Tehri Hydro Development Corporation Ltd

Environmental Studies for Vishnugad-Pipalkoti Hydro Electric Project

TERRESTIAL BIODIVERSITY REPORT

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INTRODUCTION & POLICY FRAMEWORK

1.1 INTRODUCTION

The Vishnugad Pipalkoti Hydroelectric Project (VPHEP) is a run-of-the river hydro power project proposed on River Alaknanda in district Chamoli in Uttarakhand. The project envisages construction of a diversion dam near village Helong (79°29' 30 E and 30°30'50" N). The Index map of the project is given as **Fig 1.1**. An underground power house is proposed at village Haat (79°24'56" E and 30°25'31"N), 3 km from Pipalkothi. The installed capacity for power generation is 444MW.

THDC has already undertaken Environmental Impact Assessment (EIA) study for VPHEP through an independent Consultant. Environmental Clearance and Forest Clearance has been obtained from MoEF for the project. However after reviewing the EIA report, THDC felt the need to strengthen the report in certain areas such as downstream issues, terrestrial biodiversity and constructed related impacts. Therefore THDC appointed M/s Consulting Engineering Services (India) Private Limited, New Delhi to carry out the additional studies and prepare a Comprehensive EA Document in line with the requirements of the Government of India and World Bank.

The present study comprise of Terrestrial Biodiversity Study for the VPHEP.

1.2 PROJECT BACKGROUND

River Alaknanda is a major tributary of river Ganga, originating from the glacial regions of Himalayas. The river has tremendous scope for development of hydro-power, which needs to be harnessed to meet the ever-growing demand for power. At present, various hydropower schemes are in different stages of development on river Alaknanda. Vishnugad Pipalkoti is one of the various hydropower schemes envisaged in this region. The river stretch under the project is about of about 27 km from village Helong to village Birahi.

The operation of VPHEP is linked to the upstream projects on Vishnugad (by JP) and of Topovan- Vishnugad (by NTPC). Downstream of this project, further run of the river power project are planned, which will also divert water from Alakananda through headrace tunnel. The salient feature of the proposed hydroelectric project is given in the box below:

Box 1: Salient Features of Vishnugad- Pipalkoti Hydroelectric Project		
Location	$30^0 30' 50''$N to $30^0 25' 31''$E ; $79^0 29' 30''$N to $79^0 24' 56''$ E	
State	Uttarakhand	
District	Chamoli	
Hydrology	Snowy Catchment	2896 km^2
Catchment area	4672km^2	Maximum 10 daily flow: 1308.12 Cumec (average)

Box 1: Salient Features of Vishnugad- Pipalkoti Hydroelectric Project			
at Vishnugad		Average Annual Runoff: 5682.6 MCM	
Head Race Tunnel		**U/S Surge Shaft**	
Type	Modified Horse Shoe	No.	01
Size	8.8 M	Type	Controlled orifice
Length	13.4 KM	Diameter/ Depth	U/S 2 m/ 110m
Tail Race tunnel		**D/S Surge Shaft**	
Type	Modified Horse Shoe	No.	01
Size	8.8m	Type	Underground
Length	3.07 km	Diameter / Depth	120 x 12 x 27
Penstock		**Underground Power House Complex**	
Number	4	Installed Capacity	111 x 4 = 444MW
Size	5.20 M/ 3.65 M dia	Size	127 x 20.3 * 50 M
Type	Circular	Turbine	Francis.4Generating Units
Length	351 m/36.7 m	Gross / Net Head	237m/211m
Switch Yard		**Transmission of Power**	
Size and Type	8 Bays/GIS/420 KV	By transmission Line Constructed by Power grid Corporation	

Source: Tehri Hydropower Development Corporation, 2008

1.3 SCOPE OF WORK

The scope of Terrestrial Bio-diversity study includes survey of flora and fauna of the Project Affected Area-PAA, Project Immediate Influence area-PIIA (500mt on either side of constructions sites), and Project Influence Area-PIA (7 Km Surrounding Project Sites). Scope of Biodiversity assessment is as below:

- To conduct Botanical survey of flora with reference to. taxonomy and physio-gnomical approach
- The flora survey also include information on forest type, cover structure of forest, major and minor associations
- Composition & structure of forest with reference to abundance, distribution, phenology, & ethno-botanical approach for major forest species
- To identify ecological status of flora & fauna species with reference to endangered, rare, threatened or endemic. Categorization of species as native or exotic species, commercially important species, weed or parasite species

- To identify major uses of tree species in terms of timber, fodder, food, medicinal etc base on available literature as well as through consultation with local institute / people
- Calculation of density and diversity flora
- Preparation of map of the study area
- To identify major and minor habitats of fauna
- To identify major threats to existing biodiversity
- To review compensatory afforestation plan/ Catchments Area Treatment Plan and re-devolvement plan for Muck Area Disposal of VPHEP and recommend vegetative measures.
- To formulate biodiversity management plan for protection of flora and fauna

1.4 POLICY AND LEGAL ASPECTS OF BIODIVERSITY CONSERVATION

Biogeographically, India is situated at the tri-junction of three realms, namely Afro-tropical, Indo-Malyan, and Paleo-Arctic realms and therefore, has characteristic elements from each of them. As a result, India has a rich biological heritage that qualifies it as one of 12 mega diversity nations of the world. (Gadgil 1992)

In order to project biodiversity resources of the country Government of India (GOI) is actively involved in various conservation measures such as establishment of National Parks & Sanctuaries, Biosphere Reserve Program, World Heritage Sites, Specific Animal Targeted Project (Project Tiger 1973, Project Elephant 1991-92, Rhinoceros i.e. Sanctuary / National Park in North East and North West India), etc. Besides this GOI is actively co-operating with other nations with reference to biodiversity conservation. There are many international treaties/regional treaties concentrate specifically on conservation and use of global biodiversity. Following are some of the international treaties relevant to biodiversity

- Convention on Biological Diversity, (1992)
- Convention Relative to the Preservation of Fauna and Flora in their Natural State. 8th Nov. 1993, London
- International Plant Protection Convention. 6th Dec. 1951, Rome
- Plant Protection Agreement for South East Asia and Pacific Region 27th Feb. 1956, Rome
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat 2nd Feb 1971, Ramsar
- Convention on the conservation of Migratory Species of Wild Animals, 23rd June 1979, Bonn

- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 3rd March 1973, Washington
- International Tropical Timber Agreement 19th Nov. 1983, Geneva

International Treaties to which India is a signatory:

- Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)
- The United Nations Convention on Biological Diversity

1.4.1 Legal Framework

Govt. of India has established policy framework to conserve biodiversity of the nation that foster the sustainable use of biological resources and the maintenance of biodiversity. The economic policies and legal frameworks established by GOI create the incentives and obstacles that influence decision about how to utilize and manage biological resources. Following are some of the legal & policy framework which relates specifically to biological diversity.

- Biodiversity Act, 2002
- The Biological Diversity Rules, 2004
- Environment (Protection) Act ,1986
- The Forest (Conservation) Act, 1988
- The Indian Forest Act, 1927
- The Wildlife (Protection) Act,1972 , amended 2002
- National Conservation Strategy 1992
- National Wildlife Action Plan 1973
- OP/ BP/ GP 4.04 Natural Habitat
- OP/ BP 4.36 Forests

Under the Biodiversity Act, National Biodiversity Authority (NBA) is formed at central level. NBA regulates activities and issue guidelines for access to biological resources and for fair and equitable benefit sharing.

State Biodiversity Board (SBB) is formed at state level. State Biodiversity Board Uttarakhand was establishment as per notification No.1773/X-2-2006-8(83)/2001 dt.01-04-2006

Functions of State Biodiversity Board

- Advise the State Government, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources;
- Regulate by granting of approvals or otherwise requests for commercial utilization or bio survey and bio utilization of any biological resource by Indians;

- Perform such other functions as may be necessary to carry out the provisions of this Act or as may be prescribed by the State Government.

1.4.2 Protected Area in Uttarakhand

There are 97 existing National Parks in India covering an area of 38,199.47 km^2 which is 1.16% of the geographical area of the country (National Wildlife Database, June, 2008). Uttarakhand have 6 national parks covering an area of 4,731km^2 which is 8.85% of the geographical area of the state. Two national parks Nanda Devi National Park and Valley of Flowers National Park fall in the Alaknanda basin.

There are 508 existing wildlife sanctuaries in India covering an area of 118,236.94km^2 which is 3.60% of the geographical area of the country (National Wildlife Database, June. 2008). Uttarakhand have 6 wildlife sanctuaries covering an area of 2418.65km^2 which is 4.52% area of the state. The Kedarnath Wildlife Sanctuary falls in Alaknanda Basin. No wildlife sanctuary or national park fall in the project area. The project area falls in the transitional zone of Nanda Devi Biosphere Reserve.

Table 1.1: Status of Protected Areas

Location	National Parks	Sanctuaries	Biosphere Reserve	Conservation Reserve	Community Reserve
India	97	508	14	7	2
Uttarakhand	6	6	1	2	0
Alaknanda Basin	2	1	1	0	0
Project Area	0	0	1	0	0

Table 1.2: List of Protected Areas in Uttarakhand

Location	National Park	Wildlife Sanctuary
Uttarakhand	i. Nanda Devi National Park ii. Valley of Flowers iii. Rajaji National Park iv. Corbett National park v. Gangotri National Park vi. Govind National Park	i. Kedarnath Wildlife Sanctuary ii. Binsar Wildlife Sanctuary iii. Mussoorie Wildlife Sanctuary iv. Govind Wildlife Sanctuary v. Askot Wildlife Sanctuary vi. Sonanadi Wildlife Sanctuary

Source: Wildlife Institute of India, Dehradun, 2008

Table 1.3: Status of Forest Cover

Place	Geographical Area km ^{2}	Dense Forest km ^{2}	Moderately Dense Forest km ^{2}	Open Forest km ^{2}	Percent of Geographical Area
India	32,87,263	54,569	3,32,647	289,872	20.60
Uttarakhand	53,483	4,002	14,396	6,044	45.7
Chamoli District	8,030	406	1,558	734	33.60

Source: State of Forest Report 2005, Forest Survey of India, Dehradun

1.5 OUTLINE OF THE REPORT

The outline of the Draft Final Report for Terrestrial Biodiversity is given below

Chapter 1: Introduction

Chapter 2: Biodiversity Assessment Methodology

Chapter 3: Baseline Biodiversity Status

Chapter 4: Impact of Project Activities on Biodiversity

Chapter 5: Biodiversity Management Plan

Chapter 6: Recommendations

CHAPTER 2
BIODIVERSITY ASSESSMENT METHODOLOGY

2.1 INTRODUCTION

The main objective of ecological survey is to collect the baseline terrestrial biodiversity status regarding flora and fauna in the Project Influence Area, (7 Km surrounding the project site), project immediate influence area (500 m on both sides along the alignment project impacted area. For Terrestrial ecosystem data has been collected through extensive survey of the areas with reference to flora and fauna. Information is also collected from different Government Organizations such as Forest Department, Forest Survey of India and District Statistical office. On the basis of onsite observations as well as forest department records a checklist of flora and fauna was prepared.

2.2 TERRESTRIAL ECOSYSTEM

The terrestrial eco-system of the study area is dominated by open forest on hills, foothills and river valley. The details of assessment techniques used are discussed below.

2.3 FLORA ASSESSMENT

To characterize the vegetation under the project area study was carried out by using Standard Quadrat Method and Random Sampling approach was followed. Quadrat size of 10 x 10 m used for tree species and 5x5m was used for shrub species. For grasses and herbs 1× 1m quadrats were used. The properties of vegetation with reference to species composition and functional attributes are expressed on species basis. The specific formats used to collect information regarding flora & fauna of the project / study area (**Annexure -I**). The details of forest studies are discussed in details below

2.3.1 Assessment Techniques

The density measurements reflect as to how many individuals were present, the dominance measurements denote which species is largest in terms of its presence and the frequency measurements indicate how widely species is distributed among the same plots Importance value is a reasonable measure to assess the overall significance of a species since it takes into account several properties of the species in the vegetation. Importance value index will be calculated as per Curtes & McIntosh (1950). The following parameters will assessed from the field data measurements.

$$\textbf{(i) Density} = \frac{\text{Number of species A}}{\text{Area sampled}}$$

(ii) Frequency = $\frac{\text{Number of plots in which species A occurs}}{\text{Total no. of plots sampled}}$

(iii) Dominance = $\frac{\text{Total cover or basal area of species A}}{\text{Area sampled}}$

(iv) Relative density = $\frac{\text{Density of species A}}{\text{Total density of all species}} \times 100$

(v) Relative frequency = $\frac{\text{Frequency value for species A}}{\text{Total of all frequency values for all Species}} \times 100$

(vi) Relative dominance = $\frac{\text{Dominance for species A}}{\text{Total Dominance of all species}} \times 100$

(vii) Importance value Index = (relative density + relative dominance+ relative frequency)

(2) Shanon – Wiener Index

The number of species and number of individuals in a community is measure of species diversity which depends on stability of the habitat. Vegetation of the study area was assess by determining Shannon – Wiener diversity index(1963).

$$H = -\Sigma (ni / n) \log_{ln} (ni / n)$$

ni = Number of individuals of each species in the sample

n = Total number of individuals

2.4 FAUNA ASSESSMENT

The fauna assessment technique followed during study varied with type of animal present. The domestic animals were listed based on direct observation during field survey. The list of wild life was obtained from Kedarnath Forest Division Gopeshwar and Badrinath Forest Division Gopeshwar, as well as onsite observations (direct/ indirect method). On the basis of onsite observations and records of Forest Department a checklist of fauna was prepared. Birds were also identified with the help of a binocular.

2.5 PUBLIC CONSULTATION

Public consultation was conducted during survey of the project area to know about various aspects of forest. Information about uses of various plant species by local people as well as sighting of any wildlife species, uses, poaching etc. were obtained through consultation with the local community and Forest Department Officials.

CHAPTER 3
BASELINE BIODIVERSITY STATUS

3.1 INTRODUCTION

Biodiversity encompasses the variety of all life on earth. India is one of the 12-mega diverse countries of the world. The diversity of physical features and climatic conditions in India has resulted in diverse ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems which harbors and sustain massive components of bio-diversity. Bio-geographically, India is situated at the tri-junction of three realms the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms. Because of its unique proximity to all three realms, India possesses a unique assemblage of characteristic elements of biodiversity from each of them.

The floral diversity of India represented by 47,000 species of flowering and non-flowering plants which is about 12% of the world's flora. The faunal diversity is comprised of a total number of 90,000 animal species (Annual Report, 2007-08, National Biodiversity Authority). The forests in India can be divided into 16 major groups comprising 221 types of forests.

3.2 BIODIVERSITY OF UTTARAKHAND STATE

The State of Uttarakhand came into existence as the 27th state of republic of India on 9th November 2000. It lies between 28^{o} 44' and 31^{o}28' N latitude and 77^{o}35' and 81^{o}01' E longitude. The total geographic area of the state is 53,483 km^{2} constituting 1.63 % of the land area of the country. The state has 13 districts, 49 tehsils, 95 development blocks and 15,669 villages. The high altitude mountain ranges of the state are perpetually snow covered and are perennial sources of water not only for the state but also for the down stream states.

The state of Uttarakhand can be broadly divided into four topographical regions as: Plains of Haridwar, Udhamsingh Nagar, Dehradun district, Bhabar & Tarai area of Dehradun and Nainital, Middle Himalayan region, Higher Himalayas and Trans Himalayas. The plains of the state are endowed with rich & fertile soils while the hills are characterized by undulating & rugged topography with varied climate, soil texture, limited land for cultivation, predominance of scattered and marginal land holdings, terrace farming and higher units cost of infrastructure development. The major land cover of the state is under forests followed by agriculture. As terrain and topography of the state is largely hilly with large areas under snow cover and steep slopes, a substantial portion of land cover is not accessible for agriculture

The forests vegetation of the Uttarakhand ranges from tropical dry deciduous forests in the foothills to alpine meadows above timberline. The enriched biodiversity of the state is reflected through its state symbols.

Forests diversity is the main source of livelihood of the people of Uttarakhand. Biodiversity is used variously for fodder, fuel wood, timber, leaf litter for crop manure, construction, industrial raw material and several non timber forests produce.

State Symbols

State Tree: *Rhododendron arboreum* (Burans)

State flower: *Saussures obvallata* (Brahm Kamal)

State animal: *Moschus chrysogaster* (Musk Deer)

State Bird: *Lophophorus impejanus* (Monal)

3.2.1 Forests

The state Uttarakhand is covered with rich forests. The recorded forest area of the state is 34, 662 Sq.Km which constitute 64.79 % of its geographic area of the state. 8 out of 16 forests types existing in India are found in Uttarakhand.

Natural Flora

Remarkable variation in altitude and forests types resulted in diversity of flora recorded through out the state. The floristic diversity of the Uttarakhand state is represented by a total number of 4,048 species belonging to 1,198 genera and 192 families. The angiosperm is comprised of 4,000 species while gymnosperm of 48 species. It is estimated that nearly 116 species are endemic to the state. The state harbours 161 rare and threatened species as per the IUCN guidelines. More than 350 species of plants are threatened and endangered in all forested area of the state. Most of these threatended plant species occur on the hills and are over exploited for medicinal, aromatic or commercial values.

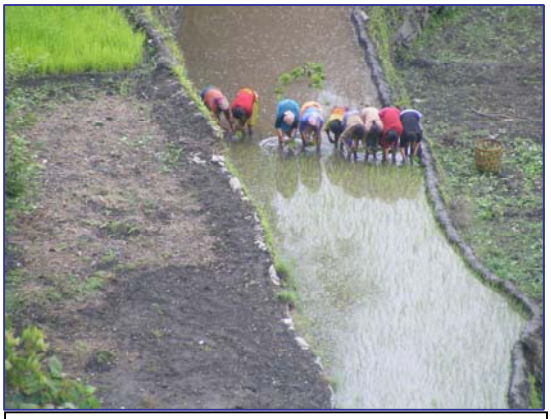
Dense Forest in Kedarnath Forest Division

Dense Forest in Nainital Region

Primary and tertiary forests are located at higher altitudes. These forests are dense and thick lower story is also present in Oak forest. The Forest near habitats and lower elevations are secondary and are disturbed due to human activities and frequent fire.

Agriculture is the main source of livelihood of the people of the state, more than 75% are engaged either in agriculture or its allied practices. Cultivation in the state is done mainly in the narrow patches of terraced fields on hilly slopes. The principle crops are wheat, rice, millets, barley, pulses and oil seeds. The state has proved to be suitable for growing different types of temperate, sub-tropical and tropical fruits. Temperate fruits such as apple, pear, peach, plum, apricot, cherry and walnut are grown in the places of 1000 – 3000 m altitude. Other fruits grown in the state are citrus, mango, guava, papaya and strawberry. Among vegetables potato is the most important cash crop.

Orange common fruit in the area



View of paddy transplantation

3.2.3 Natural Fauna

Musk Deer

The variation in altitude, forests types and vegetation leads to the variation in faunal diversity of the state. Faunal diversity of the state is represented by a total number of 2,248 species of which 1045 are invertebrates and 843 vertebrates. The state is a home for many species of pisces (124), amphibian (19), reptelia (69), aves (521) and mammals (102). The diversity of faunal components in Himalayas clearly indicates the extent of fauna restricted to the forests zone and above timberline, including a remarkably high percentage predominance of Indo-Malayan elements. The richness of fauna is distinctly higher in forests zone especially in the broad-leaf wet forests.

Sambar, Dear, Wild Boar in the sub-tropical foot hills ; Musk dear, Serow, Thar, Koklas and Monal Pheasants in the temperate and sub-alpine region and in alpine region are Bharal, Snow Leopard, Brown Bear and Snow Cock are some of the significant wildlife of the state. The threatened species of fauna of the state is

represented by 14 species of mammals, 8 species of Birds, 5 species of reptiles and 12 species of Insects.

The common domestic animals are represented by common livestock. Livestock rearing along with agriculture is the main occupation of people. Sheep & goats are reared in high altitudinal region. Pasture lands are usually above 2000 m while in winter they move down ward to river valleys or low-lying areas. Cows are reared in the middle and low altitudinal regions and are the major source of milk. Buffaloes are major source of milk & milk products. Goat, sheep, horse, mule, donkey and pony are used for transportation of goods.

3.3 BIODIVERSITY OF ALAKNANDA RIVER BASIN

The Alaknanda River is the major tributary of the river Ganga. The Alaknanda originates at a height of 3641 meters below Balakun peak 16 km upstream from Badrinath form the two glaciers of Bhagirath Kharak and Satopanth. The total catchment of the river Alaknanda is 4672 km^2. The Alaknanda valley is U –shaped in the initial stretches: a typical feature of glacial valleys.

View of River Alaknanda

Confluence of River Alaknanda & River Pindar at Karanprayag

Saraswati river joins the Alaknanda at 9 Km downstream from Mana. Khilrawan Ganga joins it below the Badrinath Shrine and Bhuynder Ganga below Hanuman Chatti. Downstream small tributaries- Helong, Garud, Patal and Birahiganga join the Alaknanda between Joshimath and Chamoli. The rivers of Chamoli district generally flow with great force in steep and narrow channels often resulting in excessive erosion and collapse of the banks. Alaknanda River forms five major confluences given below

i. With Dhauliganga river at Vishnuprayag,
ii. With Nandakini river at Nandprayag,
iii. With Pindar river at Karanprayag,
iv. With Mandakini river at Rudraprayag
v. With Bhagirathi river at Devprayag.

3.3.1 Forest & Natural Flora

The unique geographical location climate and topography along with latitudinal variation of the area has endowed the Alaknanda basin with highly luxuriant and diverse flora. Depending upon the altitude and floristic combination Botanical survey of India, Dehradun identified 800 species of plant. The following major forest types have been identified:

i. Himalayan Sub tropical Pine (between 900 – 2000m)
ii. Temperate Forest (between 2000-2800).
iii. Sub alpine Forest (between 2800-3800m).
iv. Alpines land (above tree line between 3800-4500m).
v. Alpine meadows (above tree line in above 3800-4500m).

Out of the total forest cover of the Alaknanda Basin above 47% area is under dense forest (74% crown cover) followed by 35% not open cover (10-40% crown cover) and 17% under less than 10% crown cover.

(I) Himalayan Sub tropical Pine

This forest type occur between 900m to 200m and is is described in thesection under Project influence , Project Immediate Affected Area and Project Affected Area

(II) Temperate Forest

Temperate Forest occurs between 2000-2800m and are of two types - Deciduous forests and Evergreen Forest

Deciduous forests include deciduous broad leaved species. The common tree species are *Acer cappadocium, Juglans regia*, *Corylus jacquemontii, Celtis australis, Populus regia, Alnoides* and *Meliosma dilleniaefolia*. Shrubs such as *Rubus, Desmodium elegans, Viburnum cortinifolium, Deutzia staminea* and *Arundinaria falcata* are common in the middle layer

Evergreen forests which are found along with the deciduous forests are dominated by the Coniferous trees. *Picea smithiana, Pinus wallichiana* and *Quercus floribunda* are dominant species and middle canopy is dominated by *Sarcococca saligna, Rosa moschata* and *Arundinaria falcata.*

(III) Sub Alpine Forest

Sub Alpine Forest occur between 2800-3800m and are of two types (a) deciduous forests which are distributed in Dudh Ganga, Lata Kharak, Sainikarak, Himtoli, Dibrughetta, Deodi Trishul nullah, Ramni, Bagnidhar, and Bhujgara. *Acer acuminatum, Prunus comuta, Salix disperma, Populus ciliata* and *Sorbus foliolosa* are the dominant tree species of the forest and supported by shrubs such as *Rubes glaciale, Sarcococca saligna, Salix denticulate, Desmodium elegans, Viburnum cortinifolium, Rosa sericea, Lonicera werbiama, Rhododendron campanulatum, Syrina emodi, Sorbus foliolosa, Crotoneaster affine* and *Ailanthus nepalensis*

Evergreen forest occurs in the same localities. These are dominated by *Abies pindrow, Abies spectabilis, Pinus wallichiana* and *Taxus baccata.* The other associates are *Betula utilis, Prunus cornuta,* and *Acer acuminatum*.

The middle layer is dominated by *Salix elegans, Rosa macrophylla, Rosa serica, Lonicera augustifolia, Sorbus foliolosa, Berberis aristara, Inula cuspidata* and *Rubes himalayensis.*

(IV) Alpine Scrubland

Above treeline, between 3800 and 4500m scrubs namely *Rhododendron anthopogon, Rhododendron lepidotum, Rhododendron campanulatum, Juniperus indica, Juniperus recurva, Cotoneaster microphylla, Cotoneaster integrifolius, Berberis umbellate, Cassiope fastigiate, Salix karelinll, Salix hylematica, Salix calyculata, Salix lindleyana, Lonicera spinosa* and *Lonicera obovata* are found growing luxuriantly and forms peculiar associations. The common associations are:-

(a) *Rhododendron – Crotoneaster* association includes species such as *Rhododendron lepidotum, R. anthopogon, Cotoneaster microphylla* and *C. integrifolius.*
(b) *Piptanthus – Crotoneaster-Rhododendron* association includes species such as *Cotoneaster microphylla, Piptanthus nepalensis* and *Rhododendron lepidotum*.
(c) *Salix – Rhododendron* association includes species such as *Salix karelinii, S. hylematica, S. lindleyana* and *Rhododendron anthopogon.*
(d) *Juniperus – Lonicera* association includes species such as *Juniperus indica, J. recurva, Lonicera spinosa* and *L. obovata.*
(e) *Rhododendron – Cassiope* association: species are *Rhododendron anthopogon* and *Cassiope fastigiata*

(v) Alpine Meadows

Alpine meadows are mainly dominated by herbaceous species. Few scrubs such as *Juniperus indica, Nicera obovata, Rhododendron anthopogon, Cassiope fastigiata, Salix hylematica* and *S. Rindleyana a*re found in the meadows.

The herbaceous species of the meadows are *Tanacetum tomentosum, Iris kumaonensis, Nomocharis oxypetala, Artemisia maritime, Allium wallichii, A humile, A. stracheyi, Leontopodium himalayanum, Dactylorhiza hatagirea, Geranium wallichianum, Cortia depressa, Anaphalis contorta, A. busua, Sibbaldia purpurea, Rhodiola bupleuroides, Potentilla astrosanguinea, P. argyrophylla, Thymus linearis, Polygonum affix, Anemone rupicola, A. obtusiloba, Danthonia cachemiriana, Carex nubigena, C. nivalis, Pedicularis hoffmeisteri, P. bicornuta, Thalictrum alpinum, Lloydia serotina, L. longiscapa, Jurinea himalaica, Gentiana argentea, G.carinata, , Geum roylei, Bupleurum candollei, Taraxacum officinale.*

3.3.2 The Natural Fauna

The Alaknanda Basin has a wide variety of mammals & birds. An account of 17 known rare & endangered of mammals is given by Sathya Kumar (1993) who added 3 more species to the earlier record of Tak & Lamba (1985) and Lamba (1987). The important mammals are Snow Leopard (*Panther uncia*) (Dang 1967), Kachan 1978,

Kandan (1982), Himalayan black bear (*Selenarctos thibetanus*), Himalayan brown bear (*Ursus aretos*) Himalayan Musk deer (*Moschus chrysogaster*), Bharal (*Psueudois nayaur*) Himalayan Tahr (*Hemitragnus jemlahicus*).

Some of the important high altitude birds formed in the reserve are Monal pheasant (*Lophophorus impejenus*) Snow cock (*Tetroaogallus himalayensis)*, Koklas pheasant (*Pucrasia macrolopha),* Chukor (*Alectoris gricea*), Snow partirift (*Lerwa perwa*), Kaleej Pheasant (*Lophura lencomelanos*) and Snow Ridge (*Columba lanconota*) (Recd 1979, Tak and Kumar 1983).

Monal Pheasant

3.4 NANDA DEVI BIOSPHERE RESERVE (NDBR)

Nanda Devi Biosphere Reserve (30° 05'-31° 02'N Latitude, 79()12'-80^{0}19'E Longitude) is located in the northern part of west Himalaya and comprises of parts of Chamoli district in Garhwal, Bageshwar and Pithoragarh districts in Kumaun in the Uttarakhand State (**Fig 3.1**). It has a large altitudinal range (1,800-7,817 m msl). It belongs to Himalayan Highland Biogeographic Zonation of India and among the World Heritage Sites.

