Monitoring and Evaluation of Phaktshoding Heritage Forest, Chukha Bhutan

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Contents

1. Background on Heritage Forest

Bhutan has more than 50 percent of the total area conserved under the network of protected areas (PAs). However, significant areas outside those management regimes have been reported to be under increasing threats from various anthropogenic activities. Often small patches of forest ecosystems lying within or nearby a settlement were reported to harbour significant ecological and cultural values, but are threatened by intentional or unintentional human activities.

Thus, a concept of Heritage Forest (HF) was initiated during the 11th Five Year Plan (FYP) to bring those critical areas under sustainable management regime through community engagement. As a pilot project in 2016, erstwhile Nature Recreation and Ecotourism Division (NRED) started working on the establishment of six HF in six Dzongkhags with the funding from the Bhutan REDD+ Readiness project and the World Bank. Watershed Management Division (WMD) facilitated the fund and necessary technical support where possible. Based on experiences from six pilot HF sites, an additional 14 sites were established in the rest of 14 Dzongkhags by the end 11th FYP.

A management plan for the HF was developed to:

- Protect the natural forests and rehabilitate degraded forest ecosystems around monasteries, religious and spiritual sites, important national monuments, lakes and critical watersheds;
- Serve as one of the models for conservation and management of natural resources undertaken by the community;
- Ensure the continuous supply of critical ecological services like watershed protection, carbon sequestration, regulate local climate, and improve water quality and conservation of biodiversity; and
- To present the implementation of management plans of HF as one of the potential strategic options under REDD+ strategy and action plan for conservation and sustainable management of natural resources

2. Purpose of Monitoring and Evaluation

The current evaluation was to review the status of Phaktshoding Heritage Forest (PHF) using standard evaluation criteria like relevance, effectiveness, efficiency, impact and sustainability. The report will be used for guiding future proposals and plans for the establishment of HF and also serve as a reference document for assessing the impacts of HF in the long run.
This evaluation assessed how effectively the management plan had been implemented by the Gedu Forest Division (GFD) as an implementing agency. It is foreseen to identify strengths and challenges of achieving the objectives set for the HF. The strengths and weakness of management and governance of HF by the GFD is expected to understand better.
The roles of different stakeholders; as visioned that the communities will have a stake in the management and utilizing the ecosystem services of HF will be understood after having established as the HF. The other components such as the contribution of ecosystem services generated from PHF to its stakeholders will be understood.

3. Evaluation Method

The management plan was used as the guiding document to evaluate the PHF. The recommended management strategies and actions for the thematic areas which were developed in consensus with the stakeholders were considered for evaluation. The evaluation primarily assessed thematic strategies and actions against the following criteria.

a. Relevance
b. Effectiveness
c. Efficiency
d. Impacts
e. Sustainability

Figure 1: Preliminary evaluation team at the Phaktshoding lake

For the evaluation of PHF, different stakeholders were identified before the actual evaluation.
Three semi-structured questionnaires were developed and then used for interviewing the different groups of stakeholders (Annexure-II). The questionnaires were structured in line with the set objectives of HF and then devised in a way to be able to understand if the objectives set in the management plan were achieved or not. A preliminary evaluation team visited the PHF before the actual evaluation (Figure 1).

During the evaluation, the stakeholders such as implementers of HF, HF beneficiaries (communities and local residents) and representatives from the local government were interviewed. The samples of communities representing all the three villages of Rebana, Trashignag and Alaykha was selected. The sample size of different category of respondents was, ten for communities, six forestry officials and twelve visitors. A semi-structured interview and open-ended questions were asked to those critical stakeholders for understanding direct/in-direct or intentional/unintentional HF impacts. The questions were drafted to evaluate the HF site against standard evaluation criteria such as relevance, effectiveness, efficiency, impact and sustainability.

The identification of the participants was made by snowball sampling; where the first interviewee identified the most knowledgeable next participant. The first sample was the local government leader, who is the elected leader of the geog. This method had to be used because it was difficult to gather all the communities at one time in one place as it was the peak cardamom weeding season. Another reason for the adoption of this method is also due to the distance of three villages from each other. The interviewer went to the houses of the interviewees only after confirming their availability in advance through the telephonic conversation. The interviews were recorded on the hard copies for the communities by the interviewer. Separate voice recordings were made with the consent of the interviewees. The voice recordings were referred to as a supplementary source to validate the written responses during the documentation of the responses on the excel sheet. For the literate interviewees such as visitors and forestry staffs, the questions were explained to them and asked to write their answers. Then the hard copies were written on the MS Excel sheet. The thematic analysis was done for the responses. The evaluation team also conducted physical verification of the infrastructures developed, plantation sites and other areas, whenever necessary.

4. Monitoring and Evaluation of Phaktshoding Heritage Forest

4.1 Background on Phaktshoding Heritage Forest

Phaktshoding HF (Figure 2) has an area 41.46 hectares (equivalent to 102.45 acres) falls under Gedu chiwog, Bongo gewog under Chukha Dzongkhag. The HF was identified and its management plan prepared and handed over to GFD in 2016. Gedu is about 135 km from the Chukha Dzongkhag Administration and 120 km south from the capital city Thimphu. The altitude of the HF ranges from 1740 to 2200 masl. The Phaktshoding Tsho within the HF serves as a drinking water and irrigation for three villages namely Tashigang, Ribana and Alaykha under Bongo gewog. Tashicholing Community Forest is designated to the east of PHF. The type of forest is cool-broad-leaved forests. In the past, Bhutan Board Products Limited (BBPL) extracted its raw material from these forests according to the communities. The BBPL's plantation areas from which the trees were removed and now planted by them are located to its south.

Based on field survey and the issues identified by stakeholders at the Dzongkhag and Gewog levels, management strategies and actions set to achieve the following specific objectives:

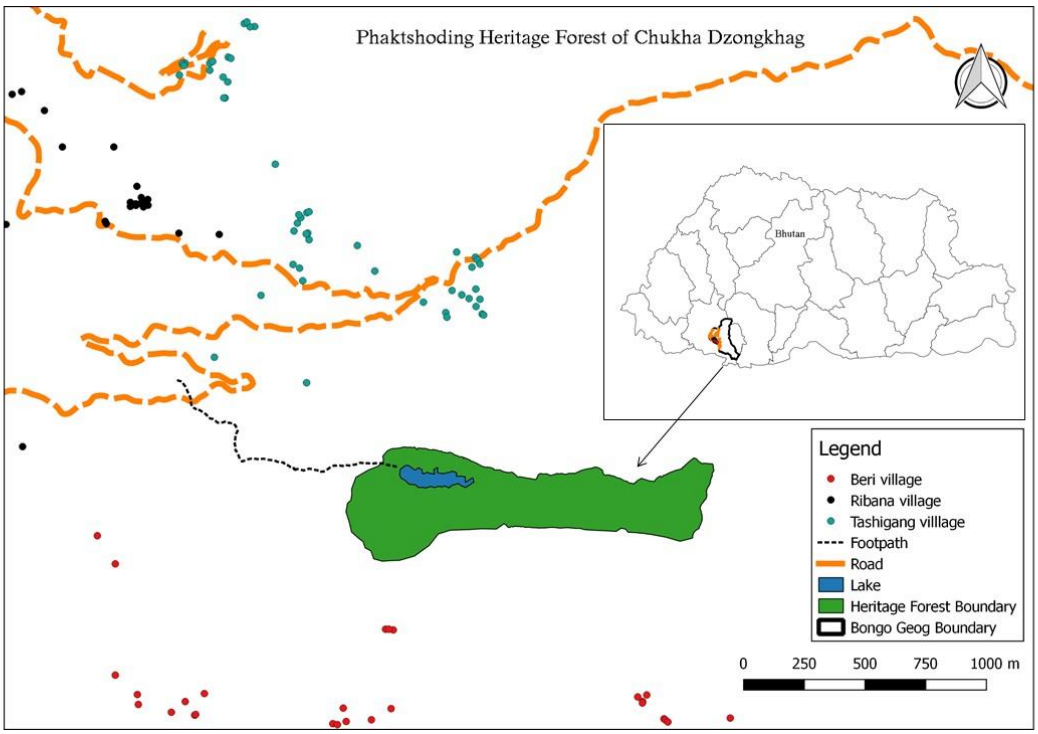

Figure 2: The location of Phaktshoding Heritage Forest

a) Identify and formalize institutional responsibility
b) Protect and improve the forest ecosystem
c) Conservation of Biodiversity
d) Protect and improve water components
e) Facilitate public participation and education
f) Identify future management strategies

4.1.1 Forest ecosystem improvement and management

One of the primary objectives of PHF is to protect and improve the forest ecosystem. To achieve this objectives, multiple actions were identified in the management plan such as to conduct plantation to improve the vegetation, to strengthen watershed services and also to stabilise the erosion-vulnerable lands by adopting sustainable land management practices.

