

# SOCIO-ENVIRONMENTAL SURVEY AND SUSTAINABLE MANAGEMENT PLANNING OF A FOREST HAMLET PROXIMATE TO MAHANANDA WILDLIFE SANCTUARY IN THE EASTERN HIMALAYAS, INDIA

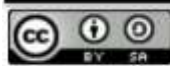
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**ABSTRACT:** The Himalayas have significant impact on the climate and biodiversity of the Indian Subcontinent. Many hamlets are situated in the Eastern Himalayas and some of them are proximate to the forest areas. *Latpanchar* (26.7083 N, 88.4268 E) is one of the emerging tourist destinations of the Eastern Himalayas, situated at an altitude of 4200 feet, nestled on the highest part of *Mahananda* wildlife sanctuary. *Latpanchar* being home to over 200 diverse varieties of bird species including Rufous Necked Hornbill is a very attractive destination for bird watchers. As a result, the hamlet has developed as an attractive ecotourism destination. Most of the inhabitants of the village are associated with *Latpanchar* Cinchona Plantation, which was established in 1943. The present study focuses on the physical and cultural environment of the forest and mountain areas in *Latpanchar*. The survey work integrates the perspectives of social ecology, ecosystem services and sustainable development. Primary data were collected using a mixed-methods approach, collecting background baseline information, scheduling interviews with members of the local villages and field observations. Focus was given on demography, agriculture, livestock management, water management, education, health, waste management, disaster management, biodiversity, ecosystem services, conservation initiatives and human animal conflict. Photographic documentation accompanied every phase of the survey. Policy proposals for sustainable development of the hamlet were discussed for conserving the biodiversity and socio-environmental condition of the village. Extensive study is needed in other mountain areas of the Eastern Himalayas to explore the socio-ecological conditions in the context of climate change.

*Keywords: Survey, Forest, Himalayas, Biodiversity, Sustainable Development*



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## 1. INTRODUCTION

The Eastern Himalayas are the meeting grounds of three bio-geographical realms, namely, Indo-Malayan, Palaeartic and Sino-Japanese with diverse range of flora and fauna [1]. The region includes a wide variety of ecological zones and contains parts of three global Biodiversity Hotspots. The complex mountain topography has diverse bioclimatic zones (near tropical, subtropical, lower temperate, upper temperate, subalpine evergreen, alpine evergreen, and alpine shrubs and meadows) [2].

The welfare of millions of people downstream is linked to the natural resources of the Eastern Himalayas. The indigenous communities of the Eastern Himalayas have a rich blend of religious, cultural, and local traditions. The traditions are interwoven with the biodiversity and landscape elements of the region. The inhabitants derive various ecosystem services from the forest resources, including provisioning (finding food and

fodder), cultural (aesthetic, religious), supporting (soil formation and water cycle), and regulatory (erosion, climate) services [3].

Several hamlets are found in the Eastern Himalayas and many of them are proximate to the forests enriched with endemic biodiversity. *Latpanchar* (26.7083 N, 88.4268 E) is one of the emerging tourist destinations of the Eastern Himalayas, situated at an altitude of 4200 feet, nestled on the highest part of *Mahananda* wildlife sanctuary. The village is situated in *Kurseong* division of Darjeeling district in West Bengal, India. The place is also famous for cinchona plantation, established in 1943 during the British period [4]. The small village has become famous among the tourists because of the spectacular view of the scenic snow-capped mountain ranges visible from the village and high diversity of bird species in the adjoining areas of the village. More than 200 species of Himalayan birds are found in the village, including Rufous Necked Hornbill [5]. The beauty of *Latpanchar* lies mostly in its lush green forests

covering the undulating slopes of the Himalayas. Surrounded by dense mixed wet forests, *Latpanchar* is a sparsely populated and a less explored forest village with numerous trekking trails (Fig.1). *Sitong* is another village proximate to *Latpanchar*, which is famous for its orange orchards.

The survey was conducted in April, 2019 by visiting *Latpanchar* village in Darjeeling district, West Bengal, India. The study focuses on an interdisciplinary understanding of the bio-cultural landscape and human-nature interactions in the village situated in the fringe area of a Himalayan forest.



Fig. 1. *Latpanchar* is a hamlet in the Eastern Himalayas, proximate to Mahananda Wildlife Sanctuary

## 2. METHOD

The survey work was conducted in April, 2019 by visiting *Latpanchar* village in Darjeeling district, West Bengal, India. The survey work integrates perspectives of human and social ecology, ecosystem services and sustainable development. Data were collected using a mixed-methods approach, collecting background baseline information, scheduling interviews with members of the local villages and field observations. PRA (Participatory Rural Appraisal) techniques were employed for data collection and included methods such as key informant interviews (KIIs), focus group discussions (FGD) and field observations. Based on the study framework and research objectives, structured questionnaires and semi-structured interviews supplemented by field notes were arranged to collect data from the village areas at *Latpanchar*. Most of the questions involved in the study were descriptive, and one-on-one interviews were used as the most appropriate method of data collection. The length of each interview was about 40–50 minutes and was supplemented by field notes. The interviews were conducted in local dialects (Bengali and Hindi) and English. The

questionnaires were made available in English, Hindi and Bengali languages.

