KAMAND VALLEY MONOGRAPHS

VOLUME I

Ecological Management Plan for IIT Mandi Campus at Kamand

Indian Institute of Technology Mandi

Kamand Valley Monographs

Volume One

Ecological Management Plan for the Indian Institute of Technology Mandi

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Kamand Valley Monographs
General Preface to the Series

Established 2009, the Indian Institute of Technology Mandi is one of the youngest entrants to the IIT League. Notably, it is the first Indian Institute of Technology to be located in the Himalayan region. Seldom is a remote mountain valley prime choice of locale for setting up a premier technological institute, going as it does against the conventional strategy of a city-based location clustered around other, equally significant educational institutions. The Kamand Valley, rich in bio-diversity, is located amidst steep, rugged mountains, tree-lined hills and terraced slopes, hamlets and homesteads, flanked by snow fed streams – all held together in delicate balance by a fragile ecosystem. Thus, the very locale confers a two-fold responsibility on the IIT Mandi. For one, it needs to bridge geographic distances and engage in constant dialogue with its educational partners at home and abroad; for another, it needs to resist academic insularity and forge a vibrant relationship with the immediate neighbourhood.

Indeed, it is in the spirit of seeking to explore and to comprehend the neighbourhood in all its expressions—social, political, economical, cultural and ecological—that the Kamand Valley Monographs have been commissioned. As a publication initiative of the Indian Institute of Technology Mandi, these monographs are designed to promote an understanding in particular of the ecology, topography, rural habitat and lifestyles, rural practices, flora and fauna, local medical practices, and the like. Public expectations of a premier engineering institution like the IIT Mandi, would point obviously to likely technological solutions to a range of issues affecting daily life in the mountains. Even if they are not of Himalayan proportions, issues like connectivity, health care, water conservation, agricultural techniques and the like call for attention. However, prudence dictates that acute understanding of local life in its entire amplitude will have to precede any change. Any attempt on the part of the IIT Mandi to make inroads into improving the quality of rural life through technological or institutional interventions, has to be backed by meaningful civic engagements. This series emphasizes,

therefore, the nature of the understanding that ought to precede any change. It is meant for the reader at large as well as the professional scientist and technologist. There is little doubt that the earnest academic engaged creatively with the world around him or her in the strict universal sense, will also respond to the challenges posed by the immediate surroundings and go beyond the narrow confines of academic disciplines.

The privileged location of the IIT Mandi in an area of undisputed ecological wealth thus holds great potential for its scholarly community. Remarkably, there is the unique prospect of living in close proximity to the local populace and of gaining deep insights into its enduring legacy of eco-friendly existence, informed as it is by concerns of sustainability and conservation of nature. Such insights prompt us to showcase, as it were, this scenic region of Himachal in all its splendour to visitors from the rest of the country and from around the world.

Admittedly, these considerations have played a significant part in the planning of this publication project, the Kamand Valley Monographs. In calling upon subject experts to visit and to explore the Kamand Campus and its neighbourhood, the idea has been to enlist their help in illuminating both the potential of the Institution in its present location as well as to address the need to prepare a road map for the future. This series of publications complement various other initiatives of the IIT Mandi such as the establishment of a Botanical Garden in its Kamand Campus.

In the main, the monographs seek to trace the history and political economy of the Kamand Valley, changes in this region over the ages as well as in the last half a century; they also attempt to delineate the diversity of flora and fauna, and further, to present a clear guide for the future. Underlying such endeavour is the firm conviction that the IIT Mandi from its very inception should have a sense of its place in the history of this region of Himachal Pradesh as well as a blueprint indicating the direction and scope of its future development and expansion. Taken in this spirit, the Kamand Valley Monographs, therefore, are as much of a chronicle as a compass.

-The Editors

Editorial Note

The genesis of the Ecological Management Plan for the Kamand Campus goes back to April 2010 when the IIT Mandi commissioned the Care Earth Trust to aid and to advise it in preparing a blueprint for campus development, keeping in mind the fragile environment of the Kamand Valley. Dr. R.J. Ranjit Daniels of the Care Earth Trust carried out the study with the help of his project team comprising experts besides enlisting local assistance as set out below.

Project Team

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Author's Acknowledgements

The field studies, logistically and technically, and the preparation of the Ecological Management Plan would not have been possible without the cooperation and support of the following authorities, officers, local administrators, village heads and service providers and colleagues at Care Earth to whom the Project Team is greatly indebted.

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1. Introduction

Institutional campuses have served as repositories of biodiversity throughout the world; as such, they are gaining a lot of significance in global efforts to save the biosphere. There are many classic examples of plants and animals that were once believed to have gone extinct, but discovered centuries later within institutional campuses. A good example is the campus of Indian Institute of Technology Madras in Chennai where recent studies have shown the presence of plants like garcinia spicata that the rest of the city had lost in recent times and others like typhonium trilobatum, an entirely new record for the state of Tamil Nadu (Daniels et al, 2008).

Well-managed campuses located in biodiversity-rich landscapes serve as refuge and attract plants and animals that lose their natural habitat due to urbanization. While it is good to see birds and other animals sharing the campus with its human inhabitants, harmonious co-existence is not something that automatically evolves. Human-animal conflicts are common and call for foresight if they have to be kept under control. In biodiversity-rich institutional campuses a practical ecological management plan should be at hand (Care Earth, 2006; Daniels and Arivazhagan, 2008).

Whereas post facto ecological management plans (EMP) are available (example Care Earth, 2006), the initiative by Indian Institute of Technology Mandi to first evolve an EMP and plan the campus infrastructure guided by the EMP, is laudable. The proposed EMP is meant to provide guidelines on sustaining the ecology of the campus and the landscape that surrounds it.

The main objectives of the proposed EMP are as follows:

1. To create a baseline ecological map that will guide all decision-making on land use and infrastructure development.
2. To identify critical habitats and the ecosystem processes which naturally sustain them.

3. To identify the potential re-colonizers of the landscape, specifically the ones that might prove invasive in the long-term.
4. To assess the potential of natural regeneration of vegetation and the direction in which it will move without human interference.
5. To assess the drainage pattern and identify threats, if any, to the downstream riparian ecosystem.
6. To document the ecological history of the landscape such that future socio-ecological impacts of the campus can be anticipated and mitigated.

2. Mountains

Mountains are very special places. For many they are sacred; to most they bring an uplifting of the spirit and refreshment; to a few, they bring fear. They are the home of many different peoples in every continent. They occur in all biogeographical regions of the world, where, because of their history, isolation, and great variability of habitat, they are treasuries of high biodiversity and rich in endemic species. They contain a great variety of climates and of geological and physiographic features. They provide magnificent scenery and the qualities of remoteness and wilderness – a solace and a challenge to those who visit them. And they are the gathering grounds of much of the world's water. In fact, they are of untold value to those who live in them, those who visit them, and enjoy or study them, and those in the valleys and plains who count upon a dependable yield of high quality water, other products (wood, minerals, game, food, etc.) and recreational opportunity from them. Hamilton & McMillan (2004)

According to Hamilton and McMillan (2004), mountains are "steep-sided, three-dimensional earth features that are conspicuous in the landscape, have more than one altitudinal vegetation zone, and are regarded as mountains by local people." Given their steepness and extreme weather conditions and instability of soils, mountains are not ideal for commercial agriculture. Some may however support subsistence farming, grazing and agro-forestry. Many are remote and inaccessible in that they are far from markets and services such as education and health.

In many countries, the lowland urban centers have viewed mountains as supply areas, to be used or exploited for wood, water, wildlife, minerals, or recreational opportunity including mass tourism. Also, since they frequently form international borders, they are important for defense. The people who live there are often proud and independent, and considered unruly and backward by lowlanders. But the mountains, because of their very remoteness and difficulty of access, often remain the last bastions of wild, pristine nature and unfettered evolutionary processes. This makes them rich treasuries of native biological diversity. It also means that they possess some of the last remaining large wildernesses for those who crave for or need solitude and as much absence of human disturbance as possible (Hamilton and

McMillan, 2004).

Hamilton and McMillan (2004) have listed a number of reasons for conserving mountains. These reasons, although focused on wildlife protected area management, are relevant to the management of the upcoming IIT Mandi Campus and are therefore listed below (with minor changes).

1. Mountains are often associated with "sacred" aspects of nature. There may be pilgrimage to holy hills or taboo places of fear that present unusual management situation.
2. Mountains have mystique for scholars, visitors and the general public. This has plus and minus effects.
3. Traditional indigenous groups with threatened cultures often occupy or use the areas.
4. They add greatly to the interest, can contribute much and represent a clear case for cultural diversity conservation. Cultural diversity may be more threatened than biodiversity.
5. Mountains are headwaters of valuable surface water resources.
6. Special care is needed to safeguard water quality for all downstream sites. The few remaining economically feasible water storage reservoirs for water and power are in mountain valleys.
7. Mountain biota, under climate stresses at the best of times, is particularly vulnerable to climate change from increasing greenhouse gases, as well as from exogenous airpollution. They offer great possibilities for global climate change and air quality research and monitoring.
8. Mountains are a last refuge for many rare plants and animals eliminated from more transformed lowlands. They are vital to biological diversity conservation.
9. These are dynamic landscapes of relatively rapid change. Volcanism, uplift, erosion, glacial outbursts, seismic activity, avalanches and torrents, all contribute to significant rapid alterations in topography, vegetation and land use. These are high-energy environments where some control over human alterations is often needed.

10. There is a concentration of high scenic value, attractions for tourists and recreational use. Management is needed to maintain these values.

The concentration of humans in confined landscapes demands a proactive policy and management approach to avoid overcrowding and degradation (rubbish, sanitation, erosion, etc.) and call for positive control to avoid site degradation and require that equipment, materials and refuse brought in be taken out.

3. Himachal Pradesh: Geography and Wildlife

Himachal Pradesh (Himachal) is a mountainous Himalayan state (300 22'N-330 12'N; 750 45E-79004'E) with a rugged and steep topography. It has a geographical spread of 55,673km2. The altitude varies from around 450m to 6500m ASL. The state is well drained and the major rivers that flow through it are the Chenab, Ravi, Beas, Sutlej and Yamuna. All these rivers are snow-fed and perennial. Reservoirs cover an area of 41,796ha; the largest being the Bakra Nangal (Gobind Sagar) and Pong with a water spread of 16, 867ha and 24,629ha (at full level) respectively (Katiha et al, 2009). The state accounts for 17% of the northwest Himalayan region with a forest cover of 10,770km2 and a human population density of 109/km2 (Prasad et al, 2004; Vijayan et al, 2004). As per the Botanical Survey of India the major forests types of Himachal include Subtropical Pine Forest, Montane Wet Temperate Forest and Sub-alpine and Alpine Forest. Around 11% of the state has been brought under the system of wildlife protected areas (Satyakumar & Shivakumar 2007: 117-119).

Elsewhere, the state has been described as a mosaic of vegetation types that are typical of the Himalayan eco-region. The broad categories of vegetation are Montane Grasslands and Shrublands that are representative of the Tibetan Plateau and Northwestern Himalayan Alpine Shrub and Meadows and Temperate Broadleaf Forests such as Western Himalayan Broadleaf Forests. There are also sub-alpine and subtropical conifer forests, Western Himalayan Sub-alpine Conifer Forests and Himalayan Subtropical Conifer Forests (Vikramanayake et al, 1998).

Himachal is divided into 5 distinct provinces as per the Wildlife Institute of India's biogeographic classification of India (Prasad et al, 2004): the Trans-Himalaya-Ladakh Mountains (Biogeographic Province 1A), Trans-Himalaya Tibetan Plateau (Biogeographic Province 1B), Himalaya-Northwest Himalaya (Biogeographic Province 2A), Himalaya-West Himalaya (Biogeographic Province 2B) and Semi-arid Punjab Plains (Biogeographic Province 4A).

The state is known for its diverse high-altitude Himalayan flora and fauna. The region comprising the hills of Jammu and Kashmir, Himachal and Uttar Pradesh is home to 450 species of endemic flowering plants (Rawat, 1997; Wikremanayake et al, 1998).

Amongst birds, pheasants are ecologically important (being ground birds, large in body size, attractive in plumage and relished as food). Six species including the Himalayan Monal (Lophophorus impejanus), Kalij (Lophura leucomelana), Cheer (Catreus wallichii), Koklass (Pucrasia macrolopha), Western Tragopan (Tragopan melenocephalus), Red Jungle Fowl (Gallus gallus) and Indian peafowl (Pavo cristatus) are known to the State (Sathyakumar & Shivakumar 2007:117).

While there are many species of pheasants and other birds of ecological significance, the state as a whole falls within the Himalayan zone that has, relatively speaking, and the lowest diversity of birds. According to Wikremanayake et al (1998) the number of species of birds known within the state varies from as low as 84 to a maximum of 485 locally. This figure is considered as 'low' only when compared with the central and eastern Himalayas where the species richness of birds falls in the range of 609-682.

The northwest and western Himalayan regions, that cradle Himachal, are well known for the diversity of highly elusive, rare and endangered mammals such as the Musk Deer and Snow Leopard. Much less is known of the smaller mammals, especially the carnivores including Mongooses, weasels, civets and martens. The important species representing this group of carnivorous mammals known from the region are Beech or Stone Marten (Martes foina), Yellow-throated Marten (Martes flavigula), Himalayan Stoat or Ermine (Mustela erminea), Pale Weasel (Mustela altaica), Yellow-bellied Weasel (Mustela kathiah), Siberian Weasel (Mustela sibrica) and the Himalayan Masked Civet (Paguma larvata) (Hussain, 1999).

4. Ecological Significance of Mandi District

Mandi district has a geographical extent of 3950km^2. The elevation varies from 750m ASL or less (as around Mandi town) to 4038.5m ASL at the Nargu Peak. The human population is 901,344 with a density of 228km^2. One per cent (3951ha) of the district is designated as forest (www.himachalpr.gov.in).

As with most parts of Himachal, the district falls within the Palearctic biogeographical realm largely experiencing temperate climate. According to Sharma (undated) the district has three distinct seasons; winter (November-March), summer (April-June) and rainy season (July-September). It is warm during April-October when the maximum temperature tends to exceed 30°C, becoming hot locally with a recorded maximum of 41°C. Winters are freezing when snow descends to around 1200m ASL. Snow descends lower occasionally as during the years 1961, 1973 and 1991, when Mandi town had experienced snowfall in winter (Sharma, undated). Rainfall, as recorded at the Pandoh dam site during the years 1982-1993, varied from 358mm to 1954mm, the average being 1224mm placing the district within the moist climatic regime (Sharma, undated).

