Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh

Government of the People's Republic of Bangladesh

Bangladesh Forest Research Institute

Chattogram

December 2020

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The report is based on the findings of a study titled "Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh" funded by Bangladesh Forest Research Institute and conducted by the Forest Economics Division of BFRI

Front cover photograph

Ecosystem services from trees adapted from "Biodiversity and human health diagram developed by World Health Organization and Conservation of Biological Diversity.

Foreword

Now-a-days, the scientists and policy makers are making the increasing use of the concept of ecosystem services to describe the mix of productive and non-productive benefits that society obtains directly or indirectly from our environment. The key messages is that holding on to all of these benefits depends very much on how well we look after our unique native plants and animals and the ecological systems that support them. After all, these ecosystem services support us. The concept of ecosystem services has become part of our approach to effectively manage the Protected Areas by intervening the biodiversity, water, primary industries, human settlements, regional planning and climate change. It is also reshaping thinking around sustainable environmental management and stimulating new ideas for managing landscape resilience. The idea of ecosystem services has been well developed scientifically, but we have scarce information in Bangladesh.

The Bangladesh Forestry Master Plan 2017–2036 underlined the importance of conducting ecosystem services valuation to inform decision making. Despite a growing attention to ecosystem services in policy documents in recent years, scientific literature on ecosystem services valuation remains limited in Bangladesh. The importance of forest-based ecosystem services was also highlighted in many other policies and plans such as the draft National Forest Policy, the Bangladesh Climate Change Strategy and Action Plan, the National Adaptation Plan, the Coastal Zone Policy, the Nationally Appropriate Plan of Action, and the Land Use Policy. The importance of ecosystem services valuation for monitoring the progress and the impacts of such programmatic decisions on ecosystems is likely to grow in the future Bangladesh. Baraiyadhala National Park is a familiar Protected Area and biodiversity hotspots of Bangladesh because of the species richness, beautiful landscape crisscrossed by attractive streams and water falls. Baraiyadhala National park is the abode of *Cycas pectinata* an endangered gymnosperm found in Bangladesh. People living surrounding the national park are directly and indirectly benefitted from it's numerous ecosystem services.

Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh is the first of it's kind in the valuation of services from a prominent Protected Area. This valuation study is conducted by Bangladesh Forest Research Institute (BFRI) will broaden the stakeholders understanding on the economic value of the services received from a Protected Area. It is intended to reach the policy makers, researchers and practitioners for better management of the protected areas of Bangladesh. BFRI is appropriately pioneering the valuation of Baraiyadhala National Park (BDNP) and I hope it reaches far and wide. This report makes an important contribution to the forestry sector of Bangladesh.

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Acknowledgement

List of acronyms and abbreviations

AGB   Above Ground Biomass

BBS   Bangladesh Bureau of Statistics

BDT   Bangladeshi Taka

BFD   Bangladesh Forest Department

BFRI   Bangladesh Forest Research Institute

BDNP   Baraiyadhala National Park

BGB   Below Ground Biomass

CBD   Convention on Biological Diversity

CI   Cash Income

CICES   The Common International Classificaiton of Ecosystem Services

CST   Total Cost of Production

DBH   Diameter at Breast Height

ECTS   EU Carbon Trading Scheme

EPHH   Expected Number of Households

ES   Ecosystem Service

FAO   Food and Agriculture Organization of the United Nations

GBH   Girth at Breast Height

GFV   Gross Financial Value

ha   Hectare

HH   Households

MEA   Millennium Ecosystem Assessment

MoEFCC   Ministry of Environment, Forest and Climate Change

NFV   Net Financial Value

PAs   Protected Areas

PES   Payment of Ecosystem Services

SOC   Soil Organic Carbon

TCM   Travel Cost Method

TGF   Trip Generating Function

TQE   Total Quantity Extracted

ZTCM   Zonal Travel Cost Method

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Executive Summary

Eliciting the economic benefits provided by Protected Areas (PAs) is important in order to ensure that they are properly considered in policy and decision making. There are relatively few studies that provide a comprehensive overview of the economic benefits provided by the forest ecosystems of Bangladesh, in spite of the large share of forest resources in the protected area system. An economic valuation of the selected ecosystem services supplied by the Baraiyadhala National Park (BDNP) located in the Chattogram district of Bangladesh is the outcome of the study. The National Park forest is one of the well-known protected areas in the country. The study estimated the economic values of 11 ecosystem services under four ecosystem service categories (i.e. provisioning, cultural, regulating and supporting), and examines the policy implications for financing protected area management. The services are fuelwood, bamboo, broom grass, sungrass, medicinal plants, potential timber harvests, groundwater recharge, carbon sequestration, air filtration, tourism, and biodiversity. Data collection was conducted through forest survey, household and tourist interview, and key informant interview during the period of July 2019 to June 2020.

The methods of valuing the ecosystem services varied with the nature of the services. Direct market valuation method is used for valuing the provisioning services; zonal travel cost method is applied for tourism; and value transfer method was applied for the other services. A conservative estimate of the total economic benefits generated by the National Park is around 2,43,113 BDT/ha/yr (USD 2,860 per ha/yr; 1 USD = 85 BDT), whereas the total economic value is 561.36 million BDT/yr (USD 6.60 million/yr). This study provides a comparatively higher value of ecosystem services per unit area than that's of similar forests reported by some other studies from Bangladesh. It might be due to the number of ecosystem services considered in this study and popularity of BDNP as an ecotourism site. The study indicates a necessity of indepth research for developing reference values for a number of key ecosystem services. The findings would help the policy makers to understand the direct and indirect economic contributions of a forest ecosystem like BDNP. It will also help draw more attention and fundings for better management of the PA to improve and maintain a sustainable flow of ecosystem services.

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1. Introduction

Bangladesh is exceptionally rich in biodiversity, but the natural resources particularly the forest coverage of Bangladesh are degrading at an alarming rate (Alam et al., 2008). As a consequence, the tangible and intangible ecosystem services from forests are declining proportionately with the reduction of the forest health (Bourguignon, 2015). Forests provide myriads of visible and invisible services in both direct and indirect ways (Hein, 2011). Local people living in and around the forests especially in the impact zone of a certain forest ecosystem are the major beneficiaries of that ecosystem (Jannat et al., 2018). Any disruption of the ecosystem functions causes reduction of the services from a forest which severely affects the associated communities and overall environment (Secretariat of the Convention on Biological Diversity, 2001). Every year the amount of harvestable resources from forests, the flow of stream water from forest ecosystem, and the amount of carbon sequestration is diminishing worldwide which not only directly harms local livelihoods and agriculture but also exerts numerous indirect damaging effects on human civilization (Millennium Ecosystem Assessment, 2005).

The world community is now conscious about the intrinsic value of biodiversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of ecosystems and its components (MoEF 2007). Some of the major values of forest ES are, i) Environmental value, ii) Social value, iii) Ecosystem services, iv) Economic value, v) Consumptive use value, vi) Productive use value, vii) Ethical and moral value, and viii) Aesthetic value. Biodiversity of an ecosystem is the most precious gift of nature and mankind is blessed with it. As all the organisms in an ecosystem are interlinked and interdependent, the value of biodiversity in the life of all the organisms including humans is enormous. Direct use values (goods) are food, medicine, building material, fiber, fuel etc. Indirect use values (services) are atmospheric and climate regulation, pollination, nutrient recycling, cultural, spiritual and aesthetic etc. Non-use values include potential or option value (future value either as a good or service), existence value (value of knowing something exists), and bequest value, i.e. value of knowing that something will be there for future generations. In fact, most of the environmental or ecological services are non-marketed and hence does not have a market price. Even if a market price for a resource exists, market complexity structure often does not reflect the true 'opportunity cost' of resources (Haque and Aich, 2014).

Millennium Ecosystem Assessment (2005) defined the ecosystem services conceptually

based on four pillars, e.g., support, regulatory, provisional and cultural services. The ecological services of Bangladesh Sundarbans including 9 support, 7 regulatory, 5 provisional, 3 cultural plus waste treatment etc value ranges from US$ 105.07-840.59 per ha per year (Haque and Aich, 2014). Similar valuation of ecosystems including the biodiversity is getting preferences in a number of ecosystems of the world. The conservation priority may be given to the ecosystems, if the proper valuations of the natural resources are done.

In Bangladesh, forest ecosystem is degrading due to the anthropogenic causes which may be checked for upholding the ecosystem health by undertaking measures for protection and conservation of forests and socio-economic development of local people (Alcamo et al., 2003). Undertaking the necessary and adequate measures for retaining and further upgrading the ecosystem health requires significant policy attention. Since, the policy decisions are mostly driven by the economic interests, so valuation of ecosystem services may help drawing attention of policy makers for making sufficient allocation of funds, logistic and administrative supports for conservation of the ecosystems (Huq et al., 2017). Moreover, valuation of ecosystem services of forest ecosystem is crucial for understanding the significance of the contributions of the concerned ecosystems to the human society (Adekola et al., 2008; Hossain, 2019). The ecosystems services are tagged as provisioning, supporting, cultural and regulatory services which are characterized by use values and non-use values (Alcamo et al., 2003). However, to help the valuation, a range of methodologies have been proposed by the ecologists and economists many of which are well recognized and used widely (McDonough et al., 2017).

The government of Bangladesh, so far, declared 45 Protected Areas (PAs) including the terrestrial and marine PAs which covers 4.31% of the total area of Bangladesh. Declaration and management of protected areas is one of the efforts from the government side to tackle the loss of forest resources, especially the biodiversity. But unfortunately, none of these PAs were valued economically for their ecosystem services as a result of which there is great dearth of information about the value of ecosystem services of the PAs in Bangladesh. Baraiyadhala National Park (BDNP) is one of the 18 National Parks and the only national park located in Chattogram district out of these 45 PAs. Considering the above-mentioned contexts, BDNP has been considered for ecosystem services valuation in the present study for understanding the value of the PAs. Findings of the study are believed to be useful to the scientific community, commitments to the international conventions and treaties, Bangladesh Forest Department (BFD) and respective policy makers for sustainable PA management.

1.1 Objectives of the study

The aim was to assess the economic value of the selected ecosystem services of Baraiyadhala National Park. Specific objectives of the present research are to-

i.   Assess the economic value of selected provisioning, supporting, cultural and regulatory ecosystem services from BDNP,

ii.   Understand the significance of the ecosystem services to the local beneficiaries of BDNP. and

iii.   Recommend the necessary measures for conservation of the BDNP, to sustain the ecosystem services.

2. Baraiyadhala National Park

The Baraiyadhala National Park is featured by tropical semi-evergreen, tropical wet evergreen, tropical moist deciduous, bamboo thickets, and plantations (Fig. 1). It was declared as National Park on 6th April, 2010 by the Ministry of Environment and Forest (MoEF) by gazette notification no. MoEF/For-Sec-02/02 National Park /11/2010/210 dated 06/04/2010 applying the authority given under section 23(3) of Bangladesh Wildlife (Preservation) (Amendment) Act 1974.

a   b

Figure 1. Forests of Baraiyadhala National Park

2.1 Location

Baraiyadhala National Park is located in Sitakunda-Mirsharai Upazilla of Chattogram district. The national park is located approximately 207 km East-Southeast of Dhaka and 40 km North of Chattogram in both Mirsharai and Sitakunda upazilla under Chattogram district. Geographically, the area lies between 22°39' - 22°47' N latitude and 91°35' - 91°41' E longitude (Fig. 2). It is under the jurisdiction of Baraiyadhala range of Chittagong North Forest Division. The park is surrounded by Gobania block of Gobania beat, Mirsharai Range on North; Jungle Sitakunda mouza of Sitakunda block and beat on South; Ramgarh-Sitakunda reserve forests, Balukhali beat, Fatikchari beat, Hazarikhil beat and Baromasia beat on East and Gobania mouza, East Mogadia, East Khoiyar chara, Wahedpur, Baro Kamaldah on West. There are signboards and indications about the location of Baraiyadhala National Park on the Dhaka-Chittagong Highways so that tourists can find their destination easily (Fig. 3).

Location of Baraiyadhala National Park

Figure 2. Location map of Baraiyadhala National Park

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2.2 Area

As per the administrative structure of Bangladesh Forest Department, Baraiyadhala National Park is composed of Baraiyadhala and Wahedpur blocks of Baraiyadhala Sadar beat and Kunderhat block of Bartakia forest beat under the Baraiyadhala range. The national park covers an area of 2,933.61 hectare (Table 1) which is consisted of the forests from Sadar beat and Bartakia beat.

Table 1. Distribution of land area of Baraiyadhala National Park under different forest beats

Range	Beat	Block		Area (hectare)
Baraiyadhala	Sadar	Baraiyadhala		644.78
		Wahedpur		1110.93
	Bartakia	Kunderhat		1157.90
Total				2933.61

2.3 Surrounded localities of Baraiyadhala National Park

The Baraiyadhala National Park is surrounded by a number of villages of Baraiyadhala union under Sitakunda upazila as well as two unions and a municipality of Mirsarai upazila. The villages are Rahmatnagar, Sahebdi nagar, Fulgazipura from Baraiyadhala union. On the other hand, south, middle and north Wahedpur, Jumma para and Khoiyachara para are from Wahedpur union of Mirsarai upazila. A number of large industries are also located in the vicinity of BDNP.

Figure 3. Baraiyadhala National Park indications from the Dhaka-Chittagong highway

2.4 Hydrology

The forest valleys of BDNP comprising sandy bedded streams (chara), canals and lakes contain and carry the water to the Bay of Bengal. The national park is crisscrossed by more than 10 streams most of which developed from the hills located in the middle of the BDNP. The small streams enable drainage water stagnation in the depressions and valleys in the hilly landscape, which serve as important habitat for flora and fauna, as well as provide drinking water for both human and animal populations. These streams are associated with a beautiful landscape and charming natural waterfalls. Water flows through some of the steams round the year keeping the waterfalls active and attractive to people while the remaining steams flow sufficient water only in the monsoon season.

2.5 Topography and soil

The topography of BDNP is very undulating consisted of a linear hill range stretching North to South reaching an altitude up to 350 m. The soils in this area are clay to clayey loam in the valleys and sandy loam to coarse sand in hilly areas. The clayey and sandy loams are fertile, and the sandy soil is often impregnated with iron resulting in red or yellowish tinge. Hilly soils contain unconsolidated rocks, sandstones, shale and siltstones. Moderately well to excessively well drainage capacity and high depth of the soil made it highly suitable for plant growth. The soil of high hills is, sometimes, yellowish-brown or strong brown.

2.6 Climate

BDNP has a tropical monsoon climate, characterized by basically four seasons, e.g. winter (December-February), summer (March-May), monsoon (June-September) and autumn (October-November). The south-west monsoon provides the majority of the annual rainfall. An average annual rainfall of the areas is 3,000 mm with a range of 1,611 - 3,878 mm. On average highest rainfall occurs in July (727 mm) and the lowest rainfall in January was 5 - 6 mm. Monthly average minimum and maximum temperature of the area ranges from 14.5^{o}C to 32.4^{o}C (Khatun et al., 2016), whereas yearly minimum and maximum humidity ranges from 73 - 80% (mean 78.04%).

BDNP is frequently affected by monsoonal heavy rainfall and cyclones during May and October. Pre-monsoon north-westerly and cyclonic storms are accompanied by high-speed winds and rains, which do significant damage to property and biotic life.

The International Disaster Database lists 157 cyclones between 1900 and 2009 for Bangladesh, with the five most devastating ones occurring in 1960, 1970, 1991, 1994 and 1997. Floods and cyclones have both direct and indirect repercussions for the forests and forest resources. Extensive damage of this forest took place in the cyclone of 1991, 1994 and 1997.

2.7 Demography

Localities are situated all along the western part of the park as the other three sides are surrounded by reserved forests. The direct and indirect dependence of local peoples on the forests is very high. Other than extracting resources, the local peoples earn their livelihood through farming, daily wage earning, service in the city or nearby industry, automobile driving and small business.

3. Materials and Methods

3.1 Identification of the ecosystem services for valuation

All major ecosystem services received from BDNP are considered for valuation in this study. The major ecosystem services were identified through interviews of the key informants i.e., park management and local stakeholders. Table 2 presents the ecosystem services considered in this valuation study. Extraction of any resources from the protected areas is banned but local people collect timber, fuelwood, bamboo, broom grass and Sungrass. Since, the collection by local people is illegal, it is a highly likely that the people interviewed underreported their collection of provisioning services, and thus the economic value of them are an underestimate. The research team collected data about extraction of these provisioning services to assess their value.

Table 2. Ecosystem services identified for valuation in BDNP

SN	Service types	Specific services accrued at regular basis
1	Provisioning	Timber, Fuelwood, broom grass, bamboo, Sungrass, medicinal plants
2	Cultural	Tourism, education and spiritual value
3	Regulatory	Carbon sequestration, ground water infiltration, air pollution control, regeneration
4	Supporting	Biodiversity

3.2 Data collection

For valuation of the identified ecosystem services, data has been collected through forest, household and tourist survey. The forest survey was conducted within the boundary of BDNP whereas systematically selected households and randomly selected tourists were interviewed from the surrounding localities and tourist sites of the PA respectively. Moreover, key informant interview and extensive literature survey were conducted for gathering relevant information and meeting gaps in field data.

3.2.1 Key informant interview

Respective officials of BFD, entrepreneurs conducting small business in the tourist spots, and conscious local stakeholders were interviewed as key informant for exploring overall socio-economic condition of the local people, adjacent villages of BDNP, forest health, forest dependency of the local people, tourist spots, and heterogeneity of the population etc.

3.2.2 Forest survey

Woody plants having DBH ≥ 5 cm (GBH 15.7 cm) has been measured from 67 square sample plots (10 m × 10 m) selected following random sampling method (Fig. 4). Moreover, woody plants of DBH ≥ 2 cm and DBH < 5 cm were sampled as sapling from 3 m × 3 m sized square plot nested in the center of the 10 m × 10 m plot. Regeneration of tree species also sampled from the same plots. All seedlings having DBH <2 cm (GBH 6.3 cm) were considered as regeneration. Number of sample plots was adjusted to achieve a sampling intensity of 0.05%. Total height, DBH and name of the tree species occurred in the sample plots were measured and recorded. In case of surveying the regeneration plot, the species and number of individuals per species were counted and recorded. Coordinate and land cover type were recorded for each plot. In addition, soil samples were collected from each plot from 0-15 cm, 15-30 cm and 30-50 cm soil depths.

a   b
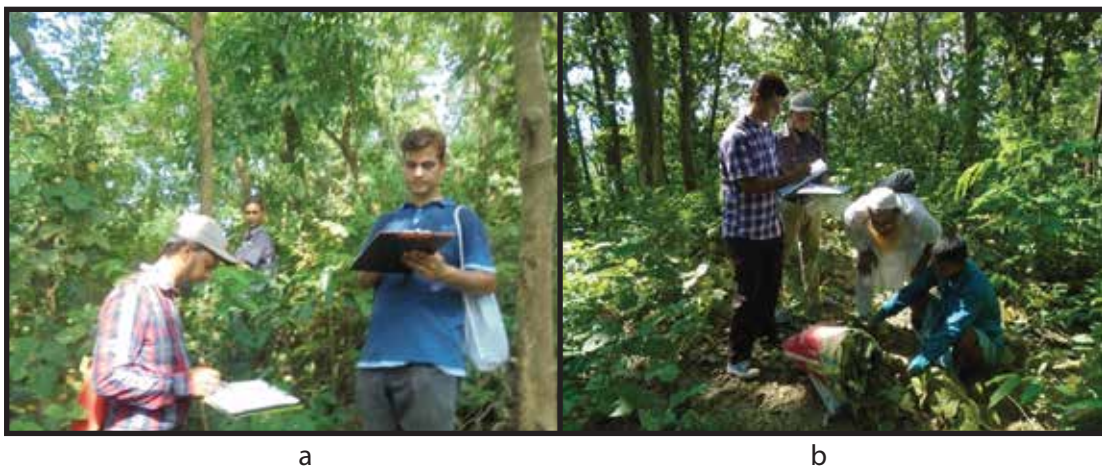
Figure 4. Forest survey- a) tree data collection from the sample plots, and
          b) litter sample collection.

3.2.3 Household survey

A semi-structured questionnaire was used to interview the households from the impact area of BDNP. A total of 126 households were interviewed to cover 1.5% of all households from the impact area. The BDNP is surrounded by another protected area and reserve forests in three sides (i.e., south, east and north), human localities are only in the western side. We considered the villages between BDNP and the Dhaka-Chattogram highways as the impact areas. This area constituted almost half of the three unions (i.e., Baraiyadhala, Wahedpur and Khaiyachhara) and 5 wards (i.e., Ward no. 3, 4, 6, 7 and 9) of Mirsharai municipality. So, we assumed that population of the impact zone constitute approximately half of the total number of households in these three unions and 5 wards of Mirsharai municipality. Total number of households in the impact areas is 8,629 whereas the populations are approximately 43,019 (BBS, 2015). In order to select households for interview, firstly, the existing village roads were identified as walking trails through the villages of the impact area. Then, a house is selected for interview after each two houses through the identified walking trail. A total of 6 households were interviewed from each of the selected trails. Immediately next household was selected for interview in case a selected household couldn't be interviewed. In total 126 households were interviewed from 21 village walking trails (Fig. 5). Data was collected about the extraction of forest resources, cost of collection and income from sale of resources along with basic family variables (Fig. 6).