According to geog focal forestry officer, a plantation activity around the lake was carried twice in the years of 2015 and 2016 of walnut and champ species. It was carried out even before the establishment of the HF. It was done to improve the vegetation around the lake by the members of the community forests. The seedlings did not survive, and its remains were not seen during the evaluation period. According to the forest officials, they report that it was browsed and damaged by the cattle, while the communities say that the number of cattle browsing in the area has drastically decreased as compared to the past. Apart from this plantation activity, any form of exercise to improve the ecosystem and watershed was not conducted. The reason for not having had these activities was due to lack of resources according to the forestry officials.

On the context of evaluating the presence of illegal activities inside the PHF, evidence of illegal timber harvesting was observed (Table 1). At least ten types of trees were seen harvested and its

average diameter, when measured on the stumps, conveys that all the trees were illegally harvested and converted into the sawn timber. Also due to the location of the illegal site not near to the farm road, the timber would have been sawn and then transported out of the forests. From the diameter of the illegally cut trees, it is evident that illegal loggers have cut the more giant trees for the purpose of convert into *drashing* (sawn timber). The forest officials are not aware of these incidents inside the PHF.

Table 1: Illegally cut trees inside the Phaktshoding Heritage Forests

			Northing			Easting			
Sl no	Species	Diameter(cm)	Degree	Minute	Sec	Degree	Minute	Sec	Altitude (m)
1	*Michelia cathcartii*	82	26	54	40.3	89	34	4.1	2079
2	*Cinnamomum bejolghota*	70.5	26	54	47.1	89	34	19.4	2044
3	*Cinnamomum bejolghota*	90	26	54	37.9	89	34	12.8	2083
4	*Persea frutifera*	83	26	54	38.3	89	34	15.1	2118
5	*Michelia cathcartii*	96.5	26	54	38.7	89	34	17	2148
6	*Michelia cathcartii*	82	26	54	38.8	89	34	17.2	2147
7	*Exbucklandia populenea*	127	26	54	39.1	89	34	20	2171
8	*Castonopsis tribuloides*	130	26	54	41.3	89	34	17	2166
9	*Michelia cathcartii*	72.4	26	54	39.4	89	34	4.3	2096
10	*Cinnamomum bejolghota*	74	26	54	41	89	34	3.6	2090
11	Average	90.74							

4.1.2 Water-lake management

The central cultural value associated with PHF is the lake Phaktshoding inside the HF (Figure 3). The presence of this lake primarily led to the identification of this HF in Gedu. Socially, the Phaksthoding lake is very special to all the communities interviewed. Drying up of the lake was identified as one of the issues of PHF and all communities shared the willingness to cooperate to protect and stop the water from drying in the lake. They are culturally united and attached to the lake since the long past. They all believe that this lake is the wealth to the community and if not protected, they will face consequences of not having a good household fortune and bountiful crop harvest. They also believe that there will be an outset of disease outbreak in their community if the lake is not cared and protected. Due to this revered space in the hearts of the villagers, the lake is the central of the PHF.

Figure 3: The Phaktshoding Lake inside the heritage forest with evidence of anthropogenic intervention

This valuable weight of lake to the communities has a positive influence to enhance sustainable and effective management of the PHF. Other activities such as protecting the vegetation around the lake, lake rehabilitation activities, ecotourism products development and its diversification around the lake is seen achievable. All the communities showed the highest level of willingness to support if such programs are initiated. Communities conveyed that they are anticipating for someone to lead. GFD and its relevant stakeholders should take the opportunity of this conducive setting to start beneficial activities immediately.

The water from the lake is a source of irrigation water for communities of Tashigang (60 HHs) and Rebana Chiwog (30 HHs) according to the interviewed participants. The communities of Tashigang and Alakha do not use the water from the lake for drinking but the communities of Rebana uses the seepage water as a drinking water source. In the past the water from the lake was sufficient for drinking and irrigation. In recent history since the water was insufficient for these purposes, communities built a wall out of the local materials to stop the water seepage. With this intervention, the water quantity in the lake was prevented from draining. But they are still not happy with the level of water loss from the seepage. All the communities feel that the water level in the lake should be increased by building more concrete walls or by water regulating sluice gate. For this building of the walls, they are anticipating that the relevant government agencies (potentially the Gedu Forest Division) will help them with the resources. A promising sustainable watershed improvement program should be initiated as it is the source of irrigation and drinking water. All the communities

interviewed expressed their concern about the decreasing water level in the lake. 60% of them expressed that fencing the lake would help lower the disturbance to the lake and to improve water quantity retention in the lake.

The catfish (*Parachiloglanis hodgarti* and *Pseudecheneis sulcata*) which according to the beliefs of the communities was introduced by the Late Lam of Gedu Laptshakha Lhakhang has been a problem. All the communities, visitors and forest officials interviewed accepts that this fish has caused the problem or imbalance to the lake ecosystem. All of them expressed that this fish population which has dirtied the lake water should be removed but do not understands whom or which agency to approach to seek the help to do it.

Some interviewees informed that Indian labourers fish out the fishes sometimes, but local communities do not fish due to their Buddhist philosophy of not killing the animals. Also when asked if they are willing to fish out, they indicated they would not be able to fish, and on the other hand, people are scared of inviting natural disasters such as heavy storms and ill-luck to the communities, if they catch the fish from the lake. A separate study on the aquatic biodiversity and water quality of lake were conducted for the evaluation (Annexure-I).

4.1.3 Waste management

Waste has been identified as an emerging issue to be managed vigorously in the management plan. It was observed by the stakeholders during the preparation of the management plan that the increasing visitors from the Gedu residents to the lake have increased the waste generation. Meticulous actions were identified to be implemented inside the PHF. During the evaluation, almost all of these identified actions were not implemented. An important activity was to have an implementable waste management plan and currently, this has not been developed, and forestry officials did not share plans to have one soon.

On the ground, there is a waste pit on the trail downhill. This trail most probably is used less frequently as compared to the other one due to its steep slope. The visitors most likely use the trials with less slope, for the entry into the HF and might exit towards the lower hill. With this situation, the waste pit is not used frequently by visitors and having waste disposal at both the trails may help visitors not to dump the waste on the walking trails.

As per the communities, the waste in the PHF is generated by the students of Gedu College of Business studies who visit frequently. Communities say that the students dump waste or food wraps and also leave the sanitary pads; which according to their beliefs invites stormy weather suddenly even when it is not a rainy season. The group of visitors from the Gedu residents and students of the college when interviewed communicated that they bring back the waste. Only a few of the interviewees burnt their trash in the pit constructed on the footpath.

4.1.4 Human-wildlife Conflict Management

Human-wildlife conflict (HWC), has been identified by the stakeholders as one of the issues of PHF. During the evaluation period, the communities expressed that the incidence of HWC is very minimal or absent. The wild dogs which were harming the animals in the past are not seen frequently. Since it

is not a significant problem with the communities, they did acknowledge the need to attend HWC urgently. So, this situation did not appeal them to institute interventions to tackle HWC as identified in the management plan. One of community reported that monkeys do eat the young shoots of the cardamom. There are not community-based insurance schemes initiated, and this is probably due to low severity of HWC incidences or its impact on the livelihood.

