natural calamities. Many transactions relate to exchanges of products between economic units. Product flows are recorded in monetary terms in the monetary supply and use table.

**3. Stocks in physical terms**

In physical terms, stocks refer to the total quantity of assets at a given point in time. For each environmental asset, the measurement scope includes all stocks that may provide benefits to humanity; in practice, a specific measurement boundary is defined for each environmental asset.

**4. Stocks in monetary terms**

The measurement of stocks in monetary terms focuses on the value of individual environmental assets and changes in those values over time. The valuations of these assets focus on the benefits that accrue to economic owners of environ mental assets.

According to the SNA, the preferred approach to the valuation of assets is the use of market values. However, for many environmental assets there are few markets that buy and sell them in their natural state; hence, determining an asset's economic value can be difficult. Several approaches to estimating market prices are possible if observable market prices for assets do not exist. The proceeding section explains the various valuation methods employed for assessing the ecosystem services identified in Bangladesh.

## Identification of Ecosystem Services

The SEEA framework uses the Common International Classification of Ecosystem Services to group the ecosystem provided by the ecosystem. SEEA framework identifies 36 ecosystem services and classified them into classes, divisions, and groups.

The details of all the provisional services included in the SEEA framework is provided in the following sections:

- Provisioning Services

Provisioning services are the material and direct services that are obtained to be used for the sold. These include timber, fuelwood, fodder, bamboo and other NTFPs. A study shows, total of 52 studies were identified and 30 of them provided 67 value estimates for 19 ecosystem services covering all major forest zones of Bangladesh which shows most of them focused on the Sundarbans. Mostly, the studies focused on the provisioning services. The result shows that on an average, forests of Bangladesh are worth USD 840 ha−1 yr−1. The value for the Sundarbans was found highest (USD 2176 ha/ yr) while the value of hill forests' is a distant second (USD 1066 ha −1yr−1).

SEEA Framework identifies the following provisioning services[45]:

| S. No. | Ecosystem service | Sub service | Description |
|---|---|---|---|
| **1** | Provisioning | | |
| **a)** | Biomass | Crop | It is the contribution of the ecosystem to the growth of cultivated plants that is harvested by economic units for various uses including food and fibre production, fodder, and energy. |
| | | Grazed biomass | It is the contribution of the ecosystem to the growth of grazed biomass that is an input to the growth of cultivated livestock. This excludes the contributions to the growth of crops used to produce fodder for livestock like hay and soybean meal as they are included in crop provisioning services |
| | | Livestock | This is the contribution of the ecosystem to the growth of cultivated livestock and livestock products like meat, milk, egg, wool, and leather that are used by economic units for various uses, mainly food production. |
| | | Aquaculture | It is ecosystem contribution to the growth of animals and plants like fish, shellfish and seaweed in aquaculture facilities which are harvested by economic units for various uses. |
| | | Wood | This is the ecosystem contribution to the growth of trees and other woody biomass in both cultivated and uncultivated production which are harvested for various uses including timber production and energy. It excludes contributions to non-wood forest products. |
| | | Wild fish and other natural aquatic biomass | These services are the ecosystem contributions to the growth of fish and other aquatic biomass which are reproduced in uncultivated production for various uses, mainly food production. |
| | | Wild animals, plants, and another biomass | It is the contribution of ecosystem to the growth of wild animals, plants and other biomass which is reproduced and harvested in uncultivated production for various uses including non-wood forest products (NWFP). It also includes the services related to hunting, trapping and bio-prospecting activities; but excludes wild fish and other natural aquatic. |
| **b)** | Genetic material | | This service is the ecosystem contribution from all biotas including seed, spore or gamete production that is used-<br>(i) To develop new animal and plant breeds.<br>(ii) In gene synthesis; or<br>(iii) In product development directly using genetic material.<br>This is most recorded as an intermediate service to biomass provisioning. |

[45] https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf

| | | | |
|---|---|---|---|
| **c)** | Water supply | | It reflects the combined ecosystem contributions of water purification, water flow regulation and other services to the supply of water of appropriate quality to users for various uses including household consumption. |
| **d)** | Others | | |

***Source: SEEA EEA Framework***

As mentioned in previous sections, based on the review of available secondary literature following are the provisional services are identified for valuation in the three study regions:

**A. Timber**

The ecosystem timber production is the contribution of wood by ecosystem assets (forest, other wooden areas) to the production of timber by forestry. The value of the timber after harvest is the economic benefit which is the result of the combined input of ecosystem services, goods, and services, produced capital and human capital[46].

Forests are the chief source of timber for the local communities which include wood for making furniture, fencing and poles and agricultural implements.

The value of timber will be estimated with the local market price of timber by adjusting price for management and transportation costs. Residual value method will be used which estimates the value by taking the gross value of the final marketed good (to which the ecosystem service provides input) and then deducting the cost of all non-ecosystem inputs, including labour, produced assets and intermediate inputs.

**B. Fuelwood**

Fuel wood is a dominant source of energy, especially in rural settings. Mostly, the poor people in urban, rural and tribal areas heavily rely upon fuelwood for meeting their energy needs. It is harvested from forestlands and directly used for in the residential and commercial sectors. Local people collect fallen wood/dry tree branches from the forests. Total value of fuelwood includes the value of fuelwood used for domestic purposes, i.e., for cooking and water heating, and the fuelwood used for various industrial and commercial purposes like jaggery making, bakery, cremation, etc.

**C. Fodder**

It is a type of food for feeding domesticated animals like cattle's, cow, bull, buffalo, rabbit, horses etc., which is made from farming or other agricultural processes. It is an important source of nutrients for livestock. Tree leaves and grass are collected (from the forests) to feed the livestock, and fallen leaves are used to prepare compost and for mulching in gardens.

**D. Bamboo**

It is a natural organic material which is used in industries and is identified as the most assuring building material and is used as an alternative to tropical hardwoods in recent years. They are used in veneer, paper, flute, window blinds, fishing rods, ladders, scaffolding, carving etc.

**E. Fish and other aquatic produce**

[46] SEEA Framework, 2021

Inland fishing is an important economic activity in the forest ecosystem and are harvested by local peoples in rivers, streams, reservoirs, lakes, etc., which are inseparable parts of the forest area. Hilsha (*Tenualosa ilisha*), has been declared the Geographical Indicator (GI) for Bangladesh. Around 0.5 million traditional Hilsha fishers (38% of the total catch fisheries employment) are directly dependent on the Hilsha catch.

The value of fish will be estimated with the local market price of fish by adjusting price for management. Residual value method is used which estimates the value by taking the gross value of the final marketed good and then deducting the cost of all non-ecosystem inputs, including labor, produced assets and intermediate inputs.

**F. NTFPs**

Non timber forest products (NTFPs) are significant provisions towards food security and income generation for the under-privileged socio-economic groups in developing countries.

NTFPs are important to millions of people world-wide because they are the source of income and have been harvested by human populations for livelihood over thousands of years. NTFPs includes seeds, flowers, fruits, leaves, roots, bark, latex, resins, and other non-wood plant parts.

**Data collection**

In collection of primary data, the first step of the survey is to identify the services and classify the beneficiaries utilizing the benefits from ES boundary into either domestic or commercial. The data will then be gathered on quantity of goods extracted based on user category and on market prices of that product. Data on quantities will be collected through unstructured interviews and questionnaire surveys. If direct market price is not available, then close substitutes will be used as a proxy. The data of the quantum of provisions will be gathered through questionnaires and prices obtained from primary and/or secondary sources at various markets (local to global, if commercially marketed).

In case they are marketed, the market price will be multiplied with the quantity, and if not marketed, surrogate market methods will be used to estimate the values[47].

The provisional services are accounted using the residual method by the given below formula:

**Residual Method, $Qi \times (Pi - Ci)$**

[Where, Qi represents quantity, Pi is the price, Ci is the cost involved in the harvest]

## ► Regulating and Supporting Services

The Regulating services represent the ability of ecosystems to regulate local climate, biochemical and hydrologic cycles, earth surface activities, and a range of biological processes; they are also referred to as regulation and maintenance services. Some of the regulatory services given by ecosystems include pollination, disease, and flood management, and maintaining the quality of the air and soil. Since they are frequently inconspicuous, they are frequently taken for granted. Providing living spaces

[47] https://pdf.usaid.gov/pdf_docs/PA00XDSP.pdf

for plants or animals and maintaining a diversity of plants and animals, are the supporting services provided by an ecosystem.[48]

Regulating and supporting ecosystem services can be regarded as classes of ecological processes and functions that tangibly contribute to human welfare[49]. They serve as the underlying support for human safety, biosphere integrity, and the functioning of most other ecosystem services, such as provisioning and cultural services[50]. Thus, the production of all ecosystem services depends upon the level of contributing ecosystem processes and functions.[51]

However, these services are often overlooked and undervalued as tracking the benefits of these services is very complex and there accounting often leads to double counting[52].

The regulating and supporting services are grouped into four divisions which are further divided into 11 groups. The details of the services are provided in the table below.

