Perception-based assessment of ecosystem services of Ghagra Pahar forest of Assam, Northeast India

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ABSTRACT

Specific survey for collecting peoples’ perception, knowledge, and their general attitudes towards “ecosystem services” has been conducted in the tropical deciduous forest of Ghagra Pahar in Goalpara district, Assam. Data were collected through a household survey, personal interview, and group discussion and were analysed to assess the various ecosystem services, and ranked on a (1–10 point scale) based on perceptions. Socio-economic variables were also characterized during the study and analysed using statistical methods such as frequency, per cent, and mode. Grading scale such as very high (−2), high (−1), neutral (0), low (+1), and very low (+2) were used for analysing drivers of ecosystem change. Identified drivers were prioritized emphasizing on the impact of livelihood. A total of 12 services belonged to the provisioning category, followed by regulating (6), supporting (4), and cultural/aesthetic (2) were assessed from the study area. This study provided a checklist for the species that had been disappeared and possible causes of their disappearance. Dominant tree species were recorded based on availability and economic uses. Findings of the study will be useful to natural resources managing agencies to formulate the strategic working plan for resource conservation, economic development and sustainable livelihood of local residents.

Introduction

The natural ecosystems provide several benefits to the people and they were emphasized as ecosystem services and primarily grouped into provisioning, regulating, supporting, and cultural services (MEA 2005). Ecosystem services derived from forest communities are vital to the welfare of human society. A myriad of literature is available about the benefits of ecosystem services provided by natural resources to society and their proper management. However, not much emphasis has been given on how the people making the decisions perceive of existing and potential services provided by ecosystems surrounding them. Human beings have too lightly valued most of the basic resources on which they survive, including the air to breathe in, the water to drink, and the ability of the earth to support a wide variety of life (Alexander, 1999). The cumulative human impact on the natural system supporting a myriad of life over a century and our recent knowledge over the consequences of the adverse impact on the life-supporting systems, make it impossible for us to take natural resources for granted any longer. Ecosystem services approach offers the prospect of developing more integrated solutions to the problem of understanding the nature and scale of ecosystem degradation, and the kinds of strategy that might be needed in the face of future environmental change.

Depending on its location and management status, a forest can provide all major ecosystem services from provisioning to cultural/amenities which have not been much scientifically explored yet (Ray, Chandran, & Ramachandra, 2010). Forests assist mainly forest-dwelling communities for meeting their day-to-day needs since time immemorial. These forest communities support a large number of threatened species including that have vanished from the major landscape. The decrease in forest cover generally attributed due to the transform in social and religious values mainly due to advancement in technology and infrastructural development. The ever growing market growth of the various natural resources including medicinal, firewood, and other non-timber forest products was among the key drivers for depletion. However, for the general population of villages, it is easier to understand the economics than the ecology. Several tested frameworks for preserving forest ecosystem associated with the rapid expansion in sustainable forest management were available (Tittensor, Walpole, & Samantha, 2014). Recent methodological advancements have improved the assessment of distributions, synergies, and trade-offs of various ecosystem services at different spatio-temporal scales (Raudsepp-Hearne, Peterson, &
Bennett, 2010). Considering the substantial contributions of forest services to the global society, forest managers including practitioners and scientists have significant responsibility for the integrity and sustainability of future societies (CPF, 2008).

The benefits derived from ecosystem services cover various dimensions of human well-being, namely basic human needs, economic, environmental, and subjective happiness. However, the notion of value should not be restricted to the merely monetary value. Therefore, it was important to include other values as well, such as health, socio-cultural, or conservation value. Forest supports local biota, non timber forest products (NTFP’s) s, medicinal plants, and fuelwood, along with long-lasting services such as groundwater recharge, flood control, and fire resistance and thus require a larger dimension of proper management. Further, the forest provides shelter to a variety of wildlife, have great powers to heal body and spirit, reservoirs of endemic and endangered plant and animal species, carbon sequestration, contain relatives of crop species that can help to improve cultivated varieties, maintains water cycle, and improve soil stability. Hence, forests are the lifeline for the rural community (Ray et al., 2010) in many ways either socio-religious, cultural, or livelihood maintenance. There is not much detailed study in this direction to assess the potential of the forest ecosystem services and their importance in livelihood. Forests are nowadays under tremendous threats ranging from natural to anthropogenic in nature. Encroachments over the forest area by both local as well as government machinery are common ongoing practices. Loss of native plant may alter the microclimatic conditions which may put biota in great risk of extinction. Similarly, as the native species have a definite role in water conservation, changing the pattern of vegetation may have an enormous impact on water availability in the downstream area.