4.1.5 Livelihood Improvement Program through Income Generation

The management plan has identified promising and implementable actions to help communities generate alternative income through community-based ecotourism. Still today, communities expressed their interest and eagerness to turn PHF into an ecotourist hub. But no existing tourism activities are happening within HF and as well in the periphery of the HF. The communities and forest officials expressed the high potential to attract the tourists to the lake but facilities such as good walking trails (Figure 4) during the monsoon season are the prerequisite facility. Communities expressed their willingness to support ecotourism but initially the support from the relevant agencies is required to develop the product, to market the product and build their capacities. Communities would like to get their youth trained to be nature guides. According to GFD officials, all the actions of PHF could not be implemented due to lack of funds.

Figure 4: Walking trail inside the PHF leading to the lake.

While most of the communities expressed the potential of ecotourism program to help them sell the PHF to the tourists, one of the farmers was against the bringing of tourists. According to this farmer,

the trails have actually desanctified the lake by helping more visitors to the lake and has invited more problem such as the increase of waste generation and disturbance of the lake (Figure 3). The interference of the lake has invited the ad-hoc and sudden stormy rains during crop harvest time. This mixed feelings amongst the local communities demand the GFD as the manager of the PHF to discuss and table out the best actions that will meet the objectives of the PHF and as well as educate and discuss with communities with these perception differences. In managing the common resources such as this HF, the consensus of whole communities is the primary need in order to manage the resources effectively.

As envisioned in the management plan to collect visitor fees for managing the waste, to create recreational facilities and to maintain the environment, this means if implemented will be a sustainable means, in the long run, to manage the PHF as a tourist site.

4.1.6 Environmental Education and Awareness Program

Education and advocacy programs were envisioned for the stakeholders such as schools, monasteries and communities. After the institution of the PHF, any specific educational programs were not conducted to any of the stakeholders. It was due to lake of such programs that during the time of the interview, few (20%) of the communities interviewees were aware of the PHF and its separate management plan while rest were not sure if HF was different from their community forest. Interviewees who were not sure of the independent management plan of the PHF was also because they did not attend consultation meetings on PHF in the past. This indicates the lack of sufficient advocacy and education programs on the HF. Periodic advocacy programs on the HF, its regulations will be useful and effective in the management of HF in the long future. This measure is also a potential means to decrease illegal activities inside the HF.

4.1.7 Sustainable Resource Use and Management

Non-Wood Forest Products (NWFP) resources inside the PHF are an extensive and promising source of livelihood. Of the communities interviewed, 30% of them goes to collect NWFP mostly fiddlehead and mushroom. One of the respondents reported that she gets about Nu. 3000-4000 a season which usually lasts for three to four months and she is happy to be able to collect the NWFP from the HF. The rest of the interviewees do not collect the NWFPs because they don't have a sufficient workforce to collect.

Since the PHF is not far from the Gedu town, communities report that residents of Gedu come to collect the NWFPs and they are not happy for this encroachment. The regular collectors of NWFP are cardamom carers[1] according to the communities. According to them, some of the cardamom carers at least collect 5-10 kg of mushroom daily for four months (3 to 8th Month) and fetches about Nu 200/kg. Cardamom carers at least make an income of about Nu. 10000 during the season of *Sisi shamo* (mushroom grown on oak trees). As on the fiddleheads, during its season an individual can at least collect about 50-60 bundles at one collection time and in the Gedu town, it is sold at Nu 20-25 per bundle.

[1] Cardamon carers are not the native people of the geog but hired mostly from southern Bhutan to take care of the cardamom field by the owner of cardamom fields.

With the rampant collection of NWFP inside the PHF, there is also evidence of increasing anthropogenic disturbances like cutting of shrubs on the trails, waste-generation, trampling of young plants and hardening of soils. These shreds of evidence are substantial enough and signal the need to institute a sustainable collection of NWFPs inside PHF. The contribution of NWFP to the communities' livelihood and other residents needs to be clearly understood with more in-depth research and analysis.

4.1.8 Information and Data Management

Data generation and storage at GFD and relevant offices have been identified as necessary in the management plan to prepare annual reports and to generate management activities for PHF based on evidence. Currently, there is no data storage and management at GFD specifically on the PHF. There was also no generation of annual reports and its dissemination to the key stakeholders.

There is a trained data manager at GFD, and all the periodic data generated from the PHF should be stored and analysed to generate reports as per the need of the management plan. All kinds of information on biodiversity, NWFP, HWC and any other variables can be collected, stored and interpreted to help implement the management plan activities.

4.1.9 Forest Protection Strategies

Forest protection actions are well spelt in the management plan to curb illegal activities and to encourage participatory patrolling by the community. None of these actions could be implemented. GFD overall do not perform SMART patrolling activities due to lack of budget.

The forest officials submit that the patrolling activities inside the PHF happen most of the time as an ad-hoc activity. It is not a planned program. It also happens when the cases of illegal activities are being reported to them by the informants. The team, when visiting the HF to establish long term monitoring plots encountered sites where trees were illegally cut without the print of the marking hammer (Table 1 and Figure 5). When enquired to the forest officials on this, they were not informed or aware of such incidences inside the PHF. This indicates that if the cases are not reported to the forest officials by the informants, the forest officials do not come to know about it. But according to all the communities, they do not comit the illegal timber harvesting as they are bound by the rules of the community forest. A defaulter will not volunteer to confess on his illegal activities, and this demands periodic patrolling exercise. It could also be traced or observed if the residents of the different village or the local resource users such as petty contractors building infrastructure in the locality might have extractred illegally.

Figure 5. An illegally felled tree in the Phaktshoding Heritage Forest

On the issues of the illegal harvesting of the trees and to regulate the waste management in the PHF, 50% of the communities submit the plea to the GFD to help them employ a caretaker or a *Resoop* to their HF. They think that someone delegated with at the site will help regulate waste and also sustainable harvesting of NWFPs. On the payment, few of them voiced that the income generated from the visitor fees can be utilized to pay the caretaker. One of the communities strongly expressed that the visitors should not be allowed during the crop harvest time as it brings stormy rains destroying the crops. To him the stormy rains are brought when the visitors have disturbed or dirtied the lake. He also voiced out that the visitors should be banned from visiting the lake during this time or else regulated by the caretaker of the PHF or by designating a no-go-time (like *Ladham or Ridham*) as practised in some sacred sites in Bhutan.

Figure 6: Preliminary evaluation team validating the information on the signboard.

Currently, there are three signboards installed at the entry or exit points of the walking trails and one near the Phaktshoding (Figure 6). The signboard near the lake mentions the information on the lake (Figure 7). It also informs the visitors on the actions they can and cannot conduct inside the PHF. Some of the visitors interviewed suggested that some more signage on the walking trails into the HF would be more useful to direct the visitors to the lake. Pictoral information on wildlife and plant diversity could be installed on the walking trails, and this will be effective to educate the visitors on the biodiversity and conservation values of PHF.

Figure 7: Signage near the Phaktshoding lake

4.1.10 Research and Monitoring

HFs are visioned to conserve and manage biological diversity values and cultural values outside the protected area system of the country. Envisioned to protect these values against increasing anthropogenic pressures, there is a need to study and understand the natural dynamism for long to prescribe management actions. For this, it is necessary to implement a standard research protocol to generate information from the forest ecosystem. This is also identified as an essential activity to be conducted in the management plan. For this, a long-term monitoring plot called permanent sample plot (PSP) was established to fulfil this requirement.

PSP is long term observation plots where individual trees are permanently marked and re-measured after 5 years. PSPs are used as an ecological tool and reference centre for the natural process and one of the major components in the field of forestry research. It is a spatiotemporal document which is monitored over space and time. The following describes how the PSP was established in the PHF.

Layout and design of PSPs[2]

A square plot of 50x50m is laid out and divided into 25 subplots of 10x10m (Figure 8). The right angles are formed by surveying and orient the plot along with the cardinal bearings at 0° (N),90°

[2] Annexure with regard to the data recording formats for PSP are different from the main report annesures. PSP annexure refers to the annexure number written on the PSP data forms of report's annexure III.