**Table 2: Reference list of Regulating and Supporting Ecosystem Services**

| Division | Group | Examples of ecosystem services | Examples of benefits derived |
|---|---|---|---|
| **Remediation and regulation of biophysical environment** | Bioremediation | Chemical detoxification/breakdown of pollutants by plants, algae, microorganisms and animals | Reduced level of pollutants/ contaminants in soil and groundwater |
| | Dilution, filtration, and sequestration of pollutants | Removal of organic materials and nutrients from wastewater by biogeochemical process, filtration of particulates and aerosols, sequestration of nutrients and pollutants in organic sediments, removal of odours | Cleaner air, water, and soil |
| **Flow regulation** | Air flow regulation | Natural or planted vegetation that serves as shelter belts, air ventilation services | Dust storm mitigation, heat mitigation in urban areas |
| | Water flow regulation | Regulation of timing and magnitude of water run-off, flooding, and aquifer recharge | Prevention of flood damage, recharge of water into surface water |

[48] https://www.fao.org/ecosystem-services-biodiversity/background/supporting-services/en/

[49] *Costanza, R., De Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., ... & Grasso, M. (2017). Twenty years of ecosystem services: how far have we come and how far do we still need to go?. Ecosystem services, 28, 1-16.*

[50] Sutherland, I. J., Villamagna, A. M., Dallaire, C. O., Bennett, E. M., Chin, A. T., Yeung, A. C., ... & Cormier, R. (2018). Undervalued and under pressure: A plea for greater attention toward regulating ecosystem services. *Ecological Indicators*, *94*, 23-32.

[51]https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0252463#pone.0252463.ref019

[52] Sutherland, I. J., Villamagna, A. M., Dallaire, C. O., Bennett, E. M., Chin, A. T., Yeung, A. C., ... & Cormier, R. (2018). Undervalued and under pressure: A plea for greater attention toward regulating ecosystem services. *Ecological Indicators*, *94*, 23-32.

| | | | |
|---|---|---|---|
| | | | and groundwater, reduced damage from high water levels |
| | Mass flow regulation | Stabilization of soil and mudflows | Prevention of soil erosion, avalanches, and mudflows |
| **Regulation of physic-chemical environment** | Atmospheric regulation | Capture of carbon dioxide, climate regulation, maintenance of urban climate and regional precipitation patterns | Reduced amount of GHGs in the atmosphere, reduced impact of climate change, improvement of climate conditions |
| | Water regulation | Oxygenation of water, retention, and translocation of nutrients in water | Improvement of water quality |
| | Pedogenesis and soil cycle regulation | Maintenance of soil fertility and structure in the cultivated system | Improvement of soil fertility and productivity in the cultivated system |
| | Noise regulation | Natural buffering and screening | Reduction of noise level |
| **Regulation of biotic environment** | Life-cycle maintenance, and habitat and gene pool protection | Pollination, seed dispersal, maintenance of habitat nursery population and habitats | Improvement of productivity of crops, habitats conservation |
| | Pest and disease | Control of pathogens | Reduced hazard level to crops, human health and the environment |

***Source: SEEA EEA Framework***

As mentioned in previous sections, based on the review of available secondary literature, the provisional services are identified for valuation in the three study regions.

**Carbon Sequestration**

The storage and sequestration of carbon is one of the most crucial services provide by forest ecosystem as functioning and sustainability of other services heavily rely on it and vice versa. Forest plays various roles in the carbon cycle, from net emitters to net sinks of carbon. Forest sequesters carbon by capturing the atmospheric carbon dioxide and transforming it into stored carbon via photosynthesis. Over the time this sequestered carbon is accumulated in the forms of living biomass, deadwood, litter, and soil and contributes to the forest carbon stock. Currently existing forest stores approximately 45% of organic carbon on land in their biomass and soil[53]. The InVEST software provides a standardized protocol by using open models to evaluate ecosystem services and trade-offs in geospatial environment.

**Water purification and Soil conservation**

[53] *Bonan, G. B. (2008). Forests and climate change: forcings, feedbacks, and the climate benefits of forests. Science 320, 1444–1449. doi: 10.1126/science.1155121*

Soil and water conservation and water purification are the different but interrelated services provided by forest ecosystems. Forests and the natural vegetation present in it control all hydrological events such as flow, recharge, and precipitation, etc. Forest soils and root systems, and microorganisms present in soil and water help filter and absorb contaminants and bacteria from the water received from precipitation. Diverse microorganisms interact with plant roots, and soil helps in the transfer of nutrients from the soil to plants which aids in the remediation of water[54]. The water received from rainfall in forest areas is rich in mineral nutrients and highly valued for its cleanliness and therapeutic value[5556].

**Biodiversity and Conservation**

Our quality of life depends not only on a strong economy, but also on a healthy natural environment. Biodiversity is a major contributor to the economy through the provision of many ecosystem goods and services. Many of the goods and services provided by biodiversity and ecosystems are crucial, but not always quantifiable in monetary terms. Many of these goods and services are not traded in the marketplace and so do not have an obvious price or commercial value. Forest is a major source of species and genetic diversity. It harbours diversity of flora and fauna. The danger is that if these unpriced values are not included in the decision-making process, the final decision may favour outcomes which do have a commercial value.

**Data collection**

The data is collected from questionnaire survey, informant interview and focus group discussion. Disproportionate stratified random sampling of households is conducted and the size of the sample of households is taken. The questionnaire includes the question about the socio-economic aspect of the surveyed population. The questionnaire is in single dichotomous form (Yes or No questions). WTP responses will be analysed using two statistical models- logistic model and multiple regression model. These models analysed using SPSS software. Logistic model separates the respondents who are willing to pay from those who are not. Multiple regression model shows the relationship between variables and stated amount of money for those who are willing to pay)

- Cultural Services

Cultural services are the non-material benefits people obtain from the ecosystems. The services include tourism; recreation and physical as well as mental health; the aesthetic appreciation and inspiration for culture, art, and design; spiritual experience and sense of place; and education, research and scientific values. These allow urbanites to reconnect with the nature.

There are 5 cultural services identified in SEEA Framework[57]:

[54] *Zawadzka, J., Gallagher, E., Smith, H., & Corstanje, R. (2019). Ecosystem services from combined natural and engineered water and wastewater treatment systems: Going beyond water quality enhancement. Ecological Engineering, 142, 100006.*
[55] *Chatterjee R (2011) Groundwater resources estimation—case studies from India. J Geol Soc India 77:201–204*
[56] *Ramachandra TV, Vinay S, Bharath S, et al (2020) Insights into riverscape dynamics with the hydrological, ecological and social dimensions for water sustenance. Curr Sci 113891:118*
[57] https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf

| S. No. | Ecosystem service | Description |
|---|---|---|
| **3** | Cultural | |
| **a)** | Recreation | Through the biophysical characteristics and qualities of ecosystems, these contributions enable people to use and enjoy the environment through direct interactions with the environment. It includes services to both locals and non-locals i.e., visitors, including tourists. These may also be supplied to those undertaking recreational fishing and hunting. |
| **b)** | Visual amenity | The ecosystem contributions to local living conditions, mainly through the biophysical characteristics and qualities of ecosystem which provides sensory benefits, especially visual and combines with other ecosystem services, including recreation-related services and noise attenuation services to underpin amenity values. People prefer living in a green neighbourhood for healthier living conditions and more possibilities for all kinds of recreational activities close to home. |
| **c)** | Education, scientific and research | It is the contribution of ecosystem through the biophysical characteristics and qualities of ecosystem which enables people to use the environment through intellectual interactions with the environment. |
| **d)** | Spiritual, artistic, and symbolic | These services are the ecosystem contributions through the biophysical characteristics and qualities of ecosystem which are recognized by people for their cultural, historical, aesthetic, sacred or religious significance. These may underpin people's cultural identity and can inspire people to express themselves via various artistic means. |
| **e)** | Others | |

***Source: SEEA EEA Framework***

For the valuation of cultural ecosystem services, nature tourism and recreation need to be carefully defined as discrete activities, to avoid double counting. As mentioned in previous sections, based on the review of available secondary literature following are the provisional services are identified for valuation in the three study regions:

A. Tourism
   - Ecotourism is a nature-based tourism that comprises social, environmental, cultural, and economic sustainability criteria. It sustains the local peoples' well-being and ensures biodiversity conservation[58].
   - Nature attracts millions of travellers worldwide and presents benefit both to the visitors and income opportunities to the tourism service providers. This involves the activities of people travelling to and staying in places outside their usual environment for leisure.

B. Recreation
   - In maintaining physical and mental health, nature-based activities play an important role like walking in nature and playing sports in parks and urban green spaces.

[58] https://wedocs.unep.org/bitstream/handle/20.500.11822/9045/-Ecotourism_Principles,PracticesandPoliciesforSustainability-2002518.pdf?sequence=2

For measuring recreation services, TCM is used which evaluates the individual preferences for non-market good where consumption is equivalent to the travel cost to acquire it[59]. It is mainly applied to the outdoor recreation activities (like fishing) and is applicable for certain ES. For example, Recreational fishing is evaluated in which a TCM survey would gather information on travel costs, license fees, on-site expenses, and capital expenditure on fishing equipment. Varying costs and predicting fishing activity is then used to collect surrogate demand functions for fishing at a specific location.[60]

**Data collection**

The information is collected by conducting a survey among the visitors of a site being valued. The survey should ask questions concerning the number of times the site was visited over a certain amount of time, the distance travelled from the visitor's home to the site, the mode of transportation (car, plane, bus, train, etc.), the amount of time spent travelling to the site, the respondent's income, and other socioeconomic factors such as gender, age, level of education, etc. To determine the cost of travel, the researcher uses data on distance and mode of transportation. Alternatively, visitors can be directly questioned about their travel expenses in the survey; however, this information tends to be less trustworthy. Time spent travelling is also considered as part of the travel costs, because this time has an opportunity cost. It could have been utilized for other profiting activities (e.g., working, spending time with friends or enjoying a hobby). The value of time is determined based on the income of each respondent.