Further, the literature review revealed that not much emphasis has been given on assessment of ecosystem services particularly in the tropical deciduous forest of Goalpara district in Assam. Meanwhile, peoples’ perceptions on the ecosystem services, synergies, and trade-offs, need to be studied to prioritize for the conservation of forest. Thus, this study attempted to evaluate peoples’ perceptions and disposition on the ecosystem services of Ghagra Pahar (GP) forest area of Goaplara, Assam. Emphasis is given to identify and assess ecosystem services, the drivers of change of forest ecosystem and prioritize the most relevant ecosystem services and the impacts of those changes on people’s livelihoods. Findings of the study will be useful to strengthen the ongoing conservation efforts taken by the government, NGOs, and rural communities and also to prioritize the management of the forests based on ecosystem services.

Materials and methods

Study site

GP forest was selected primarily because of its past ecological and ethnobotanical glory, and the threat that it is facing currently. Second, in order to understand the impact of management and conservation, strategy adopted by the local people under the banner of Nabajyoti Bon Sangrakhan Committee fascinated to undertake the research on the present site. The landscape of GP forest is hilly and the ground slopes downs in all directions. The top part of the hill comprises of mixed vegetation type with a shift to Shorea robusta (Sal) dominated in the lower regions. It is surrounded by human habitation in all the directions consisting of several villages namely, Budlung Chanchalipara, Ouguri, Budlung Garopara, Bakrapara part-I, Ghagra Pahar, Ghagra saljhar, and Budlung saljhar under Kahibari gram panchayat (Table 1). GP forest (tropical deciduous) is in Rangjuli forest circle and situated 12 km away from sub-district head-quarter Rangjuli and 64 km from district headquarter Goalpara. The district lies in the southern bank of mighty Brahmaputra river and western part of Assam, situated between 25° 53’ and 26°15’ N latitude and 90° 07’ and 91° 05’ E longitudes with a geographical area of 1824 sq. km (Figure 1). About 298 sq. km (16.34%) of the total geographic area is covered by forest (FSI, 2017). Annual mean temperature ranged between 7°C and 33°C and relative humidity from 67% to 90%. About 80% rainfall is received from south-west monsoon. Since the GP forest has no definite geographical boundary, a centre coordinate point (26° 0’ 56.59° N and 90° 57’ 47.17” E) is considered within the core region of the forest and the area within 2 km radius is taken as the study site covering a total area of 12.56 sq. km (1256 ha).

Sampling procedure

A preliminary assessment was made based on the household survey and personal interview following standard methods (Barik, Malhotra, Gandhi, & Manav, 2012) during the year 2016–2017. Out of the existing villages surrounding the GP forest, seven villages were selected randomly. Forest-dependent residents within a 2 km radius of GP forest were selected for interviews and focussed group discussions. Altogether 70 households were selected randomly for household survey and 35
Table 1. Characteristics of peripheral villages of Ghajra Pahar forest.

| Parameters             | Budlung Chanchalipara | Budlung Gangipara | Budlung Garopara | Bakrapara Part-I | Ghagra Pahar | Ghagra salihar | Budlung salihar |
|------------------------|------------------------|-------------------|------------------|------------------|--------------|----------------|----------------|
| Geo-coordinates        | 26°0’30.22”N 90°56’47.62”E | 26°0’40.59”N 90°57’00.44”E | 26°1’13.07”N 90°56’59.07”E | 25°59’52.06”N 90°57’18.42”E | 26°1’26.65”N 90°57’8.79”E | 26°0’10.32”N 90°57’5.24”E | 26°0’0.72”N 90°57’1.61”E |
| Area (ha)              | 153.47                 | 57.32             | 158.78           | 84.06            | 277.87       | 26.16          | 99.75          |
| Population size        | 652                    | 218               | 541              | 377              | 100          | 39             | 68             |
| Population density (ha⁻¹) | 4                       | 4                 | 3                | 5                | <1           | 2              | <1             |
| Household number       | 134                    | 46                | 107              | 79               | 23           | 9              | 16             |
| Average household size | 5                      | 5                 | 5                | 4                | 4            | 4              |                |
| Ethnicity              | Rabha and Bodo         | Rabha and Bodo    | Garo             | Bodo             | Rabha        | Rabha          | Rabha and Bodo |

(Source: Census report of 2011, Govt. of India).

respondents belonging to different groups (group by age, sex, literacy) were interviewed from each of the 7 villages. Most of the peoples were dependent on agriculture for their livelihood. The help of local moderator was taken during the sampling to ease the barriers in communications.