Mandi district is also known for its rock salt deposits, iron ore, limestone and clay and slate (Sharma, undated). The major forest types are Subtropical Pine and Montane Wet Temperate. Judging by the vegetation type in adjoining hills of the state, the specific type of vegetation could be treated as Himalayan Subtropical Pine, dominated by Chir Pine (Pinus roxburghii) and Lower Western Himalayan Temperate, dominated by species of Oak (Quercus spp) (Jayapal & Ramesh, 2009). Specifically, the HP Forest Department has described the forests as moist temperate and at lower elevations, dry, tropical and subtropical forests (Sharma, undated). Twenty-four subcategories of vegetation have been listed for the Mandi and Joginder Nagar forest divisions (see Table 1).

Table 1: Vegetation types of Mandi and Joginder Nagar forest divisions (Sharma, undated)

Northern dry mixed deciduous forest
Upper or Himalayan Chir Pine forest
Himalayan subtropical scrub
Subtropical euphorbia scrub
Olea cuspidata scrub forest
Lower western Himalayan temperate forest and Ban oak forest
Moru oak forest
Oak scrub
Moist Deodar forest
Western mixed coniferous forest
Spruce-Deodar forest
Predominantly spruce forest
Spruce-silver fir forest
Pure silver fir forest
Moist temperate deciduous forest
Low level blue pine forest
Kharsu oak forest
West Himalayan upper oak & fir forest
Montane bamboo brakes
Himalayan temperate pastures
Himalayan temperate secondary scrub
West Himalayan sub-alpine fir forest
West Himalayan sub-alpine birch and fir forest
Birch-Rhododendron scrub forest

The district falls within the Himalaya-Northwest Himalaya biogeographic province (2A) (Prasad et al, 2004). Three of the 34 (or more) wildlife protected areas declared in Himachal Pradesh fall within the district; Bandi Wildlife Sanctuary, Nargu Wildlife Sanctuary and Shikari Devi Wildlife Sanctuary. Together they cover an area of 390km2 (10% of the district) (Mathur, 2000).

Mandi district lies within one of the important biodiversity conservation landscapes of the Himalayas. The Himalayan landscape described as Govind Pashu-Kedarnath-Pin Valley Complex, a designated endemic bird area as per the International Council for Bird Preservation assessment, cradles the district and its surrounding areas (Wikremanayake et al, 1998).

However, the district has not been fully explored for its biodiversity wealth. There is lack of information on plants and even the most obvious animals. For instance, the only list of plants available as a benchmark is that provided for the Mandi and Joginder Nagar forest divisions in the Working Plan. The list provided in Sharma (undated) includes around 385 species of plants. Similarly, for animals the only baseline information on species that are known from the district is that provided by the Zoological Survey of India (ZSI, 2005). This list, while apparently comprehensive for the State as a whole is rather rudimentary for Mandi district. The list includes 132 species of birds, 21 species of fishes, 11 species of amphibians and no reptiles. There is no specific list of mammals for the district although at least 107 species are known from the State of Himachal (ZSI, 2005). Further, while Zoological Survey of India has listed 288 species of butterflies for the State, only 34 are listed from Mandi district (ZSI, 2005).

Mandi district is also an important watershed that sustains Beas, a major tributary of the River Indus. Tirthan, Hansa, Bakhli, Jiuni, Suketi, Panddi, Son and Bather that flow from the north join the Beas within Mandi district (Moza & Mishra, 2009). These are the left bank tributaries. Bajuara and Uhl are amongst the right bank tributaries that feed river Beas (Sharma, undated). According to river ecologists the district covers two Himalayan riparian zones; Lesser Himalayan Riparian Zone (1000-2000mASL) and Siwalik Riparian Zone (<1000m ASL) (Sehgal, 1999).

5. The River Beas

River Beas is the only tributary of the River Indus that is confined to India. The 460km (470km according to some sources, e.g. Sehgal, 1999) long river originates from two sources, Beas Kund (4060mASL) and a cavern Beas Rishi adjacent to the Rohtang Pass at an elevation of 4350mASL. The two streams meet at Palchan village, 10km north of Manali to form the river Beas (Moza & Mishra, 2009). The Beas is a perennial river and has drainage of 25,900km2. However, the rate of water discharge varies with the seasons, being the highest in July-September wherein 67% of the water is discharged, and lowest in January-March when the discharge is just 8% of the annual volume. The seasonal fluctuation in the discharge of water and drying out of streams, leaving only isolated pools, is vital to the ecology of the river (Sehgal, 1999). The water quality parameters of the Beas are: 23.30C, transparency 29.5cm, dissolved oxygen 6.7mg/l, pH 6.8, total alkalinity 71.5mg/l, conductance 208 µmhos, total dissolved solids 103mg/l, total hardness 89mg/l, chloride 20.7mg/l, silicate 2.0mg/l and phosphate 0.290mg/l (Pathak & Tyagi, 2009).

The ecology of the river is better studied within the limits of Punjab, starting from Talwara till the Harike Lake (about 165km stretch of the river). The primary productivity estimated during 2002-05 ranges between 177.09 mg C/m3/hr and 207.03 mg C/m3/hr. The average standing crop of plankton varied between 80 and 270µ/l, 80-95% being phytoplankton. Eunotia, Cyclotella, Staurnies, Naviucla, Diatoma, Frustulia, Microcystis and Spirulina were the common phytoplankton observed during 2002-05. Rotifers (Brachionus, Filina), copepods (Cyclopsis, Diaptomus, Nauplii) and protozoans were the predominant zooplankton observed (Moza & Mishra, 2009). Around 100 genera of aquatic invertebrates have been recorded in river Beas. Sixty percent of the invertebrate genera are of insects, while 25% are mollusks (snails and allies). The river is home to 53 species of fish, important being the Snow Trout (Schizothorax richardsonii)*and Golden Masheer (Tor putitora) both popular game fish (Moza & Mishra, 2009).

Seasonal migration of fish has been reported along the river Beas. The Snow Trout, for instance, migrates upstream towards the higher reaches during summer when the water downstream becomes warmer. This species breeds in the upper reaches of the river during July-

August when the water temperatures are between 16.5 and 18.50C. The Snow Trout is adapted to fast flowing and turbulent waters (0.9-1.8m/sec), lower temperature (monthly mean of 17.30C) and high concentrations of dissolved oxygen (10.1mg/l). The Masheer, also a migratory fish, is a species of warmer and less turbulent water; temperature 22.10C, dissolved oxygen 8.0mg/l and velocity 0.5-0.7m/sec (Sehgal, 1999).

The first reservoir across the river Beas, namely Pandoh is in Mandi district from where water is diverted to the river Sutlej through the Beas-Sutlej Link Canal (Moza & Mishra, 2009). The reservoir is at an altitude of 987mASL. The water temperature varies between 10.5 and 16.50C (Raina & Petr, 1999). Cold water stream fishes including the Snow Trout and the Golden Masheer inhabit the reservoir. Other species known from the waters are carps (labeo dero and Labeo dyocheilus)* (Raina and Petr, 1999).

*Note: Snow Trout is known as Asela or Rasela, Labeo spp as Unera and Barilius spp as Dhaur or Jabua in Kumaun Himalayas (Sunder Singh, Undated); Labeo dero as Chhali and labeo dyocheilus as Torki, Schizothorax spp as Swati, Keerni, Baltastani, Barilius spp as Chilwa in Urdu (Mirza and Alam, 1994)

6. Kataula Forest Range

The IIT Mandi is to be located within the Kataula forest range. The Katuala forest range is a part of the Mandi forest division. As with the rest of the division, it has had a long history of forest exploitation. According to Sharma (undated) the forests have been worked for timber starting 1880. Much of the natural Deodar, Chir Pine and Ban Oak have been depleted in the past 200 years. Remnant vegetation that provides habitat for the 3 species is scarce, and most of what has been left (especially of Chir Pine) within the range is planted.

The forests, at present, within the Kataula range represent 5 of the 24 vegetation types known from Mandi-Joginder Nagar forest divisions (see Table 1 above). The vegetation is secondary (degraded) although it has not entirely lost its original character. As with the rest of the landscape, altitude and aspect have played a major role in determining the distribution, extent and quality of each vegetation type (Table 2).

Table 2: Major vegetation types of Kataula

Type of vegetation	Associated plants	Topographic distribution
Northern dry mixed deciduous forest	Acacia catechu, Bombax ceiba, Erythrina variegate, Lannea coromandelica, Bauhinia variegata, Ougenia sp, Kydia calycina, Emblica officinalis, Albizzia spp, Mallotus philippinensis, Murraya koenijii, Adhathoda vasica, Woodfordia fruticosa, Indigofera pulchella, Euphorbia royleana, Rubus spp	Less than 1200m ASL; south, southeast and east-facing aspects that are lit by the morning sun
Upper Himalayan Chir Pine forest	Pinus roxburghii, Quercus spp, Rhododendron arboreum, Berberis sp, Rubus spp, Prinsepia utilis, Pedicularis carnosa, Heteropogon contortus, Agrostis alba, Plectranthus strictus	600-2200m ASL; north, northwest and west-facing aspects that receive sunlight only in the afternoon and evenings
Subtropical Euphorbia scrub	Euphorbia royleana, Bombax ceiba, Ficus spp	Rocky slopes that are lit by the morning sun; more associated with the northern dry mixed deciduous forest
Predominantly spruce forest	Picea sp, Cedrus deodara, Juglans regia, Acer spp, Aesculus indica, Quercus spp	Scarce & locally along the slopes overhanging the nallah; restricted to slopes that receive only evening sunlight
Montane bamboo brakes	Arundinaria falcata, Arundinaria Spathiflora	No specific information

7. IIT Campus

IIT Mandi is to be located at Kamand. The word Kamand means 'sugarcane', a crop that was once extensively cultivated here. The Campus is shaped like an unfinished boomerang with an east-west spread of around 3 km and a north-south reach of a little more than 2 km (Fig 1). The northeastern limit of the Campus lies closer to the Kataula village at a distance of 3-4km (by road) from the Forest Rest House. At this end the Campus is at an elevation of 1000-1200m ASL from where it gently slopes downwards till about 950m ASL at the valley (southwestern end) through which the river Uhl flows. The Uhl is one of the right bank tributaries of the River Beas (Sharma, undated).

The entire Campus that covers 531 acres (212ha or 2.12km2) has an undulating topography with the Kautala ki khad (nallah) running east-west like a backbone. The nallah flows through a gentle gradient. Boulders characterize the course of the nallah keeping it narrow in most parts. Wherever the nallah meanders, the course is wider and in some parts, where it flows through gorges, it is narrow.

Uhl River

Downstream the nallah joins the river Uhl, a major tributary of river Beas, close to the historic wooden bridge, forest nursery and check post at Kamand. The river Uhl flows from north to south and, like the nallah, is strewn with boulders. Where it meanders, there are deep pools and sandy beaches. South of Kamand, the north-south boundary of the Campus is defined by the river Uhl, and may be treated as the western limit of the Campus.

In cross-section, the Campus is rather narrow, accommodating the valleys of the nallah and the river Uhl that locally assume the topography of gorges, spreading out into rather flat or gently sloped table lands (around 1000-1100m ASL) and all along the periphery bounded by hills that rise rather steeply to around 1300m ASL. In other words, it may be said that the Campus has all the topographic features of a small watershed.

8. Present Study: Duration and Approach

An ecological study was undertaken in March 2010. The field study led by Care Earth Trust was spread over 17 days (March 10-27, 2010) and involved a team of ecologists and foresters (see Project Team for details). The study adopted the following approach:

1. Compile available information on ecology and biodiversity of the landscape from various sources such as the Wildlife Institute of India, Dehra Dun (Jayapal & Ramesh, 2009; Jishtu et al, 2007; Rawat, 1997 & 2007), Indian Council of Agricultural Research (Das et al, 2007; Katiha et al, 2009; Moza & Mishra, 2009; Pathak & Tyagi, 2009) and ZoologicalSurvey of India (ZSI, 2005).
2. Visit the various habitats in and around the Campus, and assess the biodiversity and the apparent ecological processes that govern them.
3. Map the topography and current land use of the Campus and surrounding landscape.
4. Visit the neighboring villages and conduct interactive meetings to document peoples' views and concerns about the establishment and long-term impacts of an educational institution.
5. Meet with officials of the Forest Department to understand the history of the forests and their views on sustainable management and ecological restoration of the vegetation within .the Campus and surrounding areas.
6. Review the proposed land use and infrastructure development (e.g. IIT Roorkee, 2009; Vaidya & Associates and Space Matrix, 2009) for their ecological appropriateness.

9. History of Land Use

Agrarian and pastoral villages including Kamand, Siram, Salgi, Hilog, Gharpa, Khara and Kani have a historical bearing on the Campus. Other than these villages, Chargha and Mayal are localities that are marked in the revenue map, though at present without human habitation. According to local residents, the villages Salgi, Hilog and Gharpa were handed over to the Animal Husbandry Department (HP) by the government around 50 years ago. These areas, mostly flat, have since been used for intensive grazing and agro-forestry. There are also many buildings, including cattle sheds, built by the Animal Husbandry Department, spread across these flat tablelands but abandoned of late. Whereas Salgi and Hilog are mostly confined to the tablelands that lie south of the nallah and east of the river Uhl, Gharpa is on the north, overhanging the river Uhl and the nallah, and at a higher elevation (around 1100m ASL).

The Gharpa tableland presently accommodates a temple within the northern part of it (31.780010N; 76.987280E) and (what appeared like) the administrative buildings of the Animal Husbandry Department in the south (31.777120N; 76.984630E). The two fragments of tableland are divided by a ridge, yet connected by footpaths; the longer one (cemented) that passes the temple descends down to the school and primary health centre, close to the new bridge (31.776430N; 76.989820E). The Gharpa tableland has motorable access from the Kataula- Kamand road (to the right as one approaches the historic wooden bridge; 31.776260N; 76.984890E). Opposite this point there is yet another motorable road that runs downhill and through the nallah providing access to the Hilog flat areas previously used by the Animal Husbandry Department.