Figure 5. a) Key informant interview (KII) in the Baraiyadhala Range Office, and b) household interview

Figure 6. Forest resource extraction from Baraiyadhala National Park-
a) fuelwood collection, and b) bamboo collection

3.2.4 Tourist survey

Tourist survey was conducted through interview of the tourists guided by a semi-structured questionnaire from July 2019 to June 2020. Information about the origin of the tourist, distance travelled, means of travel, total costs of travel, number of previous visits, nature of tourist (single or group), impression on the visited sites, other spots in the list of visit and basic visitor information (i.e. age, occupation, gender, family size, education level etc.) was collected during the interview. Moreover, visitors' perceptions about improvement needed in the visited sites of BDNP has been discussed and recorded. The total number of tourists surveyed was 77originating from 10

administrative districts under 7 administrative divisions of Bangladesh. Most of the tourist came from Chattogram (47) followed by Dhaka (17). The divisions have been considered here as zone to calculate the visitation rate. This number of visitors has been used for calculation of the visitation rate (dependent variable in the regression analysis) from each zone.

As there is no entry fee for any of the spots, so record of the number of tourists per annum or any other time frame doesn't exist. Moreover, a few ways are used by the tourist to enter in the spots that's why it is very difficult to count the number of tourists. The study has collected information on the number of tourists visiting the sites in different months on the year from the key informants. The key informant survey indicated that, in total 62,553 tourists visited the tourist spots of BDNP during July 2018 to June 2019.

3.2.5 Market survey

Market survey was conducted to estimate the unit prices of the timber timber of different commercially important species in the adjacent areas of BDNP through visiting the nearby sawmills and timber markets.

3.2.6 Secondary data collection

Secondary data has been collected from a number of sources to meet the necessary data gaps i.e., zonal population from BBS (2015), local population from BBS (2019) and respective union parishads, litter carbon sequestration rate from Hossain et al. (2019) etc. Previous recorded about floristic composition of BDNP has been collected from Hossain (2015) and Harun-ur-Rashid et al. (2018). Faunal diversity of the BDNP has been collected from a study of Bangladesh Forest Research Institute (BFRI) titled "Status of Wildlife in Baraiyadhala National Park". This study was conducted through transect survey and camera trapping during the period of 2014 to 2017. Many other data (i.e., value of carbon, annual rate of above ground carbon sequestration in the hill forests etc.) have been collected for valuation of ecosystem services from multiple sources which were mentioned in relevant section of this document.

3.2.7 Literature survey

Extensive literature survey has been made to explore the previous studies; establish the scientific basis and validate the methods used in this study. The literatures

include research article, books, reports, manuals etc. Information also collected from the Forest Working Plans of the Forest Department and the Management Plan of Hazarikhil Wildlife Sanctuary and Baraiyadhala National Park (Hossain, 2015). Most of these literatures have been sourced from libraries of BFRI and different websites through internet.

3.3 Classification of the ecosystem services

The classification of ESs has been debated widely in recent years (Boyd and Banzhaf, 2006; Costanza, 2008; de Groot et al., 2002; Fisher et al., 2008; Wallace, 2007), and many classification schemes have been proposed. A globally recognized scheme was introduced in Millennium Ecosystem Assessment which is adopted in several studies and initiatives (Millennium Ecosystem Assessment, 2005). The Common International Classificaiton of Ecosystem Services (CICES) classified and defined the contributions of the ecosystems for human well-being which is also regarded as the most elaborate classification (Haines-Young and Potschin-Young, 2018). MEA defined four ecosystem service (ES) categories are described below (Table 3).

1. **Provisioning** – products and materials obtained from ecosystems, such as food, fibres, building materials, fresh water, energy, biochemicals and genetic resources.

2. **Regulating** – benefits obtained from the regulation of ecosystem processes and the environment, such as climate regulation, disease regulation, water regulation, water purification, pollination, soil protection, carbon sequestration, and protection against natural hazards and extreme events.

3. **Cultural** – nonmaterial benefits obtained from ecosystems that enrich lives, such as spiritual and religious values, recreation and tourism, aesthetic value and landscape, inspirational value, education, research, sense of place, and cultural heritage.

4. **Supporting** – underpinning services that enable other services to function, such as soil formation, nutrient cycling and primary production.

Table 3. The classification of ecosystem services according to the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005)

Provisioning Services	Regulating Services	Cultural Services	Supporting Services
Products obtained from ecosystems	Benefits obtained from regulation of ecosystem processes	Nonmaterial benefits obtained from ecosystems that enrich lives	Underpinning services that enable other services to function
Example- • Food • Fresh water • Fuel wood • Fibre • Biochemicals • Genetic resource	Example- • Climate regulation • Disease regulation • Water regulation • Water purification	Example- • Spiritual & religious • Recreation & ecotourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage	Example- • Soil formation • Nutrient cycling • Primary production

3.4 Data analysis

Analysis of data for assessment and valuation of provisioning, cultural, regulatory and supporting services is discussed under the respective ecosystem services.

3.4.1 Provisioning services

3.4.1.1 Tree volume estimation

The tree data collected through the forest survey was used for estimation of standing timber volume. Gross volume was estimated using species specific total volume models from BFD (2007) to determine the timber and bamboo volume. In cases of the unavailability of volume model quarter girth formula along with appropriate average form factor (from factor 0.693) following Hossain et al. (2019) has been used for estimation of the gross tree volume. The gross timber volume is presented as the current growing stock in BDNP.

3.4.1.2 Estimating the collection of provisioning services

The extraction of provisioning services (i.e., timber, fuelwood, broom grass, sungrass, medicinal plants etc.) by the surrounding communities is estimated using the data from household survey. Quantities expressed by respondents in local units were converted to

standard units, while monetary values were expressed by respondents in Bangladeshi Taka (BDT). The 'expected' number of households participating in a specific production activity (EPHH) (e.g., timber, fuelwood, bamboo and broom grass collection etc.) and the total annual quantity extracted (TQE) were used to compute for GFV and NFV (Eq. 1).

$$EPHH_i = \frac{m}{n} \times N \dots\dots\dots\dots\dots\dots\dots\dots\dots(Eq.\ 1)$$

Where, m is the number of households participating in the activity in the sample, n the total number of sampled households (n = 126) and N the total number of households in the population (N = 8629).

TQE (i.e., for extraction of ith resources) was computed from the average annual quantity collected per sample household, multiplied by the 'expected' number of households participating in that specific production activity (EPHH).

3.4.1.3 Valuation of the provisioning services

The values of the BDNP provisioning services were estimated and expressed as annual values using three economic indicators: the gross financial value (GFV – economic worth of total quantity extracted), the net financial value (NFV – the total subsistence plus cash value to households net of input costs but not household labor costs) and CI (economic worth of quantity sold). GFV captures the total monetary value of the services. This indicator is appropriate for services that are used for subsistence. On the other hand, NFV is an acceptable indicator of the potential market values that could be received, if the ecosystem service would be sold on markets and if the costs of collection involve the direct financial costs made. In other words, it gives a good indication of the profit made. CI is an appropriate indicator for the actual cash generated from the sale of ecosystem services. This indicator measures cash generated from sale of ecosystem services and used for other household livelihood activities.

GFV was computed as follows (Eq. 2)-

$$GFV_i = TQE_i \times P_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(Eq.\ 2)$$

Where, P is the average price per unit at which a product is sold in Sitakunda and Mirsharai area (April 2019 to March 2020).

NFV was computed as follows (Eq. 3)-

$$NFV_i = GFV_i - CST_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(Eq.\ 3)$$

Where, CST is the total costs of collection/production, including cost of family labor and travel. The cost of family labor was taken into account as the opportunity cost was considered valuable in the context of needs of labor for farming and industrial activities. By using GFV and NFV as indicators we are able to assess the level of financial investment needed to derive benefits from the BDNP. Finally, the CI is the monetary monetary value of quantity sold estimated by multiplying the total quantity of product sold (QSD) and selling price of the resources. CI is different from GFV in that it is an indication of the total local market value of the quantity sold out of the total harvest.

Gross financial value (GFV) of the extracted forest resources per unit area of BDNP is estimated using the following formula (Eq. 4).

$$P_i = \frac{GFV_i}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(Eq. 4)}$$

here, P_i = Gross Financial Value of the ith extracted resource per ha (BDT/ha); GFV_i = Gross Financial Value of the ith resource (BDT); and A = Area of BDNP (ha).
Eq. 5 is used to estimate the value of all forest resources (P_T) per unit area of BDNP.

$$P_T = \sum_{i=1}^{n} P_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(Eq. 5)}$$

3.4.1.4 Valuation of potential timber harvests

Timber is one of the provisioning ecosystem services. Harvesting timber is prohibited from BDNP as it is a Protected Area. However, illegal logging is reported sometimes from the study area (personal communication with BFD, 2020). Timber seized from illegal loggers is just a small part of the potential timber supply from BDNP, and thus cannot be considered as an ecosystem service. That's why economic value of the potential timber harvest is estimated based on the net annual increment of the growing stock. Since, estimamtion of the timber yield rate for a seconday natural forest ecosystem like BDNP is beyond the scope of the present study, that's why we used the net annual increment of the growing stock (2.91 m³/ha/yr; FAO (2014)) for estimating the total annual growing stock. Then we have used the average market price (BDT 13141 ± 1411 per m³ or BDT 372 ± 39 per cft) of the timber irrespective of species based on a timber market survey for valuing the potential harvests.

3.4.2 Cultural services

3.4.2.1 Application of travel cost method

The team assessed the cultural services (tourism) using the Travel Cost Method (TCM), a revealed preference method, which was developed from a suggestion made by Harold Hotelling in 1947. The TCM is predominantly used to estimate the value of environmental and recreational sties. Two main advantages of TCM are, i) it is based on market prices that directly reveal people's preferences for a good or services, and ii) it has been used to value a range of cultural goods and services and compare those values (O'Brien, 2010). TCM is a relatively simple and inexpensive method to use and the results are easy to interpret. In this process the data can be collected easily and the value estimation is based on a simple assumption that the value of a recreation option depends on and is inversely related to the travel cost. The method applies demand theory to estimate and explain the value of a recreation choice (Prayaga et al., 2006). However, it is to be noted that TCM is not able to estimate the values of people having travelled to the site in question by foot or other "free" means of travel. Considering the overall context of our tourist survey data and nature of tourism in BDNP, among the two types of TCM, we used zonal TCM (ZTCM) in this study following Clawson and Knetsch (1966).

3.4.2.2 Visitation rate estimation

The visitation rate from each zone is calculated by dividing the total number of visitors in the sample from a particular zone (V_i) were with the total number of visitors in the sample (V_s) (individuals who attended the festival and were surveyed). This gives the proportion of festival visitors from each zone. This proportion was then multiplied by total number of visitors to the festival and further divided by the population (population data was collected from (BBS, 2019) of the Zone i. This is summarized in Eq. 6 and the resultant visitation rate is presented in Table 4.

$$v_i = \frac{\left[\frac{V_i}{V_s} \times V\right]}{N_i} \quad \text{.................................(Eq. 6)}$$

where, v_i is the visitation rate for zone i, V is the total number of visitors per year and Ni is the populations from the ith zone. Here, we have computed the visitation rate per 1000.

Table 4. Visitation rate of BDNP

Zone	Number of visitors sampled (Vi)	Population of the zone (Ni)	Visitation rate (vi) per 1000	Total travel cost/trip
Chattogram	39	28423019	1.11	682.6
Dhaka	23	47424418	0.39	1794.1
Rajshahi	6	18484858	0.26	2941.7
Rangpur	3	15787758	0.15	3175.0
Barisal	2	8325666	0.20	3375.0
Sylhet	3	9910219	0.25	3006.7
Khulna	1	15687759	0.05	4140.0

3.4.2.3 Travel cost calculation

As there was no entry fee, the total cost of travel includes the transportation cost, food cost and any other expenditure made in the tourist spots. The average round-trip travel cost is computed for each zone in BDT per trip per person. The average travel cost indicated that the distant travelers incurred higher amount of cost than those of nearer zones.

3.4.2.4 Regressing for trip generating function development

To obtain the trip generation function the visit rate is regressed against the travel cost and income. Through the regression analysis (Table 5), the equation that relates visits per capita to travel cost and income has been prepared.

Table 5. Linear regression coefficients

Model	Coefficients			Test statistic	
	Constant**	Travel cost**	Income**	F***	Generalized R^2
Linear	1.196 (0.0002)	-0.00031 (0.0008)	-	51.86 (0.0008)	0.912
Linear	1.104 (0.002)	-0.00032 (0.00017)	$2.9×10^{-6}$ (0.321)	28.01 (0.0044)	0.933
Logarithmic	4.9253 (0.00)	-0.5863 (0.00)	-	559.52 (0.00)	0.991

**P-value in the parenthesis.
*** Significance F value in the parenthesis.

The regression indicated that income doesn't influence the visitation rate significantly but travel cost does. With the increase of travel cost the visitation rate reduced significantly. This may depend on the fact that in Bangladesh the disparity of average

income between the zones is not that high and hence there is not enough variation in this variable. The logarithmic model showed comparatively higher significance influence of the natural log of travel cost on the vigitation rate. Thus, the regression provides the following Trip Generating Function (TGF) for estimating the demand curve (Eq. 7).

Visitation rate = 4.9253 - 0.5863 LN(TC) -------------------------------- (Eq. 7)
Here, TC = Travel cost (BDT).

3.4.2.5 Valuation of tourism

Travel cost methods and hedonic pricing methods are usually classified as revealed preference methods. The travel cost method for valuing outdoor recreational assets was originally suggested by Harold Hotelling (1947). It was developed by Clawson (1959) and Knetsch (1963) and was followed up in Clawson and Knetsch (1966). Basically, it involves using the travel costs incurred by travelers to a natural area plus any entry fee paid as a proxy for their effective price for visiting the area. Those travelling longer distances to visit the natural area will usually incur greater travel cost. Therefore, the effective price or cost of a visit is higher than for those who live closer to the natural area. Other things equal, a lower relative frequency of visits would be expected from residents living more distant from the natural attraction than those closer by, given that the demand for visits is a normal economic good.

Problems for this method also arise when there are substitute sites, if visitors visit several sites on the one trip, and if individuals have limited knowledge of the site to be visited or if the site covers a large area (Tisdell and Wilson, 2002).

3.4.2.6 Assumptions of travel cost value estimation

The cost of the travel and of the time spent to reach and stay at the site are a proxy for the value of the recreational experience. Use value is assessed taking into account the number of homogeneous visits to the sites among respondents. This method of travel cost valuation assume that tourists take a trip for single purpose- to visit a specific site, thus it avoids visitors who in one day visit several sites. That means environmental quality of the site affects the number of visits to the site. The weak complementarity

assumption allows us to identify how the variation in the quality of an environmental good affects the behavior of a person (to visit/not to visit/how many times). The opportunity cost of the time spent travelling the site is not estimated to avoid the complexity of defining and measuring the opportunity cost. Thus the present study may provide an underestimation of the cultural value as the opportunity cost of time is not added to the travel cost.

3.4.3 Regulatory services

Estimation and valuation of the regulatory services (i.e., carbon sequestration etc.) is described below.

3.4.3.1 Biomass estimation

Above Ground Biomass (AGB) was estimated using the data from forest survey applying the species specific allometric equation from Hossain *et al*. (2019), Khushi *et al*. (2018) and Mahmood et al. (2019). In cases, the species-specific equation is not available common equation for hill zone of Bangladesh was used from Hossain *et al*. (2018). Wood density data for the recorded species were sourced from different publications of BFRI to use in the allometric equations. An average wood density (0.6133782 g/cc) was used for some species as the species-specific density data was not available. The Below Ground Biomass (BGB) was estimated following Pearson et al. (2007) considering the overall context of BDNP.

3.4.3.2 Carbon sequestration estimation

Carbon estimation has been conducted in AGB and BGB along with litter and soil organic carbon (SOC) pools. Carbon in AGB and BGB is assumed to be 50% (Ragland et al., 1991). Carbon in all pools has been expressed for per unit area (hectare) and whole area of BDNP. Determination of soil organic carbon were carried out in the laboratory following Walkaly and Black (1934) wet oxidation method (Huq and Alam, 2005) using the soil samples collected during the forest survey.

3.4.3.3 Valuation of carbon sequestration

Carbon sequestration in above ground biomass, below ground biomass, soil and litter has been valued as a regulatory service. Carbon sequestration depends on the dynamics

and management of the vegetation. It is generally high in young forests, and declining in mature forests. Management of the forest stands in the park follows more or less the guidelines of PA management. As BDNP is a PA, any kind of logging is banned. There is no precise information about the annual increment rate of the timber or other forest resources. The growth rate of Akashmoni (*Acacia auriculiformis*) is about 2.5 m^3/ha/yr in the plantations of Bangladesh (Hossain, 2016). Khan and Millate-e- Mustafa (2001) reported that the productivity of the forests was around 1.5 - 2.5 m^3/ha/yr. As per the FRA 2015, the net annual increment of the growing stock is 2.91 m^3/ha/yr (FAO 2014). Taking this into account the total annual increment in the forests of the national park is therefore around 3,454.73 m^3/year. Since, there is a ban on timber harvesting and no information is available about the illegal annual extraction, it is assumed that the total annual increase in biomass in the BDNP can therefore be estimated at 3,454 m^3, i.e., 1,865.55 tonnes of wood per year, based on the average specific weight of 540 kg/m^3. Bangladesh Forest Department is trying to increase the protection status of the PA through increasing patrolling, enhancing conservation program and involving local people in the forest management activities through co-management, that's why no significant decline in annual increment can be expected in the coming decade (Personal communication with the BFD 2019). The average carbon content of dry wood is assumed to be 50% (Ragland et al., 1991). Therefore, the total amount of CO_2 sequestered annually in the above ground biomass of the BDNP is currently 932.78 t C/yr, or 3,423.29 t CO_2/yr which amounts to 0.79 t C/ha/year.

Estimates for the economic value of a unit of carbon sequestered vary widely. Indications of the marginal value of sequestered carbon can be obtained from either price at which CO_2 is traded in existing carbon markets, or from damage cost assessments. There are two types of markets for selling carbon. One is the compliance market. A compliance carbon market can be defined as a marketplace where regulated entities can buy and sell carbon emission permits (allowance) or offsets in order to meet predetermined regulatory targets set by national, regional or local governments (Ecosystem Marketplace, 2020). The European Union Emissions Trading Scheme (EUETS) is one of the most prominent compliance carbon markets in the world. At the moment, forest carbon sequestration is not allowed to be sold in any compliance market.

The above means the only option for selling forest carbon sequestration is in voluntary

market. A voluntary carbon market consists of transactions of the carbon offsets which are purchased by various entities with the intention to re-sell or retire to meet carbon neutral or other environmental targets. The demand for carbon offsets in the voluntary markets is driven by companies and individuals that take responsibility for offsetting their own emissions and the entities that purchase pre-compliance offsets before emissions reductions are required by regulation (Ecosystem Marketplace, 2020) The largest carbon trading scheme is the European Emission Trading Scheme (EUCTS), which does not apply to forestry. According to Hamrick and Gallant (2017) prices ranged from less than \$0.50 / t CO_2 emission to more than \$50/ t CO_2 emission. The average price across all transactions was \$3.0/ t CO_2. Zhang (2000) suggests that, if there are no limitations placed on worldwide carbon trading, carbon credits will exchange at just under \$10 per t C. Forest Trends' Ecosystem Marketplace (2020) estimated an average price of USD 4.3 per t CO_2 sequestered through forestry and land-use practices for 2019. Further analysis of the price of carbon is beyond the scope of this report, for the purpose of analysis \$4.3 per t CO_2 is considered as a conservative estimate.

3.4.3.4 Groundwater infiltration

The forest of BDNP, serves as an important area for groundwater replenishment. Drinking water wells are located in the villages and sub-urban areas around the national park and supply water to the people living in the area, for some 43,019 people in total (BBS, 2015). Shamsudduha et al. (2011) reported that the average annual ground water recharge rate for Chattogram region is 1,080 mm/year. The ground water replenishment varies as a function of rainfall, vegetation cover, tree density, land use and land cover (Owuor et al., 2016). However, due to the unavailability of the more precise data for BDNP we used this recharge rate for estimation of the amount of water replenished in the whole area of BDNP.

Ground water recharge is linked with a number of ecosystem services i.e. drinking water supply, maintaining adequate stream flow, supplying irrigation water (Fig. 7), protecting soil from erosion by reducing surface run-off, supporting plants and animals with necessary water etc. Household survey indicated that 76% households living in the impact area of BDNP use water from stream for many purposes (i.e., daily household use, bathing, irrigation, washing dishes or cloths, water for cattle etc.).