Data collection

A multidisciplinary approach was adopted which included data based on scientific as well as socio-economic assessments (CCI and Bird Life International 2011). A pre-tested semi-structured questionnaire was used for household survey and informal interviews. Questions were focused on the ecosystem services used, people’s dependency on them, drivers of changes, and knowledge related to the existence and disappearance of species of the forest ecosystem over a certain period of time. A questionnaire was prepared to collect the relevant data of the existing ecosystem services available in the GP forest area emphasizing on peoples’ perception and knowledge. Data related to socio-economic characteristics such as sex, age, income, education, household size, marital status, occupation, place of origin, and period of residence were also collected. Other relevant data such as population, demographics, land characteristics and climate were also collected through an extensive literature survey.

Data analysis

A questionnaire-based assessment was carried out to analyse the characteristics of ecosystem services. A few statistical tools such as frequency, percentage, and mode were considered to analyse the socio-economic variables such as age, gender, marital status, education, and occupation. Data collected through a household survey, personal interview, and group discussion were analysed to assess the various ecosystem services and ranked them based on community perception. Ranking of the ecosystem services was done to identify the top 10 most important ecosystem services that the stakeholders perceived from GP tropical forest. During the study, a basic explanation regarding the purpose of the assessment was provided beforehand to the participants. Initially, each participant was asked to put relative scores on the listed ecosystem services. After individual scoring, 7 groups out of the 35 members (constituting 5 each) were involved in the discussion to assign an overall score to each service. Finally, each group came to a consensus about the final scoring for each ecosystem services and shortlisted the 10 prominent ecosystem services from the study site. The shortlisted services were then scored based on a scale of 1–10 (1 with least preference and 10 with the highest). The order of ranking from the most preferable to the least preferable was derived by summing up the individual marks for each service given as a score by the participants divided by the number of respondents (Bhatta et al., 2016). Utility and economic gain from the services were taken into consideration for ranking the services. A similar approach was undertaken to produce a list of the drivers of ecosystem change, which influences the ecosystem services of the present study area. The 10 dominant drivers of ecosystem change were analysed with a grading scale as very high (−2), high (−1), neutral (0), low (+1), and very low (+2). The grading scale derived the order of priority of different drivers of change of ecosystem. Dominance was calculated by the relative scores given by the participating groups during group discussion (Appendix II).

Results

Socio-economic assessment

Based on the personal interview from 35 villagers responded to the questionnaire prepared for identifying socio-economic characteristics of the study site (Figure 2), the majority of respondents were males (60%). Respondents belong to three different age groups i.e., 25–45 (49%), 46–65 (37%), and 66–85 (14%) and among them, 63% were married and rest are unmarried. Higher education was not much witnessed among the villagers while about only 6% each of the respondents was graduates...
and post-graduates. Literacy rate can be interpreted as low, as 48% of the respondents were under matriculate level. The highest percentage of education level was 23% from the matriculate category.

The primary occupation of the villagers was revealed as agriculture (51% of the respondents were farmers). Only 12% were government employees, 11% were students, and other 23% were either

Figure 1. Map of the study site.
wage earners or working in private organizations. Healers and priest (3%) were also available in the study site.

**Ecosystem services assessment**

Twenty-four ecosystem services were identified (7 villages) based on peoples’ perception and knowledge from the household surveys and personal interviews. Categorization of ecosystem services was as per Millennium of Ecosystem Assessment (2005), 12 services belonged to the provisioning category, followed by regulating (6), supporting (4), and cultural/aesthetic (2) (Figure 3). Freshwater, water for wild and grazing animals, irrigation, fuelwood, timber, and medicinal plants were the most regularly used provisioning services from the study site. The regulating services known to people include air quality regulation, climate regulation, carbon sequestration, water regulation, and purification. Supporting services perceived was the provision of habitat to the wild and aquatic life, photosynthesis, and soil formation. Spiritual belief and inspirational folklore were the only two cultural services recorded from the site (Figure 4).