Major roads that are of immediate relevance include the Kataula-Kamand link road and the Kamand-Mandi road (steep road uphill) that are used rather intensively for public transport (buses ply frequently on these roads). One less intensively used kutcha road from the historic wooden bridge (also known as the old Mandi road) links the Siram village with Kamand and Kataula. Near the school and primary health centre at Kamand a metal (tar-capped) road deviates and runs south after crossing the new bridge, and through the Animal Husbandry flat areas through Hilog (touching the site where the IIT Mandi

foundation stone has been erected;31.775650N;76.987420E). This road links the Navalay village to Kamand. Further, there is a wide, dirt road that runs across the nallah through a new concrete bridge starting from Salgi and uphill beyond Mayal (31.783240N; 76.999260E; an old iron bridge lies abandoned adjacent to this bridge). There is a traditional watermill (still in use) right below this bridge.

The rather dynamic nature of the hamlets is due to large scale internal displacement facilitated not only by the establishment of the Animal Husbandary Unit during 1958 - 62, but also because of the nomadic nature of some of the tribal groups who either practice slash and burn agriculture or are pastoralists who moved animals further north. There has also been a largescale inflow of Rajputs (Thakurs) from the lower reaches of the region about 40-45 years ago in search of livelihoods (lands and timber felling).

Agriculture is dominated by the cultivation of wheat, maize, minor millets and vegetables through a system that can be broadly described as intermediate between subsistence and commercial – with cereals being largely consumed or partly used for barter, while vegetables and spices are sold in the nearby markets. The reasons for the abandonment of sugar cane (cash crop) could not be probed during the current study and may well be a point of interest, since not many landscapes have rejected commercial crops for food crops notably cereals. While apple is not locally cultivated, there are apple nurseries around Kataula.

Land within Hilog has been traditionally used as pasture and for agro-forestry, largely for tree- fodder. Cultivated land, closest to the Campus, are those within Salgi and Siram villages. Cultivation bordering the nallah is irrigated through a simple network of canals that are made using boulders and slates in the lower reaches of the landscape, or rainfed along the slopes and higher reaches. The last few years have witnessed the use of sprinklers in some of the hamlets. Keeping in view overall the many hill-dwelling communities of India, home gardens are not exclusive entities but are to be seen as natural extension of the habitations with many plants being a common property resource. The tradition and practice of pastoralism is rather well entrenched and there are about 3800-4000 cattle in the landscape.

10. Flora

Background information, specifically on the diversity of plants in and around the Campus, is scarce and limited to reports and publications that focused on similar terrain within the Western Himalayas; for example Jayapal & Ramesh, 2009; Jishtu et al, 2007; Rawat, 1997 & 2007; Sharma, undated; Collett & Hemsley, 1980; Dhaliwal & Sharma, 1999; Polunin & Stainton, 2006. Around 200 species of plants were observed in and around the IIT Campus during the brief field studies in March 2010. The complete list of plants is provided in Appendix 4.

Based on the March 2010 field investigation and the plants identified it may be said that the vegetation on the Campus is a mosaic of three broad types amongst those listed in Table 2, viz., northern dry mixed deciduous forests, upper or Himalayan Chir Pine forests and subtropical Euphorbia scrub (Champion & Seth, 1968). Of these the mixed deciduous forests and Euphorbia scrub are predominant covering most of the Campus designated as forest.

Chir Pine (Pinus roxburghii) is associated with Rhododendron arboreum, Phoenix sylvestris, Myrica esculanta and Engelhardia spicata. The common shrub species-forming understory of the Chir forest includes Rhus cotinus, Berberis lycium, Berberis asiatica, Reinwardtia indica and Prinsepia utilis. The ground vegetation is represented by a variety of herbaceous species such as Gentiana capitata, Geranium wallichianum, Gerbera gossypina, Artemisia vestita, Eupatorium adenophorum, Galium aparine, Stellaria media, Taraxacum officinale, Campanula argyrotricha, Aechmanthera pedata, Bergenia ciliata, Sauromatum pedatum, Leucas lanata, Micromeria biflora, Scutellaria angulosa, Ajuga parviflora, Ageratum conyzoides, Senecio nudicaulis, Notholirion thomsonianum and Tulipa stellata. Common grasses associated with Chir forest are Arundinella nepalensis, Themeda anathera, Oplismens burmanii, Eulaliopsis binata, Thysanolaena maxima, Apluda mutica, Cynodon dactylon, Arundinaria falcata (Nargal) and Pennisetum orientale.

Chargha is the only part of the Campus where there is a dense natural stand of the Chir Pine (Pinus roxburghii). As with the rest of the landscape, aspect plays a major role in determining the distribution of vegetation, in that the natural Chir forests are confined to the slopes.

Here there are occasional trees of Rhododendron arboreum (for example, the southern slopes facing Salgi). Chir Pine trees over the rest of the Campus are largely planted. They are young, as inferred by the slender boles.

Rhododendron Flower

Myrica esculenta is a very valuable medicinal plant and its fruits are cherished by the local people and also eaten by a variety of frugivorous birds and other animals. Tulipa stellata (Wild Tulip) and Notholirion thomsonianum (Lily) are small interesting herbaceous flowering plants growing exclusively in the Chir forests. These species are of high conservation significance.

A major chunk of vegetation in the Campus is represented by scrub which seems to be a result of degradation of the dry mixed broadleaved deciduous forests and subtropical scrub due to overgrazing, timber and fuelwood collection during the past several decades. This vegetation type can be seen mainly around Hilog and Gharpa. Besides, a number of shrub species, a few tree species can be seen scattered here and there, e.g. Albizia julibrissin, Bauhinia variegata, Bombax ceiba, Celtis tetrandra, Emblica officinalis, Ficus palmata, Ficus roxburghii, Ficus semicordata, Glochidion velutinum, Grewia optiva, Juglans regia, Mallotus philippensis, Machilus odoratissima, Morus alba, and Myrica esculenta. The shrub species of the this habitat are Adhatoda zeylanica, Agave americana, Barleria cristata, Berberis asiatica, Berberis lycium, Boehmeria platyphylla, Buddleja paniculata, Pogostemon benghalense, Caryopteris odorata, Colebrookea oppositifolia, Debregeasia hypoleuca, Dendrocalamus strictus, Deutzia corymbosa, Ficus foveolata, Idigofera pulchella, Inula cappa, Kirganellia virosa, Maesa indica, Murraya koengii, Myrsine africana, Plumbago zeylanica, Prinsepia utilis, Cyathula tomentosa, Hypericum elodeoides, Rabdosia rugosa, Reinwardtia indica, Rosa moschata, Solanum verbascifolium, Solanum indicum, Solanum torvum, Urtica dioca, Vitex negundo, Zanthoxylum armatum and Lantana camara.

Steeper slopes, relatively free from anthropogenic pressures,

harbor quite a few species representing subtropical scrub and dry mixed broadleaf forests, e.g. Ougenia oogeinensis, Pistacia integerrima, Pyrus pashia, Rhamnus triqueter, Sapindus mukorossi, Saurauia napaulensis, Syzygium cumini, Terminalia belerica, Toona ciliata, Ulmus wallichiana, Zizyphus mauritiana, Sapium insigne, Sterculia villosa and Bridelia retusa. The steep sides of the gorges along the nallah (Kataula ki Khad) near Kamand have a profuse growth of broom grass (thysanolaena maxima).

Kataula ki Khad, a small tributary of the Uhl river that forms the lower boundary of the Campus is characterized by steep ravines and gorges. The vegetation is unique and marked by the presence of typical riparian species such as Salix alba, Machilus odoratissima and Syzygium cumini. Other species along the river courses are Acorus calamus, Ageratum conyzoides, Ajuga parviflora, Anagalis arvensis, Eupatorium adenophorum, Mantha longifolia, Mazus surculosus, Nasturtium officinale, Nepeta hindostana, Oxalis corniculata, Kirganellia virosa, Ranunculus sceleratus, Rumex nepalensis, Rumex hastatus, Rungia pectinata, Solanum indicum, Solanum nigrum, Stellaria media, Veronica anagallis-aquatica and Veronica persica.

The riparian and rocky slopes also harbor a number of climbers and shrub species such as Ampelocissus latifolia, Cayratia divaricata, Asparagus adscendens, Bauhinia vahlii, Cissampelos pareira, Dioscorea belophylla, Helinus lanceolatus, Clematis barbellata, Ipomea sp., Piper brachystachyum, Pueraria tuberosa, Rubus ellipticus, Rubus niveus, Rubus paniculatus, Smilax aspera and Trachelospermum axillare.

The fallow fields (abandoned since the past 5 to 10 years) have scattered trees largely planted for fodder or ornamental purposes. Common trees along the field borders and building premises are Albizia julibrissin, Bauhinia variegata, Callistemon lanceolatus, Cassia fistula, Cedrus deodara, Celtis tetrandra, Dalbergia sissoo, Grevillea robusta, Grewia optiva, Melia azedarach, Jacaranda mimosifolia, Leucaena leucocephala, Populus cilita, Prunus armeniaca, Pyrus pashia, Quercus leucotrichophora, Thuja compacta, Ulmus wallichiana, Lagerstroemia indica, and Eucalyptus sp. In addition, a few native species can be seen scattered along the edges of fallow fields such as Ficus palmata, Ficus religiosa, Ficus roxburghii, Bombax ceiba, Erythrina suberosa, Mallotus philippensis, Mangifera indica, Morus alba, Oroxylum

indicum, Pistacia integerrima Salix alba, Punica granatum, Syzygium cumini, Terminalia bellerica and Toona ciliata.

Colorful Slope

The other shrubs and herbaceous species in fallow lands and along the roadside are Opuntia dillenii, Agave wightii, Berberis asiatica, Berberis lycium, Boehmeria platyphylla, Buddleja paniculata, Cannabis sativa, Pogostemon benghalense, Carissa opaca, Caryopteris odorata, Colebrookea oppositifolia, Dendrocalamus strictus, Deutzia corymbosa, Lepidagathis cuspidata, Maesa indica, Murraya koengii, Plumbago zeylanica, Prinsepia utilis, Rabdosia rugosa, Reinwardtia indica, Rosa moschata, Solanum indicum, Solanum torvum, Urtica dioca, Zanthoxylum armatum, Lantana camara, Asparagus adscendens, Cissampelos pareira, Rubus ellipticus, Rubus niveus, Rubus paniculatus, Smilex aspera, Artemisia nilagirica, Acorus calamu aechmanthera pedata, Aerua scandens, Ageratum conyzoides, Ajuga parviflora, Anagalis arvensis, Bidens pilosa, Bidens wallichii, Vicia hirsuta, Cynoglossum zeylanicum, Cannabis sativa, Dicliptera bupleuroides, Duchesnia indica, Erigeron canadensis, Eupatorium adenophorum, Euphorbia hirta, Evolvulus alsinoides, Galium aparine, Geranium ocellatum, Geranium wallichianum, Lepidagathis incurva, Leucas lanata, Mantha longifolia, Mazus surculosus, Micromeria biflora, Nasturtium officinale, Nepeta hindostana, Oxalis corniculata, Ranunculus sceleratus, Rumex nepalensis, Rumex hastatus, Rungia pectinata, Sauromatum pedatum, Scutellaria angulosa, Solanum indicum, Solanum nigrum, Stellaria media, Strobilanthus glutinosus, Saraxacum officinale, Trifolium repens, Vernonia cinerea, Veronica anagallis-aquatica, Veronica persica, Xanthium strumarium and Youngia japonica. A few grasses along the edges of the forests are Arundinella nepalensis, Oplismenus burmanii, Eulaliopsis binata, Thysanolaena maxima, Apluda mutica, Cynodon dactylon and Pennistum orientale.

Albizia julibrissin, Celtis tetrandra, Pistacia integerrima and Grewia optiva are important fodder species favored by the local communities for agro-forestry. Zanthoxylum armatum, Asparagus adscendens, Pueraria tuberosa, Acorus calamus, Scindapsus officinalis, Plumbago zeylanica and Hydrocotyle asiatica are some important medicinal plants found in this landscape.

Common invasive species of plants like Lantana camara (choti podari), Parthenium hysterophorus, Eupatorium adenophorum, Cassia tora and Cassia occidentalis are frequent on the Campus. Choti podari is used locally as a hedge plant. Parthenium is abundant throughout the grazed areas, especially within the Hilog and Gharpa flat spaces. These plants are unusually tall here reaching heights of close to 2m.

Other than these, there are a few species of undesirable plants such as Cannabis sativa (Bhang), Papaver somnifera (Opium Poppy) and Nicotiana tabaccum (Tobacco). Bhang naturally occurs in the Western Himalayas and is also nurtured by the people locally and is quite prolific on the Campus. Opium poppy is cultivated around Kullu, especially close to Bajuara. Apparently, though not on the same scale, poppy is also locally cultivated around the Campus. Isolated plants were observed in Siram village. Tobacco grows as a roadside plant and sparse weed in the cultivated areas.

11. Fauna

Available information on fauna is limited, covering select groups of animals and generally for Mandi district (ZSI, 2005). Supplementary information was obtained from Jayapal & Ramesh, 2009. It was evident during the present study that the Campus (Kataula Range in general) falls in a Himalayan zone that has not been previously explored for its fauna. For instance, the study that began with a list of 132 species of birds for the entire Mandi district (ZSI, 2005) extended it by another 54 species (see Appendix 2 D). Similarly, the list of 34 species of butterflies for Mandi district has since increased to 48, despite the fact that March is not the best season for observing them (see Appendix 2 A). These additions are remarkable as butterflies and birds are the two most easily observed groups in any habitat. Had there been any previous study in the landscape, at least the common ones would have been listed.

Bird at IIT Mandi Campus

One hundred and fifteen species of birds were observed during the two weeks, and many of these including Laughing Thrushes, Yuhina, Blue Magpie, Great Barbet, etc. are typical Himalayan birds. The Khaleej (a pheasant), Red Jungle Fowl and Black Francolin are ground birds that are vulnerable to habitat loss and transformation. The rich diversity of birds on the Campus may be attributed to the mosaic of habitats including the cultivated areas; in fact smaller species like the Whiskered Yuhina, Black-chinned Babbler, Scaly Breasted Wren Babbler, etc. were encountered only along cultivated areas. These birds have a preference for scrub and thickets. The nallah is another important habitat for Himalayan birds that are associated with streams. Whistling Thrush, Brown Dipper, Crested Kingfisher, Forktail and Redstarts are generally confined to the nallah.

The Campus attracts a fairly sizeable population of vultures. Three species including the Himalayan Griffon (the largest of Indian vultures), the Red-headed Vulture and the Egyptian Vulture were observed during the study. The Griffon is particularly common and has

probably benefited by the animal carcasses that are disposed of in the open ever since the Animal Husbandry Department managed the area. Indian vultures are ranked amongst the world's endangered birds.