In many villages of the Eastern Himalayas, families have traditionally delegated decision-making rights regarding social and economic issues to the head of the household. Considering this fact, data was collected from the household heads of the families. Focus was on demography, agriculture, livestock management, water management, waste management, disaster management, education, culture, health, ecotourism activities, biodiversity, NTFP usage and human animal conflict. Demographic information was collected from the village population and from the local *Panchayat* office. Information on health and education was collected from local schools and sub health centers. Information regarding transportation facilities was collected from the local transport syndicate. Biodiversity of the region was documented by visiting the adjacent forest areas. Photographic documentation accompanied every phase of the survey [6, 7].

## 3. RESULTS AND DISCUSSION

### 3.1. Population

There are 166 families at *Latpanchar* village with total population of 725 individuals. 50.75% of the population is female and 49.24% is male. Literacy rate of the village is 81.69%, higher than the average literacy rate of the state of West Bengal. Majority of the population are Hindus, followed by Buddhists and Christians. The Buddhist community comprises of ethnic groups of *Gurung* and *Tamang*. The majority of Hindu population belongs to the ethnic group *Sherpa*, followed by *Bhujel* and *Rai* communities. More than 70% of the population is engaged in cinchona plantation. Besides, agriculture, tourism and business are the main occupations of the inhabitants. The male members of the families are involved in tourism business, transportation and agricultural activities. The female members are engaged in household work, hospitality of the tourists in the homestays and agricultural activities.

Table 1: Population structure at *Latpanchar* village [Census, 2011]

Particulars	Total	Male	Female
Total number of houses	166		
Population	725	357	368
Children (0-6 years)	75	38	37
Schedule caste	15	7	8
Schedule tribe	463	213	250
Literacy	81.7%	85.9%	77.7%

### 3.2. Agriculture and Livestock management

The Eastern Himalayan landscape is considered as the original location of over 50

important tropical and sub-tropical fruits, cereals, and rice varieties [8]. Out of approximately 800 species consumed in India, about 300 species are found in North East Indian part of the Himalayas [9].

Terrace cultivation or step cultivation is practiced in *Latpanchar* village. The common cultivable edible plants at *Latpanchar* village are maize, ginger, beans, spinach, potato, squash, green peas, carrot, raddish, *raisak*, orange. The villagers follow the methods of mixed farming and crop rotation in the agricultural fields. The inhabitants of *Latpanchar* practice organic farming. Organic compost is produced and applied as manure. Compost pits are prepared in the village area, adjacent to the houses and in adjoining farmlands. Leaves and forest soil collected from the forests are mixed with cow dung for the production of organic compost. Rainfed Irrigation is practiced in the agricultural fields. Occasionally water from the local springs is brought to the fields during the period of water crisis. Pipe irrigation is a common practice in vegetable farming.

Most of the houses at *Latpanchar* have cultivable lands adjacent to the houses. Agricultural production is one of the main economic sources of the people of this area. The villagers sell the surplus foods in the local markets.

The major threats to agricultural production are:

1. *Natural disasters*: Strong wind and rainfall during July and August affect maize production. Occasional landslides have considerable effect on terrace cultivation, especially during the rainy seasons.

2. *Wildlife*: Agricultural fields are often attacked by monkeys, giant squirrels and wild boars, causing crop damage. In the productive croplands of cinchona plantation, elephants regularly attack the orange orchards, cinchona and ipecac cultivation fields.

3. *Pest and disease*: The farmers report that the production of large cardamom has decreased significantly in the recent years due to shortage of water, increase in temperature and frequent pest attacks. The production of large cardamom has been reduced to few patches in the village area.

4. *Climate change*: According to the opinion of the local farmers, considerable decrease in production of ginger and orange due to change in rainfall pattern and increase in temperature. Orange plants are drying up, resulting in decreased productivity.

The common livestock at *Latpanchar* are local breeds of cows, goats and pigs. Almost every household has small poultry farm with cow and goat shelters in their own backyards. Meat, eggs and milk are the main livestock products which are among the important economic sources. The waste

generated by the livestock are converted into organic manure and used in the agricultural fields.

### 3.3. Water management

The main water source of *Latpanchar* is the water coming from the hills through natural water channels like “*jhoras*” (local springs). There are more than 20 local springs from which the villagers collect and store water. Most of the local springs are perennial, however, there is considerable fluctuations in water flow in the streams. The springs flow below the ground and water is naturally filtered while passing through the soil layers. The *jhora* water is collected in a big storage tank, situated outside the village, and subsequently supplied in the smaller water tanks situated inside the village. There are 8 tanks in the village for water storage. A network of pipelines distributes water from the water tanks to the houses.



2a



2b

Fig. 2. The spring water is collected in a big storage tank situated near *Latpanchar* village (2a) and is distributed from the main storage tank to the water tanks situated in the village (2b).