(S),180° (E) and 270° (W) respectively. At 10m interval along the access line, quadrat boundaries are marked by durable wooden pegs coloured with yellow paints.

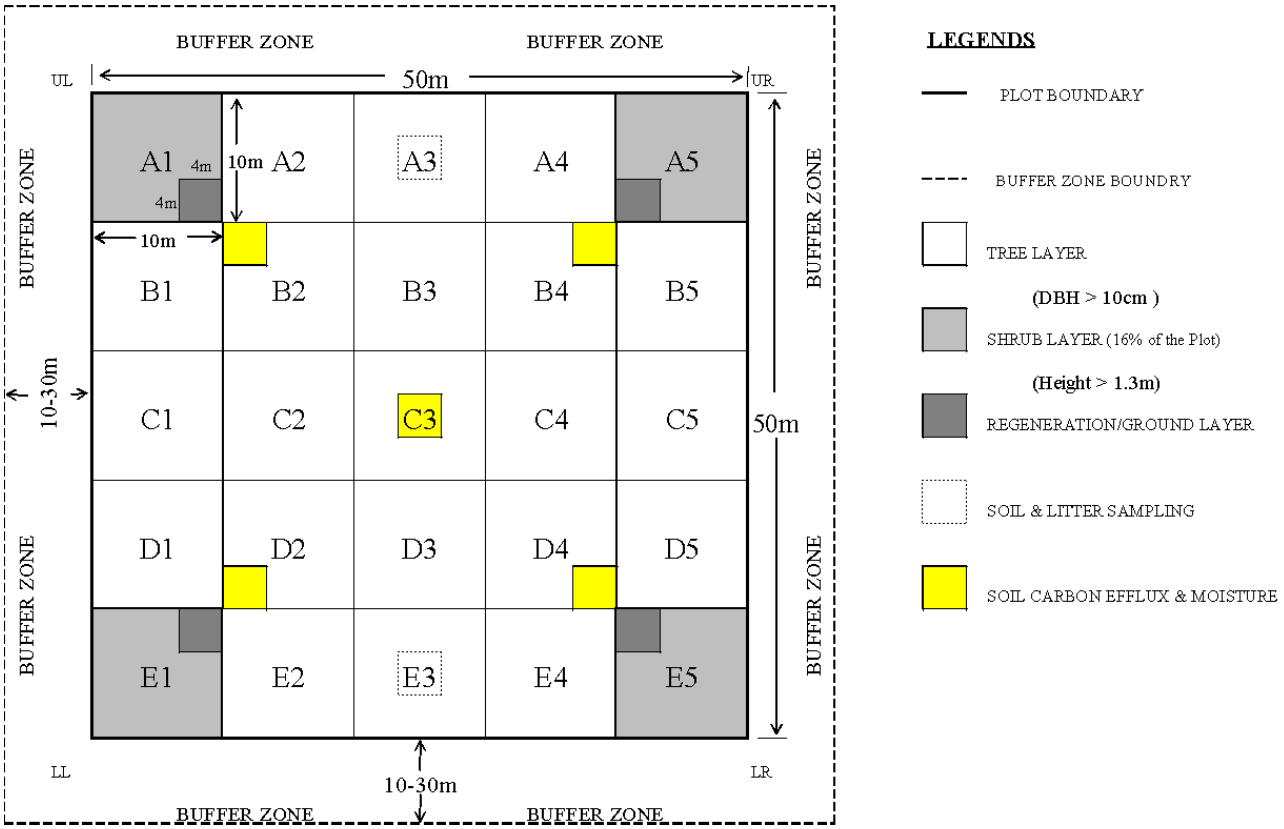

Figure 8: Layout and design of PSPs

Numbering of the Plot marker

The plot corners and quadrat boundary intersections are numbers from North-West corner (upper Left) as A1, A2, A3 etc. up to E5 at the South-East corner (lower right). The inner corners are number correspondingly (Figure 8).

Permanent demarcation of the plot corner

The corners of the plot are marked with wooden poles painted with distinct colour and marked by the upper left (UL), upper right (UR), lower left (LL) and lower right (LR). The corners are permanently marked so that they can be precisely relocated after 2-5 years. The geographic coordinates are also provided for each corner to easily relocate in case if corner posts are lost (Figure 8).

Marking the point of measurement (POM)

The POM is established at 1.3m (breast height) by a continuous painted red band to record its diameter. It is creating a reference point for diameter measurement where same point will be used at subsequent re-measurement time.

Tree numbering

All the trees having more than 10cm (dbh) are numbered except in the 4 corners of the subplots (A1, A5, E1 & E5). The trees are sequentially numbered on the plot so that each tree has a unique number.

The tree numbers are printed using locally available tin sheet material with the help of digital hammers. The pre-numbers are nailed on the trees above the point of measurement (1.3m) which will be replaced after 2-5 years.
In subplots (A1, A5, E1 & E5), all trees having height more than 1.3m (breast height) are numbered which will be accounted for shrubs layers (Figure 8).

Mapping of tree location- measuring of tree coordinates
The location of the trees is helpful when some tree numbers have faded or been lost. Coordinates (X Y) are recorded relative to the NW corner of each quadrat. One tape is laid down from the western-most boundary of the quadrat beside the tree, and the distance (X) in meters read to the tree center and another tape is laid from the southern-most boundary and similarly read.

Recording and determination of species
All the numbered/tagged trees are recorded as per the format. A preliminary determination of trees species both living and dead was made at the time of initial demarcation and measurement. For recording, Annexure 1 (tree), Annexure 2 (regeneration) and Annexure 3 (ground flora) are used.

Nomenclature of plants is followed after Flora of Bhutan; Volume I, Part 1,2,3, Volume II, Part 1,2,3, and Volume III, Part 1,2 (Grierson, A.J.C & Long, D.G. 1983-2000), Pteridophytes of Bhutan-a list of families, genera and species (Wangdi, 2009), Flowers of the Himalaya (Polunin & Stainton, 1984), Flowers of the Himalaya; a Supplementary (Stainton, 1988). For unidentified specimens, they are stored in herbarium press for the confirmatory process.

Height measurement
The total height was measured from ground level at the center of the stem to the highest point of the crown with the help of Hypsometer.

Regeneration Plots
In every four corners at A1, A5, E1 & E5 (Figure 8), a quadrat of 4mx4m are laid out and marked by fixing wooden painted posts. All the seedlings with more than 1.3m height are measured and age is recorded for regeneration. For ground flora, the tallest plant of different species are measured and coverage in percentage is recorded.

Monitoring of PSPs
Re-measurement
A complete remeasurement will be carried out after 2-3 years depending on the urgency with which production forecast is required. The result will forecast disturbances level, recruitment, mortality and growth rate.
Leaf litterfall and it is nutrient cycling
Litterfall and leaf decomposition represent the main pathway for nutrient cycling in the forest ecosystem linking tree part to the soil and water. According to scientific study, the release of plant litter carbon (C) as CO_2 through heterotrophic decomposition by soil micro-organizations contribute 20% soil surface CO_2 efflux which is often referred to as soil respiration.

