ECO-DEVELOPMENT OF RANI RESERVE FOREST

KAMRUP – EAST FOREST DIVISION, ASSAM

MASTERS OF ARCHITECTURE
(LANDSCAPE)

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2016MLA001

SCHOOL OF PLANNING AND ARCHITECTURE

NEELBAD ROAD, BHAURI, BHOPAL – 462030

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Submitted

in partial fulfillment of the requirements for the award of the degree of

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By

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Declaration

I, Shweta Das, Scholar No. 2016MLA001 hereby declare that the thesis entitled **Eco-Development of Rani Reserve Forest**, Kamrup-East Forest Division, Assam submitted by me in partial fulfillment for the award of Master of Architecture (Landscape), in School of Planning and Architecture, Bhopal, India, is a record of bonafide work carried out by me. The matter embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

18th May, 2018 Shweta Das

Certificate

This is to certify that the declaration of Shweta Das is true to the best of our knowledge and that the student has worked under the guidance of the following panel.

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PREFACE

The instinct of survival, which is seated deep into the psyche of any living being, in this case us, the humans, has made us to beat into submission any other being that does not retort back. We are so designed and programmed that once survival is taken care of, we then struggle to make our lives easier, even at the cost of the very space and planet without which live itself would not have been possible.

The one question that often makes me pause and go back in time to think, “To what extent have humans transformed their natural environment?” The question makes us pause and go back time to think. This period has seen a remarkable transformation in interest in the impact that humans are having on the environment, together with an explosion of knowledge. In any consideration of the human impact on the environment, it is probably appropriate to start with vegetation, for humankind has possibly had a greater influence on plant life than on any of the other components of the environment. [1]

Humans have done much to transform the vegetation cover of the Earth. It is deforestation that has been the most potent cause of change. Modifications in the form of alteration to the character of some major biomes, including secondary forests, can be realized.

This thesis is an attempt to critically understand these issues and come up with solutions that will help us to thrive with nature, which we are a part of as well. Moreover it also tries to remind the human race that if we do not take necessary steps now, nature can and ‘will’ take care of itself.

[1] Ellis, 2011

“Go to the limit,
And perhaps when you see nothing left,
You will see existence.”

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i. **ABSTRACT**

We create monuments in parks, we build cairns in the forest, and we leave shrines on the waterfront, as humanized imprints/ associations, on/ with nature. The need for humans to connect to nature, as refuge from everyday life, is fulfilled by green space in all its varied site types and forms, creating ample opportunities. The landscape which we experience possesses a large diversity of components, as well as a whole plurality of views. The geographic reality is nourished by its representation, images and meanings.

While India is often referred to as the land of spirituality, religion and nature worship; the flora and fauna in both urban and rural areas seem to be on a constant decline. The notion of craving for respite and opportunity for mindfulness increases as the cities grow and our lives get busier. A nearby space as sacred and pristine as nature offers such breather and charges us up for upcoming endeavors.

In a similar context, the *Rani Reserve Forest,* in the outskirts of *Guwahati* City, sharing a boundary with the *Garbhanga Forest* of Meghalaya towards East, overlooking the wetland *Deepor Beel* (a Ramsar Site) towards North and several rural settlements on the other peripheries is undergoing constant pressure. The pressure is adding up due to the *City's* massive sprawl, the patterns of resource use along the fringe and in the core of the forest, unmanaged visitation etc. leading to illegal encroachment, exploitation of natural resources, human-animal conflicts, lack of social awareness, mismanagement by concerned government agencies and several other threats. Moreover, increased religious tourism on the Sacred Site of *Dakini Hill* has given rise to anthropomorphized landscapes that are modified in a banal way, monotonous, and without feeling or reason, which undermines aforesaid landscape's sacred meaning.

This landscape has been evolving, basically in an unplanned way, through a sequence of implementation of individual activities, losing its character and health. It has also been declared that this reserve forest is a disturbed secondary forest where the management authorities have to deal more and more with rather than with primary forests, so that these are effectively able to meet the multi-purpose needs of the communities.

As long as forest management organizations carry out activities that change vegetation, new landscape patterns will be created. The loopholes in such management activities affect resources (especially biological resources) or human interactions. There is also the possibility that the developing landscape pattern jeopardizes faunal species dependent on certain habitat characteristics.

In a nutshell, the direct as well as indirect implications of human actions, the kinds and intensities of disturbances, the senses of place created/ disrupted around geographical scales and around cultural ideas either to ‘protect’, ‘control’ and ‘exploit’ nature are to be addressed sensitively.

Hence, this thesis tries to document and analyze the natural and human forces acting on the forest, design interventions and manage the larger landscape in which human activities are harmlessly integrated into nature to facilitate more visitation and appropriate resource use with less ecosystem degradation.

Keywords

Forest, Landscape Ecology, Cultural Geography, Patterns of Resource Use, Tourism, Sacred, Landscape Management

1. INTRODUCTION

1.1 BACKGROUND

Forests are dynamic systems occupying around 7% of the earth's area *(Myers, 1984)*. These ecosystems are under threat across the world in the form of deforestation. Also the impact of this disturbance on the global biodiversity has become a global concern in recent years.[1]

Although the forests are known to contribute significantly to the global diversity *(Sutton & Collins, 1991; World Conservation Monitoring Centre, 1992)*, not more than 4% of the total tropical forest cover is within the boundaries of reserves or national parks[2]. Sometimes even the best-protected areas might not be adequate to maintain the original ecosystem either due to their small size or difficult political and social conditions[3]. Ecological disturbance is a continuously operating process in such landscapes. Most estimates of species loss have focused on forests, as they are known to harbour the majority of species. However with increasing anthropogenic pressures, tropical forests are undergoing fragmentation, leading to a loss of habitat and subsequently erosion of biodiversity[4].

In developing countries such as India, degradation of tropical forests through selective logging, hunting, change in land-use practices, shifting agriculture and urbanization is both widespread and are still continuing. Practices leading to severe disturbances like clear felling and conversion of forest into farmlands, tea plantations etc. usually reduce diversity but impacts of moderate habitat disturbances such as commercial selective logging, commercial plantations, quarrying still remains unclear. Given the rapid loss of forest habitats, ecologists, conservationists and also landscape architects/ designers see a calling that need to understand the factors contributing to this lack of unanimity.

India being a densely populated country, forest degradation is a serious problem. Indiscriminate utilization of both forest and non-forest resources is leading to a change in the quality of the forests/ habitat. Shifting cultivation, which was once said to be a sustainable practice, is causing a serious threat to the endemic flora and fauna *(Ramakrishnan, 1993)*. Shifting cultivation is widely prevalent in Northeast India. It is the major land-use in this

[1] *Fimbel et al., 2001; Groombridge & Jenkins, 2000; Lawton et al., 1998*
[2] *Whitmore & Sayer, 1992*
[3] *Terborgh, 1999*
[4] *Pimm 1998; Laurance 1999*

region and extends over 1.73 million hectares[5]. Considering the scenario in a different perspective, the increasing urbanization is making people more and more turn to our forests for recreation and tourism. *Contact with nature is a basic human need not a cultural amenity, not an individual preference, but a universal primary need. Just as we need healthy food, and regular exercise to flourish we need on-going connections with the natural world*[6]*.*

Fig1:

Various disruptive uses of forests (a) forest clearing for commercial plantations, (b) illegal tree felling and (c) quarrying activities

Planning and providing for this growing demand poses challenges that need to be addressed by managers and designers alike. A meaningful solution to all such problems has become critical not only from the point of ecological sensitivity and biodiversity conservation, but also for the productive agriculture resulting into rise in economy and efficient forest recreation in the region.

The tropical moist deciduous forests occur under varied climatic conditions, but essentially with alternate wet and dry periods. The structure and composition of deciduous forests change with the length of the wet period, amount of rainfall, latitude, longitude and altitude[7].

In Northeast India, the moist mixed deciduous forests are classified as 'East Himalayan moist deciduous forest' (*Champion & Seth, 1968*) and in Assam, the tropical deciduous forests cover is 11,358 sq. kilometers, which is 14.5% of the total forest cover[8]. Deciduous

[5] *FSI, 1999*
[6] *E.O. Wilson*
[7] *Shankar, 2001*
[8] *FSI, 2003*

forests are not considered species rich but have a diversity of life forms[9]. These forests still assume unusual significance for conservation as they are the most used and threatened ecosystems[10], especially in India.

[9] *Gentry, 1995 & Medina, 1995*
[10] *Janzen, 1986*

1.2 **LANDSCAPES AND THE NORTH-EAST INDIA**

India has figured with two hotspots - the Western Ghats and the Eastern Himalayas - in an identification of 8 'hottest' biodiversity hotspots[11]. The North-Eastern states of India comprise a vast and varied landscape. Gigantic rivers, mountains, flood plains, steamy rainforests, wilderness, snowy peaks, they are a world unto themselves. This amalgamation of terrains creates some fantastic natural wonders that serve as asset for the people as well.

The Eastern Himalayas covering entire Northeast India is located at the confluence of the Oriental and Palaearctic realms and exhibits a high level of endemism in the flora and fauna.

Fig 2: Thanza valley, Bhutan, Eastern Himalayas (Source: Wikipedia)

This region portrays India's ecological and social identity by virtue of being the center of biological and cultural diversity with the ethnic hill tribes primarily depending on the natural forest resources for their daily sustenance. The cultural and ethnic diversity in the region is remarkable, with each group of people adapting to the demands of the region in their own unique way. Great differences in altitude, latitude and longitude create vast variation in microhabitats throughout this range. The Western Himalaya is relatively dry and cold, while the Eastern Himalayan region is extremely wet. However the exceptionally rich and higher biological diversity in the Eastern Himalaya is attributed to its multiple biogeographic origins. Its location at the junction of two continental plates places it in an ecotone that is represented by flora and fauna from both. The monsoon forests below 1000 meters have a close affinity with the monsoon forests of Indo-China where *Dipterocarpaceae* is the dominant family while the faunal elements are mainly the representatives of the Indo-Malayan realm.

[11] *Myers et. al. 2000*

The region's lowland and montane moist to wet tropical evergreen forests are considered to be the northernmost limit of true tropical rainforests in the world[12]. The region harbours India's largest elephant (*Elephas maximus*) population and the world's largest population of the one-horned rhino (*Rhinoceros unicornis*). This region also harbours the highest avian diversity in the Orient with about 836 of the 1200 species of birds known from the Indian subcontinent[13]. The political boundaries of this region now include entire Northeast India, Bhutan, Nepal, Myanmar and Southern China. Physio-geographically the region can be categorized into the Eastern Himalayas, Northeast hills (*Patkai-Naga Hills and Lushai Hills*) and the Brahmaputra and Barak valley plains.

Northeast India forms the main region of tropical forests in India with a rich diversity of medicinal plants and many other rare and endangered taxa. Although 64% of the total geographical area is under forest cover, there has been a decrease of about 1800 sq.kms. in the forest cover between 1991 –1999 *(FSI, 2000)*. The region is also the abode of approximately 225 ethnic tribes out of a total of 450 in India, the culture and customs of which have an important role in understanding biodiversity conservation and management issues. This region provides a good example of the linkages that exists between cultural diversity and biological diversity[14]*.* Assam is a part of this mega diversity zone by virtue of its rich tropical evergreen rain forests and moist deciduous forests[15]*.*

Disturbance regimes are mostly dominated by land-use practices and these land-use practices are important contributors for overall interpretation of ecological processes operating within the landscape. The varying impacts of human interventions reflected in such zones at landscape level have been brought out in the present study. Characterization of landscape dynamics is important in the perspective of decision makers and policy makers in order to prioritize conservation strategies, so that urgent and necessary action can be taken in this regard.

[12] *Proctor et al., 1998*
[13] *ICBP, 1992*
[14] *Ramakrishnan 1999*
[15] *Champion & Seth, 1968*

1.3 **CULTURAL UNDERSTANDING OF FORESTS IN INDIA**

Usually forests are not designed but they are altered due to human use and management. Natural Forests seem self-regulating owing to either gradual process (like growth) or more dynamic ones (e.g. Windstorms). Nevertheless, natural and managed forests form spatial mosaics over large areas. Nature, form and distribution of these mosaics over space can be designed consciously.

Not only in India but also in other countries of the world, there are some traditional ethics to protect nature. History of mankind shows us how communities lived in the lap of nature, drawing their essential commodities from nature. But modern man tends to disregard 'indigenous' people (ecosystem-people) as primitive, backward and superstitious. Rather, they have sound understanding with the nature. They realize the value of ecosystem, although they are poor and illiterate.

Environmental conservation is not a new idea for the Indians. From the ancient times Indian people's love for nature is reflected in their arts, religions and beliefs. *10,000 years* old Cave painting at *Bhimbetka* in Central India, the Indus Valley Civilization, all these provide evidence of the Indians love for Wild Life.

Conservation of environment was an innate aspect of the Indians. Although modern man considers some of the ancient rituals as superstitions and meaningless (as the Worship of trees, rivers etc.). Virtually those were traditional strategies to preserve the unbroken relationship between *Man* and *Nature*. Such rituals help us even today, to preserve some natural resources as Oasis in the deserts, sacred ponds attached to temples, sacred groves etc. in many parts of India.

It cannot be denied that along with other nations, India is also responsible for the environmental degradation of the planet due to rapid growth of population, industrialization, urbanisation etc. All these make our planet ailing.

Madhav Gadgil and *Romila Thapar (1990)* focus our attention to the innate relationship between man and nature when they say:

"*India obviously needs a new strategy of resource use and a new common belief system to hold the society together and put this strategy into operation. According to them the present*

belief system centered on development and national prestige has proved inadequate. The new strategy has to be grounded in efficient, sustainable use of resources and supported by a belief system based on respect for the natural endowments of the country. "

2. PROJECT AND SITE INTRODUCTION

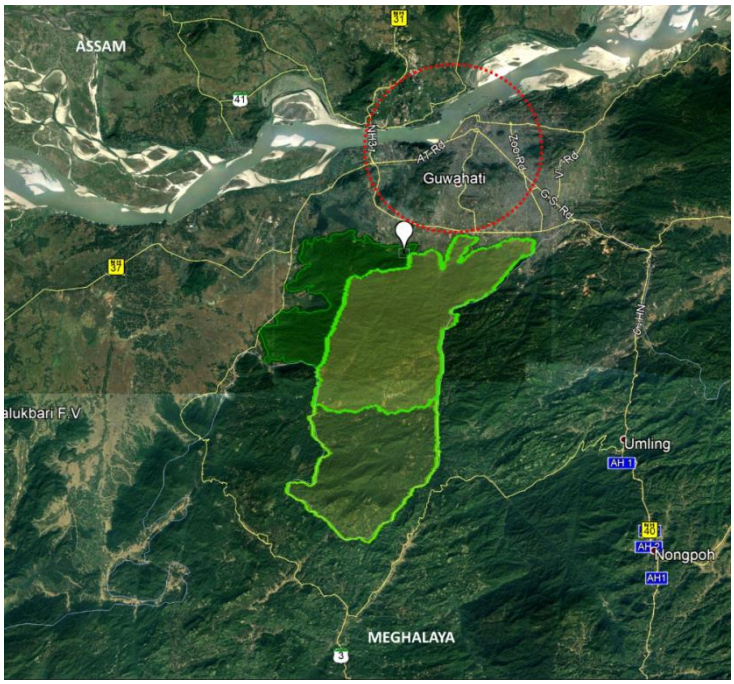
2.1 RANI-GARBHANGA FOREST RANGE – AN OVERVIEW

Fig 3: Location Map of Assam in India (Source: Wikipedia)

Rani-Garbhanga Reserve forest located between 26°55' to 26°0.5' N latitude and 91°35'E to 91°49'E longitude is situated on the south bank of the river Brahmaputra and is adjacent to Guwahati, the capital city of Assam in Northeast India. In Assam, which is a part of the Eastern Himalayas, there are a total of 312 Reserved forests covering an area of 13,870 sq.kms (17.68% of the state's geographical area). The total recorded forest area in Assam is 26,748 sq.kms out of which the Protected Area Network (25 in number) covers 3925 sq.kms. (5% of the state's total geographical area). The Unclassed State Forests (USF) covers an area of 5865 sq.kms.

The number of proposed reserve forests in Assam is 145 covering a geological area of 3103 sq.kms *(State Forest Department Records, 2005)*. The total area of Rani-Garbhanga reserve forest is 232 sq.kms (23,230.58 hectares) and is divided into two ranges - The Garbhanga range having 188.86 sq.kms area (18,860.58 hectares) and the Rani Range with 45 sq.kms (4370 hectares). The reserve site is situated at an altitude of 170-200 metres above the mean sea level. The forest type in Rani-Garbhanga reserve resembles to Champion and Seth's (1968) 'Assam valley Tropical mixed moist deciduous' forest with bamboos and are classified as 'Khasi Hill Sal' [3C/C1 a(ii)] and 'Kamrup Sal' [3C/C2 d(ii)] *(Champion & Seth, 1968)*.

This protected forest is predominantly a high-density elephant habitat (Asiatic elephant, *Elephus maximus*) and home ground to an endemic primate species, *Hylobates hoolock* (Hoolock or White browed Gibbon), the only species of ape to be found in the natural habitats of Northeast India. The other common species amongst the larger animals are Tiger (*Panthera tigris*), leopard (*Panthera pardus*), Barking deer *(Muntiacus muntiak*), Indian wild Boar (*Sus cirstatus*), Assamese macaque (*Macca inulata*), Pangolin (*Manis crassicaudata*). The Reserve has a good diversity of birds (170 species), reptiles (60 species) and a large diversity of insects including butterflies *(State Forest Department Records, 2005)*.



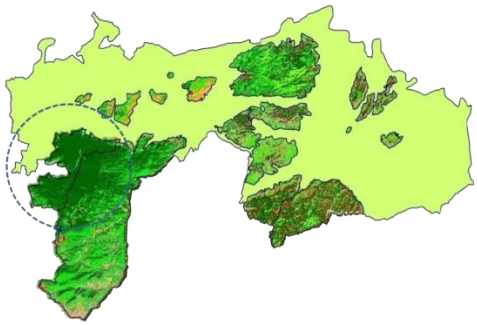


Fig 4: Kamrup-East Forest Division

Fig 4: Contextual map of Rani Reserve Forest showing the urban core of Guwahati up north with the mighty Brahmaputra and adjoining Garbhanga Reserve Forest with the State of Meghalaya (Source: Wikipedia & Google Earth)

This Reserve is the original habitat of the Sal, *Shorea robusta (IUCN, 1991)*. The Sal forests, which are typically categorised as 'Tropical Moist Deciduous Forest' are mainly, distributed in South and South-east Asia and in India alone the Sal forests extend over an estimated area of 13 million hectares [16]. A special type of microclimate existing in the Sal forest ecosystem facilitates and nourishes the huge association of undergrowth diversity. However like all other Sal forests in India which have been facing a great threat, in Rani-Garbhanga as well due to over-exploitation, deforestation and encroachment, the indigenous Sal vegetation was slowly replaced by moist deciduous secondary bamboo brakes. Some amounts of Sal trees are still present in the higher altitudes in the forest. The possible decline in the wealth of medicinal plants as undergrowth and also the fragmentation of the natural habitat for threatened animals (like the Hoolock gibbon) is of environmental concern.

