

Forestry and Watershed Management

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1. ECOLOGICAL ASSESSMENT OF THE STUDY AREA FOR ALLAIN DUHANGAN HYDROELECTRIC PROJECT

1.1 INTRODUCTION

The Allain-Duhangan hydroelectric project falls in the Beas basin and is expected to generate about 192 MW of power. The Ministry of Environment and Forests have already cleared the project from environmental and forest angles. A detailed ecological assessment of the proposed project area was required to be completed. The primary objective of the ecological assessment was to look into the biodiversity aspects of floral and faunal species and to identify any special feature related to them, including any region of biosensitivity.

1.2 APPROACH AND METHODOLOGY

A participatory and consultative approach was followed for executing the assignment on Ecological Assessment of a Hydroelectric Project in Manali, District Kullu, Himachal Pradesh. A team of consultants visited the project catchment near Manali and conducted the ecological survey of the area. The ecological survey was conducted in March 2003. Meetings were also held during the ecological survey with forest officials, officers from the fisheries department and local villagers, as part of public consultations.

During the survey period, the project catchment area was facing winter season. Climatologically, fresh snowfall and rains were experienced during ecological survey, due to late start of snowfall this year. As a result of fresh snowfall, the higher reaches of the project catchment area were snow bound. The temperature during the survey period ranged approximately from 2°C to 17°C. The temperature of the water of the Allain and Duhangan streams were recorded at 5°C to 6°C and 7°C to 8°C respectively during the survey period.

1.2.1 Identification and mapping of forest types

Forest types were closely observed and identified, as also vegetation types were sampled for assessing their ecological status. The forest types are based on the composition of the forests and the dominant species found in them. The identified forest types have been confirmed from published and authenticated sources. The identified forest types were mapped, for which a trace print of the project area was developed for depicting the various forest types on it.

1.2.2 Phytosociological survey

The vegetation was sampled by employing standardised field ecological survey methods. Random sampling was employed for enumerating the Phytosociological characteristics of the various elements of the vegetation.

The study area was divided into four Transects based on the location of survey. These four Transects are given below in *Table 1.1* along with their locations within the project catchment.

Table 1.1: *Sampled Transects and their location within the project catchment*

Transect	Location within Study area
Transect 1	Region encompassing the area covered along the Upstream of Duhangan stream
Transect 2	Region encompassing the area covered along the route from Prini to Sethan village, via Hamta village, Forebay Reservoir.
Transect 3	Region encompassing the area covered along the Pahali stream, from Prini Village
Transect 4	Region encompassing the area covered along the Allain stream, and adjoining areas where the proposed switchyard and magazine-site (near powerhouse) would come up.

At each Transect, for the purposes of surveying the vegetation, a line transect was taken on both sides of which quadrants were laid to record phytosociological features of the vegetation. Detailed notes on ecological features, including the habitat types were also taken. Depending on the terrain, the available trail was taken as the line transect and quadrants were taken randomly along the sides of the line transect. Based on the vegetation type, the quadrants were of two sizes. For tree-dominated forests, the quadrants measured 100 sq. m and for grasslands and pastures or herb-dominated patches of vegetation, the quadrant size was 1 sq. m. These are recommended quadrant sizes for such vegetation types and have been variously used in many studies world-wide. A total of 80 quadrants were taken for the ecological survey of the project catchment. Twenty-five quadrants each were taken at Transect 1 and 2 and 15 quadrants each were taken at Transect 3 and 4.

Quadrant analysis was then performed and phytosociological parameters were worked out. These parameters include frequency, density and abundance.

Three phytosociological parameters, namely, frequency, density and abundance are measured to determine the distribution and ecological aspects of the species. Frequency is expressed in percentage and is a reflection of the probability of encountering the species within the sampled area. It is calculated by dividing the number of quadrants of occurrence by the total number of quadrants taken. Density is a measure of how dense is the distribution of an individual species within a given area. It is calculated by dividing the number of individual of a species by the total number of quadrants taken. This is an absolute value without units. The third parameter, Abundance, is a reflection of how evenly the species is distributed within the sampled area. It is calculated by dividing the number of individuals of a species by the total number of quadrants in which that species is present. It is an absolute value without any units.