Valuing all these services following a TEV approach is beyond the scope of this study. Value transfer approach is used for determining the approximate value of ground water recharge. WTP (US$ 36.62 HH^{-1}yr^{-1}) reported by (Khanal et al., 2010) for receiving water supply related services from a community forest was applied thorugh inflation adjustment for valuing the groundwater infiltration by BDNP.
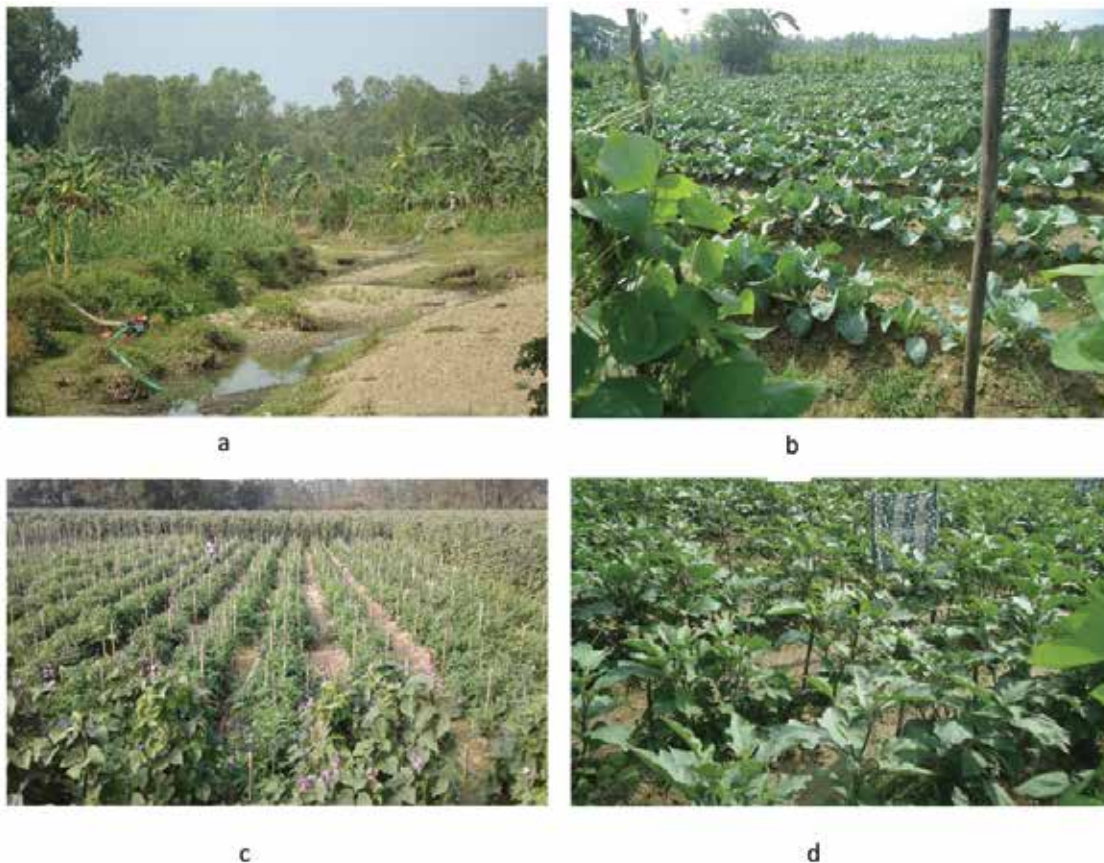
Figure 7. a) Irrigation into agricultural field from the streams flown from BDNP, b) cultivation of vegetables largely depends on irrigation water, c & d) bamboo sticks used in the agricultural fields adjacent to the BDNP.

3.4.3.5 Air pollution removal

Air pollution removal takes place through the interception of PM (particulate matter) by leaves (dry deposition). The total amount of particulate matter deposited on a certain

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site can be estimated as a function of the area, deposition velocity, time period, and average ambient PM_{10} concentration (Beckett et al., 2000; Powe and Willis, 2004) which can be expressed as the following equation (Eq. 8).

$$F = V_d \times C_d \text{ --------------------------- (Eq. 8)}$$

Where, F = Pollution flux (µg/m2/s), V_d = deposition velocity (m/s), C_d = pollutants concentration (µg/m^3). Finally, the particulate matter deposition is calculated using the Eq. 9.

$$PM_D = F \times A \times t \text{ --------------------------- (Eq. 9)}$$

Where, PM_D is the particulate matter deposition (µg) in the area and time period under consideration, A = area of land considered (m^2), t = period of analysis (s). The area is calculated as a function of canopy cover and land area of the study area (Eq. 10).

$$A = C_C \times A_P \text{ --------------------------- (Eq. 10)}$$

The deposition velocity of PM_{10} depends on the vegetation type, air velocity, and in the absence of better data is assumed to correspond to the deposition velocities measured in England, which has generally comparable types of deciduous forest (Powe and Willis, 2004). The PM_{10} concentration (Cd) is assumed to be 117 µg/m^3, which is average concentration of the nearby PM_{10} monitoring station in Chattogram over the period 2010-2012 (Begum et al., 2014). The velocity of the PM_{10} is assumed to be 0.0064 ms^{-1} for growing season (7 months of a year) and 0.0014 ms^{-1} for the leaf-off season, a 50% resuspension rate for PM_{10} back to the atmosphere was assumed (Yang et al., 2005). Moreover, the canopy cover was assumed to be 60% based on the data of hill forests canopy cover from Bangladesh Forest Inventory.

A range of studies have shown that forests remove air pollution by means of dry deposition of pollutants to plant surfaces (Beckett et al., 2000; Nowak et al., 2014). The removal of particles from ambient air generates an economic benefit, related to increased well-being and reduced sickness due to air pollution (Hall et al., 1992). Health impacts of air pollution occur as a function of long-term exposure, and there is still significant uncertainty regarding these effects (Kunzli et al., 2000). Consequently, it is difficult to solicit people's willingness to pay for clean air, and data are not available for Bangladesh. This study estimates the value of the air filtration service by estimating the avoided marginal damage costs associated with one unit of PM_{10} removal from the atmosphere. The cost is estimated using the inflation adjusted economic value of the benefits of per unit PM_{10} removal from Hein, 2011.

3.4.4 Supporting services valuation

3.4.4.1 Biodiversity

The essence of the value of diversity is that it embodies the value of information and insurance (CBD 2001). The existing diversity embodies a stock of information and the diversity of living things also embodies characteristics that make them resilient to further 'natural' change. Biodiversity protects the entire range of goods and services, including information, provided by the diverse system. The informational value of forest diversity for pharmaceutical use is better studied. There are two distinct views- i) the implicit economic value is huge, and ii) it is very modest, at least when converted to economic values per unit of land area. The total value of biodiversity is clearly unbounded: without biodiversity there would be no human life and hence no economic value.

In this study we followed benefit transfer method to value the biodiversity. Studies estimated value of biodiversity in Bangladesh is scarce. For biodiversity hot spots in Western Ghats of India the WTP of pharmaceutical companies is US$ 2,026 per hectare (Rausser and Small, 2000). In the same study the WTP of pharmaceutical companies for Eastern Himalayas was reported as US$ 332 per ha. Considering the similarity of BDNP with the biodiversity of that region we used this value after necessary adjustment for inflation for valuation of biodiversity.

3.4.5 Adjustments for inflation rate

The economic valuation of the ecosystem services based on value transfer methods, converted all the values published in different years to values in 2020 constant USD. The consersion process used the inflation rate of USD from World Bank data bank. The pulication year was considered as the base for adjustments due to inflation unless stated otherwise.

$$V_{2020} = V_i \{(1+IR_{i+1})(1+IR_{i+2})..............(1+IR_{i+n=2017})\} \text{ -------------------------- (Eq. 11)}$$

where,

V_i = Original value (i.e., value in USD per ha per year of an ecosystem service in the year i)

V_{2020} = Value per ha per year of an ecosystem service in 2020 constant USD.

IR = USD inflation rate based on consumer price.

4. Results and Discussion

Results of the study is presented by categorizing as the socio-economics features of the respondents, value of provisioning, cultural, regulating and supporting services. It is to be noted that the value presented here is a conservative valuation. The real value of the services obviously will be much higher than the estimations here.

4.1 Socio-economic features of the local stakeholders

4.1.1 Family size

The household survey indicated that total number of members per family varied from as low as 2 to as much as 17. Families having 5 - 6 members are very common (48%) followed by families having ≤ 4 members (34%) (Fig. 8). However, large families are comparatively less common as we found more than 8 family members in only 4% households.
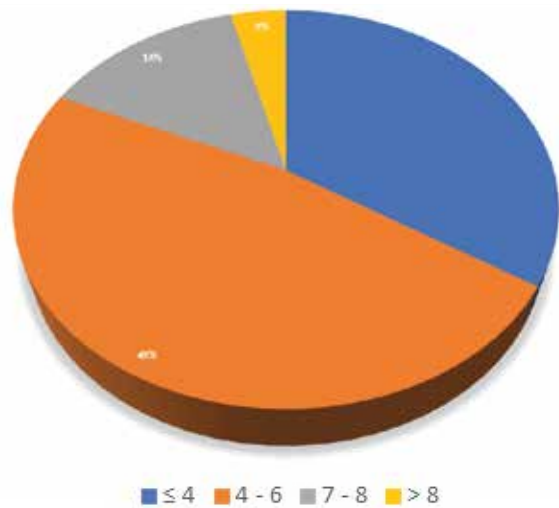
Figure 8. Family size of the households living in the impact area of BDNP

4.1.2 Educational level

It has been found that most of the respondents living in the impact area of BDNP are illiterate (61%) followed by primary level education (29%) and secondary level education (8%) (Fig. 9). The higher rate of illiteracy reduced their access to better professions. However, during the field work, we observed that people are conscious about the education of the children.

Table 6. Occupation of the household heads

Occupation	Percentage of the respondents	
	Primary (%)	Secondary (%)
Business	7	13
Carpenter	2	0
Cook	1	0
Day labor	2	27
Farming	81	1
Service	5	2
Other	2	0
Total	100	43
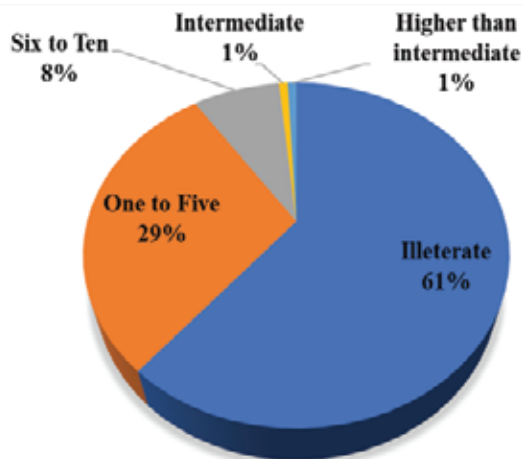
Figure 9. Household head's education level

4.1.3 Occupation of the respondents

Farming, business, service and wage earning are the main professions of the local people living surrounding the BDNP. The household interview indicated that majority of the respondents were involved in farming (81%) whereas wage earing is the most common (27% respondents) secondary occupation (Table 6). In case of primary occupations, farming is followed by business (7%) and service (7%). On the other side, as a secondary occupation business (13%) and part time service (2%) are the second and third most common occupation after wage earning. The others category in Table 5 include minor occupations expatriate, driving etc.

4.1.4 Households income

Family income of the residents varied from BDT 4,000 - 51,800 per month. The share of households earning BDT 10,000 - 20,000 is maximum (48%) (Fig. 10). This range is followed by BDT 20,000 - 30,000 with 29% households. However, only one percent families have their monthly income more than BDT 50,000. Families involved in business, service and having expatriate family members have higher monthly income.

Income ranges of the HH respondents (BDT)
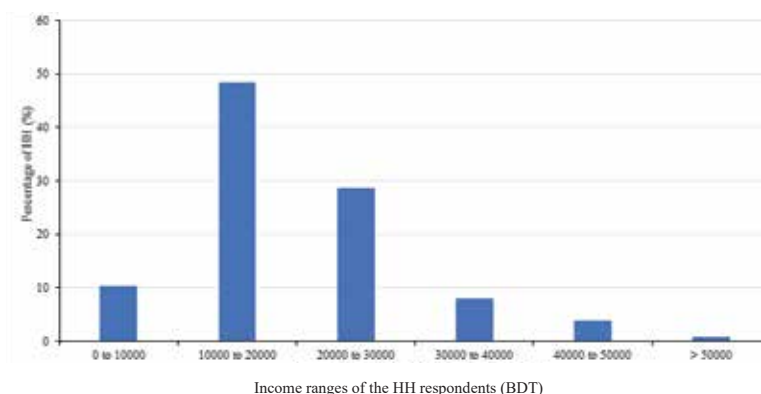
Figure 10. Monthly income of the households

4.1.5 Land ownership

A large number of households are landless in the impact area of BDNP. The survey indicated that there were more than 48% households having no land in their own. They are living in a rented house or government's temporary shelter houses. About 27% families have their own land of size ≤ 0.25 acres (Table 7). It is followed by 10.32% households who have 0.25 to ≤ 0.5 acres of land. There are some people own more than 1.25 acres of land including house and farms. However, a handsome percentage of households cultivate other peoples' agricultural lands in contract (borga or lease) basis.

Table 7. Land ownership of the households living in the vicinity of BDNP

Land ownership	Percentage of households (%) under different ownership categories		
Landless	48.41		
Land area (acre)	possess own land	Cultivate *Borga*[1] land	Cultivate leased[2] land
≤ 0.25	26.98	15.87	3.17
0.25 to ≤ 0.5	10.32	18.25	0.79
0.5 to ≤ 1.0	4.76	20.63	1.59
1.0 to ≤ 1.25	4.76	3.17	0.00
≥ 1.25	4.76	5.56	3.17
Total	100	63.48	8.72

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[1] Borga land means the land being cultivated by a farmer under an agreement of sharing a certain portion of the harvested crop with the owner. Here, the share of crop between the parties depends on the amount of harvest.

[2] Leased lands are the land being cultivated by a farmer under an agreement of paying a fixed amount of money for a certain period of cultivation. Here, the agreed amount doesn't depend on the amount of harvest.

4.1.6 Value of the provisioning services

The household survey showed that, though illegal, local people extract significant amount of fuelwood, broom grass, bamboo and medicinal plants and plant parts along with a limited quantity of sun grass. It was evident that 94% households collect fuel wood from BDNP whereas bamboo and broom grass collecting families constitute about 76% and 65% of the total number of families living in the impact area of BDNP (Table 8). Yearly fuelwood collection amounts 27,575 tonnes whereas per household collection is 3,404 kg per year. Along with household consumption, most of the families sell fuelwood for earning money. The study indicated that in total 25% of the collected fuelwood is sold each year. Gross financial value of fuelwood extracted from BDNP is maximum (BDT 23,688 per ha/yr) followed by broom grass (BDT 8,159 per ha/yr) and bamboo (BDT 23,248 per ha/yr). The total gross financial value of the provisioning services extracted by the local people per year is estimated as BDT 101.58 million from BDNP, whereas it is BDT 11,772 HH^{-1} of the impact area and BDT 34,627 per ha of the national park.

It is relevant to mention here that the local people haven't mentioned about timber extraction as it is punishable offence by law. However, if there is any illegal timber extraction from BDNP, Forest Department immediately seizes those timber products. With permission from courts the BFD sell the seized timber through auction. Based on the last few years sell of timber through auction we found that the mean value of timber seized is BDT 224,079 per year. Moreover, the annual timber growth is 3,454.7 m^3/ha as per the net annual increment of the growing stock reported by FAO (2014). It was considered as the potential timber harvest from BDNP and thus an ecosystem service of the PA. Taking the average market value of the timber irrespective of species into consideration, the total value of timber is estimated as BDT 45.39 million/yr. Including the value of potential timber harvests, the total value of provisioning services is BDT 146.98 million/yr and BDT 50,103 per ha/yr.

Table 8. Monetary values of the major provisioning services extracted annually from Baraiyadhala National Park (2019/2020)

Resources	Total number of resource extracting households (EPHH) (1)	Total extracted amount (TQH) (2)	Unit	Average quantity collected per participating household (3)	Extraction per ha	Percent sold (%)	Unit price in Taka (BDT) (P)	Gross financial value (GFV) (million BDT) (5)	Net financial value (NFV) (million BDT) (6)	Cash income (CI) (million BDT) (7)	GFV/EPHH (BDT)	GFV per ha (BDT/ha)
Fuelwood	8101	27575423	kg	3404	23227	25	2.52	69.49	58.86	17.37	31498.97	58533.2
Broom grass	5635	19780931	culm	3510	16662	23	1.21	23.93	20.86	5.54	5309.18	20161.0
Bamboo	6516	1468709	culm	225	1237	36	4.49	6.59	4.45	2.37	3097.18	5554.7
Sungrass	176	144	bundle	1	0.12	38	600	0.09	0.08	0.03	489.80	72.7
Medicinal plant or plant parts	959	30787	kg	32	26	78	48	1.48	1.33	1.15	1541.33	1244.8
Total product extraction (million BDT/yr)								101.58	85.59	26.47		
Average per household in the impact area (BDT/HH/yr)								11772	9919	3068		

Notes: (1) Estimated from proportion of resource extracting households in the sample and total household number in the population.

(2) Computed from average quantity extracted per participating household and total number of resource extracting households.

(3) Estimated from surveyed households.

(4) Unit prices were estimated from household survey and observation in local markets.

(5) GFV is the economic worth of total quantity extracted.

(6) NFV is GFV less cost of resource extraction. Here the cost of extraction is based on the time spent for collection of resources by the households.

(7) CI is the economic worth of quantity sold.

4.2 Cultural services

In general, for a natural ecosystem cultural values include aesthetic, artistic, educational, spiritual, and/or scientific values. Tourism is the only cultural ecosystem service considered from BDNP for valuation in this study.

4.2.1 Visitor's general information

4.2.1.1 Sample size and gender breakdown

The tourism valuation is based on a sample of 77 tourist composing mainly of male. Individuals were selected at random in locations where enumerators were most likely to encounter them. Thus, the survey was administered at the car parking located in the entrance of the Khoiyachora tourist spots of BDNP. Since, there was no car parking in case of other tourist spots and those are mainly seasonal, that's why the visitors were surveyed in suitable location from entrance to the way to target spot. Almost all the respondents were male and came from different parts of Bangladesh. There were no foreign visitors during the study period.

4.2.1.2 Education level of the visitors

The survey indicated that most of the tourist are educated from secondary to higher level. There was no illiterate tourist (Table 9). As the tourist sites of BDNP has long walking tracks (i.e. 1.5 to 3.5 km each) through rough terrain that's why most of the visitors are young and from different educational institutes i.e. colleges and universities. The findings indicated that education level of the 93% visitors ranged from secondary to higher level.

Table 9. Education level of the tourists

Level of education	Number %	Cumulative frequency
Illiterate	0	0
Primary	6	6
Secondary	31	38
Higher Secondary	32	70
Higher	30	100

4.2.1.3 Age groups

As mentioned earlier that most of the visitors are young, the age class distribution of the visitors indicated that 53% visitors age ranges between 21 to 30-year age groups followed by <20 years old with 40% visitors (Fig. 11). It is due to the physical

characteristics (i.e. rough and slippery terrain, long and risky walking track etc.) of the tourist site needing strength and capability to bear stress of walking in an uneven hilly terrain for long time.
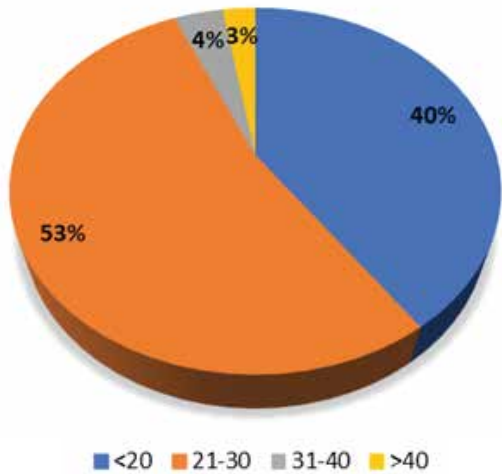
Figure 11. Age group distribution of the visitors of BDNP

4.2.1.4 Occupation

The professional breakdown of the tourists of BDNP indicated that most of them were students (about 58%) followed by service (about 19%) and business (about 10%) (Fig. 12). However, a few proportions of visitors were also involved in teaching, craftsman, driving, masonry, tailoring etc.
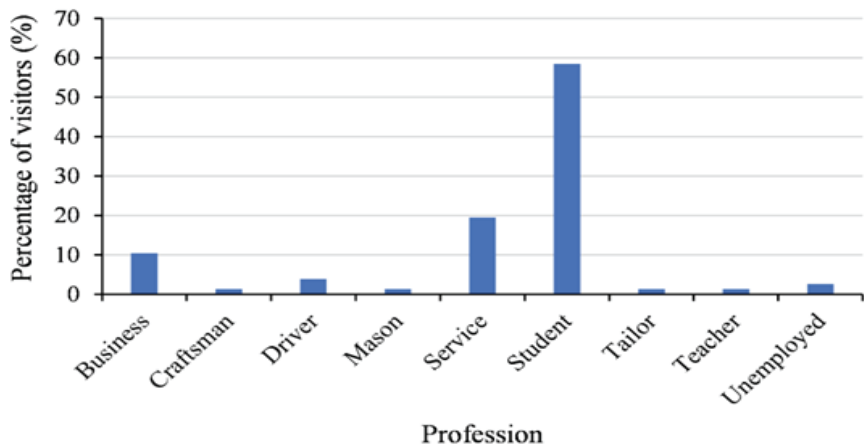
Figure 12. Occupation of the visitors from BDNP

4.2.1.5 Marital status

About 82% of the tourists visiting BDNP were unmarried (Fig. 13). Most of the unmarried came in group with friends and colleagues while some of them came alone to visit the national park. On the other side, in most of the cases, the married visitors were accompanied by their family members.
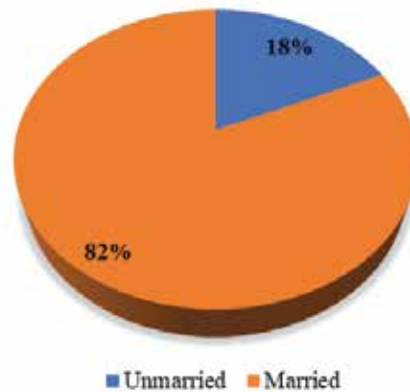
Figure 13. Marital status of the visitors

4.2.1.6 Monthly income

Family income per month of the visitors varied from BDT 6,000 to 200,000. Family income of most of the visitors were between BDT 25,000 - 50,000 (60%) (Table 10). The study also indicated that family income of the 86% visitors were up to BDT 50,000, whereas it is up to BDT 100,000 for 92% visitors.