The Area Statement

Initially in 1988 the notified area under NDBR was 2,236.74 km^2 with 624.62 km^2 as core zone with no human interference except research and patrolling and rest as buffer zone. On 07-02-2000 GOI extended the total area of NDBR from existing 2,236.74 km^2 to 5,860.69 km^2 and core area has been extended to 712.12 km^2 by adding the Valley of Flower National park as the second core zone. The core zone consist of Nanda Devi National Park area and area of Valley of Flowers National Park

Biosphere Reserve (BR) is an international designation by UNESCO for representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/marine ecosystems or a combination thereof. The programme of Biosphere Reserve was initiated under the 'Man & Biosphere' (MAB) programme by UNESCO in 1971. The National Biosphere Reserve Programme was initiated in 1986 and NDBR was notified on 19 Jan 1988. In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones. These are:

(I) Core zone

The core zone is defined as absolutely undisturbed zone. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. Core areas often conserve the wild relatives of economic species and also represent important genetic reservoirs. The core zones also contain places of exceptional scientific interest**. A core zone secures legal**

protection and management and research activities that do not affect natural processes and wildlife are allowed. In NDBR strict conservation measures are taken to presrve the core zone and no human activity except regulated tourism is allowed inside the core zone. Regular patrolling activity and monitoring atictivity is taken up in side the core zone

(II) Buffer zone

The buffer zone adjoins or surrounds the core zone. In this Zone, uses and activities are managed in ways that protect the core zone. These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing and grazing, which are permitted to reduce its effect on core zone. Research and educational activities are to be encouraged. Human activities, if natural within Biosphere reserve, are likely to be permitted to continue if these do not adversely affect the ecological diversity.

(III) Transition zone

The Transition Zone is the outermost part of a Biosphere Reserve. This is usually not delimited one and is a zone of cooperation where conservation, knowledge and management skills are applied and uses are managed in harmony with the purpose of the Biosphere Reserve. This includes settlements, crop lands, managed forests and area for intensive recreation, and other economic uses characteristic of the region. Under this efforts are made to set up a harmonius and mutually benefiting mechanism where both forest and the people who's livelyhood is based on the use of forest , may live in perfect peace and harmony.

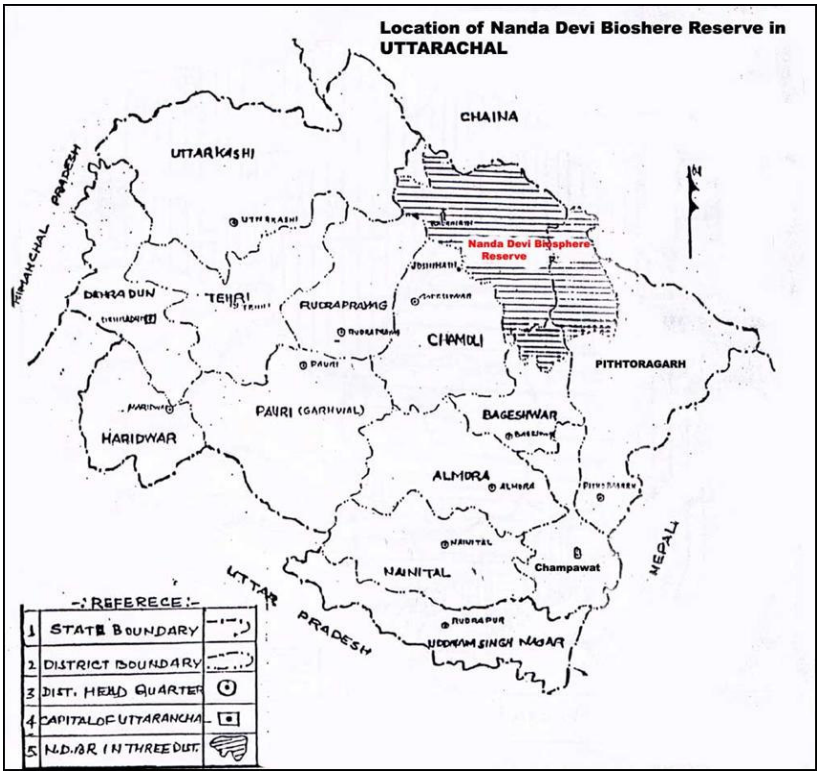


Fig 3.1: Location of Nandadevi Biosphere Reserve in Uttarakhand

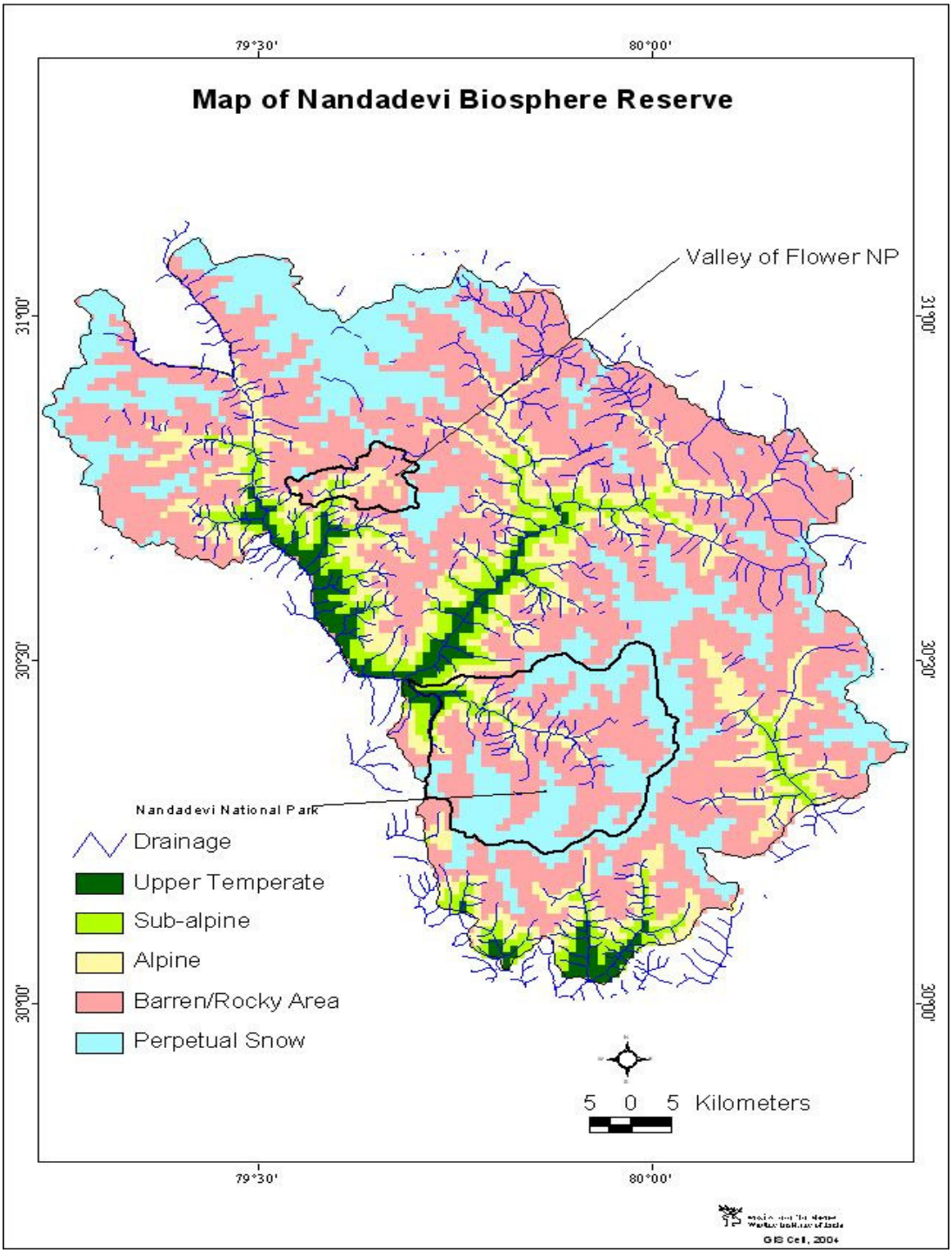


Fig 3.2: Physiographic Map of Nandadevi Biosphere Reserve

Nanda Devi Basin has a distinctive microclimate. Conditions are generally dry with low annual precipitation, but there is heavy rainfall during the monsoon from late June to August. The basin is usually snow-bound for six months between October and March, the snow accumulating deeper and at lower altitudes on the southern than on the northern side of the valley.

3.4.1 The Core Zone

The total core area of the NDBR consists of 712.12 km^2 and is completely protected. It comprises two National Parks of international repute.

i. Nanda Devi National - total area 624.6 km^2
ii. Valley of Flower National Park - total area of 87.5 km^2.

View of Wildlife in Nandadevi National park

View of Valley of Flowers

The core zone of NDBR harbors high diversity of species, alpine communities, rare, endangered, native and endemic species of both flora and fauna. The core area has 17 species of mammals such as Snow Leopard *(Panthera uncia).* Leopard *(P. pardus),* Himalayan Black Bear *(Selenarctos thibetanus),* Himalayan Brown Bear *(Ursus aretos),* Himalayan Musk Deer *(Moschus chrysogaster)* Blue sheep *(Pseudois nayaur),* Himalayan Tahr *(Hemitragus jemlahicus),* etc. many species of birds such as Monal Pheasant *(Lophophorous impejanus),* Himalayan Snow Cock *(Tetraogallus himalayensis),* Koklas Pheasant *(Pucrasia macrolopha),* Snow Pigeon *(Columba leuconota),* Himalayan Golden Eagle *(Aquila chrysaetos),* Himalayan griffon *(Gyps himalayensis),* Lammergeier *(Gypaetus barbatus),* etc. (Tak 1997) and 19 species of butterflies such as Common yellow swallowtail *(Papilio machaon).*

Common Blue Apollo *(Parnassius hardwickii),* Bath white *(Pontia daplidice),* Painted lady *(Cynthia cardui),* etc**.** (Baindur 1993). In Nanda Devi National Park about 493 species of plants (Balodi 1993**;** Samant 1993) and from Valley of Flowers 521 species of plants have been recorded (Kala et al. 1998).

The Valley of Flowers National Park has an area of 87.50 km^2. About 63.58 km^2 area is estimated to be under perpetual snow and glaciers based on Satellite Imagery. The forest area of the Park is about 5.29 km and the alpine meadows covers 18.63 km^2 area. Based on the altitude, aspect and climatic conditions the vegetation of the Park is divisible into three broad climatic zones viz., sub-alpine, lower alpine and higher alpine

(Kala et al. 1998). Nanda Devi National Park, covers 624.6 km^{2}area, of which 65 km area is under forests, 20 km area under grasslands, 36 km area under wasteland and 504 km^2 area is under snow/glaciers. The forest density i.e., closed (>40% crown cover) covers 62 km^2 area while degraded (<10% crown cover) covers 3 km^2 area (Sahai & Kimothi 1994).

The changes in the vegetation cover from 1981-1991 indicated that forest resources of the reserve are well conserved or rather improved during the eighties. During this period, even 12 km^2 area under the open forest category has improved to closed forest category. Apparently no biotic interference has taken place resulting in improvement of vegetation cover (Sahai & Kimothi 1994).

3.4.2 The Buffer Zone

The buffer zone adjoins or surrounds the core zone. In the NDBR the whole buffer zone has mainly three types of lands. Vegetation in the buffer zone comprises of temperate, subalpine and alpine types.' It supports over 800 species of plants including fungi, lichens and bryophytes and 520 species of fauna. Over 23 forest communities and over 62 alpine communities have been recorded from the buffer zone of the reserve. Two hundred twenty four species of plants in Pindari area and 193 species in Lata-Tolma-Malari area are used by the native communities for various purposes (Samant 1993,1999; Samant et al. 2000,2001; Bisht etal. 1994; Tewarietal. 1994; Hajra& Balodi 1995;Negi &Gadgil 1996). The buffer zone supports 29 species of mammals (Sathyakumar 1993; Tak 1997; Kala et al. 1998). The important species are Goral *(Nemorhaedus goral),* Indian crested porcupine *(Hystrix indica),* Yellow bellied Weasel *(Mustela kathiah),* etc., 229 species of birds such as Indian whitebacked vulture *(Gyps bengalensis),* Egyptian Vulture *(Neophron percnopterus),* Peregrine Falcon *(Falco peregrinus),* Chukor Partridge *(Alectoris chukor).* White Crested Kaleej Pheasant *(Lophura leuvumvlunu),* Himalayan Red Bellied Blue Magpie *(Cissa erythrorhyncha),* Yellow Bellied Blue Magpie (C. *flavirostris),* etc. (Tak 1997; Khan 2000)

The land cover/land use in buffer zone of old reserve is 1,612 km^2 in which 15 km^2 is under built up and agriculture, 432 km^2 is under forests, 82 km^2 is under grassland, 111 km^2 is under wasteland, and 972 km^2 is under snow/glacier covered area. The forest density (closed with >40% crown cover) covers 172 km" area, forest density (open with 10-40% • crown cover) covers 176 km^2 area and degraded (<10% crown cover) covers 84 km^2 area (Fig. 4) (Sahai & Kimothi 1994).

Forty seven (47) villages are located in buffer zone of the reserve. The villagers are totally dependent on the forests for fuel, fodder, medicinal and wild edible plants and various other purposes. The livestock grazing is common in the grasslands, meadows and forests of the zone. The main economic activities of the buffer zone are cultivation of medicinal plants, horticultural and agricultural crops, Sheep Farming, bee keeping and eco-tourism.

The Forest Panchayat Land.

Under buffer zone 57.92 km^2 land is under Forest Panchayat. These areas are under the direct control of Village Panchyat Committee and are looked after by them under the supervision and guidance of the Divisional Forest Officer.

Civil Forest Land.

The major chunk of the buffer comprises of the civil forest lands and the total area of such land is 4,595.10 km^2. The administrative control of these areas lies with the revenue department but the civil forest being protected forest lands the provisions of Indian Forest Act applies in these areas. From the point of view of NDBR management these areas needs maximum attention because the human population of the NDBR meet their maximum biomass needs from these areas. These areas suffer from maximum forest cover degradation over the years and maximum soil erosion. These areas are also the areas of free grazing and subject to fire incidences.

The Reserve Forest Area.

The buffer zone of the NDBR has 490.17 km^2 of Reserve Forest areas. The Reserve Forest Areas are totally owned and managed by the Forest Department of Uttarakhand. These areas are also subject to human pressure and biotic intervention since almost all the areas are situated in close proximity with the villages.

3.4.2 The Transition zone

The transition zone surrounding the buffer zone covers 546.34 km^2 area and inhabited by 52 villages. The vegetation mainly comprises of temperate, sub-alpine and alpine types. The species composition is almost similar to buffer zone. The transition zone has been identified in May 2002. It forms the cushion for the buffer zone towards the southern boundary. The Joshmath area of the transition zone has been demarcated based on the dependence of habitants in the reserve particularly for fodder, fuel and medicinal plants. The Ghat and Bedani-Auli areas in Chamoli district and parts of Bageshwar and Pithoragarh districts have been demarcated in view of the protection to wildlife and dependence of inhabitants for various purposes. The villagers are totally dependent of plant resources for fodder, fuel, livestock grazing, house building, agricultural tools, religious and various other purposes.

Most area of the transition zone is poorly explored in terms of biodiversity, human dependence, rare-endangered, native, endemic and other economically important species. Development activities such as sheep farming, ecorestoration, eco-tourism, cultivation of medicinal plants, bee keeping, training programmes, etc. need to be encouraged in this zone. The land use pattern mainly comprises of forests, agricultural land, waste land, settlements, cultivable waste land, orchards, etc. The inhabitants are mainly dependent on horticultural and agricultural crops such as Apple (*Pyrus malus),* Walnut *(Juglans regia),* Apricot *(Prunus armeniaca)* Potato *(Solanum tuberosum),* Amaranth *(Amaranthus paniculatus),* Bee keeping, medicinal plants cultivation and sheep farming for income generation.

The main thrust of landscape planing of NDBR is on this zone. This is usually not delimited one and is a zone of cooperation where conservation knowledge and management skills are applied and uses are managed in harmony with the purpose of the Biosphere Reserve. This includes settlements, crop lands, managed forests and area for intensive recreation and other economic uses characteristics of the region.

3.5 BIODIVERSITY OF PROJECT INFLUENCE AREA

The Project Influence Area (PIA) is considered as the 7 Km area surrounding the project sites. Forests of the project influence area falls in Badrinath division and Kedarnath Divisionin District Chamoli. All proposed project units are situated along the bank of Alaknanda River The details of project influence area are discussed below.

3.5.1 Climate

The climate of the area is temperate type with four main season i.e. winter season from Dec-Feb followed by pre-monsoon or mild summer season from March to May. The monsoon season begins in June and continue upto middle of Oct. The period from second half of the October to November is the post-monsoon season.

The Temperature in the area varies with elevation. It rises after March and the month of July is the hottest month of the year with mean daily maximum temperature going up to 27-28^{o}C. With the withdrawal of monsoons, by the end of September, there is a sharp decrease in temperatures. The months of December and January are the coolest months of the year, with mean daily minimum temperature as low as 3-4^{o}C . The average annual rainfall is about 125 cm per annum. The maximum rainfall is received in the months of July and August e average annual rainfall is about 125 cm per annum.

3.5.2 Geology & Soil Types

The geology of the area consist of of exposes rocks belonging to Garhwal Group and Central Himalayan Crystalline and are composed mainly of calcareous rocks with basic intrusive and migmatite bodies, while around Helong low to medium grade metamorphic rocks are exposed. The Lithootectonic set of project area is given in Table below.

Table 3.1: Litho-Tectonic Setup of the Project Area

	Litho-Units	Lithology
Central Crystalline	Joshimath Fm. (Inner Crystalline)	Kyanite gneiss, banded augen gneiss, migmatite, garnetiferous-biotite-schit and amphibolite
	----------Vaikrita Thrust / MCT-II---------- (Jharkula-Bargaon-Saldhar)	
	Helong Fm. (Outer Crystalline)	Mylonitised augen gneisses and migmatites, mica-schist, amphibolites and crystalline marble Sericite quartzite and quartz mica schist Quartzite and chlorite schist.
	----------Munsiari Thrust / MCT-I / Floor Thrust---------- (1.5 km South-west of Helong to south of Tapovan via Salur)	
Garhwal Group / Lesser Himalaya	Chamoli/ Gulabkoti Formation	Grey fine-grained dolostone. Siliceous on the top and base. Numerous magnesite lenses. Medium grained, grey to greyish green quartzite along the contact. Subordinate schistose quartzites with a thin band of amphibolite.
		----------Gulabkoti Thrust ----------

	Litho-Units	Lithology
	Pipalkoti Formation	Alternate slate and dolostone units. Slates are mainly graphitic and calcareous. Thinly intercalated limestone and slate unit. In the upper horizon of this unit limestone becomes massive and contains chip of bluish limestone. This is arenaceous phyllite and chloritoid slate. Numerous pockets of magnesite.
		----------Birhi Fault----------
	Chamoli/ Chinka Formation	Shear Zone: Mylonite quartzites, blasto mylonites, augen mylonites, augen schists. Thin amphibolites along Birhi fault.
		----------Chinka Fault----------
		Pure quartzites of greyish green colour. Orthoquartzites and subordinate schistose quartzites

The project area lies within Seismic Zone V. On 29th March 1999, a major earthquake shook Uttarakhand and inflicted moderate to heavy damage The earthquake recorded a magnitude of 6.8 at Richter's scale and an epicenter intensity of VIII. Loss of life and property was caused in Chamoli, Rudraprayag, Tehri and Pauri districts.

The soil in a region varies according to altitude and climate. Soil on the slope above 30°, due to erosion and mass wasting processes, are generally shallow and usually have very thin surface horizons. Such soils have medium to coarse texture. Valley soils are developed from colluvium and alluvium brought down from the upper slopes and are deposited in the valleys and low-lying tracts or river terraces. In general north facing slopes support deep, moist and fertile soils. The south facing slopes on the other hand, are too precipitous and well exposed to denudation

3.5.3 Forest

The vegetation of the area varies with altitude and topography. The major forest type observed in the project area up to an elevation of 2000-2200m is Upper Himalayan Pine forest. At higher elevations within the study area, scrubs are observed. *Pinus roxburghii* (Pine) chiefly occurs between the altitudinal range of 750 m and 1,600 m. Within the wide altitudinal distribution, the optimum zone of Chir is between 900 m and 1500 m, beyond which, it is observed in association with other species up to an elevation of about 1600 m.The forest of the project area fall under Badrinath and Kedarnath forest division.

View of Pine Forest

The forests of the project area mainly fall in the degraded category. The forest areas are dominated by pine. The pine crops comprise mostly of middle age to mature trees. Young trees are generally deficient, occurring scattered or in small patches. The degeneration stage occur scattered in the Chir zone in patches where the trees are either destroyed or are unable to develop owing to excessively dry and shallow soil. Open shrub formations occupy the ground.

Formation of plant story such as top, middle and lower is absent. Middle story and ground flora is absent in the pine forest. Pine forests are generally pure. No other species reaches the top canopy and there are only scattered trees representing a second storey and similar discontinuous undergrowth.

Degraded Forest areas, devoid of trees.

Degraded Forest Areas

In the areas near habitation felling of trees is done for fuel, fodder and construction. The forests are open and poor in regeneration. The factors contributing to the degradation of the forest are

- Annual fire in the area.
- Grazing and browsing
- Felling for fuel, fodder and pole
- Natural factors – Dry rocky and steep slopes.

Occurrence of annual fire is one of reason for degradation of the Forest. Inflammable condition prevails during hot weather. The Chir forests are highly inflammable and the dry leaves burns quickly and the fire spreads fast. Burning encourages Chir to spread upward in Oak. At higher elevation degraded Oak forests are encroached upon by pine. Oak Forests are not inflammable but suffer from fire spreading up from Chir forests. Green leaves of Oak catch fire and burn out quickly.

Grazing in the Project Area

Large herds of cattle, sheeps and goats pass through the forest during their up and down migration with the Bhotias. Besides the nearby habitants cattle graze the forest area regularly. Grazing affect the forest through physical injury to the plants in seedling and sapling stages by browsing and trampling, this also makes the soil hard.

The forests are also subjected to biotic pressure. Most of the species near habitation are heavily lopped and hacked for winter fodder, manure, fuel and is also cut for

timber for use in building and agriculture implements. Natural factor such as dry rocks and steep slope are also the cause of poor forest cover. The hot exposed southern slopes consist of shallow soil; the soil does not support forest, Pine forests are replaced by scrubs.

View of settlements on Right side of Alaknanda

Agriculture fields along settlements on Left side of Alaknanda along NH-58

The major vegetation characteristics in the project area are Himalayan Moist Temperate Forest and Himalayan Dry Temperate Forest

Himalayan Moist Temperate forests

This forest type can be divided in two types
(i) Upper West Himalayan temperate forests

(ii) Alder forests

Upper West Himalayan temperate forests are generally found in depressions and ravines as found at Bargaon, Helong and Selong. Important species in this category are *Quercus dilata, Quercus Incana, Cedrela toona, Ficus palmata, Ficus auriculata, Punica gratanum* and a few bamboo species. At lower elevations, *Alnus* borders the river-courses extending down into the subtropical zone. *Rumex hastatus* is the predominant ground vegetation.

View of Pine Forest

View of Forest in Valley

Alder forests are found as pure forest of 20-30 m high. It is mostly observed as a strip of varying width along stream sides, spreading out to larger areas on landslips. The vegetation is of deciduous type.

Himalayan Dry Temperate Forests

Most project area belongs to this type of forest. It is essentially an open formation with locally closed canopy only on favourable sites. Conifers predominate. Such broad leaved trees are of poorer height growth and occurring either scattered among the conifers or forming more or less pure patches. Xerophytic shrubs are commonly observed, which form a continuous cover but more often leave a great deal of the soil exposed.

View of Forest areas, dominated by shrubs

3.5.4 Natural Flora

The climatic and altitudinal variations markedly influence the type of species distribution in various zones. Physiognomically flora of the study area can be categorized as trees, shrubs, herbs and grasses the list of Flora recorded during survey is given in **Table 3.2.** Total 154 species were recored, 56 trees, 39 shrubs, 40 herbs, 5 climbers, 7 grasses, 3 bamboo, 2 fern, 1 epiphyte and 1fungi. The climax and dominant species of forests are species of the forests are Chir (*Pinus roxburghii*) and Ban Oak (*Quercus incana*).