1.2.3 *Faunal survey*

The animal species were observed and recorded at each of the four transects. Due to the time of ecological assessment and survey of the project catchment in winter and due to prevailing climatic conditions, including fresh snowfall and rainfall, many of the wild animals were not observed. The population sizes of the observed species were also low. Some of the higher reaches of the project catchment were inaccessible due to snow cover.

Animal presence was measured both through direct sightings and by indirect measures, such as quills, scats etc. All along the line transect, visual

observations were recorded for a distance of up to 200 m on both the sides of the line transect. Binoculars were used for recording details of distant animals.

To ascertain aquatic diversity, mainly fishes, both the Allain and Duhangan streams within the project catchment area were surveyed. Different types of methods were used for surveying the streams for fishes. Trap nets, Dragnets, and Fish Traps were used. Three trap nets, 3 dragnets, and 3 fish traps were used. Trap nets and fish traps were laid in three locations simultaneously for a period of 5 hours, after which they were taken out and checked for any yield or fish catch. Dragnets were used for checking for fishes with special adaptations that remain attached to under surfaces of rocks to avoid fast stream flow. For each of the two streams, nets were fixed in six locations. Therefore, nets were fixed in a total of twelve locations. Similarly, Dragnets were also used at twelve locations. For each stream, survey locations started from area near the confluence of these streams with Beas and then moving upstream. *Figure 1.1, Figure 1.2, Figure 1.3 and Figure 1.4* shows the attempts for catching fishes in Allain and Duhangan streams.

1.2.4 *Biodiversity aspects of flora and fauna*

Besides measuring these parameters, other biodiversity aspects in the form of endemic status, conservation status and life form have been enumerated. For all the species found in the area during ecological survey, Red Data Books of the Botanical Survey of India have been screened to verify their conservation status. For wild animal species, Schedule 1 of the Wildlife Preservation Act (1972) has been screened.

1.2.5 *Species Diversity – flora and fauna*

Shannon Diversity Index has been used for estimating the diversity between the four-sampled Transects in order to highlight the most diverse Transect. The Shannon Diversity Index was calculated both for floral and faunal species. Diversity index is a unit of number of species and measures the effective number of species present in a sample. This effective number is expressed as the measure of the degree to which proportional abundance's are distributed among the species. Thus, Shannon index is a measure of the average degree of uncertainty in predicting what species an individual chosen at random from a collection of 'S' species with 'N' individuals will belong.

1.2.6 *Catchment area Survey*

Upon field survey, observations have been made with regard to the land use in the catchment area and special attention was paid to present / potential problems in the area such as deforestation, soil erosion, bank degradation, and suggestions have been made accordingly.