Figure 9: Leaf litter trap set inside the PSP

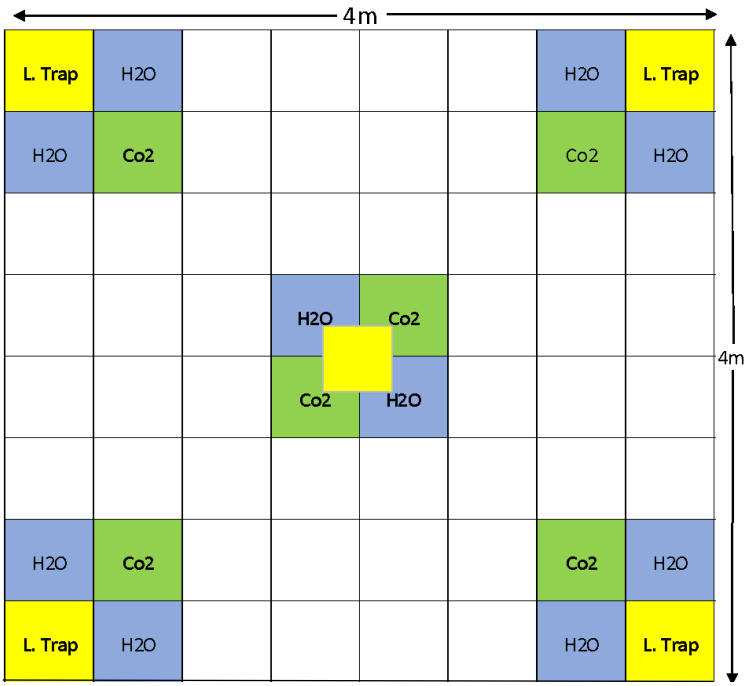

Figure 10: Location of leaf litter traps

5 numbers of 0.5m x 0.5m quadrat (Figure 10), made with locally available material framed with poles and corner connectors are set up in the plots (Figure 9). Leaf litters trapped inside the frame are collected monthly as per Annexure 4 and segregated into leaf, twigs, flower and seeds. The fresh weight samples are recorded and brought back to the laboratory for analysis. The result will forecast litter production and soil carbon stock.

Soil respiration or carbon efflux

Figure 11: Equipment to measure the soil respiration or carbon efflux

Soil respiration plays a critical role in regulating atmospheric CO_2 concentration and climate dynamics in the earth system. It is associated with decomposition and mineralization (nutrients processes). Thus, it becomes relevant to mitigate climate change and adaption.
The data will be collected monthly basis using EGM5 SRC-2 Soil Respiration Chamber (Figure 11). Soil temperature (Annexure 5) and moisture will be collected along with Carbon efflux as per Annexure 6, since soil temperature and moisture contents regulate the soil respiration.

The first set of data collected for the PSP inside PHF is interpreted in the following variables.
The diversity is high (index value is 3.88) and shows a healthy ecosystem of that forest, however, the rampant cutting of high-value timber shows some high degree of anthropological intervention. From the diameter at breast height (DBH) distribution, the forest is a young stand as the individuals are cluster towards smaller DBH (Figure 12).

The area is composed of 28 species belonging to 28 families of which *Symplocos ramosissima* has highest number 56, followed by 28 *S. lucida*, 14 *Daphniphyllum charcaceum* and 12 *Eurya ceresifolia*. The dominant species are *Castanopsis tribuloides, Alcimandra cathcartii, Quercus lamellose, Cinnamomum impressinervium, Persea odoratissima, Elaeocarpus lanceifolius, Acer campbellii, Eurya cerasifolia, Symplocos ramosissima* and *Nyssa javanica*.

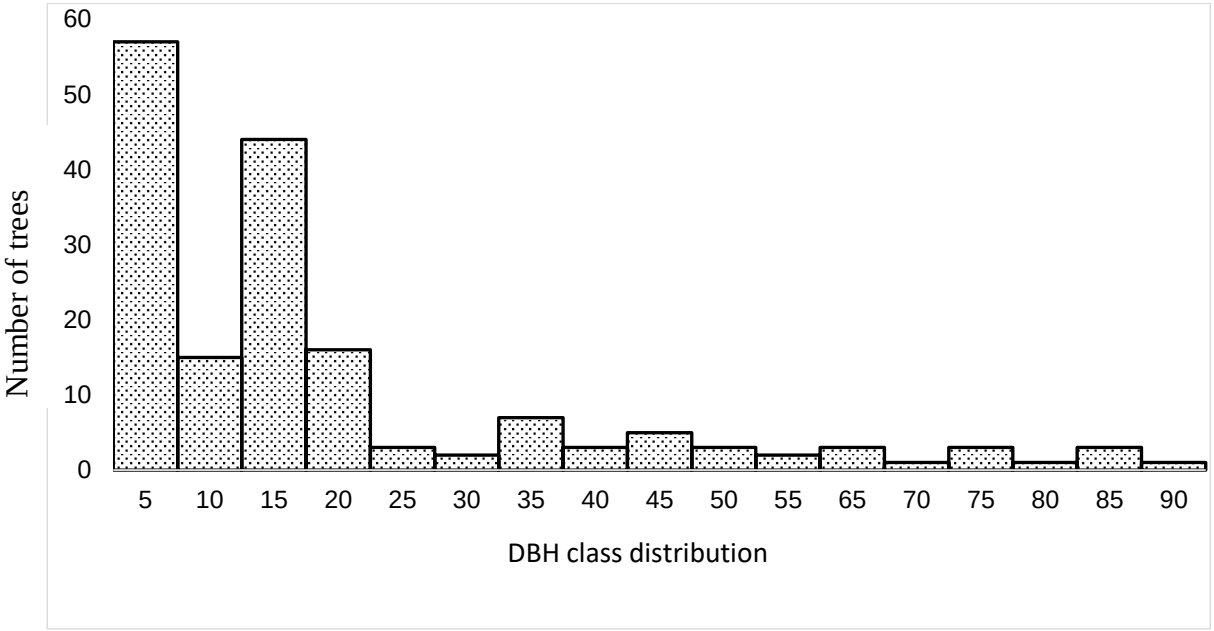

Figure 12: Diameter at breast height class distribution of PSP in PHF

4.1.11 Suitable area of current HF

On the suitability of the area and its acreage to the PHF, the communities are happy to have this designated in their geog. They are positive and supportive that this initiative will help protect their local resources and also help them use sustainably. They are particularly happy that the

4.1.12 Recommendation from the evaluation

On the general observation, the PHF management plan did not receive ownership by the GFD. Indeed none of the activities could be implemented apart from making a walking trail to the lake, a waste pit and built two gazeebos in 2017 with the fund from RGoB of Nu 150000 and that was 13% of the budget outlay planned. Forestry officials informed that they are not able to get the budget from the government and it was proposed every year. It was planned that Nu. 10,85,000 will be required to conduct activities from 2016-2026 which is a very minimal budget forecasted for HF management (Nu. 108500/year). Till today, the PHF should have received Nu.4,34,000.
At the central program and HF has earned an important place in the program three of the 12 FYP. This ensures that HF programs in the country will receive the Department of Forests and Park Services' budget allocation consideration. Nature Conservation Division (NCD) should ensure that this allocation materialize. With the budget allocation to the HF, achieving the objectives will not be distant.

Human resources to implement plans (forestry officials) and communities' capability to understand the long-term value of PHF and to agree to implement the planned activities are important for the effective and sustainable management of the PHF. Forestry officials should be given skills, knowledge and experience to implement the management plan and they should receivecapacity-building support from the GFD and NCD. The communities should also receive a form of capacity building and exposure to manage a tourist site and to fathom and accept the importance of HF. Two such programs for the forestry officials and communities within the management period is necessary and recommended.

Phaktshoding lake is the central component of the PHF and programs associated with the lake component will be easier to implement and also to garner support from the communities in implementing. The communities' attachment with the lake should be used as the strength to implement activities such as; water level rising in the lake, day hike to the lake and also to manage the catfish population. Communities' level of sadness over the exploded fish population and lowering water level in the lake is the highest concern expressed. The management intervention should be taken as early as possible by the GFD. All the communities expressed their delight to sell PHF as a tourism destination, then the facilities such as good walking trails to suit the heavy monsoon season, resting sheds along the trails and waste collection spots are necessary. A minimal fee collection from the visitors could be enforced and use the collection to maintain the facilities or designate a caretaker for the PHF. The visiting time and seasons for the visitors may be designated, if the visitor's disturbance to the lake brings stormy weather to the locality and destroys the crop harvest. Also if the visitors are coming to pick mushroom and other NWFPs, then a specific visitor fee to collect the NWFPs can be levied.