Table 3.2: Flora Recorded under the Project Influence Area (7km)

S. No.	Scientific name	Local name	Family
Trees			
1.	*Aegle marmelos*	Bel	Rutaceae
2.	*Aesculus indica*	Pangar	Sapindaceae
3.	*n*	Siris, Bhandir	Leguminosae

S. No.	Scientific name	Local name	Family
4.	*Alnus nepalensis*	Utis	Betulaceae
5.	*Bauhinia variegata*	Kachnar	Leguminosae
6.	*Boehmeria regulosa*	Genthi	Urticaceae
7.	*Bombax ceiba*	Semal	Bombaceae
8.	*Callistemon citrinus*	Bottle brush	Myrtaceae
9.	*Cedrela toona*	Toon	Meliaceae
10.	*Cedrus deodara*	Devdaar	Coniferae
11.	*Celtis australis*	Kharak	Ulmaceae
12.	*Cinnamomum tamala*	Dalchini	Luraceae
13.	*Citrus limon*	Nimu	Rutaceae
14.	*Citrus spp*	Malta	Rutaceae
15.	*Cupressus torulosa*	Surai	Cupressaceae
16.	*Dalbergia sissoo*	Shisham	Fabaceae
17.	*Delonix regia*	Gulmohar	Caesalpiniaceae
18.	*Emblica officinalis*	Amla	Euphorbiaceae
19.	*Eucalyptus globulus*	Safeda	Myrtaceae
20.	*Ficus auriculata*	Timal	Moraceae
21.	*Ficus bengalensis*	Bargad	Moraceae
22.	*Ficus palmata*	Bedu	Moraceae
23.	*Ficus religiosa*	Pipal	Moraceae
24.	*Grevillea robusta*	Silver oak	Proteaceae
25.	*Grewia oppositifolia*	Biul	Tiliaceae
26.	*Jacaranda mimosifolia*	Jacrada	Bignoniaceae
27.	*Juglans regia*	Akhrot	Juglandaceae
28.	*Lannea coromandelica*	Jhingan	Anacardiaceae
29.	*Lannea grandis*	Jinghini	Anacardiaceae
30.	*Litsea umbrosa*	Shuru	Lauraceae
31.	*Mallotus philippinenisis*	Ruin	Euphorbiaceae
32.	*Mangifera indica*	Aam	Anacardiaceae
33.	*Melia azedarach*	Dhenk	Meliaceae
34.	*Morus alba*	Tut	Moraceae
35.	*Musa paradisiaca*	Kela	Musaceae
36.	*Myrica esculenta*	Kafal	Myricaceae
37.	*Phoenix humilis*	Khajoor	Palmae
38.	*Pinus roxburghii*	Chil	Coniferae
39.	*Populus ciliata*	Poplar	Salicaceae

S. No.	Scientific name	Local name	Family
40.	*Prunus armeniaca*	Chuli	Rosaceae
41.	*Prunus communis*	Aloocha	Rosaceae
42.	*Prunus persica*	Aroo	Rosaceae
43.	*Prunus puddum*	Phaja	Rosaceae
44.	*Punica granatum*	Aanar	Punicaceae
45.	*Pyrus malus*	Seb	Rosaceae
46.	*Pyrus pashia*	Mehal	Rosaceae
47.	*Quercus incana*	Ban	Fagaceae
48.	*Quercus dilata*	Moru	Fagaceae
49.	*Quercus semicarpifolia*	Kharsu Oak	Fagaceae
50.	*Robinia pseudoacacia*	Pahari kikar	Papilionoidaea
51.	*Rhododendronarboreum*	Burans	Ericaceae
52.	*Salix tetrasperma*	Gadhbains	Salicaceae
53.	*Sapindus mukorossi*	Ritha	Sapindaceae
54.	*Sapium insigne*	Khinna	Euphorbiaceae
55.	*Syzygium cumini*	Jamun	Myrtaceae
56.	*Toona serrata*	Kakuru	Meliaceae
Shrubs			
57.	*Adhatoda vasica*	Basinga	Acanthaceae
58.	*Agave americana*	Rambans	Cactaceae
59.	*Artemesia vulgaris*	Kubash	Compositae
60.	*Berberis aristata*	Karmshal, Kashmoi	Berberidaceae
61.	*Calotropis gigantea*	Aak	Asclepiadaceae
62.	*Cannabis sativa*	Bhang	Cannabaceae
63.	*Carissa spinarum*	Karonada	Apocynaceae
64.	*Colebrookea oppositifolia*	Bindu	Lamiaceae
65.	*Coriaria nepalensis*	Makhoi	Coriariaceae
66.	*Cotoneaster acuminata*	Ruinish	Rosaceae
67.	*Datura stromonium*	Datura	Solanaceae
68.	*Debregeasia hypoleuca*	Sihanru	Urticaceae
69.	*Desmodium tiliaefolium*	Martoi	Leguminosae
70.	*Erythrina suberosa*	Dhaul	Leguminosae
71.	*Eupatorium adenophorum*	Kala bansa	Asteraceae
72.	*Euphorbia royleana*	Shuru	Euphorbiaceae
73.	*Hypericum oblongifolium*	Phiunli	Hypericaceae
74.	*Jasminum humile*	Shunjai	Oleaceae

S. No.	Scientific name	Local name	Family
75.	*Jatropha curcas*	Arand	Euphorbiaceae
76.	*Lantana camara*	Lantana	Verbinaceae
77.	*Murraya koenigii*	Kath Neem	Rutaceae
78.	*Opuntia dillenii*	Nagphani	Cactaceae
79.	*Opuntia monocantha*	Nagphani	Cactaceae
80.	*Plectranthus coesta*	Chichiri	Labiatae
81.	*Princepia utilis*	Bhekal	Rosaceae
82.	*Pyracantha crenulata*	Ghingaru	Rosaceae
83.	*Rhus parviflora*	Tung	Anacardiaceae
84.	*Ricinus communis*	Arandi	Euphorbiaceae
85.	*Rosa brunonii*	Kunja	Rosaceae
86.	*Rubus ellipticus*	Hinsar	Rosaceae
87.	*Rubus niveus*	Kala Hinsalu	Rosaceae
88.	*Rumex hastatus*	Bhilmora	Polygonaceae
89.	*Sarcococca saligna*	Tiliari	Euphorbiaceae
90.	*Solanum surattense*	Kateli	Solanaceae
91.	*Urtica parviflora*	Kandali	Urticaceae
92.	*Vitex negundo*	Shimalu	Verbenaceae
93.	*Woodfordia floribunda*	Dhaula	Lythraceae
94.	*Zanthoxylum alatum*	Timbur	Rutaceae
95.	*Ziziphus mauritiana*	Ber	Rhamnaceae
Herbs			
96.	*Achyranthes aspera*	Aghada, Puthkanda	Amaranthaceae
97.	*Ageratum conzoides*	Gunriya	Asteraceae
98.	*Argemone mexicana*	Prickly poppy	Papaveraceae
99.	*Arisaema flavum*	Meen	Araceae
100.	*Artemisia capillaris*	Pati	Compositae
101.	*Artemisia vulgaris*	Kunjha	Asteraceae
102.	*Bergenia ligulata*	Silphara	Saxifragaceae
103.	*Bidens bipinnata*	Kuru	Asteraceae
104.	*Cassia tora*	Chakunda	Caesalpinaceae
105.	*Centella asiatica*	Brahmi	Apiaceae
106.	*Cestrum verutum*	Kanjalu	Solanaceae
107.	*Asparagus racemosa*	Sahansarpali	Liliaceae
108.	*Bauhinia vahlii*	Malo	Leguminosae
109.	*Chenopodium album*	Bathwa	Chenopodiaceae

S. No.	Scientific name	Local name	Family
110.	*Chromolaena odorata*	Triva gandha	Asteraceae
111.	*Clematis montana*	Kauniabali	Ranunculaceae
112.	*Colocasia affinis*	Pindalu	Araceae
113.	*Datura suaveolens*	Datura	Solanaceae
114.	*Echinops echinatus*	Gokhru	Compositae
115.	*Erigeron bellidioides*	Horse weed	Compositae
116.	*Euphorbia hirta*	Dudhi	Euphorbiaceae
117.	*Fragaria indica*	Bhumla	Rosaceae
118.	*Galinsoga parviflora*	Marchya	Asteraceae
119.	*Frageria vesica*	Bhumla	Rosaceae
120.	*Heliotropium strigosum*	Hatta-juri	Boraginaceae
121.	*Heychium spicatum*	Banhaldi	Zingiberaceae
122.	*Jasminium officinale*	Chameli	Oleaceae
123.	*Lespedeza sericea*	Khunju	Leguminosae
124.	*Leucas lanata*	Biskapra	Laminaceae
125.	*Ocimum basilicum*	Vantulsi	Lamiaceae
126.	*Oxalis corniculata*	Amrit sak	Oxalidaceae
127.	*Polygonum chinense*	Jangli palak	Polygonaceae
128.	*Solanum nigrum*	Makoi	Solanaceae
129.	*Sonchus asper*	Dudhi	Asteraceae
130.	*Sonchus oleraceus*	Dudhi, Pathari	Asteraceae
131.	*Thalictrum foliolosum*	Mamiri	Ranunculaceae
132.	*Thymus serpyllum*	Hasha	Lamiaceae
133.	*Tridex procumbens*	Ground weed	Amaranthaceae
134.	*Trifolium pratense*	Purple clover	Fabaceae
135.	*Verbascum thapsus*	Gidar tamakus	Scrophulariaceae
Climbers			
136.	*Asparagus racemosa*	Sahansarpali	Liliaceae
137.	*Bauhinia vahili*	Malo	Leguminosae
138.	*Clematis connata*	Kanguli	Ranunculaceae
139.	*Ipomea purpurea*	Besharam	Convolvulaceaea
140.	*Vallaris solanaceae*	Dudhi Bel	Apocynaceae
Grasses			
141.	*Arundo donax*	Phiral, Naru	Gramineae
142.	*Cynodon dactylon*	Dhub	Gramineae
143.	*Chrysopogan fulvus*	Godia	Gramineae

S. No.	Scientific name	Local name	Family
144.	*Cymbopogan martini*	Ghas	Gramineae
145.	*Saccharum spontaneum*	Kans	Gramineae
146.	*Parthenium hysterophorus*	Congress grass	Compositae
147.	*Eulaliopsis binata*	Babul	Gramineae
Bamboo			
148.	*Arundinaria falcate*	Phiral, Naru	Gramineae
149.	*Dendrocalamus strictus*	Nigal	Gramineae
150.	*Phragmites communis*	Naal	Gramineae
Ferns			
151.	*Pteris sp*	Fern	Pteridaceae
152.	*Adiantum sp*	Fern	Pteridaceae
Epiphyte			
153.	*Vanda roxburghii*	Badang	Orchidaceae
Fungi			
154.	*Morchella esculenta*	Mushroom	Helvellaceae

Source: Field Survey CES (I) Pvt. Ltd April –July, 2008

3.5.5 Ecological Features

The ecological features with reference to their habitat, nature i.e. evergreen or deciduous, and their distribution in terms of altitude of the major forest species is given in details below

Table: 3.3: Ecological Features of Major Species

S. No	Name of Species		Ecology		
	Scientific	Local	Habitat	Nature	Distribution (m)
1.	*Albizzia lebbek*	Siris	Hills	Deciduous	300 – 1300
2.	*Alnus nepalensis*	Utis	HillSlopes	Deciduous	1500 – 2700
3.	*Bombax ceiba*	Semal	Hill slopes	Deciduous	300 – 1500
4.	*Cedrus deodara*	Deodar	High forest	Evergreen	1800 – 3000
5.	*Cinnamomum tamala*	Tejpat	Hill slopes	Evergreen	450 - 2100
6.	*Cupressus torulosa*	Surai	Hill slopes	Evergreen	1800 – 3600
7.	*Bauhinia variegata*	Kachnar	Forest	Deciduous	300 – 1500
8.	*Celtis australis*	Kharik	Slopes	Evergreen	1800 –3000
9.	*Dalbergia sissoo*	Shisham	Hill slopes	Deciduous	300 – 1500
10.	*Ficus palmata*	Bedu	Hill slopes	Deciduous	200 - 1400
11.	*Mallotus philippinenisis*	Roghs	Forest	Evergreen	300 – 1200
12.	*Pinus roxburghii*	Chir	Forest	Deciduous	300 – 1500

S. No	Name of Species		Ecology		
	Scientific	Local	Habitat	Nature	Distribution (m)
13.	*Populus ciliata*	Poplar	Forest	Deciduous	200 – 3600
14.	*Quercus semicarpifolia*	Kharsu Oak	Forest	Evergreen	2100 – 3800
15.	*Rododendron arboreum*	Brans	Forest	Evergreen	1800 – 4300
	Shrubs				
16.	*Berberis aristata*	Kilmora	Hill slopes	Deciduous	1500 - 1800
17.	*Boehmeria platyphylla*	Khagra	Hill slopes	Deciduous	800 - 2700
18.	*Debregesia salicifolia*	Syanru	Hill slopes	Evergreen	1000 - 2000
19.	*Opuntia spp*	Nagphani	Hill slopes	Sacculrnt	0 – 1800
20.	*Rumex hastatus*	Almora	Hill slopes	Evergreen	1000 - 2400
21.	*Rubus ellipticus*	Hisar	Hills & slops	Deciduous	800 - 2700
	Herbs				
22.	*Artimesia cappilaris*	Pati	Floor Fors.	Evergreen	600 - 2400
23.	*Cannabis sativa*	Bhang	Floor Fors	Annual herb	200 - 2700
24.	*Cassia tora*	Chakunda	Hills & slops	Seasonal	450 -1500
25.	*Oxalis cornuculata*	Bhilmora	Floor Fors	Perrineal	0 -2800

Source: Data collected during field survey

3.5.6 Community use of Natural Flora

The people from surrounding villages depend on forest for various purposes the Table given below depict various uses of trees by local people. The major uses of trees falling under the project area are as given below:

Table 3.4: Uses of Major species by Community

Name of Tree	Local	Shade	Food	Fodder	Fuel	Timber	Manure
Albizzia lebbek	Siris	_	-	+	+	+	-
Alnus nepalensis	Utis	_	-	+	-	+	+
Bauhinia variegata	Kachnar	_	+	+	+	-	+
Bombax ceiba	Semal	_	-	-	+	+	+
Cedrus deodara	Deodar	-	-	-	+	+	-
Cinnamomum tamala	Tejpat	+	+	-	-	+	
Celtis australis	Kharik	+	_	+	-	+	+
Dalbergia sissoo	Shisham	+	-	+	-	+	-
Mallotus philippinenisis	Ruin	-	-	-	+	+	+
Morus alba	Tut	-	-	+	+	-	+
Pinus roxburghii	Chir	+	+	-	+	+	+

Name of Tree	Local	Shade	Food	Fodder	Fuel	Timber	Manure
Poplus ciliata	Poplar	+	-	-	+	+	-
Pyrus pashia	Mehal	-	-	+	+	-	+
Quercus incana	Ban oak	-	-	+	+	+	+
Rhododendron arboreum	Burans	+	+	-	+	-	+
Cedrela toona	Tun	+	-	+	-	+	-

Source: Public consultation

* + In Use - Not in use

In order to know the community uses of native flora of the project area public consultation were carried out. The various medicinal, commercial uses of plant species were come out through discussions. Older persons were concerned as their past experiences are very useful in this regards. Besides the above uses bamboos are widely used for basket making. *Bauhinia vahili* (Malo) leaves are widely used for making plates and bowls used in marriage and other functions

Local boy making baskets

Table 3.5: Important Medicinal Plants of Project Influence Area

S.No	Scientific Name	Common name	Medicinal Use
1.	*Aegle marmelos*	Bel	Used in ailment s as diarrhea, dysentery, dryness of eyes and common cold. Antidote for chronic constipation
2.	*Emblica officinalis*	Awla	Used for digestion, treat constipitation, reduce fever ,purify the blood ,cough, asthma, benefit the eyes , stimulate hair growth,and enhance intellect
3.	*Ficus palmata*	Bedu	Fruit used in digestive disorder
4.	*Melia azedarach*	Dhenk	Leaves, fruits and seeds used in skin disease
5.	*Sapindus mukurossi*	Reetha	Fruit posses emetic, tonic, astringent and antihelmintic properties and are used in treatment of asthma, washing hair.
6.	*Cinnamomum tamala*	Tejpat	As condiment
7.	*Ocimum basilicum*	Tulsi	In fever , cough and cold
8.	*Adhatoda vasica*	Vashaka	Antibronchitis & cough
9.	*Asparagus racemosa*	Sahansarpali	Tonc, antidysentry

S.No	Scientific Name	Common name	Medicinal Use
10.	*Bergenia ligulata*	Silphara	Kidney stones, anti diarrhea
11.	*Heychium spicatum*	Banhaldi	useful for liver complaints, diarrhea and food poisoning, also used in treating fever, snake bite and indigestion.
12.	*Centella asiatica*	Brahmi	Antiperiodic, diuretic, febrifuge, ophthalmic, purgative, salve, stomachic and tonic. Useful in peptic ulcers, indigestion, fevers, toothache, applied to boils and pimples

Source: Public Consultation

3.5.7 Fauna of Project Influence Area

The fauna of the study area is represented by reptiles, birds and animals. The variation in altitude, climate, topography, forests type and forest cover leads to variation in animals the fauna can be characterized as domestic animals and wild life. The details are discussed below

(I) Domestic Animals

The rural population is primarily dependant on agriculture based economy for livelihood almost every family owns land and is engaged in agriculture, horticulture, and animal husbandry. Every family rears livestock for their day to day requirements for agriculture purposes and for cash income. The live stock is mainly dependant upon the natural resources, mainly forest for sustenance. Local people use horses, mule and donkeys for carrying their luggage/material in hilly areas. Other domestic animals are buffalo, cow, ox, goat and sheep.

(II) Wildlife

The wildlife of the Project Influence Area is given in the table below. Most of the wildlife are present at higher elevation in the forest area and are not found near the river course, eg: *Hemitragus jemlahicus* (Thar), *Moschus chrysogaster* (Musk Deer), *Nemorhaedus goral* (Goral) etc.

Table 3.6: Wildlife of Project Influence Area

S.No	Scientific name	Common name
1	*Canis aureus*	Jackal
2	*Capricornis sumataensis*	Serow
3	*Cervus unicolor*	Sambar
4	*Hemitragus jemlahicus*	Himalayan Thar
5	*Martes flavigula*	Himalayan Marten
6	*Moschus chrysogaster*	Himalayan Musk Deer
7	*Muntiacus muntjak*	Barking Deer

S.No	Scientific name	Common name
8	*Nemorhaedus goral*	Goral
9	*Panthera pardus*	Leopard
10	*Pressbytis entellus*	Common Langur
11	*Sus scrofa*	Wild Boar
12	*Ursus aretos*	Brown bear
13	*Vulpes montana*	Red Fox
	Reptiles	
14	*Hemidactylus frenatus*	Asian house Gecko
15	*Varanus bengalensis*	Common Indian Lizard
16	*Trimeresurus albolabris*	Green Pit Viper
17	*Gloydius himalayanus*	Himalayan Pit Viper
18	*Naja naja*	Cobra
	Amphibians	
19	*Bufo himalayanus*	Toad
	Birds	
20	*Acridotheres tristis*	Indian Myna
21	*Alectoris chukar*	Chukor Patridge
22	*Corvus corax*	Common raven
23	*Cissa flavirostris*	Yellow build Magpie
24	*Corvus splendens*	House Crow
25	*Dicrurus adsimilis*	Black Drongo
26	*Dendrocopos himalayensis*	Wood pecker
27	*Lanius excubitor*	Grey Shrike
28	*Milvus migrans*	Pariah Kite
29	*Motacilla maderatensis*	Large pied wagtail
30	*Passer domesticus*	House Sparrow
31	*Passer montanus*	Eurasian Tree Sparrow
32	*Pycnonotus cafer*	Red vented Bulbul
33	*Pycnonotus leucogenys*	White Cheeked Bulbul
34	*Saxicoloides fulicatus*	Indian Robin
35	*Copsychus saularis*	Magpie Robin
36	*Streptopelia orientalis*	Spotted dove
37	*Turdoides caudatus*	Common babbler
38	*Turdus merula*	Blackbird

Source: Public Consultation & Forest Department

The census data of Badrinath Forest Division and Kedarnath Sanctury in Kedarnath Forest Division given below

Table 3.7: Wildlife Census Data of Badrinath Forest Division

S.No	Species	1993	1999	2001	2003	2005	2008
1	Leapord	27	26	6	7	24	36
2	Bear	61	93	82	162	-	68
3	Jadav	39	71	38	-	-	-
4	Kakad	113	237	194	567	-	147
5	Goral	132	384	364	369	-	341
6	Musk Deer	14	26	18	3	-	-
7	Bharal	-	-	4	-	-	26
8	Serow	-	38	4	-	-	2
9	Deer	-	-	8	-	-	-
10	Chital	-	-	3	-	-	-
11	Wild Boar	248	134	179	164	-	522
12	Rabbit	12	08	-	-	-	-
13	Fox	-	14	20	-	-	-
14	Monkey	3,103	2,147	3,878	4,102	-	-
15	Langur	4,369	1,939	3,428	2,271	-	-
16	Sambar	-	-	-	-	-	40
17	Thar	-	-	-	-	-	2
Total		**8,118**	**5,117**	**8,226**	**7,645**	**24**	**1,184**

Source: Badrinath forest Division, Gopeshwar, 2008

Table 3.8: Census Data of Wildlife of Kedarnath Wildlife Sanctuary

S.No	Wildlife	1997	1999	2001	2003	2005	2008
1	Leopard	121	178	185	149	165	129
2	Musk Deer	0	0	61	63	37	67
3	Himalayan Thar	0	0	376	353	230	470
4	Serow	0	0	4	27	35	38
5	Wild Boar	0	0	755	776	832	942
6	Goral	0	0	606	810	695	762
7	Bear	0	0	128	162	132	94
8	Kakad	0	0	299	314	384	261
9	Sambar	0	0	262	181	173	138

S.No	Wildlife	1997	1999	2001	2003	2005	2008
10	Monkey	0	0	2,459	3,919	0	0
11	Langur	0	0	3,746	3,230	0	0
12	Porcupine	0	0	1	40	0	38
13	Marten	0	0	29	28	0	0
14	Jackal	0	0	0	31	0	0

Source: Kedarnath Wildlife Sanctuary, Gopeshwar, 2008

The wildlife data does not reflect any consistency it may be due to the difficulty in counting the wildlife residing in the mountainous terrain. In Badrinath Forest division no. of wild boar has gone up. In Kedarnath wildlife sanctuary also wild boar shows highest no. Goral and Thar are also well represented. The population of Leopard is fluctuating and does not show any trend.

Birds were identified with binox. The common birds recorded during the survey were Myna, Magpai, Pigeon, Black Drongo, Grey Shrike and White Cheek Bulbul.

3.6 BIODIVERSITY OF PROJECT IMMEDIATE AFFECTED AREA

The Project Immediate Affected Area (PIAA) is comprised of 500m on both sides of project sites. The main features are steep hill slopes, foothills and National Highways -58 and major town Pipalkoti and villages Hat, Pakhi, Langsi, Helong, Tangni Jaisal, Mat, Tenduli, Guniyala, Dwing etc. The entire area interrupted by agricultural or horticultural activities. The detail of forest types, Natural Flora and Fauna is discussed in detail below.

View of Alaknanda Valley, Steep slopes with out forest cover

Scattered open pine trees along the slope. No under story and middle story

3.6.1 Forest Types

The Akaknanda valley has characteristic physiography. From Dam site to Pipalkoti the river passes through George shaped valley with steep slopes with rock outcrop. These slopes are devoid of dense/ moderate forest. There are scattered pine trees in patches along the slopes without under cover. Habitation / villages are located on flat terrain or on gentle slope on both sides of the river. The land near the village are used by the habitants for cultivation and grazing of animals. No dense forest located in project affected area expect near Maina Adit.

View of Tapon Village in PIAA

(I) Himalayan Chir Pine Forest Sub- group 9/C1 b

This type is most widely distributed, occupying the lower slope in the Alaknanda river valley . It occurs at altitude between 750 - m to 2000m elevation. *Pinus roxburghii* (Chir) occurs remarkably in pure and gregarious form. The crop is irregular and mature trees few and widely scattered. The top height of the chir crops ranges from 20 -45 m

Major Associates : Pinus roxburghii – Rhododendron - Lyoni - Abizzia

Minor Associates : Woodfordia - Berberis - Rubus
Artemisia -Desmodium – Plectranthus

(ii) DS-I Himalayan Sub tropical Scrub: 9/ C1/DS1

This degradation stage occurs scattered in the chir zone in patches where the over wood has either been destroyed or perhaps has been unable to develop owing to excessively dry and shallow soils. This type occurs up to 1500 m. This type is due to heavy biotic interference of grazing and burning.

Major Associates: Debregesia - Rhus - Woodfordia

Minor Associates: Berberis - Cotoneastor- Prinsepia

3.6.2 Natural Flora

The natural flora of the immediate affected area is represented by natural flora along the slopes, foothills, the avenue plantation carried out along the existing NH-58 of *Jacaranda mimosifolia, Cedrela toona*, *Eucalyptus globulus* & *Melia azedarach* by Forests Department. A total number of 93 plant species were observed during survey. The maximum number of 40 species accounted for trees followed by 26 for

shrubs, 17 for herbs, 4 species for grasses, 3 climbers 2 pteridophytees and 1 epiphyte. The detail of flora recorded is given below.

Table 3.9: Flora of Project Immediate Affected Area

S. No.	Scientific name	Local name	Family
Trees			
1.	*Aegle marmelos*	Bel	Rutaceae
2.	*Aesculus indica*	Pangar	Sapindaceae
3.	*Albizzia lebbek*	Siris	Leguminosae
4.	*Alnus nepalensis*	Utis	Betulaceae
5.	*Bauhinia variegata*	Kachnar	Leguminosae
6.	*Bombax ceiba*	Semal	Bombaceae
7.	*Callistemon citrinus*	Bottle brush	Myrtaceae
8.	*Cedrela toona*	Toon	Meliaceae
9.	*Celtis australis*	Kharak	Ulmaceae
10.	*Cinnamomum tamala*	Dalchini	Luraceae
11.	*Citrus limon*	Nimu	Rutaceae
12.	*Citrus spp*	Malta	Rutaceae
13.	*Cupressus torulosa*	Surai	Cupressaceae
14.	*Dalbergia sissoo*	Shisham	Fabaceae
15.	*Delonix regia*	Gulmohar	Caesalpiniaceae
16.	*Emblica officinalis*	Amla	Euphorbiaceae
17.	*Eucalyptus globulus*	Safeda	Myrtaceae
18.	*Ficus auriculata*	Timal	Moraceae
19.	*Ficus bengalensis*	Bargad	Moraceae
20.	*Ficus palmata*	Bedu	Moraceae
21.	*Ficus religiosa*	Pipal	Moraceae
22.	*Grevillea robusta*	Silver oak	Proteaceae
23.	*Jacaranda mimosifolia*	Jacrada	Bignoniaceae
24.	*Juglans regia*	Akhrot	Juglandaceae
25.	*Mallotus philippinenisis*	Ruin	Euphorbiaceae
26.	*Mangifera indica*	Aam	Anacardiaceae
27.	*Melia azedarach*	Dhenk	Meliaceae
28.	*Morus alba*	Tut	Moraceae
29.	*Musa paradisiaca*	Kela	Musaceae
30.	*Phoenix humilis*	Khajoor	Palmae
31.	*Pinus roxburghii*	Chil	Pinaceae

S. No.	Scientific name	Local name	Family
32.	*Prunus armeniaca*	Chuli	Rosaceae
33.	*Prunus communis*	Aloocha	Rosaceae
34.	*Prunus persica*	Aroo	Rosaceae
35.	*Punica granatum*	Aanar	Punicaceae
36.	*Pyrus pashia*	Mehal	Rosaceae
37.	*Sapindus mukorossi*	Ritha	Sapindaceae
38.	*Sapium insigne*	Khinna	Euphorbiaceae
39.	*Syzygium cumini*	Jamun	Myrtaceae
40.	*Toona serrata*	Kakuru	Meliaceae
Shrubs			
41.	*Adhatoda vasica*	Basuti, Vasika	Acanthaceae
42.	*Agave americana*	Rambans	Cactaceae
43.	*Berberis aristata*	Karmshal, Kashmoi	Berberidaceae
44.	*Calotropis gigantea*	Aak	Asclepiadaceae
45.	*Cannabis sativa*	Bhang	Cannabaceae
46.	*Carissa spinarum*	Karonada	Apocynaceae
47.	*Colebrookea oppositifolia*	Bindu	Lamiaceae
48.	*Coriaria nepalensis*	Makhoi	Coriariaceae
49.	*Debregeasia hypoleuca*	Sihanru	Urticaceae
50.	*Eupatorium adenophorum*	Kala bansa	Asteraceae
51.	*Euphorbia royleana*	Shuru	Euphorbiaceae
52.	*Jatropha curcas*	Arand	Euphorbiaceae
53.	*Lantana camara*	Lantana	Verbinaceae
54.	*Opuntia dillenii*	Nagphani	Cactaceae
55.	*Plectranthus coesta*	Chichiri	Labiatae
56.	*Princepia utilis*	Bhekal	Rosaceae
57.	*Pyracantha crenulata*	Ghingaru	Rosaceae
58.	*Ricinus communis*	Arandi	Euphorbiaceae
59.	*Rosa brunonii*	Kunja	Rosaceae
60.	*Rubus ellipticus*	Hinsar	Rosaceae
61.	*Rubus niveus*	Kala Hinsalu	Rosaceae
62.	*Rumex hastatus*	Bhilmora	Polygonaceae
63.	*Urtica parvifora*	Kandali	Urticaceae
64.	*Woodfordia floribunda*	Dhaula	Lythraceae
65.	*Zanthoxylum alatum*	Timbur	Rutaceae
66.	*Ziziphus mauritiana*	Ber	Rhamnaceae

S. No.	Scientific name	Local name	Family
Herbs			
67.	*Achyranthes aspera*	Aghada, Puthkanda	Amaranthaceae
68.	*Argemone mexicana*	Prickly poppy	Papaveraceae
69.	*Artemisia capillaris*	Pati	Compositae
70.	*Artemisia vulgaris*	Pati	Asteraceae
71.	*Bidens bipinnata*	Kuru	Asteraceae
72.	*Calatropis procera*	Aak	Asclepiadaceae
73.	*Cassia tora*	Chakunda	Caesalpinaceae
74.	*Cestrum verutum*	Kanjalu	Solanaceae
75.	*Chenopodium album*	Bathwa	Chenopodiaceae
76.	*Datura suaveolens*	Datura	Solanaceae
77.	*Euphorbia hirta*	Dudhi	Euphorbiaceae
78.	*Fragaria indica*	Bhumla	Rosaceae
79.	*Galinsoga parviflora*	Marchya	Asteraceae
80.	*Oxalis corniculata*	Amrit sak	Oxalidaceae
81.	*Polygonum chinense*	Jangli palak	Polygonaceae
82.	*Sonchus asper*	Dudhi	Asteraceae
83.	*Tridex procumbens*	Ground weed	Amaranthaceae
Climbers			
84.	*Bauhinia vahlii*	Malo	Leguminosae
85.	*Clematis connata*	Kanguli	Ranunculaceae
86.	*Ipomea purpurea*	Besharam	Convolvulaceaea
Ferns			
87.	*Pteris sp*	Fern	Pteridaceae
88.	*Adiantum sp*	Fern	Pteridaceae
Epiphyte			
89.	*Vanda roxburghii*	Badang	Orchidaceae
Grasses			
90.	*Apluda mutica*	Tachula	Gramineae
91.	*Cynodon dactylon*	Dhub	Gramineae
92.	*Chrysopogan fulvus*	Godia	Gramineae
93.	*Parthenium hysterophorus*	Congress grass	Compositae

Source: Field survey CES, April-July, 2008

3.7 BIODIVERSITY OF PROJECT AFFECTED AREA

The Project Affected Area (PAA) is comprised of, land acquired for establishment of various project units i.e. 120 ha of land of which 80 ha is forest land for establishment of various project units. The roposed dam site is is located at near village Helong in Joshimath tehsil where as an underground power house is proposed near village Hat 3 km from Pipalkoti.