**Utility of the ecosystem services**

During the field, survey opinions were recorded regarding the use of various ecosystem services available to the villagers. A checklist was prepared with all the existing ecosystem services from the site given by the people. Based on the opinion of the interviewers and a focussed group discussion among the forest-management committee, the top 10 services related to uses were identified (Figure 5) and ranked. Among the selected services, five services belonged to provisioning followed by supporting and regulating (2 each) and cultural services (1). Firewood service was used by almost 100% of the households although some families used modern cooking gas in addition to it. Some section of the villagers sold the excess collected firewood in the market for sustaining their livelihood. Local healers use several valuable plant species for curing various diseases like the dog bite, bone fracture, jaundice, and kidney stone by preparing the traditional medicine. Other NTFPs like fruits, edible corms, and seeds are also harvested from the study site. Wild animals, birds, cattle use waterbodies for drinking purposes. Study site provides suitable habitat for varied flora and fauna. A few households were also engaged in trading wild shrubs locally known as Ketari (Zingiberaceae) and it is being used in aromatic and pharmaceutical purposes. Merchants weekly visit them to collect the harvested material thereby helping the community to sustain livelihood to some extent. However, the streams from the site are not abundantly perennial but supply sufficient water to the agricultural fields during the cultivation period. Seventy-six per cent of the villagers use stream water from the site for irrigating the agricultural field. Locals maintain the timing and scale of run-off efficiently of the waterbodies so that neither flooding nor drought is observed in the adjoining agricultural fields/human habitation thereby not creating any havoc to the locality. Pollination (supporting) service is well perceived by the elder group of people as compared to the younger generation. Several pollinating agents such as insects,
Figure 3. Graphical representation of identified ecosystem services according to Millennium Ecosystem Assessment (2005).

Figure 4. Relationships between ecosystem services, beneficiaries/users, impact of drivers on the services/livelihood and implication of management strategies on community and GP forest.
bees, birds, and pollination activities like the season and time interval were known to the older members of the community. Cultural services were more or less familiar to all sections of people having a firm belief that the site is a home to spirits that have been protecting the forest since time immemorial. Several folklores were still preserved and communicated among the people residing nearby the forest. Supporting service, like provision of aquatic habitat, benefitted the local community with sufficient fishes for day-to-day consumption.

Drivers of ecosystem services change

Questionnaire-based analysis along with the personal interview and focused group discussion was applied to identify the drivers of ecosystem change. Key drivers of the change of forest ecosystem over a period of 20 years were listed from questionnaire data (Figure 6). In the data, interviewers who provided perception on change were prioritized in a grading scale. Deforestation, illegal feeling, over-exploitation of resources, use of chemical fertilizers in the agricultural fields, and climate change were the highly
prioritized drivers of change of ecosystem. Burning of the forest ground at a particular season, shifting to monoculture rubber plantation, use of advanced fishing equipment, and an imbalance in water regulation were the drivers having an intermediate effect on the ecosystem. Sewage and other pollution, invasive and alien species, and change of religion were among the least prioritized drivers identified by the people. Drivers such as erosion, landslide, chemical poisoning, silting, river cutting, and flood were not at all perceived by the people in regard to the present site. All the major drivers as stated above had drastically decreased (except irrigation) both in quality and quantity of various ecosystem services, resulting in a negative impact on the livelihood of the people (Table 2). A positive report was witnessed regarding the availability of water for irrigation as people addressed no change in irrigation water supply in their agricultural field over the period of 20–30 years.

**Loss of biodiversity and causes of disappearance**

The present site was a rich home to a wide variety of flora and fauna. During the field study, information was collected regarding the present and past scenario of the GP forest. The older section of the villagers reported about past glory of the GP forest. Different varieties of medicinal plants available in the forest besides fruits, fodder, timber yielding trees, etc. were abundant along with numerous variations of fauna. According to villagers, the present forest was being degraded due to varied natural as well as anthropogenic factors directly or indirectly. Bird species such as *Pavo cristatus, Buceros bicornis, Treron phoenicopterus, Ploceus philippinus, Milvus migrans, Aegypius monachus, Leptoptilos javanicus*, and *Pteromyini* sp. which existed earlier are now totally missing in the area. Poaching, loss of habitat due to human inference in the forest area, climate change, and installation of mobile towers were some of the possible causes of their disappearance as reported. As informed, *Bos frontalis* and *Semnopithecus* sp. were the two animal species disappeared from the GP forest area. Local fishes like Hebagali, Serkani, and *Dendrobranchiata* sp. (Prawn) were not observed at present in the rivers and waterbodies which were abundant in the past. A decrease in the depths of the river, chemical poisoning of the waterbodies due to use of fertilizers in the agricultural field, use of the advanced fishing net, and over-consumption were among the primary reasons reported for disappearance and decline in fish population. No trace of *Saccharum spontaneum, Canarium strictum*, and *Dipterocarpus macrocarpus* species is presently available in the forest, but these species were abundant in the recent past. Lack of suitable habitat, nutrient unavailability, climate change, and felling were among the other possible cause of extinction drawn from the local people perceptions (Table 3).