Two species of sparrows, the House Sparrow and the Cinnamon Tree Sparrow are common. The House Sparrow is particularly abundant in the villages that border the Campus. At a time when the world is lamenting the decline of the House Sparrow, IIT Mandi could be one of the long-term conservation areas for the Sparrow. Indeed, it can be an ideal study area for validating the numerous theories that biologists have proposed in recent times to argue why the species has disappeared from most urban areas.

The nallah and the river Uhl are also important habitats for native Himalayan fish. Masheer (Tor putitora) were quite numerous in the nallah. There were also smaller fish like the Baril (Barilius spp). Most interesting, however, is the occurrence of Snow Trouts. Two species, Schizothorax richardsonii (locally known as sal) and Schizothoraichthys labiatus were observed in the nallah during March 2010. Sal is known for its large size, and listed amongst Indian sport fishes (Daniels, 2002). Adults may grow to 2 feet (60cm) in length. Both species of Snow Trout are much relished as food by the local people, and are an important source of livelihood. Small restaurants at Kamand regularly sell 'fish pakoda' made using sal.

Sal Fish

Snow trout are not previously recorded anywhere from Mandi district; the latter Schizothoraichthys labiatus not reported earlier from Himachal (ZSI, 2005). The Snow Trout migrates upstream towards the higher reaches during summer when the water downstream becomes warmer. This species is known to breed in the upper reaches of the river during July-August when the water temperatures are between 16.5 and 18.50C. It is adapted to fast flowing and turbulent waters (0.9-1.8m/sec), lower temperature (monthly mean of 17.30C) and high concentrations of

dissolved oxygen (10.1mg/l) (Sehgal, 1999).

Local people also reported the presence of a large species of Channa (could be Channa striatus or Channa marulius). A large specimen that was caught near Siram village from the river Uhl apparently weighed 14 lbs (c. 6.5kg). According to villagers, trout introduced from Europe (Salmo spp) migrate downstream during winter when there is heavy snow in the mountains. Other species of fish that might be found in the river and nallah are listed in Appendix 2 B.

March marks the transition from winter to summer. It is certainly not the best time to observe reptiles and amphibians. While 11 species of amphibians are known from Mandi district (see Appendix 2 C), the only species that was active during the study is Euphlyctis cyanophlyctis. This aquatic frog commonly known as the Indian Skipper is one of the most adaptive and widespread of Indian animals (Daniels, 2005). Other than the Skipper, the Common Indian Toad (Bufo melanostictus) was observed during the study. Unfortunately, the Toad was found only as a road kill.

The only reptile that was seen during the study on Campus was a Checkered Keel-back Water Snake (Xenochrophis piscator). Someone had killed this! Other than the Water Snake, the villagers reported the Dhaman (Rat Snake Ptyas mucosus) and a viper (Saptad) and Cobra. Cobras are apparently common during the rainy season and from what people have described, it is the Central Asian Cobra (Naja oxiana); locally called Spade. The Central Asian Cobra, also known as the Black Cobra, is common to Himachal as are vipers such as the Saw-scaled Viper (Echis carinatus), Russell's viper (Daboia russellii) and Himalayan Pit Viper (Gloydius himalayanus). The pit viper is known to inhabit conifer forests around 1500m ASL and rocky terrain close to glaciers (4877m ASL); it may also occur in the hills that border the Campus (Whitaker & Captain, 2008). March may be the season when the lizards re-emerge after winter hibernation. Lizards were just beginning to come out during the study period. One Garden Lizard (Calotes versicolor), two individuals of the Spotted House Gecko (Hemidactylus brooki), one Ground Skink (Scincella/Asymblepharus sp) and a few individuals of the Kashmir Agama (Laudakia tuberculata) were observed during the study. However, none of these were seen on Campus. The Agama was seen on the road from Kataula to Parashar

Lake. The others were all within the Kataula village. Undoubtedly, all these species would occur on Campus too.

Very little information is available on mammals found in Kataula and on IIT Mandi Campus. The Indian Jackal (Canis aureus) was once sighted close to the Campus and heard at nights at Kataula. Fresh scat and pug marks on Campus confirmed the presence of Leopards (Panthera pardus). Local people too confirmed the presence of the Leopard. A local forester described a small wild cat that he once observed fishing in the river. When shown pictures of the species (Prater, 1980) he pointed to the Fishing Cat (Felis viverrina). However, since the list of mammals provided by Zoological Survey of India (ZSI, 2005) for Himachal, and that, by Jayapal & Ramesh (2009) for Rupi-Bhaba Wildlife Sanctuary (Kinnaur District) do not include this species of wild cat, its occurrence in Kataula has to be treated with reservation.

Small bats were observed during the study. One species of Pipistrelle (Pipistrellus sp) was seen flying over cultivation at dusk. The abandoned Animal Husbandry Department's buildings showed signs of the presence of one or more species of fruit bats. It is likely that the Short-nosed Fruit Bat (Cynopterus sphinx) and the Fulvous Fruit Bat (Rousettus leschenaultia) occur on Campus. The local forester reported the presence of the Flying Fox (Pteropus giganteus) in and around Kataula.

During the study, the Grey Mongoose (Herpestes edwardsii) was observed on Campus. A sizeable population of the Rhesus Macaque (Macaca mulatta) was observed regularly. One road kill of the House Rat (Rattus rattus) was the only sign of the presence of rodents on Campus. The local forester, however, reported the occurrence of the Northern Palm Squirrel (Funambulus pennanti). He also mentioned that he had seen the Indian Porcupine (Hystrix indica) in and around Kataula.

There were signs of the presence of the Wild Pig (Sus scrofa) in many parts of the Campus and the villagers also confirmed its presence in the area. Other than these, the local residents reported the Indian Hare (Lepus nigricollis), Otter (Lutra sp) and Civets. The specific identity of these animals has to be confirmed.

12. Land Use and Infrastructure Development

Land use and infrastructure development on the 531 acre Campus should be guided by ecosystem principles (see Hamilton & McMillan, 2004), considering the fragility of the mountain and riparian ecosystems that sustain the landscape and its people. Throughout the landscape, including the surrounding areas (such as Kullu, Mandi and Parashar Lake that were visited during the March2010 study) altitude, slope and aspect play a major role in creating diverse micro-environmental regimes. It is evident that forest types, despite the degraded nature, are still limited by the topography to the extent that there is a marked difference between the slopes that receive sunlight during the morning and the slopes that enjoy morning shade. This pattern is apparently very consistent and will have a major bearing on the ecology and micro-climate of the Campus. Topography playing a major role in the phenology of plants and animals was evident during the study; for instance, while the wild rose (rosa spp) in and around Mandi town was profusely in bloom, there was not even one plant within the Campus that had flowers during March 2010. (The wild rose is seen on Campus and in the villages.)

Local residents reported that there has been snowfall in winter in Kamand and other villages, and that it is likely that area of the Campus that are around 1200m ASL experience snow and frost during winter. Lowered winter temperature can drive wild animals closer to the residential areas leading to conflicts. Although there have not been recent reports of earthquakes in and around the Campus, landslides are frequent. Local residents attribute this to the loss of vegetation and frequent widening of roads, especially the newly laid Kamand-Mandi road.

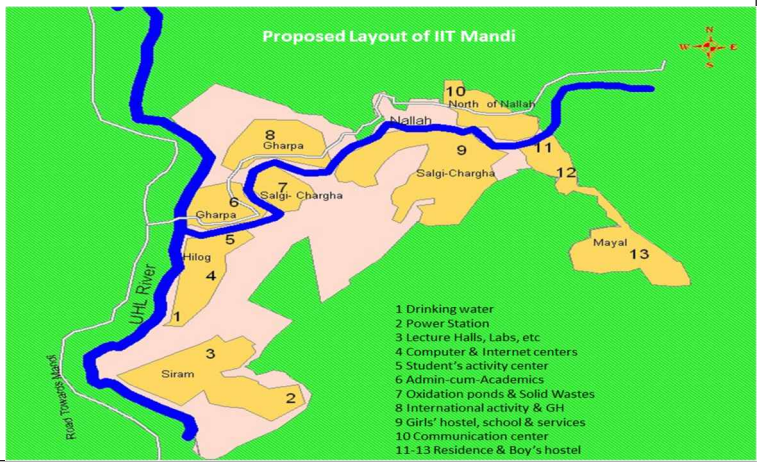


Table 3: Proposed land use and distribution of infrastructure on Campus

Number on Map	Facility/infrastructure*	Plinth area*		Suggested location (Block)
		Sq m	Acres	
1	Drinking water pumping/ purification station	-	-	Hilog
2	Main power station	-	-	Siram
3	Lecture hall complex	16,000	4.0	Siram
	Laboratory complex	32,000	8.0	
	Central laboratory facility	6,000	1.5	
	Health center	6,000	1.5	
	WRRC & veterinary facility	-	-	
	Automobile workshop	-	-	
	Wastewater collection and treatment - 1	-	-	
4	Computer center & internet center	6,000	1.5	Hilog
5	Students activity center & cafeteria	8,000	2.0	Hilog
6	Academic-cum-administration building	16,000	4.0	Gharpa (south)
	Central library	10,000	2.5	
	Conference-cum-auditorium	10,000	2.5	
	Technology incubation center	10,000	2.5	
	Continuing education center	6,000	1.5	
	Faculty offices building	12,000	3.0	
	Wastewater collection and treatment - 2	-	-	
7	Oxidation ponds and Solid waste management	-	-	Salgi- Chargha (west)
8	International activity center	8,000	2.0	Gharpa (north)
	Guest houses including international GH	10,000	2.5	
	Community center	4,000	1.0	
	Placement cell	4,000	1.0	
	Wastewater collection and treatment - 3	-	-	

Number on Map	Facility/infrastructure	Plinth area		Suggested location (Block)
		Sq m	Acres	
9	Campus school	10,000	2.5	Salgi- Chargha (east)
	Indoor sports	4,000	1.0	
	Commercial center including bank, etc	Not provided	Not provided	
	Recreation center for students, faculty and staff	4,000	1.0	
	Girls' hostel	4,000	1.0	
	Outdoor games/stadium	-	-	
	Wastewater collection and treatment - 4	-	-	
10	Communication center	4000	1.0	North of nallah (north Salgi)
	Wastewater collection and treatment - 5	-	-	
11-13	Faculty housing	50,000	12.5	Mayal
	Staff housing	40,000	10.0	
	Boy's hostel	6,000	1.5	
	Wastewater collection and treatment - 6	-	-	

*Note: Infrastructure and the required plinth area are based on the Project Report Prepared by IIT Roorkee (2009) with a few additional facilities as deemed necessary.

The Campus falling within an important watershed of the river Beas has to be planned and managed with utmost care so that the riparian ecology is not disturbed. The following are the four main guiding principles that have been adopted while outlining the EMP:

1. To the extent possible, to restrict the buildings to the flat areas that have already been used by the Animal Husbandry Department.
2. As far as possible to avoid disturbing the vegetation on the slopes, ridges and riparian gorges.
3. Neither the nallah nor the river Uhl should be burdened with the task of waste water disposal.
4. The Campus cannot be managed as an island insulated from the rest of the landscape.

Table 3 provides the details of land use and infrastructure development based on the assessment of the ecological vulnerability of the Campus and surrounding villages. Suitable areas (Figure 2), designated as blocks (A-L), their extent and location as provided in the land use report prepared by Vaidya & Associates and Space Matrix (2009) were reassessed during the study and the map redrawn (Figure 3). The required infrastructure and the proposed plinth area of each facility have been taken from the project report prepared by IIT Roorkee (2009).

The location and clustering of buildings are proposed adopting the four guiding principles. Locating the Administration Building and the associated infrastructure at Gharpa (South) is strategically ideal as it oversees the rest of the Campus, especially the lecture halls and laboratories within the Hilog flat areas. The International Center (including the Guest Houses) is also being proposed at Gharpa (North). This is a scenic location from where it is easy to have a good view of the valley. Moreover, it will be compatible with the overall serene ambience of the temple.

The hostels and other residential facilities have been located closer to the villages. These areas are farther away from the forests thereby reducing the chances of intrusion by wild animals, although the ultimate factor behind the choice of location for infrastructure development is the discharge of waste water and management of solid wastes. A centralized oxidation pond and solid waste management facility is proposed in Salgi-Chargha (West). This facility has to be used very judiciously. Right from the time of construction, solid wastes have to be segregated and all organic wastes should be composted. And as composting will attract wild animals, it is best that the facility is created and maintained as close to the forests as possible such that the movement of animals (especially Wild Pig and the Rhesus Macaque) into residential areas is restricted.

Decentralized collection and treatment of waste water will certainly help to reduce the burden on the nallah and river. The proposed infrastructure has been segregated and clustered such that there is a waste water collection and treatment facility for each building complex. With the exception of the proposed waste water collection and treatment facility - that will contain inorganic (laboratory & workshop

wastes) and medical wastes - all others will only generate organically enriched (largely domestic) sewage that can be locally treated using soak pits and natural filters. The topography will help in the use of gravitational flow to a large extent and the filtration technique adopted should take advantage of this. It is proposed that the filtered domestic sewage be used for restoring the vegetation (and also preventing forest fires during summer) on the slopes through a network of sprinklers. Surplus treated domestic sewage can be provided for irrigation of crops in the adjoining villages during summer (for example around Mayal). The location of the hostels and residential quarters is chosen for this reason.

Waste water from facility should be treated more carefully to detoxify it, eliminating the oil, diesel, etc. before sending it into the oxidation ponds. There must be a provision by which all the waste water collection and treatment units are also linked to the oxidation ponds. This is necessary as local irrigation will not be viable during the rains. Treated water from the oxidation ponds can be discharged into the river only during the rainy season (July to September) when the flow of water is at its peak. The nallah is shallow. The summer flow is considerably less (as inferred during March 2010) suggesting that during the height of summer, the water does not reach the river Uhl. Any discharge of sewage into the nallah, especially during summer, will cause substrate pollution due to sedimentation, thereby permanently ruining the ecology of the nallah and the river.

The suggested layout will also enable securing the boundary of the Campus against unwarranted human intrusion. The perimeter of the Campus is quite long due to its shape and orientation. Further, the topography, the presence of the nallah and at least one highway (Katuala-Mandi Road) do not permit construction of a wall all around the Campus. The boundaries of the Campus can at best be marked and secured with a fence. The suggested layout does permit securing the buildings and other infrastructure block wise. For instance, the Administration Building and the Guest House Complex at Gharpa can be secured as a single block. This block can be approached from the Kataula-Mandi Road via the kutcha road already available (31.776240N; 76.985850E).