Table 3.10: Forest Land to be Acquired for Establishment of Various Project Units

S.No	Project Activity	Area (Ha)
1	Submergence Area for Reservoir	26.50
2	Working area at Dam Site	10.00
3	Adits	
	I) Dam Site	2.5
	II) Power House site & Maina river	2.5
4	Dumping Yard	
	I) Dam site , Adit- I & II	6.00
	II) Power House Site & Maina	6.00
5	Approach Roads	38.0
6	Quarries	
	I) Dam Site	8.00
	II) Power House site & Birahi	4.00
7	Colony	13.0
8	Pot yard area	1.5
9.	Power House site	2.0
Total		120

Source: DPR, VPHEP

Proposed Dam Site

Colony site Siyasen

Road to Powerhouse site

3.7.1 Natural Flora

The species were identified and categorized for their ecological characteristics. The flora of project affected area is represented by 87 species. Physio-gnomically vegetation has been categorized as trees, shrubs, herbs grasses, climbers,

pteridophytes and epiphyphytes. The trees dominated by contributing maximum number of 34 species followed by 26 species of shrubs, 18 species of herbs , 3 climbers, 4 species of grasses, 2species of pteridophytes and one species of epiphyte.

The common shrubs recorded at site are *Eupatorium adenophorum (Kala bansa), Adhatoda vasica* (Basinga) *Prinsepia utilis* (Bhaikul), *Colebrookea oppositifilia* (Bindu) *Rubus ellipticus* (Hisar) *Euphorbia royleana* (Shuru), *Berberis ariststa* (Kilmora), *Rubus niveus* (Kala Hinsal) and *Zanthoxylum alatum* (Timru). The pteridophytes were represented by ferns such as Adiantum sp and Drypteris sp. The common grass species were *Apluda mutica* (Tachula), *Cynodon dactylon* (Dhub).

All the floral species found in the project affected area are common in occurance and are found abundantly throughout the region. None of the species belonged to the rare, endangered and threatened category.

Table 3.11: Flora of Project Affected Areas

S. No.	Scientific name	Local name	Family
Trees			
1.	*Aegle marmelos*	Bel	Rutaceae
2.	*Albizzia lebbek*	Bhandir,Siris	Leguminosae
3.	*Alnus nepalensis*	Utis	Betulaceae
4.	*Bauhinia variegata*	Kachnar	Leguminosae
5.	*Bombax ceiba*	Semal	Bombaceae
6.	*Cedrela toona*	Toon	Meliaceae
7.	*Celtis australis*	Kharak	Ulmaceae
8.	*Citrus limon*	Nimu	Rutaceae
9.	*Citrus spp*	Malta	Rutaceae
10.	*Cupressus torulosa*	Surai	Cupressaceae
11.	*Dalbergia sissoo*	Shisham	Fabaceae
12.	*Emblica officinalis*	Amla	Euphorbiaceae
13.	*Ficus auriculata*	Timal	Moraceae
14.	*Ficus bengalensis*	Bargad	Moraceae
15.	*Ficus palmata*	Bedu	Moraceae
16.	*Ficus religiosa*	Pipal	Moraceae
17.	*Grevillea robusta*	Silver oak	Proteaceae
18.	*Juglans regia*	Akhrot	Juglandaceae
19.	*Mallotus philippinenisis*	Ruin	Euphorbiaceae
20.	*Mangifera indica*	Aam	Anacardiaceae
21.	*Melia azedarach*	Dhenk	Meliaceae

S. No.	Scientific name	Local name	Family
22.	*Morus alba*	Tut	Moraceae
23.	*Musa paradisiaca*	Kela	Musaceae
24.	*Phoenix humilis*	Khajoor	Palmae
25.	*Pinus roxburghii*	Chil	Pinaceae
26.	*Prunus armeniaca*	Chuli	Rosaceae
27.	*Prunus communis*	Aloocha	Rosaceae
28.	*Prunus persica*	Aroo	Rosaceae
29.	*Punica granatum*	Aanar	Punicaceae
30.	*Pyrus pashia*	Mehal	Rosaceae
31.	*Sapindus mukorossi*	Ritha	Sapindaceae
32.	*Sapium insigne*	Khinna	Euphorbiaceae
33.	*Syzygium cumini*	Jamun	Myrtaceae
34.	*Toona serrata*	Kakuru	Meliaceae
Shrubs			
35.	*Adhatoda vasica*	Basinga	Acanthaceae
36.	*Agave americana*	Rambans	Cactaceae
37.	*Berberis aristata*	Karmshal, Kashmoi	Berberidaceae
38.	*Calotropis gigantea*	Aak	Asclepiadaceae
39.	*Cannabis sativa*	Bhang	Cannabaceae
40.	*Carissa spinarum*	Karonada	Apocynaceae
41.	*Colebrookea oppositifolia*	Bindu	Lamiaceae
42.	*Coriaria nepalensis*	Makhoi	Coriariaceae
43.	*Debregeasia hypoleuca*	Sihanru	Urticaceae
44.	*Eupatorium adenophorum*	Kala bansa	Asteraceae
45.	*Euphorbia royleana*	Shuru	Euphorbiaceae
46.	*Jatropha curcas*	Arand	Euphorbiaceae
47.	*Lantana camara*	Lantana	Verbinaceae
48.	*Opuntia dillenii*	Nagphani	Cactaceae
49.	*Plectranthus coesta*	Chichiri	Labiatae
50.	*Princepia utilis*	Bhekal	Rosaceae
51.	*Pyracantha crenulata*	Ghingaru	Rosaceae
52.	*Ricinus communis*	Arandi	Euphorbiaceae
53.	*Rosa brunonii*	Kunja	Rosaceae
54.	*Rubus ellipticus*	Hinsar	Rosaceae
55.	*Rubus niveus*	Kala Hinsalu	Rosaceae
56.	*Rumex hastatus*	Bhilmora	Polygonaceae

S. No.	Scientific name	Local name	Family
57.	*Urtica parviflora*	Kandali	Urticaceae
58.	*Woodfordia floribunda*	Dhaula	Lythraceae
59.	*Zanthoxylum alatum*	Timbur	Rutaceae
60.	*Ziziphus mauritiana*	Ber	Rhamnaceae
Herbs			
61.	*Achyranthes aspera*	Aghada, Puthkanda	Amaranthaceae
62.	*Argemone mexicana*	Prickly poppy	Papaveraceae
63.	*Artemisia capillaris*	Pati	Compositae
64.	*Bidens bipinnata*	Kuru	Asteraceae
65.	*Bergenia ligulata*	Silphara	Saxiferaceaa
66.	*Cassia tora*	Chakunda	Caesalpinaceae
67.	*Cestrum verutum*	Kanjalu	Solanaceae
68.	*Chenopodium album*	Bathwa	Chenopodiaceae
69.	*Datura suaveolens*	Datura	Solanaceae
70.	*Euphorbia hirta*	Dudhi	Euphorbiaceae
71.	*indica*	Bhumla	Rosaceae
72.	*Galinsoga parviflora*	Marchya	Asteraceae
73.	*Hedychium spicatum*	Banhaldu	Zingiberacea
74.	*Oxalis corniculata*	Amrit Sak	Oxalidaceae
75.	*Polygonum chinense*	Jangli palak	Polygonaceae
76.	*Sonchus asper*	Dudhi	Asteraceae
77.	*Thalictrum foliolosum*	Mamiri	Ranunculaceae
78.	*Tridex procumbens*	Ground weed	Amaranthaceae
Climbers			
79.	*Bauhinia vahlii*	Malo	Leguminosae
80.	*Clematis connata*	Kanguli	Ranunculaceae
81.	*Ipomea purpurea*	Besharam	Convolvulaceaea
Grasses			
82.	*Apluda mutica*	Tachula	Gramineae
83.	*Cynodon dactylon*	Dhub	Gramineae
84.	*Chrysopogan fulvus*	Godia	Gramineae
85.	*Parthenium hysterophorus*	Congress grass	Compositae
Ferns			
86.	*Pteris sp*	Fern	Pteridaceae
87.	*Adiantum sp*	Fern	Pteridaceae

3.7.2 Flora of Advance Construction Sites

Four approach roads are proposed under the project which will be taken under advance construction works.

i. Approach Road to Dam site
ii. Approach Road to Langsi adit
iii. Approach Road to Maina adit
iv. Approach Road to Power house & Colony site

i Approach Road to Dam Site

The approach road to Dam site will be diverted from NH-58 near Helong village. The approach road to dam site passes through the forest area. The study is based on extensive field survey. Flora of the area is dominated by tree species of Forest Trees. Total 36 plant species were observed out of which 10 species of trees, 12 of shrubs, 9 of herbs 2 grass 1 climber and 2 pteridophytes were recorded. Dominant species comprise of Pine *(Pinus roxburghii)*, Utis (*Alnus nepalensis),* Bhandir (*Albizzia lebbek)*, Surai (*Cupressus torulosa)*, Bakel (*Princepia utilis)* and Kilmora (*Berberies aristata).* The table given below presents the Flora of the area and its ecological status as per the Red Data Book of India by Nayar and Shastry and (1987-90) and IUCN Red List. All the species found at the site are common in occurrence.

Starting Point of Proposed Approach Road

View of Flora of the Site

Table 3.12: Flora of Approach Road to Dam Site

S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
Trees					
1.	*Albizzia lebbek*	Bhandir	Leguminosae	Common	Common
2.	*Alnus nepalensis*	Utis	Betulaceae	Common	Common
3.	*Bauhinia variegata*	Kuiral	Caesalpinaceae	Common	Common
4.	*Cedrela toona*	Tun	Meliaceae	Common	Common

S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
5.	*Celtis australis*	Kharik	Ulmaceae	Common	Common
6.	*Cupressus torulosa*	Surai	Cupressaceae	Common	Common
7.	*Ficus palmata*	Bedu	Moraceae	Common	Common
8.	*Grevillea robusta*	Silver Oak	Proteaceae	Common	Common
9.	*Melia azedarach*	Dhenkan	Meliaceae	Common	Common
10.	*Pinus roxburghii*	Chir	Pinaceae	Common	Common
Shrubs					
11.	*Agave americana*	Rambans	Cactaceae	Common	Common
12.	*Berberies aristata*	Kilmora	Berberidaceae	Common	Common
13.	*Cannabis sativa*	Bhang	Cannabaceae	Common	Common
14.	*Coriaria nepalensis*	Makhoi	Coriariaceae	Common	Common
15.	*Eupatorium adenophorum*	Kala bansa	Asteraceae	Common	Common
16.	*Princepia utilis*	Bekal	Rosaceae	Common	Common
17.	*Pyracantha crenulata*	Ghingaroo	Rosaceae	Common	Common
18.	*Rubus ellipticus*	Hinsalu	Rosaceae	Common	Common
19.	*Rumex hastatus*	Almora	Polygonaceae	Common	Common
20.	*Urtica parviflora*	Kandali	Urticaceae	Common	Common
21.	*Ziziphus mauritiana*	Ber	Rhamnaceae	Common	Common
22.	*Zanthoxylum alatum*	Timru	Rutaceae	Common	Common
Herbs					
23.	*Artemisia capillaris*	Pati	Compositae	Common	Common
24.	*Bidens bipinnata*	Kuru	Asteraceae	Common	Common
25.	*Cestrum verutum*	Kanjalu	Solanaceae	Common	Common
26.	*Fragaria indica*	Bhumla	Rosaceae	Common	Common
27.	*Galinsoga parviflora*	Marchya	Asteraceae	Common	Common
28.	*Oxalis corniculata*	Bhilmora	Oxalidaceae	Common	Common
29.	*Parthenium hysterophorus*	Gajar ghas	Asteraceae	Common	Common
30.	*Sonchus asper*	Dudhi	Asteraceae	Common	Common
31.	*Tridex procumbens*	Ground weed	Amaranthaceae	Common	Common
Grasses					
32.	*Chrysopogan fulvus*	Godia	Gramineae	Common	Common
33.	*Eulaliopsis binata*	Babula	Gramineae	Common	Common
Climbers					
34.	*Cryptolepsis buchananii*	Dudhi	Asclepiadaceae	Common	Common
Pteridophytes					

S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
35.	*Adiantum spp*	Fern	Adiantaceae	Common	Common
36.	*Dryopteries*	Fern	Dryopteridaceae	Common	Common

ii Approach Road to Langsi Adit

The Approach road to Langsi adit starts from NH -58 and crosses River Alaknanda and ends near Dwing village. The section of the road from starting point on NH-58 to Alaknanda river consist of old road route to Badrinath which is abandoned now. The Road was washed by flood in 1970 and new road was constructed from Pakhi to Langsi Village. On right side after crossing Alaknanda it crosses Tapon stream which is vulnerable to flood. The Bridge on Tapon stream was washed away three times in 2004. The road alingnment passes through agricultural fields on both side of the river.

View of Approach road (old road route to Badrinath)

Total 44 plant species are recorded out of which 17 are trees, 13 shrubs, 8 herbs, 2 grass, 2 climbers and 2 pteridophytes species were recorded. Fruit trees of Aru (*Prunus persica)*, Dalim (*Punica granatum)* Banana *(Musa paradisiaca)* Akrot (*Juglans regia)* Lemon (*Citrus limon)* were observed near Tapon and Dwing villages on agricultural land. All species are common and found abundantly in the area

Table 3.13: Flora of Approach Road to Langsi Adit

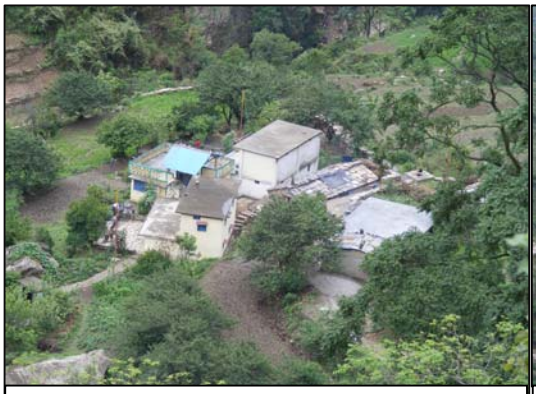
S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
Trees					
1.	*Boehmeria regulosa*	Genthi	Urticaceae	Common	Common
2.	*Cedrela toona*	Tun	Meliaceae	Common	Common
3.	*Citrus limon*	Nimu	Rutaceae	Common	Common
4.	*Citrus spp*	Malta	Rutaceae	Common	Common
5.	*Cupressus torulosa*	Surai	Cupressaceae	Common	Common
6.	*Emblica officinalis*	Amla	Euphorbiaceae	Common	Common
7.	*Ficus auriculata*	Timal	Moraceae	Common	Common
8.	*Ficus palmata*	Bedu	Moraceae	Common	Common

S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
9.	*Grevillea robusta*	Silver Oak	Proteaceae	Common	Common
10.	*Juglans regia*	Akrot	Juglandaceae	Common	Common
11.	*Melia azedarach*	Dhenkan	Meliaceae	Common	Common
12.	*Musa paradisiaca*	Kela	Musaceae	Common	Common
13.	*Phoenix humilius*	Khajoor	Palmae	Common	Common
14.	*Pinus roxburghii*	Chir	Pinaceae	Common	Common
15.	*Prunus persica*	Aru	Rosaceae	Common	Common
16.	*Punica granatum*	Dalim	Punicaceae	Common	Common
17.	*Pyrus pashia*	Mehal	Rosaceae	Common	Common
Shrubs					
18.	*Berberies aristata*	Kilmora	Berberidaceae	Common	Common
19.	*Cannabis sativa*	Bhang	Cannabaceae	Common	Common
20.	*Colebrookea oppositifolia*	Bindu	Labiatae	Common	Common
21.	*Coriaria nepalensis*	Makhoi	Coriariaceae	Common	Common
22.	*Debregeasia hypoleuca*	Sihanru	Urticaceae	Common	Common
23.	*Eupatorium adenophorum*	Kala bansa	Asteraceae	Common	Common
24.	*Euphorbia royleana*	Shuru	Euphorbiaceae	Common	Common
25.	*Princepia utilis*	Bekal	Rosaceae	Common	Common
26.	*Pyracantha crenulata*	Ghingaroo	Rosaceae	Common	Common
27.	*Rubus ellipticus*	Hinsalu	Rosaceae	Common	Common
28.	*Rubus niveus*	Kala Hinsalu	Rosaceae	Common	Common
29.	*Rumex hastatus*	Almora	Polygonaceae	Common	Common
30.	*Urtica parviflora*	Kandali	Urticaceae	Common	Common
Herbs					
31.	*Artemisia capillaris*	Pati	Compositae	Common	Common
32.	*Bidens bipinnata*	Kuru	Asteraceae	Common	Common
33.	*Cestrum verutum*	Kanjalu	Solanaceae	Common	Common
34.	*Galinsoga parviflora*	Marchya	Asteraceae	Common	Common
35.	*Oxalis corniculata*	Bhilmora	Oxalidaceae	Common	Common
36.	*Parthenium hysterophorus*	Gajar ghas	Asteraceae	Common	Common
37.	*Sonchus asper*	Dudhi	Asteraceae	Common	Common
38.	*Tridex procumbens*	Ground weed	Amaranthaceae	Common	Common
Grasses					
39.	*Chrysopogan fulvus*	Godia	Gramineae	Common	Common

S.No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
40.	*Cynadon dactylon*	Dhub	Gramineae	Common	Common
Climbers					
41.	*Bauhinia vahlii*	Malo	Leguminosae	Common	Common
42.	*Ipomea purpurea*	Besharam	Convovulaceae	Common	Common
Pteridophytes					
43.	*Adiantum spp*	Fern	Adiantaceae	Common	Common
44.	*Dryopteries*	Fern	Dryopteridaceae	Common	Common

iii Approach Road to Maina Adit

The approach road to Maina Adit starts from NH-58 near Pipalkoti. The road crosses river Alaknanda. There are three village enroute to Maina Adit -Tenduli, Maath and Guniyala village. Vegetation on Left side of river is sparse with some scattered bushes. All the species occurring are common in nature and found abundantly throughout the valley. On the right side after crossing the river some plantation was observed. The flora of the area constitute of Pine forest, fruit trees, and thorny shrubs.



View of Tenduli Village

View of Approach Road on Left side of River

There is a dense forest after Guniyala villages as the road approaches the Maina Adit site. Three herb species *Bergenia ligulata* (Silpara), *Hedychium spicatum* (Ban haldi) and *Thalictrum foliolosum* (Mamiri) are reported in the forest area near Maina adit, these species fall in vulnerable category as per IUCN Red list. However these species are common in India in Himalayan region and are found in altitudinal range from 1000 to 3000 m. These species are in common category and does not fall in threatened list of Red Data Book of Indian Flora. Total 51 plant species were observed in the area out of which 16 trees, 15 shrubs, 12 herbs, 3 grasses, 3 climber and 2 fern.

Table 3.14: Flora of Approach Road to Maina Adit

SNo	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
Trees					
1.	*Albizzia lebbek*	Bhandir	Leguminosae	Common	Common
2.	*Alnus nepalensis*	Utis	Betulaceae	Common	Common
3.	*Bauhinia purpurea*	Kuiral	Leguminosae	Common	Common
4.	*Boehmeria regulosa*	Genthi	Urticaceae	Common	Common
5.	*Cedrela toona*	Tun	Meliaceae	Common	Common
6.	*Celtis australis*	Kharik	Ulmaceae	Common	Common
7.	*Cinnamomum tamala*	Dalchini	Luraceae	Common	Common
8.	*Cupressus torulosa*	Surai	Cupressaceae	Common	Common
9.	*Emblica officinalis*	Amla	Euphorbiaceae	Common	Common
10.	*Ficus auriculata*	Timal	Moraceae	Common	Common
11.	*Ficus palmata*	Bedu	Moraceae	Common	Common
12.	*Grevillea robusta*	Silver oak	Proteaceae	Common	Common
13.	*Mallotus philippinenisis*	Ruina	Euphorbiaceae	Common	Common
14.	*Pinus roxburghii*	Chir	Pinaceae	Common	Common
15.	*Prunus communis*	Alu bukhara	Rosaceae	Common	Common
16.	*Toona serrata*	Kakuru	Meliaceae	Common	Common
Shrubs					
17.	*Agave americana*	Rambans	Cactaceae	Common	Common
18.	*Berberies aristata*	Kilmora	Berberidaceae	Common	Common
19.	*Cannabis sativa*	Bhang	Cannabaceae	Common	Common
20.	*Colebrookea oppositifolia*	Bindu	Labiatae	Common	Common
21.	*Coriaria nepalensis*	Makhoi	Coriariaceae	Common	Common
22.	*Debregeasia hypoleuca*	Sihanru	Urticaceae	Common	Common
23.	*Eupatorium adenophorum*	Kala bansa	Asteraceae	Common	Common
24.	*Princepia utilis*	Bekal	Rosaceae	Common	Common
25.	*Pyracantha crenulata*	Ghingaroo	Rosaceae	Common	Common
26.	*Rubus ellipticus*	Hinsalu	Rosaceae	Common	Common
27.	*Rubus niveus*	Kala Hinsalu	Rosaceae	Common	Common
28.	*Rumex hastatus*	Almora	Polygonaceae	Common	Common
29.	*Urtica parviflora*	Kandali	Urticaceae	Common	Common
30.	*Woodfordia floribunda*	Dhaula	Lythraceae	Common	Common
31.	*Ziziphus mauritiana*	Ber	Rhamnaceae	Common	Common
Herbs					

SNo	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
32.	*Artemisia capillaris*	Pati	Compositae	Common	Common
33.	*Bidens bipinnata*	Kuru	Asteraceae	Common	Common
34.	*Bergenia ligulata*	Silphara	Saxifragaceae	Vulnerable	Common
35.	*Cestrum verutum*	Kanjalu	Solanaceae	Common	Common
36.	*Galinsoga parviflora*	Marchya	Asteraceae	Common	Common
37.	*Hedychium spicatum*	Banhaldu	Zingiberaceae	Vulnerable	Common
38.	*Oxalis corniculata*	Bhilmora	Oxalidaceae	Common	Common
39.	*Parthenium hysterophorus*	Gajar ghas	Asteraceae	Common	Common
40.	*Polygonum chinensis*	Syaru	Polygonaceae	Common	Common
41.	*Sonchus asper*	Dudhi	Asteraceae	Common	Common
42.	*Thalictrum foliolosum*	Mamiri	Ranunculaceae	Vulnerable	Common
43.	*Tridex procumbens*	Ground weed	Amaranthaceae	Common	Common
Grasses					
44.	*Apluda mutica*	Tachula	Gramineae	Common	Common
45.	*Chrysopogan fulvus*	Godia	Gramineae	Common	Common
46.	*Cynadon dactylon*	Dhub	Gramineae	Common	Common
Climbers					
47.	*Bauhinia vahlii*	Malo	Leguminosae	Common	Common
48.	*Clematis connata*	Konya	Ranunculaceae	Common	Common
49.	*Ipomea purpurea*	Besharam	convolvulaceae	Common	Common
Pteridophytes					
50.	*Adiantum spp*	Fern	Adiantaceae	Common	Common
51.	*Dryopteries*	Fern	Dryopteridaceae	Common	Common

Vulnerable Species

(i) Bergenia ligulata

It belongs to family Saxifragaceae and grows on moist rocks and under forest shade. A juice or powder of the whole plant is used to treat urinary troubles. The root is used as a tonic in the treatment of fevers, diarrhoea and pulmonary affections. The root juice is used to treat coughs and colds, haemorrhoids, asthma and urinary problems. Externally, the root is bruised and applied as a poultice to boils and ophthalmia, it is also considered helpful in relieving backache. The root of this plant has a high reputation in indigenous systems of medicine for dissolving stones in the kidneys.

Propagation : By seeds. Seed, sown as soon as it is ripe in late spring is liable to germinate better than stored seed. When they are large enough to handle, prick the seedlings out into individual pots and grow them in light shade in the greenhouse for at least their first winter. Plant them out into their permanent positions in late spring or early summer, after the last expected frosts

Bergenia ligulata (Silphara)

(ii) Hedychium spicatum

It belongs to Zingiberaceae family. It is found near forest clearings and shrubberies. The plant prefers light (sandy), medium (loamy) and heavy (clay) soils. The plant prefers acid, neutral and basic (alkaline) soils. It cannot grow in the shade. It requires moist soil. The rhizome is considered as stomachic, carminative, stimulant and useful for liver complaints, diarrhea and food poisoning. It is also used in treating fever, snake bite and indigestion.

Hedychium spicatum (Banhaldi)

Propogation : By rhizomes. Best sown as soon as it is ripe in a warm greenhouse at 18℃. Prick out the seedlings into individual pots when they are large enough to handle and grow them on for at least their first winter in the greenhouse. Plant out in late spring after the last expected frosts. Dig up the clump and divide it with a sharp spade or knife, making sure that each division has a growing shoot. Larger clumps can be planted out direct into their permanent positions, but it is best to pot up the smaller divisions and grow them on in a greenhouse until they are established. Plant them out in the summer or late in the following spring

(iii) Thalictrum foliolosum

It is a herbaceous plant and belongs to Ranunculaceae family.It is found in Forests and shrubberies. The plant prefers light (sandy), medium (loamy) and heavy (clay) soils and requires well-drained soil. The root is antiperiodic, diuretic, febrifuge, ophthalmic, purgative, salve, stomachic and tonic. It is considered to be a good remedy for atonic dyspepsia and is also useful in treating peptic ulcers, indigestion, fevers, toothache, haemorrhoids and for convalescence after acute diseases. The juice of the leaves is applied to boils and pimples

Propogation : By seeds. Seed - best sown as soon as it is ripe in the autumn in a cold frame. When they are large enough to handle, prick the seedlings out into individual pots and plant them out in the summer. The seed can also be sown in an outdoor seedbed in spring. Plant them into their permanent positions the following spring

Thalictrum foliolosum (mamiri)

iv Approach Road to Powerhouse & Colony Site

The approach road to powerhouse and colony starts from NH-58 near Pipalkoti and crosses river Alaknanda and ends near Haat village at the Power house site. The Road traverses through agricultural and barren area. Some part of the old foot route to Badrinath on Right bank of the river is present which is in used by people of Haat to communicate. Total 49 plant species were observed in the area out of which 16 are trees, 19 shrubs, 8 herbs, 2 grasses, 2 climber and 2 fern species. All the species are common in occurrence.