What is more significant about this protected area is that its close proximity to an urban human habitation (Guwahati city) on the northern side of Garbhanga Range and on the other side (touching the northern boundary of Rani range) the protected reserve lies adjacent to an important wetland, the *Deepor Beel* which is a freshwater lake and also the only Ramsar site in Assam *(designated November, 2002)*. This wetland with a core area of 4.14 sq.kms. is known for its extraordinary avifaunal diversity. It is a favourable staging ground on the

[16] *Champion & Seth, 1968*

migratory flyways for several species like the Siberian crane including many endemic species. Amongst the 219 species of birds (terrestrial and aquatic) recorded in the wetland, some of the threatened species that are present are such as the Greater Adjugant stork (*Leptoptilus dubius*), Whistling teal (*Dendrocygna javanica*), Openbilled stork (*Anastomus oscitans*), Little Cormorant (*Phalacrocorax carbo*), Shoveler (*Anas clypeata*), Pintail duck (*Amauvor sp*.), Garganey (*Anas querquedula*), Pond Heron (*Ardeola grayii*), CattleEgret (*Bubulcus ibis*), Brahminy duck (*Casarca farruginea*), River Tern (*Sterna aurantia*), Pheasant tail jacana (*Hydrophasianus chirurgus*). There are 70 species of endemic waterfowls. The other indigenous species recorded include 30 species of reptiles, 6 species of turtles and tortoises, 50 species of fishes, 20 species of amphibians [17].

This bird paradise is being fringed by the mixed moist deciduous to semi evergreen forests of Rani-Garbhanga on its southern edge and exhibits a fascinating convergence of both wetland and forest ecosystem. Fishing is carried out to unsustainable proportions and the area of the wetland is slowly shrinking due to steady encroachment on its northern part. Massive siltation that is a direct consequence of deforestation and quarrying activities in the adjacent forests has emerged as a potential threat to the '*beel*'.

Fig 5: Deepor Beel, the wetland, an important ecosystem for many avi-faunal species & for Elephas Maximus as well (Source: Wikipedia)

Sustainable forest management is a key issue not only for biodiversity conservation but is also equally significant for the local economy[18]. In Assam where culturally distinct ethnic societies living close to nature and natural resources have sculptured a cultural landscape around them, the concept of cultural landscape can be seen as an effective tool for linking conservation with sustainable development of this marginalized society. With a rapid decline in the forest cover of Assam, forest rehabilitation initiatives in which local communities get involved are already being introduced. Under the National Afforestation Programme in

[17] *State Forest Department Records, 2005*
[18] *Ramakrishnan, 1999*

Assam, Joint Forest Management (JFM) has been implemented which has been working on the local peoples' participation for the regeneration and protection of the forests. Rani-Garbhanga Reserve forest in Assam, Northeast India has five Joint Forest Management committees under Forest Development Agency, where the local forest village community who are the actual traditional owners of the forest are an equal stake holder, and in collaboration with the forest department have been actively involved in various community development programs like constructing village roads, school buildings, providing safe drinking water and primary health facilities, incorporation of smaller income generation schemes and growing cash crops along with the main crops. Bamboo (*Dendrocalamus hamiltonii*) is a very important bio-resource of Rani-Garbhanga Reserve that provides subsistence and livelihood security to the local village community and is a part of the cultural, social and economic tradition of the region in general.

Agro-forestry and village-level social forestry initiatives have also been implemented, as unless the local people are not involved they will jeopardize the forest management. It is also critical that special emphasis should be placed on socially/culturally valued species within the forest ecosystem because such species are invariably also the keystone species and it is through this medium that the forest management authorities and other local non-governmental organizations can relate with the local communities and make such an interdisciplinary approach the basis for making management decisions. Formal knowledge based forestry management practices can then provide added value to and help in arriving at appropriate management decisions.

Fig 6: Practices by local people along the foothills of the forest (Source: Wikipedia)

Management of 'shifting cultivation' (locally called Jhum) has been the next big problem in particularly the southern range of the reserve. The shortening fallow cycle has been managed through using appropriate tree species rather than introducing an alien technology.

Scientifically analyzed '*Traditional Ecological Knowledge*' (TEK) available with the local and indigenous communities is a significant tool to redevelop 'Jhum' as process of a short-term strategy and as a component of a larger and more comprehensive landscape management plan[19].

In tropical regions where the management authorities have to deal more and more with secondary forest systems rather than with primary forests, more emphasis needs to be given on the value of secondary forests in our research and management plans so that these forests are effectively able to meet the multi-purpose needs of communities[5]. Rani-Garbhanga Reserve Forest in Assam is also a disturbed secondary forest where such a management approach that will sustain community participatory rehabilitation or management plans can alone be sustainable in the long run as the focus is towards restoring the integrity of the landscape with which the local ethnic community is closely linked.

[19,5] *Ramakrishnan, 1999*

2.2 **RANI RESERVE FOREST – EXISTING SCENARIO**

Rani landscape comprises of a mosaic of different land forms that lies in the transitional zone between Meghalaya plateau and Assam valley. It consists of roughed valleys and hilly terrains with perennial streams.

The Rani Reserved forest was established on 26th of July, 1882 under the purview of the Indian Forest Act VII of 1878. On the enactment of Assam Forest Regulation VII of 1891, the RF is constituted under this regulation. The Rani headquarter at present has been supported by eight beat offices namely the Chakardeo, Sajjanpara, Hatimaraghuli, Nalapara, Garopara, Sukurban, Sessa and Satargaon under one Range Officer who is manned by a team of more than 35 forest staff and few personnel of foe Assam Forest Protection Forces.

The Rani Reserve Forest attracts visitors for its unique hills, thick forests and wild animal species including timber smugglers. Its ecological sensitivity is added on with Meghalaya sharing a common boundary towards South and for about 35 km in the East with the great Garbhanga Reserved Forest. A broad-gauge track from *Kamakhya* to *New Bongaigaon* has been established in the year 1989 that cuts through an area close to the Rani-Garbhanga forest reserve, home to several herds of elephants besides serving as a natural corridor for them. The reserve forests sharing its Southern boundary with the *Jirang* Reserved Forest of Meghalaya and Northern boundary with the Ione Ramsar site of Assam, Deepor Beel Sanctuary, providing about 70 kilometers of natural corridor between the two forests for the movement of various animals including elephants is being threatened due to a plethora of anthropogenic pressures. The magnificent beasts often go to Deeper Beel at night in search of food and water thus giving rise to human-animal conflicts as well.

Proposals are being forwarded from time to time by various NGOs to declare Rani and Garbhanga Reserve forest as new wildlife sanctuary. It has been proved time and again that several endangered and rare wildlife finds their habitat within the greater Guwahati city limits. Large scale human settlements in these wildlife habitats are compelling wild animal to stray into human habitats. Human-animal conflicts have been thus on rise, and wildlife conservation processes have been adversely affected due to loss & fragmentation of natural habitats.

Other threats include forest clearing for agriculture, tea plantations and quarrying activities impacting the vegetation, landforms, drainage patterns, scenic values etc. The pressure is adding up due to the *City's* massive sprawl, the patterns of resource use along the fringe

and in the core of the forest, unmanaged visitation etc. leading to illegal encroachment, exploitation of natural resources, human-animal conflicts, lack of social awareness, mismanagement by concerned government agencies and adding on new issues. Moreover, increased religious tourism on the Sacred Site of *Dakini Hill* has given growth to anthropomorphized landscapes that are reformed in a banal way, monotonous, and without feeling or reason, which undermines aforesaid landscape's sacred meaning.

This landscape has been evolving, basically in an unplanned way, through a sequence of implementation of individual activities, losing its character and health. It has also been declared that this reserve forest is a disturbed secondary forest where the management authorities have to deal more and more with rather than with primary forests, so that these are effectively able to meet the multi-purpose needs of the communities.

Fig 7: Current threats to the Rani forest ecosystem (Source: Author)

The study area is composed of hills and hillocks, with presence of numerous marshy lands and wetlands giving.it a unique physiographic appearance with great ecological value. Situated adjacent to greater Guwahati and are in the southern bank of the river Brahmaputra, which are characterized by several hilly areas along with some hillocks surrounded by agricultural land. The hills are actually continuation in the form of spurs of Khasi Hill ranges of Meghalaya. The plain forests are located in the alluvial tarries and these forests are cut up by numerous narrow, winding low-lying tracts. The reserve forest is of

various significant geologic and physiographic make-up of the state and is composed of special habitat mosaic. The river Brahmaputra along with the presence of marshes has an impact on the humidity level of the area.

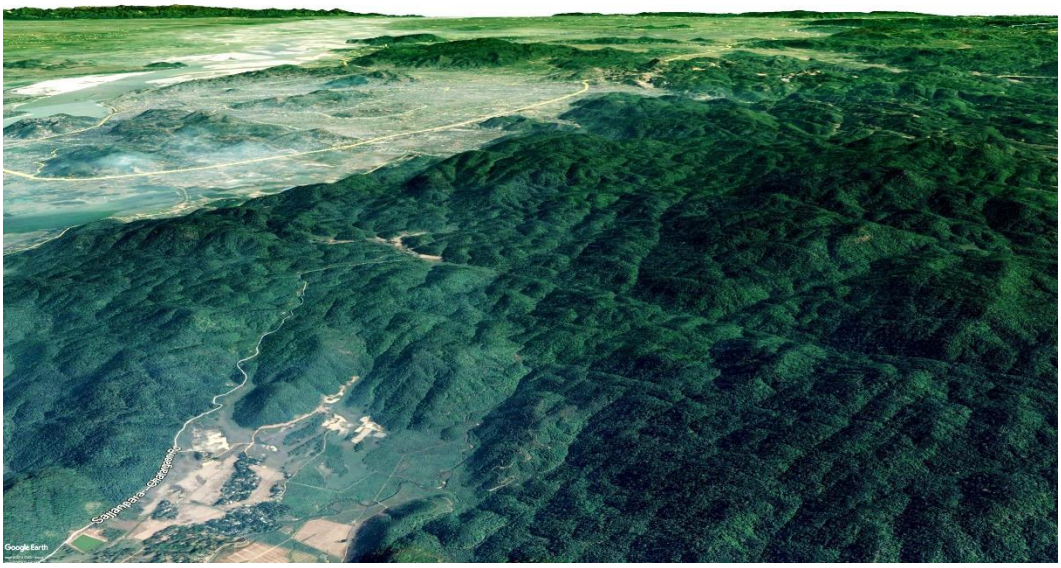


Fig 8: Aerial images of the Site along with its contextual surroundings.

(Source: Google Earth Imagery)

2.3 SITE INTRODUCTION

2.3.1 SETTLEMENTS

There is a remarkable ethnic diversity of people in the fringe villages of the forests. The communities which inhabit in and around the reserve are Rabha, Hira, Kaibarta, Boro, Karbi, and Nepali.

The people of Rani Area substantially depend on the biodiversity of the Rani Reserve forest and the *Deepor Beel* wetlands. These two ecosystems have become the essential source of extracting bio-resources for daily needs of the villagers. From forest they gather fuelwood, timber, thatch, fodder, wild fruits and vegetables, often hunt wild animals for meals as well. They use the area of Deepor Beel for wet cultivation, fishing and also communication path to the other side of the wetland when needed. It is evident that people maintain a distinct connection with the biodiversity product from these ecosystems, despite receiving essential commodities from the adjacent city. All these villages are just 5-8 kilometers away from the villages which has a great impact on the lifestyle of people.

Following are some village profiles to understand its dynamics:

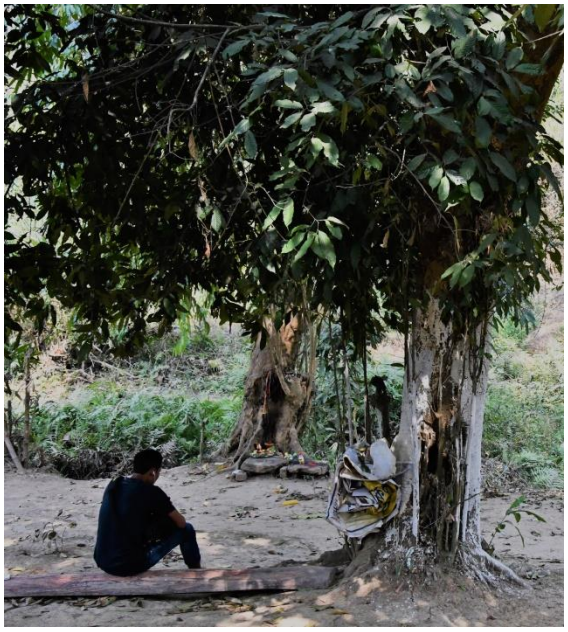
Name of the Village	Pamohi
District	Kamrup
Avg. Annual Rainfall (approx.)	2000 cm
Temperature Range (approx.)	10 – 32 Degree Celsius
Main agricultural product	Paddy
Accessibility	By Kachha Road
Terrain	Partially hilly
Population (approx.)	600
Communities	Karbi, Bodo, Kalita
Water facility	Tubewell, Open Wells
Associated Natural Ecosystems	Rani forest, Garbhanga forest, Deepor Beel
Educational Institutions	One Primary School, One High School

Name of the Village	Kallapara
District	Kamrup
Avg. Annual Rainfall (approx.)	2000 cm
Temperature Range (approx.)	10 – 32 Degree Celsius
Main agricultural product	Paddy
Accessibility	By Kachha Road
Terrain	Undulating
Population (approx.)	500
Communities	Karbi, Bodo, Nepali, Kalita
Water facility	Tubewell, Open Wells
Associated Natural Ecosystems	Rani forest, Garbhanga forest, Deepor Beel
Educational Institutions	One Primary School

Name of the Village	Chatargaon
District	Kamrup
Avg. Annual Rainfall (approx.)	2000 cm
Temperature Range (approx.)	10 – 32 Degree Celsius
Main agricultural product	Paddy
Accessibility	By Kachha Road
Terrain	Undulating
Population (approx.)	300
Communities	Karbi, Bodo, Nepali
Water facility	Tubewell, Open Wells
Associated Natural Ecosystems	Rani forest, Garbhanga forest
Educational Institutions	One Primary School

2.3.2 **RECREATION OPPORTUNITIES**

Rani Reserve forest is one of the oldest of its type in the state of Assam. There is tremendous eco-tourism potential in the region. Pilgrims, nature lovers, and those seeking moments of contemplation and silence; all flock to the place. The diverse flora and fauna draws the scholarly and the creative types together.



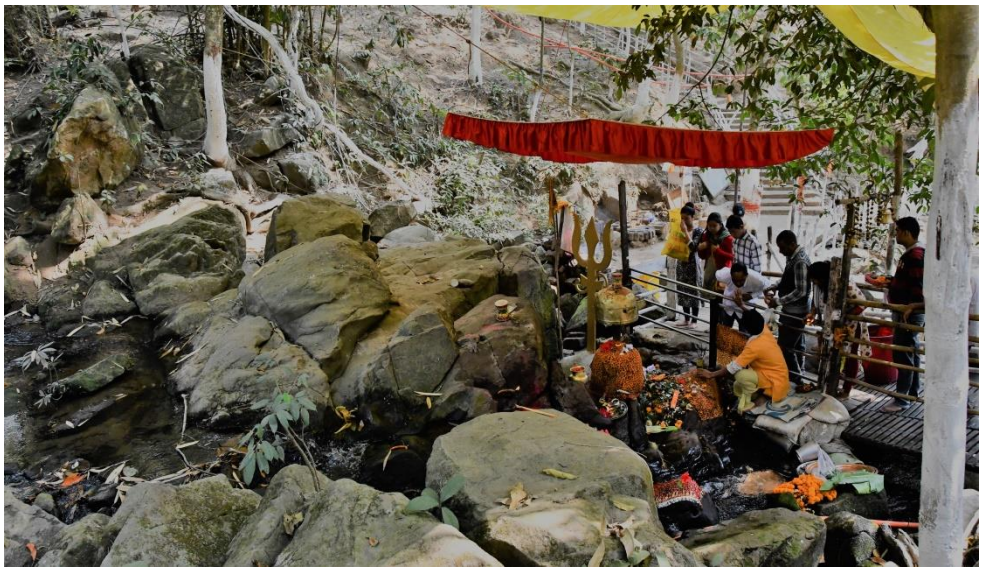


Fig 9: Pictures illustrating the various opportunities that already exist in Rani forest (Source: Author)

The religious spot in *Dakini Hill* attracts thousands of devotees every month into its sanctuary. Moreover, the forest is a living encyclopedia for the ones interested in

understanding the subtle nuances of the various species of plants and animals found in the region. The scenic beauty offers invite to artists and photographers. Being situated in the outskirts of the city, the area consists of numerous picnic spots, Kopili being one of them.

Unfortunately, the region has also been witnessing many unlawful and anti-social activities due to lack of proper planning and monitoring from concerned authorities. Such activities have resulted in many accidents and other unwanted incidents, human-animal conflicts, etc. Thoughtful planning interventions and sincere monitoring would further enrich its recreational possibilities.

2.3.3 **THE USERS/ STAKEHOLDERS**

Guwahati is the capital city of Assam, are directly or indirectly dependent on the forest resources/ rural produce as well. 14.1 per cent of the state's population was living in urban areas in 2011, which is an increase from 12.9 per cent in 2001 and 11.1 per cent in 1991. Hence the dependency rate escalated as well.

Table 1: Guwahati Population Growth

Year	GMCA*		GMA excluding GMCA		GMA*	
	Population in	CAGR (%)	Population	CAGR (%)	Population	CAGR
1951	43,615	-	53,774	-	97,389	-
1961	1,00,707	8.7	98,775	6.3	1,99,482	7.4
1971	1,23,783	2.1	1,68,436	5.5	2,93,219	3.9
1981**	2,68,945	8.1	1,02,351	-4.9	4,35,280	4.0
1991	5,84,342	8.1	61,827	-4.9	6,46,169	4.0
2001	8,09,895	3.3	80,878	2.7	8,90,773	3.3
2011	9,63,429	1.8	85,998	0.6	9,68,549	0.8

* GMCA-Guwahati Municipal Corporation Area; GMA-Guwahati Metropolitan Area (also known as the Guwahati Urban Agglomeration)

** The Census 1981 was not conducted in Assam. The population figures have been extrapolated on the basis of the 1971-1991 Compound Annual Growth Rate (CAGR).

Source: (i) GMDA (2009: 12), and (ii) Census 2011 from files downloaded from http://www.censusindia.gov.in/2011census/population_enumeration.aspx.

The hilly areas of Guwahati have gradually been settled and occupied by different socio-economic groups. The urban poor on these hilly areas comprise of three main groups. The displacement of tribals from Guwahati's plains led most of them to move to the hills. Tribals displaced by development projects as well as natural calamities from elsewhere in Assam as well as those fleeing from ethnic conflicts in rural parts of Assam who migrated to Guwahati also preferred to live in the hills because of their lifestyle. Poor and lower-income non-tribals have also increasingly gone to live in the hills because of the lack of vacant lands in the plains and the high cost of land and housing in the informal sector in the plains. While these groups have been denied land rights like many amongst the middle class, it is the poorer groups living on the Reserve Forest lands in the hills that have recently borne the brunt of the state's denial of land rights. The state has attempted to label these as 'hill encroachments' and remove them in the name of ecological concerns.