The survey revealed that in the last few years the local stream water flow has been decreasing during summer and has negative impacts on water availability and distribution. March to May is the period of water crisis in *Latpanchar*. The home stays which have developed recently for tourism

purpose, suffer from water shortage during the period. The increasing number of tourists led to increased water consumption, which has subsequently affect the per capita water distribution in the village.

*Ahal Dara* is a newly developed ecotourism destination which is situated 5 km. away from *Latpanchar*. *Ahal Dara* has poor water supply, which is a constrain for developing home stays in that area. The local inhabitants have initiated rainwater harvesting at *Ahal Dara*. The roofs have aluminium gutters (long, hollow device that is attached to the edges of the roof to catch rainwater and carry it away from a building) at the corner for collecting rainwater. The roofs have inclined slope, so that water can flow easily in the gutter. The rainwater falling on the roof top can be collected through these gutter channels. Small funnels are attached to the gutters by which water moves through the pipes connected with the funnels. The water is then filtered by charcoal and sand and subsequently stored in two big tanks of 2000 litre capacity. The filtered water is then channelized into four tanks of 16,000 litre capacity each. Water is supplied to the home stays from these big storage tanks.



3a



3b

Fig. 3. The local inhabitants have initiated rainwater harvesting at *Latpanchor* (3a). The harvested water is stored in two big tanks and then channelized into four tanks for water supply (3b).

For sanitation and hygiene requirements, pit toilets are present in each household. Toilets are constructed both by government and private initiatives. However, many of these pit toilets do not follow the guidelines provided by the World Health Organisation [10]. Sanitation systems without prescribed guidelines could be a serious threat to nearby water streams and groundwater sources. Wastewater from the houses is directly discharged into the ground; no drainage channel is constructed or developed for wastewater discharge.

### 3.4. Waste Management

The common wastes generated from the household activities of the villages are solid wastes including plastic packets, paper boxes, plastic bottles, glass bottles, discarded electrical appliances, old clothes, vegetable wastes etc.; liquid waste is generated from household activities like washing clothes, utensils and cattle farms, washing and cleaning of vehicles etc.

Vegetable wastes are used as cattle feed and for preparation of organic manure. Solid wastes are collected in bins and are disposed by burning. Every house burn all the solid wastes once a week. The unburned materials are buried in the ground adjacent to the houses. Burial of bottles and plastic packets may have detrimental effects on the local ecosystems and biodiversity. There is no waste management system developed for carrying, segregating, transporting and processing of the waste in the village. Sometimes plastic and glass bottles are recycled by selling in the local markets. Local villagers are concerned about the increase in waste generation because of recent growth in tourism at *Latpanchar*.



Fig. 4. The villagers use empty containers made of tin and aluminium for collecting solid wastes

The inhabitants of *Latpanchar* collect the fuel wood from the adjoining forest areas. Usually rotten and low quality woods are used for burning purpose. They store the waste wood in the storehouses, which are constructed by using wooden blocks and shades of aluminium/plastic.

### 3.5. Economy

**Tourism:** The beauty of *Latpanchar* lies in its lush green virgin forests covering the undulating slopes of hills. The spectacular view of the Himalayan ranges and biodiversity of Mahananda Wildlife Sanctuary attract tourists from different parts of India. *Sitong* is a forest village proximate to *Latpanchar*, which is famous for its orange orchards and rural ethnic livelihood. *Namthing Lake* is situated near *Latpanchar*, which is the habitat of the Himalayan Salamander (Fig.8), an endemic amphibian of Himalayan region.

*Latpanchar* is attracting large number of tourists in recent times and the villagers have started developing home stays for the tourists. Ecotourism was initiated in *Latpanchar* in 2002; however, ecotourism business has flourished in the last 5 years. Currently the village has 8 home stays with an average of 5-6 rooms per home stay. Local people support tourism initiatives and consider it as an attractive and emerging option of economic growth. Number of tourists are maximum from October to December, followed by an above average tourist inflow from March to May and lowest inflow in the rainy season (June-September). *Latpanchar* is also an attractive destination for trekkers, birdwatchers, environmentalists and researchers. Many groups from colleges, universities and research institutes regularly visit the place for biodiversity study. Apart from Indian tourists, there is also a regular tourist inflow from United Kingdom, United States, Sri Lanka, Malaysia, Russia etc.

Approximately 240 bird species can be found in *Latpanchar* including Laughing Thrush, Spotted Eagles, Burn Swallow, Robin, Magpie, Black Bulbul, Himalayan Pheasant etc. *Latpanchar* is the home of an endangered bird species- Rufous Necked Hornbill, which migrated from Nepal hills to *Latpanchar*. The breeding season and nesting behaviour of the bird attract the birdwatchers from different parts of the world.

According to the local villagers, they were ignorant about Rufous Necked Hornbill before the development of ecotourism; no conservation initiative was made by the local people in this regard. Gradually, the perception has changed as the birds started attracting many birdwatchers and environmentalists in the village and ecotourism started to flourish at *Latpanchar*. Some of the villagers started organizing awareness programme for conservation of the bird species. Extensive afforestation programme has been initiated by the local people in recent times and a number of fruit trees were planted to attract the bird species especially. Interestingly, new nests were formed by the birds after the afforestation programmes, which include plantation of pines, *katus* (*Castanopsis tribuloides* A. DC.), *arkawla* (*Quercus spicata*

Smith.), *tarsing* (*Beischimedia roxburgii*), *phaledo* (*Erythrina indica*), *uttis* (*Alnus nepalensis*) etc.