View of Approach Road to Power House Site

Table 3.15: Flora of Approach Road to Powerhouse & Colony Site

S. No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
Trees					
1.	*Aegle marmelos*	Bel	Rutaceae	Common	Common
2.	*Bahunia variegata*	Kwiryal	Leguminosae	Common	Common
3.	*Bombax ceiba*	Semal	Bombaceae	Common	Common
4.	*Cedrela toona*	Tun	Meliaceae	Common	Common
5.	*Citrus limon*	Nimu	Rutaceae	Common	Common
6.	*Ficus auriculata*	Timla	Moraceae	Common	Common
7.	*Ficus palmata*	Bedu	Moraceae	Common	Common
8.	*Ficus religiosa*	Pipal	Moraceae	Common	Common
9.	*Mangifera indica*	Aam	Anacardiaceae	Common	Common
10.	*Melia azedarach*	Dhenkan	Meliaceae	Common	Common
11.	*Phoenix humilius*	Khajoor	Palmae	Common	Common
12.	*Pinus roxburghii*	Chir	Pinaceae	Common	Common
13.	*Prunus persica*	Adu	Rosaceae	Common	Common
14.	*Punica granatum*	Danim	Punicaceae	Common	Common
15.	*Sapindus mukurossi*	Ritha	Sapindaceae	Common	Common
16.	*Sapium insigne*	Khinna	Euphorbiaceae	Common	Common
Shrubs					
17.	*Adhatoda vasica*	Basinga	Acanthaceae	Common	Common
18.	*Agave americana*	Rambans	Cactaceae	Common	Common

S. No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
19.	*Berberies aristata*	Kilmora	Berberidaceae	Common	Common
20.	*Cannabis sativa*	Bhang	Cannabaceae	Common	Common
21.	*Calotropis gigantea*	Aak	Asclepiadaceae	Common	Common
22.	*Colebrookea oppositifolia*	Bindu	Labiatae	Common	Common
23.	*Debregeasia hypoleuca*	Siyaru	Urticaceae	Common	Common
24.	*Eupatorium adenophorum*	Kala bansa	Asteraceae	Common	Common
25.	*Euphorbia royleana*	Sullu	Euphorbiaceae	Common	Common
26.	*Jatropha curcas*	Arand	Euphorbiaceae	Common	Common
27.	*Lantana camara*	Kuri	Verbeaceae	Common	Common
28.	*Opuntia dillenii*	Nagphani	Cactaceae	Common	Common
29.	*Princepia utilis*	Bekal	Rosaceae	Common	Common
30.	*Pyracantha crenulata*	Ghingaroo	Rosaceae	Common	Common
31.	*Rosa brunonii*	Kunj	Rosaceae	Common	Common
32.	*Rubus ellipticus*	Hinsalu	Rosaceae	Common	Common
33.	*Rubus niveus*	Kala Hinsalu	Rosaceae	Common	Common
34.	*Urtica parviflora*	Kandali	Urticaceae	Common	Common
35.	*Ziziphus mauritiana*	Ber	Rhamnaceae	Common	Common
Herbs					
36.	*Argemone mexicana*	Satyanasi	Papaveraceae	Common	Common
37.	*Artemisia capillaris*	Pati	Compositae	Common	Common
38.	*Cassia tora*	Chakunda	Caesalpinaceae	Common	Common
39.	*Cestrum verutum*	Kanjalu	Solanaceae	Common	Common
40.	*Oxalis corniculata*	Bhilmora	Oxalidaceae	Common	Common
41.	*Parthenium hysterophorus*	Gajar ghas	Asteraceae	Common	Common
42.	*Polygonum chinensis*	Syaru	Polygonaceae	Common	Common
43.	*Tridex procumbens*	Ground weed	Amaranthaceae	Common	Common
Grasses					
44.	*Apluda mutica*	Tachula	Gramineae	Common	Common
45.	*Cynadon dactylon*	Dhub	Gramineae	Common	Common
Climbers					
46.	*Bauhinia vahlii*	Malo	Leguminosae	Common	Common
47.	*Ipomea purpurea*	Besharam	Convolvulaceae	Common	Common
Pteridophytes					
48.	*Adiantum spp*	Fern	Adiantaceae	Common	Common

S. No	Botanical Name	Local Name	Family	Ecological Status	
				IUCN	RDB
49.	*Dryopteries*	Fern	Dryopteridaceae	Common	Common

3.7.2 Quantitative Assessment of Flora

Assessment of Importance Value Index and Diversity index of flora of Project affected areas has been conducted. Importance Value Index (IVI) expresses dominance and ecological success of any species in an area whereas Diversity Index expresses the variety of species in an area. The trees dominated by contributing maximum number of 34 species followed by 26 species of shrubs, 16 species of herbs , 3 climbers, 4species of grasses, 2species of pteridophytes and one species of epiphyte.

View of Quadrat study at Dam site

View of Quadrat study at Colony site

The flora of the dam site is represented by plantation of *Alnus nepalensis* (Utis), *Bauhinia variegata* (Guiriyal), *Cupressus torulosa* (Surai) *Ficus palmata* (Bedu), *Pinus roxburghii* (Chir) and Toona *ciliate* (Toon) by Forest Department. Among shrubs *Eupatorium adenophorum, Urtica parviflora* are dominant species. Among grasses and herbs *Cynodon dactylon, Oxalis corniculata* and *Fragaria indica* are dominant. The distribution pattern is represented by A/F ratio which shows that most of the species are random (.025-.05) and contagious (> 0.05) in distribution.

Table 3.16: Assessment of Flora of Dam Site

Name	R.Frequency	R.Density	R.Abundance	A/F	Density / (ha)	IVI
Trees						
Pinus roxburghii	21.74	26.36	9.76	0.03	143	57.85
Bauhinia variegata	8.70	5.27	4.88	0.04	29	18.85
Phoenix humilis	4.35	2.64	4.88	0.07	14	11.86

Name	R.Frequency	R.Density	R.Abundance	A/F	Density / (ha)	IVI
Trees						
Cedrela toona	8.70	8.12	7.50	0.05	43	24.31
Alnus nepalensis	8.70	8.12	7.50	0.05	43	24.31
Albizzia lebbek	8.70	5.41	5.00	0.04	29	19.11
Cupressus torulosa	8.70	16.23	15.00	0.11	86	39.93
Dalbergia sissoo	4.35	2.71	5.00	0.07	14	12.05
Melia azedarach	4.35	5.41	10.00	0.14	29	19.76
Ficus palmata	4.35	5.41	10.00	0.14	29	19.76
Boehmeria regulosa	4.35	5.41	10.00	0.14	29	19.76
Pyrus pashia	4.35	2.71	5.00	0.07	14	12.05
Celtis australis	8.70	5.41	5.00	0.04	29	19.11
Shrubs						
Colebrookea oppositifolia	10.71	7.90	7.17	0.05	343	25.79
Eupatorium adenophorum	17.86	25.02	13.63	0.05	1086	56.50
Urtica parviflora	10.71	11.85	10.76	0.07	514	33.32
Princepia utilis	7.14	3.95	5.38	0.05	171	16.47
Ricinus communis	3.57	1.32	3.59	0.07	57	8.47
Berberis aristata	7.14	3.95	5.38	0.05	171	16.47
Plectranthus coesta	3.57	3.95	10.76	0.21	171	18.28
Pyracantha crenulata	7.14	2.63	3.59	0.04	114	13.36
Cannabis sativa	10.71	13.17	11.96	0.08	571	35.84
Rosa brunonii	14.29	11.85	8.07	0.04	514	34.21
Rumex hastatus	7.14	14.48	19.73	0.19	629	41.35
Herbs						
Oxalis corniculata	13.35	18.87	23.26	0.18	14286	55.48
Ipomaea purpurea	13.35	9.44	11.63	0.09	7143	34.41
Tridex procumbens	13.35	15.10	18.60	0.14	11429	47.05
Euphorbia hirta	20.03	7.55	6.20	0.03	5714	33.78
Fragaria indica	20.03	22.65	18.60	0.09	17143	61.28
Cynodon dactylon	20.03	26.42	21.71	0.11	20000	68.15

Note: IVI: Importance Value Index

The Power house and colony site comprise of plantation and open barren areas. The area is dominated by *Pinus roxburghii.* Other important species comprise of *Cedrela toona, Cupressus torulosa and Ficus palmata.* The dominant shrub species are *Eupatorium adenophorum, Colebrookea oppositifolia, Plectranthus coesta* and *Rumex hastatus. Parthenium hysterophorus* is dominant grass species occurring in the area. The distribution pattern is represented by A/F ratio which shows that most of the species are random (.025-.05) and contagious (> 0.05) in distribution.

Table 3.17: Assessment of Flora of Powerhouse & Colony Site

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Trees						
Ficus auriculata	3.85	4.54	8.63	0.14	29	17.02
Mangifera indica	7.69	4.54	4.32	0.04	29	16.55
Cedrela toona	11.54	13.63	8.63	0.05	86	33.80
Phoenix humilis	3.85	2.27	4.32	0.07	14	10.43
Melia azedarach	7.69	9.08	8.63	0.07	57	25.41
Syzygium cumini	3.85	2.27	4.32	0.07	14	10.43
Bauhinia variegata	7.69	6.81	6.47	0.05	43	20.98
Pinus roxburghii	11.54	24.98	15.83	0.09	157	52.35
Ficus religiosa	3.85	2.27	4.32	0.07	14	10.43
Sapium insigne	7.69	2.27	2.16	0.02	14	12.12
Dalbergia sissoo	3.85	4.54	8.63	0.14	29	17.02
Sapindus mukorossi	3.85	2.27	4.32	0.07	14	10.43
Cupressus torulosa	7.69	6.81	6.47	0.05	43	20.98
Ficus palmata	7.69	9.08	8.63	0.07	57	25.41
Morus alba	7.69	4.54	4.32	0.04	29	16.55
Shrubs						
Zizyphus mauritiana	3.33	2.60	4.27	0.14	114	10.20
Jatropha curcas	3.33	2.60	4.27	0.14	114	10.20
Eupatorium adenophorum	6.67	14.29	11.74	0.28	914	32.70
Urtica parviflora	6.67	10.39	8.54	0.14	457	25.60
Cannabis sativa	10.00	12.99	7.12	0.16	1143	30.10
Colebrookea oppositifolia	10.00	6.49	3.56	0.04	286	20.05
Princepia utilis	3.33	1.30	2.14	0.07	57	6.77
Rubus ellipticus	6.67	5.19	4.27	0.07	229	16.13
Berberis aristata	3.33	1.30	2.14	0.07	57	6.77

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Opuntia dillenii	6.67	5.19	4.27	0.07	229	16.13
Lantana camara	3.33	6.49	10.68	0.35	286	20.50
Euphorbia royleana	6.67	6.49	5.34	0.09	286	18.50
Adhatoda vasica	3.33	6.49	10.68	0.35	286	20.50
Rumex hastatus	6.67	11.69	9.61	0.19	629	27.96
Rubus niveus	10.00	6.49	3.56	0.04	286	20.05
Plectranthus coesta	10.00	14.29	7.83	0.09	629	32.12
Grasses & Herbs						
Argemone mexicana	0.05	1.35	3.19	0.07	1429	4.60
Artemisia capillaris	0.11	5.41	6.38	0.07	5714	11.90
Cestrum verutum	0.11	4.05	4.79	0.05	4286	8.95
Oxalis corniculata	0.11	13.52	15.96	0.18	14286	29.58
Parthenium hysterophorus	0.21	29.73	17.56	0.10	31429	47.50
Polygonum chinensis	0.05	4.05	9.58	0.21	4286	13.68
Tridex procumbens	0.11	10.81	12.77	0.14	11429	23.68
Apluda mutica	0.11	13.52	15.96	0.18	14286	29.58
Cynadon dactylon	0.16	17.57	13.83	0.10	18571	31.56

The adit area near dwing is open barren land dominated by shrubs. *Eupatorium adenophorum* is predominant species followed by *Urtica parviflora* and *Cannabis Sativa. Parthenium hysterophorus* is most frequently occurring grass species followed by *Tridex procumbens* and *Cestrum verutum.* The distribution pattern is represented by A/F ratio which shows that most of the species are random (.025-.05) and contagious (> 0.05) in distribution.

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Table 3.18: Assessment of Flora of Dwing Langsi Site

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Trees & Shrubs						
Pinus roxburghii	18.18	17.65	13.04	0.03	300	48.87
Berberis aristata	18.18	11.76	8.70	0.02	200	38.64
Cannabis sativa	20.00	20.00	13.64	0.03	300	53.64
Pyrus pashia	10.00	6.67	9.09	0.04	100	25.76
Debregeasia hypoleuca	10.00	6.67	9.09	0.04	100	25.76
Eupatorium adenophorum	10.00	26.67	36.36	0.16	400	73.03

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Urtica parviflora	20.00	20.00	13.64	0.03	300	53.64
Ficus palmata	10.00	6.67	9.09	0.04	100	25.76
Euphorbia royleana	20.00	13.33	9.09	0.02	200	42.42
Herbs & Grasses						
Artemisia capillaris	9.09	13.79	30.37	0.16	10000	53.26
Tridex procumbens	27.27	20.69	15.19	0.03	15000	63.15
Cestrum verutum	18.18	10.34	11.39	0.03	7500	39.92
Parthenium hysterophorus	27.27	48.28	35.43	0.06	35000	110.98
Bidens bipinnata	18.18	6.90	7.59	0.02	5000	32.67

Table 3.19: Assessment of Flora of Gulab Koti

Scientific Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Trees & Shrubs						
Pinus roxburghii	21.05	22.86	11.01	0.03	640	54.92
Melia azedarach	5.26	2.86	5.50	0.05	80	13.62
Ficus palmata	10.53	11.43	11.01	0.05	320	32.96
Zizyphus mauritiana	10.53	5.71	5.50	0.03	160	21.74
Colebrookea oppositifolia	15.79	22.86	14.68	0.04	640	53.32
Berberis aristata	10.53	8.57	8.26	0.04	240	27.35
Cannabis sativa	5.26	11.43	22.01	0.20	320	38.71
Rubus niveus	5.26	2.86	5.50	0.05	80	13.62
Rumex hastatus	5.26	5.71	11.01	0.10	160	21.98
Princepia utilis	10.53	5.71	5.50	0.03	160	21.74
Grasses & Herbs						
Tridex procumbens	30.00	22.22	19.36	0.03	12000	71.58
Oxalis corniculata	20.00	18.52	24.20	0.06	10000	62.72
Artemisia capillaries	20.00	11.11	14.52	0.04	6000	45.63
Parthenium	30.00	48.15	41.95	0.07	26000	120.10

Scientific Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
hysterophorus						

The Flora of Gulabkoti adit site is represented by open Pine forest. Shrub species dominant in the area are *Colebrookea oppositifolia, Cannabis sativa* and *Berberis aristata.* Few herb species are present at the site *Tridex procumbens, Oxalis corniculata* and *Artemisia capillaries. Parthenium hysterophorus* is the dominant grass species.

The Quarry site is represented by open barren area dominated by common shrubs such as *Colebrookea oppositifolia* and *Euphorbia royleana.*

Table 3.20: Assessment of Flora of Quarry Site Birahi

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Trees & Shrubs						
Bombax ceiba	4.55	3.13	5.77	0.06	67	13.44
Pinus roxburghii	13.64	18.76	11.54	0.04	400	43.94
Jacarandu mimosifolia	4.55	6.25	11.54	0.12	133	22.34
Urtica parviflora	13.64	12.51	7.69	0.03	267	33.84
Melia azedarach	4.55	3.13	5.77	0.06	67	13.44
Princepia utilis	9.09	6.25	5.77	0.03	133	21.12
Berberis aristata	4.55	3.13	5.77	0.06	67	13.44
Cupressus torulosa	9.09	9.38	8.66	0.05	200	27.13
Colebrookea oppositifolia	13.64	18.76	11.54	0.04	400	43.94
Sapium insigne	4.55	3.13	5.77	0.06	67	13.44
Eupatorium adenophorum	4.55	3.13	5.77	0.06	67	13.44
Agave americana	4.55	3.13	5.77	0.06	67	13.44
Euphorbia royleana	9.09	9.38	8.66	0.05	200	27.13
Herbs & Grasses						
Argemone mexicana	11.11	5.72	14.11	0.12	3333	30.94
Parthenium hysterophorus	33.33	51.46	42.34	0.12	30000	127.13
Oxalis corniculata	22.22	20.01	24.70	0.11	11667	66.93
Cynodon dactylon	33.33	22.87	18.82	0.05	13333	75.02

The quarry site at Patalganga is near the stream Patalganga. It is open barren land with few scattered shrubs mostly of *Eupatorium adenophorum.*

Table 3.21: Assessment of Flora of Quarry Site Patalganga

Name	R.Frequency	R.Density	R.Abundance	A/F	Density (ha)	IVI
Trees & Shrubs						
Urtica parviflora	18.18	9.68	12.00	0.04	240	39.86
Eupatorium adenophorum	45.45	64.52	32.00	0.04	1600	141.97
Princepia utilis	18.18	6.45	8.00	0.03	160	32.63
Berberis aristata	9.09	6.45	16.00	0.10	160	31.54
Cannabis sativa	9.09	12.90	32.00	0.20	320	53.99
Grasses & Herbs						
Argemone mexicana	50.00	46.15	26.67	0.03	12000	122.82
Parthenium hysterophorus	33.33	23.08	20.00	0.04	6000	76.41
Cynodon dactylon	16.67	30.77	53.33	0.20	8000	100.77

Assessment of diversity index of the project affected area depicts that the diversity of the area is low for both trees & shrubs and grasses & herbs. All the value of diversity index is below 2.5. The diversity of the area is lowest in the quarry site. The difference in value of diversity of the area is insignificant. The assessment of diversity is presented in the tables below.

Table 3.22: Diversity Index of Project Affected Area

S.No.	Site	Biodiversity Index		
		Trees	Shrubs	Grasses & Herbs
1	Dam Site	2.29	2.13	1.71
2	Powerhouse & Colony site	2.41	2.48	1.92
3	Gulabkoti Adit	2.07 (Trees & shrubs)		0.89
4	Langsi Adit	2.40 (Trees & shrubs)		1.37
5	Quarry site Birahi	2.33 (Trees & shrubs)		1.16
6	Quarry site Patalganga	1.13 (Trees & shrubs)		1.06

3.7.3 Natural Fauna

The distribution of fauna is mainly dependant on availability and type of vegetation providing feeding, breeding, hiding & resting sites. As project, area is dominated by

hilly tracks with less vegetation cover and interrupted by agriculture activities in the form of trench cultivation. Fauna of the project area is mainly represented by reptiles, birds and mammals. The reptiles were represented by *Calotes versicolor* (Common Lizard). The mammals were represented by domestic animals such as cow, buffalo, donkey, horses, mules, sheeps, goats and dogs. Mules and horses are the backbone of transportation system of local population in hilly areas

Public consultation was carried in the villages to know about the wildlife of the area. Incidence of domestic animals (cows & dogs) lifting by Leopard and Bear has been reported. The common wildlife reported by local people during discussion was the Leopard, Bear, Monkey, Deer etc. The wildlife recorded in the area is given in the table below.

Consultation in Palda Village

Consultation in Mat Village

Consultation near Power house site Haat

Consultation near Colony site Siyasain

Table 3.23: Wildlife of Project Affected Area

Scientific Name	Common Name	Family	Status	
			IWPA 1972	IUCN
Panthera pardus	Leopard	Felidae	Sch I	NT
Ursus aretos	Brown Bear	Ursidae	Sch I	LR/lc

Scientific Name	Common Name	Family	Status	
			IWPA 1972	IUCN
Macaca mulatta	Monkey	Cercopithecidae	Sch II	LR/NT
Mus booduga	Field mouse	Muridae	Sch V	LR/lc
Caprolagus hispidus	Hispid Hare	Cervidae	-	-
Canis aureus	Siyar	Canidae	Sch II	LC
Muntiacus muntjak	Kakad	Cercopithecidae	Sch III	LR/lc
Vulpes bengalensis	Fox	Canidae	Sch II	LC
Suncus murinus	Chuchunder	Soricidae	-	LC
Presbytis entellus	Langur	Cercopithecidae	Sch II	LR/lc
Sus scrofa	Wild Boar	Suidae	Sch III	LR/lc
Lepus nigrocolis	Khargosh	Leporidae	-	-
Reptiles				
Varanus bengalensis	Monitor Lizard	Varanidae	Sch I	LC
Calotes spp	Common Lizard	-	-	-
Amphibians				
Bufo himalayanus	Toad	-	-	-

V: Vulnerable LC: Least Concern LR/lc or LC: Least Concern NT: Near Threatened

As per IUCN Red List most of the wildlife fall in "LC" least concern category and only one species fall in vulnerable category. As per wildlife Protection Act (1972) three species *Panthera pardus, Ursus aretos* and *Varanus bengalensis* fall in schedule I category and three species fall in schedule II category. Two species fall in schedule III and one in schedule V. Schedule I species are the species which are most critical and require appropriate protection measures.

White cheeked Bulbul

Yellow Billed Magpai

Birds were identified with binox. The common birds recorded during the survey were Myna, Magpai, Pigeon, Black Drongo, Grey Shrike and White Cheek Bulbul. The list of birds found in the area is given below

Table 3.24: Birds of Advanced Construction Site

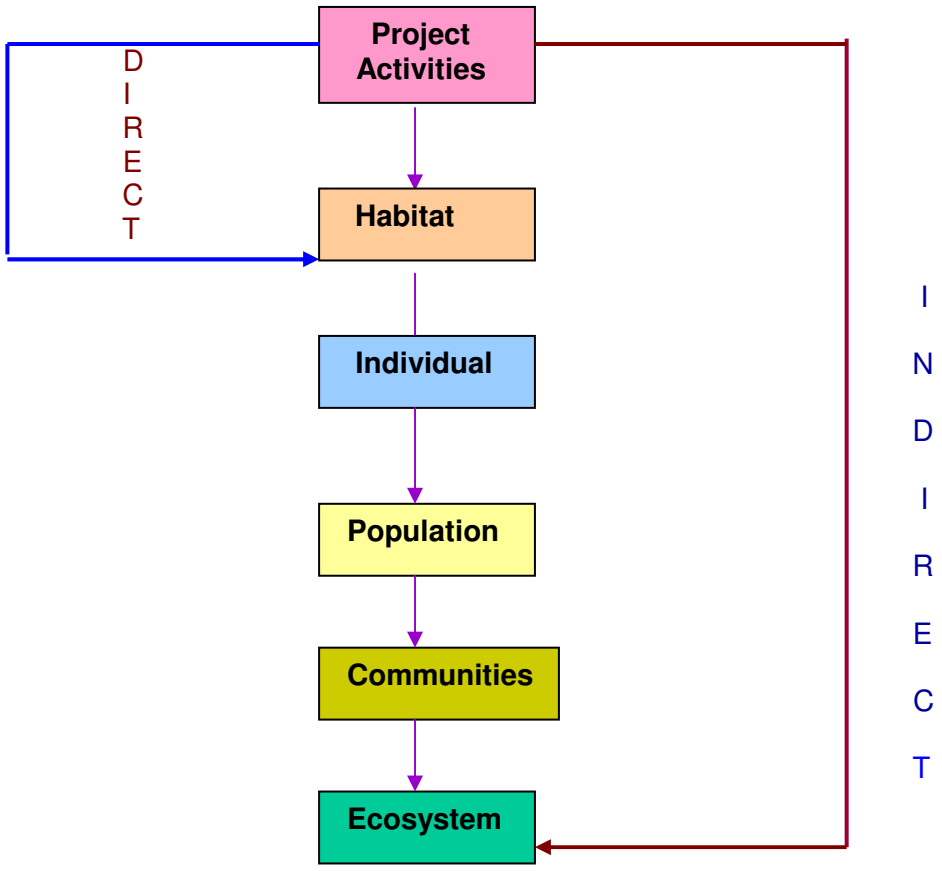
Scientific Name	Common Name	Family	Status	
			IWPA 1972	IUCN
Acridotheres tristis	Indian Myna	Sturnidae	Sch IV	LC
Alectoris chukar	Chukor Patridge	Phasianidae	Sch IV	LC
Corvus corax	Common raven	Carvidae	Sch IV	LC
Cissa flavirostris	Yellow build blue Magpie	Corvidae	Sch IV	-
Corvus splendens	House Crow	Carvidae	Sch IV	LC
Dicrurus adsimilis	Black Drongo	Dieruridae	Sch IV	LC
Dendrocopos himalayensis	Woodpecker	Picidae	Sch IV	LC
Lanius excubitor	Grey Shrike	Campehagidae	Sch IV	LC
Milvus migrans	Pariah Kite	Accipitridae	-	LC
Motacilla madaraspatensis	Large pied wagtail	Motacillidae	Sch IV	LC
Passer domesticus	House Sparrow	Passeridae	-	LC
Passer montanus	Eurasian Tree Sparrow	Passeridae	-	LC
Pycnonotus cafer	Red vented Bulbul	Pycnonotidae	Sch IV	LC
Pycnonotus leucogenys	White Cheeked Bulbul	Pycnonotidae	Sch IV	LC
Saxicoloides fulicatus	Indian Robin	Muscicapidae	Sch IV	LC
Copsychus saularis	Magpie Robin	Muscicapidae	Sch IV	LC
Streptopelia orientalis	Spotted dove	Columbidae	Sch IV	LC
Turdoides caudatus	Common babbler	Muscicapidae	Sch IV	LC
Turdus merula	Blackbird	Turadinae	Sch IV	LC

Source: Observation & consultation during field survey conducted during April-July 2008

CHAPTER 4
IMPACT OF PROJECT ACTIVITIES ON BIODIVERSITY

4.1 INTRODUCTION

Natural flora and fauna are the two important component of terrestrial ecosystem. They are organized into community and constantly interact with their physical environment as well as among themselves. They show various responses to outside influences. Environment impacts on biotic communities vary in directness, intensity and duration depending upon both nature of project activities and type of biotic communities. The response of biotic communities to project mediated changes in surrounding environment varies with ecological hierarchy i.e. from individual organism to ecosystem level as indicated in following flow chart (Manzel 1979).



Flow Diagram 4.1: Chain of Impacts and Structural Relationship of Terrestrial Biota

The project activity may directly affect organism by removal from habitat or indirectly through bringing out physico-chemical changes / alterations in their habitat. Long-term effect may be at population, communities and ecosystem level.

Impacts on terrestrial biodiversity have been considered at various levels such as project-affected area, project immediate influenced area and project influenced area (7 km surrounding project site). Based on baseline terrestrial biodiversity status and various project activities during construction & operation phase of project impacts are predicted. Impacts are categorized as direct, indirect, cumulative and induced impacts. The mitigation measures for each impact is detailed out in **Table 4.2** hence, are not discussed along with impacts. The details of impacts are discussed below.

4.2 IMPACTS ON FLORA

Impacts of various project activities are directly related to project affected area. The baseline terrestrial biodiversity status of the project affected area revealed that, two forests types i.e. Himalayan Chir Pine Forest, Himalayan Subtropical Scrub and Subtropical Euphorbia Scrub.

The flora of the project affected area is dominated by *Pinus roxburghii* (Pine) and *Cedrela toona* (Tun) plantation. Common tree species observed during the survey were *Bauhinia variegata (*Kachnar*), Melia azaderach(*Dhenk*), Ficus palmata* (Bedu), *Sapium insigne* (Khinna), *Phoenix humilis* (Khajoor) and *Mallotus philippinensis* (Kamela),) Shrubs such as *Berberies aristata* (Kashmoi)*, Eupatorium adenophorum* (Kala bansa) *Euphorbia royleana* (Shuru)*, Princepia utilis (*Bhekal) *Zanthoxylum alatum* (Timru) and *Rubus ellipticus* (Hinsar) *etc* The dominant weeds recorded were *Colebrookia oppositifolia* (Bindu)*, Calotropis gigantea* (Aak)*, Lantana camera* (Lantana) *Urtica parviflora* (Kandali) and *Rumex hastatus* (Bhilmora) etc. *Parthenium hysterophorus* (Congress grass) was also widely found.

4.2.1 Direct Impacts

There will be direct impacts of project activities on flora in the project-affected area due to acquisition of forests land, tree felling and clearing of land for providing various project units. Details are discussed below

.

(I) Acquisition of Forests Land

Potential negative direct impact of hydroelectric project is considered to be loss of flora/ forests due to construction of dam/ reservoir. The total land requirement of the project is 120 ha out of which 80 ha is forestland 40 ha is private land.

(ii) Tree Felling

The direct impact on flora is attributed to loss of trees, which are required to be cleared for establishment of various project units. Total 2,465 trees are to be felled/ cleared. The details of tree are given below.

Table 4.1: List of Trees to be felled for clearing of the Sites

S.No	Location	Number
1	Helong, Pani, Thang (Urgam R.F)	153
2	Siyasen	379
3	Hat	156
4	Tungli Bridge –Maina river	804
5	Gulabkoti	14
6	Nauligwad	43
7	Pala	15
8	Dwing	10
9	Tapan	5
10	Dam Site	706
11	Helong Vanpanchayat	180
	Total	**2,465**

Source: Tree Cutting Report, Vishnugad Pipalkoti Hydroelectric Project

Tree cutting report revealed that most of the trees are planted in the area by Forest Dept. and Van Panchayat. The major species grown are *Melia azaderach, Albizzia lebbek, Cedrela toona, Pinus roxburghii, Alnus nepalensis, Boehmeria regulosa, Embelica officinalis, Dalbergia sissoo* and *Cupressus torulosa,* The species reported are commonly distributed throughout the project immediate influence area and project influence area.

The project is not likely to affect the structure composition, of existing forest types, forest cover or distribution characteristics of flora. Therefore, adverse impacts on terrestrial biodiversity due to proposed tree felling is not at all expected.