Cutting of the hills and illegal tree felling on them has led to massive erosion, destruction of the hills, landslides and flash floods. This degradation has occurred due to cutting into the natural slopes to make the land habitable, leading to loss of vegetation, soil loss and soil erosion, and vulnerability to landslides. GMDA has therefore identified the hills as 'eco-sensitive zones' and the hill settlements on Reserve Forest lands as 'encroachments'

requiring resettlement and rehabilitation[20]. However, the degradation of the hills has occurred due to a number of other reasons as well. Stone quarrying in the hills is one of these reasons. Furthermore, cutting into the natural slopes for habitation on the hills has not only been done by poor and lower-income tribals and non-tribals, but also by many influential politicians and companies.

In the context of Rani Forest, for classification of user groups, people performing/ executing similar type of activities and having similar relationship with biodiversity are considered in the same user group. *Primary user group* are those practicing only one life supporting activity. The groups of people who often change the practice from one to another (which are not the main life supporting activities) in different periods of time are considered as *Secondary user group*. Tertiary user group are those who do not directly exploit the biodiversity resources but only consume its products through the mode of purchasing from primary and secondary user groups.

Therefore based on the livelihood activities, following categorization has been done:

Primary User-group – a) Cultivator b) Fisherman c) Firewood Collector d) Grazer e) Wild Vegetable/ Fruit Collector

Secondary User-group – a) Medicinal Plant/ Fruit Collector b) Timber Collector c) Hunter d) Labour e) Business folk

Tertiary User-group – a) Labour (outside labour in stone quarry, railway construction, illegal tree operation) b) Officials (forest dept. officials)

Forest department personnel, labourers of the stone quarry and railway construction work and a few other Government employees are the outsiders who use the resources of the villages. There are no outsider traders in the village but illegal traders do exist as timber collectors. The locals from the villages usually sell the forest goods to the traders in Guwahati city or in the nearest community markets.

Visitors as users, visiting such forest areas for recreational purposes, to connect with nature and feel at peace, forms the last category of stakeholder. Those living in habitats void of nature often revert to alternative experiences to simulate the feelings that result from frequent interactions with forest systems.

[20] *GMDA, 2009*




Fig 10: Pictures illustrating the various users/ stakeholders of the forest namely the users, quarry labors, villagers, forest dept. authorities etc. (Source: Author)


2.3.4 **EXISTING FOREST MANAGEMENT STRATEGIES**

The Government of India issued guidelines in June 1990 and adopted the '*Joint Forest Management*' (JFM) under the '*National Afforestation Programme*' for conservation of forests with distinct identified duties and functions for ensuring protection and significance of forests. The Government of Assam adopted the 'Assam Forest Policy', 2004 which emphasizes the JFMs to graduate to 'Community Forest Management' aiming at sustainable forest management. The main objective is to '*support the livelihoods of the forest fringe communities through improved natural resource management with community participation*'[21].

Sal Regeneration:

- Arrest depletion in growing stock of Sal by regulating the yield and boost natural regeneration of Sal.
- Improve the depleted growing stock of Sal under intensive system of management with the aim of attaining a normal forest in the future.
- Conserve and improve the existing growing stock of Sal in areas other than those marked for regeneration operation.
- Reclaim all Sal areas, which had been lost to invading bamboos and other miscellaneous species due to human activities.

Miscellaneous Plantation:

Human interferences in the form of illegal felling of trees by the adjacent forest villagers, encroachment by migrant population from the adjoining hilly regions of Meghalaya leading to springing up of pockets of habitations inside the reserve forest, 'jhum' or shifting cultivation, large scale deforestation in the neighbouring forests of Meghalaya and the raising of pure teak plantations in the past have disturbed the ecosystem and caused shrinkage in the habitats of large animals. The main management objectives under this circle are:

- Conservation and protection of existing forest cover.
- Rehabilitate the depleted forest cover by raising plantations of valuable indigenous species without disturbing the forest ecosystem.
- Replacement of existing teak plantations by indigenous species in a phased manner and thus remove all the demerits of monoculture.

Bamboo Overlapping:

[21] *Assam Forest Policy, 2004*

The major objectives of management include:

- Maintain a sustained yield and regular supply of bamboo to the paper mills of the state. Only areas where there are continuous stretches of bamboo have been considered for commercial exploitation.
- Maintain ecological balance by prevention of unlimited cutting and removal of bamboos.
- Prevent erosion and stabilize watershed areas of the reserve covered by bamboo forests.
- Meet the demands of the local people for construction of their dwellings, agricultural implements, fencing, cottage industries etc. A sustainable use will be maintained through encouragement of 'cultivation and extraction of bamboo' by scientific management of forest based bamboo resources, systematic and block plantation of commercially significant species and improved harvesting and post-harvest practices.
- Enhance employment and income generating opportunities using bamboo and cane as the prime resource.

Biodiversity Conservation:

The closed canopy as well as the open forests of this reserve is included in this plan and the main objectives are:

- Protect the forests and allow nature to take its own course in rehabilitating the forests by the re-introduction of some indigenous plant species.
- Preserve and improve the habitats of the *Asiatic elephant*, *Leopard*, *Barking deer* and *Hoolock gibbon*.
- Study and record the degree of success achieved in regeneration and succession of various species.

Watershed management and Soil Conservation

This Reserve forest forms only a small part of the catchment area of the rivers and streams flowing through and around this region. The sources of most of these rivers and streams originate in Meghalaya. However, a positive effect is that due to favourable climatic conditions the abandoned '*Jhum*' areas quickly regenerate resulting in less quantity of soil run-offs. A more serious threat is posed by some of the teak plantations in the hilly areas of the reserve, which have very thin undergrowth, resulting in much heavier erosion as compared to the jhum areas. Following heavy rainfall during the monsoon period, high degree of siltation has occurred in the adjoining low-lying swamps and depressions as well as in the 'Deepor Beel', and the elevation of the riverbeds. Therefore the major objective of

this strategy is to reduce disturbance by way of restricting felling and secondly is the thinning of the congested teak plantations in order to encourage good undergrowth.

Joint Forest Management (JFM) / Peoples' Participatory Plantation Program

With a view to execute and emerge the policy of the government by way of active participation and involvement of local people for regeneration, maintenance and protection of forests owned by the state but appropriated by the local communities. The working area covers both peripheral degraded as well as some of the encroached areas of the Reserve. There are almost 8 different ethnic tribes living in the fringe villages and although their agricultural customs vary to a certain extent, all of them cultivate paddy in the low-lying land adjoining the reserve. They raise only one crop in a year from June-July to December. The cattle maintained by these villagers are entirely dependent on the reserve for their grazing till paddy is harvested. The basic needs of the villagers like firewood, thatch, bamboo, and cane are met from this reserve. So to stop destruction of the forests and decrease encroachment, this plan intends to create a buffer with peoples' participation. The local people are therefore involved in converting the encroached and degraded areas into productive land so as to meet their basic needs on sustained basis. This initiative thus helps Forest department and the local community to harmonize the interests of people and long-term sustainability in a mutually supporting manner.

2.3.5 **NEED AND RELEVANCE OF THE PROJECT**

Visions of the future are rendered as places too – planned and projected, advertised, hoped-for or dreaded. Our lives are steeped in place experiences, most of which we take for granted and scarcely reflect about.

The hunger for infrastructure development is causing immense pressure on land in urban areas, often resulting in massive tree-cutting drives. Forest clearing to satisfy the current needs of the increasing population leads to the growth of invasive species on the edges and reduces the habitat area for core species, making them vulnerable.
Overuse of trails, development inside and along the peripheries of the forest is leading to compaction, soil excavation, increasing erosion, deforestation for firewood and threatening the fragile ecology. Recent developmental activities like increasing number of stone quarrying within forest area, besides earth cutting, encroachment and poaching have affected the pristine ecosystem to large extent and brings about disturbances and imbalance in the environment. If not dealt with, it will result into degraded landscapes that are less resilient in the scenario of climate change ultimately losing its scenic quality.

The Reserve Forest though has a protected status, but in reality do not get the form of protection and management it deserves. Assam falls under the mega biodiversity hotspot area, where a large number of flora and fauna are found outside the protected area network. The protection of this flora and fauna are also equally important in the very survival of human mankind.

Forest landscapes such as this are revered owing to unique features that appear in natural formations of earth, water, sky, and the energies emanating from them. These are the few spaces conducive to stillness, silence, and reflection. It is essential to preserve/ manage these landscapes as reserves of nature for their aesthetic, spiritual, ecological qualities.

2.4 **PROJECT DETAILS**

2.4.1 **Aim**

To design landscape interventions at site level, and management strategies for the larger landscape in which human activities are to be harmlessly integrated into nature to facilitate more & prolonged visitation and appropriate resource use with less ecosystem degradation.

2.4.2 **Objectives**

- To understand the Site based on its *ecology* and *people-place interactions* with reference to published literatures on Landscape Ecology, Cultural Geography, Human Ecology and Place Theory in Landscape Architecture.

- To analyze the site data, mapping stresses and disturbances along with its impact, pattern and intensity & other transactions happening in and around the study area.

- To understand the role of multiple user groups & stakeholders, their associative values and activities in sculpting the existing landscape character.

- To enhance the experience of traversing through & within the site, evoking meaningful (sacred) engagement with nature thus fostering environmental stewardship.

- To identify various locations for pause-points/ stop-overs and formulate a design programme with a spatial quality that engenders new forms of interaction.

2.4.3 **Scope and Limitations**

- The strategy for primary survey & collection of preliminary data are based on behavioral traces and interactive sessions with the user groups and stake-holders.

- Published literature and thesis works of other study fields on ecology, cultural geography, and eco-poetic approach are used as a base to understand & analyze the landscape. But the extent of this study is limited to the relevance of the topic in the field of landscape architecture.

- In depth site study based on Transect and Quadrat methods at various locations is absent due to time limitations.

- The site-based observations are restricted to visually accessible areas along the trail landscape. Assumptions and conclusions are made based on these observations & available research literature for the Forest area.

- Subjective data as evidences are used as a guide for some aspects of site study where published/ existing maps or literature are not available.

- The notion of sacred as deeply held values associated with nature is interpreted beyond religious values and traditional cultures.

2.4.4 **Expected outcomes**

- Identification of critical areas in the Forest landscape based on stresses, changing patterns of use and interaction with the surrounding ecology and addressing the same through minimal landscape design interventions.

- Preparation of guidelines/ policies/ checklist of parameters to be considered for Landscape Management, Planning and Design at a larger scale in the Rani-Garbhanga Forest Range.

- Planning and Management strategies that ensure ecological health of the landscape, preservation of its pristine quality, while facilitating human experiences through tourism and stewardship over place association.

- Design interventions to minimize adverse human-nature interaction, and to improve legibility and anchor, and educate the public while providing a seamless experience of the landscape.

3. LITERATURE STUDY

3.1 LANDSCAPE ECOLOGY

Landscape ecology puts emphasis on the associations between spatial pattern and ecological processes, their interactions, to understand the causes and consequences of spatial heterogeneity across a range of scales. To put this is detail, landscape ecology focuses on :

(1) the spatial relationships among landscape elements, or ecosystems,

(2) the flows of energy, mineral nutrients, and species among the elements, and

(3) the ecological dynamics of the landscape mosaic through time. [22]

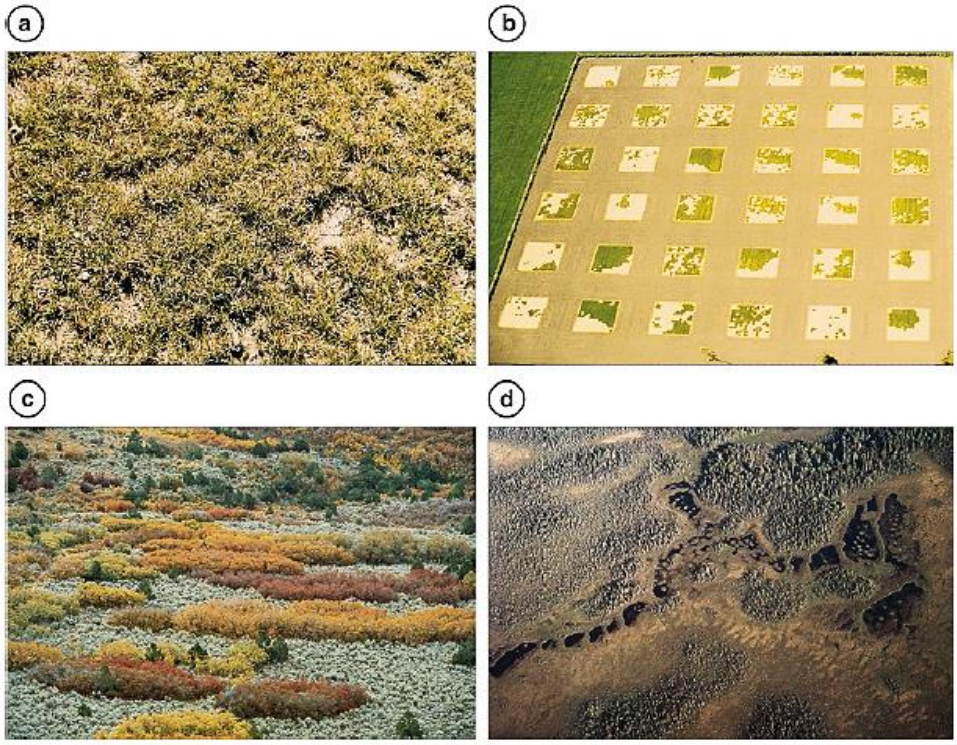


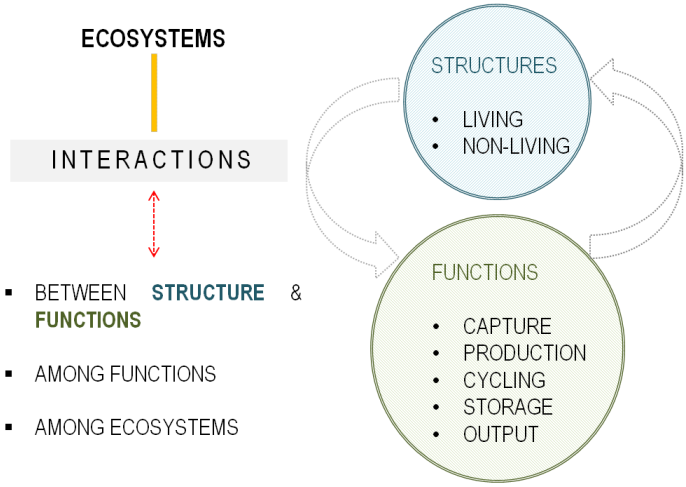
FIGURE 1.1.

Photos illustrating the concept of landscape as a spatial mosaic at various spatial scales. (a) An example of a microlandscape, or landscape complexity from the perspective of a grasshopper. Grass cover is *Bouteloua gracilis* and *Buchloe dactyloides*, and vegetation cover in the ~4 m^2 microlandscape is occasionally disrupted by bare ground. Photo by Kimberly A. With. (b) Set of experimental microlandscapes used to explore relative effects of habitat abundance and fragmentation on arthropod communities in an agroecosystem. System consists of a replicated series of 12 plots (each 16 m^2) that vary in habitat abundance and spatial contagion based on fractal neutral landscape models (With et al. 1999). Photo by Kimberly A. With. (c) Clones of Gambel oak (*Quercus gambelii*) in Colorado illustrating heterogeneity within approximately 1 km^2. Photo by Sally A. Tinker. (d) Aerial view of a muskeg and string bog landscape, Alaska. Photo by John A. Wiens.

[22] *Forman 1983*

3.1.1 **UNDERSTANDING FOREST ECOSYSTEMS**

The following figure suggests the three major factors to understand ecological systems: structures, functions, and the interactions among them.



Structures are defined as the physical, palpable elements of the system. These are the things that we can touch, see and feel. They can be either living or non-living, mobile or stationary. These structures perform certain activities, processes or roles, which are defined as Functions. Ecosystem functions can be classified in various ways. For example, *Cycling* - resources are transported within the system (e.g., animal migration within a system)

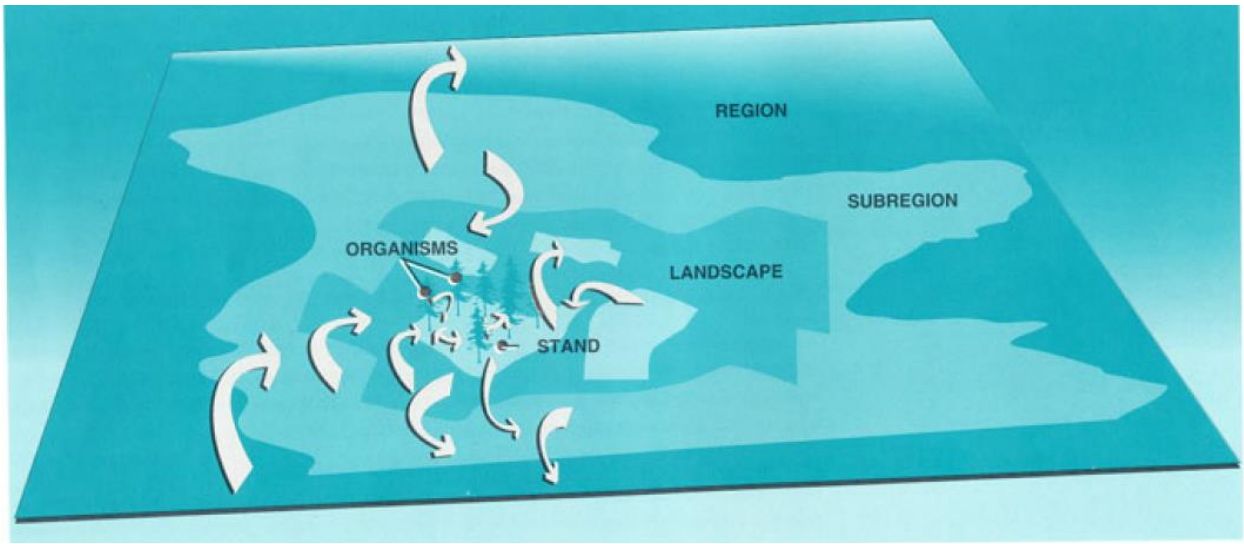


Fig : Levels of organization of ecological processes, interactions among processes within the same level, and also between levels

3.1.2 **PATCH – CORRIDOR – MATRIX MODEL** [23]

Landscapes normally consist of 3 types of structures: a matrix, corridors and patches (which are conjointly referred to as “landscape elements”). The vegetation is the most obvious feature of a landscape element that might be modified by landforms or other factors. Again, vegetation may be of community type and successional stage as well. Apart from the inherent qualities of an individual landscape element, its pattern or arrangement on the overall landscape is of particular interest.

The most connected segment of the landscape is the **Matrix**. It is the vegetation type of the matrix which is the most neighboring.

Areas of vegetation which are internally relatively homogenous (with respect to the composition and successional stage) are known as **Patches**. Patches differ from what surrounds them, i.e. the matrix, or for that matter, other patches. For instance, in a forested landscape, clear-cuts, wetlands, immature vegetation envelopes are some of the most commonplace patch types within the forested matrix.