Fig. 5. The beauty of *Latpanchar* lies in its lush green virgin forests covering the undulating slopes of hills



6a



6b

Fig. 6. Biodiversity of *Latpanchar*. Himalayan Salamander is an endemic amphibian of Himalayan region, found in *Namthing Lake* situated near *Latpanchar* (6a). Rufous-Necked Hornbill at *Latpanchar* (6b)

For tourists, the sources of information about *Latpanchar* are mainly websites of the home stays, role of touring agencies and operators, daily newspapers and travel magazines. The villagers are also using social networking sites like Facebook for connecting with the world. The homestay owners

upload short videos on Facebook and YouTube, highlighting the natural resources, biodiversity and beautiful landscapes. The web-based promotion of this less known destination has been effective for attracting tourists and making direct contacts with tourists and community-based service providers. At the community level, socially cohesive bonds have been observed among the inhabitants of *Latpanchar*, which could be a strong regulating factor in community-based ecotourism development. Some of these tourism initiatives partially depend on Government support; some of the home stay owners receive micro-credits and financial support from the Govt. of West Bengal. Previous research showed the expansion of ecotourism at *Latpanchar* from 2008-2011[11].

Table 2. The expansion of ecotourism at *Latpanchar* from 2008-2011

	2008-2009	2009-2010	2010-2011
Number of tourists	1,742	4,188	9,141
Overnight stays	876	2098	7681
Income generated by tourism (% of total income)	16.8%	22.4%	29.7%

Ecotourism activities at *Latpanchar* include trekking, bird and wildlife watching, hiking, photography, mountaineering etc. Ecotourism services at include transportation, local cuisine, camping, home stay, guiding and interpretation. These services should cause minimum damage to the natural and cultural environment and promote a better understanding of the natural and cultural aspects of the area.

**Cinchona plantation:** *Latpanchar* Govt. Cinchona Plantation, a smallest and youngest plantation in the Directorate was established in 1943. It comes under *Kurseong* Sub-Division of Darjeeling district. This plantation consists of 2 divisions viz. (i). *Latpanchar* division and (ii) *Sittong* division.

The Directorate of *Cinchona* and Other Medicinal Plants started functioning since 1862, from Himalayan foothills to an altitude of 1800 meter in Darjeeling district, India. Initially there was only Directorate of *Cinchona*, later the Directorate of Medicinal Plants was established in 1950 [12]. These two Directorates were ultimately joined to form a single Directorate in 1968. The initial objective of the Directorate was to grow different species of *Cinchona* trees for producing anti-malaria drug Quinine from the bark. Gradually the activities of the Directorate expanded and the cultivation of *Cephaelis ipecacuanha*, *Dioscorea* composite, large Cardamom, Rubber, Mulberry, Turmeric, *Taxusbacata*, Broom stick, Citronella,

Vetiver, Lemongrass, *Artemisia annua*, Mandarin Orange etc. started along with *Cinchona* plantation [12].

Recently experimental plantation has been initiated at *Latpanchor* cinchona plantation which include plantation of black pepper, strawberry and mushrooms. However, extensive research and management tools are needed to establish the new introduced species in the area.

Table 3. extensive research and management tools are needed to establish the new introduced species in the area.

<b>Cinchona plantation at Latpanchar: General features [12]</b>	
Altitude	1200-5000 feet MSL
Temperature (Max/Min°C)	34/08
Average rainfall and humidity	4600 mm. Per annum, humidity 65-91%
Agricultural scenario	Cinchona, Ipecac, Mandarin Orange and Coffee.
Climate	Temperate, humid
Water resources	Natural springs and <i>jhoras</i> , pipe irrigation, rainfed, bore well.
Soil	pH 4-7, normal acidic, reddish colour, sandy, application of lime in the soil; jungle soil and cow dung are used as fertilizer.
Number of workers	1320
Total area	Total 2445.17 acres a. Productive crop land (Cinchona, Ipecac, Cardamom, rubber plantation, Mandarin orange): 1482.54 acres. b. Greeneries (Bamboo, Thatch, Afforestation, Forest area): 419.44 acres. c. Other land (Research complex, Fallow/Cultivable): 16.86 acres. c. Non-productive land (Workers' colony, hospitals, schools, Roads etc.): 526.33 acres.



Fig. 7. Cinchona plantation near *Latpanchar* village in *Mahananda* Wildlife Sanctuary area

### 3.6. Transportation

There are few private cars available at *Latpanchar* which connects the area with *Darjeeling*, *Kalimpong* and *Siliguri*. Shuttle services are available in the morning on sharing basis for going towards city areas. With the growth of ecotourism at *Latpanchar*, the number of vehicles has increased. No bus service is available at *Latpanchar*, and car is the only mode of transport.