(III) Clearing of Project Land

Direct impact on flora is also attributed to loss of flora due to clearing for forests land for providing various facilities such as provision of approach road, job facilities, construction of adits, power house, excavation for quarry and dumping areas etc. The detailed site specific investigation has been carried out to establish terrestrial biodiversity status it revealed that, dominant shrubs were *Berberies aristata* (Kashmoi)*, Eupatorium adenophorum* (Kala bansa) *Euphorbia royleana* (Shuru)*, Princepia utilis (*Bhekal) *Zanthoxylum alatum*(Timru), *Colebrookia oppositifolia (Bindur), Cannabis sativa* (*Bhang), Agave americana (Rambans), Euphorbia royleana (*Shuru*), Opuntia dilenii* (Nagpani*), Rubus ellipticus* (Hinsar*), Lantana camara* (Lantana*), Rumex hastatus(*Bhilmora*)* etc. The common tree species observed were *Pinus roxburghii* (Pine), *Cedrela toona* (Tun) *Bauhinia variegata (*Kachnar*), Melia azaderach* (Dhenk*), Ficus palmata* (Bedu), *Sapium insigne* (Khinna), *Phoenix humilis* (Khajoor) and

*Mangifera India (*Aam*)* etc. These species are widely distributed throughout the project immediate influence area as well as project influence area.

Three herbaceous species *Berginia ligulata* (silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) reported in the advance construction site fall under vulnerable category as per IUCN categorization. These species are common in Himalaya and are available in 1000 to 3000m. The species may be conserved and developed in separate herbal garden. THDC may undertake development of Herbal garden at suitable place in consultation with Forest Department and propagation of the species must be taken. Besides the three species other species of medicinal value may be also encouraged.

The flora of the project area is very sparsely distributed showing low diversity index, which varied between 0. 8 to 2.28 indicative of degraded forestland. Thus, it revealed that loss of flora due to clearing of trees for various project activities will not have any direct significant impacts on flora of the region in terms of total forest cover, loss of ecologically significant species, change in structure, composition and distribution pattern of flora and there by any adverse significant impacts on existing terrestrial biodiversity status of the forest area in particular and flora of Alaknanda Basin or Uttarakhand in general. As direct impacts of project activities are confirmed to project affected areas only hence, any direct impacts on project immediate influence area and project influence area are not expected.

In order to compensate the loss of forests land acquired for establishing various project units, loss due to tree felling as well as due to land clearing the approved **Compensatory Afforestation Plan** may be implemented by State Forest Department. The Compensatory Afforestation may be carried out as per the **Forests (Conservation) Act 1980**.

4.2.2 Indirect & Cumulative Impacts

Indirect impacts of project activities on flora are expected to be limited to project immediate influence area and to some extent to project influence area. Indirect impacts will be due to various construction activities such as generation of dust due to earthwork, excavation, transportation of construction materials (sand aggregate, cement etc), quarry, crusher & blasting operations, air pollution due to movement of construction vehicles, equipments and machineries, influx of labour population and pollution generated through provision of labour camps established temporarily at construction sites etc. These impacts will be short term and limited to construction period only.

The existing terrestrial biodiversity status of the project immediate influence area revealed the, natural flora is interrupted by human settlements and intensive agricultural & horticultural activities, heavy lopping & browsing activities, continuous traffic on existing NH-58 etc. The flora is dominated by trees due to avenue plantation.

The dominant trees of avenue plantation along existing NH-58 are *Cedrela toona* (Tun) *Bombax ceiba* (Semul*), Eucalyptus globules* (Safeda) *Erithrina indica* (Pangar)*, Mallotus philippinensis* (Kamela)*, Melia azederach* (Baken*), Pinus roxburghii* (Chir)*, Robinia*

pseudoacacia (Pahari kikar) etc. Common shrubs were represented by *Adhatoda vasica* (Vasaka)*, Colobrookia oppositifolia* (Bindu), *Calotropics gigantea* (Aak), *Euphorbia royleana* (Shuru)*, Rubus ellipticus* (Hinsar) *Cannabis sativa* (Bhang)*, Debregeasia hypoleuca* (Sihanru)*, Urtica parviflora* (Kandali)*, Rumex hastatus* (Bhilmora) etc. The indirect impacts due to various project activities are discussed in details below.

(I) Generation of Dust

The dust is primary air pollutant in the form of Suspended Particulate Matter generated due to various project activities such as earthworks, general transportation, loading/unloading/ transportation of construction material, blasting, crusher & quarry operation etc.

Long-term exposure of dust primarily affects vegetation by interfering the matter exchange between plants and atmosphere. The exchange of gaseous components is an important for various vital physiological processes such as photosynthesis, respiration & evapo-transpiration etc leading to various morphological effects such as chlorosis, necrosis, discoloration and ultimately reduction in primary productivity.

As the avenue plantation along the existing NH-58 is well grown (which will be used for transportation) and will helpful in filtering out dust and impact due to dust during transportation will minimize. The vegetation in project immediate influence area is dominated by thorny shrub hence, impact will be insignificant. As indirect impact due to dust will be restricted during construction period only hence long terms impacts are not expected. However to mitigate adverse impact due to dust suggested mitigation measures (Table 4.2) may be strictly followed.

(II) Generation of Noise

The noise will be generated due to various construction activities such as movement of construction vehicles machineries and equipments, working force as well as blasting. Blasting is a common practice of tunneling activity. It is short-lived phenomenon i.e. duration generally less than 0.5 seconds. There are no direct impacts of blasting activity on vegetation as vegetation attenuates sound by absorption. The blasting will be carried out by controlled blasting techniques hence any adverse impacts on vegetation are not expected.

(III) Temporary Labour Camp

The hydroelectric projects are labour intensive hence, large number of labours are expected to influx the area during construction phase. The important project activity-affecting flora surrounding the project influence area is due to establishment of laborer camps. The major threat to surrounding flora is through collection of fuel wood by labour for cooking purposes and thereby loss of trees. Hence, to mitigate this impact on flora necessary alternate arrangement should be done for fuel such as provision of LPG, Kerosene etc. It should be ascertained that no open fire should be allowed in labor camps as it may lead to fire to surrounding forest leading to loss of forest. The solid

wastes generated in the form of garbage and effluent due to sewage should be properly collected and suitably disposed so as to avoid any impact on surrounding flora.

(IV) Generation of Debris& Muck

Huge amount of construction spoils/ muck is expected to be generated from various constructions it may adversely affect the surrounding forest areas leading to loss of flora. Hence, necessary steps to be taken to mitigate impact by suitable disposal at identified dumping areas.

It revealed that dumping areas are either devoid of vegetation or showed few weedy shrubs. Hence, any adverse impacts on flora are not expected as these shrubs are widely distributed in project immediate influence area as well as project influence area. To mitigate this loss of shrubs approved **Muck Disposal Plan** should be strictly implemented. As such no vegetation was recorded at proposed quarry site, however to avoid impacts due to quarry operations on surrounding quarry site necessary dust suppression measures should be implemented. After completion the quarry operation area should be reclaimed.

(V) Soil Erosion

The soil erosion due to natural and anthropogenic activities cause major threat to survival of vegetation. The Alaknanda River flows in narrow deep channels with steep hills rising on either side in the project area. The hills are very steep with poor or no ve getation cover. Due to poor vegetation cover the rate of soil erosion is high. Different forms of erosion such as sheet erosion, gully erosion, riverbank erosion are quite prevalent throughout the project affected/immediate influence and project influence area. Common anthropogenic factors leading to erosion are over gazing, collection of trees for fuel, fodder, timber and road construction.

The project activities accelerating soil erosion will be quite significant during construction phase such excavation work, tunneling/blasting, construction of temporary and permanent road in project area to move vehicle/machinery/equipments and working force (Labour). The land acquired for the project had to be cleared to make way for various project components clearing of vegetation accelerates erosion process in addition to above-mentioned activities.

The excavated material is generally loose, unstable and keeps rolling down and thereby affecting natural drainage channels of the river deteriorate water quality as well as accelerate sedimentation & soil erosion. As dumping area are located closed to river Alaknanda and chances of rolling down of muck/ loose material leading to blockage in river flow or contamination of water due to silting are more. In order to avoid this retaining wall varying from of 2 – 7 m height is proposed along the bank of the river at all Muck Disposal Areas. In order to control the soil erosion the approved Catchments Area Treatment Plan should be strictly implemented.

4.2.3. Induced Impacts

The induced impacts largely concentrated on project influence area owing to dependency of local people on forests. These impacts are discussed specially in light of various human activities affecting forest such as new migrant labour, associated development, and induced commercial developments

The forests of the influence area are interrupted with various settlements along with agricultural, horticultural, animal husbandry practices. Local villagers are fully dependent on forests for their day-to-day requirements including fodder, fuel, timber grazing etc. All these activities adversity affect the forests and it is under pressure due to increasing human population and their activities. Besides this, lopping of trees for fodder manure and bed preparation for cattle sheds, heavy grazing and forest fire have thinned out the forest to varying degree, destroy all undergrowth and reduced shrubby ground cover.. The induced impacts are discussed below in details.

(I) Migrant Labour

The induced impact associated with migrant labor are loss of vegetation/flora for provision of facilities such as accommodation, provision of road for transportation, provision of waste disposal such as solid waste/garbage and effluents generated through sewage, provision of commercial complexes to meet their day to day requirements and provision of parking facilities etc. Moreover large scale migration of labour/ employees during operation phase is not expected as working staff will be limited to skilled workers & trained officials of THDC. Therefore loss of forest land, loss of flora, pollutions generated via sewage & garbage & thereby adverse impacts on surrounding flora is not at all envisaged.

(II) Associated Developments

Development of Vishnugad Hydro-electric project is likely to trigger associated development in several sectors such as transportation, automobile, commercial sectors such as daily needs, agriculture related developments such as vegetable, fruit, grain, fertilizer, pesticides, irrigation, electric appliances, which is likely to provide employment opportunities for local people and help to increase their social & economic status. All these development need space/land. The land is to be cleared before establishment of any facility. Loss of flora attributed to clearing of land for development & thereby any adverse impacts are not envisaged.

(III) Induced Commercial Development

As such the project area is located in interior areas away from the township in hilly area hence, large-scale commercial development is not expected. All commercial facilities are available at Pipalkoti and Chamoli that are near from proposed powerhouse and colony area therefore additional commercial development is also not envisaged. Hence any adverse impacts on flora of the either project influence area or project immediate influence area due to induced commercial development is not expected.

4.3 IMPACTS ON FAUNA

The major factor affecting the distribution of animals in entire area is found to be forest types, altitudinal variation, interference of human activities and forest cover. The data has been collected on fauna based on extensive field survey, direct and indirect methods, secondary data collected from Forests Dept. Impacts on fauna are categorized as direct, indirect, cumulative and induced impacts and are discussed below.

4.3.1 Direct Impact

Direct impacts of project activities are restricted to project influence area. The presence of fauna is directly related to type of flora present. Himalayan Chir Pine Forest Himalayan Subtropical Scrub and Subtropical Euphorbia Scrub, which are sparsely distributed along hill slopes, foothills and Alaknanda river valley, represent Flora of project-affected area. The forest patches present in the project affected area is mostly plantation carried out by state forest department and Village panchatyat. Most of the hill slopes are very steep and almost without any vegetation or with thin vegetation dominated by pine which is already discussed in details on vegetation impacts.

The baseline faunal biodiversity status of project affected area revealed that common representation of reptiles was *Calotes versicolor* (Common Lizard). The common birds recorded were *Acridotheres tristis* (Indian Myna), *Corvus splendens* (House Crow), *Dandroatta vagabunda* (Treepie), *Lanius excubitor* (Grey Shrike), *Milvus migrans* (Pariah Kite), *Pycnonotus leucogenys* (White Cheeked Bulbul), *Turdoides caudatus* (Common babbler), *Sexicoloides fulicata* (Indian Robin), *Turdus merula* (Blackbird) etc. showing typical agrarian bird community as area is marked by intensive agricultural & horticultural activities.

The mammals were represented by domestic animals. As the agricultural & horticultural activities dominated the project area the domestic animals of local importance were mainly observed such as Cow, Buffalo, Ox of agricultural importance, Horses, Mules and Donkeys used for carrying loads in hilly areas and common pet animal such as Dogs & Cats.

Presence of wildlife has been reported by the local inhabitants during public consultation. The wildlife reported by local people during discussion were Leopard, Bear, Wild Boar, Monkey, Deer etc. As per IUCN Red List most of the wildlife fall in “LC“ least concern category and only one species *Ursus aretos* (Brown bear) fall in vulnerable category. As per wildlife Protection Act (1972) two species *Panthera pardus* (Leopard) and *Ursus aretos* (Brown Bear) and *Vulpes bengalensis* (Fox) fall in schedule I category and three species *Macaca mulatta* (Monkey), *Canis aureus* (Siyar), and *Presbytis entellus* (Langur) fall in schedule II category. Two species *Muntiacus muntjak* (Kakad) and *Sus scrofa* (Wild Boar) fall in schedule III category. Schedule I species are the species which are most critical and require appropriate protection measures

The wildlife inhabits the forest areas mostly at higher elevations away from settlement. However they roam and hunt in the area. The project affected area is mostly

open/plantation area with settlements, the wildlife move in the area during nighttime. The project activities are likely to disturb the normal peace of the wildlife and they are likely to move in other areas.

4.3.2 Indirect & Cumulative Impacts

Indirect and cumulative impacts are associated with various construction activities such as clearing of vegetation for establishment of various project units, movement of vehicles, construction equipments & machineries etc, interferences due to influx of labours as well as temporary establishment of labour camps, blasting operations etc.

The major direct impact of and hydro -electric project is primarily through construction of reservoir and submergence of forest leading to loss of habitat for wildlife. The proposed dam site is just below the NH-58 near Helong. The area is plantation site of Van panchayat and is not habitat to wildlife. Hence it is not likely to cause any impact on wildlife.

The loss of 80 ha of forest land for various project unit will also not adversity affect the fauna as similar habitat is present throughout the project immediate influenced area as well as project influence area. Therefore impact due to loss of habitat for birds, reptiles and mammals of the project area is not expected.

The blasting activity is short term activity and impact is lest up to 0.5 sec. Due to noise generated during blasting may lead to short time driving way of birds & animals in surrounding areas. As the controlled blasting technique will be followed hence any long-term adverse impacts are not engaged.

Impacts on surrounding fauna due to movement of vehicles, machinery, equipments and work force may slightly interfere in animal movements. As most of the domestic animals Cows, buffaloes, goats sheeps, donkies & horses are guided & controlled by the owners /caretakers and hence any causality in terms of killing or accident are not expected. However proper maintenance of vehicle and controlling speed during driving may avoid impact totally. As no wildlife reside in project-affected areas which is open area with intermittent settlements any adverse impacts on wildlife is ruled out.

4.3.3 Induced Impacts

The induced impacts are considered to be due to establishment of propose hydroelectric project, migration of labours/employees, induced commercial developmental activities on surrounding fauna. As project affected area and project immediate are is mainly represented by common domestic animals, which are protected by their owners, hence any adverse impacts are not envisaged. However the project influence are 7 Km surrounding the proposed project varies forest types as well as wildlife is reported hence induced impacts are discussed with reference to forests & wildlife reported from project influence area.

The variation in altitude leads to variation in forest types and associated changes in wildlife. Important wild animals are reported at higher altitude such as Himalayan Black bear (*Selenarctor thibetenus*) reported at 1800 to 2500mt altitude, Musk deer (*Moschus moschiferus*) is reported from 2900-4000 meters. Rhus Macaque (*Macaca mulata*) from 1200-2400m while Languor (*Presbytes entellus*) from 1800-2800 meters. Hence, any adverse impacts due to induced developmental activities on wildlife are not expected. However, in order to improve forest cover & wild habitat suggested recommendations to be strictly implemented as per approved Compensatory Afforestation Plan and Catchment Area Treatment Plan.

4.4 IMPACT ON NANDA DEVI BIOSPHERE RESERVE (NDBR)

The NDBR comprise of Chamoli, Bageshwar and Pithoragarh districts. It is divided into Core zone -712.12 km^2, Buffer Zone - 5,148.57 km^2 and Transitional Zone -546.34 km^2. The buffer zone is inhabited by 47 villages whereas the transition zone is inhabited by 52 villages. The core zone consists of Valley of Flowers and Nanda Devi National Park. The Valley of flowers is a trek of about 16 km from Govindghat which is about 25 km from Joshimath. The Nanda Devi National Park is situated at a distance of 25 km from Joshimath, the territory starts at a distance of 9 km trek from the Village Lata. The Map of NDBR is given in Fig **4.1.**

The project site is located in the transitional zone of NDBR. The territory of Nanda Devi Biosphere reserve starts from Patal Ganga. The transitional zone in project area is approximately 5km from dam site to Patalganga. The land use pattern of this zone comprises of forests, agricultural land, waste land, settlements, cultivable waste land and orchards. The National Highway NH-58 is located on the left side of the Alaknanda river in the project area and is a pilgrim/tourist route.

Starting point of NDBR after crossing Patalganga

The development of the project will not have any impact on the Core and Buffer zone of the NDBR. The Impact in the transitional zone NDBR of is not significant. The project sites are located along the river course. The area along the river consists of steep rocky slopes with scattered pine forest.

Fig 4.1: Area of Nanda Devi Biosphere Reserve

The impacts which are likely to occur on NDBR due to the project activities are:

- The construction work is likely to increase the noise level in the area however the impact will be intermittent and temporary and localized.
- The Air quality is likely to be affected due to generation of dust and fugitive emission. The impact will be temporary and limited to construction phase.
- Cutting of trees and clearing of land. No rare/endangered and threatened species located in the area. The Dam site consists of panchayat forest areas which consist of plantation. The project entails construction of underground tunnel which is not likely to affect the top flora and fauna.
- No impact on Fauna of the area as no fragmentation of habitat is taking in the zone and there is no dense forest in this zone.
- Influx of labour population is likely to occur which may impart pressure on the local resources of the area.
- The overall impact of the project will be positive on the NDBR, under the project Catchment Area Treatment plan and Afforestation Plan will be undertaken which is likely to enhance the existing environmental status of the area.

Following mitigation measures are suggested to minimize/compensate the impact on the NDBR area.

- The project area does not fall in Core zone of the NDBR, The core zone consists of Valley of Flowers and Nanda Devi National Park. The Valley of flowers is a trek of about 16 km from Govindghat which is about 25 km from Joshimath. The Nanda Devi National Park is situated at a distance of 25 km from Joshimath. Joshimath town is approx 12 km upstream from the Dam site. **As per the guidelines and proformae of MoEF for Protection, Development, Management and Research in Biosphere Reserves in India (Oct 2007) only the core zone secure legal protection and management and must be kept free of human pressure. The project does not fall in core zone of NDBR hence does not attract any legal obligation.**
- The construction work may be carried within the occupied area only. Acquisition of extra land must be taken only after permission from concerned authority, if required.
- The machineries, vehicles and equipments use in construction shall strictly confirm to CPCB standard. All vehicles equipment machinery used in construction shall be fitted by exhaust silencers. Blasting shall be carried out as per the statutory laws, regulation and rules pertaining to acquisition, transport, storage, handling and use of explosives.
- Plants, machinery and equipment shall be handled so as to minimize generation of dust. All earth work shall be protected to minimize dust generation
- Compensation must be given to Vanpanchayat for the land and standing crop. Fruit bearing trees may be compensated including cost of fruit yield of 5 years. Cutting of

trees should be strictly prohibited outside construction site. Timely implementation of Compensatory Afforestation plan.

- Wildlife check post must be established in the project area and hunting must be strictly banned.
- Labours must be provided fuel-kerosene/LPG by contractor. No felling of trees must be done by labour for fuel and shelter. Labour camps must be located away from forest area. Local people must be given preference for skilled and unskilled jobs in the project.
- Awareness program must be undertaken by THDC on environmental importance and natural resources.

The implementation of CAT plan and Afforestation plan is likely to enhance the resources and environment of the area. **The CAT plan covers Joshimath region and Pipalkoti region. The Joshimath region covered under the plan is part of NDBR Transitional Zone,** the interventions proposed in CAT plan under NDBR include:

Forestry Work

- Afforestation work- 145 ha
- Densification – 120 ha
- Pastureland development – 50 ha
- Medicinal plant plantation – 50 ha
- Assisted natural regeneration in the area 270 ha

The budget provided to NDBR for the Forestry activities is Rs 121,39,805/-

Soil & Moisture Conservation Engineering Work such as

- Vegetative check dams- 6600 No.
- Gully Plugging – 1650 No.
- Stone check dams - 7550 No.
- Crate wire check dams -16500 No.
- Spurs – 15200 No.
- Water percolation tanks – 4700 No.

The budget provided to NDBR for the Soil & Moisture Conservation Engineering Work Rs 207,15,000/-

For management of Wildlife a budget of Rs.6150000/- is proposed in NDBR region under CAT Plan. **The total Budget for NDBR is Rs.4,72,14,805/- under CAT plan out of Rs 47,07,41,780/-**

The Management plan of NDBR is prepared by the Forest Department and takes care of the environmental and social concerns of the area. The Man and Biosphere (MAB) programme is operational in the Niti and Johar valley of NDBR since 1988. The management plan of NDBR is discussed below.

Management Plan of Nanda Devi Biosphere Reserve

Management Plan of Nanda Devi Biosphere Reserve is prepared by Forest Department for managing natural resources of the area in a sustainable manner. To reduce dependency on natural resources of NDBR by local inhabitants the need of local people is also addressed and participatory approach is followed to involve people in conservation of the area.

Strict conservation measures are taken to preserve the core zone and no human activity except regulated tourism is allowed inside the core zone. Regular patrolling activity and monitoring activity is taken up in side the core zone

Management of buffer & transition zone is mainly rest of man management. Under this efforts are made to set up a harmonious and mutually benefiting mechanism where both forest and the people whose livelihood is based on the use of forest, may live in perfect peace and harmony.

Following activities are undertaken as part of management plan of NDBR:

i. Eco-development Activity

- Distribution of Fruit Plants
- Solar lights
- Gas Connection
- Purchase & distribution of locally produced raw wool

ii. Value Addition Activity

- Grassland improvement and Management

iii. Rehabilitation of Habitats

- Maintenance of Forest Nurseries
- Maintenance of Medicinal Plant Nurseries
- Advance soil work in degraded forest lands
- Soil Conservation works
- Propogation of medicinal plants in unused agricultural fields

iv. Ecotourism

- Development of Trek Routes
- Development of community based NDNP Eco Tourism zone CBT planning, Capacity building, Training

v. Social Welfare Activities

- This consist of activities such as
- Drinking water facility
- Immunization of domestic cattle

- Support for rural School

vi. Capacity Building and Awareness

- Education programme in school
- Exposure visit
- Capacity building and training programme of the staff
- Capacity building and training programme of the villagers of buffer and transitional zone for income generating progammes from agriculture, horticulture, livestock management and medicinal/ aromatic plants.

vii. Protection and Communication System

- Maintenance of wireless seta and communication systems
- Setting up of high gain repeater station
- Construction of anti poaching huts for the staff of NDBR posted at far flung areas.

viii. Research , Documentation and Monitoring

- Survey of flora, fauna
- Documentation
- Publication

An annual budget is earn-marked to undertake the activities under various heads in the NDBR Region. The project does not have any direct impact on the NDBR as all the construction area are outside NDBR area. The Left side of the river falls under transition zone of NDBR.

The approved Compensatory afforestation plan and Catchment Area Treated (CAT) Plan must be implemented accordingly. The CAT plan cover Joshimath region and Pipalkoti region. The Joshimath region is part of NDBR Transitional Zone and the interventions such as Assisted Natural Regeneration, Medicinal plant plantation, Afforestation, Pasture land development, Vegetative check dams, stone check dams, catwire check dams proposed for management of the area. These measures are likely to enhance the NDBR area with respect to natural resource and ecosystem management.

Budget of Rs.100,00,000/- is proposed for capacity building, training & exposure visit in the CAT plan. Some fund may be allocated by the project for training and awareness campaigns to sensitize and motivate people for management of resources in NDBR area. **Training program for livelihood support can be conducted for the villages which are likely to be affected / fall in project influence area.**

The project can also support research, documentation and monitoring program.

4.6 CONCLUSION

The terrestrial biodiversity of project affected area and project immediate influence area is represented by low floral & faunal diversity. The forests of the area are represented by

Pine forests and Euphorbia Scrub and Himalayan Subtropical Scrub. Weedy shrubs with some common tree species dominate the area. Direct impacts of project activity on flora are considered to be due to acquisition of forestland for establishment of various project units, loss of trees due to felling and clearing

The impact due to tree felling will be insignificant as the tree species are commonly available thought project immediate influence area and project influence area. As a result there will no change in community composition and structure of forest due to tree felling.

The loss due to clearing is also not expected as weedy shrubs, which are widely distributed, dominate project area. Adverse impacts on Terrestrial Biodiversity due to loss of species are not expected. The loss of forestland and trees felled will be compensated by implementation of approved **Compensation Afforestation Plan** not only this but it will also increase forest cover area of the surrounding region. Thus, it revealed that no significant adverse impacts on terrestrial biodiversity due to proposed Vishnugad Hydro-electric project is envisaged.