Education and advocacy programs should be a focus on all the themes and issues related to the PHF, such as waste, illegal activities and visitor disturbance to the lake. The periodic educational programs to all the stakeholders will help alleviate the degree of these incidences. Visitors are major problem creator for the waste generation and lake disturbance and specific activities for these stakeholders should be immediate and to be conducted as a periodic program. Planned and ad-hoc patrolling and rules enforcement activities should be implemented without fail. This will ensure to minimize illegal activities and fallacious activities inside in the PHF by communities, visitors and NWFP collectors.

NWFP collection inside the PHF is a sweeping activity and there is huge potential to institute sustainable harvesting and plough-back of income to the HF communities. The permit to collect and minimal fees or royalty collection from the NWFP collectors are not practised. For example if the cardamom carers are not the local residents but enjoy and get good income by collecting and selling NWFPs from the HF, they should be responsible to pay minimal fees for enjoying these resources. Long term analysis for NWFP-generated income to the communities and other groups of collectors will be useful and informative for PHF. Communities interviewed did not express their happiness for cardamom carers for enjoying these benefits but they acknowledged gloominess over this issue. The communities for PHF and community forests could be the same, and if this is true, then GFD has sizable role to create an NWFP group that belongs and be abided by the same bylaws to operate an NWFP group for community forest and as well as PHF.

Annexure-I

Aquatic Biodiversity in the Heritage Forest Lake of Phaktshoding, Bongo Gewog, under Chhukha District

Abstract

Freshwater biodiversity is the bioindicator for the health of the aquatic system and environment. Their system has been impaired upon alteration by the anthropogenic activities both in lotic and lentic aquatic system. Perhaps no studies are carried out in the lentic freshwater system in Bhutan. As the preliminary assessment of freshwater biodiversity, we measured the water quality by using the NLBI tool and water quality multi-parameter PCStestr. The results revealed that the water at Phaktshoding falls on the category of "fair" moderately polluted. Eleven families from seven taxa group were used to determine water quality. The impairments of lakes' health are mainly attributed to introduction of exotic fish that turned the water turbid almost yellow to brown color throughout the year. Removal of fish perhaps will help restore the lake's health. However, this study data is inadequate by one-time measurement to generalize the result from the present findings. A seasonal assessment including the vertebrate group will provide holistic biodiversity result and health of the lake.

Introduction

Naturally occurring mountain lakes are spiritually and historically revered as the commonplace for worshipping deities to accumulate the merits and subside the demerits in the respective locality. Some of the lakes in Bhutan has been documented that predates to 1976 when the Royal Government of Bhutan had assigned Food and Agriculture Organization to study the potential of raising the fisheries in the cold water which includes rivers and lakes. They have reported that Bhutan has over 59 naturally occurring lakes covering the total surface area of 4250 hectares (Dubey, 1978). Hokotsho (1823) in Punakha, Luchikhatsho in Wangduephodrang, Bulitsho in Zhemgang, and Gulanditsho in Samdrupjongkhar district, are lakes below the elevation of 2000 m a.s.l reported by Dubey, 1978. Still this report is inadequate and doesn't cover the gross estimate of the natural lakes in the country. Quite a number of naturally occurring low altitude lake's biodiversity and aquatic health are not measured in the country. Lake has been one of the common avenues for humankind and wildlife that holds both ecological and socio-cultural significances. Despite the important services particularly the aesthetic values that lake provides, people started exploiting the many lakes of Bhutan by introducing the exotic species and dumping waste in the lake. These two has caused the ecological insecurity for sustenance of lakes role.

To address the issue of deteriorating the forest ecosystem, Royal Government of Bhutan developed an approach to declare the small area of importance which requires protection and conservation as Heritage Forest during the 11th Five Year Plan. Phaktshoding lake measuring 41.46 hectares is one of the lakes and its surrounding was declared as HF located at Gedu, under Chhukha District (NRED, 2016). The HF declared area ranges elevation from 1740 to 220 m a.s.l. The lake is also revered as the lifeline support for the downstream communities as drinking, and irrigation for their livelihood. In recent years, the surrounding forest of the lakes and water in the lake itself faced degradation due to increasing population visiting the lake and extraction of forest resources upstream and around the lake. The sedimentation and increasing population in the locality observed that the quality and quantity of the lake of water is on decline. However, no empirical study was conducted to this far. Thus, to address the causal effect, lake is declared as HF and management plan is developed for 10

years (July 2016-June, 2026) to restore the degraded forest, improve the water quality and conservation of biodiversity (NRED, 2016).
In order to devise the management plan with bassline line data, freshwater and biodiversity constitute main component of the HF to be best inform the decision-makers on requirement of intervention on maintaining the health of forest and freshwater ecosystem. We initiated the rapid assessment of freshwater biodiversity survey along the upstream, downstream and reservoir from 8th to 9th July 2019.

Methodology

Study area

Phaktshoding lake is located within Gedu sub-block, Bongo block, under Chukha district. It is about 47 km from the headquarters of Chukha district. The lake and it's surrounding forest measures 41.46 hectares delineated for HF collectively managed by the community with technical expertise from Gedu Territorial Division (NRED, 2016). To the south, has the Bhutan Board Product Limited Plantation, to the east has Tashicholing Community Forests, to the west is the Gedu town, and to the north there are three villages; Tashigang, Rebana, and Alaykha. The Lake has about 1.62 hectares covered by water bodies surrounded by the cool-broadleaf forest. Many residents both from the locality and outside visit lakes as it serves as the recreational spot in the locality.

Figure 1. Study site, a lake in Phaktshoding Heritage Forest in Gedu

Sampling

The sampling was carried out during the monsoon season from 8th July to 9th July 2019. All together eight randomly selected sites in the littoral zone of lakes were sampled from the upstream and downstream of the lake and another two from the right and left bank of the lake. The sample was collected using the locally made kick net measuring 25 cm X 25 cm with 500 µm. Kick net was dipped in the water against the water current along the upstream and downstream stretch while in right and left bank, the net gently scooped the substrate from the littoral region. The samples were placed and net was rinsed thoroughly to ensure all samples are caught. All morphotypes were grouped and enumerated in the ice-cube trays and specimen of each morphotype was collected for later identification in the lab at 70% ethanol. Latter all the sub-samples were grouped as downstream, upstream and reservoir. Sampling units were distributed across all available microhabitats, pool

(organic debris, clay, and slit), riffle and run. At the lab, specimens are identified using the dissecting scope and keys from HKH regions and keys from elsewhere. Images were taken for every morphotype. The identified specimens are labelled and stored in the room temperature.
Physicochemical measurement was also taken using the multiparameter (pH/conductivity/TDS/ Salt/ temperature) Oakton PCSTSTestr from a strategic location from the collection area of samples.

Data analysis

Shannon diversity index, NLBI (Nepal Lake Biotic Index) was used to analyze the data in addition to the excel, 2016.

Results

Macroinvertebrate diversity

From the eight sampling units of different microhabitats; pool, riffle and run, 214 individuals from 11 families and seven orders were enumerated from the study area. The most abundant group are Gerridae (water strider) followed by Sphaeriidae and Oligochaeta (Table. 1). Most invertebrates at the site were found to be pollution resistant, and they can resist in the fewer oxygen habitats. We did not encounter any highly sensitive indicator groups in the study area.

Table 1. Taxa with their respective families and number of individuals from different sampling sites

Sl. No.	**Order**	**Family**	**Upstream**	**Reservoir**	**Downstream**
1	Coleoptera	Dytiscidae (Larva)	0	0	3
2		Dytiscidae (Adult)	5	3	0
3	Diptera	Chironomidae	0	0	13
4		Tabanidae	0	0	1
5	Hemeptera	Corixidae	5	2	0
6		Gerridae (*Onychotrechus* sp.)	0	1	0
7		Gerridae-I	55	30	15
8		Gerridae-II	0	7	10
9	Heteroptera	Notonectidae	0	0	4
10	Odonata	Libellulidae	1	0	1
11		Coenagrionidae	0	1	0
12		Aeshnidae	0	1	0
13	Oligochaeta	Aquatic earthworm	0	0	16
14	Veneroida	Sphaeriidae	24	0	0

The surface area of the lake appears brownish in colour, typically attributed to erosion from the upstream operation of forest activities that may have transported the clay and silt, suspended bottom sediments, and organic detritus. The other reason could be channelization, increased flow rates, flood, and too many bottoms feeding fish and organism may stir up bottom sediments which increase the cloudiness of the water (Michaud, 1991; Moore, 1989). In the lake, no bottom-feeding invertebrates have been encountered in the reservoir. However numerous invertebrates belonging to Garridae that walk on the surface of the water were observed. This indicates high concentration of particulate matter allows less penetration of light for invertebrate activities; organic matter settled in the bottom can

suffocate the eggs, larva and organisms; damage the gill structures of invertebrates; and decrease the resistivity against diseases (Michaud, 1991), thus less biological activity is prevalent in such lakes.