### 3.7. Education, culture and health

There are two nursery level schools and four primary schools upto 4<sup>th</sup> standard at *Latpanchar*. There is also a high school situated at *Latpanchar* with 20 teachers. The villagers of *Latpanchar* visit *Darjeeling*, *Kalimpong* and *Siliguri* for higher education in colleges and universities. Literacy rate of the village is 81.69%, higher than the average literacy rate of the state of West Bengal; male literacy stands at 85.9% while female literacy rate is 77.7% [13].

A small health centre (Government Cinchona Plantation Hospital) (Fig.11) was established in 1975 for treatment of the cinchona plantation workers. No operation facility is available in that health centre; only one compounder and three nurses are available for treatment. For major treatments and health services, the inhabitants of *Latpanchar* visit hospitals in *Darjeeling*, *Kalimpong* and *Siliguri* city.

At *Latpanchar*, local food products are mainly based on agricultural and livestock products. *Gundruk* is considered to be one of the most popular local foods in *Latpanchar*. *Gundruk* is fermented leafy green vegetable and one of the national dishes of Nepal [14]. It is an important source of minerals during the seasons of less production, when the local people depend mostly on starchy tubers and maize, having low mineral content.

*Sinki* is also a local food and is prepared from radish tap roots. It is consumed in the forms of soup and pickle. The other traditional foods and drinks are round chilli pickle, *Khapsey* (Deep fried Tibetan pastry eaten and offered during *Losar* festival), *Chhaang* (Nepalese and Tibetan alcoholic beverage made from barley, millet or rice).

The Buddhists population celebrates festivals like *Buddha Purnima* and *Losar* in the village. *Losar* is a Buddhist festival (Tibetan New Year) which is celebrated for 15 days. The Hindus celebrate festivals like *Dussehra*, *Diwali*, *Makar Sankranti* and *Bhai tika*.



Fig. 8. Government Cinchona Plantation Hospital was established in 1975 at *Latpanchar* for treatment of the cinchona plantation workers

### 3.8. Ecosystem services

NTFPs collection is a traditional practice of the villagers of *Latpanchar*. They collect small size timbers from the forest area for house construction and firewood as household fuel. The villagers also collect local bamboo species (*Muli Bamboo*, *Melocanna sp.*) and use them in roof construction. They occasionally collect edible roots and tubers, mushrooms and fiddlehead ferns (*ningro*) as substitute of staple foods especially during lean seasons.

*Latpanchar* and the adjacent areas of Mahananda Wildlife Sanctuary have high diversity of medicinal plants. The villagers cultivate the medicinal plants for personal uses in the adjoining land areas of their houses. The common medicinal plants available in the village area are varieties of cinchona, ipecac (*Carapichea ipecacuanha*), *banmara* (*Eupatorium cannabinum*), *pakhanbeth* (*Bergenia ciliata*), *titepati* (*Artemisia vulgaris*), *uttis* (*Alnus nepalensis*), *abhijal* (*Drymaria cordata*), *sisnu* (*Urtica dioica*), *golpata* (*Centella asiatica*), *buo-okhati* (*Astilbe rivularis*), *tite champ* (*Michelia cathartii*) etc. Studies show similar types of medicinal plant diversity in other hamlets of Eastern Himalayas [4,15].

According to the reports of the local villagers, the ancestors of the inhabitants had more knowledge about the medicinal plant resources of the forest areas. The present generations are less aware about the medicinal plant varieties because of availing medical facilities from the health centres and hospitals.

Local economy is also dependent on honey production. The inhabitants of *Latpanchar* make artificial wooden structures in which bees can take shelter and store honey. Honey is collected regularly and is sold in the market. Analysis of semi-structured interviews in the study area indicated dependence of people on forest ecosystems through the provision of ecosystem services.

### 3.9. Disasters

The Eastern Himalayan ecosystems are under rapid habitat destruction due to several anthropogenic pressures and developmental activities like hydro-electrical projects, development of roads, establishment of tea gardens, mining and quarrying, landslides, forest fire etc. These factors jointly have increased the fragility of the Himalayan Mountains. [16]. Landslide is one of the most widespread disasters in Eastern Himalayan landscapes. Small and medium landslides are common in the adjoining areas of *Latpanchar*. The inhabitants also reported about thunderstorm hazards in the village. Besides, the area is also earthquake prone and falls under seismic zone IV; small earthquake incidences are common at *Latpanchar*. Minor cracks in the houses and local roads at *Latpanchar* can be seen, stemmed the disastrous earthquake of Nepal in 2015. The houses made of concrete experienced more damage than the wooden houses. The villagers have limited means to cope with natural disasters due to remote location and hilly terrain.

During the survey, the aged villagers (> 55 years) shared their experience on the changing climate in the village. According to them, the temperature has been increasing in the village area and rainfall is becoming more unpredictable. The frequency of landslides has also increased and can be one of the possible impacts of developmental activities and dam construction in the adjoining areas. The villagers also reported that there is a substantial drop in ginger and orange production in response to changing climate in the village area. There was occasional snowfall in the upper part of the village in earlier times, now snowfall has almost stopped in the last 10 years. The bird diversity in the village area has also decreased in recent times. Climate change, deforestation and increase in human population could be the possible reasons behind the decline in bird diversity in the village.