**Dominant plant species: uses and economic importance**

Based on the availability, 10 dominant plant species were recorded that were frequently used by the local villagers for domestic and economic uses. Dominance was calculated with the help of household survey and group discussion. A total of 19 species were listed that they consider of having an economic gain. Out of the total, 10 dominant species were prioritized using a ranking scale of 1–10 on the basis of total marks for each species divided by the number of respondents.

### Table 2. Drivers for the change of ecosystem services, a trend (compared to last 20 years) and impact on livelihood.

| Ecosystem services                  | Trend (Increasing/Decreasing) | Reasons for change (drivers)                                                                 | Impact on livelihood                                                                 |
|-------------------------------------|-------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Firewood                           | Decreasing                    | Illegal felling of trees; easily accessible forest areas                                      | Negative impact as limited firewood can be gathered throughout the year (15 days in a year is allowed for firewood collection) |
| Medicinal and aromatic plants       | Decreasing                    | Ovenuse; burning of the forest ground; rubber plantation                                      | Negative impact as several valuable medical herbs had extinct from the forest          |
| Drinking water                      | Decreasing                    | Feeling of trees in hilly areas, rubber plantation                                            | Availability of drinking water is not uniform.                                        |
| Irrigation water                    | No change                     | Use of chemical fertilizers in the agricultural field; increase in population; advanced fishing nets | Negative impact as several local varieties of fishes Hebagalil, Serkani, Nisila mas (local name) had extinct |
| Fish                                | Decreasing                    | Rubber plantation                                                                            | Negative impact as grazing lands shifted to the rubber plantation                    |
| Fodder, leaf litter                 | Decreasing                    | Irregularity and imbalance in rainwater; climate change                                      | Negative impact as people had to depend on market products instead of consuming home-grown products |
| Edible plants (fruits, vegetables)  | Decreasing                    | Overuse                                                                                      | Negative impact as people are restricted for selling in the market                    |
| Other construction materials        | Decreasing                    | Destruction of forest areas for monoculture plantation                                       | Negative impact as the Man–elephant conflict is a burning problem                     |
| Habitat                             | Decreasing                    | Change in religion; death of the elderly people                                              | Negative impact as emotions between Nature and human beings is loosening              |

...
Shorea robusta was identified as the most dominant species for economic gain. One cartload of firewood was sold at a rate of INR 300–500 while one bundle (boja-local unit) sold at a rate of INR 40–60. Other available economically important species also help the poor section of the people to earn their livelihood to some extent and meet their own basic needs (Table 4). The medicinally important plants like Terminalia belerica, T. chebula, and Phyllanthus emblica also provided economic benefit to the people. Edible plants viz., Gon kosu, Ul kosu, Artocarpus heterophyllus were among the other important plants of the GP forest.