Bioassessment of the lake using Nepal Lake Biotic Index (NLBI)

Biological monitoring is considered one of the integrated approaches and less time consuming to assess the health of the water bodies (Hynes, 1960). In the Himalayan region, most of the assessment is limited to analysis of physiochemical parameters (Sharma et al. 2009; Reynolds, 1960). Most available biotic index for biological monitoring is focused on lotic water system, no indices are available in the Himalayan region until the NLBI was developed, applied and published in 2011 (Shah and Narayan-Shah, 2011) which can be feasible because of the similar topography and geographical landscape.

Biotic assessment of the lake based on NLBI score was 4.31 and revealed that the water quality at the lake falls is with fair degree of pollution and "*moderately"* polluted (Table 1). At this range the water color can be close to yellow which is agreeable as given in the figure 1 showed the water color close to between yellow and orange. This result may fairly overlook as the assessment was one-time measurement and season of sampling was not considered per se with the biological metamorphotic activity.

Table 2. Scale of NLBI and LWQC (Lake Water Quality Class), degree of pollution and color code adapted from Shah and Naratyan Shah, 2011

NLBI	LWQC	Degree of Pollution	Color Code
6.10-10.00	High	None to minimal	Blue
4.91-6.09	Good	Slightly	Green
4.00-4.90	Fair	Moderately	Yellow
2.00-3.99	Poor	Heavily	Orange
00-1.99	Bad	Extremely	Red

Fish Diversity

As per the management plan of Phaktshoding lake, there is mention of two introduced catfish *(Parachiloglanis hodgarti and Pseudecheneis sulcata*) in the lake (NRED, 2016). Survival of these two species is in question because these two species are found only in the torrent stream or river flow. We observed that there seem to have more than two species of fish, that may not be catfish. The substrate and littoral region of the lake have been borrowed that caused the to be turbid by the common carp, *Cyprinus carpio*. Other possible species could be Grass Carp. We could not sample

Figure 2. Fish movement and its substrate in the lake

the fish as we were not equipped with the fishing gear during the time of survey. As per the local people, grass carp were introduced. Further confirmation is required to understand when and types of species introduced from the local communities and stakeholder involved. The possible cause of water pollution and turbid water all-round the year is mainly attributed to the introduced fishes. Grass carp are usually herbivores, consumes large amount of aquatic plants, altering the habitats and impact the aquatic communities (Dibble and Kovalenko 2009). The substrate of the lake is mainly composed of oak leaves transported from upstream and bank of the river.

Aquatic plant diversity

List of aquatic plants is presented of those encountered in the process of sampling the benthic invertebrate. No systematic sampling was applied for acquiring the data on aquatic plants. Plant specimens were collected as and when it encountered. Most of the plants presented in table 3 are from littoral region and bank of the lake with marshy habitat.

Table 3 List of plants from littoral region and bank of the lake

Sl.no	Botanical name	Sl.no	Botanical name
1	*Callitriches tagnalis*	7	*Geranium* sp.
2	*Oenathe thomsonii*	8	*Percaria hydropiper*
3	*Myriophyllum specatum*	9	*Ainsliaea* sp.
4	*Oplismenus* sp.	10	*Neanotis* sp.
5	*Persicaria capitata*	11	*Collitriche* sp.
6	*Pilea* sp.	12	*Hydretra* sp.

Physiochemical parameters

The composition, richness and diversity of benthic macroinvertebrates in the freshwater aquatic system are affected by a number of physicochemical parameters (Graca et al. 2004). Further, these parameters are altered by the range of natural and anthropogenic disturbances including the seasonal variation in flow regimes (García-Roger et al., 2011).

Table 4. Physiochemical parameters of lake

Sample code	pH	EC	Salinity	TDS	Temperature
Down stream	8.7	8.4	0.00	6	20.4
Reservoir	8.55	6.4	0.00	6	20.9
Upstream	7.87	23.2	0.001	15.8	19.6
Mean	8.37	12.67	0.00	9.27	20.30
Standard deviation	0.36	7.49	0.00	4.62	0.54

pH: Potential of Hydrogen, EC: Electrical Conductivity, TDS: Total Dissolved Solids

The temperature in the lake is measured from epilimnion region, and this region is influenced by turbidity of water. In here the amount of Dissolved Oxygen (DO) will be low and provide shelter and food for pathogens. The availability of DO may range 2–4 mg/L where only a few fish and aquatic insects can survive. The pH of the lake is slightly alkaline 8.37±0.36. The EC (12.67 ± 7.49 uS/cm) and TDS (9.27±4.62 ppm) indicated that the low ions are present in the water. We are not confident as the multiparameter was not used for quite some time and not recalibrated. We expect the error may

have contributed if the sensor has not worked properly as we have no calibration buffer during the time of survey.

Acknowledgement

We want to express the deepest gratitude to Head, Center for Non-Wood Forest Products and Agroforestry Technology, Darla for logistical and field support. School for Field Studies, Center for Himalayan Environment and Development Studies in Paro for allowing us to barrow the PCStestr Multi-parameter.

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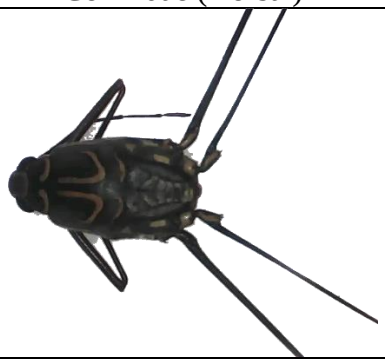
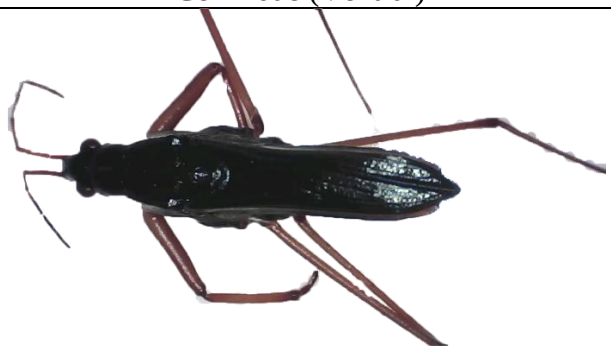
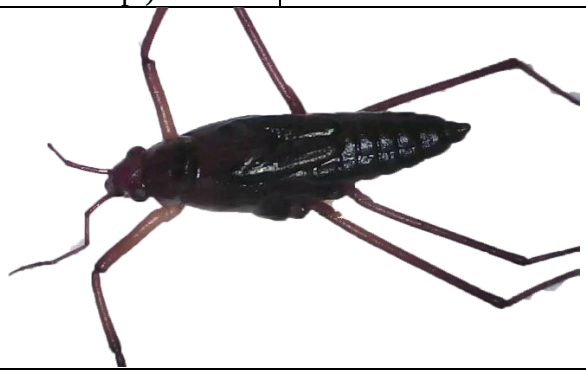
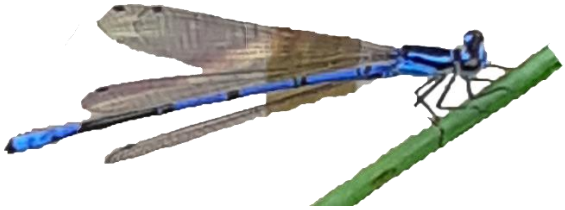
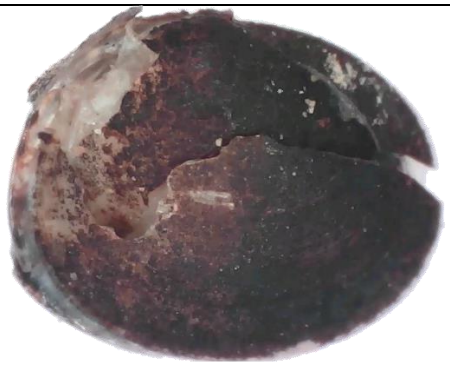
Pictures of the water biodiversity