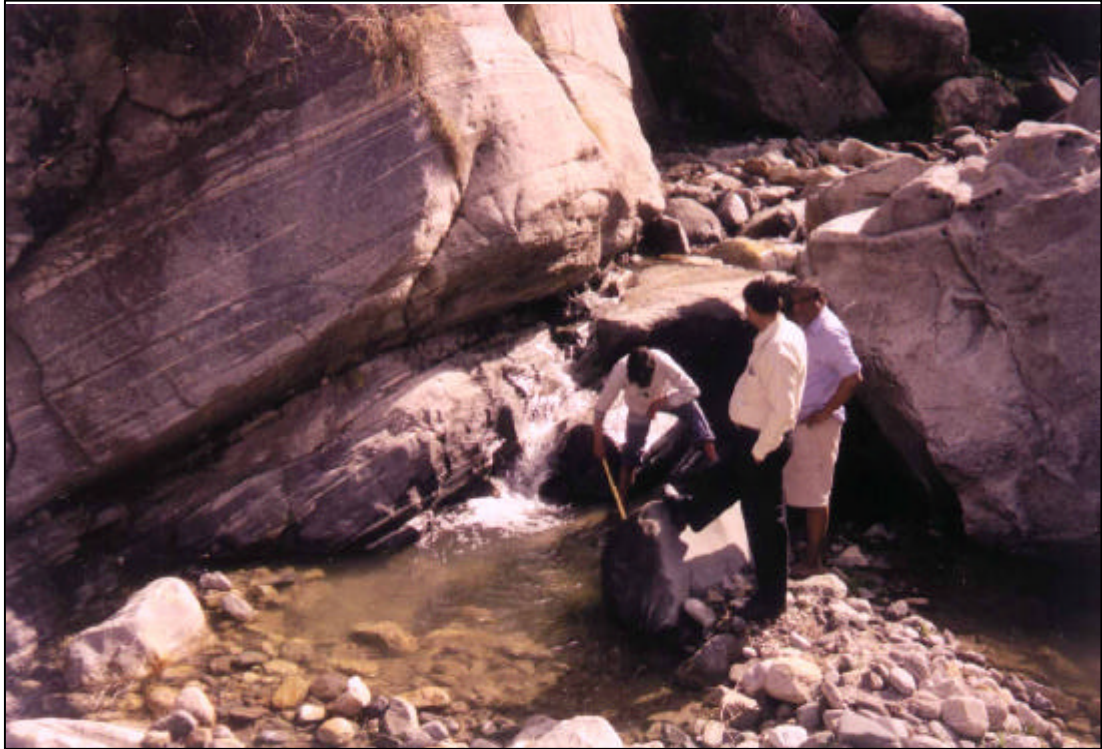


Figure 1.1: Attempts for catching fish at Allain Stream during ecological survey



Figure 1.2: Attempts for catching fish at Duhangan Stream during ecological survey



Figure 1.3: Fish catch – Fingerling caught at the confluence of Duhangan stream and Beas river



Figure 1.4: Fish catch from Beas at a local trader near Manali

1.3

OBSERVATIONS AND DISCUSSION

1.3.1

Overview of forest resources of Himachal Pradesh

The forests of the State have been classified on an ecological basis as laid down by *Champion and Seth*, and can be broadly classified into Coniferous Forests and broad-leaved Forests. Distribution of various species follows fairly regular altitudinal stratification. The vegetation varies from Dry Scrub Forests at lower altitudes to Alpine Pastures at higher altitudes. In between these two extremes, distinct vegetational zones of Mixed Deciduous Forests, Bamboo, Chir, Oaks, Deodar, Kail, Fir and Spruce, are found. The richness and diversity of flora of Himachal Pradesh can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the State. About 150 species are exotics, introduced over the last 150 years.

Geographically, the total legally defined forest area of the state is 37,033 sq. km, of which about 13,083 sq km is under tree cover. Thus about 35.3% of the forest area is under tree cover. Dense forest (crown density >40%) in the state is about 9,120 sq km (16.38%). In district Kullu, out of the total geographic area of 5,503 sq km, legally classified forest area is 4,956 sq km. Of this, about 1,631 sq km is dense forest (crown density >40%).

1.3.2

General Description of the Project Catchment Area

The project falls in the state of Himachal Pradesh representing the Himalayan Biogeographic Zone and specifically in the Biotic Province of the Northwest Himalayas. The altitude of the study area shows a wide variation and ranges from 1700 m (near Beas river) to 4800m (near Allain barrage) above the mean sea level. Characteristically, the area is a temperate zone, but based on variations in the altitude, sub temperate to alpine vegetation is found across the altitudinal gradient.

The project catchment area faces a strong and rather long winter from October to April. During the winter season, the higher reaches of the study area are always snow bound. Until end of March and sometimes up to the middle of April fresh snowfall is experienced in the area. December to February is the time for heavy snowfall and access to most of the proposed construction sites for barrages on both Allain and Duhangan remain inaccessible during this period of heavy snowfall.