Corridors form a very intrinsic part of the landscape. It is that landscape element which affixes identical patches through a disparate matrix or a collection of patches. A fine illustration would be a complete and cultivated forest riparian zone which connects patches of the mature jungle in a disintegrated landscape. Nodes are the linkage of patches through corridors. Even roads may be considered corridors, provided they are able to connect early successional patches (clear-cuts). Various kinds of corridors help in the promotion of the flow (which is the cycling function) of diverse materials and organisms. For instance, a road, i.e. a corridor, may serve as a corridor for some organisms while proving to be a barrier for others. The capability of a corridor to administer connectivity usually depends on its width (how much is actually edge), and how intermittently there are encounters of discontinuity.

[23] *Model by Richard Forman & Michel Godron, 1980*

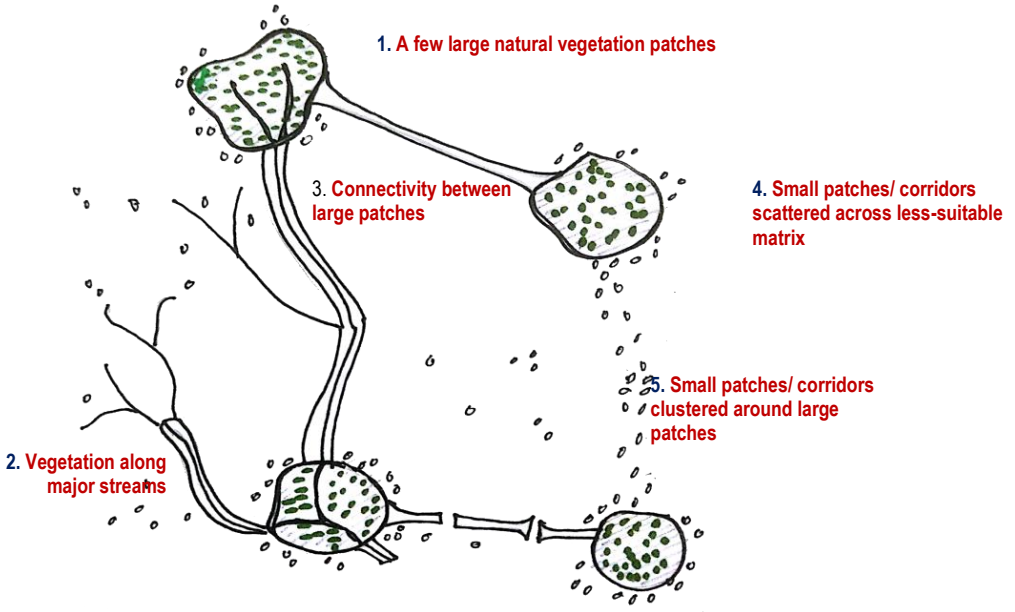


Fig : Schematic illustration of a Patch-Corridor-Matrix Model

3.1.3 **LANDSCAPE STRUCTURES AND LANDSCAPE FLOWS**

Analysis of Landscape Structures

As per the **Patch – Corridor – Matrix** model by *Forman* and *Godron* (1986), basic types of landscape elements are often described as follows :

- *Mosaic*: Usually consisting of a number of various patches of vegetated and non-vegetated areas.
- *Corridors*: These are linear patches along which water, wildlife or people move within a landscape. The structure of the element enables movement to take place and is significant.
- These patches and corridors may be set within a *matrix*, i.e., the landscape element most strongly connected across the landscape, which exerts a major influence over the functions within it.

Corridors also show different degrees of continuity, ranging from complete continuity to a discontinuous character. [24]

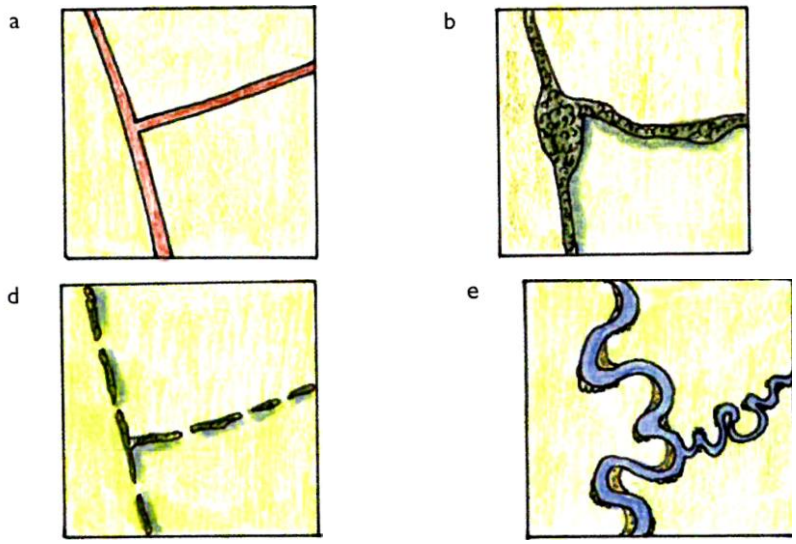
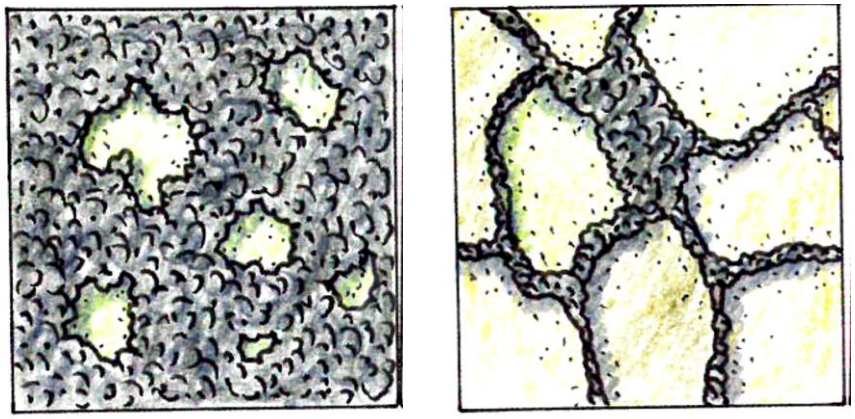


Fig: Characteristics of corridor-
a) straight, parallel; b) variable width; c) braided; d) discontinuous; e) meandering

As patches develop and evolve, the matrix changes. A disturbance to a matrix, such as an area of farmland, creates a patch that can be said as an altered patch. Fragmentation of the matrix by many patches can be measured by the relationship of number and size of patches in proportion to the area of matrix, edge-to-area ratios & the degree of connectivity, relative to the number of breaks in the matrix.[25]

[24] *Simon Bell, 2012*
[25] *Simon Bell, 2012*



a b

Fig: Characteristics of matrix patterns – a) the most connected & extensive in area; b) most connected but not the most extensive

In the context of biodiversity conservation, other ways of considering landscape structures have been developed, or rather of placing values on certain elements or combinations of elements. Part of the analysis of landscape structure may be aimed at identifying and categorizing these areas as a prerequisite for management.

- **Core areas**

Core areas, or reserves, are essentially, strictly protected zones, or zones managed with biodiversity conservation as the primary goal. Natural disturbances are allowable, or may be simulated by managers (e.g., forest authorities, forest village people). Generally, core zones are established at centers of the greatest biodiversity.

- **Biological hotspots**

The areas that have special significance for either organisms or ecosystem processes are referred to as biological hotspots. They may or may not be recognized as distinct patch types, but for some reason play a key role in sustaining local biodiversity. For example, there may be an old vegetation cover that is in a sheltered area near a stream corridor, and thus it has much greater productivity than an old vegetation cover of similar structure somewhere else.

- **Refugias/ Buffers**

These are areas that occupy positions protecting them from large-scale disturbance or alterations, thus they have an imperative role as a repository of biological legacies.

Analysis of Landscape Flows

Landscape ecology is also associated with certain scales of processes, for instance those acting throughout a landscape and between a particular landscape and its surroundings which can be regarded as inflows and outflows of a system. Flows are the things like animals, water, people, energy etc. that move in, around & through one or more landscape systems through various mediums such as air, ground, vegetation and soil.

For analysis, the selection of flows can be defined by focusing on species high or significant in the food chain, as indicators of the health of the ecosystem; for instance keystone or umbrella species can be considered for the same. Hence the success of such species can indicate the status of all the other kinds of flows upon which it depends. Following this, there would be no requirement to analyze all of the potential flows.

Apart from water being the key flow phenomena, inclusion of human aspect is also relevant. The flow of people can be examined by splitting the effects of living and working in the landscape from those of recreation in this context of thesis project.

Plants flow around the landscape colonizing areas, utilizing freshly exposed sites by spreading out slowly or by moving readily. Some are slow to move, exhibiting sensitivity to particular site conditions. They can be used as indicators of late successional forest, a relatively stable and long lasting element in a landscape. [26] Across a landscape, the movement of warm or cool air and the heat currents in water bodies that impact the ecosystem function are considered energy flows.

Mapping all these flows keeping in mind its aspects, the spatial relationships with landscape structures can be understood.

Interaction of Landscape Structures and Landscape Flows

The interaction among them can be systematically interpreted in a matrix where flows are to be specified in columns and similarly structures plotted in rows. The specific interaction then can be added to each cell building up a comprehensive picture of the existing pattern of interaction taking place in the larger landscape.

[26] *Simon Bell, 2012*

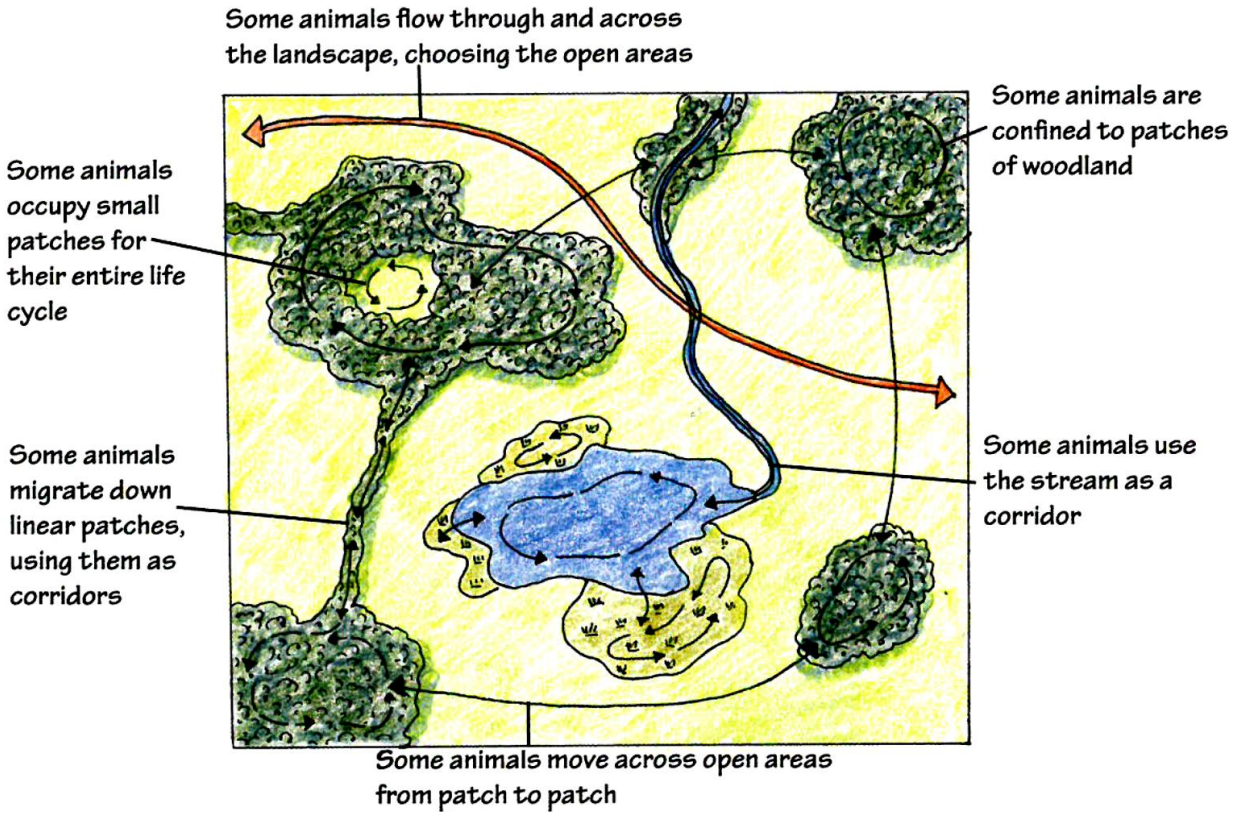


Fig: The relationship of flow patterns of different animals at different scales with respect to patches and matrix in a mosaic landscape

3.2 **DISTURBANCES IN LANDSCAPE**

Disturbances are events resulting in compelling changes to vegetation pattern and structure, usually over a short period of time. These disturbances, that may interact with and initiate changes to the landscape structure, can either be natural or human-caused events. No ecosystem or landscape is forever unchanging.

De facto, to maintain an ecosystem's functioning and resilience, change is one of the most primary and crucial drivers. Production, storage, cycling or outputs would not be possivle without plants growing, dying and. Thus, it is absolutely imperative to understand the dynamics of the natural and human-caused processes at work in any given landscape. This is particularly important for the purpose of developing management systems for forests that enable the production of outputs such as timber while maintaining the ecosystem functioning. Disturbances can be described in terms of their type, intensity, frequency, duration and effect.

Natural disturbances incorporate fire, flood, wind, landslides, insects and pathogens, all of which contribute to the change in forest landscapes. Some alter very large areas while others tend to be more localized such as quarrying. Windstorms may do their work in only a few hours while root rot can take years. Most disturbances follow somewhat predictable cycles of occurrence, with the most extensive and severe usually having a low frequency of manifestation. Disturbances mutually interact with the landscape mosaic in that the current pattern and structure in part determines the location and spread of disturbance, while the disturbance sets the phase for future landscape structural development. Disturbance cycles are subject to change over a period of time, as they take place within larger climatic cycles, such as warming and drying, or increased wetness and cooling. Consequently, an increase in carbon emissions due to global climate change may have an effect on such cycles, but in ways that will vary from place to place.

Fig: Illustrative Images for Natural Disturbances (Forest fire and landslide respectively)

Human-induced disturbances can be as or more essential than natural disturbances in terms of impacting landscape pattern and structure. These may include gradual forest change brought on by over-grazing by domestic livestock, fire suppression, introduced pests, rapid change through the introduction of large-scale clear-cuts, and forest fires. In most situations, there are various effects on the landscape due to human-caused disturbances in comparison to natural disturbances. For example, a natural fire may affect a large area but it will leave behind pockets of unburned trees, fringes of partly burned edges and even occasional thick-barked single trees that survive, together with ash, carbonized wood, standing dead but not burned trees and so on. A clear-cut of the same area may leave few or none of these biological legacies. Thus there may be a lack of long-term nutrients, and little habitat for organisms that use charred wood, perching posts and tree cavities, as well as insufficient seed sources for natural regeneration.

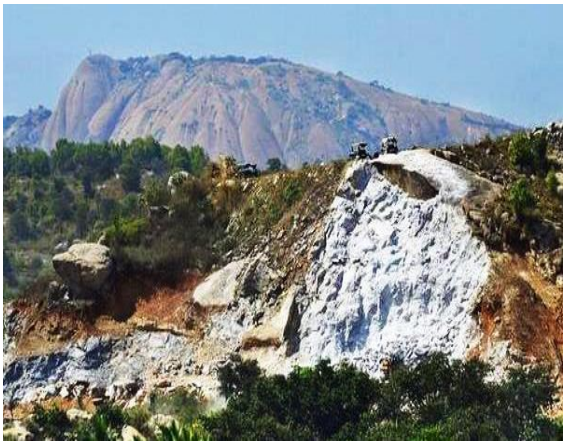



Fig: Illustrative Images for Human-Induced Disturbances (clear-cuts and quarrying respectively)

3.3 **HUMAN-ENVIRONMENT RELATIONSHIPS/ ASSOCIATIONS & PATTERNS OF RESOURCE-USE**

Amongst the interactions between landscape structure and human use are the perceptual, aesthetic and emotional issues, as well as practical and physical ones. Indigenous tribes often have completely different patterns of use, based on a long cultural tradition.

3.3.1 **UNDERSTANDING CULTURAL GEOGRAPHY**

The humanistic approach to '*place*' considered with respect to this thesis emphasizes the narrative qualities of place, bodies, and differences in experiencing as well as constructing place, and the emotional dimensions of place. Things, ideas, practices, and emotions all occur in a context. These influence, value, celebrate and regulate particular activities and objects.

Culture includes the material things, the social ideas, the practices, and the emotional responses that we participate in, produce, resist, celebrate, deny or ignore. Culture is therefore the constituted amalgamation of human activity – the culture of a place is defined by the activities that are performed by the inhabitants of that place.

Any alteration made to a place continually influences its meanings and identities of that, until the basic character of the place undergoes a change, even if a minute one. In both material and non-material form, these human alterations function as connections, tying the meaning of places to the identity of the cultural groups that make them. These alterations in natural landscape that grow with time therefore tie cultures and geographies together, influencing the identity of both. As a consequence of the constant changes arising out of various needs, places become dynamic entities; they are in fluid states of transition as new alterations react with existing or older ones to change the meaning and identity of the location.

Cultural geography thus can be said to interrogate these traces, their interactions, and outcomes.

Any alteration made to an existing landscape may overlap one another, synergize together, or come into conflict with one another. They may change over time, thus making the identities and meanings of places dynamic, but nevertheless these alterations or manipulations of natural landscape often remain in place as shadows and echoes of places

past. They can take physical shapes, such as things, events, and processes; and even can involve emotional, intellectual, and psychological connections.

Fig: Arrangement of stone pieces depicting religious notions of *Shiv Linga*. The religious association of local with the landscape taking physical shape (in Dakini Hill)

Taking the above considerations into view, the sacred site inside the forest premises has undergone significant changes because of increased human activity. The place has been molded as per the beliefs attached with the *Jyotirlinga* Temple in Dakini Hill. And religious beliefs either work to strengthen or undermine the geographical sense of a place. Moreover, our senses of cultural and geographical place are not always coherent. This is especially the case when we add into this mix, senses of place that do not come directly from geography as such, but rather from cultural ideas and beliefs. And religious belief is often a value system centered on powers and deities beyond the human.

However, a detailed understanding of these interfaces through study would help to realize that the culture/ value of sacredness attached to a site often combine with other trace connections, working to strengthen particular senses of place. All belief systems have sacred sites at the local level, where individuals can congregate to worship. At the supra

local level there are also sacred sites where key events in the development of that religion took place where people throng to on pilgrimages.