### Discussion

The present study discussed briefly the concept of ecosystem services and by application of the MEA (2005) classifications, an evidence-based list of ecosystem services for the tropical deciduous forest of GP has been identified and prioritized. Accordingly, 12 services (50%) belonged to the provisioning category, followed by regulating (25%), supporting (16%), and cultural/aesthetic (8%). It is well-established fact that forest ecosystems play a vital role in supporting the livelihoods and alleviating the poverty of rural communities in many tropical countries (Hicks et al., 2014). A similar result is witnessed in the current study as several forest products are used by the local community for economic gain and to meet their basic needs. The reliance of the community on NTFPs such as firewood, food, fodder, and traditional medicines signifies that the tribal communities of GP forest area are dependent extensively on forest wealth. These commodities are a dynamic source of income, nutrition, and healthcare as witnessed by Solomon (2016) from Ethiopia. The role of forests in the conservation of the regional medicinal plants has been emphasized in several studies from different parts of the country (Airi, Rawal, Dhar, & Purohit, 2000; Dhar, 2002; Sumit & Dhar, 2002). It was confirmed by community people that they were conscious about conservation and sustainable management of forest resources. The local people undertook strategies like limiting the firewood collection only for 15 days in a year from GP forest, which is a positive sign of sustainable management. The approach undertaken to explore and document the traditional knowledge of the people from the GP forest area will provide data and lessons for conservation and could be preserved for upcoming generations and will assist in human welfare. The older section of the people has a remarkable knowledge of plants and their uses in healthcare. The respondents of the present study hold beliefs and traditions that the forest harbours evil spirit which matches with the study of Adekunle and Kolade (2013) in Ogun state. Moreover, the community people have a firm belief that the forest is a home to spirits that have been protecting the forest since time immemorial that complements with the work of Ramakrishnan (1998) and Kandari, Bisht, Bhardwaj, and Thakur (2014) in the sacred grove forests. The implications of drivers of ecosystem changes on human well-being are not only affected by environmental variables but also social political and economic advancement of the people and the similar statement was observed in the research findings of Dawson and Martin (2015). All the identified drivers (except irrigational water - Appendix 1) were found having a negative impact on the livelihood of the community as witnessed a decreasing trend. Irrigational water supply in the agricultural field is noted of having no change for over a period of 20–30 years rendering a positive impact on the livelihood of the people. Uneven topography of the site along with forest cover with the presence of a few small perennial streams across the hill might be the possible reason of perennial irrigation water supply. Local villagers applied traditional techniques to harvest the rainwater and built artificial channels from the streams connecting to the river so that water run-off takes directly to their agricultural fields. Flora fauna and aquatic species were reported disappearing from the site mainly could be due to poaching, loss of habitat, climate change, and other anthropogenic factors. Community people had devised a strict punishment and imposition of a heavy fine in violation of forest management rules. A related conclusion was drawn in the study of Kandari et al. (2014) where they mentioned the

| Lifeform | Species                  | Local name | Possible causes                                                                 |
|----------|--------------------------|------------|---------------------------------------------------------------------------------|
| Birds    | Aegypius monachus        | Sogun      | Poaching; loss of habitat due to human                                           |
|          | Buceros bicornis         | Dhana       | Interference in the forest area; climate change; installation of mobile towers   |
|          | Leptoptilos javanicus    | Har-gilla   |                                                                                  |
|          | Mixus migrans           | Chila       |                                                                                  |
|          | Paco cristatus           | Mayur      |                                                                                  |
|          | Placeus philippinus      | Tokora      |                                                                                  |
|          | Pteronymi sp.            | Flying      |                                                                                  |
|          | Teron phoenicopterus     | Haitha      |                                                                                  |
| Animals  | Bos frontalis            | Methon      |                                                                                  |
|          | Semnopithecus sp.        | Goli       |                                                                                  |
|          | Hanuman bandar           | Leongera/   |                                                                                  |
| Fishes   | Dendrobanchiata sp.      | Nisal mas   | Depths of river decreasing; chemical poisoning; use of advanced fishing net;    |
|          | -                       | Herbali     | increase in population                                                          |
| Flora    | Canarium strictum        | Dhup        | Lack of suitable habitat; nutrient unavailability; climate change, cutting       |
|          | Dipterocarpus macrocarpus| Chak/       |                                                                                  |
|          | Saccharum spontaneum     | Nol         |                                                                                  |
|          |                          | Khagori     |                                                                                  |

**Table 3.** Disappearing flora and fauna from the site and the possible causes of their disappearance.
need for inflexible legislation and punishment against violation of management laws for the long life of healthy forest ecosystem.