## Valuation methods of Ecosystem Services

### Market value method

Market-price method includes the directly observed prices from actual market of an environmental good or service[61]. This method evaluates the economic value of ecosystem products or services which are bought and sold in commercial markets and can be used to value changes in either the quantity or quality of a good or service. Based on the quantity people purchase at different prices, and the quantity supplied at different prices, this method measures the economic benefits of marketed

[59] *Garrod, G. D., & Willis, K. G. (1999). Methodological issues in valuing the benefits of environmentally sensitive areas. Journal of Rural Studies, 15(1), 111-117.*

[60] https://www.researchgate.net/publication/222424799_An_ecological_perspective_on_the_valuation_of_ecosystem_services

[61] *Arias-Arévalo, P., Gómez-Baggethun, E., Martín-López, B., & Pérez-Rincón, M. (2018). Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. Environmental values, 27(1), 29-53.*

goods[626364]. Its advantage is that it reflects an individual's willingness to pay for the costs and benefits of goods that are bought and sold in markets, price, quantity, and cost data are comparatively easy to obtain for established markets. It also allowed to use the standard, accepted economic techniques and uses observed data of actual consumer preferences.

### Residual value method

Provisioning service of an ecosystem is evaluated through the residual value method. This method has been used to estimate a value for an ecosystem service by taking the gross value of the final marketed good (to which the ecosystem service provides input) and then deducting the cost of all non-ecosystem inputs, including labour, produced assets and intermediate inputs.

Residual Method, $Qi \times (Pi - Ci)$

[Where, Qi represents quantity, Pi is the price, Ci is the cost involved in the harvest]

### InVEST Model

Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) is a suite of models used to map and value ecosystem services. It helps explore how changes in ecosystems can lead to changes in the flows of many different benefits to people. InVEST returns results in either biophysical terms (e.g., tons of carbon sequestered) or economic terms (e.g., the net present value of that sequestered carbon). Carbon sequestration services value is calculated by considering the social cost of carbon per tonne.

Carbon storage capacity of the forest ecosystem is estimated using the InVEST Caron storage and Carbon sequestration model. This model evaluates the amount of carbon stored each year and the amount of carbon sequestered over a period of time. It aggregates the biophysical amount of carbon stored in four carbon pools (aboveground living biomass, belowground living biomass, soil, and dead organic matter) based on land use/land cover (LULC) maps. The LULC maps are generated using Landsat Data are utilized for change detection and to calculate the conversion of classes between the years. The model considers inputs as land use maps and a CSV file containing the values of carbon above ground, carbon below ground, soil carbon, and dead carbon concerning each land-use class.

Using data on the social cost of carbon, its annual rate change, and a discount rate, the model provides a value for the amount of carbon sequestered over time expressed as a monetary value. The model provides outcome in form of (i) amount of carbon fixed in each carbon pool in Mg/ha, (ii) net amount of carbon stored over the years (iii) market value of sequestered carbon in the remaining stock.

---

[62] *Arias-Arévalo, P., Gómez-Baggethun, E., Martín-López, B., & Pérez-Rincón, M. (2018). Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. Environmental values, 27(1), 29-53.*

[63] *Christie, M., Fazey, I., Cooper, R., Hyde, T., & Kenter, J. O. (2012). An evaluation of monetary and nonmonetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. Ecological Economics, 83(2012), 67–78. https://doi.org/10.1016/j.ecolecon.2012.08.012*

[64] *Koetse, M. J., Brouwer, R., & Van Beukering, P. J. H. (2015). Economic valuation methods for ecosystem services. Ecosystem Services: From Concept to Practice, 108–131. https://doi.org/10.1017/CBO9781107477612.009*

## Benefit Transfer method

The benefit transfer method is used where simplified quantification functions and indicator values from different international research are used. The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context. Thus, the basic goal of benefit transfer is to estimate benefits for one context by adapting an estimate of benefits from another context.

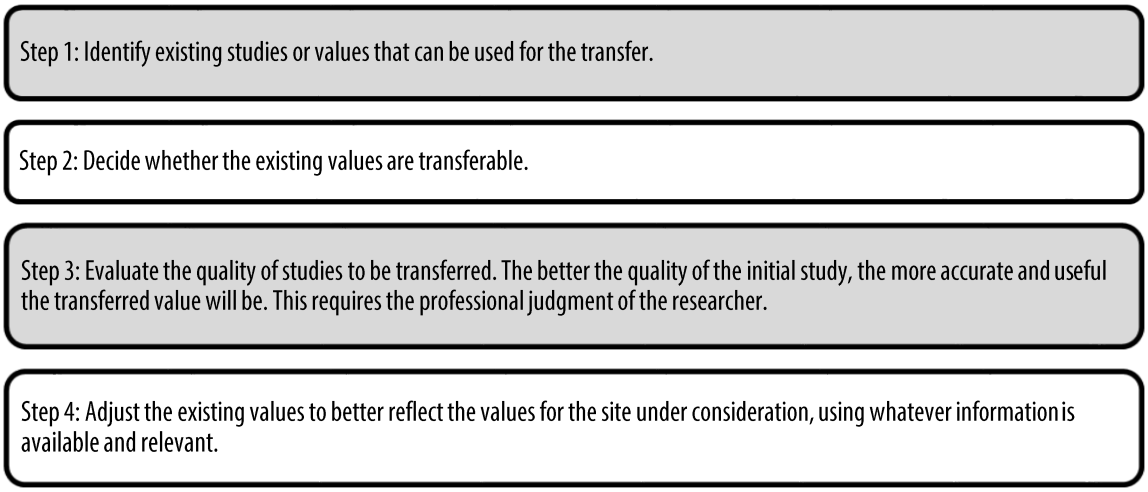



**Figure 9 Steps for application of benefit transfer method**

***Source: SEEA CF Framework***

## Contingency methods

CVM is a survey-based technique for valuation of resources and services that do not have established markets, typically environmental attributes, and amenities[6566]. It uses a hypothetical market approach to appraise consumer preferences by directly asking their willingness to pay for changes in the level of environmental goods or services[67]. Therefore, it is under the direct classification. That is, direct valuation method involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions, and hence it does not depend on market information. It is "contingent", because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service. This method is now ubiquitous, and it has received increasing attention to estimate option and existence values[68].

[65] *ALBERINI, A., & KAHN, J. R. (Eds). (2009). Handbook on contingent valuation. Edward Elgar Publishing*
[66] *CHO, S. H., YEN, S. T., BOWKER, J. M., & NEWMAN, D. H. (2008). Modeling willingness to pay for land conservation easements: treatment of zero and protest bids and application and policy implications. Journal of agricultural and applied economics, 40(01), 267-285.*
[67] *Carson, R. T., & Hanemann, W. M. (2005). Contingent valuation. Handbook of environmental economics, 2, 821-936.*
[68] *Haab, T. C., & McConnell, K. E. (2002). Valuing environmental and natural resources: the econometrics of non-market valuation. Edward Elgar Publishing.*

Individual travel cost method

It is a Surrogate Market Approach technique that uses the price people pay to visit an ecosystem as a measure of its recreational value when valuing ecosystems or natural resources. TCM calculate the economic advantages of ecosystem service that result from people using them for leisure activities. It can also be used to assess how a nature park's visitor count and overall entrance fee revenue would change in the event of a higher entrance cost. However, it cannot estimate benefits of providing habitat for endemic species.

TCM assumes that travel costs represent the price of access to a recreational site. Peoples' willingness to pay for visiting a site is thus estimated based on the number of trips they make at different travel costs. This is called a revealed preference technique because it reveals willingness to pay based on consumption behaviour of visitors.

Two approaches of TCM are distinguished – individual and zonal.

Individual TCM calculates the travel costs separately for each individual and requires a more detailed survey of visitors. While Zonal TCM, takes the area surrounding the visiting site into consideration and divides it into zones, which can be either be divided as concentric circles or as administrative districts. The number of visits from each zone is counted. The demand function for the average visitor to the site can be linked to the travel cost and number of trips as the higher costs of travel to a site leads to fewer visits to that site. From this demand functions, one can derive the average visitor's willingness to pay. This average value can further be used to estimate the total economic value of the recreational site by multiplying the average willingness to pay with the relevant population size.[69] [70]

### 3.4.1 Ecosystem supply in Physical terms

The physical flows are recorded by compiling supply and use tables in the physical units of measurement. They are used to assess how an economy supplies and uses energy, water, and material, as well as examine the changes in production and consumption pattern over time. The structure for physical supply and use table is based on the monetary table, with few other extensions such as the addition of environment column and rows of natural inputs and residuals.

In PSUT, the government activities are not separately accounted rather they are recorded in the intermediate consumption. In the PSUT, the household column only refers to the consuming activity of households. Numerous homes also engage in a variety of self-sufficient activities, such as gathering water and firewood and heating water with solar energy. While this activity is often regarded as direct household consumption from the environment, in the SEEA, all products that are consumed must first be recorded as being produced. Hence, all this production activity and the associated flows of natural inputs and products should be recorded in the first column under industries. The consumption activity of households recorded in the PSUT extends to the generation of solid waste and other residuals because of consumption.