Table 10. Monthly income of the tourists of BDNP

SN	Income ranges (BDT)	Frequency %	Cumulative frequency
1	0 – 25,000	25.97	25.97
2	25,001-50,000	59.74	85.71
3	50,001-75,000	2.60	88.31
4	75,001-100,000	3.90	92.21
5	100,001-150,000	2.60	94.81
6	>150,000	5.19	100.00

4.2.1.7 Nature of tourists

There were single and grouped tourists visiting the tourist spots of BDNP. The single tourists were constituting the maximum proportion (48%) of the tourists (Fig. 14). The tourists coming in group were of two categories i.e. grouped with family members and grouped with friends. The tourists coming in group with friends were more (39%) whereas the family groups were 13%.
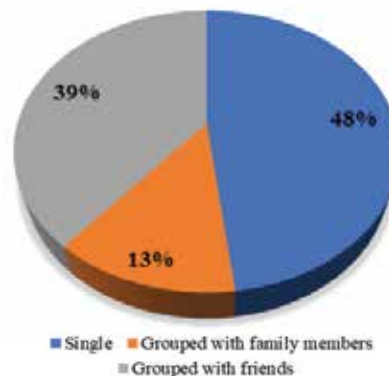
Figure 14. Nature of tourists visiting the BDNP

Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh

4.2.1.8 Number of tourists' visits to BDNP

It has been found that 77% of the tourists visiting the BDNP for the first time whereas 21% visited any of the spots of BDNP once before (Table 11). However, there were few tourists who visited the park twice before. It is mostly the local tourists who visited the park before.

Table 11. Number of visits to the tourist spots of BDNP

SN	Number of visits	Frequency (%)	Cumulative frequency (%)
1	Never visited	76.62	76.62
2	Once	20.78	97.40
3	Twice	2.60	100.00

4.2.1.9 Means of travel

Bus, car, train and taxi were the common vehicles used by the visitors. In many cases they had to use more than one vehicle to reach the tourist spot. The survey indicated that 42% of the tourists used only bus whereas 29% tourist used car to reach the tourist spots (Fig. 15). About 19% tourists used both train to reach the nearby railway station and taxi to reach the tourist spot from the railway station to tourist spots.

4.2.1.10 Travel distance

Tourist came from a wide range of distances as indicated by the survey. 48% of the tourist came from a distance ranging from 51-100 km indicating the higher proportion of local tourists particularly from Chattogram and nearby areas (Table 12).
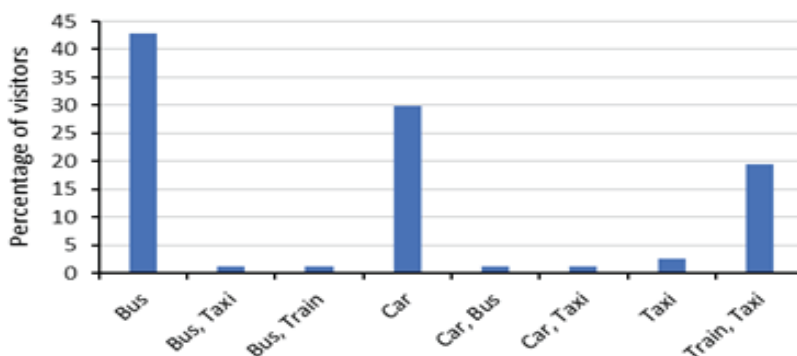
Figure 15. Means of travel by the tourists

Table 12. Distance traveled by the tourists

Distance range (km)	Number	Frequency (%)	Cumulative frequency %
0-50	5	6.49	6.49
51-100	37	48.05	54.55
101-150	13	16.88	71.43
151-200	12	15.58	87.01
201-300	5	6.49	93.51
>300	5	6.49	100.00

4.2.2 Desired improvements

Visitors were asked about the quality of services provided in the BDNP. Many expressed a wish for improvements in the transportation networks and security of the tourists visiting the spots of BDNP (Table 13). However, availability of first aid facility in the tourist spot was also demanded by a good number (16%) of tourists.

Table 13. Types of improvements suggested by visitors

SN	Improvements needed	Frequency (%)
1	Transportation network	76.62
2	Security of the tourists	36.36
3	First aid facility	15.58
4	Food shop	12.99
5	Cleanliness	10.39
6	Plantation	9.09
7	Tour guide	9.09
8	Public toilet	2.60
9	Safe walking track	2.60
10	Camping facility	1.30
11	Pure drinking water facility	1.30
12	Rest house	1.30
13	Vehicle parking	1.30
14	Washing and shower facility	1.30

4.2.3 Visitor expenses

Visitor expenses can be explained as expenses for transport, food and additional spending.

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4.2.3.1 Transport

Transport ranged from BDT 80 to 2,600 per round trip of a tourist as they came from different parts of the country (Table 14). For most of the tourists (70%) the cost of transport is ranged between BDT 101-500.

Table 14. Cost of tourists for transportation purpose to reach the BDNP

SN	Cost of transportation (BDT/per tourist)	Frequency (%)	Cumulative frequency (%)
1	0-100	6.49	6.49
2	101-500	70.13	76.62
3	501-1000	16.88	93.51
4	1,001-1,500	5.19	98.70
5	> 1,500	1.30	100.00

4.2.3.2 Spending on food

Expenses for food by the tourists during the round trip were also significant proportion of the total travel cost. It was found that most of the tourist incurred BDT 101 - 300 for food per trip (Table 15). However, the cost of food for 53% of the tourists was up to BDT 300.

Table 15. Expenses by the tourists for food during the travel to and from BDNP

SN	Cost of transportation (BDT/per tourist)	Frequency (%)	Cumulative frequency (%)
1	≤ 100	7.79	7.79
2	101-300	45.45	53.25
3	301-500	28.57	81.82
4	501-700	7.79	89.61
5	701-900	2.60	92.21
6	901-1200	6.49	98.70
7	>1200	1.30	100.00

4.2.3.3 Additional spending

A total of 69% of the respondents haven't mentioned any expense other than travel and food. However, the remaining 31% tourist incur money on additional needs or crafts available in and around the tourist spots. The additional spending ranges from BDT 10 to 1,000 while the percentage of tourists spending up to 500 BDT is 25% and only a few spent an amount of money ranging from 500 to 1,000 BDT.

4.2.4 Distribution of tourists in different spots

The survey indicated that the number of tourists varies with the season. The main tourist attractions are the walking trail, waterfall, stream flow and wilderness. As per the opinion of the local stakeholder and the study team's field observation, there are 7 streams (i.e. Khoiyachora, Napittachora, Rupasi Jhorna, Sohosradhara, Bawachora, Sonaichara and Baraiyadhala Baro chora) more or less visited by the tourists seasonally or round the year (Fig. 16).

Figure 16. Waterfalls in Baraiyadhala National Park- a) Napittyachora, b) Rupa-sichora, c) Khoiyachora in holidays, d) Khoiyachora in dry seasons.

Besides these streams there are a few other streams named Moralichora and Garurdhala chora but not much attractive to the tourists. However, these streams contribute to the draining out of water from high hills of BDNP. Some of the streams (i.e. Bawachora and Sonaichari Jhorna) contain water only for 4-5 months of the year in the monsoon

season and get dried or flow very little amount of water during the dry season. Among the streams, Napittachora and Rupasi Jhorna have appealing water flows for about 8-9 months of the year. Khoiyachora and Sohosradhara are the two most popular waterfall having water flow in almost round the year (10-12 months). However, with the reduction of the flow of water in these streams the number of tourists decline proportionately. Overall, Khoiyachora, Sohosradhara, Napittachora and Rupasi Jhorna are major tourist attractions of which Koiyachora alone draws about 77% of total number of tourists (Fig. 17).
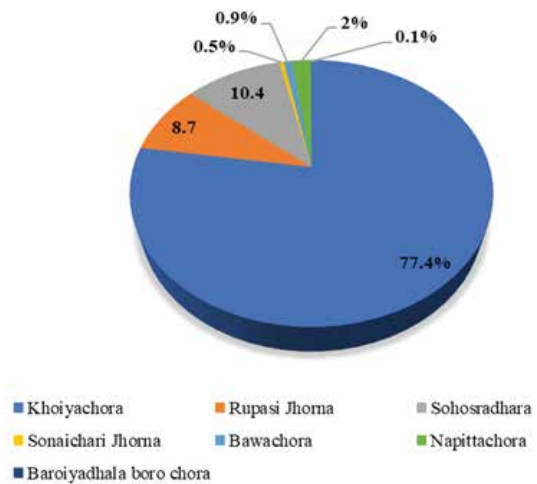
Figure 17. Percentage distribution of tourist in different spots of BDNP

4.2.5 Monthly distribution of tourists

November, December and January were the most popular months for tourists to visit the BDNP (Fig. 18). However, during the field data collection we came to know that during the Eid festival a huge number of tourists visits the spots to enjoy their festival vacations. Moreover, during the national holidays i.e. 16 December and 21 February a good number of tourists visits the spots. The number of young tourists is higher during the period of August – November as at that the level of water flow is comparatively higher and the spots are suitable for visiting. In the months of March-May the level of water is very low and very few tourists visits at that time. Again, during the monsoon season especially in the months of June-July the terrain is very dangerous and risky. That's why though the level of water is high, but the number of tourists is few at that time.
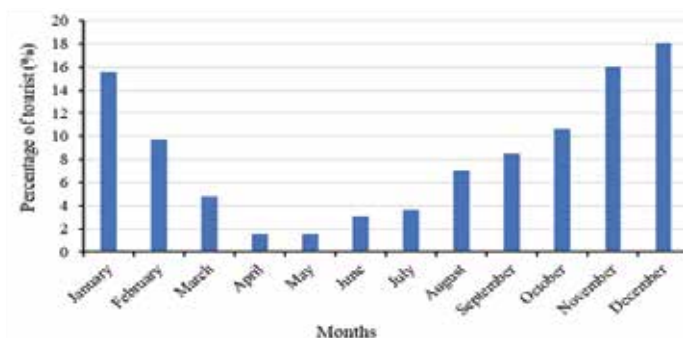
Figure 18. Distribution of tourists by months in BDNP

4.2.6 Valuation of tourism

The demand curve approach explained in the methodology part is applied for estimation of the value of tourism. To estimate the demand function, the travel cost per person was increased and sequentially added to the average cost for each zone. The visitation rates from each zone under these additional costs are predicted from the TGF, and the total expected number of visitors at each hypothetical entry price is computed. The total predicted visits for each level of additional entry fees (additional costs) are summarized in Table 16 and comprise the data for estimation of the demand function. To estimate the demand function, the number of estimated visits (Q) was regressed against the hypothetical increase in entry fee (P) using simple linear model which resulted in the following equation (Eq. 8).

Table 16. Estimated demand schedule for BDNP

Serial no.	Additional travel cost (BDT) per person/trip	Total expected number of visitors (person)
1	0	62553
2	250	52989
3	500	43849
4	750	36007
5	1000	29030
6	1250	22913
7	1500	17935
8	1750	14231
9	2000	10843
10	2250	7705
11	2500	5586
12	2750	4326
13	3000	3154
14	3250	2060
15	3500	1032
16	3750	65
17	3767	0

The regression resulted following model-

$C = 3071.5 - 0.0587*LN (V)$ ------------------- Eq (8);

R square 0.8767 here, C = added cost (BDT), V = No. of visits.

The demand curve using this function and Table 16 is given below.
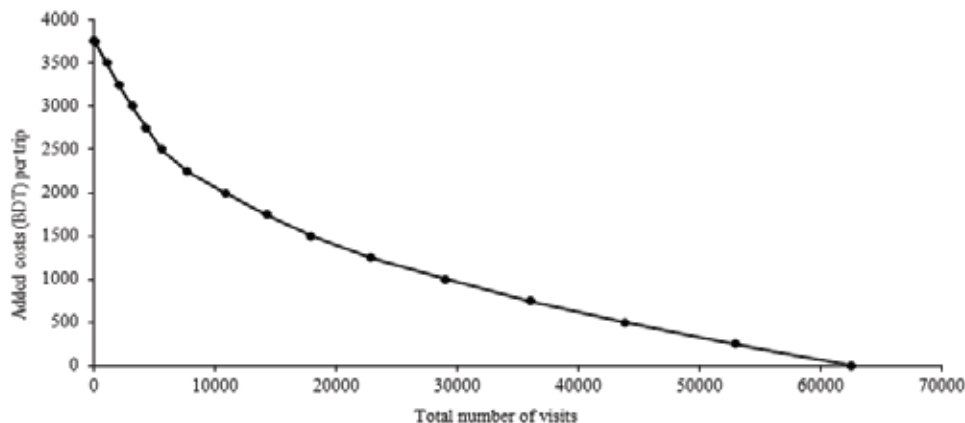
Figure 19. Demand curve for tourist of BDNP

Consumer surplus is calculated as the area under the demand curve (Fig. 19). The demand functions for BDNP were estimated in terms of the additional travel costs of visitors would be willing to incur and above the average travel costs they had already spent, so the entire area under the demand curve indicates the consumer surplus and this represents the value of tourism. It is relevant to mention here that the value is a conservative estimate whereas the true value should be much more than the estimate as indicated in the Table 17.

It results in a total estimate of economic benefits from recreational (tourism) services of the site of around BDT 70.74 million or around BDT 1,131 per visit and BDT 75,872 per ha (Table 17).

Table 17. The annual value of tourism as a cultural ecosystem service in BDNP (2019-2020)

SN	Parameter	Unit	Value
1	Total economic benefits from tourism	Million BDT	70.74
2	Marginal economic value	BDT/trip	1131
3	Economic value of tourism on forests	BDT/ha/yr	75872

4.3 Regulatory services

Carbon sequestration, groundwater infiltration and air pollution removal are the three regulatory services from BDNP considered for valuation under this study.

4.3.1 Carbon sequestration

Carbon in above ground biomass, below ground biomass, soil and litter has been estimated and presented in Table 18. The annual carbon sequestration varied with the type and density of forest, species and land use. Since, the annual sequestration rate of carbon in litter and soil was not available that's why the valuation was not possible for annual carbon sequestration. However, the value of present carbon stock for all the four pools were estimated as presented in Table 18. The total value of annual carbon sequestration is BDT 1202 per ha whereas the total value of carbon stock in all pools is BDT 2,94,092 million per ha. Since this estimate is based on yield rate of forests and the timber yield is very low in the natural forests of Bangladesh that's why the value of annual carbon sequestration is also low.

Table 18. Carbon sequestration and it's monetary value in BDNP

Parameters	Estimated annual carbon sequestration		Value of annual carbon sequestration		Present carbon storage		Value of current carbon storage	
	tC/ha/yr	tC/yr	BDT/ha/yr	BDT/yr	tC/ha	tC	BDT/ha	Million BDT
Carbon in AGB	0.79	230.78	1054	309	146.43	173837.45	196416	233.18
Carbon in BGB	0.11	324.68	148	195822	26.56	31528.67	35624	42.29
Litter carbon	-	-	-	-	0.43	510.49	577	0.68
Soil organic carbon (up to 50 cm depth)	-	-	-	-	45.98	54587.10	61677	73.22
Total	0.90	2629.62	1202	1447035	219.39	260463.71	294293	349.38

4.3.2 Ground water infiltration

South-Eastern region of Bangladesh receives an abundant amount of rainfall every year. A higher proportion of the rainfall is infiltrated which is presented here as ground water infiltration. A number of services is linked with the ground water infiltration i.e., flow of water in the streams, irrigation in the agricultural fields, use of water by local people, withdrawal of water for irrigation or daily use. The valuation indicated that total value of ground water recharge accounts 24.08 million BDT/yr (Table 19).

Table 19. Amount of groundwater recharge in BDNP

SN	Parameter	Unit	Value
1	Groundwater recharge rate	mm/yr	1,080
2	Amount of groundwater recharge	million m^3/year	12.82
3	WTP for forest water supply	BDT/HH/yr	3,672
4	Households using stream water	Number	6,558
5	Value of recharge	BDT/Ha/yr	8,209
6	TEV of groundwater recharge	million BDT/yr	24.08

4.3.3 Air pollution removal

Trees help deposition of air pollutants i.e., dust, particulate matter (PM) etc. PM_{10} deposition by vegetation is very important as it helps purifying air and relieves people from being affected by many air borne diseases. Forests reduce the cost of treatment due to illness and mortality by many ways among which air pollution removal is significant. The present study estimated total value of 195.81 million BDT/yr (Table 20).

Table 20. Avoided cost of illness through air pollution removal by BDNP

SN	Parameter	Unit	Value
1	PM_{10} deposition	t/yr	55.22
2	PM_{10} deposition	kg/ha/yr	46.51
3	Economic benefits related to deposition of PM_{10}	million BDT/yr	195.81
4	Economic benefits related to deposition of PM_{10}	BDT/ha/yr	66,747

4.4 Supporting services

4.4.1 Biodiversity

4.4.1.1 Floral and faunal composition

The study assessed the floral and the faunal composition. Among the recorded plants, 204 species are trees (Appendix 1), followed by large shrub to trees (27 species), shrubs (71 species), climbers (45 species), herbs, epiphytes and parasites (205 specices) (Appendix 2 and Appendix 3). Of the recorded tree species, 77 are becoming rare followed by endangered (23 species), critically endangered (10 species), common (51 species) and cultivated/planted are 45 species. This agrees with the findings of Hossain (2015). Apart from this study Harun-Ur-Rashid et al. (2018) reported flora from all habit forms. According to that study there are 528 wild taxa belonging to 337 genera and 73 families in BDNP. Trees (179 species) and herbs (174 species) constitute the major categories of the plant community followed by shrubs (95 species), climbers (78 species), and two epiphytes. Status of occurrence of 165 (31.25%) species is rare, 23 (4.36%) is endangered, 12 (2.27%) is critically endangered and 4 species (0.76%) is vulnerable in the forest. Fabaceae is the dominant family represented by 75 taxa, followed by Rubiaceae (47 taxa), Malvaceae (28 species), Asteraceae (27 species) and Euphorbiaceae (24 species).

The faunal diversity of BDNP consisted of 102 species of birds, 27 species of mammals, 20 species of reptiles and 12 species of amphibians (Fig. 20-21, Appendix 4-7). Forest canopy and ground dwelling as well as wetland associated wildlife species are still available in the forest areas of Baraiyadhala. But, large wildlife species such as tiger, elephant, leopard, wild dog have disappeared from these PAs due to habitat degradation and hunting. Some other species like Sambar, Wild goat, Asian black bear, hollock gibbon are going to be extinct (Hossain 2015). The wildlife habitat of BDNP is characterized by 32 fruit bearing tree species providing food and support to the wildlife.

Cycas (*Cycas pectinata*): a native threatened taxon of BDNP

Cycas (Cycas pectinata), a very ancient genus of the Gymnosperm is often considered as living fossil. It is an evergreen palm-like tree globally distributed in India, Myanmar, Nepal and in Bangladesh. The species was first discovered in this region by William Griffith from Baroiyadhala forest of Chittagong in 1838 and is naturally confined to a few hills near Baroiyadhala in Sitakunda. Considering the richness of both flora and fauna, Baroiyadhala forests declared as National Park in 2010 with an area of 2,933.61 ha. But, the loss of this native gymnosperm from this forest is alarming. To conserve the Cycas species in Baroiyadhala National Park (BDNP), it is important to know the present status and the threats of the species in its natural ranges. It was found that the number of remnant Cycas individuals is decreasing gradually in Baroiyadhala due to illegal removal, land use change and forest fire. Study needs to assess the status of Cycas population in its native range, identify the drivers responsible for the loss of the species and need a comprehensive conservation plan for protection of the species.

Cycas naturally growing in BDNP

Illegal fire damages the Cycas in BDNP

Naturally grown Cycas in BDNP

BDNP is important for Forestry, Botany, Zoology and NaturalScience students
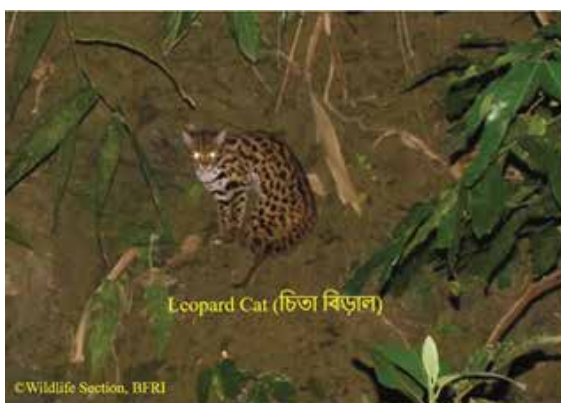
Figure 20. A few representative wildlife of Baraiyadhala National Park in photographs i.e. a) Leopard cat, b) Common moorhen, c) Blue Whistling Thrush, d) Long-tailed Shrike, e) Spangled Drongo, and f) Spotted litter shink.

Figure 21. A few representative wildlife of Baraiyadhala National Park in photographs i.e. a) Scaly breasted munia, b) Assamese Macaque, c) Indian Crested Porcupine, and d) Wild boar

4.4.1.2 Value of Biodiversity

Experts worldwide associated the value of biodiversity with the bio-prospecting value. Simply, the value largely depends on the scarcity of biological resources and availability of substitutes. The value of biodiversity increases with the higher abundance of genetic material and decline with the technological improvements and increased accessibility of cheaper substitutes. However, the value of biodiversity in BDNP based on the assumptions of Rousser and Small (2000) is presented in Table 21.