The second major chunk of land that can be secured as one

includes the Hilog-Siram blocks (Animal Husbandry Department area). This unit has an unused motorable access from the Kataula-Mandi Road (opposite the road to Gharpa). However, to make it more usable, a bridge will have to be built where it crosses the nallah. The Hilog block can also be accessed by vehicles (including heavy vehicles that transport building material and other equipment) through the metal-capped road that connects Kamand with Navalay village.

The third block will be within Salgi-Charga (East). This block has a wide access (dirt road) from the Kataula-Mandi road almost at the beginning of the Campus. The block at Mayal can be a part of Salgi-Charga (East) or it may be maintained as another smaller block. The segment north of the road/nallah (Salgi North) where the Communication Center has been proposed is to be managed as a small walled block, for it is right next to the road and isolated from the rest of the Campus. Thoroughfare through the Campus cannot be entirely stopped as the Kataula-Mandi Road runs across. While this road is outside the boundary in most parts of the Campus, it cuts through the North Salgi block and divides the Gharpa blocks from the Hilog block. The dirt road opposite the proposed Communication Center that runs through Salgi-Charga (East) and the metal-capped road from Kamand to Navalay (through Hilog), are within the boundaries of the Campus. These roads are important links to some of the villages around the Campus and, therefore, public use cannot be stopped altogether.

Whereas each block can have a gate, the Campus as such cannot function within a walled or insulated area. Check posts at strategic points can regulate unwarranted human intrusions. The existing roads can serve as arterial roads. Newer roads can be minimized, restricting them to stairways along the slopes, foot overbridges across the nallah and, if necessary, cable cars (for emergencies and restricted use) to the guest houses.

13. Sustaining Critical Habitats and Biodiversity

The most critical habitat within the Campus is the nallah and the riparian vegetation that sustains it (see Vikramanayake et al, 1998). The riparian vegetation overhangs the nallah (also in some parts the river Uhl) and is home to a range of native herbs, shrubs, palms, grasses and ferns. Native species such as the Ivy (Hedera helix), climbing fig (Ficus foveolata), wild pepper (Piper brachystachyum) and the aroid Scindaspus officinalis are species that not only have attractive evergreen foliage but also roots and stems that bind soil and rocks together. Along with these, there are many species of grasses and ferns creating on the faces of the gorges lush evergreen vegetation, much like in tropical rainforests. There are also palms (Phoenix spp) that adorn the gorges. This vegetation plays a very crucial role in preventing soil erosion and in protecting the gorges against landslides. The habitat attracts numerous birds such as babblers and laughing thrushes.

The scrub on the slopes is critical too. This vegetation comprises native plants that lend spring and autumnal colors to the landscape. The rich diversity of birds on Campus may be attributed to this vegetation. Broadleaved deciduous vegetation is found along the slopes in parts of Salgi bordering Chargha. This type of vegetation is the most extensive in Chargha. The characteristic species is the emergent wild silk cotton Bombax ceiba. The silk cotton tree provides nectar to many species of birds.

Chir Pine (Pinus roxburghii) and Deodar (Cedrus deodara) are largely planted and can be seen on the hills bordering Hilog and down the slopes of Gharpa. These forests are known to sustain ground birds, especially pheasants and jungle fowl. The Khaleej Pheasant and Red Jungle Fowl are common here.

The critical habitats are integrated and as the entire landscape is subject to variations in micro-climate due to the complex topography and aspect, management should be holistic. Summer fires are frequent and during the March 2010 study fires were observed in and around the Campus on two or three occasions. Often, in these fires human agency is responsible. But certain plants like Chir Pine and Lantana Camara are more prone to catching fire, thus capable of aggravating the situation.

Accidental fire can be avoided by adopting stringent steps. Wherever there is a Chir Pine forest patch, 'no smoking' signs should be

displayed. Burning of solid wastes should be carried out strictly within designated incinerators. Outdoor camping and bonfires in these habitats should not be allowed. Chir Pine forests should be bordered by a live fire-line of plants such as Euphorbia royleana, Agave sp; Prinsepia utilis, Berberis sp, etc. (see Appendix 3). Regular sprinkling of waste water during summer will complement the regeneration of vegetation by keeping fires at bay. In addition, the fallen pine needles should be periodically removed and composted. They can also be used in making fuel briquettes, an activity that can benefit local women.

14. Ecological Restoration and Dealing with Invasive Species

Ecological restoration is by no means an easy exercise. Critical habitats will regenerate rather quickly when the grazing and fire are controlled and the soil moisture is conserved. Further, irrigation using sprinklers will at least initially lead to rapid regeneration of vegetation, especially of herbs, grasses and shrubs. Species of plants and animals that are opportunists will take advantage of the newly created niches and proliferate, proving to be invasive. One invasive alien species of plant, the Lantana camara, is quite a difficult plant to deal with as its fruits are dispersed by birds. Extensive growth of Lantana camara will interfere with the regeneration of other native species. Further, it is prone to catch fire in summer. This species can be identified and controlled.

Another species of plant, although native to the landscape, that has proven invasive on the Campus is Cannabis sativa (Bhang). This plant is also locally cultivated. It is likely to proliferate further when the Campus becomes more moist and hospitable. Bhang has to identified and systematically eradicated. The job may be entrusted with the local women who can be organized into self-help groups for sustainable Campus management.

It is recommended that no plant species other than that identified and listed in Appendix 3 be planted on the Campus. Conventional 'landscaping' can be detrimental and should not be entertained. Alternatively, natural avenues, hedges and meadows can be created and maintained using native grasses and the plants listed in Appendix 3. The natural vegetation on the Campus is quite attractive and diverse, capable of producing spring and autumn flushes. It is best that the natural vegetation is restored wherever there is a need for an avenue, hedge or woodlot. Natural vegetation can also be effectively used on slopes to prevent soil erosion and landslides.

According to the information provided by the Forest Range Office at Kataula there are 17,568 trees within the forestlands that have been earmarked for the IIT Campus. Some of these trees may have to be felled while the infrastructure is developed. It is suggested that the trees to be felled are marked and identified with the help of the local foresters. A blockwise inventory of trees to be felled should be created and made available to the Forest Department before the construction

work starts. Trees that are felled should duly be handed over to the Forest Department and are not be used for purposes of construction or fuel without prior approval.

There is a sizeable population of Rhesus Macaque (Macaca mulatta). Rhesus Macaques are known invaders, and unless there is a clear policy of not disposing food and household wastes in the open, and a strict regulation on voluntary feeding by animal lovers, there will be a lot of conflict between the residents and the mammal. Local residents are facing problems due to the Macaque (and also Wild Pig), for they raid crops. If these animals proliferate on Campus due to protection and surplus food, they will lead to conflicts between the neighbors and the residents of the Campus. The Rhesus Macaque will invade the Campus even as the construction begins and the resident labor force will invariably feed these animals. A system has to be put in place to regulate the invasion by the Macaque and strictly monitored.

Monkey at Kamand Campus

The topography of the Campus does not permit creation of a walled or insulated space. Wild animals like the Wild Pig and even the Leopard are likely to invade the Campus. Home gardens, especially when vegetables are grown, will attract the Wild Pig and also hare. While fencing the gardens might keep the animals out, it is better to avoid home gardens that attract wild animals so that conflicts are minimized. Leopards are also attracted by the presence of domestic dogs. Bhutia sheep dogs are common and are adorable pets. Free-ranging dogs on the Campus, however, are a sure cause for trouble. Residents should adhere to a strict code of conduct by not feeding and maintaining free-ranging dogs (and cats).

Free-ranging cats can be quite destructive, killing small birds, especially those that nest close to the ground or on the ground. There are many species of babblers that nest low in scrub and the Peafowl, Jungle Fowl, Black Francolin and Khaleej Pheasant, on the ground. Cats when let loose take a heavy toll of the chicks of ground-nesting birds.

Invasions by wild animals were foreseen during the March 2010 study and independently by the Forest Department. During discussions, the Conservator of Forests (Mandi) suggested that a Wildlife Rescue and Rehabilitation Center (WRRC) be set up on Campus. The WRRC should have the services of a fulltime veterinary doctor and the support of the local Forest Department. The WRRC should prescribe guidelines on the maintenance of mammalian pets on Campus and the residents should strictly adhere to the guidelines. The WRRC and its functioning may be overseen by the Estate Officer who should ideally be one with experience in managing forests and wildlife.

The presence of livestock on the Campus for over 50 years, if not more due to grazing by the local shepherds, has led to the proliferation of parasitic ticks and mites. Whereas ticks are visible the mites are too small and can only be felt by the itch (sometimes rashes) that they cause on the human skin. Members of the field team experienced the mites. Obviously, these mites are more numerous than what is normally found in natural forests. Human response to tick and mite bites is quite varied. Some develop rashes, allergic reactions and fever. And as these tiny organisms are not seen with the naked eye, few really attribute the itching and trauma to mites. A list of parasitic mites known from Mandi district is provided in the Appendix (1B). Knowledge of the species will help in seeking the right treatment without undue stress and trauma. It is not easy to eradicate these organisms. Since mites inhabit grass, pastures and meadows, it is safer to avoid these habitats.

15. Carrying Capacity of the Landscape

According to the WWF-UNDP report by Vikramanayake et al (1998) the Himalayan region is characterized by generally rising human population growth rates in the last half a century. In many areas, the human population has apparently doubled in the last 50 years. The landscape where the IIT Mandi is coming up is within an eco-region wherein the human population does not currently exceed 500/km2 on average (Vikramanayake et al, 1998). Considering that the Mandi district hasan average human population density of around 200/km2, a sudden influx of people, locally, can really have a shocking impact on the landscape. Can the landscape cope with the shock?

There is no simple formula or rule of thumb to estimate ecological carrying capacity of a landscape given the human population size. What is critical to the IIT Mandi Campus is its ability to absorb the initial shock due to transformation of land for creating infrastructure and the long-term capacity to handle the solid and liquid wastes that the system generates. What would be a safe approach is limiting the intake of students, at least during the first 10 years. For instance, if there are 250 students that come in during the first year, at the end of four years, there could be around a 1000. One thousand students plus, 2000 faculty, staff and their dependents, would limit the resident population to 3000.

A resident human population size of 3000 is one and a half times higher than the current population of the entire Kamand Panchayat. Given the extent of the Campus this would imply there are 1200-1500 people/km2, a density that is three times higher than the eco-regional average (Vikramanayake et al, 1998). If it is possible that the student intake (and hence the support human population) is kept low during the first ten years, it might work well as the landscape will be able to cope with the impact (as there will also be simultaneous efforts to restore the critical habitats).

After 10 years, the ecological impact can be evaluated and the resilience of the landscape, its critical habitats and biodiversity reassessed. While the resident population of the Campus may remain at around 3000, the same cannot be said of the adjoining villages. There are at least 3 villages where the rush to provide basic services (amenities) will lead to large-scale human immigration. From the overall pattern of livelihoods inferred during the study, it is foreseen that Kataula, Silog

and Kamand will experience rapid transformation due to the influx of markets and service providers (example transport, restaurants, petrol bunks, etc.) Population rise, locally, in these villages will have a major impact on the landscape's carrying capacity, further jeopardizing the ecology and resilience of the IIT Mandi Campus.

Most habitable areas earmarked for IIT Mandi have been under human possession and use for over 50 years. Since it was first transferred to the Animal Husbandry Department around 1960, the land has been subject to intensive grazing, fires and pressures of institutional infrastructure development. Apparently there was no system of waste management and (as inferred from the numerous bones strewn all over) dead animals were just dumped in the open, amongst scrub and forests. The fact that there is a resident population of vultures would only substantiate this inference. Further, waste water from the Animal Husbandry Department and the adjoining villages (including Kataula) have for long gone into the nallah and river. But, the volume being very small, has not had any visible impact.

That the land use around the nallah and river Uhl has not had deplorable ecological impact on the riparian habitats was made evident by the abundance of fish. Snow trout and masheer were quite abundant (with signs of breeding) and local people enjoy the bounty. In fact, one of the concerns of the local residents was that the IIT Campus should not in any means transform the ecology of the nallah and river such that it affects their livelihoods and food security. The riparian habitats are also home to many species of Himalayan birds like Redstarts, Brown Dipper, Forktail and Crested Kingfisher. These species of birds were quite commonly seen during the study (see Appendix 2D). Carrying capacity of the landscape that cradles the Campus will be evaluated by its ability to absorb, recycle and reuse the waste water and solid wastes. Himachal is a 'no-plastic-bag' state and it is quite strictly adhered to even in remote villages like Kataula. Plastic and non-degradable material that is brought in during the construction phase should all be safely disposed of. A system that guarantees the safe handling and disposal of all non-degradable construction (and other) wastes should be in place right from the beginning. Wood, cardboard and other degradable material can be disposed of with the help of the local people (who may welcome these as fuel).

The numerous stone buildings abandoned by the Animal Husbandry Department will generate a lot of debris and muck when broken down. Unless there are plans of reusing the stones for the new buildings, they would be best used to secure the erosion-prone banks of the nallah and river (as is commonly done in and around the Campus) or to stabilize the slopes that overhang the riparian gorges and in demarcating the boundary. They can also be used to create (in the traditional manner without cementing) to build compost pits and incinerators. Using stones to stabilize the steep slopes may be very crucial, at least during the early years, in preventing soil erosion and landslips as the plant growth will be slow and may not provide the service immediately. Debris or muck, on no account, should be pushed into the nallah or river.

Treated wastewater (from the oxidation ponds) can be discharged into the river only during the three rainy months (July-September). The ability to reuse the waste water without sending it into the nallah or stream during the other nine months of the year is the yardstick to measure the carrying capacity of the Campus. It is this that will ultimately limit the number of residents that can be sustained without having an adverse impact on the riparian ecosystem. The layout of the Campus proposed in Table 3 takes this into consideration and provides a protocol for maximizing the reuse of waste water. The network of collection and treatment units (including the soak pits, gravitational sedimentation) and the oxidation ponds should guarantee that the waste water is not directly discharged into the riparian habitat.

It is recommended that water samples be collected from upstream and downstream at preset locations in both the nallah and river and tested and recorded as a benchmark before any work begins on Campus. While the EMP has provided available information on water quality for the river Beas, specific information on the nallah and river Uhl are lacking. Water quality should be continuously monitored during construction and also after the Campus becomes functional.