[69] http://www.ejolt.org/2013/01/travel-cost-method/

[70] https://www.cbabuilder.co.uk/Quant4.html#:~:text=The%20travel%20cost%20method%20involves,original%20location%20to%20the%20amenity.

**Table 3: Basic form of a physical supply and use table.**

| | **Industries** | **Households** | **Accumulation** | **Rest of the world** | **Environment** | **Total** |
|---|---|---|---|---|---|---|
| ***Supply table*** | | | | | | |
| Natural inputs | | | | | Flow from environment | Total supply of inputs |
| Products | Output | | | Imports | | Total supply of natural inputs |
| Residuals | Residuals generated by industry | Residual generated by household consumption | Residuals from scraping and demolition of produced assets | | | Total supply of residuals |
| ***Use table*** | | | | | | |
| Natural Inputs | Extraction of natural inputs | | | | | Total use of natural inputs |
| Products | Intermediate consumption | Household consumption | Gross capital formation | Exports | | Total use of products |
| Residuals | Collection and treatment of waste and other residuals | | Accumulation of waste in controlled landfill sites | | Residual flow direct to environment | Total use of residuals |

**Dark grey cells are null by definition*
**Light grey cells represent flow of input*

***Source: SEEA CF Framework***

### 3.4.2 Ecosystem supply in monetary terms

Monetary supply and use tables record all flows of products in an economy between different economic units in monetary terms. They are compiled to describe the structure of an economy and the level of economic activity. Many of the flows of products recorded in monetary terms relate to the use of natural inputs from the environment (e.g., the manufacture of wood products) or to activities and expenditures associated with the environment (e.g., environmental protection expenditure). When goods are either produced domestically by businesses or imported from abroad, they are considered "supplies" inside the economy. All the delivered goods are listed as "used." The various uses of products are described in the Figure 10.

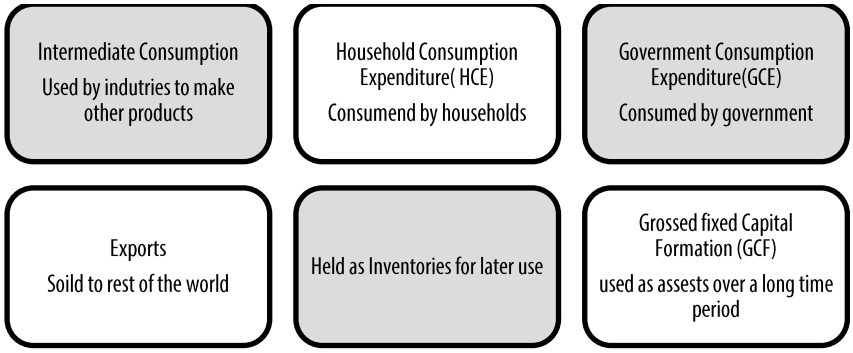



**Figure 10: Various uses of products from ecosystem**

***Source: SEEA CF Framework***

The monetary supply and use table are further divided into two parts: the supply table and the use table. Overall, the total supply of each product must equal the total use of each product. This equality between the total supply and total use of each product is known as the supply and use identity. The row of the supply table shows that for each product total supply is equal to output plus imports. The row for the use table shows that total use is equal to all the different uses of product.

**Table 4: Basic form of a monetary supply and use table.**

| | **Industries** | **Households** | **Government** | **Accumulation** | **Rest of the worlds** | **Total** |
|---|---|---|---|---|---|---|
| ***Supply Table*** | | | | | | |
| Products | Output | | | | Imports | Total supply |
| ***Use Tables*** | | | | | | |
| Products | Intermediate Consumption | HCE | GCE | GCF(including changes in inventories) | Exports | Total use |
| | Value added | | | | | |

**Dark grey cells are null by definition*

**Light grey cells represent flow of input*

***Source: SEEA CF Framework***

### 3.4.3 Ecosystem Assets

The purpose of an asset account is to record the opening and closing stock of environmental assets and various types of changes in the stock over an accounting period. It assesses whether the current patterns of economic activity are depleting and degrading the available environmental assets.

The System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA AFF) is a statistical system for compiling data and analysing the relationship between the economic

activities and the environment related to Agriculture, forestry and fisheries[71]. It provides information relevant to analysis of production function for individual environment assets. It provides approaches of national accounts for organizing information and statistics.

In physical terms, changes between the beginning and the end of the accounting period are recorded as additions to stock and reductions in the stock, and if possible, the nature of addition or reduction is recorded. In monetary terms, some entries are made, and an additional entry is included for the revaluation of the stock of the environmental asset. These entries show the changes in the value of assets over an accounting period due to the movement in the price of assets.

**Table 5: Basic form of Asset account**

| | Year 1 | Year 2 | Year 3 | Year 4 |
|---|---|---|---|---|
| **Opening stock of environmental assets** | | | | |
| **Additions to stock** | | | | |
| Growth in stock | | | | |
| Discoveries of new stock | | | | |
| Upward reappraisals | | | | |
| Reclassifications | | | | |
| *Total additions to stock* | | | | |
| **Reductions of stock** | | | | |
| Extractions | | | | |
| Normal loss of stock | | | | |
| Catastrophic losses | | | | |
| Downward reappraisals | | | | |
| Reclassifications | | | | |
| *Total reductions in stock* | | | | |
| **Revaluation of the stock*** | | | | |
| **Closing stock of environmental assets** | | | | |

(*Revaluation of the stock is only applicable for asset accounts in monetary terms)

***Source: SEEA EEA and AFF Framework***

The different tables are compiled for different purposes and highlight different aspects of the relationship between the economy and the environment. At the same time, there are close links between the supply and use tables and the asset accounts as shown in **Error! Reference source not found.**. These connections highlight the fact that the Central Framework is an integrated system.

The supply and use of products is recorded in both monetary and physical terms as the table includes the supply and use of products measured in monetary terms as well as the supply and use of natural inputs, products, and residuals in physical terms.

From a supply and use perspective, the main modification to the table is the restructuring of the flows into an asset account framework from the data recorded in the accumulation and environment columns of the supply and use tables. The distinction between environmental assets and produced

[71] SEEA AFF,2020

assets draws attention to the different ways that these flows are recorded in the supply and use tables, particularly the fact that the extraction of natural resources is recorded in the PSUT as a flow of natural inputs rather than in the monetary supply and use tables.

The opening and closing stocks for a given period appear at the top and bottom of the table, respectively. The supply and use tables also include some of the stock fluctuations. For instance, both the asset accounts and the supply and use tables incorporate gross capital formation and natural inputs. The cell labelled "Other changes in volume of assets" collects changes to stocks that are not reflected in the supply and use tables. Mineral resource discoveries, the loss of assets because of catastrophic natural disasters, and changes in the valuations of assets because of price fluctuations are a few examples of these shifts.

### 3.4.4 Total Ecosystem Supply Value

The total Ecosystem supply value (TESV) of the forest ecosystem present in the three Protected Areas of Bangladesh, i.e., Teknaf Wildlife Sanctuary (TWS), Madhupur National Park (MNP) and Ramgarh-Sitakunda Reserve Forest (RSRF) is calculated by aggregating all the identified ecosystem services. The TESV is calculated as per the formula given below:

**TESV= Provisioning Services + Regulating and Supporting Services + Cultural Services**

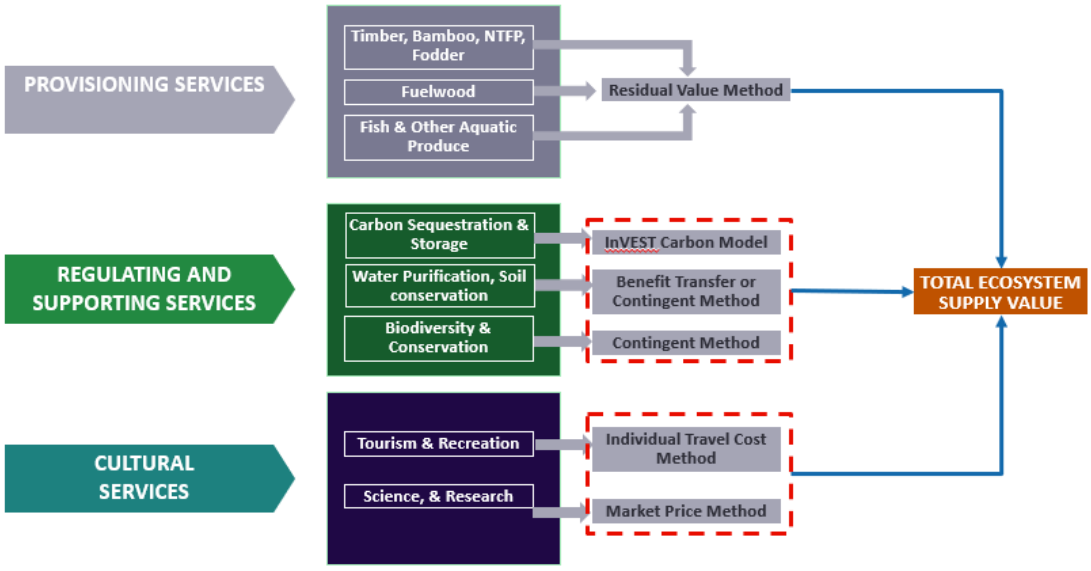



**Figure 11: Total Ecosystem Supply Value**

# 4. Detailed Workplan with Timelines

## 4.1 Step 1: Kickoff meeting

A kickoff meeting was organized on March 27, 2023 to discuss details on the timelines, methodology to be followed, document views and suggestion from the client and understand the way forward. The suggestions provided by client were duly noted and shall be considered as part of the project moving forward. The kickoff meeting was organized in the 1st month of the project after signing of the contract.