Table 4.2: Assessment of Impacts and Mitigation Measures

S. No	Project Phase	Activities	Impacts	Mitigation Measures
1.	**Construction Phase**	(i) Acquisition of Forest Land	Loss of Forests land is 80 ha.	▪ Obtain Forest clearance from MoEF ▪ Strict implementation of approved Compensatory Afforestation Plan in accordance with Forest (conservation) Act 1980 and Uttarakhand Forest Policy. Carry out plantation in 160 ha area.
		(II) Felling of Trees	The clearing of project sites for construction requires felling of trees, a total number of 2,465 trees are be felled. The trees consist of plantation in forest land and vanpanchayat land. All the species are commonly distributed throughout the project immediate influence as well as project influence area hence, the impact will be insignificant	▪ Compensatory Afforestation may be carried to compensate the loss of trees. Double no. of trees 4,930 trees may be planted in lieu of trees felled. ▪ Proper compensation must be given to vanpanchayat for the land and standing crops ▪ Compensation for fruit bearing trees may be compensated including cost of fruit yield of 5 years. ▪ **The vulnerable species *Berginia ligulata* (Silpara), *Hedychium spicatum***

S. No	Project Phase	Activities	Impacts	Mitigation Measures
				(Banhaldi) and *Thalictrum foliolosum* (Mamiri) found in the area must be developed in separate herbal garden. ▪ **THDC must undertake development of Herbal garden at suitable place in consultation with forest department and propagation of the species must be taken. Besides the three species other species of medicinal value may be also encouraged.** ▪ Under Road construction Trees falling outside the ROW should not be felled.
		(iii) Clearing of Project sites for construction activity	The project site is dominated by Plantation species and weedy shrubs which are commonly distributed throughout and none of rare, endangered or threatened or endemic species was observed during survey /reported in the project sites. Therefore no impact on biodiversity is envisaged.	▪ Compensatory Afforestation will carried under the Degraded Forest Area Development scheme hence there will be increase in the forest cover
	Construction Phase -	Impact on Fauna	The wildlife is likely to be disturbed during construction phase due to various activities. ▪ The construction activity is likely to affect the movement of the animal ▪ Increase in noise may affect the feeding, breeding and movement of	▪ Construction activities may be avoided during night hours near forest area. ▪ Poaching must be strictly banned in the Forest area. It may be ensured by the Contractor that no hunting is practiced at the site by any of the worker and that all site personnel are aware of the location, value and sensitivity of the wildlife resources

S. No	Project Phase	Activities	Impacts	Mitigation Measures
			wildlife near forest area. Felling of trees is likely to affect the avifauna. Fragmentation of the habitat is not envisaged as the road construction and other construction works does not divide any habitat area.	▪ The project area is located in the transitional zone of Nanda Devi Biosphere reserve. Movement of wildlife is reported in the area therefore check post may be established in the project sites in consultation with Forest Department. ▪ Plantation of tree species which are major sources of fodder for wildlife in consultation with forest department in degraded and open areas. ▪ Awareness program on Environment and Wildlife Conservation may be provided to the work force. Forest Act and Wildlife Act may be strictly adhered to.
		(i) Generation of dust by movement of vehicles and construction work, crusher operation	This may cause increase in SPM and RPM level in the area. Dust is also likely to settle on the surrounding flora. The impact shall be temporary, localized and reversible. No significant impact on Project Influence Area and Alaknanda Basin.	▪ All vehicles delivering materials to the site shall be covered to avoid spillage of materials. ▪ All exiting approach road used by vehicles shall be kept clean and clear of dust ▪ The roads surfaces shall be host or watered using necessary equipments. ▪ Plants, machinery and equipment shall be handled so as to minimize generation of dust. ▪ All earth work shall be protected to minimize dust generation. ▪ All crusher used in construction shall confirm to relative dust emission devises
		(ii) Generation of	The noise level of the	▪ The machineries, vehicles and

S. No	Project Phase	Activities	Impacts	Mitigation Measures
		Noise	construction site is likely to increase due to various activities, which may cause disturbance to the fauna in the area. However this impact would be insignificant as the increase in noise shall be intermittent and temporary No significant impact on fauna of Project Influence Area and Alaknanda Basin	equipments use in construction shall strictly confirm to CPCB standard. ▪ All vehicles equipment machinery used in construction shall be fitted by exhaust silencers. ▪ Equipments should be maintained regularly and soundproof gadgets should be used. ▪ Blasting shall be carried out as per the statutory laws, regulation and rules pertaining to acquisition, transport, storage, handling and use of explosives
		(iii) Movement of Labour force and Technical Staff	The labour force and technical staff may poach on occasionally invaded wildlife in the area. No significant impact on Project Influence Area and Alaknanda Basin	▪ The contractor should arrange alternative source of energy such as Kerosene or LPG ▪ The Wildlife conservation Act should be strictly adhered. ▪ Environmental awareness training should be provided to the Contractor and workers.
		(iv) Quarry activities	Extraction of rocks and sand shall be done for the construction work from quarry sites. No significant impact on Project Influence Area and Alaknanda Basin.	▪ The extraction of material should be done from the identified quarry site only. ▪ If new quarry sites are required then prior permission has to be taken from the owner. ▪ The quarry area should be reclaimed back. The pits formed should be backfilled by construction waste and site should be stabilized. ▪ The topsoil (150mm) from all areas should be preserved in stockpiles. ▪ Such a stockpile should be

S. No	Project Phase	Activities	Impacts	Mitigation Measures
				utilized for redevelopment of quarry areas. ▪ Grasses and shrub species should be planted.
		(v) Soil Erosion	The construction activities may lead to the erosion of soil in catchments area of Alaknanda Basin.	▪ Strict implementation of approved Catchment Area Treatment Plan for control of soil erosion. ▪ Work may be restricted in rainy season.
		(vi)Muck Disposal	The muck produced by the construction work shall be disposed at the dumping sites The disposal of muck shall destroy the flora at the sites. However the sites identified for muck disposal are open barren areas.	▪ The muck should be disposed at the identified sites only. ▪ Before disposal of muck retaining walls should be constructed at the edges to retain the muck as the sites area just above the river Alaknanda
3.	**Construction Phase**	(II) Influx of labour	Requirement of living places, hotels, filling stations, service stations and extra workers will arise. This will provide job opportunity to the local skilled and unskilled population.	▪ Cutting of trees should be strictly prohibited in the area for other construction work. ▪ Forest clearance should be obtained if there is any requirement for cutting trees.
		(III) Induced Commercial development	Development in Pipalkoti town and nearby places is likely to take place and land price may increase. New commercial development and adverse impacts are not envisaged The impact on Alaknanda. Basin will be insignificant	▪ Any new colonies developed in area should have provision for plantation in the colony area. ▪ As, Pipalkoti & Chamoli are well equipped with the commercial development which are very near from proposed sites hence any new Commercial development not envisaged

S. No	Project Phase	Activities	Impacts	Mitigation Measures
4.	**Operation Phase**	(i) Loss of flora	In operation phase no tree felling is anticipated. Compensatory afforestation and avenue plantation is likely to increase the greenery in the area. Hence the impact will be positive during operation phase.	▪ Proper protection measures should be taken for the plantation work carried under the project. Van Panchayats may be involved in afforestation activity and monitoring of the plantation work. ▪ Fencing of plantation area should be done. ▪ Watchman should be employed to take care of plantation for minimum 3 years.
		(ii) Loss of fauna	Loss of fauna is not anticipated during operation phase as the wildlife is found in the upper reaches of hills far away from project area. No impact on fauna of Project Influence Area and Alaknanda Basin during operation phase.	▪ No impact is envisaged on fauna during operation phase. ▪ Wildlife conservation program may be supported by the project
		(iii) Biodiversity	No significant impact is envisaged on biodiversity in Project Influence Area and Alaknanda Basin	▪ Awareness programs should be held for the stakeholders to develop concern for conservation of biodiversity in the area.

CHAPTER 5
BIODIVERSITY MANAGEMENT PLAN

5.1 INTRODUCTION

The varied topography, geological formations, climatic conditions and the altitudinal ranges has made the Uttarakhand a treasure house of biodiversity both wild and domesticated. The range of biodiversity elements represented in the state varies from those of subtropical region to that of temperate and alpine regions. Biodiversity provides a fundamental base to the mountain agriculture and to the overlap economic systems of the state. Enriched biodiversity of the State is reflected through State's emblems of pride such as.

Forests are very important natural resources of the State and are confined to higher hills and interior valleys. The forest not only saves as a haven for biodiversity but is also mainstay far rural life and livelihoods. The recorded forest area of the state is 34,662km^2 which constitutes 64.79% of the total geographical area of the state.

5.2 THREATS TO BIODIVERSITY OF UTTARAKHAND

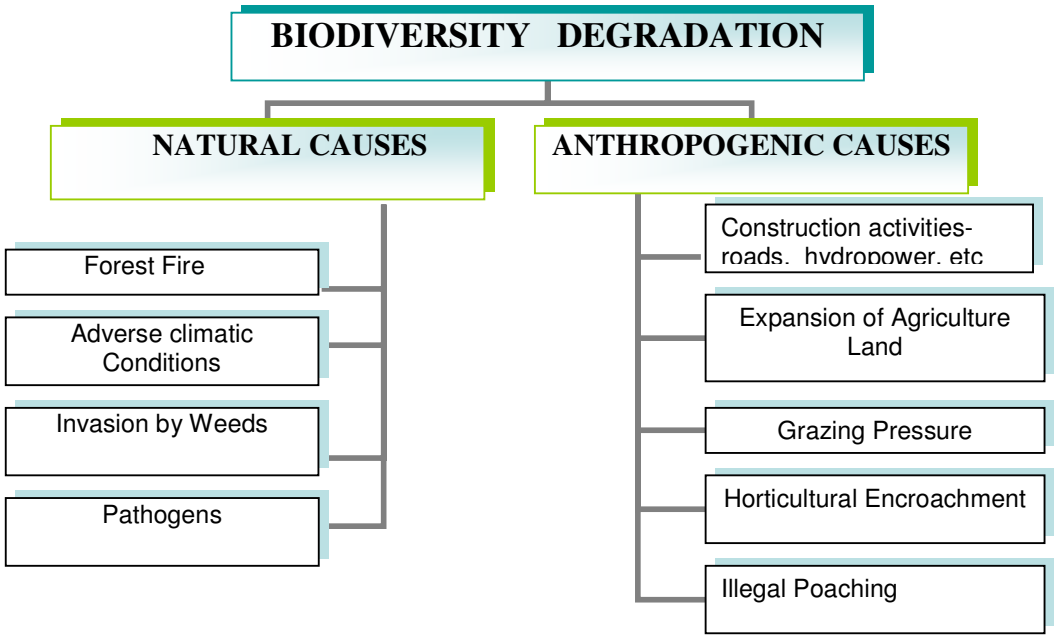


Fig 5.1: Existing Threats to Forest

Uttarakhand has rural population of 74.33%. The total number of inhabited villages, including forest villages, is 15,761 (Census 2001). The rural population is primarily dependant on agriculture based economy for livelihood. Rural population depends largely on forest for their day-to-day demands of life such as fuel, fodder, grazing, timber etc. In view of this, demand of timber, fuel, fodder, medicinal plants or non timber forest produces is borne only by a few choice species, the major threat to their continued survival.

Biodiversity in the state is under tremendous pressure due to various social issues related to agriculture, horticulture and construction activities. The area under Horticulture is 181,745 ha. Important horticultures crops of the state are Apple, Apricot, Walnut, Guava, Pomegranate, Peach, Litchi and Mango. The increase area is derived either from agriculture land or forest clearance and thus associated with loss of forest and thereby biodiversity. In the hills the major crops grown include wheat, paddy, madua, ramdana and potato whereas in the plains the major crops are wheat, paddy, pulses and sugarcane

5.3 HISTORY OF DEFORESTATION

Although a relatively small state within India, there are ranges of altitude, climate and geology that contribute rich and diversified flora of Uttarakhand. At present 46.93 percent is currently under tree cover out of which 45.70 percent is under forest cover and 1.23 percent is under tree cover. The pressure on forest is continuously increasing leading to rapid deforestation. Forest Survey of India (FSI) an organization of Ministry of Environment and Forests (Government of India) is engaged in generating information and database on forest cover and forest resources in the country. The status of forest covers in Uttarakhand since 2001 is presented below:

Table 5.1: Assessment of Forest Cover of Uttarakhand

Year of Assessment	Area Under Forest Cover (Km^2)
2001	23,938
2003	24,465
2005	24,442

Source: State of Forest Report 2003

The forest cover has increased since 2001 however it has decreased (18 km^2) from year 2003 to year 2001. The loss in forests cover is in Haridwar district and is attributed to the rehabilitation of the Gujjars and the Tehri dam outsees, and also due to the rotational felling of Eucalyptus & Poplar plantation by State Forest Department.

However, the change in forest cover type is not significant; there has been decrease of 13 km^2 of moderately dense forest and 5 km^2 in open forest.

Change of Forests Cover in Uttarakhand

Year	Dense Forest (Sq. Km)	Mod. Dense	Open Forest (Sq. Km)	Total Forest (Sq. Km)
2003	4,002	14,409	6, 049	24,460
2005	4,002	14,396	6, 044	24,442
Change in Forest cover	0.00	-13	-5	- 18

Source. State of Forests Report 2005, FSI

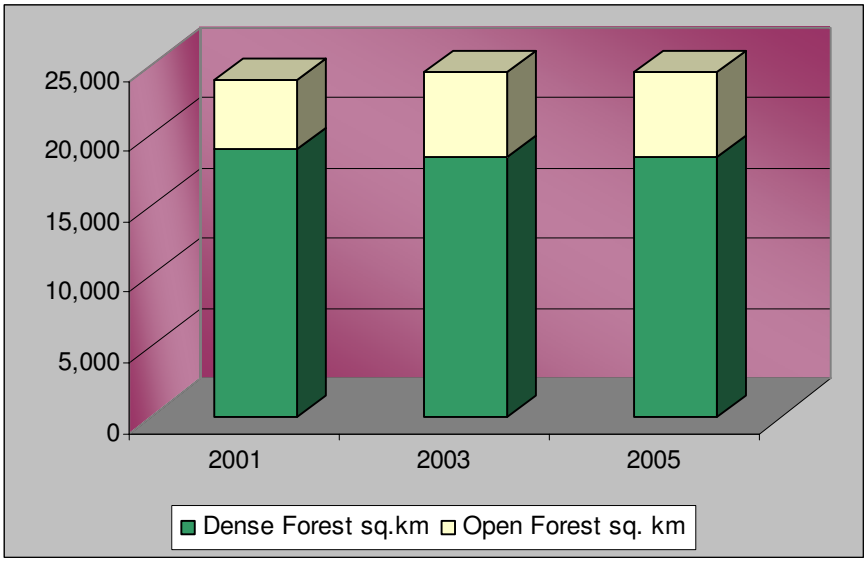


Fig 5.2: Change in Forests Cover of Uttarakhand

The large scale block plantation schemes undertaken by forest department have resulted in an overall increase of forest cover from year 2001-08. The plantation carried out by Forest Dept in last ten years under departmental plantation, natural regeneration and extensive tree plantation programme is given below.

Table 5.2: Plantation carried by Forest Department in Uttarakhand

S.No	Year	No. of Plants in Lakh
1	1997-98	85
2	1998-99	98.03
3	1999-2000	94.15
4	2000 -01	61.54
5	2001 -02	88.88

S.No	Year	No. of Plants in Lakh
6	2002 -03	108.77
7	2003 -04	145.70
8	2004 -05	154.66
9	2005 -06	260.06
10	2006 -07	255.06
Total		**1351.80**

Source .www.uttarakhandforest.org

The tables given below illustrate the plantation carried in Badrinath and Kedarnath Forest Division.

Table 5.3: Plantation Carried in Kedarnath Forest Division

S.No.	Year	Total No.
1	2000-01(Chamoli dt)	92700
2	2000-01(Rudraprayag dt)	217,592
3	2001-02	45,100
4	2002-03	60,500
5	2004-05	49,500
6	2005-06	77,000
7	2006-07	55,000
8	2007-08 (Chamoli dt)	355,5176
9	2007-08 (Rudraprayag dt)	70,090

Source: Kedarnath Wildlife Division, Gopeshwar, 2008

Table 5.4 : Plantation Carried in Badrinath Forest Division

S.No.	Year	Total No.
1	2000-01	112.370
3	2001-02	118,000
4	2002-03	120,000
5	2003-04	240,000
6	2004-05	820,000
7	2005-06	324,000
8	2007-08 Chamoli range	1040,000
9	2007-08 Nandprayag range	98,000
10	2007-08 W. Pinder range	60,000
11	2007-08 C Pinder range	60,000
12	2007-08 E Pinder range	392,000

Source: Badrinath Forest Division, Gopeshwar ,2008

5.4 BIODIVERSITY CONSERVATION INITIATIVES TAKEN BY GOI & GOUA

In order to protect rich biodiversity of country which plays significant role in livelihood & cultural sustenance of the country, Government of India, under Ministry of Environment & Forests (MoEF) constituted National Biodiversity Strategy & Action Plan (NBSAP) a, firm step towards addressing the various issues related to the use, status and conservation needs of biodiversity in the country. Under this initiative, it has been envisaged to produce a series of planning documents dealing with various facts related to the conservation of National Biodiversity. The biodiversity of India has been globally ranked amongst the 12-megadiversity countries and two of its bio-geographic provinces. These are all government initiatives and approximately 5% of the country's surface area has been successfully declared as legally protected areas.

In order to conserve the rich biodiversity of the State the Government of Uttarakhand constituted State Biodiversity Board in 2006.

(b) Legislative Approach

Uttarakhand has also adopted the National Forest Policy (1980) that seeks to integrate biodiversity conservation and sustainable use by local people. A complete ban on hunting (1982) and green felling (1984) has been imposed in the state. A number of legislation having a bearing on biodiversity conservation in the state have been enacted in the state. Some of these are as below

- Indian Forest Act 1927.
- Wildlife (Protection), Act 1972,
- Forest Conservation Act, 1980
- Environmental Protection Act, 1986
- Water (Prevention & control of Pollution) Act 1974
- Air (Prevention & control of pollution) Act, 1981
- Bio- diversity Act 2002
- Bio- diversity Rule 2004

(c) Management Level Approach

At management level, conservation of biodiversity now forms an integral part of Forest working plan, Management plans for the National Park and Wildlife sanctuaries lay special emphasis on conservation of biodiversity. Some of the important schemes implemented by the Govt. are

(i) Van Panchayats

(ii) Joint Forest Management

(ii) Eco-development in and around protected areas

(iii) Development of Minor Forest Produces

(iv) Bamboo and Fibre Development Board

(v) Ecotourism

(vi) Clean Development Mechanism (CDM) Cell

(vii) Establishment of Biosphere Reserve, National parks, Wildlife Sanctuaries

(d) Conservation of Medicinal Plants

The National Medicinal Plant Board was set up on 24th November 2000 with the objectives for co-ordination of all matters relating to medicinal plants, including drawing up policies and strategies for conservation, proper harvesting, cost-effective cultivation, research and development, processing, marketing of raw material in order to protect, sustain and develop this sector. National Medicinal Plants Board has set up a Task Force on High Altitude Medicinal Plants to deal with the following issues:

- Survey, Inventorisation and documentation of medicinal plants resources
- Identification of critical gaps in R&D and recommend projects & institutions to bridge such gaps
- Developing institutional linkages
- Capacity building and awareness
- Involvement of Civil Society of Organisations working in the field and leverage their strengths
- Identify regulatory problems in promoting conservation and cultivation and recommend appropriate amendments to the existing Acts/ Regulations
- Developing market linkages and value addition
- Developing strategy to promote in-situ/ex-situ conservation

The government of Uttarakhand has set up a State Medicinal Plant Board (SMPB) in the lines of National Medicinal Plants Board for coordination of various activities and technical inputs to various programmes. Some of the medicinal plants found in Uttarakhand are given in the table below

Table 5.5: Medicinal Plants of Uttarakhand

Common Name	Scientific Name	Uses
Dhaula	*Woodfordia fruiticosa*	Stomachic, in cough
Daya	*Calicarpa macrocephala*	Anti helmantic
Reetha	*Sapundus mukurossi*	Emetic, epilepsy & as fish poison
Calendula	*Calendula arvensis*	In herbal cosmetics
Safed musli	*Chlorophytum borivelianum*	Roots as tonic
Safed musli	*Chlorophytum borivelianum*	Roots as tonic
Kali musli	Curcilago orchides	Root as tonic
Babchi	*Psorolea carolifolia*	Antilecuodermal properties
Tagar/Samyo	*Valeriana wallichii*	Oil nerve stimulent
Bach	*Acorus calamus*	Anti- bronchial,cough

Common Name	Scientific Name	Uses
Kapoor tulsi	*Ocimum kilimandscharicum*	In fever,cough & cold, insecticidal
Saunf	*Foeniculum vulgare*	Stomchic ,Carminative
Tejpat	*Cinnamomum tamala*	As condiments
Upania jhar	*Chenopodium ambrosioides*	Insecticidal and repellent properties
Pati	*Artemisia nilagarica*	Insect repellent, anthelmintic
Dhungar	*Allium ascalonium*	Carminative, gastric properties
Genda	*Tagetes errecta*	Insect repellent properties
Geranium	*Pelargonium graviolense*	Perfumery value
Ban ajwain	*Thymus serpyllum*	Germicidal, in burns
Lahsun jangli	*Allium ampeloprasum*	In rheumalism
Citronella grass	*Cymbopogon winterianus*	Perfumery value
Lemon Grass	*Cymbopogon citratus*	Perfumery value, fungicidal properties
Kali tulsi	*Ocimum basilicum*	In fever,cough & cold
Pati	*Artemisia maritema*	Insecticidal properties, anthelmintic
Jambo/faran	*Allium tuberosum*	In cold, carminetive
Ashwagandha	*Withania somnifera*	Tonic,adaptogenic
Ghritkumari	*Aloe barbadensis*	Anti asthamatic,skin diseases
Visnasa	*Ammi majus*	Anti leucoderma
Digitalis	*Digitalis purpurea*	In heart diseases
Kuth	*Saussurea lappa*	Asthma,carminative
Bajardanti	*Potentila fulgens*	Anti tooth ache
Vashaka	*Adhatoda vasica*	Antibronchitis & cough
Satvar	*Asparagus officinails*	Tonic,antidysentry
Pivsokha	*Leucas lanata*	In boils & eczema
Pashar bhed	*Bergenia ligulata*	In dissolving kidney stones, anti diarrohea

In recent times natural environment of this region has been effected due to population pressure, changes in the weather pattern, irregular and overexploitation of herbs from their natural habitat which has resulted in the depletion of many high value medicinal herbs to the stage of extinction

Factors responsible for depletion of Medicinal plants
I. Over and indiscriminate exploitation of medicinal plants from its natural resources
II. Shrinking of natural homes of these herbs
III. Lack of agro technology and commercial scale cultivation.
IV. Illegal trading.
V. Excessive grazing.
VI. Improper and unscientific methods of collection.
VII. Forest fire
VIII. No assured marketing.

The raw plants parts are being collected by “Jila Sahkari Bheraj Sangh "working in each district of the state. They are collecting herbal plants through unskilled and unqualified labors, but due to lack of knowledge of their proper method of collection and over exploitation (destructive collection) many economically important and highly demanded medicinal plants are overexploited and are under endangered stage. Herbal Research and Development Institute (HRDI) is set up in Gopeshwar in 1992 to check the illegal trade in herbs by scientifically encouraging their cultivation in central Himalayas. The measures suggested for conservation of medicinal plants is given in the box below.

Measures to be taken to Conserve Medicinal Plants
I. Development of Agro- technology of highly demanded medicinal plants and their large scale cultivation.
II. Ban on endangered medicinal plants should be materialized by district administration
III. The laborers and other persons engaged in collection of crude medicinal plants should be trained for scientific method of collection.
IV. Medicinal plants rich areas should be protected as natural reserve sanctuaries
V. Forest should be protected from fire.
VI. People should be motivated for the conservation of medicinal plants

The benefits that are associated with the conservation of these medicinal herbs can be elaborated as follows:

- Employment opportunities for the rural youth.
- Boosting the industrial sector of the State.
- Overall economic benefits to the state.

5.5 CONSERVATION OF PROJECT INFLUENCE AREA

The altitudinal variation in project influence area leads to various forests types such as Himalayan Moist Temperate Forest and Himalayan Dry Temperate Forest. The forests are interrupted with various human activities among which agriculture, horticulture, grazing of animals, timber demand, etc are predominant. The forests are under threat due to over exploitation for timber, fodder, fuel, medicinal plants, collection for minor forests produces and construction activity.

5.5.1 Major Threats to Biodiversity

(a) Timber Demand

The climax species of natural forests are under pressure due to increased timber demand. The timber species of forests such as *Cedrus deodara* (Deodar); *Pinus roxburghii* (Chir), *Pinus wallichiana* (Kail); *Quercus incana* (Ban oak), *Quercus himalayana* (Moharu oak); *Picea smithiana* (Rai); *Grewia oppositifolia* (Biul) etc. are under pressure due to high timber demand and illegal felling of trees.

(a) Agriculture & Horticulture Activities

Intensive agricultural activities were concentrated from foothills to mid-hills valley areas where irrigation facilities exist. Horticulture, a cash crop/profit graining activity i.e. cultivation of fruits, vegetable, flowers is increasing at the cost of forestland leading to loss of forest area year by year. There is also tremendous demand of timber for packing cases for marketing of fruits due to horticulture bloom, leading to increase pressure on forest. In the year 2005-06 the area under Horticulture was 181,745 ha.

(c) Grazing Pressure

Animal husbandry is an important vocation for agriculturist and almost every family rears livestock for rears livestock for their day to day requirement the livestock is mainly defendant upon natural resources mainly forests for sustenance. Extensive grazing of livestock and severe lopping of trees for fodder had adversity affected the forests of probed-influenced area.
Ban oak forest area under pressure due to grazing, browsing, severe lopping for fodder & fuel and manufacturing of agricultural implements. It has reduced oak to low, stunted, unsound growth and form of busty trees. Due to these activities ban oak forests area is gradually denuded. Kharsu oak (*Quercus semicarpifolia*) forests are slowly gaining importance on account of their demand for various commercial uses. Heavy grazing, lopping and fire have thinned out forests to varying degree, destroyed all undergrowth except for plants of inedible species. It is grazed by enormous flocks of sheep/goats/etc.

(d) Forest Fire

Forest fire is commonly recorded throughout the forest area. Most of the fires are due to local incendiaries with the belief that burning forest areas improve the resources by getting fresh grass & tender herbages.

5.6 PROPOSED MANAGEMENT PLAN FOR PROJECT AFFECTED AREA

The Biodiversity Management of Project Affected Area is the joint responsibility of THDC, State Forest Department and Local Community.

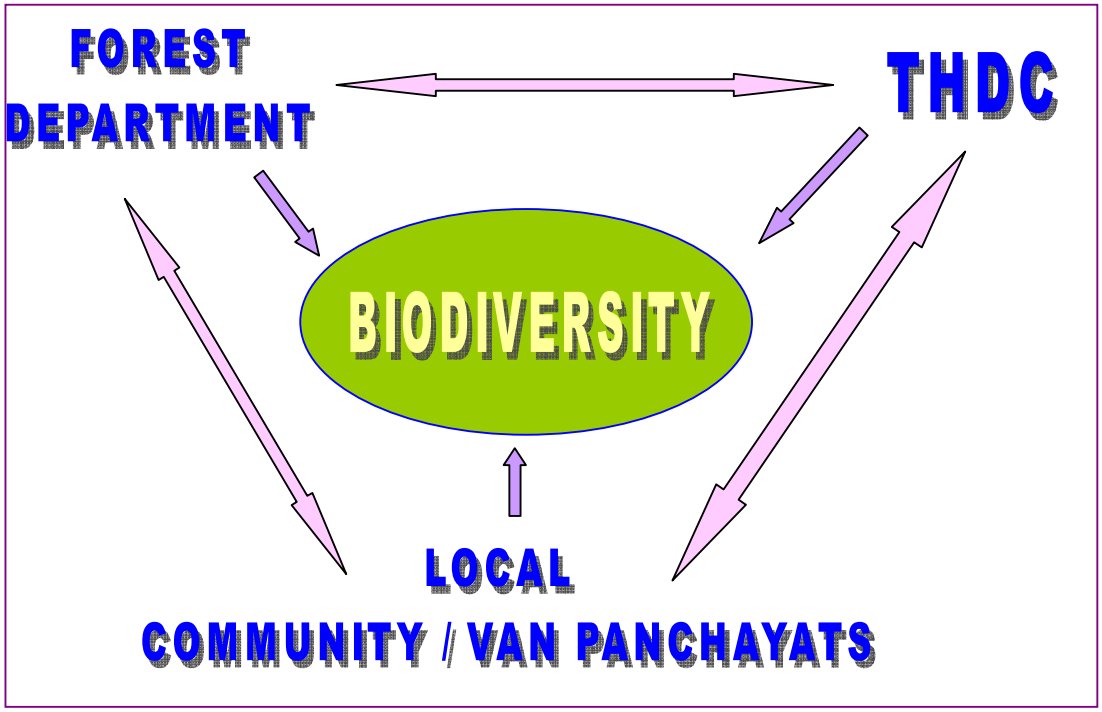


Fig. 5.3: Integrated Approach for Biodiversity Management

Compensatory Afforestation Plan, Catchment Area treatment Plan and Wild Life Management Plan will be implemented by State Forest Department; Govt. of UA. whereas Muck/Quarry Area Redevelopment Plan, Avenue Plantation and Landscaping will be implemented by THDC.

The implementation of above mentioned plans will be helpful for conservation of terrestrial biodiversity of the Project Affected Area as well as surrounding Project Immediate Influenced Area. The review of above mentioned plans are discussed in brief below.

5.6.1 Proposed Compensatory Afforestation Plan for VPHEP

In order to compensate diversion of forestland i.e. 80 ha for establishment of various project units, compensatory afforestation plan is proposed to be on 160 ha as per the Forest (conservation) Act (1980). The compensatory afforestation will be carried out by the Forest Department.

2,465 Trees are likely to be felled for development of various project sites. Double no. of trees (4,930) may be planted to compensate the loss. Fruit bearing trees may be compensated including fruit yield for 5 years.