**Conclusion**

GP forest can be regarded as a sacred landscape providing cultural space to the community as a common property resource. Community people believe that the forest is a home to spirits that have been protecting them since time immemorial. Psychological belief is associated with the existing forest as people attain moral support and guidance in performing their activities related to the forest. Economic gain from good rainfall, good agricultural production, and well-being of crops and animals are addressed as a boon to the community people from their sacred deity. But, in the recent time, factors like the transformation of ancestral religion to other religions and death of the older generation have resulted in degradation of the ancestral belief towards forest or nature. In the present study, it was perceived that firewood, under provisioning category, is the only service that attained 100% utility consensus. Drivers such as erosion, landslide, chemical poisoning, siltation, river cutting, and flood were hardly perceived by the people. A positive report was unveiled regarding the availability of water for irrigation as people addressed no change in irrigation water supply in their agricultural field over a decade. *Shorea robusta* was identified as the most dominant plant species besides other medicinally important and wild edible plants. Despite the community-level management strategy adopted by the local villages under the banner of Nabajyoti Bon Sangrakhan committee, a heavy threat is being faced by the wildlife forest as a whole. Hence, to protect the existing species, adequate steps, laws, and policy initiatives have to be adopted. The awareness programs cum capacity building should be conducted for the community people. Although the community people have rich ethnobotanical knowledge, it should be conserved, documented, and taken up for sustainable utilization and management for the socio-economic development of the rural people. Moreover, financial and technical assistance to be extended to the local communities under various Government-sponsored schemes, for better protection and conservation of biological diversity and ecosystem well-being. The findings of this research work will have a high potential for documentation of biodiversity, quantification, and valuation of various ecosystem services of forests in relation to size gradient, disturbance levels, and management regimes. Preliminary assessment of the ecosystem services would enable researchers to carry out an in-depth study of the specific prevalent ecosystem services of the area. The results of the assessment would also be helpful for the decision-makers to prioritize the services for conservation purpose.

**Geolocation**

Since the GP forest has no definite geographical boundary. The coordinate point (26° 0’ 56.59” N and 90° 57’ 47.17” E) within the core region of the forest is considered as the centre point of the study site and the area within 2 km radius is taken as the study area, covering a total area of 12.56 sq. km (1256 ha); however, geo-locations of the selected villages were presented in Table 1.

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### Table 4. Dominant plant species, their uses and economic importance.

| Species                   | Local name | Uses                                      | Economic value                                                                 |
|---------------------------|------------|-------------------------------------------|-------------------------------------------------------------------------------|
| Amorphophallus konjac    | Ul kosu    | Corm used as culinary                     | Sold at 20–100 per piece depending on size.                                   |
| Artocarpus heterophyllus | Kothal     | Used as fruit, vegetables                 | Sold at 20–50 per piece depending on size. Seed sold at 5–20 per bhag depending on quantity. |
| Colocasia esculenta      | Gon        | Corm seed as culinary                     | Sold at any convenient rate.                                                  |
| Gmelina arborea          | Goromari   | Good for making pillars in making house   | Sold at 1100–1300 per cubic metre.                                            |
| Lagerstremia speciosa    | Ajhar      | Good source of plywood                    | Sold at 800–1000 per cubic metre.                                             |
| Phyllanthus embelica     | Amlokhi    | Fruit used as medicines (in trifola)      | Sold in the local market in parts (bhag-local unit) at a rate of 5–10 (equivalent to 250 g) |
| Shorea robusta           | Sal        | Making houses, furniture, footbridges, etc.| One cartload of firewood (sold at a rate 300–500) One bundle/boja at 40–60    |
| Terminalia bellerica     | Bhomora    | Seeds used as medicines (in trifola)      | Sold in the local market in parts (bhag-local unit) at a rate of 40–80/kg     |
| Terminalia chebula       | Hilikha    | Fruit used as medicines (in trifola)      | Sold in the local market in parts (bhag-local unit) at a rate of 20–40/kg     |
| Zingiber sp.             | Ketari alu | Used as an aromatic plant in the perfumery | Sold at 100 per 40 kg (mon)                                                   |
Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix I. Relative scoring of the identified drivers expressed in percentage. (GN indicates the seven groups taking part in the assessment)