## 4.2 Step 2: Development of framework tools for Natural wealth Accounting

A detailed review of literature was undertaken to understand the studies on ecosystem service valuation in Bangladesh. The different approaches and methods suggested by multilateral organizations such as UN agencies, World Bank, FAO, DEFRA etc. were also studied and documented. Focus was provided to the SEEA CF approach which highlights the forestry sector. Based on the findings, a framework is developed for Bangladesh for natural wealth accounting which is part of this inception report.

## 4.3 Step 3: Submission of Inception report

An inception report has been prepared and submitted in the 2$^{nd}$ month after signing of the contract. The inception report consists of detailed work plan, detailed framework for natural wealth accounting and methodologies suitable for the selected study sites, field survey plan, data analysis techniques, roles and responsibilities and timelines.

## 4.4 Step 4: Training and capacity building by developing training manuals

Training and capacity building of 100 stakeholders would be conducted to support them in understanding and documentation of various methods for estimating the value of ecosystem services and payment for ecosystem services. Detailed training manuals would be developed for the stakeholders as a guidance document for them. The training manual shall focus on natural wealth accounting techniques and various payment of ecosystem services schemes. The training manuals would be developed in 3$^{rd}$ month after signing of contract.

## 4.5 Step 5: Field visits and data collection physical and monetary value of ES from forests

Data on physical and monetary value of the services provided by key ecosystems such as forests would be collated in the 4$^{th}$, 5$^{th}$ and 6$^{th}$ month of the study. Key indicators would also be documented which inform on the status of the ES and studies would be identified to assess the relation between ES and their contribution towards mitigating climate change. A database would be developed which shall consist of all the data categorically arranged with features such as filters and visual reports to easy access and assess the data whenever required in future.

## 4.6 Step 6: Submission of Mid-term progress report of field survey

A technical report would be developed detailing about the data collected, assessment of ecosystem services and ecological and socio-economic indicators in the 7$^{th}$ month of the study.

## 4.7 Step 7: Scoping study on feasibility of PES scheme for Ramgarh-Sitakunda Reserve Forest

Along with the field surveys for ecosystem service valuation, feasibility of implementing Payment of ecosystem services schemes shall also be undertaken. All the necessary PES schemes would be reviewed and strategies relevant for the reserve forest would be developed though detailed discussion with the stakeholders. A workshop would also be conducted to discuss the applicability of the potential schemes developed. The feasibility survey of the PES scheme shall be undertaken in the 8$^{th}$ month of the study.

## 4.8 Step 8: Submission of Draft Report

The results of the steps 5, 6 and 7 would be added in the draft report and the report would consist of (i) valuation of ecosystem services from Modhupur National Park, Teknaf Wildlife Sanctuary and Ramgarh- Sitakunda Reserve

forest and (ii) feasibility report for implementation of PES scheme in Ramgarh- Sitakunda Reserve forest. The draft report would be submitted for comments in the 10th month of the study.

## 4.9 Step 9: Organizing a National level stakeholder consultation workshop

All the findings of the study would be discussed and triangulated through a National level stakeholder consultation workshop which would have participation from various stakeholders such as government officials, researchers, academicians, local communities, buyers of ecosystem services etc. All the comments and suggestions received from the workshop shall be integrated in the draft report. The National level stakeholder consultation workshop shall be organized in the 11th month of the study.

## 4.10 Step 10: Submission of Final Report

A consolidated final report would be developed in the 11th and 12th month of the study which shall consist of (i) framework for natural wealth accounting (ii) Training manuals (iii) Valuation of ecosystem services for the selected PAs (iv) Report on Payment for Ecosystem services and (v) workshop proceeding to support policy makers.

The following reports will be provided as mentioned:

- Inception Report- **Submitted**
- Training manual
- Mid term progress report
- Draft final Report
- Consolidated Final report

| Sr. No | Deliverables | Months- March 2023 to February 2024 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb |
| **I)** | **Project Kickoff** | | | | | | | | | | | | |
| 1. | Issuance of Work Order & Signing of Agreement | | | | | | | | | | | | |
| 2. | Project Kick-off meeting | | | | | | | | | | | | |
| 3. | Identify the expectations of key project sponsors | | | | | | | | | | | | |
| 4. | Discuss & finalize various project essentials such as timelines, reporting meeting schedules, and team responsibilities. | | | | | | | | | | | | |
| **II)** | **Framework for Natural Wealth Accounting** | | | | | | | | | | | | |
| 1. | Review of literature on forest-based inventories for Bangladesh | | | | | | | | | | | | |
| 2. | Understanding the various ecosystem services and methods for its valuation implemented nationally and internationally | | | | | | | | | | | | |
| 3. | Analysis of SEEA frameworks focused on Forests | | | | | | | | | | | | |
| 4. | Documenting successful case studies for natural wealth accounting | | | | | | | | | | | | |
| **D1** | **Development of framework for Natural Wealth Accounting** | | | | | | | | | | | | |
| **III)** | **Inception Report** | | | | | | | | | | | | |
| 1. | Presenting the framework for ESV for comments and suggestions | | | | | | | | | | | | |
| 2. | Detailed work plan and timeline | | | | | | | | | | | | |
| 3. | Field survey and monitoring plan | | | | | | | | | | | | |
| 4. | Identification of key stakeholders and | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | collection of all project related documents | | | | | | | | | | | | |
| **D2** | **Submission of Inception Report** | | | | | | | | | | | | |
| **IV)** | **Training and Capacity building** | | | | | | | | | | | | |
| 1. | Development of agenda for training and capacity building | | | | | | | | | | | | |
| 2. | Identification of relevant stakeholders | | | | | | | | | | | | |
| 3. | Finalizing the dates and curriculum for the capacity building workshop | | | | | | | | | | | | |
| 4. | Development of training material and manual | | | | | | | | | | | | |
| 5. | Executing the workshop in Bangladesh | | | | | | | | | | | | |
| **D3** | **Training manuals for valuation of ecosystem services and PES** | | | | | | | | | | | | |
| **V)** | **Conducting field surveys and analysis** | | | | | | | | | | | | |
| 1. | Development of data sheets, questionnaires, and other data documentation material | | | | | | | | | | | | |
| 2. | Deployment of team for field surveys in each PA | | | | | | | | | | | | |
| 3. | Collection and digitizing of data at regular intervals | | | | | | | | | | | | |
| 4. | Cleaning and processing of data | | | | | | | | | | | | |
| **D4** | **Submission of midterm progress report on field survey** | | | | | | | | | | | | |
| **VI)** | **Valuation of ecosystem services and Payment for ecosystem services** | | | | | | | | | | | | |
| 1. | Identification of gaps in data and initiate further data collection | | | | | | | | | | | | |
| 2. | Conduct data analysis and estimate the value of ecosystem services for the selected PAs | | | | | | | | | | | | |
| 3. | Conduct detailed review and analysis of | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | the data collected to identify the potential services for payment mechanism | | | | | | | | | | | | |
| 4. | Develop a strategic plan based on the identified parameters | | | | | | | | | | | | |
| 5. | Develop PES scheme for Ramgarh-Sitakunda reserve forest | | | | | | | | | | | | |
| 6. | Discuss the various schemes identified and its potential through stakeholder consultation | | | | | | | | | | | | |
| **D5** | **Submission of Draft report on ESV and PES** | | | | | | | | | | | | |
| **VII)** | **Organizing National level Consultation Workshop with Stakeholders** | | | | | | | | | | | | |
| **1.** | Coordination for workshops and meetings with stakeholders/ | | | | | | | | | | | | |
| **2.** | Finalizing agenda, participants and venue | | | | | | | | | | | | |
| **3.** | Conducting the workshop and documentation of suggestion and comments from the stakeholder | | | | | | | | | | | | |
| **4.** | Incorporating the suggestions/ comments raised by the experts during the national level dissemination workshop | | | | | | | | | | | | |
| **5.** | Develop proceedings for the workshop and share with the stakeholders | | | | | | | | | | | | |
| **D6** | Submission of Final Report | | | | | | | | | | | | |

# 5. Field Survey Plan

A detailed field survey shall be conducted from June 2023 to November 2023 to collect primary data on the ecosystem services provided by the study site. The field survey plan is as follows:

**1. Site visits to the study sites**

The project implementation team shall conduct a site visit to the study sites in Bangladesh to develop the understanding of the ecosystem services provided by the Modhupur National Park, Teknaf Wildlife Sanctuary and Ramgarh Sitatunda Reserve Forest along with potential for payment for ecosystem services scheme. As suggested by the Project Director, SUFAL; an inception meeting shall be conducted in the third week of May subsequent to which the initial site visits would be conducted to understand the potential of the identified ecosystem services based on secondary literature. The site visits shall also provide us with an opportunity to conduct a discussion with the stakeholders to understand the study site in detail.