Table 5.6: Species suggested for compensatory afforestation

S.No	Scientific Name	Common Name
1	*Aesculas indica*	Pangar
3	*Albizzia lebbek*	Siris
4	*Alnus nepalensis*	Utis
5	*Bauhinia variegata*	Kachnar
6	*Cedrela toona*	Toon
7	*Celtis australis*	Kharak
8	*Cinnamomum tamala*	Dalchini
9	*Cupressus torulosa*	Leuri
10	*Dalbergia sissoo*	Shisham
11	*Embelica officinalis*	Amla
12	*Grewia oppositifolia*	Biul
13	*Melia azadirach*	Denk
14	*Pinus roxburghii*	Chil
15	*Bombax ceiba*	Semul
16	*Juglans regia*	Walnut
17	*Pyrus malus*	Apple
18	*Prunus armeniaca*	Apricot
19	*Prunus communis*	Plum
20	*Prunus persica*	Peach
21	*Punica granatum*	Pomegranate
22	*Citrus spp.*	Malta

5.6.2 Catchment Area Treatment Plan for VPHEP

The proposed CAT plan is formulated by State Forest Department for Joshimath Range and Pipalkoti Range. The CAT plan is designed to address the basic environmental issues such as increase soil erosion, high rate of siltation, surface runoff, sheet & gully erosion and to mitigate these impacts through adoption of site specific bio-engineering technologies to reduce soil erosion, conserve water and improve vegetal cover in the catchment. Total area of selected catchment is 84085 ha. Treatable area is 71121 ha and untreatable rocky and snow bound area is 12964ha. The brief features of CAT plan is given below

Table 5.7: Features of CAT Plan

S.No.	Interventions	Description
1	***Forestry Work***	
	Afforestation	505 ha
	Densification	450 ha
	Pasture land development	375 ha
	Medicinal plant plantation	300 ha
	Assisted Natural Regeneration	1370 ha
2	***Soil & Moisture Conservation Engineering Works***	
	Vegetative Check Dams (No.)	3750
	Gully Plugging (No.)	5000
	Stone Check Dam (No.)	6000
	Crate wire Check Dam	4500
	Spur (No.)	2200
	Water percolation tank (No.)	2500
3	***Wildlife Management***	
	Anti Poaching Hut (No.)	10
	Forest Guard Residence (No.)	10
	Wildlife Chetna Centre (No.)	2
	Fire Extinguishing Centre (No.)	10
	Wireless room (No.)	2
	Watch Tower (No.)	6
	Conservation of Water Resources (No.)	25
	Water Chery (No.)	25
4	**Residential & non residential building construction and renovation for Field Staff**	
	New Construction (No.)	27
	Renovation (No.)	13
5	**Foot path Construction and Renovation**	
	New Construction (km)	178
	Renovation (km)	158
6	**Foot Bridge renovation construction and renovation**	
	New construction (No.)	4
	Renovation (No.)	6
7.	**Other Development and Participatory Activities**	

Source: CAT Plan VPHEP, Forest Department

The proposed catchment treatment plan comprised of Forest conservation & Improvement, Soil and Moisture Conservation Works and Entry point activities. The Budget proposed for CAT plan is Rs.47,07,41,780 /-(Forty seven crore , seven lakh forty one thousand, seven hundred eighty only)

(i) **Forest Conservation & Improvement**.

In order to improve forest cover of the catchment area it is proposed to increase vegetation cover through implementation of various forestry schemes such as Afforestation of degraded forestland, Densification, Assisted Natural Regeneration, Development of Medicinal Plants, Pasture improvement. Afforestation of Forestland includes blank areas devoid of vegetation or degraded forestland will be taken up for plantation. A total 3000 ha area have been identified for total forestry works.
The Assisted Natural regeneration scheme will be implemented to forest areas where conditions are conducive to natural regeneration. Forest floor will be cleared of slash, debris and felling, re-use to afford a clean seed bed to the falling seeds & to germinate. 1370 ha identified for this activity.

For development of medicinal plants 300 ha of land is marked. Under Pasture improvement schemes, Alpine pasture and Low-lying pastures will be taken up for treatment. 375 ha area is proposed for of pasture development. It is an important source of herbage/roughage for cattle, sheep & goats. Based on climatic & edaphic site-specific conditions following species are recommended for afforestation. However, preference of local communities as regard the choice of species will be planted under this scheme.

Table 5.8: Species suggested for CAT Plan

S.No	Scientific Name	Common Name
1	*Aesculas indica*	Pangar
2	*Albizzia lebbek*	Seris
4	*Alnus nepalensis*	Utis
5	*Bauhinia variegata*	Kachnar
6	*Cedrela toona*	Toon
7	*Cedrus deodara*	Deodar
8	*Celtis australis*	Kharak
9	*Cinnamomum tamala*	Dalchini
11	*Dalbergia sissoo*	Shisham
12	*Embelica officinalis*	Amla
14	*Melia azadirach*	Denk
15	*Pinus roxburghii*	Chil
17	*Quercus incana*	Ban
18	*Quercus semicarpifolia*	Kharsu Oak

S.No	Scientific Name	Common Name
19	*Quercus dilata*	Moru

(ii) **Soil & Moisture Conservation Work**

In order to control soil erosion in catchment area due to various project activities during construction & operation phase, various soil & moisture conservation work will be carried out. The soil stabalization measures such as construction of Vegetative Check Dams (3750), Gully plugging (5000), Stone Check Dam (6000), Crate wire Check Dam (4500), Spur (2200) and Water percolation tank (2500).

(iii) **Wildlife Management**

Under wildlife management Anti poaching huts, Forest guard residence, Wildlife chetna centre, Fire extinguishing centre, Wireless room, Watch towers, Conservation of water resources, Water chery, Wildlife monitoring and evaluation Plan are proposed in CAT plan.

(iv) **Residential and Non Residential Building New Construction and Renovation for Field Staff**

It involves construction and renovation of facilities for field staff

(v) **Foot Path Renovation**
It involves construction of new path and renovation of existing ways.

(vi) **Foot Bridge New Construction and Renovation**

It involves construction of new bridges and renovation of existing bridges.

(vii) **Other Development and Participatory Activities**

The CAT plan earmarks the provision for selected inputs in livelihood support activities for the local community which would facilitate eco restoration as well eco development of the catchment. Education and awareness of the community for catchment development on watershed approach is the central of all activities. The development activities proposed are:

- Micro-planning
- Fish Management
- Alternate Energy Support
- PMC running cost
- Capacities Building, Training & Exposure visit
- Village level Development and livelihood support
- Income Generation Activities

5.6.3 Wildlife Management Plan

The wildlife in the forest is exposed to lot of human disturbances besides stray cases of poaching. The excessive cattle population, lopping of trees for fodder, illegal felling of trees etc resulted in depletion of forests and thereby posing threat to wild habitat. The wildlife Management plan is proposed to maintain viable, healthy and productive population of wildlife, to improve habitat of wildlife by proving forest cover, water holes, saltlicks etc and protect them from natural & anthropogenic hazards. Following measures are suggested to protect wildlife.

(i) Protective Measures

The protection of wildlife can be afforded by implementing preventive and control measure for preservation and propagation of wildlife, as below-

- Provision of Forest Guards to control hunting & poaching
- Protection from forest fire
- Prevention from diseases spread by domestic animals
- Increase in Public Awareness about wildlife
- Reward/Incentives to informers

ii) Habitat Improvement

In order to provide suitable condition for growth, development and reproduction of wildlife following measures are suggested

- Increase in forest cover through implementation of various afforestation schemes
- Plantation of tree species, which are major sources of fodder for wildlife
- Provision of Saltlicks at various places as a source of essential nutrients required for growth of wild animals
- Increase in pastureland by sowing suitable local species of grasses, bamboo plantation etc

Besides the above mentioned activities, there is also provision conducting of wildlife census in forest areas, as well as conducting Public Awareness Programs, display of sign and slogan boards in forest areas for protection of wildlife.

5.6.4 Muck Disposal Plan

The large quantity of muck will be generated during construction phase; it should be properly disposed to avoid siltation/sedimentation of river. In order to prevent sedimentation due to muck generated during construction activities muck disposal plan may be formulated by THDC.

The sites are identified for disposal of muck are close to river Alaknanda Bioengineering measures are recommended at disposal site to prevent sedimentation & stabilization of soil.

(i) **Engineering & Mechanical Works**

Following engineering structures are recommended for stabilization of slope

- The construction of retaining wall varying from 2 to 7 m height to prevent dumped material from sliding/rolling down
- Once meter terracing along the contour at 5m intervals along the slope in staggered manner
- The Uphill side of the terraces will be provided with the walls/edging of 50cm height & 50 cm thickness to protect Uphill side of the terraces from slipping
- Fencing of dumping areas with barb wires in strand with two diagonal strands using wooden fence ports

(ii) **Vegetative Measures**

The vegetative measures includes plantation of suitable species for slope stabilization. The species suggested for plantation at muck disposal sites are given in the table below

Table 5.9: Species Suggested for Muck Disposal Sites

S. No.	Scientific name	Common Name
1	*Agave americana*	Rambans
2	*Eupatorium adenophorum*	Basinga
3	*Euphorbia royleana*	Shuru
4	*Opuntia dilleni*	Nagphani
5	*Carisa spinarium*	Karonda
6	*Zizyphus mauritiana*	Ber
7	*Rumex hastatus*	Bhilmora
8.	*Murraya koengi*	Kath Neem
9	*Colebrookea oppositifolia*	Bindu

- Plantation of ornamental plants such as Silver Oak, Bottle Brush, Gulmohar, Baken, Jacaranda etc can be also taken to increase aesthetic nature of the disposal area

5.7 ALIGNMENT OF EMP ACTIVITIES WITH GOVERNMENT SCHEMES

Forest Department is responsible for conservation of the forest and also responds to the contemporary needs of the citizens. In order to increase the forest cover and fulfill the demand of local people for timber fuel wood and fodder Forest Department carry various plantation program. Plantation Policy 2005 involves:

- Public, Government Departments, NGOs, villages, Van Panchayats, private institutions etc. in plantation activity, particularly in after-care of the plantations

- Village and Van Panchayat land is also to be taken up Agro-forestry to be re-activated by planting more of the plants giving Non Timber Forest Produce, medicinal, aromatic substances etc.

The various plantation schemes carried by forest department are such as Extensive tree plantation, Departmental plantation, Natural regeneration, development of Civil Soyam forest, plantation of Fruit trees and Fuel wood, etc. The tree plantation carried out by Forest Department under Departmental plantation since 19997-98 covers 244,192 ha area. The forest areas which are suitable for natural regeneration, in those area natural regeneration programe are taken. 575874ha Forest land has been covered under natural regeneration programme from 1997 to 2007.

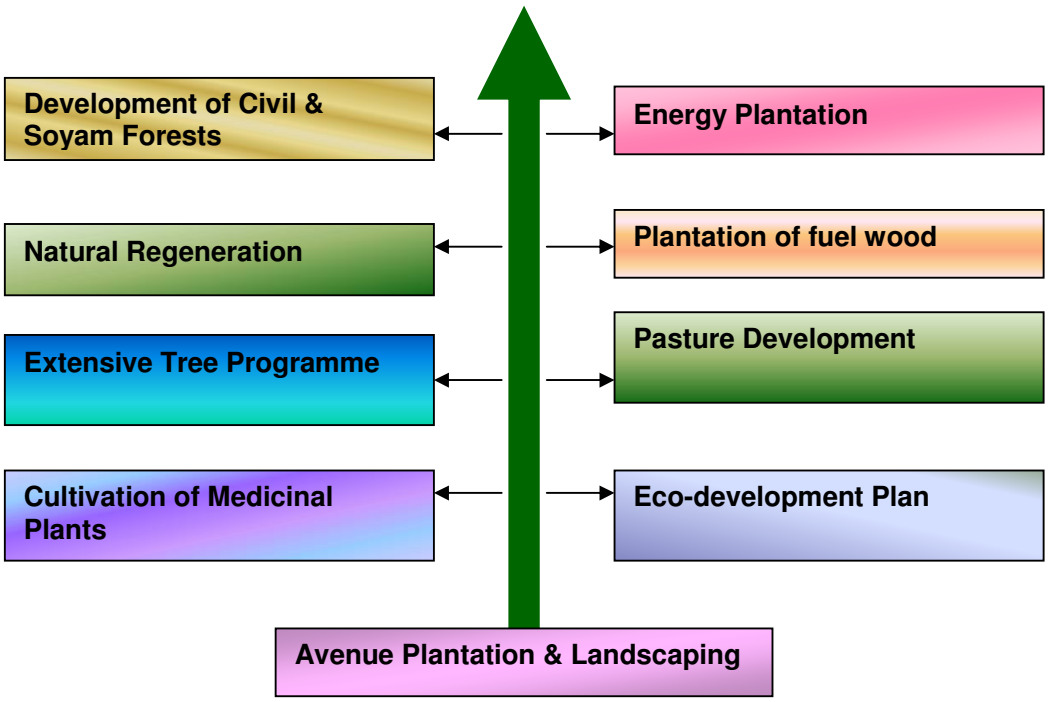


Fig 5.4: Compensatory Afforestation - Synergy with Plantation Schemes of Forest Department

The local rural communities are directly dependant on various commodities which are obtained from surrounding forests. In order to fulfill fuel wood demand plantation of fuel wood species in rural areas was implemented in 53,608 ha area. To involve local village community in conservation of bio-diversity and protection of the natural wealth and facilitate their active participation, Eco-Development Committees (EDCs) have been formed near Protected Areas (PAs).

Under Medicinal plant development 9 lakh medicinal herbs are maintained in NDBR area. The various afforestation schemes undertaken by forest department and the achievements from 1991-92 to 2006-07 is given in the table below.

Table 5.10: Plantation Schemes Implemented by Forest Department

S.No.	Name of Scheme	Description
1	Development of Civil Soyam Forests ▪ Plantation ▪ Densification	 147,094 ha 84,247 ha
2	Natural Regeneration	57,5874 ha
3	Extensive Tree Programme	1351.80 lakh trees
4	Medicinal Plants (NDBR) ▪ Maintenance (No.)	 9 lakh
5	Energy Plantation	1,049 ha
6	Non Timber Forest Produces- Plantation of fuel wood species in rural areas	53,608 ha
7	Pasture Development	21,913 ha
8	Eco-development Plan- Distribution of Fruit Plants (NDBR)	21,600

Source: www.uttarakhandforest .org (Forest Department)

The pastures and grasslands plays significant role in rural economy. These are the main sources of herbages and roughage. They are spread on the natural slopes and form considerable portion of the Alaknanda catchment. Pasture improvement plays significant role in restoration of ecosystem as well as to fulfill the demand of fodder for existing cattle population. An area of 21,913 ha pastureland has been brought under pasture improvement program.

Under eco-development plan fruit plants are planted in the NDBR area which also add the ecological resources of the area. Distribution of fruit plants to the villagers is a regular activity in NDBR with very good results. Lot of fallow lands are available in the villages of Buffer and Transition zone. These lands are used for this activity. Under civil soyam forest development 147,094 ha land has been covered under plantation and 84,247 ha covered under Densification.

5.8 PROPOSED MANAGEMENT PLAN FOR MITIGATION OF IMPACTS

In order to mitigate various impacts due to various project activities during construction and operation phase of the project management plan is suggested which is described below

Table 5.11: Management of Impacts and Mitigation Measures

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
1.	**Direct Impact** (i) Acquisition of Forests Land	Loss of Forests land is 80 ha.	▪ Obtain Forest clearance from MoEF ▪ Strict implementation of approved Compensatory Afforestation Plan in accordance with Forest (conservation) Act 1980 and Uttarakhand Forest Policy.	Forest department/ THDC / Van Panchayats
	(II) Felling of Trees	The clearing of project sites for construction requires felling of trees, a total number of 2,465 trees are be felled. The trees consist of plantation in forest land and Vanpanchayat land. All the species are commonly distributed throughout the project immediate influence as well as project influence area hence, the impact will be insignificant	▪ Compensatory Afforestation may be carried to compensate the loss of trees. Double no. of trees 4,930 trees may be planted in lieu of trees felled. ▪ Proper compensation must be given to vanpanchayat for the land and standing crops ▪ Compensation for fruit bearing trees may be compensated including cost of fruit yield of 5 years. ▪ The vulnerable species *Berginia ligulata* (silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) found in the area must be developed in separate herbal garden. ▪ **THDC must undertake development of Herbal garden at suitable place in consultation with Forest Department and propagation of the species must be taken**. Besides the three species other species of medicinal value may be also encouraged. ▪ Under Road construction Trees falling outside the ROW should not be felled.	

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
	(iii)Clearing of Project sites for construction activity	The project site is dominated by Plantation species and weedy shrubs which are commonly distributed throughout and none of rare, endangered or threatened or endemic species was observed during survey /reported in the project sites. Therefore no impact on biodiversity is envisaged.	▪ Compensatory Afforestation will be carried in the Degraded Forest Area hence there will be increase in the forest cover	
2	**Indirect impact** (i) Impact on Fauna	The wildlife is likely to be disturbed during construction phase due to various activities. ▪ The construction activity is likely to affect the movement of the animal ▪ Increase in noise may affect the feeding, breeding and movement of wildlife near forest area. Felling of trees is likely to affect the avifauna. Fragmentation of the habitat is not envisaged as the road construction and other construction works does not divide any habitat area.	▪ Construction activities may be avoided during night hours near forest area. ▪ Poaching must be strictly banned in the Forest area. It may be ensured by the Contractor that no hunting is practiced at the site by any of the worker and that all site personnel are aware of the location, value and sensitivity of the wildlife resources ▪ The project area is located in the transitional zone of Nanda Devi Biosphere reserve. Movement of wildlife is reported in the area therefore check post may be established in the project sites in consultation with Forest Department. ▪ Plantation of tree species which are major sources of fodder for wildlife in consultation with forest department in degraded and open areas. ▪ Awareness program on Environment and Wildlife Conservation may be provided to the	Construction Contractor / Forest Dept/ Environmental incharge, Project Authority

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
			work force. Forest Act and Wildlife Act may be strictly adhered to.	
	(ii) Generation of dust by movement of vehicles and construction work, crusher operation	This may cause increase in SPM and RPM level in the area. Dust is also likely to settle on the surrounding flora. The impact shall be temporary, localised and reversible. No significant impact on Project Influence Area and Alaknanda Basin.	▪ All vehicles delivering materials to the site shall be covered to avoid spillage of materials. ▪ All exiting approach road used by vehicles shall be kept clean and clear of dust ▪ The roads surfaces shall be host or watered using necessary equipments. ▪ Plants, machinery and equipment shall be handled so as to minimize generation of dust. ▪ All earth work shall be protected to minimize dust generation. ▪ All crusher used in construction shall confirm to relative dust emission devises	Construction Contractor / THDC
	(iii) Generation of Noise	The noise level of the construction site is likely to increase due to various activities, which may cause disturbance to the fauna in the area. However this impact would be insignificant as the increase in noise shall be intermittent and temporary No significant impact on fauna of Project Influence Area and Alaknanda Basin	▪ The machineries, vehicles and equipments use in construction shall strictly confirm to CPCB standard. ▪ All vehicles equipment machinery used in construction shall be fitted by exhaust silencers. ▪ Equipments should be maintained regularly and soundproof gadgets should be used. ▪ Blasting shall be carried out as per the statutory laws, regulation and rules pertaining to acquisition, transport, storage, handling and use	Construction Contractor / THDC

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
			of explosives	
	(iv) influx of labours	Large number of labor population will influx the project influence area leading to destructions of flora due to provision temporary labor camp Laborers may cut trees for cooking purpose as fuel Impact due to sewage/ solid wastes /garbage generated from labor camp	▪ Cutting of trees should be strictly prohibited in the area for other construction work. ▪ Forest clearance should be obtained if there is any requirement for cutting trees. ▪ The contractor should arrange alternative source of energy such as Kerosene or LPG ▪ Their should be provision of proper design / collection / handling and disposal system for sewage and solid wastes	Construction Contractor / THDC
	iv) Movement of Labors force and Technical Staff	The labour force and technical staff may poach on occasionally invaded wildlife in the area. No significant impact on Project Influence Area and Alaknanda Basin	▪ The contractor should arrange alternative source of energy such as Kerosene or LPG ▪ The Wildlife conservation Act should be strictly adhered. ▪ Environmental awareness training should be provided to the Contractor and workers.	Construction Contractor / THDC
	(vi) Quarry activities	Extraction of rocks and sand shall be done for the construction work from quarry sites. No significant impact on Project Influence Area and Alaknanda Basin.	▪ The extraction of material should be done from the identified quarry site only. ▪ If new quarry sites are required then prior permission has to be taken from the owner. ▪ The quarry area should be reclaimed back. The pits formed should be backfilled by construction waste and site should be stabilized.	Construction Contractor / THDC

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
			▪ The topsoil (150mm) from all areas should be preserved in stockpiles. ▪ Such a stockpile should be utilized for redevelopment of quarry areas. ▪ Grasses and shrub species should be planted.	
	(vii) Control of Soil Erosion	The construction activities may lead to the erosion of soil in catchments area of Alaknanda Basin.	▪ Strict implementation of approved Catchment Area Treatment Plan for control of soil erosion. ▪ Work may be restricted in rainy season.	Forest Department / THDC
	(viii) Muck Disposal	The muck produced by the construction work shall be disposed at the dumping sites The disposal of muck is likely to destroy the flora at the sites. However the sites identified for muck disposal are open barren areas.	▪ The muck should be disposed at the identified sites only. ▪ Before disposal of muck retaining walls should be constructed at the edges to retain the muck as the sites area just above the river Alaknanda	Construction Contractor /THDC
3	**Induced Impacts** (I) Influx of laborers	Requirement of living places, hotels, filling stations, service stations and extra workers will arise. This will provide job opportunity to the local skilled and unskilled population	▪ Forest clearance should be obtained if there is any requirement for cutting trees. ▪ Any new colonies developed in area should have provision for plantation in the colony.	Forest Department
	(II) Induced commercial development	Development in Pipalkoti and Chamoli towns and nearby places is likely to take place and land price may increase. The impact on Alaknanda. Basin will be insignificant.	As, Pipalkoti and Chamoli are well equipped with the commercial development which are very near from proposed sites hence any new commercial development and adverse impacts are not envisaged	District Collectorate

S. N	Activities/ Type of impact	Impacts	Mitigation Measures	Responsibility
4.	**Operational Phase** Loss of flora	In operation phase no tree felling is required. Compensatory afforestation and avenue plantation shall increase the greenery in the area. Hence the impact will be positive during operation phase.	▪ Proper protection measures should be taken for the plantation work carried under the project ▪ Fencing of plantation area should be done. ▪ Watchman should be also employed to care of plantation for minimum 3 years.	Forest department /THDC
	Loss of fauna	Loss of fauna is not anticipated during operation phase as the wildlife is found in the upper reaches of hills far away from project area. There shall be no impact on fauna of Project Influence Area and Alaknanda Basin during operation phase.	▪ No impact is envisaged on fauna during operation phase. ▪ Support wildlife conservation program	Forest department /THDC
	Biodiversity	No significant impact is envisaged on biodiversity in Project Influence Area and Alaknanda Basin	▪ Awareness programs should be held for the stakeholders to develop concern for conservation of biodiversity in the area.	Forest department /THDC

CHAPTER 6
RECOMMENDATIONS

6.1 RECOMMENDATIONS FOR THE PROJECT

Based on the baseline environmental status and impact assessment on biodiversity following recommendations are provided:

1 Slope Stabilization

Occurrence of landslide is the most critical aspect in road construction. Cutting of road, clearing vegetation and movement of men & machines is likely to trigger landslide. Slope stabilization measures are recommended. Both vegetative and engineering measures may be followed.

Vegetative measures include plantation of soil binding and quick growing plants. Species such as *Agave americana* (Rambans) *Eupatorium adenophorum* (Basinga) *Rumex hastatus* (Bhilmora) *Euphorbia royleana* (Shuru), etc may be planted. Seeds of grasses may be also sprinkled on the slopes as grasses grow quickly and binds the soil.

Engineering structures include surface drainage, toe protection, construction of check dams etc. Depending on the slope gabion or stone check dams may be constructed. Vegetative check dams may be also constructed wherever feasible.

2. Drainage

Construction of drainage is essential along the approach roads. The water flowing without proper drainage causes soil erosion and increases maintenance cost of roads. The drainage constructed along the roads must be properly lined and cleaned regularly to prevent blockage

3. Culverts and Bridges

Besides construction of bridges over river Alaknanda along the proposed roads there are many small channels /streams flowing in the area. Most of them are dry during lean season however during rainy season they are prone flooding. Hence proper culverts / bridges may be constructed at the waterfall/stream to avoid any accident during operation phase.

4 Wildlife Conservation Program

The project area is located in the transitional zone of Nanda Devi Biosphere reserve. Movement of wildlife is reported in the area therefore check post may be established in the project sites in consultation with Forest Department. The conservation activities carried by forest department may be supported by the THDC

5. Establishment of Herbal Garden

It is suggested that Herbal Garden may be developed by THDC at suitable place in consultation with Forest Department under the project. Propagation of the species *Berginia ligulata* (Silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) found in the advance construction area must be taken up. *Ex-situ* conservation of medicinal plant is a complementary action to conserve the genetic diversity of these species. Besides the three species other native herbal species of medicinal value may be also grown.

6. Awareness and Training Program

THDC may undertake environmental awareness program in the area involving van panchayats, gram panchayats, schools and mahila mangal dals(women's group).The environmental program may cover conservation of flora, fauna, soil, watershed and waste management. THDC may allocate separate amount for this activity and the program may be documented with Date, Place and list of participants.

Training program must be sponsored or conducted by THDC for Project Influence Area / Affected villages for income generation.

6.2 RESPONSIBILITIES WHICH CAN BE TAKEN BY VARIOUS AGENCIES

The implementation of the Biodiversity management plan seeks participation of THDC, Govt of Uttarakhand and local People. The roles and responsibilities of different agencies for proper implementation of management plan and conservation of biodiversity are given below.

i. By THDC

- Provide Compensation of Forestland , Vanpanchayat land and standing crop
- Restoration of Quarry and Borrow area.
- Wildlife check post at construction site
- Environmental Quality monitoring- Air Quality and Water Quality at construction site
- Enhancement plantation along approach road, office area and colony area.
- Provide awareness training to staff and construction workers
- Provide Income generating/ livelihood based training to project affected villages
- Supervision of CAT Plan and compensatory afforestation work.
- Support research, documentation and monitoring program of NDBR

ii. By Government Agencies

State Forest Department

- Implementation of CAT Plan

- Implementation of Compensatory Afforestation Plan
- Develop Herbal Garden
- Wildlife Conservation Program
- Develop nurseries

State Medicinal Plant Board (SMPB)

- Survey, Inventorisation and documentation of medicinal plants resources
- Conservation of Herbal / medicinal plants
- Train local people for collection of medicinal plants.

iii. By Van Panchayats/ Villagers

- Protection of Plantation sites in the project area
- Cultivation of Herbal species
- Develop nurseries for Plantation in the project area

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Flora Assessment

Date: Sheet No:

Forest Compartment:

Site Details:

Site Approachable/ Not Approachable:

Village: Roads:

1.1 Physical Features:

(a) Geography :
(b) Geology & Soil:
(c) Climate :
(d) Water source :
(e) Forest Reserved/ Unreserved:

1.2 Plant Communities SPS (Major Associations)

1.3 Plant Communities Dominant SPS

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Ecological Features of Vegetation

S. No.	Name of Species		Ecology			
	Scientific	Common	Habit	Habitat	Nature	Distribution

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Major Uses of Trees

Name of Tree	Fencing	Ornamental	Avenue Planting	Fodder	Fuel	Timber	Fruit

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Medicinal Plants

S. No.	Name of Species		Chemical Property	Part of Plant Use	Use against Disease	Collection Period
	Scientific	Local				

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Phenology of Major Species of Forest

S. No.	Name of Species		Colour of Flower	Flowering period	Mode of Pollination
	Scientific	Local			

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Structure of Forest

S. No.	Name of Species		Density Tree/100 sqm	Relative Density (%)	Relative Frequency (%)	Relative Abundance (%)	Importance Value Index (%)
	Scientific	Common					

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Fauna Assessment

Date: Sheet No:

1.1 Forest Compartment: Natural /Reserved/ Protected

1.2 Site Details:

1.3 Village: Roads:

1.4 Physical Features : Major/ Minor Habitats

1.5 Animal Communities :

Direct : Sighting / Observation

Indirect : Claw mark, Dropping, Calls, Hiding sites, Horns, Feathers any other records

1.6 Discussions with local peoples/ institutions regarding occurrence of wild animals in the area

1.7 Any record of Endangered, Rare, Endemic or Threatened Wildlife

1.8 Any records of wildlife hunting, trade, poaching in the area

1.9 Hunting of animal by people for medicine, food, trophy, or trade

1.10 Animals of Local Interest / Sacred Species/ Method of Protection followed by local people

Terrestrial Biodiversity Study for Vishnugad Pipalkoti Hydroelectric Project

Format for Fauna Study

S. No.	Name of Species		Mammals	Reptiles	Birds
	Scientific	Local			