### 3.10. Biodiversity

*Mahananda Wildlife Sanctuary* is situated in the eastern Himalayan region (26°47'54"-26°55'33"N; 88°23'36"-88°33'31"E) covering an area of 158.04 km<sup>2</sup>. It is situated in both Darjeeling and Jalpaiguri districts of West Bengal, in the lower catchment of *Mahananda River*. It was first notified as a protected area in 1949. The reserved forest was declared as a Wildlife Sanctuary by Government of West Bengal in June 1976, under the administrative control of a Divisional Forest Officer (Fig.12). It is located on the western bank of the river *Teesta* and on southern part of Darjeeling district and is listed under 7B biogeographic zone. National highway 31 passes through the southern part of the sanctuary [17].



Fig. 9. *Mahananda Wildlife Sanctuary* is under the administrative control of a Divisional Forest Officer

The area of MWLS comprises of 60 % of the forest in hilly region in the foot hills of the Himalayas, characterized by moderate to steep mountain slopes and high ridges towards the north and then sloping to almost flat stretch of the *Terai* and alluvial plains towards the south. Conversion of the higher hills into tea estates and *Cinchona* plantations has fragmented the ecological boundary in the north.

Soils types in the sanctuary are extremely diverse, and depend on the elevation and slopes of the landscape. The climate of the MWLS is mainly tropical and is mainly controlled by three seasons (summer, winter and monsoon). The average minimum temperature recorded is 10.1° C and maximum temperature is 32.4° C (from 2003 – 2007). The average rainfall was 1141.1 mm per annum, recorded in the period 1997 – 2006. The maximum rainfall is during June-August and minimum in the months of December and February [18].

A total of 584 taxa under 388 genera and 127 families have been recorded from the sanctuary. Large areas are under plantations both in plains and hills within the sanctuary areas. Plantations in plain areas are mainly of Teak and Sal.

Increasing anthropogenic activities around *Mahananda Wildlife Sanctuary* include illegal felling of trees, collection of plants for fire wood, unsustainable activities through ecotourism, illegal encroachment of forest land, increase in cattle grazing etc.

Table 4. Floral and faunal diversity of *Mahananda Wildlife Sanctuary* is listed [18].

Biodiversity of <i>Mahananda Wildlife Sanctuary</i>	
<b>Flora</b>	Dicots (74.31%), Monocots (17.46%), Gymnosperms (0.34%), Pteridophytes (7.84%). The flora comprises of herbs 302 taxa, shrubs 105 taxa, climbers 68 taxa and trees 109 taxa.
<b>Fauna</b>	Mammals: Rhesus macaque, Jungle cat, Leopard cat, Himalayan palm civet, Flying fox,



Indian porcupine, Gaur, Chinese pangolin, Small Indian mongoose, Himalayan black bear, Indian elephant, Tiger, Leopard.

Birds: Black redstart, Large egret, Night heron, Little cormorant, Openbill stork, Crested serpent eagle, Indian ring dove, Spotted dove, Spotted owl, green bee-eater, Indian pied hornbill, Himalayan pied woodpecker, Paradise flycatcher, Starling, Jungle myna, Green magpie, Himalayan tree pie, Scarlet minivet, Fairy bluebird, Common babbler, Blue-grey tit.

Reptiles: Fan-throated lizard, Bark gecko, Common Indian skink, Indian tent turtle, Ornamental flying snake. Land monitor lizard.

Amphibians: Balloon frog, Leaping frog, Tree frog, Indian bull frog.

Butterfly: Indian tortoiseshell, Common grass yellow, Blue tiger, Chocolate albatross, Common crow, Crimson rose, Common sailor, Banded treebrown, Common leopard, White orange tip.

### 3.11. Policy Proposals for Sustainable Development

*Latpanchar village* has become one of the emerging ecotourism destinations in the Eastern Himalayas for pleasure and educational trips, trekking, nature camps and medical research works. Ecotourism can become one of the prime factors in the economic development of the village. There is an urgent need for developing and implementing sustainable policies for protecting the socio-ecological structure of village, ethno-cultural conservation and conservation of local forest biodiversity. The focal areas for conservation and management of *Latpanchar* village are as follows:

**Water management:** Establishing micro scale rainwater harvesting structures can be a sustainable solution to overcome the water crisis in Eastern Himalayan villages like *Latpanchar*. The initiative of rainwater harvesting taken at *Ahal dara* ecotourism spot can be considered as a model to be followed in other ecotourism hamlets of the Eastern Himalayas to overcome the water crisis. Establishing water harvesting structures can ensure sustainable storage and supply of water, which will be helpful for establishing ecotourism business in other hamlets in the Himalayan landscape.

Household filter systems can be provided to the local inhabitants for using the collected rainwater for drinking purpose. Water storage and micro-irrigation equipment business can be developed for the benefits of the local villagers. However, financial services providers such as banks, local government, and establishment of proper training facilities could be major challenges in this regard [19].