Table 21. Value of biodiversity

Description	Area (ha)	Value of biodiversity (BDT/ha)	Total value of Biodiversity (Million BDT)
Biodiversity	2,933.61	40,980	120.22

4.4.2 Total economic value of BDNP

Table 21 represents the total value of all the ecosystem services received directly or indirectly from BDNP per year. The provisioning (except timber) and cultural services are mainly based on the primary field data collected during the period of 2019-2020 whereas the other services are mainly based on the secondary data and reported values in existing literature on similar forests. The total economic value of the selected ecosystem services of BDNP is 561.36 million BDT/yr (USD 6.60 million per year; 1 USD = 85 BDT), whereas it is 2,43,113 BDT/ha/yr (USD 2,860 per ha/yr) (Table 22). The value is quite higher than that of Barua et al. (2020) where the available estimates indicate that forests of Bangladesh are worth US$ 840 ha^{-1}yr^{-1} on average and the hill forest average is 1,066 US$ ha[-1].

Table 22. Economic value of all services regularly received by the surrounding people and the ssrelevant stakeholders from BDNP

SN	Services	BDT/ha/yr	Million BDT/yr
	Provisioning services		
1	Fuelwood	23,688	69.49
2	Broom grass	8,159	23.93
3	Bamboo	2,248	6.59
4	Sungrass	29	0.09
5	Medicinal plants and plant parts	504	1.48
6	Potential timber harvests	15,475	45.39
Subtotal		**50,103**	**146.98**
	Cultural services		
7	**Tourism**	**75,872**	**70.74**
	Regulating services		
8	Carbon sequestration	1,202	3.53
9	Groundwater infiltration	8,209	24.08
10	Air pollution removal	66,747	195.81
Subtotal		**76,158**	**223.42**
	Supporting services		
11	**Biodiversity**	**40,980**	**120.22**
Grand total		**2,43,113**	**561.36**
US$		**2,860**	**6.60**

Valuation of Ecosystem Services in Baraiyadhala National Park, Bangladesh

4.5 Discussion

The total economic valuation of the ecosystem services of any forest ecosystem is a tedious task as a myriad of services is linked with the forests. The study presents a conservative value of the selected ecosystem services among which the provisioning and cultural services are based on direct field measurement whereas the other services are based on secondary data. The net ecosystem benefits generated by the BDNP depend on a number of factors including the value of the various ecosystem services and the payments received from the society. In terms of managerial responsibility, the government manages the national park for its conservation through patrolling, community mobilization (co-management) and occasional plantations in the BDNP. These activities are conducted through the respective beat, range and division offices of BFD. The financial expenses of the government for sustainable management and conservation are very small compared to the benefits provided by the park to the surrounding community and associated environment.

Uddin et al. (2013) reported the provisioning and cultural services of Sundarbans. It was reported that the value of provisioning services is US$ 744,000 (BDT 63.34 million) per year, whereas the value of cultural services (tourism) is US$ 42,000 (BDT 3.57 million) per year. The value much lower than that's of the BDNP since this valuation is based on only the revenue received by the government.

4.6 Recommendations

The study shows how park management can influence the overall supply of ecosystem services, and that increasing the supply of a specific ecosystem service may lead to an increase or a decline in the provision of other services. For instance, coniferous trees have a relatively high capacity to filter air particles, but also have a relatively high evapotranspiration rate that reduces groundwater infiltration. Considering all the aspects following recommendations are made for sustainable management of BDNP.

1. There is no entry fee for the visitors to the tourist spots. An entry fee can be introduced for the tourist entering the national park for tourism. Prior to introducing the entry fee some infrastructural modifications would be necessary but it has to be ensured that natural setting of the tourist spots is not altered or harmed.
2. Though extraction of any forest resources is illegal, but the annual extraction of provisioning services accounts a significant amount. The bamboo collection along with collection of other resources should be controlled immediately to avoid the consequence of over extraction of bamboo culms from BDNP.

3. The local communities are benefitted from intangible services of the BDNP in a number of ways i.e., ground water infiltration, air pollution removal, carbon sequestration. Payment for the Ecosystem Services (PES) can be introduced through discussion with the local people for not harming the natural resources by any means of encroachments.
4. Further research should be conducted to assess the carrying capacity of tourists in BDNP in order to control the number of visitors in the park for sustaining it's scenic beauty.

5. Conclusion

This study shows high economic returns that were generated by protected forest ecosystems in moderately dense populated Sitakundar-Misharai upazia of Chattogram district. A conservative estimate of the economic benefits generated by the Baraiyadhala National Park (BDNP) is around BDT 561.36 million per year which is much higher the value generated by nearby agricultural land. Approximately 70% of this value is generated by only provisioning and cultural services. The benefits from nature conservation have not been quantified in monetary terms. The park is one of the well-known and most visited parks in the country. It is therefore able to generate significant income from entrance fees. In addition to the economic value of the generated ecosystem services, there are possibilities for generating additional income for park management through payment for ecosystem services. Park management authority should proactively communicate the economic benefits of Protected Areas to the public and policy makers in order to maintain support for protected area management.

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Appendices

Appendix 1. Tree species recorded from BDNP

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
1	*Acacia auriculiformis* A. Cunn.*ex* Beth.	Akashmoni	Mimosaceae	Tree	Cult.
2	*Acacia caesia* (L.) Willd.	-	Mimosaceae	Tree (Medium)	Cult.
3	*Acacia mangium* Willd	Mangium	Mimosaceae	Tree (Small)	Cult.
4	*Acronychia padunculata* (L) Miq.	Bon jamir	Rutaceae	Tree (Small)	Rare
5	*Actinodaphne angustifolia* Nees.	Tejmatan	Lauraceae	Tree	Common
6	*Adenanther apavonina* L.	Raktachandan	Mimosaceae	Tree	Rare
7	*Aidia oppositifolia* (Roxb.) Rahman & Das	Bhadi, Dalyaphul	Rubiaceae	Tree (Small)	Rare/ Endangered
8	*Albizia lucidior* (Steud.) Nielson. *ex* Hara	Sil-koroi	Mimosaceae	Tree	Rare/Cult.
9	*Albizia chinensis* (Osb.) Merr.	Chakuakoroi, Chakua	Mimosaceae	Tree	Cult.
10	*Albizia lebbeck* (L.) Benth.	Kalakoroi, Sirish	Mimosaceae	Tree	Cult.
11	*Albizia odorssima* (L.f.) Benth.	Tetuya, Koro	Mimosaceae	Tree	Cult.
12	*Albizia procera* (Roxb.) Benth.	Jath-koroi, Koroi	Mimosaceae	Tree	Cult.
13	*Allophylus cobbe* L. var. glaber	Chita	Sapindaceae	Tree (Small)	Common
14	*Allophylus villosa* (Roxb.) Blume	-	Sapindaceae	Tree (Small)	Common
15	*Alnus nepalensis* G. Don	-	Betulaceae	Tree	Rare/ Endangered
16	*Alstonia nerifolia* D. Don	Chatim	Apocynaceae	Tree	Rare
17	*Alstonia scholaris* (L.) R. Br.	Chatim	Apocynaceae	Tree	Common
18	*Antidesma bunius* (L.) Spreng.	Banshialbuka	Euphorbiaceae	Tree (Medium)	Rare
19	*Antidesma ghaesembilla* Gaer	Khudijam	Euphorbiaceae	Tree	Rare

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
20	*Antidesma roxburghii* Wall *ex* Tul.	-	Euphorbiaceae	Tree (Small)	Rare
21	*Aporosa wallichii* Hook.f.	Karullah, Kakra, Kechua	Euphorbiaceae	Tree	Rare
22	*Aporusa aurea* Hook.f.	Kechuan	Euphorbiaceae	Tree	Rare
23	*Aporusa octandra* (Buch.-Ham. *ex* D. Don) A. R. Vickery.	Patha-kharullah, Kechua, Ataligula	Euphorbiaceae	Tree	Rare
24	*Ardisia colorata* Roxb.	-	Myrsinaceae	Tree (Small)	Rare/ Endangered
25	*Ardisia paniculata* Roxb.	-	Myrsinaceae	Tree (Small)	Rare/ Endangered
26	*Artocarpus chaplasa* Roxb.	Chaplash, Capalish	Moraceae	Tree	Rare/Cult.
27	*Artocarpus lakoocha* Wall. *ex* Roxb.	Dewa, Dauphal	Moraceae	Tree	Rare
28	*Azadirachta indica* A. Juss.	Neem, Nim	Meliaceae	Tree	Cult.
29	*Baccaurea ramiflora* Lour.	Latka, Latkon, Harpata, Vaccum gola	Euphorbiaceae	Tree (Medium)	Rare
30	*Baringtonia acutangula* (L.) Gaertn.	Hijal, Kumia, Hidjal	Lecythidaceae	Tree (Medium)	Common
31	*Bauhinia variegata* L.	Rakta Kanchan, Lal-Kanchon	Caesalpiniaccae	Tree (Medium)	Rare
32	*Bischofia javanica* Blume	Kanjalbhadi	Euphorbiaceae	Tree	Common
33	*Bixa orellana* L.	Latkon, Harpara	Bixaceae	Tree (Small)	Rare
34	*Boehmeria glomerulifera* Miq.	Borthurthuri	Urticaceae	Tree (Small)	Common
35	*Bombax ceiba* L.	Simul, Tula	Bombacaceae	Tree	Rare/Cult.
36	*Bombax insigne* Wall.	Ban-simul, Pahari-simul	Bombacaceae	Tree (Large)	Rare
37	*Bouea oppositifolia* (Roxb.) Maessn.	Mailam, Miriam Uriam, Maillom	Anacardiaceae	Tree (Medium)	Critically Endangered
38	*Brassaiopsis glomerulata* (Blume) Regel	Kurila	Araliaceae	Tree (Small)	Common
39	*Bridelia roxburghiana* (Mull. Arg.) Gehrm.		Euphorbiaceae	Tree (Small)	Rare
40	*Bridelia verrucosa* Haines	-	Euphorbiaceae	Tree (Small)	Rare
41	*Briedelia stipularis* (L.) Blume	Pat khowi	Euphorbiaceae	Tree (Small)	Rare
42	*Briedelia tomentosa* Blume	Khoi	Euphorbiaceae	Tree (Small)	Rare

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
43	*Brownlowia elata* Roxb.	Mass, Masjot, Moos	Tiliaceae	Tree	Critically Endangered
44	*Buchanania lancifolia* Roxb.	Chikki	Anacardiaceae	Tree	Rare
45	*Butea monosperma* (Lam.) Kuntze	Palash	Fabaceae	Tree (Medium)	Cult.
46	*Calliandra umbrosa* (Wall.) Benth.	Chotto Betmara	Mimosaceae	Tree	Rare
47	*Callicarpa arborea* Roxb.	Barmala	Verbenaceae	Tree (Medium)	Common
48	*Cassia fistula* L.	Sonalu, Bandar-lati	Caesalpiniaccae	Tree	Cult.
49	*Cassia javanica* L. ssp. *nodosa* (Buch.-Ham. *ex* Roxb.) K & S.Larson	Bander-lutia, Bon-sonalu	Caesalpiniaccae	Tree	Rare
50	*Cassia siamea* Lam.	Minjiri, Minjuri	Caesalpiniaccae	Tree	Cult.
51	*Chaetocarpus castanicarpa* (Roxb.) Thw.	Bulkakra	Euphorbiaceae	Tree (Medium)	Common
52	*Chisochaeton paniculatus* Hiern	Rata, Kalikora	Meliaceae	Tree	Rare
53	*Chukrasia tabularis* A. Juss.	Chickrassi	Meliaceae	Tree	Rare/Cult.
54	*Cleistocalyx nervosum* (DC.) Kosterm var. *paniala* (Roxb.) J. Parn. & P. Chantara	Bhutijam, Godajam	Myrtaceae	Tree	Rare
55	*Cordia dichotoma* G. Forst.	Bohal, Bohary	Boraginaceae	Tree	Rare/ Endangered
56	*Cordia serrata* Roxb.	-	Boraginaceae	Tree	Rare/ Endangered
57	*Crateva manga* (Lour.) DC.	Barun, Gotabaruna	Capparaceae	Tree (Small)	Common
58	*Crypteronia paniculata* Blume	Goru-mara, Nishamba	Crypteroniaceae	Tree (Large)	Common
59	*Cycas pectinata* Hamilton	Cycas, Jam chattar	Cycadaceae	Palm like Tree	Critically Endangered
60	*Dalbergia sericea* G. Don	Sristi, Rebinea	Fabaceae	Tree	Rare
61	*Dalbergia lanceolaria* L. f.	Chakemdia	Fabaceae	Tree	Rare
62	*Dalbergia malabarica* Prain	-	Fabaceae	Tree	Rare

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
63	*Dalbergia sissoo* Roxb.	Sissoo gach	Fabaceae	Tree	Cult.
64	*Dalbergia stipulacea* Roxb.	Dadbari	Fabaceae	Tree (Small)	Rare
65	*Dehaasia kurzii* King *ex* Hook.f.	Modon Mostho	Lauraceae	Tree (Medium)	Rare/ Endangered
66	*Dendrocnide sinuata* (Blume) Chew	Bangaldandi, Laua-Chutra	Urticaceae	Tree (Small)	Common
67	*Derris robusta* (Roxb. *ex* DC) Benth.	Jangaria, Jamarja, Koroi	Fabaceae	Tree	Rare
68	*Dillenia pentagyna* Roxb.	Hargaza	Dilleniaceae	Tree	Critically Endangered
69	*Dillenia indica* L.	Chaltha, Chaillah	Dilleniaceae	Tree	Cult.
70	*Diospyros malabarica* (Desr.) Koste.	Gab, Deshi gab	Ebenaceae	Tree (Medium)	Rare
71	*Diospyros racemosa* Roxb.	Gab	Ebenaceae	Tree (Medium)	Rare/Endang ered
72	*Dipterocarpus turbinatus* Gaertn.	Kali garjan, Teli garjan, Kuroli	Dipterocarpaceae	Tree	Rare/Cult.
73	*Dipterocarpus alatus* Roxb. *ex* G. Don	Dholi garjan, Para garjan, Sil garjan	Dipterocarpaceae	Tree	Rare/Cult
74	*Dipterocarpus costatus* Gaertn.f.	Garjan,	Dipterocarpaceae	Tree	Rare
75	*Drimycarpus racemosus* Hook.f.	Kodi-barele, Lau-barela, Nala-amshi	Anacardiaceae	Tree	Critically Endangered
76	*Duabunga grandiflora* (Roxb. *ex* DC.) Walp	Bandarhulla	Sonneratiaceae	Tree	Rare
77	*Elaeocarpus floribundus* Blume	Jalpai, Belphoi	Elaeocarpaceae	Tree (Large)	Cult.
78	*Elaeocarpus tectorius* (Lour.) Poir.	Chekio, Jalpai	Elaeocarpaceae	Tree	Rare
79	*Engelhardia spicata* Lechen *ex* Blume	Kichra-vhadi, Bolas, Dad, Jhumka-Vhadi	Juglandaceae	Tree	Rare
80	*Erythrina indica* L.	Palita, madar, Mandar	Fabaceae	Tree (Medium)	Cult.
81	*Erythrina stricta* Roxb.	Mandar	Fabaceae	Tree	Cult.
82	*Euclalyptus citrodora* Hook.	Eucalyptus	Myrtaceae	Tree	Cult.

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SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
83	*Euonymus glaber* Roxb.	-	Celastraceae	Tree (Small)	Rare
84	*Eurya attenuata* DC.	Lapet, Sagolerbori	Theaceae	Tree (Small)	Rare/ Endangered
85	*Fagraea ceilanica* Thunb.	-	Loganiaceae	Tree (Small)	Rare
86	*Falconeria insignis* Royle	Belua, Goma, Latmel	Euphorbiaceae	Tree	Rare
87	*Ficus hispida* L. f.	Dumur, Kakdumur, Dhungri, Thoska	Moraceae	Tree (Small)	Common
88	*Ficus macrocarpa* L.f.	Bot	Moraceae	Tree	Rare
89	*Ficus bengalensis* L.	Bot	Moraceae	Tree	Common
90	*Ficus benjamiana* L.	Pakur	Moraceae	Tree	Common
91	*Ficus fistulosa* Reinwdt.	-	Moraceae	Tree (Small)	Common
92	*Ficus gibbosa* Blume	Bot	Moraceae	Tree	Common
93	*Ficus glomerata* Roxb. var. *ttenuat* Roxb.	Bot	Moraceae	Tree (Small)	Common
94	*Ficus racemosa* L.	Jagya-dumur, Jog-dumur, Duir-gach	Moraceae	Tree	Common
95	*Ficus religiosa* L.	Ashwatha, Ashwath	Moraceae	Tree	Common
96	*Flacourtia jangomas* (Lour.) Racusch.	Paniala, Paniamala, Lukluki	Flacourtiaceae	Tree (Medium)	Rare/ Endangered
97	*Garcinia cowa* Roxb.	Kao-gola, Kau, Cowa, Kao, Kawa, Kaglichu	Clusiaceae	Tree (Medium)	Rare/ Endangered
98	*Gardenia coronaria* Buch.-Ham.	Torgular, Koinar, Kanyariphul, Painnaphul	Rubiaceae	Tree (Medium)	Rare
99	*Gliricidia sepium* (Jacq.) Walp.	BashantaManjuri	Fabaceae	Tree (Small)	Rare
100	*Glochidion assamicum* (Muell-Arg.) Hook.f.	-	Euphorbiaceae	Tree (Small)	Rare
101	*Glochidion multiloculare* (Roxb. *ex* Willd.) Muell.-Arg.	Aniatori	Euphorbiaceae	Tree (Small)	Rare

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
102	*Glochidion spherogynum* Kurz	-	Euphorbiaceae	Tree (Medium)	Rare
103	*Glochidon lanciolarium* (Roxb.) Voigt.	Anguti, Bhauri, Kakra, Kechuan, Kechchua	Euphorbiaceae	Tree (Small)	Rare
104	*Gmelina arborea* Roxb.	Gamari	Verbenaceae	Tree	Cult.
105	*Grewia asiatica* L.	Pholsa	Tiliaceae	Tree (Small)	Common
106	*Grewia disperma* Roxtt.	Laonaassar, Dhaman	Tiliaceae	Tree (Medium)	Common
107	*Grewia excels* Vahl	-	Tiliaceae	Tree (Small)	Common
108	*Grewia laevigata* Vahl	-	Tiliaceae	Tree (Small)	Common
109	*Grewia nervosa* (Lour.) Panigr.	Assar, Pisla, Patka	Tiliaceae	Tree (Small)	Common
110	*Haldina cordifolia* (Roxb.) Ridsd.	Bangka, Kalakadam, Mala, Dhakudom, Haldu	Rubiaceae	Tree	Rare
111	*Helicia excels* (Roxb.) Blume	-	Proteaceae	Tree (Medium)	Rare
112	*Holarhena antidysenterica* (L.) Wall. *ex* DC.	Kurchi	Apocynaceae	Tree (Small)	Common
113	*Holigarna longifolia* Roxb.	Barola, Rakta-Barola	Anacardiaceae	Tree	Critically Endangered
114	*Hopea odorata* Roxb.	Telsur	Dipterocarpaceae	Tree (Large)	Rare/Cult.
115	*Hydnocarpus kurzii* (King) Warb.	Chaulmoogra	Flacourtiaceae	Tree	Rare
116	*Ixora pavetta* Andr.	Swetrangan, Gandhalrangan	Rubiaceae	Tree (Small)	Common
117	*Ixora spectabilis* Wall.	-	Rubiaceae	Tree (Small)	Common
118	*Ixora nigricans* R. Br. *ex* Wight &Arn.	Nikrangachuillya	Rubiaceae	Tree (Small)	Common
119	*Lagerstroemia parviflora* Roxb. var. *benghalensis* C.B. Clarke	Baturi, Sidha	Lythraceae	Tree (Medium)	Rare
120	*Lagerstroemia speciosa* (L.) Pers.	Jarul, Kanta jarul, Pannya jarul	Lythraceae	Tree (Medium)	Cult.