Coleoptera	
	
Dytiscidae (larva)	Dytiscidae (Adult)
DIPTERA	
	
Chironomidae	Tabanidae
	
Corixidae (Dorsal)	Corixidae (Ventral)
	
Gerridae (Onychetrechus sp.)	Gerridae-I
	
Gerridae-II	
Heteroptera	

<table>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Notonectidae</td></tr>
<tr><td colspan="2">Odonata</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Libellulidae</td><td>Aeshinidae</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Coenagrion exclamatonis</td><td>Sympetrum hypomelas</td></tr>
<tr><td colspan="2">Oligochaeta</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Veneroida</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Sphaeriidae</td><td>Sphaeriidae</td></tr>
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Annexure-II

Questionnaire for monitoring and evaluation of Phaktshoding Heritge Forests , Bongo Geog, Chukha

Community members (village residents of Tashigang, Rebana and Allaykha, Bongo Gup, GAO, RNR officials, Tshogpas and Chukha Dzongkahg planning officer and EDO)

1. What is your opinion on having a PHF?

2. How are the values of HF related to you? (Drinking water, source of timber, fuelwood, NWFP, tourism, cultural values).

3. What is your level of interaction with PHF? (income, tourism, cultural, employment, local culture, watershed, ecological services, water quality, conservation of biodiversity, waste generation,

4. What issues are found around the PHF? What have you done to address these issues? (Waste, extraction, town expansion, construction of farm road, plantation, forest degradation by timber extraction from other side of the hill (which side), landslide, erosion, livestock grazing, fuelwood extraction, drying up of lake, HWC,

5. What is your expectation/suggestion/opinion for the PHF and from the PHF management to you or your community?

6. Any other comments or opinion for the PHF?

Forestry officials

1. What is your opinion on the PHF?

2. Has the objectives of the HF being met? (Protect natural forests, rehabilitation of degraded forests, serve as model of conservation and mgt of the natural resources, ensure continuous supply of ecological services, strategic options under REDD+ strategy)?

    - ✓ Identify and formalize the institutional responsibility- received annual budgets?-check with the Dzo Planning officer if this is in their plan (mentioned in the plan that it is integrated)?

    - ✓ Protect and improve forest ecosystem?-what activities were taken to fulfill this objective?
    - ✓ Conservation of biodiversity- what conservation strategy has been developed or implemented?

- ✓ Protect and improve water components- is this used for drinking water in Gedu Chiwog? How the quality of the drinking water monitored?

- ✓ Facilitate public participation and education- education programs were conducted? What allied programs were conducted for the HF- upstream and down-stream community relationship?

3. What activities or allied programs were conducted for the HF after it was handed over to the GFD?
4. What measures has been done to mitigate or lower the timber extraction by the members of CF from the PHF? (was identified in the PHF mgt plan). – how many monitoring done? What data or who have conducted this illegal felling?

5. Capacity building (of water users on water mgt, awareness on the HF) of the stakeholders (community members, RNR geog extensions, geog officails) done?

6. Is the waste management plan in place? Why

7. What strategies (education, patrolling, research as identified in the plan) were developed to attend the conservation threats (wildlife poaching, illegal timber harvesting, livestock grazing, forest fire, increasing livestock and human population)?

8. Any other comments or opinion for the PHF?

Phaktshoding Lake Visitors

1. Did you visit Phaktshoding? Why?

2. What did you do there?

3. What did you do to your waste?

4. Would you like to visit again? When and why?

5. What did you like most and did not like about the lake?

6. What is your expectation from the stakeholders of lake management?

7. Any other comments or opinion for the PHF?

Annexure III- Data Recording forms for Permanent Sample Plots

Tree recording format

Annexure 1: Tree Vegetation (DBH> 10cm)						
Location:		Aspect:				
Plot No:		Slope (%):				
Northing:		Canopy opening:				Date:
Easting:		Recorder:				
Altitude:		Remarks:				
T/No	**Species**	**DBH (cm)**	**Ht (m)**	**Coordinates**		**Remarks**
				X (m)	**Y (m)**	

Regeneration recording format

Annexure 2: Regeneration (Tree height < 1.3m)				
Location:		Aspect:		
Plot No:		Slope (%):		
Northing:		Canopy opening:		Date:
Easting:		Recorder:		
Altitude:		Remarks:		
SP. No	Species	Ht. (cm)	Age	Remarks

Ground flora recording format

Annexure 3: Ground Vegetation				
Location:		Aspect:		
Plot No:		Slope (%):		
Northing:		Canopy opening:		Date:
Easting:		Recorder:		
Altitude:		Remarks:		
Sl No	Species	Ht.(cm)	C (%)	Remarks

Leaf litter recording format

Leaf litter collection format							
Name of PSP:				Trap No.:			
Date :				Name of collector:			
Month :							
Sl #	Particular	Fresh weight	Oven-dried weight				
		W1	W2	W3	W4	W5	W6
1	Mosses						
2	Leaves						
3	Twigs						
4	Branches						
5	Flowers						
6	Fruits						
7	Seeds						
8							
9							
10							
11							
Remarks:							
.....							
.....							

Carbon efflux and temperature recording format

CO2 & temperature collection format							
Name of PSP:				Trap No.:			
Date :				Name of collector:			
Month :							
Plot No.1			Plot No.2			temperature	
Sl #	Particular	Value	Particular	Value		Partilrs	value
1	C		C			Plot 1	
2	dC		dC				
3	dT		dT				
4	L		L			temperature	
5	Q		Q			Partilrs	value
6	Max DC		Max DC			Plot 2	
7	Max DT		Max DT				
8	Plot		Plot				
Plot No.3			Plot No.4			temperature	
Sl #	Particular	Value	Particular	Value		Partilrs	value
1	C		C			Plot 3	
2	dC		dC				
3	dT		dT				
4	L		L			temperature	
5	Q		Q			Partilrs	value
6	Max DC		Max DC			Plot 4	
7	Max DT		Max DT				
8	Plot		Plot				
Remarks:							
.....							
.....							

Soil moisture recording format

Soil water recording format					
Name of PSP:			Trap No.:		
Date :			Name of collector:		
Month :					
Plot No.1 (upper)			**Plot No.1 (Lower)**		
Sl #	**Particular**	**Value**	**Particular**	**Value**	
1	**Period**		**Period**		
2	**PL**		**PL**		
3	N		N		
1	**VWC %**		**VWC %**		
2	N**001A**		N**001A**		
3	**PL**		**PL**		
Plot No.2 (upper)			**Plot No.2 (lower)**		
Sl #	**Particular**	**Value**	**Particular**	**Value**	
1	**Period**		**Period**		
2	**PL**		**PL**		
3	N		N		
1	**VWC %**		**VWC %**		
2	N**001A**		N**001A**		
3	**PL**		**PL**		
Plot No.3 (upper)			**Plot No.3 (lower)**		
1	**Period**		**Period**		
2	**PL**		**PL**		
3	N		N		
1	**VWC %**		**VWC %**		
2	N**001A**		N**001A**		
3	**PL**		**PL**		
Plot No.4 (upper)			**Plot No.4 (lower)**		
Sl #	**Particular**	**Value**	**Particular**	**Value**	
1	**Period**		**Period**		
2	**PL**		**PL**		
3	N		N		
1	**VWC %**		**VWC %**		
2	N**001A**		N**001A**		
3	**PL**		**PL**		
Remarks:					
.....					
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