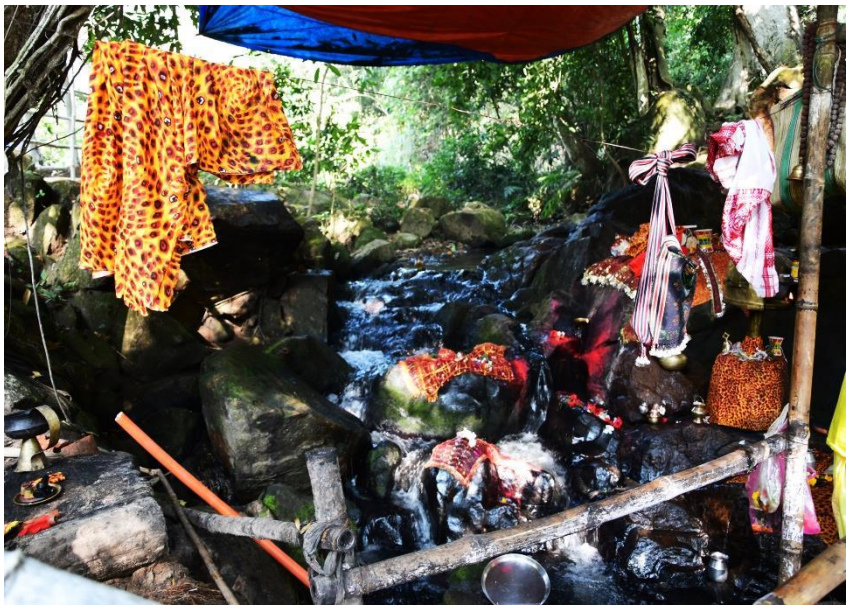


Fig: The sacred site in Dakini hill, the religious chanting, offerings, prayers as a part of culture; associating themselves with the surrounding landscape. Genius loci, the intangible aspect of the forest can be referred to in this case.

A culturally geographical approach to place thus investigates the relationships between people and places:

- It looks at how the ideas and prejudices about a place define its borders, what follows as a consequence; how politics and prejudices mark out some traces as ‘normal’ or ‘natural’, and how others are deemed as ‘novel’ and threatening.
- It analyses how different cultural groups use their power to transgress or resist these borders, and attempt to get their own meanings and interpretations of traces accepted into the dominant reading of a place.

A culturally geographical approach is representational in nature – it looks at what traces and place stand for; but it is also non-representational – it explores the emotional impacts of these traces and borders on our sense of place. It looks at the materialities and meanings, the affects, and the identities, and intensities that come to define places as ongoing compositions of traces.

Thus, understanding these dynamics of the site shall help realize the alternatives, the traces stand for, and return to the original premise that we are part of the cultural world. When this will become a leaving reality, any alteration brought into a natural landscape would reciprocate harmoniously to human activities.

3.3.2 **UNDERSTANDING HUMAN – ECOLOGICAL THEORIES**

Since time immemorial, humans have been influenced by natural landscapes and always will. Humans have shaped their cultures as per natural forces and this understanding might be used to develop understanding and consciously connect human and their environments where both can thrive.

The discussed theories are generalized; not including in depth study regarding behavioral changes with varying age group, cultural backdrop, and the purpose of visit & the nature of interaction involved.

The human ecological theories help understand how landscapes change in response to interacting biophysical and socio cultural processes. The critical concept is that of relationship. [27] Of all the natural & social sciences, ecology provides the best understanding of the landscape since it deals with the reciprocal relationship of all living things to each other (including humans) and to their biological & physical environments.[28] (Steiner 1991)

Jackson and Steiner proposed an interactive system for land use planning, in this a multi-disciplinary approach is used; insider views and their adaptive strategies guide the development of plans and the implementation process.

Their Human ecology for land-use planning approach focused on identification of interactions between the components and natural system, user groups & their demands made on the ecosystem; hence their effectiveness of existing regulations in achieving the future needs of each user group. Social values are integrated into ecological planning.[29]

The applied ecosystem Approach, views the ecosystem as a combined human and natural system in which the components are related to interact. It also states that the ecosystem is self-regulating and has a limited capacity. This concept was developed in the late 1950s and early 1960s to understand human dominated and natural landscapes and how they respond to change.

Involving explicit consideration of local diversity in land-use values, and of who would suffer and who would benefit if any particular set of values are to be used in landscape planning in

[27] *Ndubisi, n.d.*
[28] *Steiner, 1991*
[29] *J. Steiner, 1985*

order to develop more sustainable approaches to human settlement. Therefore human with ecology helps reinforce the reality of our place in environments.

In the context of *Rani* Forest, considering who the local inhabitants are, how they exchange information and make land-use decisions, how they use local resources, their outlooks on resource issues; will give an overview on the kinds of coalitions, conflicts and cooperation associated. Therefore, the impact on their relationships can be accessed and altered for the better.

3.4 **ECOLOGICAL AESTHETICS**

An ecological aesthetic cultivates a type of beauty in the landscape that is associated with its ecological health, diversity, and/ or sustainability. Landscape intactness has been defined as a quantifiable estimate of naturalness measured on a gradient of anthropogenic influence. [30]

There is an inherent assumption amongst humans that on the basis of evolutionary processes and cultural expectations, good ecological quality is associated with good aesthetic quality. Yet, they fail to directly sense ecological quality. Furthermore, there are some situations when aesthetic and ecological values firmly correlate. However, there is no assurance that this will always hold true. What might be aesthetically pleasing may or may not be a true reflection of the health of the ecosystem. A person appreciative and observant of the relevant ecological phenomena might derive pleasure from the ecological value of a landscape. This realization may occur separately from or might be an extension to the feeling of pleasure that is acknowledged as aesthetic experience. The capacity for transformation of landscapes, ecosystems, regions and other environmental phenomena can be profound due to individual preferences, actions and choices garnered over broader social and societal levels. Societal actions are further presented with the help of political and other influences on management practices, policies and programs. An aesthetic participation can not only lead to an evolution in the landscape, in fact, the diversity in landscape can also alter aesthetic experiences, like for instance, when a hurricane desecrates an admired landscape. As there is a gradual change in the landscape patterns, there seems to be a gradual evolution of people's aesthetic experience of places, which ultimately leads to a modification in their actions. Landscapes can also lead to a change in people as they assimilate from observing and interacting with landscapes.

Landscape patterns that elicit aesthetic responses of immediate pleasure or displeasure are an important starting point for formulating actions to affect landscape change. [31]

Some settings that are highly preferred by humans, thus, are least preferred ecologically.

[30] *Aldo Leopold, 1981; Saito, 1988; Howett 1987*
[31] *Paul Gobster, 2007*

3.5 **UNDERSTANDING LANDSCAPE PREFERENCES**

Landscape Preferences can be construed as the degree to which a landscape is cherished as a amplification of its possession of positive qualities relative to other landscapes. Collectively, coherence, legibility, complexity and mystery seem to be fairly universally valid factors that produce definite preferences.

In order to orient ourselves in, make sense of and find beauty and the sublime in our environment, a landscape should contain the following qualities:

- **Diversity** is *Complexity* expressed as layered, multi-scaled elements contrasting with one another. This is a characteristic of all self-organized landscapes to varying degrees and of all healthy ecosystems. Specifically, less diverse environments may either possess diversity at another spatial scale or have been simplified as a result of management or other human alteration or design.

- **Coherence** in terms of an ordered structure that we can comprehend, and where comprehension of the whole is more significant than the individual parts. Unity and conformity are synonymous with this attribute. However its absence is often marked by ad-hoc economically driven alterations that takes place in landscapes.

- **Spirit of Place** where the landscape has a special quality of uniqueness that is identifiable. All self-organized patterns and the better designed landscapes are the unique expression of all the processes at a given point in time, which yields this quality. It is sometimes known as genius loci when it is specially intense and associated with the landscape capable of producing sensations of beauty or sublimity.

- **Mystery** in the sense that when the landscape has coherence, it cannot all be perceived at once. This encourages us to explore such landscapes and spend more time learning about them. The organic, self-organized natural/ cultural landscape possess this in full measure whereas it tends to be absent in the simplified planned examples.

- **Multiple scales** where there is a ranking or range of scales to the landscape pattern in relation to the human size. This is the aspect of comparative magnitude and it

provides a framework for complexity, gives stimulation of the same diversity close at hand or far away.

- **Strength** is the overall mixture of the above five aspects which reinforce each other and enhance their individual qualities. When all are present in quantity, the aesthetic result is as potent as possible.

The above mentioned parameters are considered while locating campsites & other pause locations in the Rani Reserve Forest trail. Such an approach is essential while designing and preparing management plans for the large and complex landscape of the forest trail. The forest landscape is further classified into vegetation typologies; faunal habitat preferences etc. for ease of preparing mitigation & design strategies.

3.6 **SUSTAINABLE LANDSCAPE PLANNING**

Such landscape planning with an agenda of reconnection (natural and human elements of whole landscapes), alleged disconnections and their supposed consequences; emphasizing 'change drivers' as a potentially positive means of creating new connectivities between people and place thus crafting new 'space' for water and wildlife.

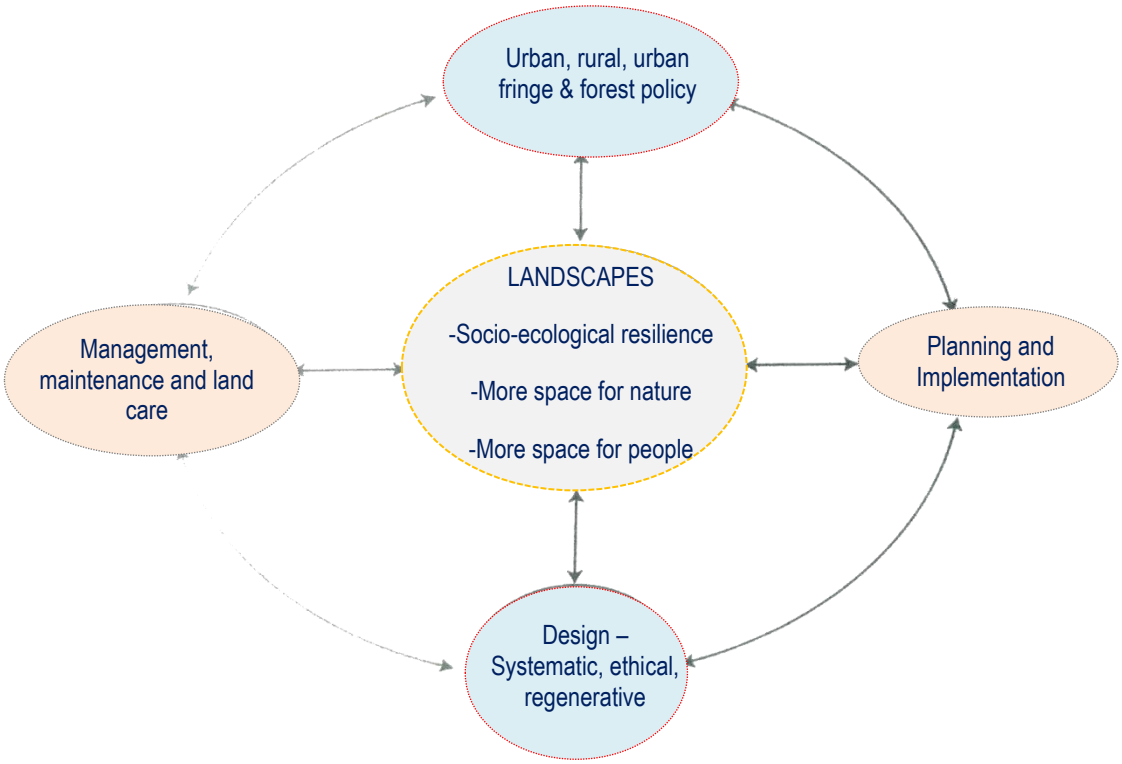


Fig: Arenas for pursuing landscape connectedness through improved policy, planning, design and management (*Paul Selman, 2012*)

The figure above suggests an approach that links policy and practice to the emergence of more sustainable and resilient landscapes.

Opportunities exist both in relations to the two-dimensional space of the landscape surface, and to the three-dimensional space of physical layers above and below ground.[32] Making an allowance for social connection with landscape along with the creation of a social competence to initiate sustainable landscape evolution, can advocate the emanation of future landscapes that are relinked, resilient and valued among all users/stakeholders that are associated with it.

[32] *Paul Selman, 2012*

4. CASE STUDIES

4.1 **BRAJ LANDSCAPE, GOVARDHAN HILL, INDIA**

Legendary associations with Lord Krishna have imbued the cultural landscape of Braj with great religious significance drawing over 50 million pilgrims annually who go on circumambulatory tours of the landscape.

Govardhan Hill is actually a long, low ridge, part of the Aravalli mountain range, rising not more than 100 feet above the surrounding plain. Nestling against the Hill where it crests are the villages of Jatipura and Aniyor, while at its southern foot lies the village of Puncharit. A schism in its profile at mid-range known as Dan Ghati or Talhati is a prominent point of arrival from Mathura just south of the flourishing town of Govardhan. The Hill is visible only for a short distance on its north, tapering off well before one reaches Radhakund village.

The sacred hills, groves, and ponds of Braj are facing loss of forest cover and drying up of water bodies. Ecological stability of the pastoral landscape of Govardhan is being threatened due to recent development in the region, thus leading to over commercialization of its sacred ambience.

In circumambulating the landscape, pilgrims frequent sacred tanks and groves, temples and shrines located around the Hill. Scholarship on Braj has emphasized the (re)construction of sacred landscape in pilgrimage and a continuing re-enactment of rituals that affirm an idealized vision of that landscape. The physiological impact is lessened as well as the quality of engagement with the sites are reduced due to the incongruence between the imagined and real landscapes.

Natural features of Govardhan Hill—its forest cover, flora and fauna, site hydrology—and its land use patterns that create a mosaic of fields, groves, and villages clustered tightly around tanks. The intricately complex web of paths and trails with the main circumambulatory route around the Hill are traced and the visual as well as haptic experience of movement is represented in collages. Sacred sites are, thus, categorized into *vans* (forests), *kunds* (water tanks), *raas sthalis* (sites for Krishna lila), temples, shrines. They are interpreted as narrative place markers and mnemonic devices that invite ritual enactment of Krishna stories and worship, constituting the intangible heritage of Braj. By means of cultural landscape protection and management, it is believed that this form of heritage can be conserved and promoted.

The landscape design proposals are guided by archetypal landscape imagery and local practice of nature veneration. They are based upon the premise that traditional belief systems can be harnessed in the promotion of environmental health of degraded sites. Reclaiming the sites will in turn lead to active encouragement and sustenance of traditional practices.

Fig: Master Plan of Govardhan Hill (Source: Unversity of Illinois at Urbana-Champaign, USA and Braj Foundation, Vrindavan, India)

Trees form a protective enclosure for parakeets and peacocks, as well as for the fatigued pilgrim. They not only serve as visual frames of a landscape view, but also as place markers of Krishna narratives, as wayside shrines and resting places as well as nodes on the pilgrim path taking one to spiritual and physical wanderings through the landscape.

Fig: Existing Fauna of Govardhan Hill (Source: Unversity of Illinois at Urbana-Champaign, USA and Braj Foundation, Vrindavan, India)

Landscape Planning, Design and Management Proposals

A framework for conservation of Govardhan Hill is proposed for guiding policy programs, planning regulations, and design interventions. Its stated objectives are not only to reclaim, remediate or restore individual sites, but also to set a standard model for preservation and

development that can be followed throughout the conservation zone. The Hill is designated as a protected cultural landscape with a 500 feet buffer zone for regulated development. Design proposals depict ways in which the idealized landscape of Govardhan can be realized by restoring the grove and the *kund* that form the archetypal landscape unit. The intended goal for organizing movement in the landscape is to reclaim space for the prostrating pilgrim and the holy wanderer. *Kunds* that are the primary public space for the community as well as sites of ritual ablutions by pilgrims, and lined with temples and shrines are redesigned using the principle of 'constructive surgery' such that they become the major nodes on the circumambulatory tour of the Hill. Interpretive signage for guiding visitor movement and experience is proposed and a welcome center for visitors is designed at Dan Ghati.

The master plan of Govardhan Hill assimilates the proposals for *kund* restoration, *van* regeneration, development of signage and rest facilities, traffic management, public sanitation improvement, bird sanctuary and wildlife corridor. The comprehensive planning and design proposals do not fence the Hill from people but reclaim it as sacred ground and for eco-cultural tourism destination such that heritage becomes a public good for pilgrims and tourists alike.
The sites such as sacred *sthalis* and narrative landscapes interpreted for pilgrims and other visitors are reclaimed in the inner core of the protected zone of Govardhan Hill.

Their redesign is based upon the imagined landscape of Govardhan, the transcendental vision that has captured the imagination of Hindus over centuries. Due to the redesign, there has been a reduction in the dissonance between vision and reality, enhancement in the experience of pilgrimage and introduction of the environmental and cultural heritage of Govardhan to visitors.

The primary purpose of the landscape planning and management proposal is to make Govardhan Hill a destination for eco-cultural tourism, apart from awarding it a protected status as a cultural landscape zone. This would create opportunities for economic investment, upgrade infrastructure, consolidation and separation of conflicting activities, and introduction of best practices for public sanitation as well as maintenance of public spaces. Govardhan possesses both environmental and cultural heritage, and collectively, these resources can be managed and interpreted for eco-cultural tourism.

Nature veneration is quite evident in Govardhan sites and their worship rituals such as those that are witnessed in the worship of mountain, tree, water, cattle, and snake. Thus, the

protection of *vans*, *kunds*, cattle and wildlife should be of paramount importance as they are the primary components of a cultural landscape that is unique and educational for the current times with its environmental conundrums.

Pilgrimage, a form of religious tourism can be extended to include those visitors who come not with the purpose of attaining spiritual benefit but to be acquainted with a way of life rooted in the sacred cultural landscape. Visitor infrastructure is an absolute requirement to support the needs of visitors ranging from the devout pilgrim to the casual tourist.

Therefore, in case of the increased religious tourism in Dakini Hill of the Reserve forest, a way to plan and mitigate the pressure on natural resources is to develop an approach in a similar way where the association of people remains intact with a controlled visitation and the need for fostering stewardship is felt.

4.2 **THE SATOYAMA LANDSCAPES, JAPAN**

Small forests are beautifully maintained everywhere in Japan so as to maintain the sacred atmosphere around such religious places as temples and shrines, and it is referred to as Chinju-*no-mori*. These forests are usually in village areas, and native biodiversity in the region concerned is partly conserved there. Immediately following the Meiji restoration, some 130 years ago, some of the *Chinju-no-mori* was damaged by people, but many of them have been preserved in their original form even today. Japanese people worship gods of the natural

world, believed to number some 8 million, and the Chinju-no-mori stand as an important element to sustain the sacred atmosphere in such religious areas.

With these forests, the sacred environment is maintained while at the same time they sustain the concept of a harmonious coexistence between nature and humanity. It is rather a pity to note that the idea of a sustainable lifestyle has recently changed in Japan, and the trend to a more convenient lifestyle, which only seeks economic success and materialism, has become overwhelming.

Fig : View of the Satoyama Landscape (Source: Wikipedia)

The traditional development of the Japanese archipelago led to the formation of three distinct land zones:

- Hitozato, or village areas where living areas and agricultural areas have been developed after completely cutting down the forest cover, and which are carefully maintained without recovery of the forests
- Satoyama, or the surroundings of Hitozato, from where natural resources are sustainably harvested by the village people
- Okuyama, or mountain forests where nature has been conserved in a primitive way.

This zonation of the Japanese archipelago reflects the biosphere reserves concept, although theoretically it was developed before the concept was recognized. Japanese people, who lived mostly in the Hitozato areas, loved nature, and their lifestyle proved to be widely sustainable and enabled them to consume the products of nature for many years.