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SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
121	*Lannea coromandelica* (Houtt.) Merr.	Jialbhadi, Jika, Jiga, Kapila, Bhadi	Anacardiaceae	Tree	Common
122	*Lapisanthes rubiginosum* (Roxb.) Leech.	Baraharina	Sapindaceae	Tree (Small)	Rare
123	*Lapisanthes senegalensis* (Pior.) Leenh.	Gotahorina, Amjam, Amjam, Kawajhijhi	Sapindaceae	Tree (Small)	Rare
124	*Leea macrophylla* Roxb. *ex* Hornem.		Leeaceae	Tree (Small)	Rare
125	*Lithocarpus elegens* (Blume) Hatus *ex* Soepadmo	Rai batna, Bara cakma, Bara batna	Fagaceae	Tree	Rare/Endangered
126	*Litsea glutinosa* (Lour.) Robinson	Kukur-chita, Ratan garur, Karjiuki,Menda	Lauraceae	Tree (Medium)	Rare
127	*Macaranga denticulata* (Blume) Muell.-Arg.	Burna, Bura-kochi Rata-bura, Bura gach	Euphorbiaceae	Tree (Medium)	Common
128	*Macaranga peltata* (Roxb) Muell.-Arg.	-	Euphorbiaceae	Tree	Common
129	*Maesa paniculata* A. DC.	Noa-maricha	Myrsinaceae	Tree (Small)	Common
130	*Mallotus philippensis* (Lam.) Muell.-Arg.	Kamalaguli	Euphorbiaceae	Tree (Small)	Rare
131	*Mallotus repandus* (Willd.) Müll. Arg.	Gunti, Jhante	Euphorbiaceae	Tree (Small)	Rare
132	*Mallotus roxburghianus* Muell.-Arg.	Nim puteli, Nunia kachi, Noon kochi	Euphorbiaceae	Tree (Small)	Rare
133	*Mallotus tetracoccus* (Roxb.) Kurz	Kumari-bura, Main bura	Euphorbiaceae	Tree (Medium)	Rare
134	*Mangifera indica* L.	Aam	Anacardiaceae	Tree	Cult.
135	*Mangifera longipes* Griff.	JangaliAam	Anacardiaceae	Tree	Critically Endangered
136	*Mangifera sylvatica* Roxb.	Uri Aam, Jangali Aam,	Anacardiaceae	Tree	Critically
137	*Melia azadirachta* L.	Gora nim, Kowa nim	Meliaceae	Tree (Medium)	Rare/Cult.
138	*Meliosma pinnata* (Roxb.) Maxim.	Bativa, Attalia	Sabiaceae	Tree (Medium)	Rare

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
139	*Mesua floribunda* (Wall.) Kosterm	--	Clusiaceae	Tree (Large)	Cult.
140	*Meyna spinosa* Roxb. *ex* Link	Maina, Mainakata	Rubiaceae	Tree (Small)	Rare
141	*Michelia champaca* L.	Champa, Chapa	Magnoliaceae	Tree	Cult.
142	*Micromelum minutum* Wight &Arn.	Koroiphula, Dulia	Rutaceae	Tree (Medium)	Common
143	*Miliosa longiflora* (Hook.f. & Thom.) Finet & Gagnep.	Phesicow, Horinagola, Roktagola	Annonaceae	Tree	Critically Endangered
144	*Mimusops elengi* L.	Bakul	Sapotacee	Tree	Cult.
145	*Morinda angustifolia* Roxb.	Rangash, Banamali, Harinarful, Holdiruk	Rubiaceae	Tree (Small)	Common
146	*Mussaenda roxburghii* Hook.f.	Chauri-chaonri, Silchaonri, Silchauri	Rubiaceae	Tree (Small)	Common
147	*Neolamarckia cadamba* (Roxb.) Bosser	Kadam Bul-kadam	Rubiaceae	Tree	Common
148	*Ochna wallichii* Planch.	Champabaha	Ochnaceae	Tree (Small)	Rare/ Endangered
149	*Oreocnide integrifolia* (Gaudich.) Miq.	Horhuta	Urticaceae	Tree (Small)	Common
150	*Oroxylum indicum* (L.) Kurz	Thona	Bignoniaceae	Tree	Rare
151	*Persea bombycina* (King *ex* Hook.f.) Kosterm.	Machilus Nala-amsi	Lauraceae	Tree (Medium)	Rare
152	*Phyllanthus emblica* L.	Amloki, Ambolothi, Aonla	Euphorbiaceae	Tree	Cult.
153	*Pithecellobium heterophyllum* (Roxb.) Macbr.	Kuramaragach	Mimosaceae	Tree (Medium)	Rare/ Endangered
154	*Protium serratum* (Wall. *ex* Colebr.) Engl.	Chitrica, Hajna, Haliabhadi	Burseraceae	Tree	Rare
155	*Pterospermum semisagittatum* Buch.-Ham. *ex* Roxb.	Laonaassar, Bara assar	Sterculiaceae	Tree	Rare/ Endangered
156	*Quercus semiserrata* Roxb.	Batna, Guijjabatna	Fagaceae	Tree	Rare/ Endangered
157	*Samanea saman* (Jacq.) Merr.	Belati-siris Bistigach Randi-koroi Ful-koroi	Mimosaceae	Tree	Cult.

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
158	*Sapium indicum* Willd	Hura, Batul, Bara mel	Euphorbiaceae	Tree (Small)	Rare
159	*Sapium baccatum* Roxb.	Chottomel, Champatha, Kala boil, Katagola	Euphorbiaceae	Tree	Rare
160	*Saraca asoca* (Roxb.) de Wilde.	Ashok	Caesalpiniaccae	Tree	Rare
161	*Saraca indica* L.	Ashok	Caesalpiniaccae	Tree	Rare
162	*Saurauia roxburghii* Wall.	Dalup	Actinidiaceae	Tree (Small)	Rare
163	*Semecarpus subpanduriformis* Wall.	Hijal, Bhela, Beula	Anacardiaceae	Tree (Medium)	Rare
164	*Sesbania grandiflora* (L.) Poir.	Bakful, Bagful, Agati	Fabaceae	Tree (Small)	Cult.
165	*Spondias pinnata* (L. f.) Kurz	Amra, Deshi-Amra, Pial, Piala	Anacardiaceae	Tree	Rare
166	*Sterculia foetida* L.	Udal	Sterculiaceae	Tree (Medium)	Rare/ Endangered
167	*Sterculia hamiltonii* (Kuntze) Adelb.	--	Sterculiaceae	Tree (Small)	Rare/ Endangered
168	*Sterculia villosa* Roxb. *ex* Smith	Udal, Chandal	Sterculiaceae	Tree (Medium)	Rare/ Endangered
169	*Stereospermum colais* (Bucb.-Ham. *ex* Dillw.) Mabberley	Dharmara, Kamrang, Atkapali	Bignoniaceae	Tree	Rare
170	*Streblus asper* Lour.	Sheora, Arga	Moraceae	Tree	Common
171	*Styrax serolatus* Roxb.	Kanchuni, Fulkat	Styracaceae	Tree (Small)	Rare/ Endangered
172	*Suregada multiflora* (A. Juss.) Baill.	Ban-naranga, Ban-naringa	Euphorbiaceae	Tree (Medium)	Common
173	*Swietenia mahagoni* (L.) Jacq.	Mehogoni	Meliaceae	Tree	Cult.
174	*Swintonia floribunda* Griff.	Civit, Chundul, Am chundul	Anacardiaceae	Tree	Critically Endangered
175	*Symplocos racemosa* Roxb.	-	Symplocaceae	Tree (Medium)	Rare/ Endangered
176	*Syzygium cumini* (L.) Skeets	Jam, Kalajam	Myrtaceae	Tree	Cult.

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
177	*Syzygium cymosum* DC.	Khudijam, Khurijam, Jonkijam	Myrtaceae	Tree	Cult.
178	*Syzygium formosum* (Wall.) Masamune.	Paniya jam, Phul jam	Myrtaceae	Tree	Cult.
179	*Syzygium fruticosum* DC.	Banjam, Putijam, Khudijam	Myrtaceae	Tree (Small)	Rare
180	*Syzygium macrocarpa* (Roxb.) Balak.	Banjam, Chalta-jam	Myrtaceae	Tree (Medium)	Cult.
181	*Syzygium fruticosum* DC.	Banjam, Putijam, Khudijam	Myrtaceae	Tree (Small)	Rare
182	*Syzygium macrocarpa* (Roxb.) Balak.	Banjam, Chalta-jam	Myrtaceae	Tree (Medium)	Cult.
183	*Syzygium praecox* (Roxb.) Rathakr & N.C. Nair	Dholi jam, Poorajam	Myrtaceae	Tree (Small)	Cult.
184	*Syzygium aqueum* (Burm. F.) Alston	Jambo	Myrtaceae	Tree (Medium)	Cult.
185	*Syzygium jambos* (L.) Alston	Golapjam	Myrtaceae	Tree (Medium)	Cult.
186	*Tarrenoidea wallichii* (Hook.f.) Tirveng. &Sastre	-	Rubiaceae	Tree	Common
187	*Tectona grandis* L. f.	Shegun, Shegoon, Teak	Verbenaceae	Tree	Cult.
188	*Terminalia alata* Heyne *ex* Roth.	Asal,Asna, Hasna, Saj	Combretaceae	Tree (Large)	Rare
189	*Terminalia bellerica* (Gaertn.) Roxb.	Bohera, Boyra	Combretaceae	Tree	Cult.
190	*Terminalia chebula* Retz.	Haritaki, Gol horitaki	Combretaceae	Tree (Large)	Cult.
191	*Tetrameles nodiflora* R. Br.	Chundul, Maynakat	Datiscaceae	Tree (Large)	Rare/ Endangered
192	*Toona ciliata* J. Roem	Toon, Kuma, Poma, Tongi, Suri poma	Meliaceae	Tree	Rare
193	*Trema orientalis* (L.) Blume	Bonjiyal, Jiban, Dhalagar, Dhola	Ulmaceae	Tree (Small)	Common
194	*Trevesia palmata* (Roxb.) Vis.	Vombal, Kawhtebel	Araliaceae	Tree (Small)	Common

SN	Scientific name	Bangla Name	Family	Habit	Status of occur.
195	*Trewia nudiflora* L.	Pitali, Batal, Pitabara	Euphorbiaceae	Tree (Medium)	Rare
196	*Vitex glabrata* R. Br.	Goda, Horina, Aswal	Verbenaceae	Tree	Rare
197	*Vitex negundo* L.	Baranishinda, Nishinda	Verbenaceae	Tree (Small)	Common
198	*Vitex peduncularis* Wall. *ex* Schauer	Goda, Horina, Arswal	Verbenaceae	Tree	Rare
199	*Wendlandia tinctoria* DC. subsp. *orientalis* Cowan	Tulaload, Tulaladh	Rubiaceae	Tree (Small)	Common
200	*Wrightia arborea* (Dennst.) Mabb.	Dudh-koraiya	Apocynaceae	Tree	Common
201	*Xanthophyllum flavescens* Roxb.	Ajensak, Gabdi, Han sak	Polygalaceae	Tree	Common
202	*Xerospermum laevigatum* Radlk.	Muraillahlichu	Sapindaceae	Tree	Rare
203	*Xylia dolabiformis* craib & Hutch	Lohakat	Mimosaceae	Tree	Rare/ Endangered
204	*Zizyphus mauritiana* Lam.	Kul, Boroi	Rhamnaceae	Tree (Medium)	Common

Appendix 2. Shrubs and woody climbers recorded from BDNP

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
1	*Abroma augusta* (L.) L.f.	Ulatkambal, Tambol	Sterculiaceae	Large Shrub/ Small tree	Common
2	*Abrus precatorius* L.	Kunch	Fabaceae	Woody twiner	Rare
3	*Abrus pulchellus* Wall.	Not available	Fabaceae	Woody climber	Rare
4	*Actephila excelsa* (Dalz.) Muell. -Arg.	-	Euphorbiaceae	Large shrub	Rare
5	*Anodendron manubriatum* (Wall.) Merr.	Dul	Apocynaceae	Woody climber	Rare/ Endangered
6	*Antidesma acidum* Retz.	Multa, Khudi jam, Limtoa, Elena	Euphorbiaceae	Large shrub	Rare
7	*Ardisia humilis* Vahl	Chauldhoa	Myrsinaceae	Large Shrub/ Small tree	Critically Endangered

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
8	*Ardisia solanacea* Roxb.	Ban-jam	Myrsinaceae	Shrub	Rare/ Endangered
9	*Argyreia splendens* (Hornem.) Sweet	ChhotaRupatola	Convolvulaceae	Shrubby climber	Common
10	*Artabotrys caudatus* Wall *ex* Hook.f. & Thom.	Not available	Annonaceae	Woody climber	Endangered
11	*Bauhinia acuminata* L.	Shada-kanchon	Caesalpiniaccae	Shrub	Common
12	*Bauhinia purpurea* L.	Devakanchan	Caesalpiniaccae	Shrub	Common
13	*Bauhinia scandens* L.	Nagpat, Gendi-lata	Caesalpiniaccae	Woody climber	Rare
14	*Breynia retusa* (Dennst.) Alston.	Silpati	Euphorbiaceae	Shrub	Rare
15	*Buddleja asiatica* Lour.	Neemda, Badhota	Buddlejaceae	Shrub	Common
16	*Byttneria pilosa* Roxb.	Harjora-lata, Jumi, Harbanga-lata	Sterculiaceae	Shrubby climber	Common
17	*Caesalpinia bonduc* (L.) Roxb.	Nata, Natakaranga	Caesalpiniaccae	Scandent Shrub	Rare
18	*Caesalpinia digyna* Rottl.	Umulkuchi	Caesalpinaccae	Scandent Shrub	Common
19	*Calotropis gigantea* (L.) R. Br.	Akanda	Asclepiadaceae	Shrub	Common
20	*Calycopteris floribunda* (Roxb.) Lam.	Guichalata	Combretaceae	Scandent Shrub	Rare
21	*Campanumoea lancifolia* (Roxb.) Merr.	-	Campanulaceae	Undershrub	Rare
22	*Canthium angustifolium* Roxb.	Katamalli, KattalmaliKatalichapa	Rubiaceae	Shrub	Common
23	*Capparis spinosa* L.	Kabia	Capparaceae	Trailing Shrub	Common
24	*Cassia obtusifolia* L.	Chakunda	Caesalpiniaccae	Undershrub	Common
25	*Cassia sophera* L.	-	Caesalpiniaccae	Shrub	Common
26	*Chasalia curviflora* (Wall.) Thw. var. *ophioxyloodes* (Wall.) Deb & Krishna	-	Rubiaceae	Shrub	Rare
27	*Chonemorpha fragrans* (Moon) Alston	Gar badero	Apocynaceae	Woody climber	Endangered

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
28	*Clausena heptaphylla* (Roxb.) Wight & Arn. *ex* Steud.	Karanphul, Panbahar	Rutaceae	large shrub	Common
29	*Clerodendrum indicum* (L.) Kuntze	Bamunhati	Verbenaceae	Shrub	Common
30	*Clerodendru mviscosum* Vent.	Bhant, Ghetuphul	Verbenaceae	Shrub	Common
31	*Clerodendrum wallichii* Merr.	Malbong, Dieng-julkah	Verbenaceae	Shrub	Rare
32	*Cnesmone javanica* Blume	Chottrapatha, Paharibichuti	Euphorbiaceae	Shrubby climber	Common
33	*Combretum apetalum* Wall. *ex* Kurz		Combretaceae	Scandent Shrub	Rare
34	*Combretum decandram* Roxb.	Kali gumuchi, Sadaguicha	Combretaceae	Scandent Shrub	Rare
35	*Connarus paniculatus* Roxb.	Katgular	Connaraceae	Woody climber	Rare
36	*Crotalaria bracteata* DC.	-	Fabaceae	Shrub	Common
37	*Crotolaria verrucosa* L.	Bansan, Jhanjhana	Fabaceae	Undershrub	Common
38	*Croton caudatus* Geisel.	Nanbhanti	Euphorbiaceae	Shrub	Common
39	*Dalbergia spinosa* Roxb.	Ananta, Ananta kantha	Fabaceae	Large Shrub	Common
40	*Dalbergia volubilis* Roxb.	Ankilata, Barusirkath	Fabaceae	Woody climber	Rare
41	*Dendrolobium triangulare* (Retz) Merr.	Bir Jarwar	Fabaceae	Shrub	Common
42	*Dendrophthoe pentandra* (L.) Miq.	-	Loranthaceae	Shrub	Rare
43	*Derris scandens* (Roxb.) Benth.	Amkurchi	Fabaceae	Woody climber	Common
44	*Desmodium monotorium* (Houtt.) Merr.	Gorachand, Lonchar, Telegraph plant	Fabaceae	Undershrub	Common
45	*Desmodium triquetrum* (L.) DC.	-	Fabaceae	Undershrub	Common
46	*Desmodium gangeticum* (L.) DC.	Salpani	Fabaceae	Undershrub	Common
47	*Desmodium heterocarpon* (L.) DC.	-	Fabaceae	Undershrub	Common
48	*Desmodium lexiflorum* DC.	-	Fabaceae	Undershrub	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
49	*Desmodium pulchellum* (L.) Benth	Jatsalpani	Fabaceae	Shrub	Common
50	*Desmos chinensis* Lour.	-	Annonaceae	Scandent Shrub	Endangered
51	*Desmos dumosus* (Roxb.) Saff.	-	Annonaceae	Shrubby climber	Endangered
52	*Duranta erecta* L.	Durantha, Katamehedi	Verbenaceae	Large shrub	Common
53	*Ecbolium ligustrinum* (Vahl) Vollesen	Udajati	Acanthaceae	Shrub	Rare
54	*Eranthemum pulchellum* Andrews	-	Acanthaceae	Shrub	Common
55	*Eranthimum paltiferum* (Wall.) Nees	-	Acanthaceae	Shrub	Common
56	*Euonymus attenuatus* Wall. *ex* Laws.	-	Celastraceae	Shrub	Rare
57	*Ficus heterophylla* L.f.	-	Moraceae	Large Shrub/ Small tree	Common
58	*Fissistigma rubiginosum* (A. DC.) Merr.	-	Annonaceae	Shrubby climber	Endangered
59	*Fissistigma wallichii* (Hook.f. & Thom.) Merr.	-	Annonaceae	Woody climber	Endangered
60	*Flemingia strobilifera* (L.) R. Br.	Machipatha	Fabaceae	Shrub	Common
61	*Glyocosmis pentaphylla* (Retz.) Corr.	Datmajan, Matkila	Rutaceae	Shrub	Common
62	*Gouanian apalensis* Wall.	-	Rhamnaceae	Trailing Shrub	Rare/Endangered
63	*Gounia tiliaefolia* Lam.	-	Rhamnaceae	Scandent Shrub	Rare/Endangered
64	*Gymnema acuminatum* (Roxb.) Wall.	Kharalata	Asclepiadaceae	Woody twiner	Rare
65	*Hyptianthera stricta* (Roxb. *ex* Schult.) Wight & Arn.	TahiSeing	Rubiaceae	Large Shrub/ Small tree	Common
66	*Hyptis brevipes* Poir.	-	Lamiaceae	Shrub	Common
67	*Ichnocarpus frutescens* (L.) R. Br.	Dudhilata	Apocynaceae	Woody twiner	Common
68	*Indigofera tinctoria* L.	Nil	Fabaceae	Shrub	Cult.

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
69	*Ipomoea fistulosa* Mart. *ex* Choisy	Dholkalmi, Police lata, Amar gach	Convolvulaceae	Shrub	Common
70	*Ixora athrorantha* Bremek.	-	Rubiaceae	Large Shrub/ Small tree	Common
71	*Ixora balakrishnanii* Deb & Rout	Bhantjhara	Rubiaceae	Large Shrub/ Small tree	Common
72	*Ixora pubirama* Bremek.	Kaemosi, Chichainpa	Rubiaceae	Large Shrub/ Small tree	Common
73	*Ixora subsessilis* Wall. *ex* G. Don	Pool tree, Kondor, Rengchan	Rubiaceae	Shrub	Common
74	*Ixora cuneifolia* Roxb.	Beophul, KesuaGachh	Rubiaceae	Shrub	Rare
75	*Jasminum sambac* (L.) Aiton	Belphul, Beli	Oleaceae	Shrubby climber	Rare
76	*Jasminum scandens* Vahl	--	Oleaceae	Woody climber	Rare
77	*Justicia adhatoda* L.	Vasak, Bashak	Acanthaceae	Shrub	Common
78	*Justicia gendarussa* L.	Jagat mardan, Bishalla	Acanthaceae	Shrub	Common
79	*Lantana camara* L.	Lantana	Verbenaceae	Shrub	Common
80	*Lasianthus hirsutus* (Roxb.) Merr.	Kala long	Rubiaceae	Shrub	Common
81	*Leea acuminata* Wall.	Phupharia	Leeaceae	Shrub	Rare
82	*Leea aequata* L.	Kakjangha	Leeaceae	Shrub	Rare
83	*Leea crispa* L	Banchalita, Mach	Leeaceae	Shrub	Rare
84	*Leea indica* (Burm. F.) Merr.	Kurkurjihwa	Leeaceae	Large Shrub/ Small tree	Common
85	*Ligustrum robustum* (Roxb.) Blume	-	Oleaceae	Large Shrub/ Small tree	Rare
86	*Lippia alba* Mill. N. E. Br. *ex* Brit. & Wilson	Pichas-lakr	Verbenaceae	Shrub	Common
87	*Macrosolen cochinchinensis* (Lour.) Van Tiegh.	Chotabanda, Rema	Loranthaceae	Shrub	Rare
88	*Maesa attenua* A. DC.	Narichagach	Myrsinaceae	Large Shrub/ Small tree	Common
89	*Maesa indica* (Roxb.) DC.	Sesu, Sirkhi	Myrsinaceae	Large Shrub/ Small tree	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
90	*Maesa ramantacea* Wall.	Noa-maricha	Myrsinaceae	Large Shrub/ Small tree	Common
91	*Melastoma malabathricum* L.	Lutki, Datranga	Melastomataceae	Shrub	Common
92	*Melodinus monogynus* Roxb.	-	Apocynaceae	Woody twiner	Endangered
93	*Merremia vitifolia* (Burm. f.) Hallier f.	-	Convolvulaceae	Shrubby climber	Common
94	*Mimosa diplotricha* C.Wright	Ban Lajja-bati	Mimosaceae	Shrub	Rare
95	*Mimosa himalayana* Gamble	Jharua, Bara Lajjabati	Mimosaceae	Straggling Shrub	Rare
96	*Mitragyna diversifolia* (Wall. *ex* G. Don) Havil.	Phul-Kadam	Rubiaceae	Large Shrub/ Small tree	Common
97	*Morinda citrifolia* L.	Ach, Banach, Haldikachu, Hardi, Ronch	Rubiaceae	Large Shrub/ Small tree	Common
98	*Morinda persicifolia* Buch.-Ham.	-	Rubiaceae	Shrub	Common
99	*Mosanda* sp.	Not available	Rubiaceae	Shrub	Common
100	*Mucuna monosperma* DC.	SoashGuri	Fabaceae	Shrubby climber	Common
101	*Myxopyrum smilacifolium* (Wall.) Blume	--	Oleaceae	Scandent Shrub	Rare/ Endangered
102	*Oxyceros kunstleri* (King & Gamble) Tirveng.	Mahish kanta, Maish kata, Manika gach	Rubiaceae	Shrub	Rare
103	*Paramignya scandens* (Griff.) Craib.	Bannebu, Karipa	Rutaceae	Large Shrub/ Small tree	Rare
104	*Pavetta indica* L.	Banamali	Rubiaceae	Large Shrub/ Small tree	Common
105	*Phyllanthus attenuatus* Poir	Panjuli	Euphorbiaceae	Shrub	Rare
106	*Phyllanthus sikkimensis* Muell.-Arg.	-	Euphorbiaceae	Shrub	Rare
107	*Pouzolzia sanguinea* (Blume) Merr.	-	Urticaceae	Shrub	Common
108	*Premna esculenta* Roxb.	Lalana, Lalong	Verbenaceae	Shrub	Common