**2. Finalisation of ecosystem services**

Based on the data generated from the initial field visits, the ecosystem services to be valued shall be finalised with the approval from the client. The methodologies to value these services shall be further selected to provide the best accurate results for flow and static services.

**3. Identification of sample size**

Certain ecosystem services such as Tourism, biodiversity conservation, fuelwood and fodder require detailed discussions with the stakeholders such as tourists, local communities, forest department etc. A sample size shall be identified to collect data based on the initial information gathered on population around the forest areas and tourists visiting these forest areas.

**4. Development of questionnaires**

A detailed questionnaire shall be developed to collect information on the ecosystem services provided by the forest areas. The questionnaire shall be field tested and discussed with the client after which they would be finalised. The questionnaires would be devised in a way to document the seasonal information about the services and its significance to the stakeholders.

**5. Field deployment and Data collection**

A team of well-trained surveyors would be deployed in the field for data collection. The field team shall collect data parallelly in the forest areas and ensure collection of robust data. The data shall be regularly documented concerned with the ecosystem services and payment for ecosystem services. The field managers shall ensure collection of quality data and regular documentation to avoid any discrepancies.

**6. Data cleaning and management**

Basis on the input of regular data collection, the data shall be cleaned and analysed to understand the inference generated from the data collected. This process shall also result in identification of data gaps after which the strategies could be developed to bridge the gaps by collecting additional data. The initial findings and results from data collection shall be discussed with the client for their inputs and to improve the data collection process.

# 6. Annexures

## 6.1 Biogeographic features of Bangladesh

### 6.1.1 Climate

In terms of area Bangladesh is a relatively small country but it has a well spread climatic variation. According to Rashid (1977), Bangladesh is broadly categorized into seven climatic zones namely, Northern part of northern zone, North-western zone, Northern zone, South-western zone, South-eastern zone, South-Central zone, and Western dry zone. High temperature, heavy rainfall, high humidity and seasonal variations characterises the climatic conditions of Bangladesh. Due to the presence of Bay of Bengal, tinatien plateau, and Himalayan Mountain range Bangladesh has Subtropical climatic conditions accompanied by three major seasons: summer, monsoon and winter. The maximum temperature recorded in the summer months (March-June). Monsoon accounts for 80% of the total annual rainfall in the country. The maximum rainfall is recorded in the coastal areas of Chittagong and the northern part of the Sylhet district, while minimum is observed in the western and northern parts of the country.

### 6.1.2 Topography

The topography of a land surface refers to its relief, contours, distribution of mountains and valleys, river flow patterns, and any other natural and man-made elements that contribute to the landscape. Despite being a small nation, Bangladesh possesses a wide range of topographic features. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers. On the south, a highly irregular deltaic coastline of about 600 km fissured by many estuarine rivers and channels flowing into the Bay of Bengal. The alluvial plain is part of the larger plain of Bengal, which is sometimes called the Lower Gangetic Plain. Elevations of the plains are less than 10m above the sea level; elevation furthers decline to a near sea level in the coastal south. The hilly areas of the south-eastern region of Chittagong, the north-eastern hills of Sylhet and highlands in the north and northwest are of low elevations. The Chittagong Hills constitute the only significant hill system in the country. It rises steeply to narrow ridgelines (average 36m wide), with elevation ranges between 600 and 900m above mean sea level. In between the hilly ridges lie the valleys that generally run north to south. West of the Chittagong hills is a narrow, wet coastal plain lying parallel to the shoreline[72].

### 6.1.3 Soil

The majority of the part of Bangladesh lies within the deltas of the combined Ganges-Brahmaputra-Mehgna River System and is endowed with fertile soils capable of sustained high yields. On the basis of their geological origin and properties the soils of Bangladesh have been broadly classified into seven tracts. Soils of each tract have some common characteristic properties different from those of other tracts. Characteristics of each tract together with the nutrient status of its soils are given below:[73] [74]

[72] https://en.banglapedia.org/index.php/Topography
[73] https://en.banglapedia.org/index.php/Bangladesh_Soil
[74] https://www.icid.org/i_d_bangladesh.pdf

**Red soil tract or Madhupur tract** - This tract represents red later tic soils of Madhupur Jungle area - a high land tract above the flood level intersected by numerous gentle depressions locally known as "Beels" which are highly valued for a man paddy. The soils are very clayey containing numerous ferruginous concretions. The PH value lies between 5.5 and 6.

**Barind tract** - Barind tract belongs to an old alluvial formation, which is usually composed of massive argillaceous beds of pale reddish brown, often turns yellowish on weathering; kankar and pisolitic ferruginous concretions occur throughout the mass. In the numerous depressions transplanted winter paddy is grown; the soil is deficient in lime, nitrogen and phosphorous like the red soils of Madhupur Jungle tract. The PH varies from 6 to 6.5.

**Gangetic alluvium** - This tract represents the riverine lands of the Gangetic plains. The soils are rich and are characterised by high lime content and are well supplied with patrol and phosphate. The texture varies from clay loam to light sandy loam according to its formation from the silt of the various tributaries of the Ganges. The soil is generally fertile but responds to the applications of nitrogenous and occasional phosphatic fertilizer. The PH varies from 7 to 8.4.

**Teesta silt** - This type represents a sandy loam similar to the ordinary silt soil of Bangladesh. The soil is fertile and is well supplied with potash and phosphate thought rather poor in lime. Paddy, tobacco and sugar cane are the main crops. The soils respond to the application of nitrogen and phosphatic fertilizers. The PH ranges from 6 to 6.5.

**Brahmaputra alluvium** - The soil is sandy loam, very fertile and rich and is replenished every year by fresh deposits of silts carried down by the flood water. Almost all kinds of crops are grown of which jute and rice are the most important ones. The PH varies from 5.5 to 6.8.

**Coastal saline tract** - This tract comprises a flat low-lying area. From the south, near the sea is the Sundarbans tract - a region of morasses and swampy islands most of which clothed with dense evergreen forest, while some are covered with salt water of flood tide. The soil is saline and salt efflorescence occurs in many places. The soil is well supplied with potash and phosphate.

**Unclassified hilly soils in greater Chittagong Hill Tracts** - The soil is brown sand loams to clay loams, slightly to strongly acid, sometimes shallow over Shaley/Sandstone bedrocks on very steep high hills. Mostly these types of soil are used for "Jhum" cultivation.[75]

### 6.1.4 Water Resource

The country lies in the lowest riparian of the Ganges, the Brahmaputra and the Mehgna basin. Most of its area is low lying floodplain formed by the alluvial soil deposited by three great rivers. These rivers drain a catchment area of about 1.72 million $km^2$ in India, Nepal, China, Bhutan and Bangladesh; and only 8 percent of the catchment area lies within Bangladesh. These major rivers and their tributaries have their headwaters outside Bangladesh, with about 90% of their annual flow originating outside the country. The country contains about 22155 km of river length for about 700 rivers. Rivers and water bodies occupy about 5% of the land surface of Bangladesh[76].

[75] https://www.icid.org/i_d_bangladesh.pdf
[76] http://www.nourin.tsukuba.ac.jp/~tasae/2006/Bangladesh.pdf

In Bangladesh, the major sources of water are surface water and ground water. Both the sources may be fresh or saline.

**Surface water**

Surface water sources are categorized as rainfall, trans boundary flow, water on standing water bodies (water storage in reservoir, water bodies such as river, lake and pond), water on seasonal wetlands, and in-stream storage. These are described below[77]:

i) **Transboundary flow** - Bangladesh shares 57 transboundary rivers, 54 incoming from India, 3 from Myanmar. Among the rivers, the Ganges, the Brahmaputra and the Meghna drain about 1.08 million sq.km. 0.58 million sq.km. and 0.09 million sq.km. respectively. Total annual volume of water that enters into the country from the trans boundary rivers is about 1000 billion cubic meter. Though this amount seems high, its contribution in the critical month of February is only 1% of the total showing the vulnerability of the transboundary flow to meet the water demand during dry season.

ii) **Water on standing water bodies** - In addition to natural rivers, water is retained in localized low pockets (beels/baors) and ponds in dry season. Kapatai Lake is the lonely reservoir in the country that has storage capacity. Total volume of such standing water bodies is about 0.61 billion cubic meter.

iii) **Water on seasonal wetlands** - Floodplains (about 80% of the total area of the country) become seasonal wetlands during monsoon (July-October) because of slow drainage of huge transboundary flow and local rainfall excess. The seasonal wetlands remain inundated from a few days to as long as several months (May-November). Estimated volume of water stored in these seasonal wetlands/floodplains is about 2.69 billion cubic meter. This seasonal storage has virtually no contribution during dry season.

iv) **In-stream water storage** - The numerous channels criss-crossing the entire country, in flowing stage, store water till these are completely dries. Estimated volume of channel storage is of the order of 0.5 billion cubic meters.