Fig : Artists representation of the landscape depicting various zones (Source: Unknown)

Satoyama means a zone or area between mountain foothills and arable flat land. Literally, Sato means arable and livable land or homeland, and Yama means hill or mountain. It is a mixture of forests, wet rice paddies, cultivated fields, pastures, streams, ponds & irrigation ditches surrounding a Japanese farming village. It comprises the entire landscape necessary to supply the needs of the community. In this system the forests are managed by local agriculture communities & have developed through human interventions in natural systems over years. Leaf litter collected from forests was used as manure for farms; wood was

collected for construction purposes. The constant collection of leaves & wood kept the forest open & prevented the succession of large trees & dense shade. Their mosaics provided a variety of habitat types & supported a rich biodiversity. Thus it was an effective coexistence of man and nature.

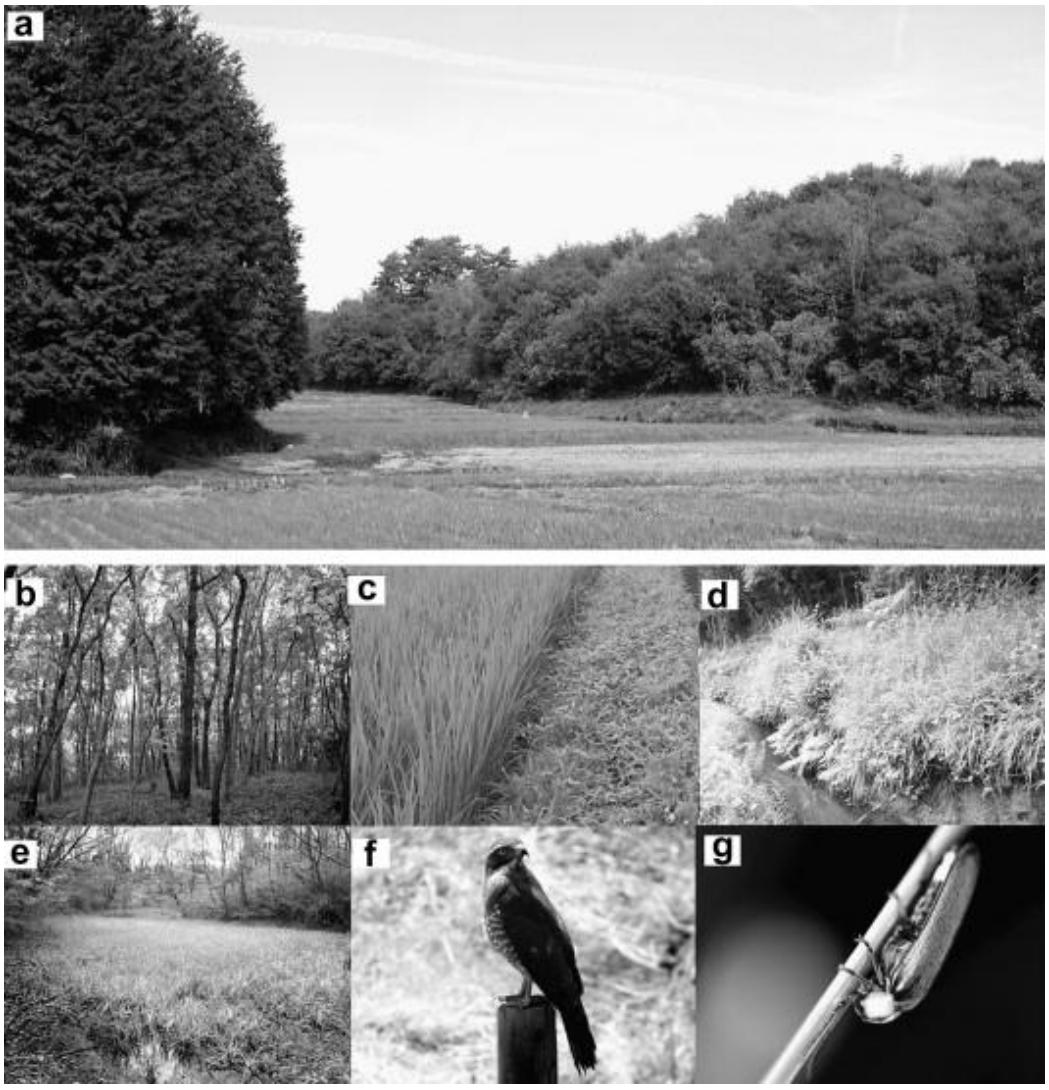


Fig: Images illustrating all the components of the ecosystem

a) Farmlands surrounded by forests

b) Woodland in winter

c) Paddy fields

d) Streams maintained as irrigation canals

e) Open marshy areas

f) Avifaunal habitat

g) Insects & similar organisms adding to soil quality

(Source: Research Gate)

Ecology & Landscape Management strategies

This system depends on habitat modification, which is a trait common to humans & nature. Managed landscapes can have a great deal of biodiversity & add an important dimension to the landscape mosaic.[33]

[33] *K.Takeuchi et al. 2003*

It was also a system developed to mitigate disasters during the rains. Human settlements were arranged linearly along the base of the hills. Immediately in front of the hills were the vegetable gardens & beyond that were the lowland paddy fields. The Forested slopes controlled erosion, while dikes were used to direct water from the woodland to the terraced paddies & then entering the local stream. This network of dikes worked even for managing the snow melt & irrigating the paddy. It also supported aquatic biodiversity & enabled migration of fishes.

The term Satoyama was originally used to denote forests surrounding farm villages and managed by farmers for different needs—timber for buildings, wood for fuel and charcoal production, leaf litter and twigs used as fertilizer for crops, particularly in the rice paddy fields situated in the lowlands.

Sometimes silk production occurred in the mountain forests. Different food products were also collected, such as bamboo shoots, nuts of chestnut (*Castanea crenata*) and horse chestnut (*Aesculus turbinata*), mushrooms, and young shoots of ferns and herbs.[34] These areas might be called Satoyama woodlands, as they comprise uplands surrounding cultivated valleys dominated by rice paddy fields between wooded uplands and open farmland in the valleys.

Some management strategies followed include:

• Trees were cut at the stem base every 10 years.

• 50 ha of paddy required 500-600ha of Satoyama woodlands for litter gathering.

• Coppicing for coal production was a common practice.

• The water from snowmelt was collected in cannels & used to flood the rice paddies & eventually meet the sea.

Satoyama Conservation

In the 20th century, Satoyama were the forgotten landscapes of Japan. In the 1980s, local movements for conserving Satoyama landscapes began. In the 21st Century, Satoyama is seen as a prototype for sustainable development. The earliest conservation activity taken up was management of vegetation & preserving symbolic species of Satoyama landscapes. Later the focus was enlarged from preserving specific species to preserving & managing the entire Satoyama landscapes. Local government, nature enthusiast groups & environmentalists support this conservation activity. Satoyama woodlands are being rediscovered as attractive leisure areas.

[34] *Kobori and Primach 2003, Takeuchi 2003, Tsunekawa 2003, Iguchi 2002*

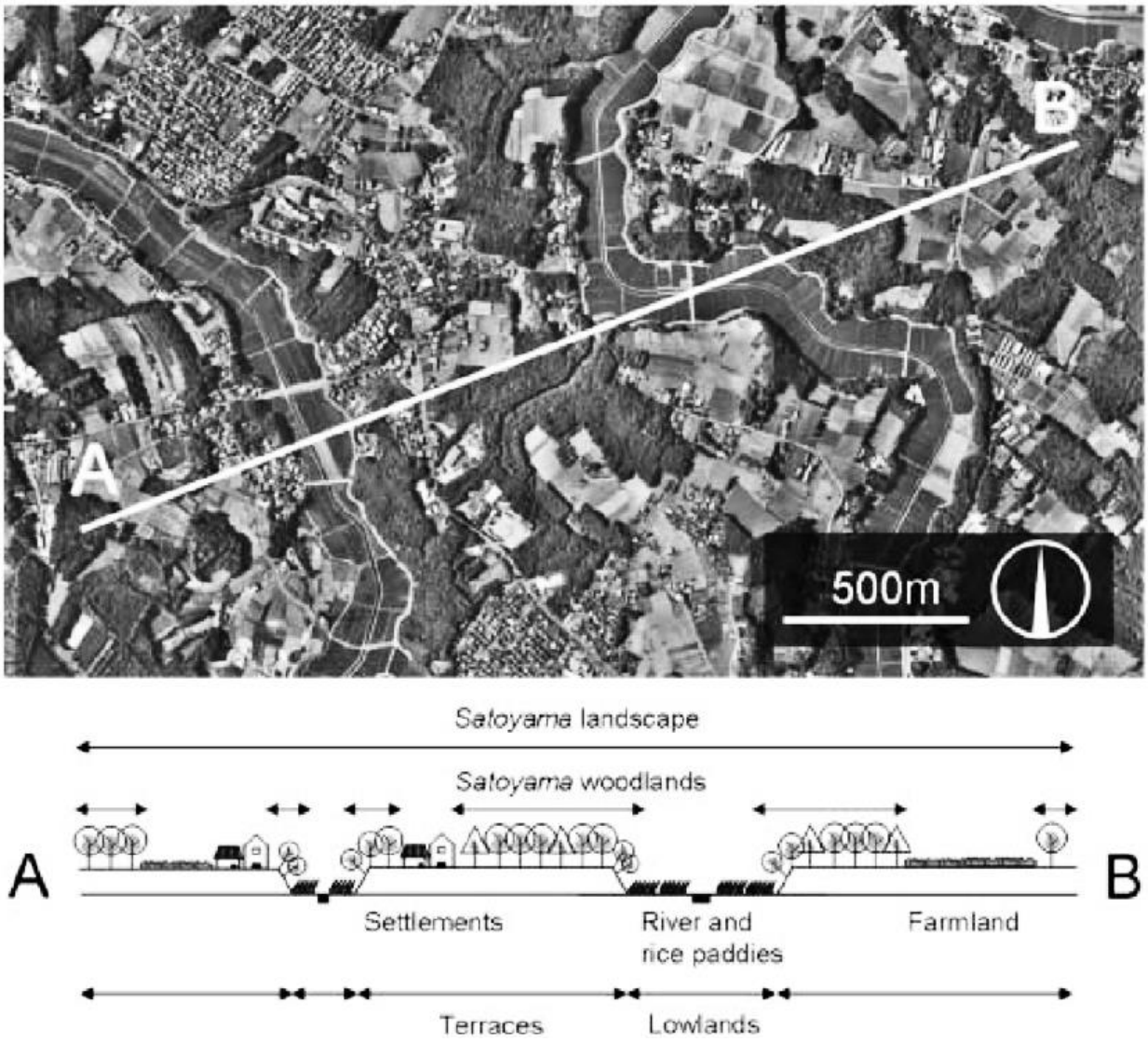


Fig : Aerial photo and cross-section of typical Satoyama landscape of peri-urban Tokyo, 40km east of central Tokyo in Chiba Prefecture (Source: Geographical Survey Institute of Japan 2005)

Public education & public participation was integrated for landscape management. This established trusting relationships between landowners & local citizens, making preservation from development more effective. Some localities have established environmental units and citizens have organized new associations to take initiatives in this activity. People are invited to take part in restoration work over weekends, and in some cases they are welcomed to cultivate small "garden lots" with rice or vegetable paddy fields in Satoyama village landscapes. Such enticements have brought many families and school groups to visit nature areas.[35]

Satoyama woodlands are easily accessible areas where everybody can enjoy nature as a contrast to the stressful daily life in crowded cities. The various activities include cycling

[35] *Tabata 2001, Iguchi 2002, Nakagawa 2003, Kuramoto 2003*

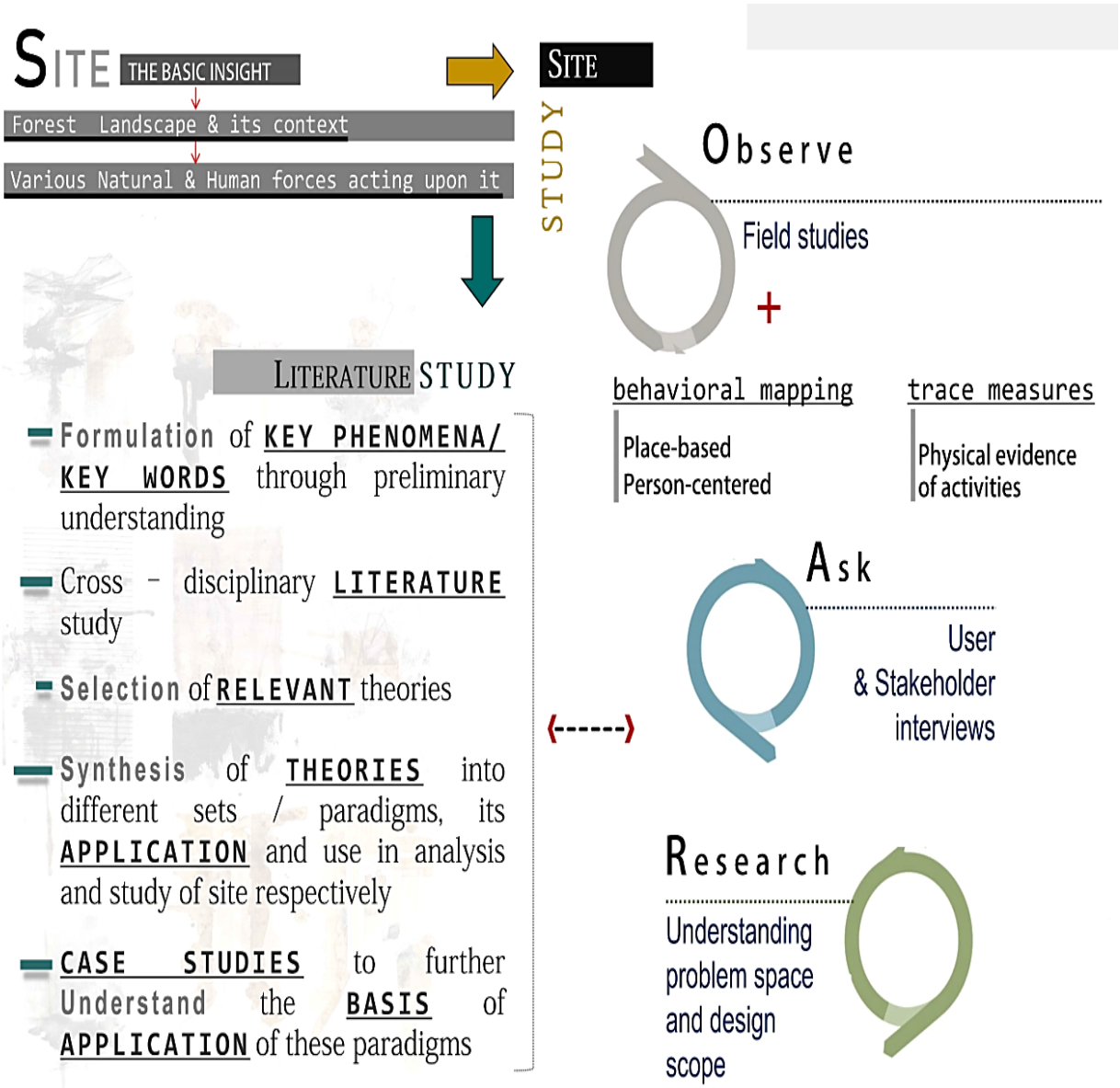
tours, town & village walks, long stays, art & cultural festivals (local food, harvesting paddy, sowing paddy)

Implementation Process Tokyo is an example to counter the steady loss of traditional agricultural landscapes & wildlife habitat a campaign was initiated by local residents together with a private environmental organization.

The project was built around four major activities. During the initial phase a broad range of people were encouraged to contribute to buy land for conservation as Satoyama. Second phase involved calling volunteers to restore the Satoyama landscapes with the help of local farmers. A total of two thousand people worked together to re-build rice paddies & water reservoirs. Third Phase involved researchers along with local to gather information about the endangered species, cultural history & landscape. The final stage included the development of an environmental education program was designed for Japanese children. This helped them familiarize the landscape & culturally important species.

Many traditions & cultures in Asia have developed observing the ecology. Over the years with industrialization & urban development many of these traditional systems are no longer functioning. The urban public has been disconnected from this knowledge. Involving & educating the public, including them in the restoration process, involvement & acknowledgement of the skills of the locals is essential for large scale conservation projects. Studying & understanding the cultural systems & adopting important strategies with management strategies to suit modern day lifestyle is the key to conservation of biodiversity and fostering environmental stewardship. It can be seen as a sustainable prototype for upcoming development in rural areas.

5. METHODOLOGY



6. SITE DOCUMENTATION AND ANALYSIS

6.1 THE NATURAL FORCES ON SITE

6.1.1 Climate

The area under study falls under humid, subtropical region characterized by warm humid climate with heavy rainfall and relatively cools winter, with rather scanty rainfall. Seasons can be categorized as humid, tropical monsoon climate with a prolonged monsoon season from May to September, a relatively cool, dry winter from October to February and a pre-monsoon period in March to May with occasional founder storms. Temperature ranges from 10.60°C to 32.0°C.
According to *Barthakur (1986)*, the climate of the region can be divided into four seasons.

The characteristics of different seasons that could be documented are:
Retreating Monsoon – This period starts in the early October and continues till the onset of winter in November. It begins with clear sky and negligible rainfall (50mm). With the advancement of the seasons, temperature goes down (22°C - 25°C) and morning mist and fogs start appearing. Relative humidity (RH) varies from 70 – 77%.

Winters***:*** This season extends from the month of December to the month of February. During this period, the temperature goes down to 9.3°C, rainfall is scarce and generally does not exceeds 30 mm. Occasionally foggy morning, clear sky and mist at night are the characteristics of this season. Sometimes thunderstorms occur in winter. RH per cent varies from 67 – 84%.

Pre Monsoon***:*** This season begins from the months of March to early May with slight rise in temperature (28°C). Vanishing of fog, occasional thunder-shower is the common features of this season. The weather remains windy during this time. In the early hours of the day, the wind becomes strong, raises dust and occasional unpleasant dust storm begins reaching its peak in the afternoon. Foliage and flower begins to sprout in the deciduous forest. During these seasons, the RH ranges between 68 – 73%.