Recorded rainfall for the project catchment for the years 1979 to 1994 indicate average rainfall of 1302.96 mm. The snowfall averages at about 343.26 mm annually. The entire project catchment is rich in water supply and water availability is adequate throughout the year. Flow rates are reduced during winter. The Allain, Duhangan and Pahali streams are perennial and drain into the Beas river.

On the basis of Primary Water Quality Criteria, it can be concluded that quality of Beas river falls under 'A' category of water with respect to pH, DO and BOD. The critical parameters observed is Total Coliform according to which category of river comes down to 'C' category in general in some stretches, which are close to towns. Table 1.2 gives the water quality of Beas measured in Manali.

Table 1.2: *River water quality measured at Manali U/S, 1001-R-BEAS*

Month and Year	Parameter				
	pH value	Dissolved Oxygen (mg/L)	Biochemical Oxygen Demand (mg/L)	Total Coliform (mg/L)	Category*
June 2001	8.16	9.8	0.1	17	A
September 2001	7.89	10.5	1.1	34	A
December 2001	7.53	11.6	0.5	350	B
March 2002	7.38	11.5	1.2	9	A

*Category A: Total Coliforms equal to or < 50, pH between 6.5 and 8.5, DO equal to or >6mg/L, BOD equal to or <2 mg/L; Category B: Total Coliforms equal to or < 500, pH between 6.5 and 8.5, DO equal to or >5mg/L, BOD equal to or <3 mg/L; Category C: Total Coliforms equal to or < 5000, pH between 6 and 9, DO equal to or >4mg/L, BOD equal to or <3 mg/L; Category D: pH between 6.5 and 8.5, DO equal to or >4mg/L, Free Ammonia equal to or 1.2 mg/L or less; and Category E: pH between 6. and 8.5, Elec conductivity max 2250 micromhos/cm, Na adsorption ratio max 26, Boron max 2 mg/L.

The mountain slopes show good to luxuriant forests. Most forests are pristine stands of spruce-fir associations, pure stands of deodar, mixed oak forests and blue pine forests. The slopes close to the Allain and Duhangan streams show good forest on the north facing slopes and a relatively rocky and less forested area on the south and southeast facing slopes.

Human population in project catchment area

A total of about 3162 individuals were recorded in the three villages of Hamta, Prini and Jagatsukh falling in the project catchment. Of this population, about 34% are involved in agriculture and 18% in non-agricultural activities. Apple orchard is the main agricultural activity. At the site for construction of the Forebay reservoir, there are no villages and also there is no human habitation at the sites of barrage construction on both Allain and Duhangan intermediate and forebay reservoirs.

1.3.3 Forest types

Due to a varied degree of altitudinal gradient, a number of forest types (based on revised Champion and Seth classification system) are found in the project catchment area. These are as follows:

- Western Mixed Coniferous Forests (12/C.1.d)
- Moist Temperate Deciduous Forests (12/C.1.e)
- Kharsu Oak Forests (12/C.2.a)
- Western Himalayan Upper Oak Forests (12/C.2.b)

- Himalayan Temperate Parklands (12/D.S.2)
- Himalayan Temperate Pastures (12/D.S.3)
- Western Himalayan Sub Alpine Fir Forests (14/C.1.a)
- Western Himalayan Sub Alpine Birch-Fir Forests (14/C.1.b)
- Sub Alpine Pastures (14/D.S.1)
- Birch-Rhododendron Scrub Forests (15/C.1)
- Dwarf Rhododendron Scrub (15/E.1)
- Dwarf Juniper Scrub (15/E.2)
- Alpine Pastures (15/C.3)

Forest Types at Project Catchment

During ecological survey, some of these forest types were found and sampled in the study area. Most broad-leaved forests are confined to lower altitudes and the project catchment is dominated by the presence of coniferous forests. Of the above-listed forest types, the following seven forest types were observed at the project catchment. *Figures 1.5, Figure 1.6, and Figure 1.7* shows some of the forest types found in the project catchment area.