In the hamlets of the Eastern Himalayas, the need for rejuvenation of springs for ensuring water security is the need of the hour. Long term strategies for recharge and rejuvenation of local springs are essential for ensuring water security in *Latpanchar* and such other hamlets in the Eastern Himalayas.

Supplementing the natural recharge of the spring aquifers by introducing artificial rainwater harvesting in the spring shed areas in the Eastern Himalayas is one of the possible ways. Resource mapping of the springs by GIS and creating a spring atlas in all the villages of the Eastern Himalayas need to be initiated.

**Agricultural management:** Enhancing ecosystem services can lead to improvement of food and nutrition security in the Himalayan landscape. This can be achieved by implementing sustainable methods such as crop rotation with legume plants to fix atmospheric nitrogen in soil instead of using nitrogenous fertilizers [20].

Organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. Encouraging and supporting the farmers towards organic farming in *Latpanchar* village can stabilize and flourish the biodiversity and economy of the landscape. Creation of community seed banks and preservation of germplasm of the indigenous varieties would ensure the conservation of genetic diversity and availability of the food resources for the increasing population. However, impact of climate change on these varieties should be studied in detail to develop more resilient varieties. Implementation of Integrated pest management (IPM) could be helpful in this regard [19].

**Health and hygiene management:** Adequate health services should be provided to the local inhabitants of *Latpanchar*. The local health centre of *Latpanchar* lacks advanced facilities and staff support. Weak infrastructure in the health centre and poor connectivity and transport facility in the village can put the villagers' health at risk. Infrastructure and human resource development in the health centre can be considered for ensuring health security. Telemedicine facilities can be established in the Himalayan hamlets like *Latpanchar*. This is especially important for enabling people in remote areas to consult specialists and then seek right suggestion for treatment.

Pit toilets of the village should be re-designed by using appropriate technology under the specifications provided by the WHO [21]. Local villagers can be trained in technical skills required for establishing and managing pit toilets and understanding how appropriate technology can minimize impacts on surrounding ecosystems.

Transportation and road conditions are a major problem in the adjoining areas of Mahananda Wildlife Sanctuary, including *Latpanchar*, making access to elementary services, like access to health and markets, difficult.

**Energy management:** The use of energy-efficient and smokeless cook stoves should be promoted to increase fuel efficiency, to reduce

cooking time, and to reduce pollution from fuel wood [22, 23]. Biomass wastes generated from agricultural activities can be utilized as raw materials for producing biofuels. Implementation of biogas plants at *Latpanchar* can reduce the pressure on fuel wood. Focusing on renewable energy sources like solar energy can be useful for the villagers.

**Biodiversity conservation:** Training and awareness should be initiated by the Forest Department to educate people on the adverse effects of deforestation and its long-term impacts on the Himalayan climate. Conservation focus should be given on areas enriched with endemic biodiversity and bio-cultural diversity, and areas with water catchments. Community-based forest management can be helpful for protecting both biodiversity and traditional practices.

Like any other protected area in India, the forest areas of Mahananda Wildlife Sanctuary suffer from illegal cattle grazing, firewood collection, encroachment on the fringes and poaching. Detailed survey works and management practices are essential for mitigation of anthropogenic threats.

The possible factors responsible for the depletion of medicinal plant diversity in the Eastern Himalayas are:

- a. Increasing demand for herbal products.
- b. Shrinking of natural habitat of medicinal plants due to population explosion and developmental activities.
- c. Over exploitation of natural sources.
- d. Forest fire.
- e. Illegal trading of medicinal plants.
- f. Overgrazing of livestock.
- g. Cutting off the medicinal trees for fuel, timber, etc., cutting off leaves for fodder and cattle bedding.
- h. Change in climate and weather patterns.

Sustainable conservation of medicinal plants is urgently needed after addressing the factors responsible for depletion of medicinal plant resources.

Biopiracy is a major threat to the endemic plant diversity in the Eastern Himalayas. Initiatives to build up private nurseries where several varieties of important plant species can be preserved should be taken at Himalayan villages like *Latpanchar*. Local training centres can be useful for educating local people about the importance of natural resources of the Eastern Himalayas. Local community engagement and participation can effectively protect the natural assets of the village and adjoining forests. The plant varieties can be preserved by establishing gene banks and genetic databases. Nature interpretation centres can be established in the village area to educate both the local villagers and the tourists about the biodiversity

wealth of Mahananda Wildlife Sanctuary and its adjoining areas.

With increase in the number of households, cattle have also increased rapidly. Reduction in cattle grazing in Mahananda Wildlife Sanctuary and other forests of the Eastern Himalayas can increase soil stability, reduce erosion, and maintain the dynamics of the ecosystems. However, a management strategy like rotational grazing might be preferable instead of sticking to the strategy of reduction and curtailing villagers' rights to forests, especially within protected areas.