Monsoon***:*** The monsoon begins towards the mid of April month and continues till the end of September. These are generally the hottest months (33°C). Cloudy weather and continuous rainfall with frequent thundershowers are the main features of this period. RH ranges from 82 – 94%.
Following graphs gives an idea of the climatic conditions in the forest area-

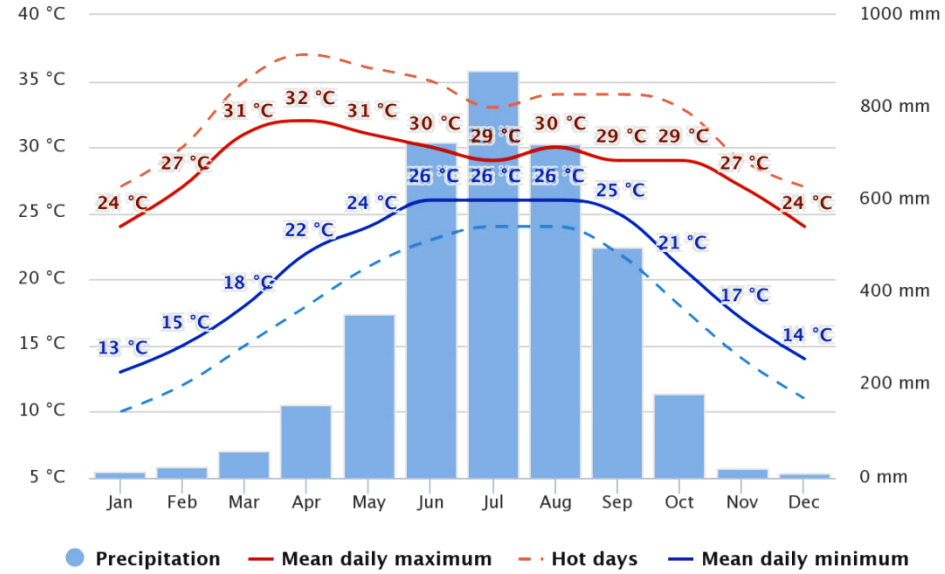


Fig: **Average Temperatures and Precipitation**

(Source: Meteoblue)

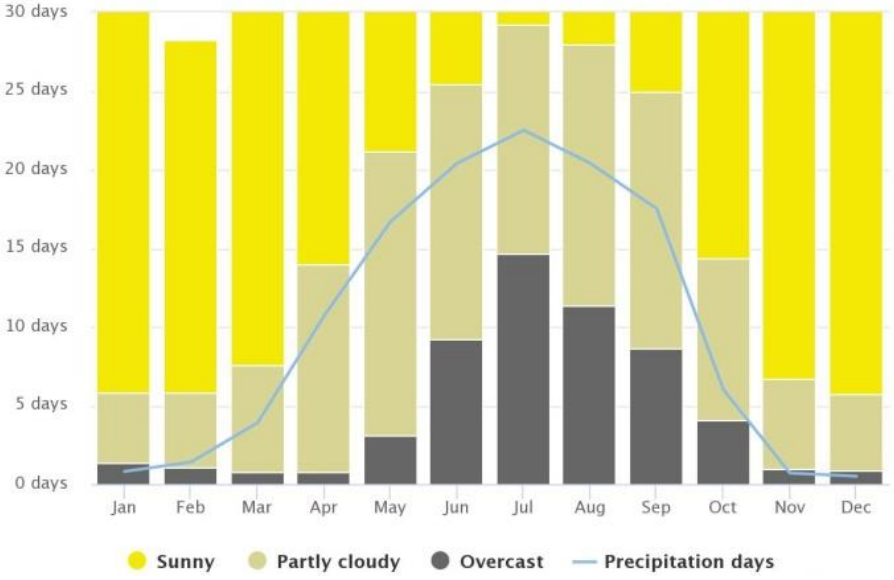


Fig: **Cloudy, Sunny and Precipitation days**

(Source: Meteoblue)

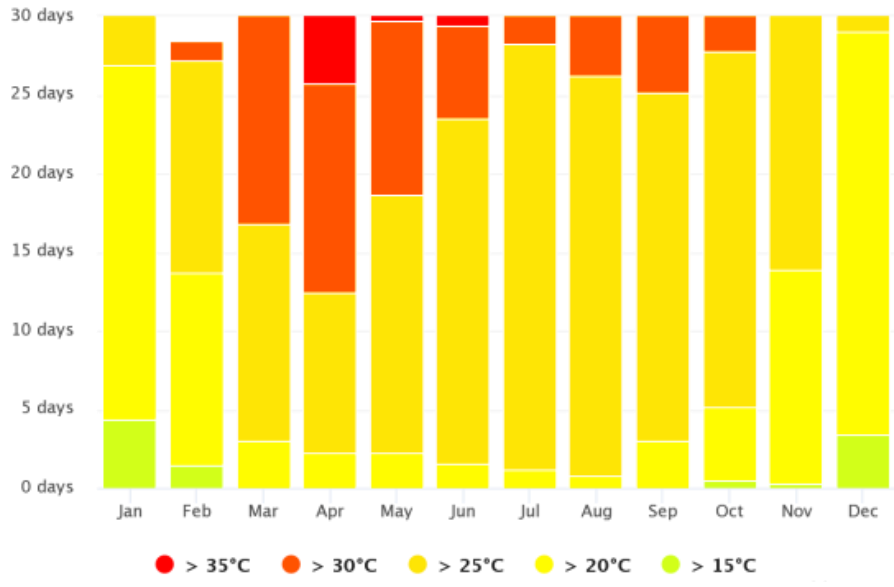


Fig: **Maximum Temperatures**

(Source: Meteoblue)

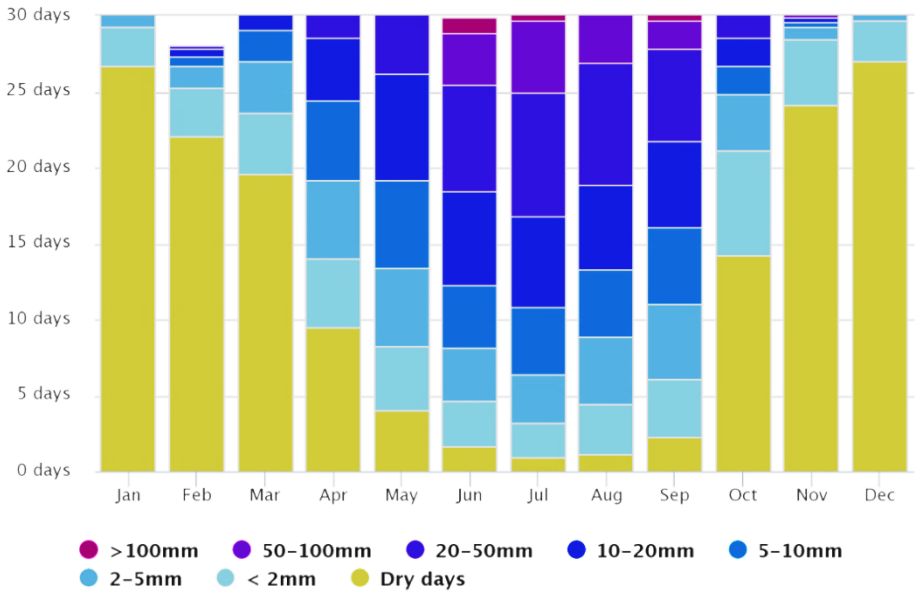


Fig: **Precipitation Amounts**

(Source: Meteoblue)

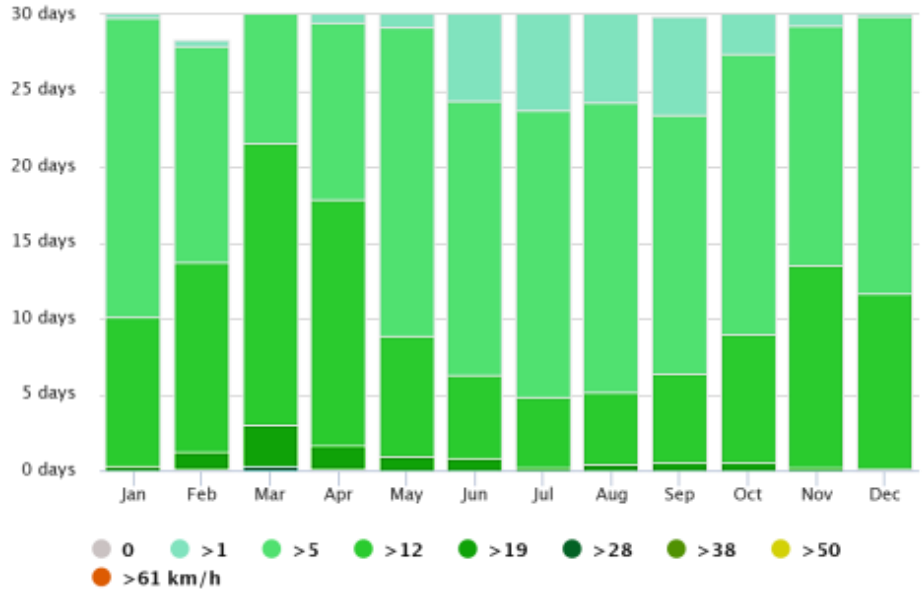


Fig: **Wind Speed**

(Source: Meteoblue)

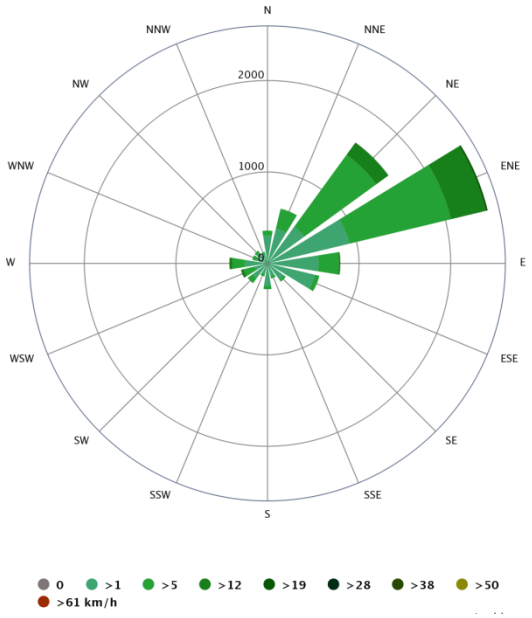


Fig: **Wind Rose**

(Source: Meteoblue)

6.1.2 **Geology and Soil**

The geological formation of Rani-Garbhanga Landscape excepting the recent soil and alluvium belong to the Archean gneisses complex. The oldest formation is composed of gneissic and schist which are extensively intruded by granites. Beds of conglomerates are frequently found at the foot of the hills. The study area is geologically situated on an outlying area of the Shillong plateau. The principal rocks of this outlying portion are acid and basic gneisses which have been metamorphosed by intruded igneous rocks.

The soil type is mainly alluvial although in the higher elevations it is red laterite type. It is shallow and dry at most places but deep and moist soil is also found in some areas. The depth of the soil varies from 15 cm to 50 cm. Organic carbon ranges from 1.3 to 5.74 per cent in the sub-surface soil. The soil texture ranges from sandy loam to clay loam. The pH ranges from 5.2 to 6.4 i.e., acidic to nearly neutral. The content of potassium, phosphorous, total nitrogen and organic carbon ranges from 8.8-35.11 kg/acre, 0.03-1.868 kg/acre, 0.003-4.78 percent and 0.001-5.73 per cent respectively, under various land use practices.

6.1.3 **Geomorphology**

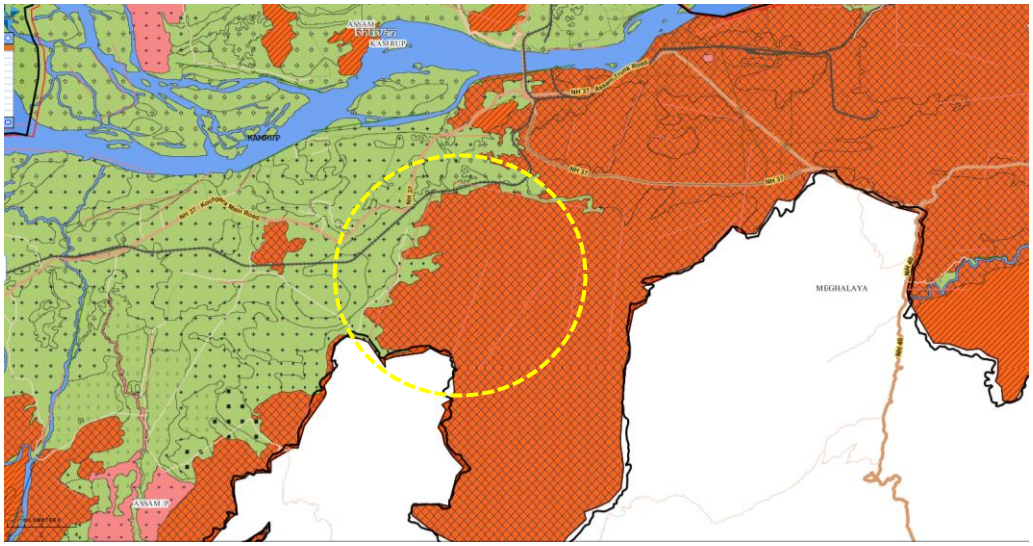


Fig: Geomorphology of the Site

(Source: Bhuvan Thematic Maps)

The study area falls under : Structural Origin – Highly Dissected Hills and Valleys. Presence of two lineaments in the area depicted in pink line.

Legend:

Geomorphology
Structural Origin-Highly Dissected Hills and Valleys
Structural Origin-Moderately Dissected Hills and Valleys
Denudational Origin-Pediment-PediPlain Complex
Fluvial Origin-Older Alluvial Plain
Fluvial Origin-Younger Alluvial Plain
Fluvial Origin-Older Flood Plain
Fluvial Origin-Active Flood Plain
Fluvial Origin-Piedmont Alluvial Plain
Waterbodies

6.1.4 **Elevation**

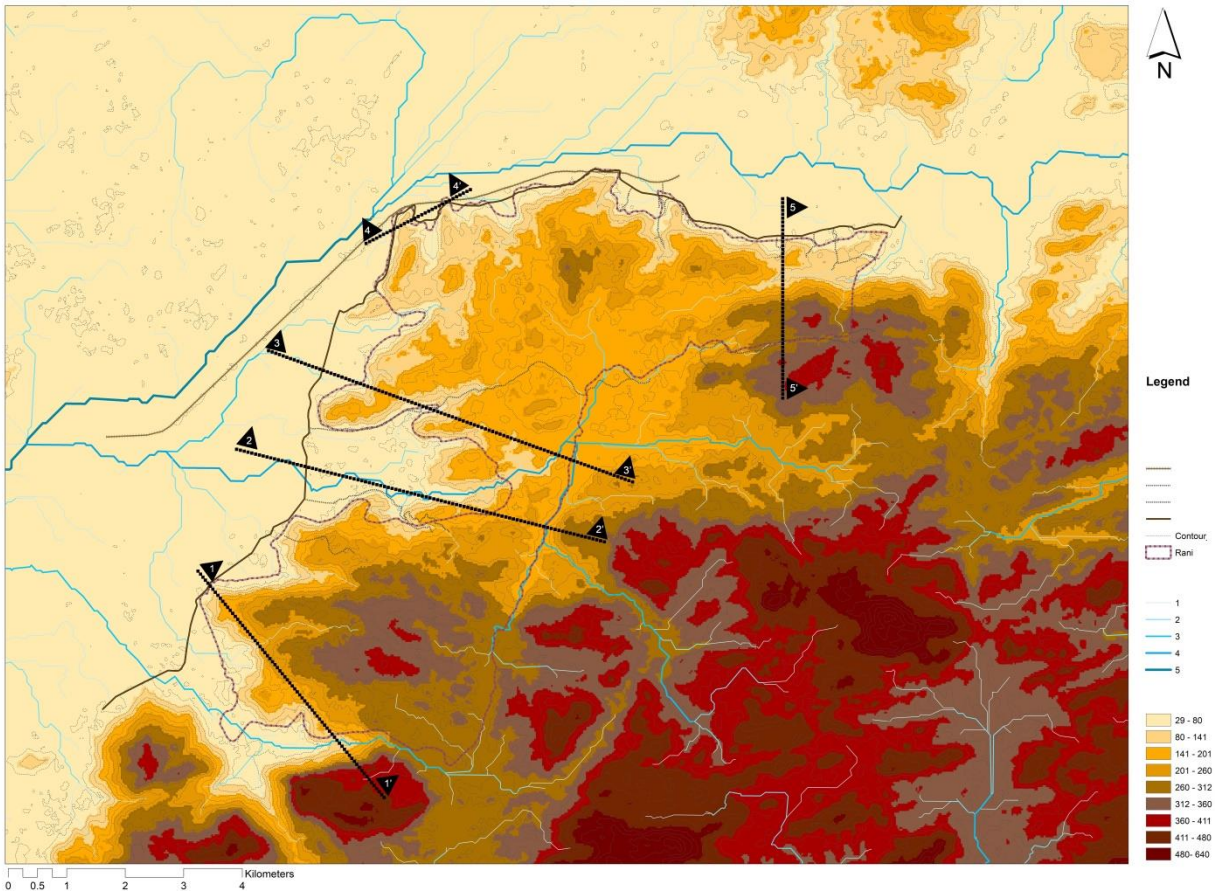


Fig: Elevation Map of the Study Area with its Context (Source: Author)

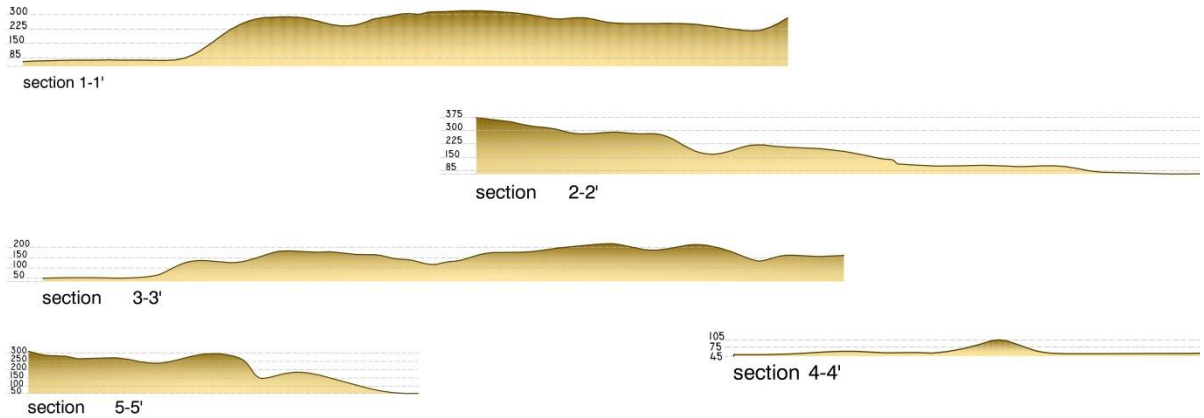


Fig: Illustrative sections showing elevation gradients (Source: Author)