**Groundwater**

The main source of ground water is the recharge from surface water. The majority of Bangladesh's land was formed by three significant rivers' sedimentary alluvial and deltaic deposits. These alluvial deposits have primarily created an unconfined aquifer in most of the country. A key natural resource for the nation, aside from sources of clean drinking water, was expected to be groundwater. But the situation has radically changed as a result of the presence of arsenic in the shallow aquifer. It is estimated that about 16% of present population of 123.15 million is exposed to arsenic contamination exceeding Bangladesh standard (0.05 mg/l). Approx. 74452 sq.km. of groundwater use area (about 50% of the country) is unsuitable for use by hand tube wells due to arsenic.[78]

[7777] http://www.nourin.tsukuba.ac.jp/~tasae/2006/Bangladesh.pdf

[78] http://www.nourin.tsukuba.ac.jp/~tasae/2006/Bangladesh.pdf

## 6.2 Annexure 1: List of studies on ecosystem services provided by forests of Bangladesh

| Year | Forest Type | Valuation Method | Value | References |
|---|---|---|---|---|
| 2002 | Sundarbans, Coastal forest | Travel Cost | 14,588 US$ | Islam, M. M., & Hossain, M. M. (2017). Community dependency on the ecosystem services from the Sundarbans mangrove wetland in Bangladesh. In: Prusty B., Chandra R., Azeez P. (eds) Wetland Science (pp. 301-316). Springer, New Delhi. |
| 2002 | Sundarbans, Coastal forest | Market Price | N/A | Islam, M. M., & Hossain, M. M. (2017). Community dependency on the ecosystem services from the Sundarbans mangrove wetland in Bangladesh. In: Prusty B., Chandra R., Azeez P. (eds) Wetland Science (pp. 301-316). Springer, New Delhi. |
| 2002 | CHT hill forest | Market Price | Tk 16,500 per farmer | Nath, T. K., Inoue, M., & Myant, H. L. A. (2005). Small-scale agroforestry for upland community development: a case study from Chittagong Hill Tracts, Bangladesh. Journal of Forest Research, 10(6), 443-452 |
| 2002 | CHT hill forest | Market Price | 11,730+680.54 TK./ha per Medium landholders | Nath, T. K., Inoue, M., & Chakma, S. (2005). Shifting cultivation (jhum) in the Chittagong Hill Tracts, Bangladesh: examining its sustainability, rural livelihood and policy implications. International Journal of Agricultural Sustainability, 3(2), 130-142. |
| 2003 | Sylhet hill | Market Price | BDT 8,750 per month from Betel Leaf and betel nut, BDT 1,054 per month from trees and BDT 263 per month from agriculture | Nath, T. K., Makoto, I., Islam, M. J., & Kabir, M. A. (2003). The Khasia tribe of north-eastern Bangladesh: their socio-economic status, hill farming practices and impacts on forest conservation. Forests, trees and livelihoods, 13(4), 297-311. |
| 2006 | Sal forest | Market Price | 17851 million BDT/year | Alam, M., Furukawa, Y., & Harada, K. (2010). Agroforestry as a sustainable landuse option in degraded tropical forests: A study from Bangladesh. Environment, Development and Sustainability, 12(2), 147–158 |
| 2009 | CHT hill forest | Market Price | Market Price | Miah, D., Chakma, S., Koike, M., & Muhammed, N. (2012). Contribution of forests to the livelihood of the Chakma community in the Chittagong Hill Tracts of Bangladesh. Journal of forest research, 17(6), 449-457. |
| 2009 | Sylhet hill | Market Price | BDT 2118.75 per month. | Mukul, S. A., Herbohn, J., Rashid, A. Z. M. M., & Uddin, M. B. (2014). Comparing the effectiveness of forest law enforcement and economic incentives to prevent illegal logging in Bangladesh. International Forestry Review, 16(3), 363-375. |
| 2009 | Sylhet hill | Market Price | BDT 2521.43 per month. | Mukul, S. A., Herbohn, J., Rashid, A. Z. M. M., & Uddin, M. B. (2014). Comparing the effectiveness of forest law enforcement and economic incentives to prevent illegal logging |

| | | | | |
|---|---|---|---|---|
| | | | | in Bangladesh. International Forestry Review, 16(3), 363-375. |
| 2009 | CHT hill forest | ___ | US$ 326 Million | Barua, S. K., & Haque, S. M. S. (2013). Soil characteristics and carbon sequestration potentials of vegetation in degraded hills of Chittagong, Bangladesh. Land Degradation & Development, 24(1), 63-71. |
| 2010 | Sal forest | Market Price | N/A | Kibria, M. G., & Saha, N. (2011). Analysis of existing agroforestry practices in Madhupur Sal forest: an assessment based on ecological and economic perspectives. Journal of Forestry Research, 22(4), 533-542. |
| 2010 | Sunderbans | Market Price | US$ 42,000 per year during the period of 2001–2002 to 2009–2010. | Uddin, Md. S., de Ruyter van Steveninck, E., Stuip, M., & Shah, M. A. R. (2013). Economic valuation of provisioning and cultural services of a protected mangrove ecosystem: A case study on Sundarbans Reserve Forest, Bangladesh. Ecosystem Services, 5, 88–93 |
| 2012 | Trees outside forest | Market Price | Fruits US$83.6, Timber US$36.3, Fuel US$71.9, Bamboo US$53.5 | Alam, M. (2012). Valuation of Tangible Benefits of a Homestead Agoforestry System: A Case Study from Bangladesh. Human Ecology, 40: 639–645. |
| 2012 | Sylhet hill | Travel Cost | 55,694,173 Tk/Year | Kawsar, M. H., Abdullah-Al-Pavel, M., Uddin, M. B., Rahman, S. A., Abdullah-Al-Mamun, M., Hassan, S. B., ... & Abdul-Wadud, M. (2015). Quantifying recreational value and the functional relationship between travel cost and visiting national park. International Journal of Environmental Planning and Management, 1(3), 84-89. |
| 2013 | Sundarbans | Market Price | EUR 587.7 for Fishermen, EUR 567.2 for Crab catcher, EUR 333.9 for Honey collector. EUR 701.4 for Nypa palm collector | Getzner, M., & Islam, M. S. (2013). Natural resources, livelihoods, and reserve management: a case study from Sundarbans mangrove forests, Bangladesh. International Journal of Sustainable Development and Planning, 8(1), 75-87. |
| 2015 | Urban park | Travel Cost | 0.29 Million USD/Year | Haider, M. Z., Hossain, T., Siddiqui, O. I., & Islam, M. S. (2018). Economic valuation of the tourist spots in Bangladesh. International Journal of Tourism Policy, 8(1), 42-64. |
| 2015 | Urban park | Travel Cost | 0.68 Million USD/Year | Haider, M. Z., Hossain, T., Siddiqui, O. I., & Islam, M. S. (2018). Economic valuation of the tourist spots in Bangladesh. International Journal of Tourism Policy, 8(1), 42-64. |
| 2015 | Sundarbans | Market Price | 18908 million BDT/year | GoB (2019), Tree and forest resources of Bangladesh: Report on the Bangladesh Forest Inventory. Forest Department, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. |

| | | | | |
|---|---|---|---|---|
| 2015 | Coastal forest | Market Price | 28336 million BDT/year | GoB (2019), Tree and forest resources of Bangladesh: Report on the Bangladesh Forest Inventory. Forest Department, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. |
| 2015 | Sundarbans, Coastal forest | Market Price | N/A | Islam, M. M., & Hossain, M. M. (2017). Community dependency on the ecosystem services from the Sundarbans mangrove wetland in Bangladesh. In: Prusty B., Chandra R., Azeez P. (eds) Wetland Science (pp. 301-316). Springer, New Delhi. |
| 2015 | Sundarbans, Wetland | Contingent Valuation | US$ 9 per ha | Rahman, M. M., Jiang, Y., & Irvine, K. (2018). Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh. Wetlands Ecology and Management, 26(4), 563-580. |
| 2015 | CHT hill forest, Sylhet hill | Market Price | 17851 million BDT/year | GoB (2019), Tree and forest resources of Bangladesh: Report on the Bangladesh Forest Inventory. Forest Department, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. |
| 2015 | Urban park | Travel Cost | 0.84 Million USD/Year | Haider, M. Z., Hossain, T., Siddiqui, O. I., & Islam, M. S. (2018). Economic valuation of the tourist spots in Bangladesh. International Journal of Tourism Policy, 8(1), 42-64. |
| 2015 | Sundarbans | Market Price | US$ 1135 per ha | Rahman, M. M., Jiang, Y., & Irvine, K. (2018). Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh. Wetlands Ecology and Management, 26(4), 563-580. |
| 2015 | Sundarbans | Damage Cost Avoided | USD 543.3 million | Sarker, A. R., Nobi, M. N., Røskaft, E., Chivers, D. J., & Suza, M. (2020). Value of the Storm-Protection Function of Sundarban Mangroves in Bangladesh. Journal of Sustainable Development, 13(3). |
| 2015 | Sundarbans, CHT hill forest, Sal forest, Sylhet hill, Coastal forest, Village Forest | Market Price | | Henry, M., Iqbal, Z., Johnson, K., Akhter, M., Costello, L., Scott, C., & Saint-AndrÃ, L (2021). A multi-purpose National Forest Inventory in Bangladesh: design, operationalisation and key results. Forest Ecosystems, 8(1), 1-22. |
| 2015 | Sundarbans, Wetland | Contingent Valuation | For storm protection US$ 13 per ha and for erosion control US$ 2 per ha | Rahman, M. M., Jiang, Y., & Irvine, K. (2018). Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh. Wetlands Ecology and Management, 26(4), 563-580 |