**Disaster Management:** The Eastern Himalayan landscape is prone to disasters like landslides and earthquakes due to natural forces and anthropogenic pressures. Vegetative control measures of soil conservation should be practiced in the forest areas of *Latpanchar* to reduce further damage of land areas. Promotion and implementation of vermicomposting techniques can be helpful for maintaining soil structure, increasing agricultural productivity and reducing solid waste generation [21]. Development of low cost earthquake proof and energy saving housings can be beneficial in the village area.

The effects of climate change are more significant in the Himalayas than compared to other mountain ecosystems [24]. Temperature changes in the Kanchenjunga landscape indicate an increase at the rate of 0.01 – 0.015°C/year, with greater warming at high altitudes [25]. Extensive study is needed on the effects of climate change on the biodiversity of the Eastern Himalayas, with special focus on the forests enriched with endemic species. Long term consistent monitoring of the climatic conditions will be helpful in this regard.

During the survey, the villagers reported that previously there were incidences of snowfall in winter in the upper parts of *Latpanchar*, however, in the last ten years, there has been no snowfall during the winter. The villagers also reported that the temperature has been increasing considerably in the village area and the rainfall has become unpredictable. Extensive studies are needed at *Latpanchar* area to understand the effects of climate change on the landscape. Monitoring climate change by establishing stations to collate long-term climatic data from Eastern Himalayas is the need of the hour.

**Pollution and waste management:** The number of automobile vehicles has been increasing significantly in the ecotourism destinations of the Eastern Himalayas. These vehicles should be monitored regularly to control pollution in the forest areas. Modern antipollution devices should be installed in the vehicles and routine checking systems need to be implemented.

Separate waste collection and disposal system should be established and managed by the

government for protecting the forest ecosystems. Effective management design should be implemented and promoted for plastic wastes. Proper management chain for solid wastes needs to be implemented (methods of collection, storage, transportation, recycling and disposal) in the Eastern Himalayan hamlets including *Latpanchar*.

**Socio-economic development:** There remains the need for a critical and thorough understanding of resource flow to and from mountain areas of the Himalayas. This will increase the net income of the mountain communities and a fairer distribution of earnings will be established. A number of innovative mechanisms allowing a greater share of the proceeds from mountain-based economic activities to reach mountain people must be evolved. Markets which channel local products and effective distribution systems with strong communication could uplift local village economies.

**Ecotourism development:** Proper training and capacity building of local communities is essential at *Latpanchar* village for development of ecotourism. The focus groups would be the home stay owners, youth and women's groups who wish to engage themselves in ecotourism activities. Training and capacity building should be focused on environmental education, home stay management, waste management, computing, finance, eco-tour program designing, cooking local cuisine, guides for trekking, bird watching, fauna and flora photography etc. Preparation and distribution of training materials including training manuals, textbooks and training courses are needed in this regard. Previous studies show that a community-based microenterprise approach can lead to strong local engagements in biodiversity conservation along with directing a substantial amount of revenue to local development [26]. The villagers who are the pioneers in establishing homestays in their villages can lead and mobilize other villagers for initiating and promoting new homestays.

The carrying capacity assessment is an important component of the ecotourism research as it will form the basis for resource allocation and future development [27]. The carrying capacity assessment for ecotourism should be done at *Latpanchar* and other Eastern Himalayan villages, based on the inflow of tourists and their activities.

The communication facilities at *Latpanchar* are not adequate, considering it is an emerging ecotourism spot. However, the construction of roads and infrastructure activities also pose major threats to the biodiversity and ecological corridors of the forest areas. Well-built roads can increase tourist inflow, as they enable easier access to the area, but also open up the possibility of commercial developments like hotels, guest houses, and other

permanent establishments that lead to pollution and subsequent destruction of local biodiversity and ecosystems [16].

**Research initiatives:** National and International cooperation and grants should be enhanced for the conservation of *Mahananda Wildlife Sanctuary* and the village communities staying at *Latpanchar*. Research grants should be raised for exploring the socio-ecological dynamics of the village and human-biodiversity interaction. Training programmes, seminars and workshops should be organized for highlighting conservation status in Mahananda Wildlife Sanctuary and adjoining village areas.

#### 4. CONCLUSIONS

The present work is the first ever socio-environmental study conducted in *Latpanchar* village till date. Extensive investigations in the hill areas should be carried out so that necessary measures may be undertaken for their conservation. Our previous research papers highlighted the socio-ecological and environmental perspectives of some of the hamlets situated in the Eastern Himalayas [4, 6, 7, 15, 28, 29]. Considering Eastern Himalayas as a 'bio-cultural hotspot' may be useful in understanding the dynamics and complexity of the landscape. It is a challenge for ecologists and environmental scientists to ensure that modernization of the native cultural values in the Eastern Himalayas takes place through a careful, step-by-step transformation. The aim should be to provide lasting and synergistic benefits for the local population in rural and semi-urban landscapes. The people of the Eastern Himalayan hamlets like *Latpanchar* are gradually realizing the importance of protected areas and are willing to engage in the decision-making process. Bringing local populations into protected area management will also have a significantly positive impact on long-term conservation of the Eastern Himalayan landscape.

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