Composted organic wastes and the sludge that comes out of the water treatment units can be used to fertilize the forests and restoration areas. A number of species of earthworms are known to Mandi district (see Appendix 1A). Earthworms can be identified and used as monitors of soil health in and around the Campus. Surplus compost and sludge

can also be supplied locally to the farmers. This activity can be entrusted with local women organized into self-help groups after appropriate training.

16. Evolving a Locally Compatible Socio-Ecological System

The district of Mandi in Himachal Pradesh is perceived to be backward not only in terms of conventional development indicators such as literacy, employment and food security, but also because of the absence of any well known institution. This is perceived as the major driver for selecting Mandi for the establishment of yet another IIT. Of the various areas surveyed within the district, Kataula-Kamand landscape has been found to be the most suitable for the following reasons:

1. Minimal diversion of forestland.
2. Nearly 500 acres of land with the Animal Husbandry Department made available.
3. Existence of large segments of (habitable) flat land within the proposed site.
4. Proximity (and connectivity) to the district headquarters, Mandi.
5. Availability of natural resources, notably water.

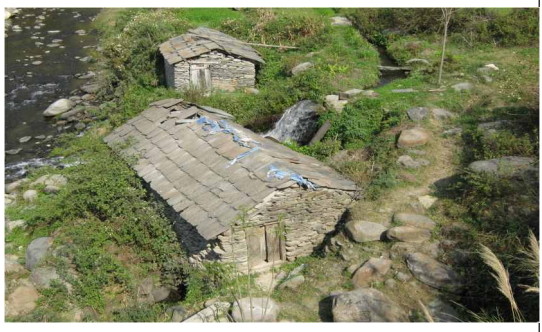
As stated in the earlier sections of the report, the landscape has not only been devoid of large scale development initiatives by the State, it is also devoid of any community-based organization or non-governmental organizations that can articulate the demands of the local populace. The current initiative of consulting the local population to develop the Environmental Management Plan was therefore viewed with bewilderment by many of the local inhabitants, notably women. It was also rather clear that much of the local population perceives IIT to be yet another college. Also emerging rather clearly was the divide amongst men and women in their overall perception and response to the new initiative. On the one hand, women were rather categorical about issues connected to the mullah and River Uhl, as well as access to grazing lands, while the men were concerned about issues such as the influx of migrant labour (and their inherent tendency to abuse the nallha and river), erosion of their traditional rights and customary regulations, availability of employment, etc. On the other hand, other stakeholders such as officials of government departments while lauding the initiative were rather categorical on the need to ensure sustained protection to the socio-ecology of the landscape.

The following section consolidates the responses of the inhabitants of the landscape:

1. The land that has been earmarked for IIT Mandi by relocating/vacating the Animal Husbandry Facility was originally agricultural land owned by 75-78 farmers of Kamand Panchayat. These lands were acquired during 1958-62 at the rate of Rs.100/bhiga (800 sqm) with the assurance that the Animal Husbandry facility would not only provide local employment but also strongly support their pastoral tradition and livelihood.
2. While regular employment was not provided by the Department, daily wage opportunities were made available in programmes dealing with fodder collection, processing, cleaning, etc.
3. The presence of the Department is not perceived negatively primarily because it functioned on an unrestricted access mode and the activities were easily understood by the local population. The institution was perceived to be engaged in activities that are of local relevance and benefit. The fact that the staff of this facility were largely drawn from within the State further strengthened the acceptance.
4. From this scenario, the following issues emerge: There is no understanding about the nature and scope of an IIT; and it is thus rather important to engage in awareness-building initiatives. The institution needs to invest effort on making itself relevant to the local population. The rather nascent aspirations that the local population harbor in being able to send the children to a good school needs to be furthered by not only ensuring access to good schooling, but also by devoting time and effort to elevating capabilities. Apart from ensuring that the local population is given the opportunity to enroll their children in the school that IIT would establish, it would also be beneficial to make available the services of resource persons to the local middle school. Similarly, the local anganwadis (kindergartens) would also benefit with expertise on preschool pedagogic training and capacity building.
5. The second issue of concern is the current absence of a veterinary facility. Emerging rather strongly from the pastoralists is the fact

that the lands were given to a facility that would provide support to local livelihoods and not for an institution that works on computers. The possibility of extending the scope of the Wildlife Rescue and Rehabilitation Centre to function as a referral veterinary centre needs to be considered.

6. The issue of continued access is a point of contention to the local population: for instance villages such as Seel Khanni reach the local markets through the proposed Campus on a footpath. Providing a road would not be acceptable since this would increase the distance, but also be difficult for the head loaders and school children. For villagers of Khara, Neeri, Khanni and Sukada, the traditional access is through the proposed Campus and this needs to be reconciled through mutual consultation.
7. Continued access to grazing lands is yet another strong demand that emerged notably from women.
8. There are three culturally significant components within the campus: the temple (Gharpa which has the shrine of Markandeya Rishi) and the access to the cremation grounds on the banks of the river. While the temple may provide an opportunity to the Campus to be included as an element of interest and relevance, the issue of the cremation ground needs to be worked out in detail. The third component is the water mill – the charka is considered symbolic and seen as being the primary reason for the palatable nature of the rotis. The possibility of expanding the use of this mill could be considered.



A Traditional Water Mill

9. The landscape has a strong history of illicit felling of trees, and it is feared that the new campus may further this menace. Apart from declaring a complete ban on the use of local wood for

construction and fuel, it would be ideal if the campus mainstreams a policy of being wood free. Promoting green buildings would serve to further conservation efforts in the region.

10. An Ecological Monitoring Cell (EMC) should be set up so that infrastructure development is monitored right from its inception. The EMC should be headed by an official from the Himachal Forest Department on deputation for a specified period of time.
11. In this context, it is also equally important to sensitize students and staff to the ecological merit of the landscape. That the services provided by the ecosystem needs to be respected and conserved needs to be made part of the student orientation programme. For instance, seemingly harmless acts as throwing garbage or a cigarette butt can wreak havoc in terms of increased human-animal conflict or forest fires. It would be of considerable help if the entire Campus is declared smoke free.
12. The Animal Husbandary facility had about 30 people on its payroll, although effectively only 15-20 personnel would be present on any given day. This did not significantly enhance the human footprint of the landscape. Even at its lowest strength, say about 3000, IIT's population would be approximately one and half times the size of the current population of 2100 in the entire Kamand Panchayat.
13. While the requirements of such a population is perceived as quantum increase in local trade opportunities, the women and the elderly population is concerned about the demand on local natural resources.
14. Also of concern is the impact that the inhabitants would have on local culture. It was stated categorically that no 'untoward' behaviour would be tolerated and this includes speeding on motorbikes, eve teasing, etc.
15. The Panchayat was also clear that in the case of employment opportunities related to labour (as in construction and allied activities), security, maintenance, etc. local inhabitants should be given priority. The possibility of reserving certain posts for the

locals needs to be explored.

16. In the event of labour brought from outside, the contractors should provide identification cards and domicile facilities to the labourers. This is to address the fear of theft or robbery. It is rather distressing to note that in the absence of any protection to the campus currently, trees on campus are being felled rather rapidly. Likewise, LPG or Kerosene stoves need to be provided so that the migrant labour does not engage in felling of trees. Migrant labour should not also be allowed to defecate in the open, polluting the river and nallah.
17. Similarly, in the event of allowing trade units such as grocery shops, tailors, photocopying facilities to be established within the campus, or engaging transport services, local inhabitants could be given priority.
18. Quality medical care is a major requirement of the landscape, and a referral-based system could be made available to local inhabitants.
19. 23 Kms from the landscape is the rather scenic village of Parashar at an altitude of 2730m ASL. While the approach to Parashar is dotted with well preserved mature forests representing native conifers and broad leaved deciduous forests, the village has an ancient three pagoda temple and a lake. This place is of immense cultural and ecological significance, and the negative impact on this sacred land is the greatest concern of all the stakeholders. That this revered land would become a picnic spot through laying new metalled roads and emergence of trade units is a fear that local inhabitants strongly articulated.

Prashar Lake

20. Evolving a strategy and action plan for long-term sustainable management of the Campus cannot be successful without the involvement

and support of the local residents. Women are dynamic and would come in as major human resource when trained and utilized. Such a scenario offers immense opportunity to the proposed Centre for Integrated Mountain Development of IIT Mandi to engage in initiatives that could effectively combine cultural, social and ecological concerns for responsible management of the Campus and the natural habitats within the vast West Himalayan landscape.

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18. Appendix 1

Species useful in monitoring the ecological health of IIT Mandi Campus

A: Earthworms

Family	Scientific Name
Moniligastridae	Drawida japonica
	Drawida nepalensis
Lumbricidae	Allolobophora parva
	Aporrectodea caliginosa
	Aporrectodea rosea
	Dendrobaena octaedra
	Dendrodrilus rubidus
	Octolasion tyrtaeum
Ocnerodrilidae	Ocnerodrilus occidentalis
Octochaetidae	Eutyphoeus incommodus
	Eutyphoeus waltoni
	Lennogaster chittagongensis
	Lennogaster pusillus
	Lennogaster yeicus
	Octochaetona Beatrix
Megascolecidae	Amynthas alexandri
	Amynthas cortices
	Metaphire anomala
	Metaphire birmanica
	Metaphire houlleti
	Metaphire posthuma
	Perionyx bainii
	Perionyx barotensis
	Perionyx excavates

Source: Zoological Survey of India, Director (2005).

B: Parasitic Mites

Laelapidae	Laelaps jugalis
	Laelaps nuttalli
	Echinolaelaps echidninus
Macronyssidae	Ornithonyssus bacoti
	Ornithonyssus bursa
	Ornithonyssus sylviarum
	Pellomyssus passeri
Dermanyssidae	Liponyssoides sanguineus
Rhinonyssidae	Tynaminyssus sp
Spinturnyssidae	Ancystropus taprobanicus
	Ancystropus zeleborii
	Meristaspis lateralis

Source: Zoological Survey of India, Direct.

19. Appendix 2: Checklist of selected species of animals known from the Mandi District also observed on the IIT Mandi Campus during the March 2010 study

A: Butterflies

Family	Common English Name	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March District 2010
Papilionidae	Common Windmill	Atrophaneura philoxenus	+	+
	Common Bluebottle	Graphium sarpedon	+	+
	Spot Swordtail	Graphium nomius		+
	Common Rose	Pachliopta aristolochiae		+
	Common Lime Butterfly	Papilio demoleus	+	+
	Spangle	Papilio protenor	+	
	Common Peacock	Papilio polyctor	+	+
	Common Mormon	Papilio polytes	+	+
Pieridae	Common Emigrant	Catopsilia crocale	+	+
	Pale Colored Yellow	Colias erate	+	+
	Common Jezebel	Delias eucharis	+	+
	Spotless Grass Yellow	Eurema laeta	+	
	Grass Yellow	Eurema hecabe	+	+
	Brimstone	Gonepteryx rhamni	+	
Nymphalidae	Plain Tiger	Danaus chrysippus	+	+
	Striped Tiger	Danaus genutia	+	+

Family	Common English Name	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March District 2010
	Common Crow	Euploea core	+	+
	Glassy Tiger	Parantica aglea	+	+
	Chestnut Tiger	Parantica sita	+	
	Tawny Coster	Acrea violae		+
	Narrow-banded Satyr	Aulocera brahminus	+	
	Common Tree Brown	Lethe rohria	+	+
	Dark Evening Brown	Melanitis phedima	+	
	Large Three-ring	Ypthima nareda	+	
	Himalayan Five-ring	Ypthima sakra	+	
	Common Sergeant	Athyma perius	+	+
	Great Egg Fly	Hypolimnas bolina	+	
	Chocolate Pansy	Precis iphita	+	+
	Lemon Pansy	Precis lemonias		+
	Yellow Pansy	Precis hierta		+
	Peacock Pansy	Pecis almanac		+
	Commander	Limenitis procis		+
	Common Leopard	Phalantha phalantha		+
	Baronet	Euthalia nais		+
	Orange Oak-leaf	Kallima inachus	+	

Family	Common English Name	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March District 2010
Lycaenidae	Indian Tortoiseshell	Aglais kaschmirensis		+
	Common Nawab	Polyura athamas	+	
	Indian Red Admiral	Vanessa indica	+	
	Blue Admiral	Kaniska canace		+
	Common Sailer	Neptis hylas		+
	Indian Lascar	Neptis hordonia		+
	Angled Sunbeam	Curetis acuta	+	
	Dull Oak Blue	Narathura centaurus	+	
	Eros Blue	Polyommatus eros	+	+
	Common Flash	Rapala nissa	+	
	Himalayan Red Flash	Rapala selira	+	
	Common Pierrot	Castalius rosimom		+
	Common Shot Silver-line	Spindasis ictis	+	
	Total =		34	31

B: Fishes

Family	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March 2010
Notopteridae	Notopterus notopterus	+	
	Chitala chitala	+	
Cyprinidae	Barilius barila	+	To be confirmed
	Barilius bendelisis	+	To be confirmed
	Crossocheilus latus	+	
	Garra gotyla	+	
	Garra lamta	+	
	Labeo dero	+	
	Labeo dyocheilus	+	
	Labeo pangusia	+	
	Labeo rohita	+	
	Puntius conchonius	+	
	Puntius sarana	+	
	Puntius sophore	+	
	Puntius ticto	+	
	Tor putitora	+	+
	Schizothoraicthys labiatus		+
	Schizothorax richardsonii		+
Cobitidae	Noemacheilus botia	+	

Family	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March 2010
	Noemacheilus corica	+	
	Noemacheilus montanus	+	
Amblycipitidae	Amblyceps mangois	+	
Sisoridae	Glyptothorax conirostrae	+	
Channidae	Channa spp		Reported by local people
Salmonidae	Salmo spp		Reported by local people

C: Amphibians

Family	Scientific Name	Zoological Survey of India (Director, 2005)	Observed on IIT Campus in March 2010
Ranidae	Euphlyctis cyanophlyctis	+	+
	Fejervarya limnocharis	+	
	Hoplobatrachus tigerinus	+	
	Sphaerotheca breviceps	+	
	Paa minica	+	
	Paa liebigii	+	
	Paa vicinia	+	
	Amolops afghanus	+	
Bufonidae	Bufo melanostictus	+	+
	Bufo stomaticus	+	
	Bufo himalayanus	+	