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
109	*Prismatomeris tetrandra* (Roxb.) K. Schum.	Chinatita, Katmali	Rubiaceae	Large Shrub/ Small tree	Common
110	*Psychotri acalocarpa* Kurz	Ranga bhutta	Rubiaceae	Undershrub	Common
111	*Psychotria monticola* Kurz	Hatichotra	Rubiaceae	Shrub	Common
112	*Psychotria adenophylla* Wall.	Barosudma	Rubiaceae	Large Shrub/ Small tree	Common
113	*Psychotria symplocifolia* Kurz	-	Rubiaceae	Large Shrub/ Small tree	Common
114	*Rhynchotoechum ellipticum* (Wall. *ex* Diet.) DC.	-	Gesneriaceae	Undershrub	Common
115	*Sarcochlamys pulcherrima* Gaud.	Acila	Urticaceae	Large shrub	Common
116	*Scurrula gracilifolia* (Roxb. *ex* Schult.) Danser	Pargacha, Parul	Loranthaceae	Shrub	Rare
117	*Scurrula parasitica* L.	Parula	Loranthaceae	Shrub	Common
118	*Senna alata* (L.) Roxb.	Dadmordan	Caesalpiniaccae	Shrub	Common
119	*Senna tora* (L.) Roxb.	Teraj	Caesalpinaccae	Undershrub	Common
120	*Sida acuta* Burm. F.	Kureta	Malvaceae	Undershrub	Common
121	*Sida cordifolia* L.	Pitberela	Malvaceae	Undershrub	Common
122	*Solanum torvum* Sw.	Goth begun	Solanaceae	Shrub	Common
123	*Spatholobus parviflorus* (DC.) Kuntze	Goalialata	Fabaceae	Woody climber	Rare
124	*Stephania glabra* (Roxb.) Miers	Akanadi, Musaahanilata	Menispermaceae	Woody climber	Rare
125	*Stephania japonica* (Thunb.) Miers	Akanadi, Nimukha, Raj Pathda	Menispermaceae	Shrubby climber	Common
126	*Strobilanthes auriculatus* Nees	Kara,	Acanthaceae	Shrub	Rare
127	*Strophanthus wallichii* Decne	-	Apocynaceae	Shrubby climber	Endangered
128	*Tabernaemontana recurva* Roxb.	Chootakatwad ar, Rupa tola	Apocynaceae	Shrub	Rare
129	*Tarenna companiflora* (Hook.f.) Balakrishnan	Kakra, Rebek	Rubiaceae	Large Shrub/ Small tree	Common
130	*Teprosia candida* DC.	Bilakshani	Fabaceae	Shrub	Common
131	*Tetrastigma leucostaphylum* (Dennst.) Alston	Horinia-lata, Jarul lata	Vitaceae	Woody climber	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
132	*Tinospora crispa* (L.) Hook.f. & Thom.	Gulancha	Menispermaceae	Shrubby climber	Endangered
133	*Tylophora hirsuta*	-	Asclepiadaceae	Shrubby climber	Endangered
134	*Tylophora tenuissima* (Roxb.) Wight &Arn.	-	Asclepiadaceae	Shrubby climber	Endangered
135	*Uraria rufescens* (L.) Desv. *ex* DC.	Dieng-kha-riu	Fabaceae	Shrub	Common
136	*Urena lobata* L.	Banokra	Malvaceae	Undershrub	Common
137	*Uvaria cordata* (Dunal) Alston	-	Annonaceae	Woody climber	Endangered
138	*Uvaria hamiltonii* Hook.f. & Thom.	Latkan	Annonaceae	Woody climber	Endangered
139	*Vallaris solanacea* (Roxb.) Kuntze	Hadpur, Mali	Apocynaceae	Scandent Shrub	Critically Endangered
140	*Vitex trifolia* L.	Chotonishinda	Verbenaceae	Shrub	Common
141	*Woodfordia fruticosa* (L.) Kurz	Dhatriphul, Ragkat	Lythraceae	Shrub	Rare
142	*Zizyphus glabrata* Heyne *ex* Roth.	Pahari boroi	Rhamnaceae	Shrub	Rare
143	*Zizyphus oenoplia* (L.) Mill.	Boot boroi	Rhamnaceae	Large Shrub/ Small tree	Common

Appendix 3. Herbs and herbaceous climbers recorded from BDNP

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
1	*Abelmoschus moschatus* Medik.	Mushakdana, Kalokasturi	Malvaceae	Herb	Common
2	*Abuliton indicum* (L.) Sweet	Petari, Jhampi	Malvaceae	Herb	Rare
3	*Achyranthes aspera* L	Apang	Amaranthaceae	Herb	Common
4	*Actinostemma tenerum* Griff.	-	Cucurbitaceae	Herbaceous climber	Common
5	*Adenia trilobata* (Roxb.) Engl.	Akandaphal	Passifloraceae	Herbaceous climber	Common
6	*Adenosma indianum* (Lour.) Merr.	Barakesuti	Scrophulariaceae	Herb	Common
7	*Adenostemma lavenia* (L.) Kuntze	Baro-kesuti	Asteraceae	Herb	Common

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
8	*Aeginetia indica* L.	-	Orobanchaceae	Herb	Common
9	*Ageratum conyzoides* L.	Fulkuri	Asteraceae	Herb	Common
10	*Alternanthera sessilis*	Chanchi	Amaranthaceae	Herb	Common
11	*Alternanthera philoxeroides* (Mart.) Griseb.	Helencha	Amaranthaceae	Herb	Common
12	*Amaranthus spinosus* L.	Kantanotey, KatamarisKantadenga	Amaranthaceae	Herb	Common
13	*Amaranthus viridis* L.	Notey, Nateyshak, Marissag	Amaranthaceae	Herb	Common
14	*Ammannia multiflora* Roxb	-	Lythraceae	Herb	Common
15	*Ampelocissus barbata* (Wall.) Planch.	Jarila-lahari	Vitaceae	Herbaceous climber	Common
16	*Ampelygonum chinense* (L.) Lindl.	Mohicharansak	Polygonaceae	Herb	Common
17	*Andrographis laxiflora* (Blume) Lindau.	-	Acanthaceae	Herb	Common
18	*Andrographis paniculata* (Burm. f.) Wall. *ex* Nees	Kalomegh	Acanthaceae	Herb	Common
19	*Anisomeles indica* (L.) Kuntze	Gubura	Lamiaceae	Herb	Common
20	*Argyria argentea* (Roxb.) Chosy.	Bara rupatola, Chotto-biztarak	Convolvulaceae	Herbaceous climber	Common
21	*Argyria capitiformis* (Poir.) van Cheek. Oostr.	-	Convolvulaceae	Herbaceous climber	Common
22	*Aristolochi atagala* Cham.	Ishwarmul	Aristolochiaceae	Herbaceous climber	Common
23	*Aristolochia indica* L.	Ishwarmul	Aristolochiaceae	Herbaceous climber	Rare
24	*Asclepia scurassavica* L.	Moricha	Asclepiadaceae	Herb	Rare
25	*Barleria strigosa* Willd.	Barleria	Acanthaceae	Herb	Common
26	*Begonia* sp.	-	Begoniaceae	Herb (succulent)	Endangered
27	*Biophytum sensitivum* (L.) DC.	-	Oxalidaceae	Herb	Common
28	*Blumea fistulosa* (Roxb.) Kurz	-	*Asteraceae*	Herb	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
29	*Blumea lacera* (Brum. F.) DC.	Kukursunga, Barakukshima	Asteraceae	Herb	Common
30	*Blumea lanceolaria* (Roxb.) Druce	-	Asteraceae	Herb	Common
31	*Blumea virens* DC.	-	Asteraceae	Herb	Common
32	*Blumeopsis flava* (DC.) Gagnep	-	Asteraceae	Herb	Common
33	*Calystegia hederacea* Wall.	-	Convolvulaceae	Herbaceous twiner	Common
34	*Capsella bursa-pastoris* (L.) Medik.	-	Brassicaceae	Herb	Common
35	*Cardiospermum helicacabum* L.	Phutka	Sapindaceae	Herbaceous climber	Common
36	*Cayratia japonica* (Thunb.) Gagnep.	-	Vitaceae	Herbaceous climber	Common
37	*Cayratia trifolia* (L.) Domin	Amallat, Amal lata	Vitaceae	Herbaceous climber	Common
38	*Celosia argentea* L.	Moraghphul	Amaranthaceae	Herb	Common
39	*Centella asiatica* (L.) Urban	Thankuni, Adamoni, Ada gongoni, Ada molki	Apiaceae	Herbaceous trailer	Common
40	*Ceratophyllum demersum* L.	Sheola	Ceratophyllaceae	Herb	Common
41	*Chenopodium album* L.	Betushak, Vathua-sak	Chenopodiaceae	Herb	Common
42	*Chromolaena odorata* (L.) King & Robinson	Barashialmati, Assamlata	Asteraceae	Herb	Common
43	*Chrozophora rottleri* (Geisel.) A. Juss. *ex* Spreng.	Khudi Okra	Euphorbiaceae	Herb	Common
44	*Cissus assamica* (Laws.) Craib	Amashalata	Vitaceae	Herbaceous climber	Rare
45	*Cissus elongata* Roxb.	Dhemna, Chemna	Vitaceae	Herbaceous climber	Common
46	*Cissus javana* DC.	Bichitralata	Vitaceae	Herbaceous climber	Rare
47	*Cissus pentagona* Roxb.	Sona-lota, Sona-tola	Vitaceae	Herbaceous climber	Rare
48	*Citrullus colocynthis* (L.) Schrad.	Indrayan	Cucurbitaceae	Herbaceous climber	Endangered

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
49	*Cleome rutidosperma* DC.	-	Capparaceae	Herb	Common
50	*Cleome viscosa* L.	Haldehurhure	Capparaceae	Herb	Common
51	*Coccinia grandis* (L.) Voigth	Kawajhinga, Telakucha, Kuchila	Cucurbitaceae	Herbaceous climber	Common
52	*Cocculus hirsutus* (L.) Theob.	Huyer	Menispermaceae	Herbaceous climber	Rare
53	*Corchorus aestuans* L.	Titapat	Tiliaceae	Herb	Rare
54	*Crassocephalum crepidioides* (Benth.) S. Moore	-	Asteraceae	Herb	Common
55	*Crotalaria acicularis* Buch.-Ham. *ex* Benth	-	Fabaceae	Herb	Common
56	*Crotalaria albida* Roth	-	Fabaceae	Herb	Common
57	*Crotalaria calycina* Schrank	-	Fabaceae	Herb	Common
58	*Crotalaria incana* L.	Chotojhunjhuna	Fabaceae	Herb	Common
59	*Crotalaria tetragona* Roxb. *ex* Anders.	-	Fabaceae	Herb	Common
60	*Crotolaria pallid* Aiton	Jhunjhuni	Fabaceae	Herb	Common
61	*Crotolaria dubia* Graham *ex* Benth.	-	Fabaceae	Herb	Common
62	*Crotolaria ferruginea* Graham *ex* Benth.	-	Fabaceae	Herb	Common
63	*Croton bonplandianus* Bail	Dongalas	Euphorbiaceae	Herb	Common
64	*Croton lobetus* L.	-	Euphorbiaceae	Herb	Common
65	*Curanga amara* Juss.	-	Scrophulariaceae	Herb	Common
66	*Cuscuta reflexa* Roxb.	Sornalata, Jarbuti	Cuscutaceae	Herbaceous climber	Common
67	*Cyathula prostata* Blume	-	Amaranthaccae	Herb	Common
68	*Dentella repens* (L.) Forst. & G. Frost.	Bhuipat	Rubiaceae	Herb	Common
69	*Desmodium heterophyllum* (Willd.) DC.	-	Fabaceae	Herb	Common
70	*Desmodium triflorum* (L.) DC.	Kulalia, Kodalia	Fabaceae	Herb	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
71	*Dicliptera chinensis* (L.) Juss.	-	Acanthaceae	Herb	Common
72	*Drosera burmannii* Vahl	Surjasishir	Droceraceae	Herb	Critically Endangered
73	*Eclipta alba* (L.) Hassk.	Kesoraj, Kalokeshi, Keshute	Asteraceae	Herb	Common
74	*Elephantopus scaber* L.	Shamdalan, Gajiashak	Asteraceae	Herb	Common
75	*Emilia sonchifolia* (L.) DC.	Mechitra, Sadimudi	Asteraceae	Herb	Common
76	*Eranthemum strictum* Colebr. *ex* Roxb.	-	Acanthaceae	Herb	Common
77	*Euphorbia hirta* L.	Ghaopata, Barakeru, Dudhiya	Euphorbiaceae	Herb	Common
78	*Euphorbia thymifolia* L.	Dudhiya, Swetkan	Euphorbiaceae	Herb	Rare
79	*Exacum tetragonum* Roxb.	Kuchuri	Gentianaceae	Herb	Rare
80	*Fioria vitifolia* (L.) Mattei	Bon-karpas	Malvaceae	Herb	Rare
81	*Flemingia macrophylla* (Willd.) Merr.	Bara-salphan	Fabaceae	Herb	Common
82	*Gomphrena celosioides* Mart.	-	Amaranthaceae	Herb	Common
83	*Grangeama deraspatana* (L.) Poir.	Nemuti	Asteraceae	Herb	Common
84	*Hedyotis auricularia* L.	Mutialata	Rubiaceae	Herb	Common
85	*Hedyotis corymbosa* (L.) Lam.	Ketpapra, Panki	Rubiaceae	Herb	Common
86	*Hedyotis diffusa* Willd.	-	Rubiaceae	Herb	Common
87	*Hedyotis neesiana* Arn.	-	Rubiaceae	Herb	Common
88	*Hedyotis scandens* Roxb.	Kannayabata, Kumbhardhala	Rubiaceae	Herb (scandent)	Common
89	*Helitropium indicun* L	Hatisur	Boraginaceae	Herb	Common
90	*Hemidesmus indicus* (L.) R. Br.	Anantamul	Asclepiadaceae	Herb	Endangered
91	*Hewittia sublobata* (L. f.) Kuntze	-	Convolvulaceae	Herbaceous climber	Common

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
92	*Hodgsonia macrocarpa* (Blume) Cogn.	Gular, Pathligular	Cucurbitaceae	Herbaceous climber	Critically Endangered
93	*Hoya parasitica* (Roxb) Wall. *ex* Wight	Pargacha	Asclepiadaceae	Herbaceous Epiphyte	Rare
94	*Hydrocotyle sibthorpioides* Lam.	-	Apiaceae	Herbaceous trailer	Common
95	*Hydrolea zeylanica* (L.) Vahl	Kasschara	Hydrophyllaceae	Herb	Rare
96	*Hygrophila polysperma* (Roxb.) T. Anders	-	Acanthaceae	Herb	Common
97	*Hygrophyl asalicifolia* (Vahl) Nees	Kakmasha	Acanthaceae	Herb	Common
98	*Hyptis capitata* Jacq.	-	Lamiaceae	Herb	Common
99	*Hyptis suaveolens* Poir	Belatitulshi, Tokma	Lamiaceae	Herb	Common
100	*Ipomoea attenua* Forsk.	Kalmishak	Convolvulaceae	Herbaceous trailer	Common
101	*Ipomoea alba* L	Hal kalmi, Dudhia kalmi, Dudh kalmi	Convolvulaceae	Herbaceous climber	Common
102	*Ipomoea batatas* (L.) Lam.	Misti Aloo	Convolvulaceae	Herbaceous trailer	Common
103	*Ipomoea hederifolia* L.	-	Convolvulaceae	Herbaceous climber	Common
104	*Ipomoea littoralis* Blume	-	Convolvulaceae	Herbaceous trailer	Rare
105	*Ipomoea mauritiana* Jacq.	Huffta Alu, BalaiKand	Convolvulaceae	Herbaceous Climber	Common
106	*Ipomoea pes-tigridis* L.	Langulilata	Convolvulaceae	Herbaceous climber	Common
107	*Ipomoea pileata* Roxb.	-	Convolvulaceae	Herbaceous climber	Common
108	*Ipomoea yomae* Kurz	-	Convolvulaceae	Herbaceousc limber	Common
109	*Jacquemontia paniculata* (Burm. f.) Hallier f.	-	Convolvulaceae	Herbaceous climber	Common
110	*Knoxia sumatrensis* (Retz) DC.	-	Rubiaceae	Herb	Common
111	*Lapithogathi sincurva* Buch.Ham. *ex* D. Don	-	Acanthaceae	Herb	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
112	*Leonurus sibiricus* L.	Roktodron	Lamiaceae	Herb	Rare
113	*Leucas aspera* (Willd) Link	Chotohalkusa	Lamiaceae	Herb	Common
114	*Leucas indica* (L.) R. Br. *ex* Vatke	Dondokalosh, Hal-kusa, Shetodron	Lamiaceae	Herb	Common
115	*Leucas pulkenetii* (Roth.) Spreng.	Shetodron, Dangalos	Lamiaceae	Herb	Common
116	*Lindernia antipoda* (L.) Alston	-	Scrophulariaceae	Herb	Common
117	*Lindernia ocumina* (Colsmann) Pennell	-	Scrophulariaceae	*Herb*	*Common*
118	*Ludwigia hyssopifolia* (G. Don.) Exell.	-	Onagraceae	*Herb*	*Common*
119	*Ludwigia adscendens* (L.) Hara	Keshardam	Onagraceae	Herb	Common
120	*Merremia attenuata* (L.) Halleer	Sadakalmi	Convolvulaceae	Herbaceous twiner	Common
121	*Merremia umbellata* (L.) Halleer	Sadakamni, Korma lata	Convolvulaceae	Herbaceous climber	Common
122	*Mikania cordata* (Burm. F.) Robinson	Tufanilata, Taralata, Shankunilata	Asteraceae	Herbaceous climber	Common
123	*Mimosa pudica* L.	Lajja-bati	Mimosaceae	Herbaceous trailer	Common
124	*Mitracarpus hirtus* (L.) DC.	-	Rubiaceae	Herb	Common
125	*Mollugo pentaphylla* L.	Khetpapra	Molluginaceae	Herb	Common
126	*Mucana pruriens* (L.) DC.	Al-kushi	Fabaceae	Herbaceous climber	Common
127	*Nelsonia canescens* (Lam.) Spreng.	Paramul	Acanthaceae	Herb	Common
128	*Nicotiana plumbaginifolia* Viv.	Ban Tamak	Solanaccae	Herb	Common
129	*Nymphaea nouchali* Brum. f.	SadaSapla	Nympheaceae	Herb (Aquatic)	Common
130	*Nymphoides hydriphilla* (Lour.) Kuntze	-	Menyanthaceae	Herb (aquatic)	Common
131	*Ocimum americanum* L.	Bon-tulshi	Lamiaceae	Herb	Common
132	*Ocimum basilicum* L.	-	Lamiaceae	Herb	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
133	*Ocimum sanctum* L.	Tulshi	Lamiaceae	Herb	Common
134	*Operculina turpethum* (L.) Marso.	DudhKalmi	Convolvulaceae	Herbaceous climber	Common
135	*Ophiorrhiza mungos* L.	Gandhanakuli	Rubiaceae	Herb	Common
136	*Ophiorrhiza rugosa* Wall. var. *prostrata* (D. Don) Deb & Mandal	Jari, Kalashona	Rubiaceae	Herb	Common
137	*Oxalis corniculata* L.	Amrul	Oxalidaceae	Herb	Common
138	*Paederia foetida* L.	Gandha-badali, Baduli-badulia, Modhu-lata	Rubiaceae	Herbaceous climber	Common
139	*Parabaena sagittata* Miers.	Samanuia	Menispermaceae	Herbaceous climber	Rare
140	*Passiflora foetida* L.	Jomkalata	Passifloraceae	Herb	Common
141	*Peperomia* sp.	Peperomea	Piperaceae	Herb (succulent)	Common
142	*Persicaria orientalis* (L.) Spach.	Bara panimarich	Polygonaceae	Herb	Common
143	*Persicaria hydropiper* (L.) Spach.	Pakurmul	Polygonaceae	Herb	Common
144	*Persicaria viscosa* (Buch.-Ham. *ex* D. Don) Nakia	Atala Biskatali	Polygonaceae	Herb	Common
145	*Phaulopsis imbricata* (Forssk.) Sweet	-	Acanthaceae	Herb	Common
146	*Phyla nodiflora* (L.) Greene	Bhuiokra, Karoghar	Verbenaceae	Herb	Common
147	*Phyllanthus niruri* L.	Bhuiamla	Euphorbiaceae	Herb	Common
148	*Physalis angulata* L.	Fotka	Solanaceae	Herb	Common
149	*Physalis micrantha* Link.	Bantipariya, Phuika, Terare	Solanaceae	Herb	Common
150	*Physalis minima* L.	Fotka	Solanaccae	Herb	Common
151	*Piper longum* L.	Pipul	Piperaceae	Herb	Common
152	*Piper rhytidocarpum* Hook. F.	-	Piperaceae	Herbaceous creeper	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
153	*Piper sylvaticum* Roxb.	Ban Pan	Piperaceae	Herbaceous creeper	Common
154	*Pogostemon auricularius* (L.) Hassk.	-	Lamiaceae	Herb	Common
155	*Portulaca oleracea* L.	Bara Lunia	Portulacaceae	Herb	Common
156	*Pouzolzia zeylanica* (L.) Benn.	Kullaruki	Urticaceae	Herb	Common
157	*Pseudelephantopus spicatus* (B.Juss. *ex* Aubl.)	-	Asteraceae	Herb	Common
158	*Pueraria subspicata* (Benth.) Benth.	-	Fabaceae	Herbaceous climber	Common
159	*Rauvolfia serpentina* (L.) Benth. *ex* Kurz	Sarpagandha	Apocynaceae	Herb	Endangered
160	*Rorippa indica* (L.) Hiern	Bansarisha	Brassicaceae	Herb	Common
161	*Rorippa palustris* (L.) Besser	Panisarisha	Brassicaceae	Herb	Common
162	*Ruellia acuminata* L.	-	Acanthaceae	Herb	Common
163	*Ruellia tuberosa* L.	Chatpoti	Acanthaceae	Herb	Common
164	*Rungia pectinata* (L.) Nees	Pindi, Punaka-pundu, Birlongopark	Acanthaceae	Herb	Common
165	*Salomonia ciliata* (L.) DC.	-	Polygalaceae	Herb	Common
166	*Scoparia dulcis* L.	Bandhaney	Scrophulariaceae	Herb	Common
167	*Senna occidentalis* (L.) Link	Bara-Kalkasunda, Eski	Caesalpiniaccae	Herb	Common
168	*Sida cordata* (Brum. f.) Borss.	Junka	Malvaceae	Herb	Common
169	*Sida mysorensis* Wight &Arn.	Chatehata	Malvaceae	Herb	Common
170	*Solanum nigrum* L.	Gurkhi	Solanaceae	Herb	Common
171	*Solanum sisymbrifolium* Lam.	Kanta begun	Solanaceae	Herb	Common
172	*Solanum virginianum* L.	Kantakari	Solanaceae	Herb	Common
173	*Sonchus wightianus* DC.	-	Asteraceae	Herb	Common
174	*Spermacoce articularis* L. f.	Ahtharogia	Rubiaceae	Herb	Common
175	*Sphaeranthus africanus* L.	-	Asteraceae	Herb	Common