| | | | | |
|---|---|---|---|---|
| 2015 | Sundarbans | Market Price | For provisioning services, households obtained important monetary benefits annually from capture fishery (US$ 976 per ha), fuel energy (US$ 80 per ha), honey (US$ 53 per ha) and fodder (US$ 26 per ha) | Rahman, M. M., Jiang, Y., & Irvine, K. (2018). Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh. Wetlands Ecology and Management, 26(4), 563-580. |
| 2015 | Sundarbans, Coastal forest | Market Price | 144,832 in US$ | Islam, M. M., & Hossain, M. M. (2017). Community dependency on the ecosystem services from the Sundarbans mangrove wetland in Bangladesh. In: Prusty B., Chandra R., Azeez P. (eds) Wetland Science (pp. 301-316). Springer, New Delhi. |
| 2015 | Urban park | Travel Cost | 0.06 Million USD/Year | Haider, M. Z., Hossain, T., Siddiqui, O. I., & Islam, M. S. (2018). Economic valuation of the tourist spots in Bangladesh. International Journal of Tourism Policy, 8(1), 42-64. |
| 2017 | Sunderbans | Value Transfer , Travel Cost | US$ 235 per ha per year | Barua, S. K., Boscolo, M., & Animon, I. (2020). Valuing forest-based ecosystem services in Bangladesh: Implications for research and policies. Ecosystem Services, 42, 101069. |
| 2017 | CHT hill forest , Sylhet hill | Travel Cost | US$ 583 per ha per year | Barua, S. K., Boscolo, M., & Animon, I. (2020). Valuing forest-based ecosystem services in Bangladesh: Implications for research and policies. Ecosystem Services, 42, 101069. |
| 2017 | Coastal forest | Market Price | US$ 159 per ha per year | Barua, S. K., Boscolo, M., & Animon, I. (2020). Valuing forest-based ecosystem services in Bangladesh: Implications for research and policies. Ecosystem Services, 42, 101069. |
| 2018 | Coastal forest | Travel Cost | US$ 114900 per year for total area. | Al, M. A., Akter, S., Raihan, A. H. M., & Mohammad, K. (2021). Ecosystem Services Assessment of Mangrove Forest in a Coastal Island of Bangladesh. Journal of Forests, 8(1), 88-98. |
| 2018 | Sunderbans , Coastal forest | Market Price | For Aquaculture- 183000 BDT, for golpata and goran- 22750 BDT, for keora- 50000 BDT, for Hargoza- 30000 BDT, for Baen- 60000 BDT, for Passur- 80000 BDT | Kabir, M. H., & Baten, M. A. (2019). Community Mangrove Aqua-Silviculture (CMAS Culture): An Innovation and Climate Resilient Practice by the Sundarbans Mangrove Forest Dependent Rural Communities of Bangladesh. International Journal of Environment and Climate Change, 9(1), 1-16. |
| 2018 | Coastal forest | Market Price | US$ 418257749 for fish and timber from the total area | Al, M. A., Akter, S., Raihan, A. H. M., & Mohammad, K. (2021). Ecosystem Services Assessment of Mangrove Forest in a Coastal Island of Bangladesh. Journal of Forests, 8(1), 88-98. |

| | | | | |
|---|---|---|---|---|
| 2018 | Coastal fores | Market Price | US$ 22,239,462 | Al, M. A., Akter, S., Raihan, A. H. M., & Mohammad, K. (2021). Ecosystem Services Assessment of Mangrove Forest in a Coastal Island of Bangladesh. Journal of Forests, 8(1), 88-98. |
| 2019 | Sylhet hill , semi-evergreen | Travel Cost | Taka 476.44 million per annum | Saha, N., & Mukul, S. A. (2021). Visitor's willingness to pay for cultural ecosystem services in Bangladesh: An assessment for Lawachara National Park, a biodiversity hotspot. |
| 2019 | Sylhet hill | Group Valuation | US$20 per month per household | Bhuiyan, M. S., Islam, S., Haque, M. M. U., Aktar, S., & Ahmed, R. (2021). Evaluating capital assets in governing protected area co-management in the Rema-Kalenga Wildlife Sanctuary, Bangladesh. International Forestry Review, 23(1), 16-28. |
| 2019 | Sal forest | Market Price | 54784 million BDT/year | GoB (2019), Tree and forest resources of Bangladesh: Report on the Bangladesh Forest Inventory. Forest Department, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh |
| 2019 | Coastal forest , Fish polyculture in ponds in the southwest coastal region of Bangladesh | Market Price | BDT 105,293 | Basu, S., & Roy, A. (2021). An economic assessment of fish polyculture as an adaptation strategy against environmental change in the southwest coastal region of Bangladesh. International Journal of Environmental Studies, 78(1), 105â€"116. |
| 2020 | CHT hill forest | Damage Cost Avoided , Market Price , Value Transfer | 76,158 BDT/ha/yr | Jalal, M.A.H.S., Haider, M.R., Melon, M., Rahman, M.M., Alam, S., Alam, SMR, Hossain, M.K., & Hossain, M.A. (2020). Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh (Bulletin 05; p. 90). Forest Economics Division, Bangladesh Forest Research Institute. |
| 2020 | CHT hill forest | Market Price | 50,103 BDT/ha/yr | Jalal, M.A.H.S., Haider, M.R., Melon, M., Rahman, M.M., Alam, S., Alam, SMR, Hossain, M.K., & Hossain, M.A. (2020). Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh (Bulletin 05; p. 90). Forest Economics Division, Bangladesh Forest Research Institute. |
| 2020 | CHT hill forest | Value Transfer | BDT 40,980 per ha per year | Jalal, M.A.H.S., Haider, M.R., Melon, M., Rahman, M.M., Alam, S., Alam, SMR, Hossain, M.K., & Hossain, M.A. (2020). Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh (Bulletin 05; p. 90). Forest Economics Division, Bangladesh Forest Research Institute. |
| 2020 | CHT hill forest | Travel Cost | BDT 75,872 per ha | Jalal, M.A.H.S., Haider, M.R., Melon, M., Rahman, M.M., Alam, S., Alam, SMR, Hossain, M.K., & Hossain, M.A. (2020). Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh (Bulletin 05; p. 90). Forest |

| | | | | |
|---|---|---|---|---|
| | | | | Economics Division, Bangladesh Forest Research Institute. |
| N/A | Coastal forest | N/A | N/A | Chow, J. (2018). Mangrove management for climate change adaptation and sustainable development in coastal zones. Journal of Sustainable Forestry, 37(2), 139-156. |
| N/A | CHT hill forest | N/A | N/A | Chowdhury, M. S. H., Halim, M. A., Biswas, S., Haque, S. S., Muhammed, N., & Koike, M. (2007). Comparative evaluation of physical properties in soils of orange orchard and bushy forest in Chittagong Hill Tracts, Banglandesh. Journal of Forestry Research, 18(3), 245-248. |
| N/A | Sunderbans | N/A | N/A | Abdullah-Al-Mamun, M. M., Masum, K. M., Raihan Sarker, A. H. M., & Mansor, A. (2017). Ecosystem services assessment using a valuation framework for the Bangladesh Sundarbans: Livelihood contribution and degradation analysis. Journal of Forestry Research, 28(1), 1–13. |
| N/A | CHT hill forest | N/A | N/A | Rahman, M. M., Mahmud, M. A. A., & Ahmed, F. U. (2017). Restoration of degraded forest ecosystem through non-forestry livelihood supports: experience from the Chunati Wildlife Sanctuary in Bangladesh. Forest science and technology, 13(3), 109-115. |
| N/A | Sylhet hill | N/A | N/A | Chowdhury, M. S. H., Koike, M., Akther, S., & Miah, D. (2011). Biomass fuel use, burning technique and reasons for the denial of improved cooking stoves by Forest User Groups of Rema-Kalenga Wildlife Sanctuary, Bangladesh. International Journal of Sustainable Development & World Ecology, 18(1), 88-97. |
| N/A | Sunderbans | N/A | N/A | Abdullah-Al-Mamun, M. M., Masum, K. M., Raihan Sarker, A. H. M., & Mansor, A. (2017). Ecosystem services assessment using a valuation framework for the Bangladesh Sundarbans: Livelihood contribution and degradation analysis. Journal of Forestry Research, 28(1), 1–13. |
| N/A | CHT hill forest | N/A | N/A | Gafur, A., Jensen, J. R., Borggaard, O. K., & Petersen, L. (2003). Runoff and losses of soil and nutrients from small watersheds under shifting cultivation (Jhum) in the Chittagong Hill Tracts of Bangladesh. Journal of Hydrology, 17. |
| N/A | Sylhet hill | N/A | N/A | Chowdhury, T., Rashid, A. M., & Tipu, M. T. K. Biomass and Carbon Estimation of the Four Major Tree Species in Ratargul Swamp Forest, Bangladesh. |
| N/A | CHT hill forest | N/A | N/A | Barua, S. K., & Haque, S. M. S. (2013). Soil characteristics and carbon sequestration potentials of vegetation in degraded hills of |

| | | | | |
|---|---|---|---|---|
| | | | | Chittagong, Bangladesh. Land Degradation & Development, 24(1), 63-71. |
| N/A | Sunderbans | Market Price | US$744,000 per year during financial year 2001– 2002 to 2009–2010 | Uddin, Md. S., de Ruyter van Steveninck, E., Stuip, M., & Shah, M. A. R. (2013). Economic valuation of provisioning and cultural services of a protected mangrove ecosystem: A case study on Sundarbans Reserve Forest, Bangladesh. Ecosystem Services, 5, 88–93. |

## 6.3 Forest Organization Bangladesh