D: Birds

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Snow Partridge	Lerwa lerwa	+	
Black Francolin	Francolinus francolinus		+
Blue-breasted Quail	Coturnix chinensis	+	
Hill Partridge	Arborophila torqueola	+	
Western Tragopan	Tragopan melanocephalus	+	
Koklass Pheasant	Pucrasia macrolopha	+	
Himalayan Monal	Lophophorus impejanus	+	
Red Junglefowl	Gallus gallus		+
Kaleej Pheasant	Lophura leucomelanos	+	+
Cheer Pheasant	Catreus wallichii	+	
Indian Peafowl	Pavo cristatus	+	+
Great Slaty Woodpecker	Mulleripicus pulverulentus	+	
Eurasian Wryneck	Jynx torquilla	+	
Speckled Piculet	Picumnus innominatus	+	
Grey-capped Pygmy Woodpecker	Dendrocopus canicapillus	+	+
Fulvous Breasted Woodpecker	Dendrocopus macei		+
Brown-fronted Woodpecker	Dendrocopus auriceps	+	
Yellow-crowned woodpecker	Dendrocopus mahrattensis	+	

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Rufous-bellied Woodpecker	Dendrocopus hyperythrus	+	
Lesser Yellow-naped Woodpecker	Picus chlorolophus	+	+
Scaly-bellied Woodpecker	Picus squamatus	+	
Grey-headed Woodpecker	Picus canus	+	+
Great Barbet	Megalaima virens	+	+
Brown-headed Barbet	Megalaima zeylanica	+	
Lineated Barbet	Megalaima lineata		+
Blue-throated Barbet	Megalaima asiatica	+	+
Coppersmith Barbet	Megalaima haemacephala	+	
Common Hoopoe	Upupa epops	+	+
Small Blue Kingfisher	Alcedo atthis	+	+
White-throated Kingfisher	Halcyon smyrnensis	+	+
Crested Kingfisher	Megaceryle lugubris		+
Little Green Bee-eater	Merops orientalis	+	
European Bee-eater	Merops apiaster	+	
Common Hawk Cuckoo	Cuculus varius	+	+
Oriental Cuckoo	Cuculus saturatus	+	
Asian Koel	Eudynamys scolopacea		+
Sirkeer Malkoha	Phaenicophaeus leschenaultii	+	+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Alexandrine Parakeet	Psittacula eupatria		+
Slaty-headed Parakeet	Psittacula himalayana	+	+
Plum-headed Parakeet	Psittacula cyanocephala		+
House Swift	Apus affinis	+	+
Fork-tailed Swift	Apus pacificus	+	
Alpine Swift	Tachymarptis melba	+	
Eurasian Eagle Owl	Bubo bubo	+	
Tawny Wood Owl	Strix aluco	+	
Brown Wood Owl	Strix leptogrammica	+	
Asian Barred Owlet	Glaucidium cuculoides	+	+
Large-tailed Nightjar	Caprimulgus macrurus		+
Blue Rock Pigeon	Columba livia	+	+
Snow Pigeon	Columba leuconota*		
Oriental Turtle Dove	Streptopelia orientalis	+	
Spotted Dove	Streptopelia chinensis	+	+
Eurasian Collared Dove	Streptopelia decaocto	+	
Red-wattled Lapwing	Vanellus indicus	+	
Black-shouldered Kite	Elanus caeruleus	+	
Black Kite	Milvus migrans	+	+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Egyptian Vulture	Neophron percnopterus	+	+
White-backed Vulture	Gyps bengalensis	+	
Long-billed Vulture	Gyps indicus	+	
Himalayan Griffon	Gyps himalayensis	+	+
Red-headed Vulture	Sarcogyps calvus	+	+
Crested Serpent Eagle	Spilornis cheela	+	+
Hen Harrier	Circus cyaneus	+	
Indian Shikra	Accipiter badius	+	+
Eurasian Sparrow-hawk	Accipiter nisus	+	+
Northern Goshawk	Accipiter gentilis		+
Upland Buzzard	Buteo hemilasius	+	
Steppe Eagle	Aquila nipalensis		+
Booted Eagle	Hieraaetus pennatus	+	
Common Kestrel	Falco tinnunculus	+	+
Peregrine Falcon	Falco perigrinus	+	
Little Egret	Egretta garzetta	+	
Bay-backed Shrike	Lanius vittatus	+	
Long-tailed Shrike	Lanius schach		+
Eurasian Jay	Garrulus glandarius	+	

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Black-headed Jay	Garrulus lanceolatus	+	
Yellow-billed Blue Magpie	Urocissa flavirostris	+	+
Rufous Tree Pie	Dendrocitta vagabunda	+	
Grey Tree Pie	Dendrocitta formosae	+	+
Black-billed Magpie	Pica pica	+	
House Crow	Corvus splendens	+	+
Large-billed Crow	Corvus macrorhynchos	+	+
			+
Black-headed Cuckoo-Shrike	Coracina melaschistos	+	
Long-tailed Minivet	Pericrocrotus ethologus	+	+
White-throated Fantail	Rhipidura albicollis	+	+
Black Drongo	Dicrurus macrocercus	+	
Ashy Drongo	Dicrurus leucophaeus		+
Spangled Drongo	Dicrurus hottentottus		+
Asian Paradise Flycatcher	Terpsiphone paradise		+
Common Wood-shrike	Tephrodornis pondicerianus		+
Brown Dipper	Cinclus pallasii		+
Chestnut-bellied Rock Thrush	Monticola rufiventris		+
Blue Whistling Thrush	Myiophonus caeruleus	+	+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Pied Thrush	Zoothera wardii	+	
Tickell's Thrush	Turdus unicolor	+	
White-collared Blackbird	Turdus albocinctus	+	
Asian Brown Flycatcher	Muscicapa daurica	+	
Rusty-tailed Flycatcher	Muscicapa ruficauda	+	
Ultramarine Flycatcher	Ficedula supercilliaris	+	
Slaty-blue Flycatcher	Ficedula tricolor		+
Verditer Flycatcher	Eumyias thalassina		+
Rufous-bellied Niltava	Niltava sundara		+
Grey-headed Canary Flycatcher	Culicicapa ceylonensis	+	
White-tailed Rubythroat	Luscinia calliope		+
Orange-flanked Bush Robin	Tarsiger cyanurus		+
Oriental Magpie Robin	Copsychus saularis	+	+
Indian Robin	Saxicoloides fulicata	+	+
Rufous-backed Redstart	Phoenicurus erythronotus	+	
White-winged Redstart	Phoenicurus erythrogaster	+	
White-capped Water Redstart	Chaimarrornis leucocephalus	+	+
Plumbeous Water Redstart	Phoenicurus fuliginosus	+	+
Spotted Forktail	Enicurus maculatus	+	+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Common Stonechat	Saxicola torquata		+
Pied Bushchat	Saxicola caprata	+	+
Grey Bushchat	Saxicola ferrea	+	+
Spot-winged Starling	Saroglossa spiloptera	+	
Chestnut-tailed Starling	Sturnus malabaricus		+
Indian Myna	Acridotheres tristis	+	+
Jungle Myna	Acridotheres fuscus	+	+
White-tailed Nuthatch	Sitta himalayensis	+	
Wall Creeper	Tichodroma muraria		+
Bar-tailed Tree Creeper	Certhia himalayana	+	
Great Tit	Parus major	+	+
Green-backed Tit	Parus monticolus	+	+
Black-lored Tit	Parus xanthogenys		+
Black-throated Tit	Aegithalos concinnus	+	
Euarsian Crag Martin	Hirundo rupestris	+	
Wire-tailed Swallow	Hirundo smithii	+	
Red-rumped Swallow	Hirundo daurica	+	+
Himalayan Bulbul	Pycnonotus leucogenys	+	+
Red-vented Bulbul	Pycnonotus cafer	+	+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Himalayan Black Bulbul	Hypsipetes leucocephalus	+	+
Striated Prinia	Prinia crinigera	+	+
Grey-breasted Prinia	Prinia hodgsonii		+
Oriental White-eye	Zosterops palpebrosus	+	+
Chestnut-headed Tesia	Tesia castaneocoronata	+	
Grey-sided Bush Warbler	Cettia brunnifrons		+
Lesser Whitethroat	Sylvia curruca		+
Tailorbird	Orthotomus sutorius	+	+
Tickell's Leaf Warbler	Phylloscopus affinis		+
Common Chiffchaff	Phylloscopus collybita	+	
Greenish Warbler	Phylloscopus trochiloides	+	+
Large-billed Leaf Warbler	Phylloscopus magnirostris		+
Blyth's Leaf Warbler	Phylloscopus reguloides		+
Grey-headed Warbler	Seicercus xanthoschistos	+	+
White-throated Laughing Thrush	Garrulax albogularis	+	
White-crested Laughing Thrush	Garrulax leucolophus	+	
Striated Laughing Thrush	Garrulax striatus	+	
Streaked Laughing Thrush	Garrulax lineatus	+	+
Chestnut-crowned Laughing Thrush	Garrulax erythrocephalus		+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
Scaly-breasted Wren Babbler	Pnoepyga albiventer		+
White-browed Scimitar Babbler	Pomatorhinus schisticeps	+	
Rusty-cheeked Scimitar Babbler	Pomatorhinus erythrogenys	+	
Black-chinned Babbler	Stachyris pyrrhops		+
Tawny-bellied Babbler	Dumetia hyperythra	+	
Yellow-eyed Babbler	Chrysomma sinense	+	
Jungle Babbler	Turdoides striatus	+	+
White-browed Shrike Babbler	Pteruthius flaviscapis		+
Chestnut-tailed Minla	Minla strigula	+	
Whiskered Yuhina	Yuhina flavicollis		+
Rufous Sibia	Heterophasia capistrata	+	+
Oriental Skylark	Alauda gulgula	+	
Pale-billed Flowerpecker	Dicaeum erythrorynchus		+
Fire-breasted Flowerpecker	Dicaeum ignipectus		+
Purple Sunbird	Nectarinia asiatica		+
Crimson Sunbird	Aethpoyga siparaja	+	+
House Sparrow	Passer domesticus	+	+
Cinnamon Tree Sparrow	Passer rutilans	+	+
White Wagtail	Motacilla alba		+

Common English Name	Scientific Name	Zoological Survey of India (Director, 2005) for Mandi District	Observed on IIT Campus in March 2010
White-browed Wagtail	Motacilla maderaspatensis	+	
Yellow Wagtail	Motacilla flava		+
Grey Wagtail	Motacilla cinerea		+
Tree Pipit	Anthus trivialis	+	+
Olive-backed Pipit	Anthus hodgsoni		+
Rosy Pipit	Anthus roseatus		+
Rufous-breasted Accentor	Prunella strophiata		+
Scaly-breasted Munia	Lonchura punctulata		+
Yellow-breasted Greenfinch	Carduelis spinoides	+	+
European Goldfinch	Carduelis carduelis		+
Common Rosefinch	Carpodacus roseus		+
Pink-browed Rosefinch	Carpodacus rodochrous		+
Crested Bunting	Melophus lathami	+	+
Rock Bunting	Emberiza cia		+
White-capped Bunting	Emberiza stewarti	+	
Chestnut-eared Bunting	Emberiza fucata		+
Total	186	132	115

Note: Species commonly seen on IIT Mandi Campus are highlighted in Bold; names and sequence are after Grimmett et al, 1999.

*seen only in Parashar Lake.

20. Appendix 3: List of Plants recommended for planting on the Campus

Scientific Name	Local Name	Suitability		
		Avenues & Hedges	Slope stabilizing	Restoration
Morus alba	Chimmu/Sahatut		+	
Phoenix spp	Kajri	+	+	+
Ficus roxburghii	Tremal		+	+
Celtis tetrandra	Khirok/Khadak	+		+
Mallotus philippinensis	Kambal/Kamal		+	+
Quercus leucotrichophora*	Ban/Banj	+	+	+
Salix spp	Beun, Majnu	+		
Euphorbia royleana	Thor		+	+
Ougenia oogeinensis	?	+	+	+
Rhododendron arboreum*	Burah, Baras, Parag	+	+	+
Phyllanthus emblica	Amla		+	+
Cedrus deodara*	Kelo, Diar	+	+	+
Woodfordia fruticosa	Dawa		+	+
Arundinaria spp	Ringal, Gadi, Nirgal		+	+
Prunus spp	Chuli, Paja, Jammu	+		+
Pyrus spp	Bumfal, Segal, Kainth	+		+
Artimesia spp	Drubha, Seski, Buer	+		
Hedera helix	Grumru	+	+	

Scientific Name	Local Name	Suitability		
		Avenues & Hedges	Slope stabilizing	Restoration
Rosa spp	Kujas	+		
Jasminum spp	Banmalti, Dure	+		
Prinsepia utilis	Bakhal	+	+	+
Rubus spp	Kala akha	+	+	+
Berberis spp	Kasmal, Chutrum	+	+	+
Acer spp	Mandru, Mandor, Perange, Chirndru	+		
Populus spp	Chiluna, Pahari Pipal	+		
Toona ciliata	Tun, Tooni	+		+
Bombax ceiba	Semal	+		+
Agave spp	Rambas	+	+	
Adathoda zeylanica	Bisuti			
Bauhinia spp	Kachrar, Karal	+	+	+
Sapium insigne	Dhudala		+	

*species better suited to the north, northwest and west facing slopes that do not receive sunlight in the mornings.