1. Western Mixed Coniferous Forest (12/C.1.d) – This is the most common of all forest types found in the study area. It is wide spread and covers most of the slopes extending from the stream and going up to the mountaintops. During survey period, this forest type in the upper reaches of the study area was snow covered. These forest types have a varying mixture of coniferous trees of fine growth. The main constituents of this forest types are fir, spruce, silver fir, blue pine and deodar. Most trees attain a height of up to 50 m and the tree canopy is mostly dense. At few places an intermixing of broad-leaved trees was encountered. The forests also included patches of grassy meadows that contain some deciduous trees. Some of the species found in these forest type in the study area are *Abies pindrow*, *Pinus wallichiana*, *Cedrus deodara*, *Quercus semicarpifolia*, *Acer caesium*, *Deutzia corymbosa*, *Viburnum nervosum*, *Fragaria nubicola*, *Hedera nepalensis* etc.
2. Kharsu Oak Forests (12/C.2.a) – The oak, ranging from 10-20 m height is the chief constituent of this forest type in the study area. This forest is found to be mostly in patches, as an inclusion in the otherwise fir forests. Generally, groundcover is formed by deciduous shrubs (like Barberry) and grasses. Some of the nearby associates of this forest types are blue pines, silver fir and occasionally spruce, although rarely in the study area.
3. Western Himalayan Upper Oak Forests (12/C.2.b) – It is also called as the oak-fir forest. It is a typically two-storied high forest with silver fir towering oak and other deciduous components. Shrubs are more or less present, although known to be pronounced during summer.
4. Himalayan Temperate Pastures (12/D.S.3) – These are found interspersed amongst temperate forests and provide excellent grazing grounds for high altitude wildlife, when it migrates to these areas during extreme winter. Their chief constituent species are grasses and herbs with certain bushy elements also present. *Danthonia*, *Primula*, *Rumex*, *Impatiens*, *Campanula* etc

are mostly found in these pastures. These are observed close to the Western Mixed Coniferous Forests.

5. Western Himalayan Sub Alpine Fir Forests (14/C.1.a) – This is quite similar to the Western Mixed Coniferous Forests but is usually found on a higher elevation. As its name suggests, this forest type is typically dominated by *Abies pindrow* with some amount of tree species coming in from both the lower and higher altitudes. This forest type is found near the boundary of temperate and alpine zones.
6. Sub Alpine Pastures (14/D.S.1) – Typically open patches in between other forests, such as fir forests or sub alpine birch-fir forests, these are chiefly composed of grasses and other herbs. Some of the common grasses found in these forests include *Bromus*, *Dactylis*, *Festuca*, *Danthonia* etc. Herbs such as *Iris*, *Delphinium*, *Gentiana* etc are also found.
7. Alpine Pastures (15/C.3) – This forest type is found at higher altitudes. Typical herbaceous species are found here along with some *Rhododendron* species. Most plants here show good lateral growth instead of attaining height. This is an adaptation against snow and wind. Up on further increasing of the altitude these alpine pastures show Krumholtz vegetation types, which is an extreme adaptation to high velocity winds.



Figure 1.5: Forest types encountered in project catchment: Sub Alpine Pastures, Western Mixed Coniferous Forest and Alpine Pastures