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SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
176	*Sphaeranthus indicus* L.	Murmuri	Asteraceae	Herb	Common
177	*Sphaeranthus senegalensis* DC.	-	Asteraceae	Herb	Common
178	*Sphenoclea zeylanica* Gaertn.	JhilMarich	Sphenocleaceae	Herb	Common
179	*Spilanthes calva* DC.	Marhata-tiga	Asteraceae	Herb	Common
180	*Staurogyne argentea* Wall.	-	Acanthaceae	Herb	Common
181	*Staurogyne angustifolia* T.Anders.	--	Acanthaceae	Herb	Common
182	*Strobilanthes scaber* Nees	-	Acanthaceae	Herb	Rare
183	*Syndrella nodiflora* (L.) Gaertn.	-	Asteraceae	Herb	Common
184	*Tephrosia purpurea* (L.) Pers.	Bon-neel	Fabaceae	Herb	Common
185	*Tephrosia purpurea* (L.) Pers.	Ban-nill	Fabaceae	Herb	Common
186	*Tetrastigma angustifolia* (Roxb.) Deb	Nekungriubi	Vitaceae	Herbaceous climber	Rare
187	*Tetrastigma bracteolatum* (Roxb.) Planch.	Golgotilata	Vitaceae	Herbaceous climber	Common
188	*Thladiantha cordifolia* (Blume) Cogn.	-	Cucurbitaceae	Herbaceous climber	Rare
189	*Thunbergia alata* Bojer *ex* Sims	-	Acanthaceae	Herbaceous climber	Rare
190	*Thunbergia grandiflora* Roxb.	-	Acanthaceae	Herbaceous climber	Common
191	*Torenia asiatica* L.	-	Scrophulariaceae	Herb	Common
192	*Torenia diffusa* D. Don	-	Scrophulariaceae	Herb	Common
193	*Torenia flava* Benth.	-	Scrophulariaceae	Herb	Common
194	*Tragia allidrate* L.	Bichuti, Chitta	Euphorbiaceae	Herb	Common
195	*Trichosanthes cordata* Roxb.	Bhuikakra	Cucurbitaceae	Herbaceous climber	Rare
196	*Trichosanthes tricuspidata* Lour.	Makal	Cucurbitaceae	Herbaceous climber	Rare
197	*Tridax procumbens* L.	Tridhara	Asteraceae	Herb	Common
198	*Triumfetta pilosa* Roth	-	Tiliaceae	Herb	Common
199	*Triumfetta rhomboidea* Jacq.	Ban-okra	Tiliaceae	Herb	Common

SN	Botanical name	Bangla Name	Family	Habit	Status of occur.
200	*Tylophora indica* (Burm. F.) Merr.	Antamul, Anantamul	Asclepiadaceae	Herbaceous twiner	Rare
201	*Uncaria scandens* (Smith) Hutch.	Vailfullata	Rubiaceae	Herbaceous climber	Rare
202	*Vernonia cinerea* (L.) Less.	Kukshim, Sahadebi, Shillata	Asteraceae	Herb	Common
203	*Vicia sativa* L.	Ankari, Hatka	Fabaceae	Herb	Common
204	*Xanthium indicum* Koenig	Lehra, Ghagra	Asteraceae	Herb	Common

Appendix 4. Amphibia/Amphibians in Baraiyadhala National Park

SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local Name
1	Anura	Bufonidae	*Duttaphrynus melanostictus*	Common Toad	VC	Kuno Bang
2		Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog	VC	Kotkoti Bang
3			*Fejervarya asmati*	Asmat's Cricket Frog	C	Asmater Jhi-jhiBang
4			*Fejervarya cancrivora*	Crab-eating Frog	C	Kakra bhuk Bang
5			*Fejervarya pierrei*	Pierre's Cricket Frog	C	Jhi-jhiBang
6			*Fejervarya nepalensis*	Nepal Cricket Frog	VC	Jhi-jhi Bang
7			*Fejervarya syhadrensis*	Syhadra Crickert Frog	VC	Jhi-jhi Bang
8		Microhylidae	*Microhyla ornata*	Ornate Microhylid	VC	Cheena Bang
9		Megophryidae	*Hoplobatrachus tigerinus*	Bull Frog	C	Bhawa Bang
10			*Hoplobatrachus litoralis*	Coastal Bull Frog	C	Upokulio Sona Bang
11		Rhacophoridae	*Polypedates leucomystax*	Six-lined Tree Frog	VC	Dorakata Gechho Bang
12			*Polypedates maculatus*	Maculated Tree Frog	R	Gechho Bang

[Here, VC = Very common species seen 80% to 100% of the field visits and in good number; C = common species seen during 50% - 79% of the visits; FC = fairly common/uncommon species seen during 20% - 49% of the visits; and R = rare-species observed less than 19% of the visits in very small number.]

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Appendix 5. Reptilia/Reptiles in Baraiyadhala National Park

Sl. No.	Order	Family	Scientific Name	Common or English Name	Status	Local Name
1	Squamata	Gekkonidae	*Gekko gecko*	Tokkhak	VC	Shanda
2			*Hemidactylus frenatus*	Common House Gecko	VC	Tiktiki
3			*Hemidactylus brookii*	Spotted House Lizard	C	Tiktiki
4		Agamidae	*Calotes versicolor*	Garden Lizard	VC	Rokto Chusha
5		Lacertidae	*Takydromus khasiensis*	Long-tailed Lizard	R	Tiktiki
6		Scincidae	*Eutropis carinata*	Keeled Grass Shink	C	Anjon
7			*Eutropis macularius*	Bronze Grass Shink	VC	Ghash Anjon
8	Testudines	Testudinidae	*Indotestudo elongata*	Elongated Tortoise	R	Holud Pah
9	Serpentes	Varanidae	*Varanus bengalensis*	Bengal Monitor	C	Kala Gui
10			*Varanus flavescens*	Yellow Monitor	R	Sona Gui
11		Boidae	*Python molurus*	Rock Python	R	Ajogor
12		Elapidae	*Najakaou kauthia*	Monocellate Cobra	C	Gokhra Shap
13			*Naja naja*	Spectacled Cobra	C	Khoya Gokhr
14			*Bungarus niger*	Black Krait	R	Kal Keutey Shap
15			*Enhydris enhydris*	Smooth Water Snake	VC	Paina Shap
16			*Bungarus fasciatus*	Banded krait	C	Shonkhini Shap
17		Colubridae	*Ptyas mucosa*	Indian Rat Snake	C	Daraj Shap
18			*Ahaetulla nasuta*	Common Vine Snake	C	Laudoga Shap
19			*Xenochropis piscator*	Checkered Keel Dora	VC	Dora Shap
20			*Lycodon aulicus*	Common Wolf Snake	C	Gharginni Shap

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Appendix 6. Aves of Baraiyadhala National Park

SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local name
1	Galliformes	Phasinidae	*Gallus gallus*	Red Junglefowl	C	Bon Morog
2			*Lophura leucomelanos*	Kalij Pheasant	R	Mothura
3			*Polyplectron bicalcaratum*	Grey Peacock Pheasant	R	Kath moyur
4	Charadriformes	Turnicidae	*Turnix suscitator*	Barred Batton quail	R	--
5	Piciformes	Picidae	*Dendrocopos macei*	Fulvous-breasted Woodpecker	C	Jarad Kaththokra
6			*Dinopium javanense*	Common Flame Back	VC	Kaththokra
7			*Picus xanthopygaeus*	Streak throated woodpecker	C	Sabujey Kaththokra
8			*Dinopium benghalense*	Black rumped Flameback	C	Sonali Kaththokra
9			*Dendrocopos canicapillus*	Gray Capped Pygmy woodpecker	R	Choto Kaththokra
10			*Picumnus innominatus*	Speckled Piculet	C	Khudey Kaththokra
11			*Chrysocolaptes guttacristatus*	Common Goldenback Woodpecker	R	Boro Kaththokra
12		Megalaimidae	*Megalaima asiatica*	Blue-throated Barbet	C	Bosonthoba uri
13			*Megalaima lineata*	Lineated Barbet	C	Bosontho bauri
14			*Megalaima haemacephala*	Coppersmith Barbet	C	Bosonthoba bauri
15			*Megalaim australis*	Blue-eared Barbet	R	Neelkan Boshonto
16	Bucerotiformes	Bucerotidae	*Anthracoceros albirostis*	Pied Hornbill	R	Kao Dhanesh
17	Upupiformes	Upupidae	*Upapa epops*	Common Hoope	C	Hudhud
18	Coraciformes	Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	VC	Manchranga
19			*Halcyon atthis*	Common Kingfisher	VC	Manchranga

SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local Name
20			*Halcyon capensis*	Stork-Billed Kingfisher	R	Megh-Hou
21		Meropidae	*Merops orientalis*	Green Bee-eater	C	Suichura
22			*Merops leschenaulti*	Chestnut-headed Bee - eater	C	Suichura
23	Cuculiformes	Centropodidae	*Centropus sinensis*	Greater Coucal	VC	Kanakuka
24			*Centropus bengalensis*	Lesser Coucal	R	Kukka
25			*Cuculus micropterus*	Indian Cuckoo	C	Bau kotha kou
26			*Eudynamyas sccolopacea*	Asian Cuckoo	C	Kokil
27			*Phaenicophaeus tristis*	Green Billed Malkoha	FC	Sobuj Kokil
28			*Hierococcyx varius*	Common hawk Cuckoo	C	Chokgelo Pakhi
29			*Cacomantis merulinuss*	Plaintive Cucko	FC	Chatak
30	Psittaciformes	Psittacidae	*Psittacula krameri*	Rose Ringed Parakeet	R	Tia
31			*Psittacula alexanderi*	Red-breasted Parakeet	C	Tota
32	Apodiformes	Apopidae	*Apus affinis*	House Swift	VC	Ababil
33			*Cypsiurus balasiensis*	Asian Palm Swift	VC	Nakkati
34		Caprimulgidae	*Caprimulgus macrurus*	Long-tailed Indian Nightjar	R	Rat Chara Phakhi
35	Strigiformes	Strigidae	*Athene brama*	Spotted Owl	C	Khuruly Pencha
36			*Glaucidium cuculoides*	Asian Barred Owlet	R	Pencha
37	Culumbiformes	Culumbidae	*Columba livia*	Rock Pigeon	C	Jalali Kobutar
38			*Streptopeliach chinensis*	Spotted Dove	VC	Tila Ghughu
39			*Treron phoenicoptera*	Yellow footed Green Pigeo	R	Holudpa Horial
40	Ciconiiformes	Ralidae	*Amaurornis phoenicurus*	White Breasted Waterhen	C	Dahuk
41		Jacanidae	*Metopodius indicus*	Bronze-winged Jacana	R	Jolpipi
42		Charadriidae	*Vanellus indicus*	Red Wattle Lawping Bird	C	Hot Ti-Ti

SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local Name
43		Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	C	Tila Eagle
44			*Milvus migrans*	Black Kite	R	Bhuban Chil
45		Falacrocor-acidae	*Falacrocorax niger*	Little Cormorant	C	Pankouri
46		Ardeidae	*Bubulcus ibis*	Cattle Egret	VC	Go-Bok
47			*Egretta garzetta*	Little Egret	VC	Sada Bok
48			*Ardeola grayii*	Pond Heron	VC	Kani Bok
49			*Amastomus Oscitans*	Asian Openbill	R	Shamuk-Khol
50.	Passeriformes	Cisticolidae	*Prinia inormata*	Plain Prinia	FC	Shadharan buno tuni
51			*Cisticola juncidis*	Zitting Cisticola	C	Bhomra Soton
52		Irenidae	*Chloropsis aurifrons*	Golden-fronted Leaf Bird	R	Shonakopali Horbola
53		Sturnidae	*Acridotheres tristis*	Common Myna	VC	Bhat Shalik
54			*A fuscus*	Jungle Myna	VC	Jhuti Shalik
55			*Sturnus contra*	Pied Myna	VC	Gobrey Shalik
56			*Sturnus malabaricus*	Grey Hooded Myna	C	Kat Shalik
57		Corvidae	*Corvus splendens*	House Crow	VC	Pati Kak
58			*Corvus macrorhynchos*	Jungle Crow	C	Dar Kak
59			*Dendrocitta vagabunda*	Tree Pie	VC	Kutum Pakhi
60			*Cissa chinensis*	Common Green Magpie	R	Sobuj Harichacha
61		Dicruridae	*Dicrurus macrocercus*	Black Drongo	VC	Fingey
62			*Dicrurus hottentottus*	Spangled Drongo	C	Fingey
63			*Dicrurus paradiseus*	Racket Tail Drongo	FC	Fingey
64			*Dicrurus aeneus*	Bronzed Drongo	C	Fingey
65		Oriolidae	*Oriolus xanthornus*	Black-headed Oriole	VC	Holdey Pakhi

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SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local Name
66			*Oriolus oriolus*	Eurasian Golden Oriole	R	Sona Bau
67		Aegithinidae	*Aegithina tiphia*	Common Iora	C	Fatikjol
68		Artamidae	*Artamus fuscus*	Ashy Woodswallow	C	Latora
69		Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	C	Lejnachani
70		Campephagidae	*Tephrodornis pondicerianus*	Common Wood Shrike	C	Shudhuka/ Dukka
71		Pycnonotidae	*Pycnonotus Jocosus*	Red Whiskered Bulbul	C	Sipahi Bulbul
72			*Pycnonotus cafer*	Red-vented Bulbul	VC	Kalo Bulbul
73			*Pycnonotus atriceps*	Black Headed Bulbul	R	Kalo Bulbul
74			*Alophoixus flaveolus*	White-throated Bulbul	R	Sadabook Halud Bulbuli
75		Muscicapidae	*Copsychus malabaricus*	White rumped Shama	R	Shama
76			*Copsyccus saularis*	Magpie-Robin	VC	Doyel
77			*Monticola solitarius*	Blue Rock Thru	FC	Shiladama
78			*Myophonus caeruleus*	Blue whistling Thrush	FC	Nil-shiladama
79			*Culicicapa iceylonenss*	Grey-headed Canary Flycatcher	C	Metematha Choto-Chotok
80			*Musicapa dauurica*	Asian Brown Flycatcher	C	Ashio Khoiri Chotok
81			*Zoothera citrina*	Orange Headed Thrush	R	Komla Dama
82		Sylviidae	*Orthotomus sutorius*	Tailor Bird	VC	Tuntuni
83			*Orthotomus cuculatus*	Mountain Tailorbird	FC	Pahari Tuntuni
84		Timaliidae	*Turdoides striata*	Jungle Babbler	C	Satvaila
85			*Garrulax pectoralis*	Greater-necklaced Laughingthrush	R	Panga

SN	Order	Family	Scientific Name	Common Eng. Name	Status	Local Name
86			*Garrulax ruficolis*	Rufous - necklaced Laughingthrush	R	Lalcheyghar -wala Panga
87			*Garrulax galbanus*	Yellow-throated Laughingthrush	R	Holdegola- Penga
88		Necterinidae	*Necterinia sperata*	Purple throated Sunbird	C	Begunibook Moutus
89			*Nectarinia asiatica*	Purple Sunbird	C	Niltuni
90			*Aethopyga siparaja*	Crimson Sunbird	R	Shindury Moutushi
91		Dicaeidae	*Dicaeum cruentatum*	Scarlet Backed Flowerpeacker	C	Lal Fuljhuri
92			*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	R	Metethot Fuljhuri
93			*Dicaeum chrysorrheum*	Yellow-vented Flowerpecker	R	Holde tola Fuljhuri
94			*Dicaeum agile*	Thick-billed Flowerpecker	R	Thotmota Fuljhuri
95		Paridae	*Parus major*	Great Tit	C	Tit Phakhi
96		Passeridae	*Passer domesticus*	Houses parrow	VC	Charui Pakhi
97		Ploceidae	*Ploceus manyar*	Baya Weaver	C	Babui
98		Motacillidae	*Anthus rufulus*	Paddy Field Pipit	C	Mat Chorai
99			*Lonchura punctulata*	Scaly-breasted Munia	C	Tila Munia
100			*Motacilla alba*	White Wagtail	R	Sada Khonjo
101			*Motacilla cinerea*	Gray Wagtail	R	Dhushar Khonjon
102			*Motacilla flava*	Yellow Wagtail	R	Holdey Khonjon

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Appendix 7. Mammals of Baraiyadhala National Park

SN	Order	Family	Scientific Name	CommonEnglishName	Status	LocalName
1	Primates	Cercopithecidae	*Macaca assamensis*	Assamese Macaque	R	Assamese Bandor
2			*Trachypithecus pileatus*	Capped Langur	R	Lal Hanuman
3	Carnivora	Canidae	*Canis aureus*	Golden Jackal	C	Pati Sheal
4		Viverridae	*Vivvera zibetha*	Large Indian Civet	R	Bagdash
5			*Vivericula indica*	Small Indian Civet	R	Khatash
6		Herpestidae	*Herpestes edwardsi*	Common Indian Mongoose	C	Benji
7			*Herpestes auropunctatus*	Small Indian Mongoose	C	Chhoto Beji, Nakul
8		Felidae	*Prionailurus viverrinus*	Fishing cat	R	Mechho Biral
9			*Felis chaus*	Jungle cat	R	Bono Biral
10			*Prionailurus bengalensis*	Leopard Cat	R	Leopard Cat
11	Rodentia	Sciuridae	*Callosciurus pygerythrus*	Irrawaddy Squirrel	C	Badami Kat Birali
12		Hystricidae	*Hystrix indica*	Indian Crested Porcupine	FC	Shojaru
13		Muridae	*Bandicota indica*	Bandicoot Rat	C	Boro Indur
14			*Mus musculus*	House Mouse	VC	Nengti Indur
15			*Mus booduga*	Indian Field Mouse	C	Metto Indur
16			*Rattus norvegicus*	Brown Rat	VC	Indur
17			*Rattus rattus*	Common Indian Rat	VC	Indur

SN	Order	Family	Scientific Name	Common English Name	Status	Local Name
18	Artiodactyla	Suidae	*Sus scrofa*	Wild Boar	C	Shukor
19		Cervidae	*Muntiacus muntjac*	Barking Deer	FC	Maya Horin
20			*Arctonyx collaris*	Hog-Badger	R	Gor khodok
21	Logomorpha	Leporidae	*Caprologus hispidus*	Assam Rabbit	R	Khargosh
22	Insectivora	Soricidae	*Suncus murinus*	Grey musk Shrew	VC	Chika
23	Chiroptera	Pteropodida	*Pteropus giganteus*	Flying fox	C	Badur
24			*Cynopterus spinx*	Fruit Bat	C	Badur
25		Megadermatidae	*Megaderma lyra*	False Vampire Bat	FC	Badur
26		Pteropodidae	*Rousettus leschenaulti*	Fulvous Fruit Bat	C	Kolabadur
27		Vespertilionidae	*Pipistrellus coromandra*	Indian Pipistrelle	C	Cham Chika

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