| Identified drivers                      | G1 | G2 | G3 | G4 | G5 | G6 | G7 | Total | %  |
|-----------------------------------------|----|----|----|----|----|----|----|-------|----|
| Deforestation                           | 17 | 17 | 17 | 15 | 17 | 17 | 17 | 117   | 98 |
| Illegal felling                          | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 112   | 94 |
| Over exploitation                        | 15 | 16 | 15 | 17 | 16 | 15 | 15 | 109   | 92 |
| Use of chemical fertilizers              | 14 | 14 | 12 | 13 | 14 | 11 | 14 | 92    | 77 |
| Climate change                           | 12 | 11 | 14 | 14 | 13 | 15 | 2  | 81    | 68 |
| Burning of forest ground                 | 11 | 8  | 7  | 10 | 11 | 12 | 10 | 69    | 58 |
| Shifting to monoculture rubber           | 10 | 9  | 6  | 8  | 8  | 10 | 13 | 64    | 54 |
| Use of advanced fishing equipment        | 8  | 13 | 11 | 11 | 10 | 9  | 8  | 70    | 59 |
| Imbalance in water regulation            | 9  | 6  | 5  | 9  | 9  | 7  | 7  | 52    | 44 |
| Sewage and other pollution               | 6  | 4  | 4  | 12 | 6  | 8  | 6  | 46    | 39 |
| Invasive and alien species               | 5  | 2  | 3  | 6  | 7  | 6  | 5  | 34    | 29 |
| Change in religion                       | 7  | 1  | 10 | 5  | 5  | 5  | 7  | 40    | 34 |
| Chemical poisoning                       | 4  | 12 | 8  | 7  | 12 | 2  | 1  | 46    | 39 |
| Erosion and landslide                    | 2  | 10 | 3  | 3  | 13 | 11 | 43 | 36    | 34 |
| Flood                                   | 13 | 7  | 2  | 4  | 1  | 4  | 9  | 40    | 34 |
| River cutting                            | 3  | 5  | 9  | 2  | 4  | 3  | 4  | 30    | 25 |
| Siltation                                | 1  | 3  | 13 | 1  | 2  | 1  | 3  | 24    | 20 |
Appendix II. Grading of the 10 dominant drivers by 35 respondents to derive the order of priority with a grading scale as very high (−2), high (−1), neutral (0), low (+1), and very low (+2)

| Drivers                          | R1  | R2  | R3  | R4  | R5  | R6  | R7  | R8  | R9  | R10 | R11 | R12 | R13 | R14 | R15 | R16 | R17 | R18 | R19 | R20 |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Over exploitation                | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution       | 0   | 0   | 0   | 0   | 1   | 2   | 0   | −2  | −1  | 0   | 0   | −2  | −2  | −1  | 1   | 1   | 1   | 1   | 1   | 1 |
| Shifting to monoculture rubber   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1 |
| Use of advanced fishing equipment| −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Imbalance in water regulation    | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 2   | 1   | 1 |
| Use of chemical fertilizers      | 1   | 1   | −2  | −2  | −2  | 1   | 1   | −2  | −2  | 1   | 1   | −2  | −2  | 1   | 1   | 1   | 1   | 1   | 0   | 0   |
| Burning of forest ground         | 0   | −2  | −1  | −1  | 1   | 1   | 1   | −2  | −2  | 1   | 1   | −2  | −2  | 1   | 1   | 1   | 0   | 0   | −2  | −1  |
| Climate change                   | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Shifting to monoculture rubber   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1 |
| Use of chemical fertilizers      | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Climate change                   | −2  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Use of chemical fertilizers      | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution       | 2   | 2   | 1   | 0   | 2   | −2  | −2  | −1  | 1   | 0   | 1   | −1  | 0   | −1  | 1   | 1   | 0   | 0   | 0   | 0 |
| Use of chemical fertilizers      | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution       | 2   | 2   | 1   | 0   | 2   | −2  | −2  | −1  | 1   | 0   | 1   | −1  | 0   | −1  | 1   | 1   | 0   | 0   | 0   | 0 |

Drivers          | R21 | R22 | R23 | R24 | R25 | R26 | R27 | R28 | R29 | R30 | R31 | R32 | R33 | R34 | R35 | Total score |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|
| Over exploitation | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Shifting to monoculture rubber | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| Use of chemical fertilizers    | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Climate change                | −2  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Use of chemical fertilizers    | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution     | 2   | 2   | 1   | 0   | 2   | −2  | −2  | −1  | 1   | 0   | 1   | −1  | 0   | −1  | 1   | 1   |
| Use of chemical fertilizers    | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution     | 2   | 2   | 1   | 0   | 2   | −2  | −2  | −1  | 1   | 0   | 1   | −1  | 0   | −1  | 1   | 1   |
| Use of chemical fertilizers    | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  | −1  |
| Sewage and other pollution     | 2   | 2   | 1   | 0   | 2   | −2  | −2  | −1  | 1   | 0   | 1   | −1  | 0   | −1  | 1   | 1   |