21. Appendix 4: List of plants identified on the IIT Mandi Campus in March 2010

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
1.	Acorus calamus	Bach-Ber	H	Riparian	R	Medicinal
2.	Adhatoda zeylanica	Basuti	S	Scrub Forest	C	Medicinal
3.	Adiantum veneris	-	H	Riparian	C	Ornamental
4.	Aechmanthera pedata	-	H	Open Slope	C	-
5.	Aerua scandens	-	US	Open Slope	O	-
6.	Agave americana	Rambas	S	Open Slope	C	-
7.	Agave wightii	Rambas	S	Fallow field	C	-
8.	Ageratum conyzoides	-	H	Riparian, Fallow field	C	-
9.	Ajuga parviflora	Darpatre	H	Riparian, Pine forest	C	-
10.	Albizia julibrissin	Siras	T	Scrub forest	C	Fodder
11.	Ampelocissus latifolia	-	C	Scrub forest	C	-
12.	Anagallis arvensis	-	H	Fallow field	C	-
13.	Apluda mutica	-	G	Scrub forest/ Pine forest	C	Fodder
14.	Artemisia nilagirica	-	H	Fallow field	C	-
15.	Artemisia vestita	-	H	Scrub forest	C	-
16.	Arundinaria falcata	Nargal	R	Riparian area	O	Fodder, Fiber
17.	Arundinaria spathiflora	Ringal	G	Pine forest	O	Fodder
18.	Arundinella nepalensi	-	G	Scrub forest/ Pine forest	C	Fodder
19.	Asparagus adscendens	Sabsi-muli	C	Scrub forest	C	-
20.	Asplenium dalhonsiae	-	H	Scrub forest	C	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
21.	Barleria cristata	-	S	Scrub forest	C	-
22.	Bauhinia vahlli	Taur	C	Scrub forest	O	Fodder
23.	Bauhinia variegata	Kachnar	T	Scrub forest	O	Fodder, Vegetable & Ornamental plantation
24.	Berberis lycium	Kashmal	S	Scrub forest	C	Medicinal
25.	Berberis asiatica	Kashmal	S	Scrub forest	C	Medicinal
26.	Bergenia ciliata	-	H	Scrub Forest, Pine forest	C	-
27.	Bidens pilosa	-	H	Riparian, Fallow fields	C	-
28.	Bidens wallichii	-	H	Riparian, Fallow fields	C	-
29.	Boehmeria platyphylla	Siar	S	Riparian	O	-
30.	Boenninghauseniaalbiflora	Pessumar	H	Scrub forest	C	-
31.	Bombax ceiba	Semal	T	Scrub forest	C	-
32.	Bridelia retusa	-	T	Riparian	O	-
33.	Buddleja paniculata	-	S	Scrub forest	O	-
34.	Callistemon lanceolatus	Bottle brush	T	Planted	P	Ornamental plantation
35.	Campanula argyrotricha	-	H	Scrub forest	C	-
36.	Cannabis sativa	Bhang	H	Scrub forest	C	Narcotic

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
37.	Carissa opaca	-	S	Scrub forest	C	-
38.	Caryopteris odorata	Rumri	S	Scrub forest	C	-
39.	Cassia fistula	Amaltash	T	Planted	P	-
40.	Cassia occidentalis	Chingari	S	Fallow fields	C	-
41.	Cassia tora	-	H	Fallow fields	C	-
42.	Cayratia divaricata	-	C	Scrub forest	C	-
43.	Cedrus deodara	Devdar	T	Planted	P	-
44.	Celtis tetrandra	Khadak	T	Scrub forest	C	-
45.	Cheilanthes bicolor	-	H	Scrub forest	C	-
46.	Circium sp.	-	H	Scrub forest	O	-
47.	Cissampelos pareira	-	C	Scrub forest	C	-
48.	Clematis barbellata	-	C	Scrub forest	O	-
49.	Cocculus laurifolius	-	T	Scrub forest	O	-
50.	Colebrookea oppositifolia	Banse	S	Scrub forest	C	-
51.	Cryptolepis buchanani	Khurnmble	C	Scrub forest	C	-
52.	Cyathocline purpurea	-	H	Riparian	C	-
53.	Cyathula tomentosa	-	S	Scrub forest	O	-
54.	Cynodon dactylon	-	G	Fellow field	C	Fodder
55.	Cynoglossum zeylanicum	-	H	Scrub forest	C	-
56.	Dalbergia sissoo	Shisham	T	Planted	P	Timber
57.	Debregeasia hypoleuca	-	ST	Scrub forest	C	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
58.	Dendrocalamus strictus	Bans	G	Planted	P	-
59.	Deutzia corymbosa	Chururu	S	Scrub forest	O	-
60.	Dicliptera bupleuroides	-	H	Scrub forest, Pine forest	C	-
61.	Dioscorea belophylla	Shingali Migali	C	Scrub forest	O	-
62.	Duchesnea indica	-	H	Riparian	C	-
63.	Emblica officinalis	Aamla	T	Scrub forest	O	Medicinal
64.	Engelhardia spicata	Samba	T	Scrub forest	C	-
65.	Erigeron canadensis	-	H	Riparian	C	-
66.	Erythrina suberosa	Pariara	T	Scrub forest	O	-
67.	Eucalyptus sp.	Safeda	T	Planted	C	Pulp Wood
68.	Eulaliopsis binata	-	G	Pine forest	C	Fodder
69.	Eupatoriumadenophorum	-	S	All habitat	C (Invasive)	-
70.	Euphorbia hirta	-	H	Riparian	O	-
71.	Euphorbia prostrata	-	H	Fallow fields	C	-
72.	Euphorbia royleana	-	S	Scrub forest	C	-
73.	Evolvulus alsinoides	-	H	Fallow fields	C	Medicinal
74.	Ficus foveolata	-	C	Riparian, Scrub forest	C	-
75.	Ficus palmata	Faguda/Fegra	T	Scrub forest	C	Fodder
76.	Ficus religiosa	Pipal	T	Planted	P	Religious
77.	Ficus roxburghii	-	T	Scrub forest	C	Fodder
78.	Ficus semicordata	-	T	Scrub forest	C	Fodder

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
79.	Flacourtia indica	Kangu	T	Scrub forest	C	-
80.	Galium aparine	-	H	Fallow fields	C	-
81.	Gentiana argentea	-	H	Pine forest	C	-
82.	Gentiana capitata	-	H	Pine forest	C	-
83.	Geranium ocellatum	-	H	Scrub forest	C	-
84.	Geranium wallichianum	-	H	Scrub forest	C	-
85.	Gerbera gossypina	-	H	Pine forest	C	-
86.	Girardinia diversifolia	Bichhubutti	US	Riparian	O	-
87.	Glochidion velutinum	Kaledar	T	Scrub forest	C	-
88.	Grevillea robusta	-	T	Planted	P	Ornamental plantation
89.	Grewia optiva	Bichul	T	Scrub forest	C	Fodder
90.	Hedera helix	-	C	Fallow fields	C	-
91.	Helinus lanceolatus	-	C	Scrub forest	O	-
92.	Hydrocotyle asiatica	Brahmi		Riparian	C	Medicinal
93.	Hypericum elodeoides	-	S	Scrub forest	O	-
94.	Hypodematium crenatum	-	H	Scrub forest	C	-
95.	Idigofera pulchella	-	S	Scrub forest	O	-
96.	Inula cappa	-	S	Scrub forest	O	-
97.	Ipomea carnea	Besharm-buti	C	Riparian	O	-
98.	Ipomoea sp.	-	C	Fallow fields	O	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
99.	Jacaranda mimosifolia	-	T	Planted	P	Ornamental plantation
100.	Jasmin officinal	Banmalti	C	Riparian	O	-
101.	Juglans regia	-	T	Scrub forest	O	-
102.	Kirganellia virosa	-	S	Riparian	C	-
103.	Lagerstroemia indica	-	T	Planted	P	Ornamental plantation
104.	Lantana camara	Chhoti-Padari	S	Scrub forest	C (Invasive)	-
105.	Lepidagathis cuspidata	-	S	Scrub forest	C	-
106.	Lepidagathis incurva	-	H	Fallow fields, Scrub forest	C	-
107.	Leucaena leucocephala	Subabul	T	Planted	P	Fuel & Timber
108.	Leucas lanata	-	H	Pine forest	C	-
109.	Leucasfegia innersa	-	H	Scrub forest	C	-
110.	Machilus odoratissima	Charga	T	Scrub forest	O	Fodder
111.	Maesa indica	-	S	Scrub forest	O	-
112.	Mallotus philippinensis	Kamal	T	Scrub forest	C	-
113.	Mangifera indica	Aam	T	Planted	P	Fruit
114.	Mantha longifolia	Podin	H	Riparian	C	-
115.	Mazus surculosus	-	H	Riparian	C	-
116.	Melia azedarach	Darek	T	Planted	P	Avenue plantation

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
117.	Micromeria biflora	-	H	Pine forest	C	-
118.	Morus alba	Sahatut	T	Scrub forest	C	Fruit & Fodder
119.	Murraya koengii	Kadi-patta	S	Scrub forest	C	-
120.	Myrica esculenta	Kaphal	T	Pine forest	O	Fruit
121.	Myrsine africana	-	S/ST	Scrub forest	O	-
122.	Nasturtium officinale	-	H	Riparian	C	-
123.	Nepeta hindostana	-	H	Scrub forest	C	-
124.	Notholirionthomsonianum	-	H	Pine forest	C	-
125.	Oplismens burmannii	-	G	Fellow field	C	Fodder
126.	Opuntia dillenii	-	S	Fallow fields	O	-
127.	Oroxylum indicum	Tarlu/Arlu	T	Planted	P	Plantation
128.	Ougenia oogeinensis	-	T	Scrub forest	C	-
129.	Oxalis corniculata	-	H	Fallow fields	C	-
130.	Parthenium hysterophorus	-	H	Fallow fields	C (Invasive)	-
131.	Pennistum orientale	-	G	Scrub forest/ Pine forest	C	Fodder
132.	Phoebe lanceolata	-	T	Scrub forest	O	-
133.	Phoenix humilis	-	S	Scrub forest	C	-
134.	Phoenix sylvestris	-	T	Scrub forest/ Pine forest	C	-
135.	Pinus roxburghii	Chir	T	Pine forest	C	Fuel & Timber
136.	Piper brachystachyum	-	C	Riparian	R	-
137.	Pistacia integerrima	Kakada	T	Riparian/ Slopes top	C	Fodder

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
138.	Plumbago zeylanica	-	S	Scrub forest	O	Medicinal
139.	Pogostemon benghalense	-	S	Scrub forest	C	-
140.	Polygonum capitata	Nalora		Riparian	C	-
141.	Polystichum sqnarrosum	-	H	Scrub forest	C	-
142.	Populus ciliata	Poplar	T	Planted	P	Fodder & Pulp wood
143.	Prinsepia utilis	Bhekhal	S	Scrub forest	C	-
144.	Prunella vulgaris	-	H	Scrub forest	C	-
145.	Prunus armeniaca	Chuli	T	Planted	C	Fruit
146.	Pteris cretica	-	H	Scrub forest	C	-
147.	Pueraria tuberosa	-	C	Scrub forest	O	Medicinal
148.	Punica granatum	Daru	S	Planted	O	Fruit
149.	Pyrus pashia	Kaith/Shegal	T	Scrub forest	C	Fruit, Fodder
150.	Quercus leucotrichophora	Banj/Ban	T	Planted	P	Fodder
151.	Rabdosia rugosa	-	S	Scrub forest	C	-
152.	Ranunculus sceleratus	-	H	Riparian	C	-
153.	Reinwardtia indica	-	S	Scrub forest	C	-
154.	Rhamnus triqueter	-	T	Scrub forest	O	-
155.	Rhododendron arboreum	Burans	T	Pine forest	O	-
156.	Rhus cotinus	-	T	Pine forest	O	-
157.	Rhynchostylis retusa	-	H	Epipyte in Bombax ceiba	R	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
158.	Rosa moschata	Kujas	S/C	Scrub forest	O	-
159.	Rubus ellipticus	Aanchhu	S/C	Scrub forest	C	-
160.	Rubus niveus	-	S/C	Scrub forest	O	-
161.	Rubus paniculatus	Kala-Akha	S/C	Scrub forest	O	-
162.	Rumex hastatus	Malori	H	Riparian	C	-
163.	Rumex nepalensis	Malori	H	Fallow fields	C	-
164.	Rungia pectinata	-	H	Fallow fields	C	-
165.	Salix alba	Biyus	T	Riparian	C	-
166.	Sapindus mukorossi	Ritha	T	Planted	R	Plantation
167.	Sapium insigne	Dudhala	T	Riparian/ Slopes	C	-
168.	Saurauia napaulensis	-	T	Scrub forest	R	-
169.	Sauromatum pedatum	-	H	Scrub forest	O	-
170.	Schefflera venulosa	-	S	Scrub forest	C	-
171.	Scindaspus officinalis	-	C	Riparian/Slopes	O	Medicinal
172.	Scutellaria angulosa	-	H	Scrub forest	C	-
173.	Scutellaria sp.	-	H	Fallow fields	C	-
174.	Senecio nudicaulis	-	H	Pine forest	C	-
175.	Smilax aspera	-	C	Scrub forest	O	-
176.	Solanum indicum/ Solanum nigrum	-	H	Scrub forest	C	-
177.	Solanum torvum	-	S	Riparian	C	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
178.	Solanum verbascifolium	-	S	Scrub forest	O	-
179.	Stellaria media	-	H	Fallow fields	C	-
180.	Sterculia villosa	-	H	Scrub forest	C	-
181.	Strobilanthus glutinosus	-	US	Scrub forest	O	-
182.	Syzygium cumini	Jamun	T	Riparian/ Slopes	O	Fruit,
183.	Taraxacum officinale	-	H	Fallow fields	C	-
184.	Tegetes sp.	-	H	Scrub forest	O	-
185.	Terminalia belerica	Baheda	T	Scrub forest	P	Medicinal & plantation
186.	Thalictrum foliolosum	-	H	Scrub forest	C	-
187.	Thuja compacta	More Pankhi	T	Scrub forest	P	Ornamental plantation
188.	Thysanolaena maxima	-	G	Riparian	C	Fodder
189.	Toona ciliata	Toon	T	Scrub forest	O	-
190.	Trachelospermum axillare	-	C	Scrub forest	O	-
191.	Trifolium pratense	-	H	Fallow fields	C	-
192.	Trifolium repens	-	H	Fallow fields	C	-
193.	Tulipa stellata	-	H	Open Pine	C	-
194.	Ulmus wallichiana	Kosh	T	Planted	P	-
195.	Urtica dioica	Kugas	H	Riparian Slopes	C	-
196.	Vernonia cinerea	-	H	Fallow fields	C	-

S. No.	Species	Local name	Habit	Habitat	Occurrence	Uses
197.	Veronicaanagallis-aquatica	-	H	Riparian	C	-
198.	Veronica persica	-	H	Fallow fields, Riparian	C	-
199.	Vicia hirsuta	-	H	Fallow fields	C	-
200.	Viola sp.	Banafsha		Pine forest	C	-
201.	Vitex negundo	Bahna	S	Riparian	O	Medicinal
202.	Woodfordia fruticosa	Dawa	S	Scrub forest	O	Medicinal
203.	Xanthium strumarium	-	H	Fallow fields	C	-
204.	Youngia japonica	-	H	Fallow fields & Scrub forest	C	-
205.	Zanthoxylum armatum	Tirmira	S	Scrub forest	C	Medicinal
206.	Zeuxine strateumatica	-	H	Riparian	O	-
207.	Zizyphus mauritiana	Ber	T	Scrub forest	O	Fruit

Habit: H Herb; US Under shrub; S Shrub; ST Small tree; T Tree; R Reed; G Grass; C Climber/twiner

Occurrence: C Common; P Planted; O Occasional; R Rare.

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