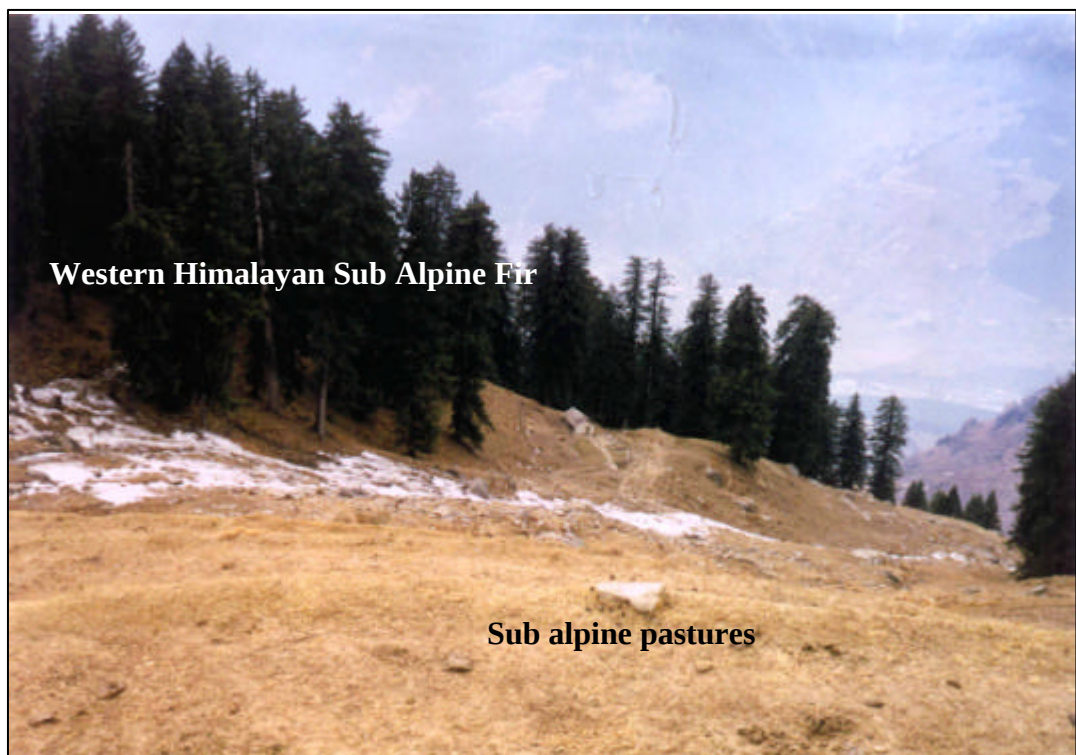


Figure 1.6: Forest types encountered in project catchment: Sub Alpine Pastures and Western Himalayan Sub Alpine Fir Forests



Figure 1.7: Western Himalayan Sub Alpine Fir Forests encountered in project catchment

The location of these forest types in the study area is given below in *Table 1.3* and shown in *Figure 1.8*.

Table 1.3: *Forest types encountered in project Catchment during ecological survey and their locations*

S. No.	Forest Type	Code	Location
1	Western Mixed Coniferous Forest (See Plate 3)	12/C.1.d	Most widespread in the entire study area. Found on the north facing slopes of the Duhangan and Pahali stream and on the upper slopes of Hamta village. Also found on way to Hamta village and upstream of Allain.
2	Kharsu Oak Forest	12/C.2.a	Found on the south-facing slope on Duhangan. Only a small patch of this forest type was found. Also found in the south of the Pahali stream, close to the road itself.
3	Western Himalayan Upper Oak Forest	12/C.2.b	Found in the form of a patchy forest on the north facing slopes of the Allain stream.
4	Himalayan Temperate Pastures (See Plate 3)	12/D.S.3	Found at higher altitudes and near the site for Forebay reservoir. Also observed on the north facing slopes of Pahali stream.
5	Western Himalayan Sub Alpine Fir Forests (See Plate 3)	14/C.1.a	Found upstream of Duhangan before the sub alpine pastures. Present on both the sides of the stream.
6	Sub Alpine Pastures (See Plate 3)	14/D.S.1	Found in the form of thatch on upstream of Duhangan and near the confluence of Duhangan with Kala Nala. Also found on the upper reaches of Hamta and near the reservoir site
7	Alpine Pastures (See Plate 3)	15/C.3	Found in upstream of Duhangan and Allain on way to barrage sites. Mostly restricted to above 3,800 m in altitude. Also seen at higher reaches near intermediate reservoir and beyond proposed Forebay reservoir site.