6.1.5 **Slope**

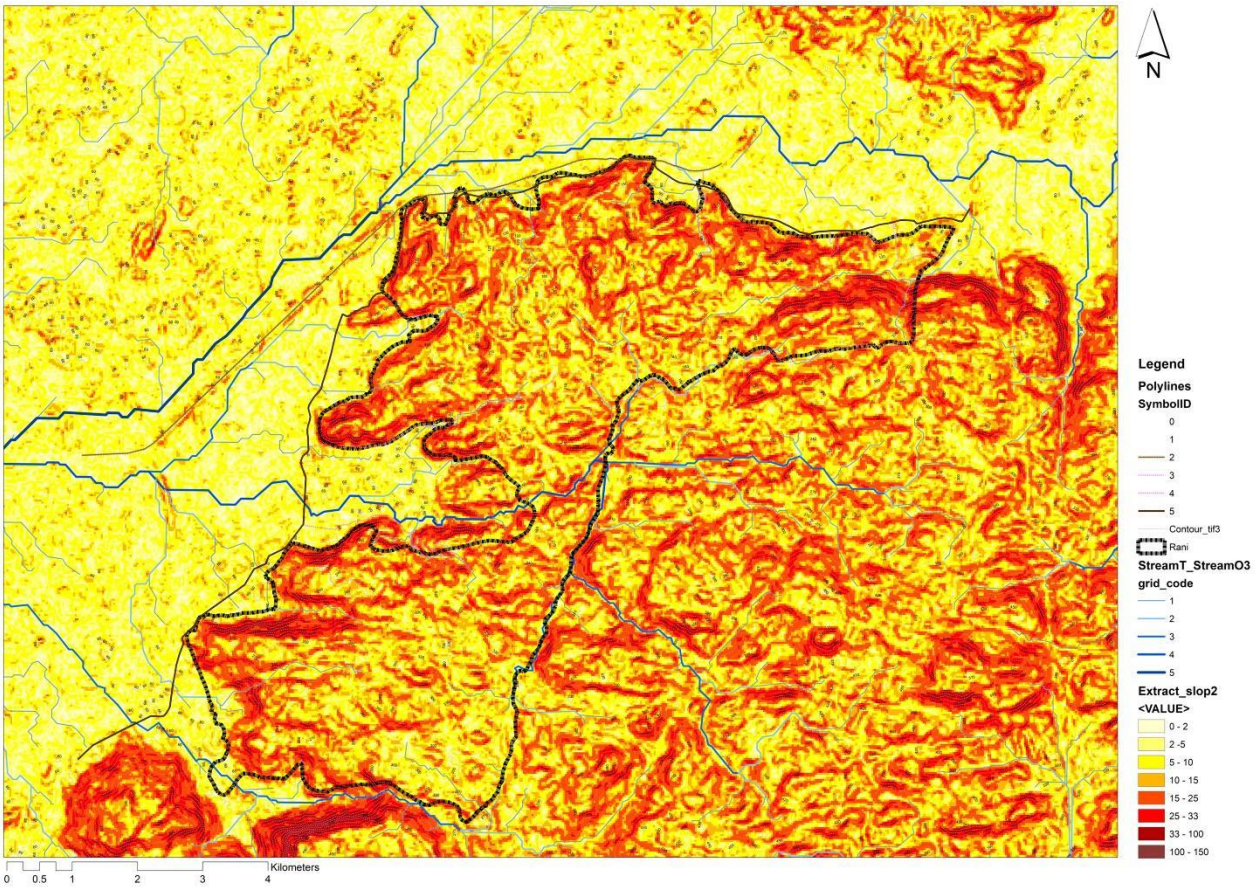


Fig: Slope Map of the Study Area with its Context (Source: Author)

SLOPE IN %		ACCESSIBILITY	DEVELOPMENT
100 & Above	Extremely Steep	Not Accessible	Unsafe
33 – 100	Very Steep	Vehicular access difficult	
25 – 33	Steep	Difficult to walk Need for meandering roads	Difficult , can be achieved
15 – 25 10 – 15	Moderate	Steps for walking Ramps	Can be achieved
5 – 10 2 – 5	Gentle slope	Easy vehicular and pedestrian access	Possible
0 – 2	Flat – Gentle slope		Easily possible

6.1.6 **Hydrology**

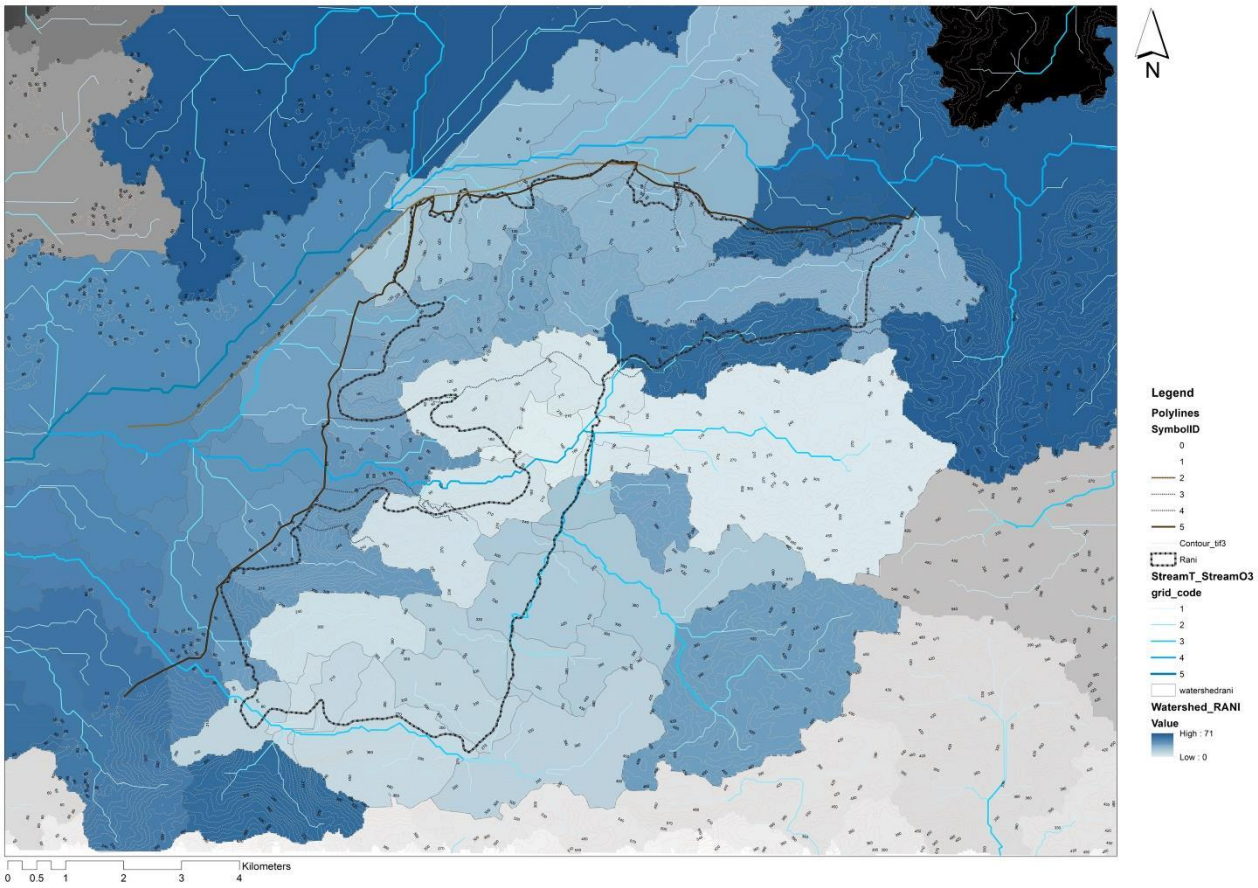
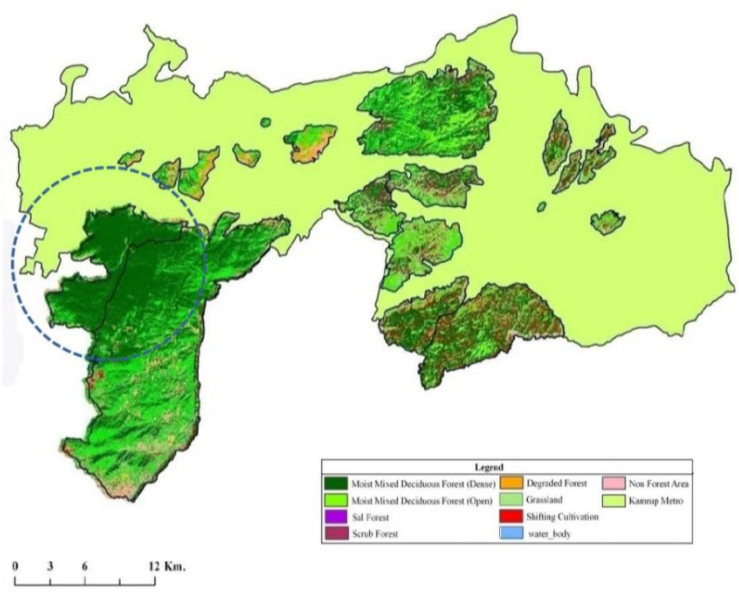


Fig: Hydrology Map (with watershed boundaries) of the Study Area with its Context (Source: Author)

There are mainly four small rivers, which touch some parts of the boundaries of the Reserve forest, and innumerable perennial and seasonal streams, which finally drain into the mighty river Brahmaputra. The direction of all the rivers and most of the streams is from south to north. Along the streams there is a high density of canebrakes. The perenniality of some of the rivulets have been lost where there are large-scale teak plantation, illegal felling of trees and encroachments.

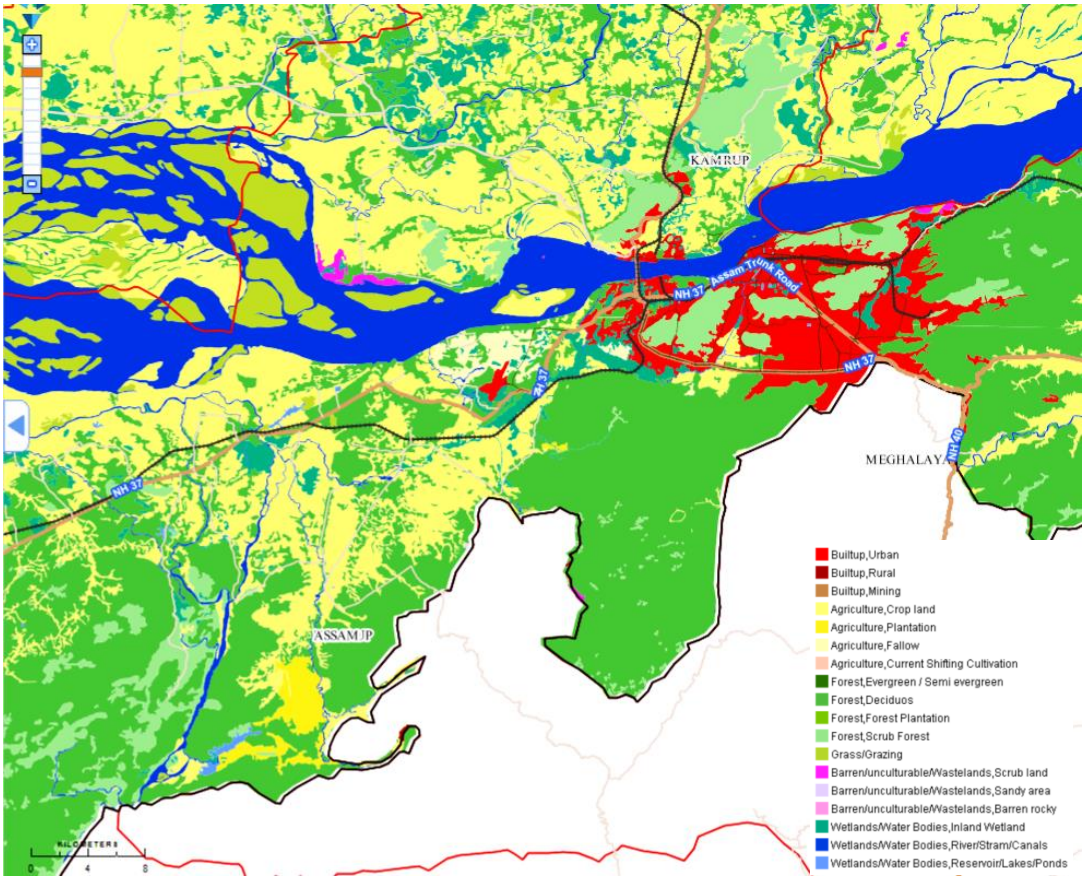
6.1.7 **Landscape typology / Landuse-Landcover Map**



Rani Reserve Forest falls under Moist Mixed Deciduous Forest (both dense and open).

Detail discussion about this landscape type is presented in Chapter 6.1.8.

Fig: Landscape type of Kamrup East forest division and landuse/ landcover map with surrounding context
(Source: Bhuvan)



6.1.8 **Forest Type and Classification**

The forest landscape is a pristine woodland forests dominated by famous 'Khasi hill' and 'Kamrup type of Sal forest' along with other valuable timber forest dominated by species such as *Michelia baillonii, Gmelma arborea, Lagerstroemia parviflora*, *Shorea robusta*, besides a rich gene pool of many important wildlife species.

The Moist Mixed Deciduous forest is composed of large trees that occupy top canopy and it includes *Schima wallichi, Bombax ceiba, Lagerstroemia parviflora, Chukrasie tubularis, Albizia lebbek, Stereospermum personatum, Albizia procera, Terminalia chebula, Sterculia villosa, Gmelma arborea* etc. Medium sized trees species that forms middle storey and includes *Bauhinia acuminata, Holarrhaena antidysenterica, Phyllanthus embetica, Syzygium cumini, Garcinia peduncalata etc.* In some areas, the middle storey is occupied by bamboos called *Dendrocalamus hamiltonii, Bambusa pallida, Bambusa baccoa, Bambusa tulda* and other species that occur in great profusion in damp locations especially along perennial streams and nallahs. In the lower slopes, *Coffea bengalensis, Clerodendrum serratum Phlogocanthus thrysiformis etc* occurs under loose canopies. Ground cover is predominated by different species such as *Chromolaena odorata, Phyllanthus fratemus, Justicia simplex, Paederia foetida, Costus speciosa, Sida cordifolia, Desmodium spp.,* different types of grass and sedges such as *Panicum sp., Carex sp., Cyperus spp., Oplismems burmanii, Eragrostris lamella.* Climbers are frequently found and most commonly species are *Clematis cadmia, Smilax macrophylla, Thunbergia grandiflora, Argyreia speciosa, Myriopleron externum, Combretum decandrum, Cissampelos pareira, Dioscorea alata* etc. They together form the canopy and subcanopy layers of the forest respectively. Below the subcanopy was a layer composed of young individuals of canopy and sub canopy trees and small trees. Moreover, different types of ferns such as *Asplenium sp, Blecnum sp, Adiantum phillipensis, Palhinhaea cemua, Pteris sp., Lygodium Jlexuosum, Helminostachys zeylanica, Pyrrosia rtuda, Drymnaglossum helerophyllum, Asplenium sp., Dryneria quercifolia* etc. are also found to occur. In regard to epiphytes, different orchids such as *Bulbophylhim careyanum, Rhyncostylis sp.* etc., are found to occur in different host plants.

There are five forest types primarily classified within the Reserve according to the 'Revised Forest Type' classification of *Champion & Seth (1968)* and the description of the forest types within the Reserve are as per the records of the *Department of Forests of Assam, 1990*.

a) <u>The Eastern Hill Sal forests</u>: These forests mainly occur in the hilly areas of the Reserve. Pure patches and groups of Sal (*Shorea robusta*) occur in ridges and spurs but these pure

patches are interspersed by mixed deciduous forests in the middle slopes and valleys and in damp patches like the banks of the perennial streams by evergreen forest.

Scima wallichii is the common associate of Sal (*Shorea robusta*) and the other dominant associates in the top canopy are *Shorea assamica* (endemic species), *Lagerstoemia parviflora, Lannea corromandelica, Vitex pedicularis, Castanopsis indica,* and *Dipterocarpus macrocarpus.*

Middle storey is composed of *Holarrhena antidysenterica, Tricalysia singularis, Oroxylum indicum, Salix tertrasperma, Malletus albus, Gmelina arborea, Careya arborea, Semicarpius anacardium.* Clumps of stunted bamboo (*Dendrocalamus hamiltonii*) occur on the ridges and slopes. The ground cover varies considerably according to the canopy opening. In fairly open canopy and near the habitations, *Imperata cylindrica* is the common species. The most common shade tolerant species in locations having closed canopy is *Microstegium ciliatum*. Other species include *Eupatorium odoratum, Carex stroementitia, Thysanllaena maxima*.

Some of the common climbers are *Dalbergia tamarindifolia, Dalbergia remosa, Ficus scandens, Caesalpinia crista, Bauhinia anguinea, Jasminum coaractatum, Mucuna prurita, Clematis cadmia, Paederia scandens,* and *Stenochleana palustris.*

This forest type covers an area of 1769 hectares.

b) **Moist Mixed Deciduous Forests**: In this forest type the principal species forming the top canopy are *Scima wallichii, Vitex peduncularis, Tetrameles nudiflora, Sterospermum personatum, Lagerstoemia parviflora, Sterculia vilosa, Syzygium cumini, Gmelina arborea, Spondias mangifera, Diospyros variegata, Bridelia retusa, Machilus bombycina, Albizzia lebbeck, A.chinensis, Ficus hispida, Sapium baccatum*.

The areas which were subjected to heavy burning in the past, the middle storey is not well defined. However at lower elevations in the valleys, the middle storey is predominanatly occupied by the bamboos (*Dendrocalamus hamiltonii*). In the hill slopes under close canopy, Sau grass (*Microstegium ciliatum*) occurs as ground cover. In the lower slopes *Coffea bengalensis* occurs under close canopy. Along the lower slopes of the foothills, thatch grass (*Imperata cylindrica*) predominates as ground cover in the open patches. Other common species forming the ground cover are *Eupatorium odoratum, Holmskioldia sanguinea, Phyllanthus simplex and Lagerstoemia parviflora.* Under bamboos there is practically no ground cover. Occurrence of climbers is higher in this forest type and some of the dominant species are *Butea parviflora, Millettia auriculata, Smylex macrophylla, Acacia pinnata, Dalbergia remosa,* and *Aristolochia indica, A.tagala.* This type covers an area of 1396 hectares.

c) **Evergreen Patches**: This type is not very common and occurs only in patches, mainly in the hill slopes and shady moist pockets along the banks of perennial streams. Such patches are mostly situated in locations far away from habitations and not subjected to any kind of human interference like shifting cultivation, grazing, forest fire and stone quarrying activities. According to *Champion & Seth (1968)* such type of vegetation is classified under *Assam valley Tropical Semi-evergreen forest, 2B/C1*. The typical evergreen tree species are *Syzygium, Cinnamomum,*
Artocarpus and *Magnolia* sp. while the deciduous species include *Terminalia myriocarpa, T.citrina*, *T.tomentosa, Tetrameles* sp. and *Stereospermum* sp. These canopy trees are 20-30m high. However in the study area the climax formation in such patches was mostly represented by *Garcinia species, Dysoxylum* sp*., Castanopsis* sp*., Artocarpus chaplasa, Echinocarpus* sp*.,* and *Ficus* species*.* The middle storey is occupied by the bamboos (*Dendrocalamus hamiltonii*). The common species forming the ground cover are *Alpinia speciosa, Phalogacanthus* sp*.,* Sau grass *(Microstergium ciliatum), Pollinia ciliata,* occasional canes and ferns. Climbers are not very abundant in this type of patches. It has an area of only 13 hectares.

d) **Secondary Moist Bamboo Brakes**: Large tracts of bamboo brakes occur along with the Moist Mixed Deciduous type in the higher elevations. They occur in great profusion in damp locations especially along the perennial and seasonal streams. These brakes have been found to extend into the evergreen patches in the hill slopes. The principal species of bamboo is *Dendrocalamus hamiltonii*. The growth along the hilly streams is so gregarious that it almost forms a continuous belt of bamboo and it is difficult to distinguish one clump from the other. It is seen lately that the bamboos also occur in the higher elevations subjected to intensive shifting cultivation.

e) **Secondary Euphorbiaceous Scrub**: The extent of area under this type is very limited and occurs in the abandoned areas of 'Jhum' (Shifting cultivation) which have been by the farmers after raising 2-3 crops continuously. The pioneer species is *Macaranga denticulata* to be succeeded by *Trema orientalis, Albizzia chinensis,* and *Callicarpa arborea.* The undergrowth is composed of some dominant species like *Solanum khasiana, Mimosa himalayana, Abroma augusta.* It covers an area of 312.48 hectares.

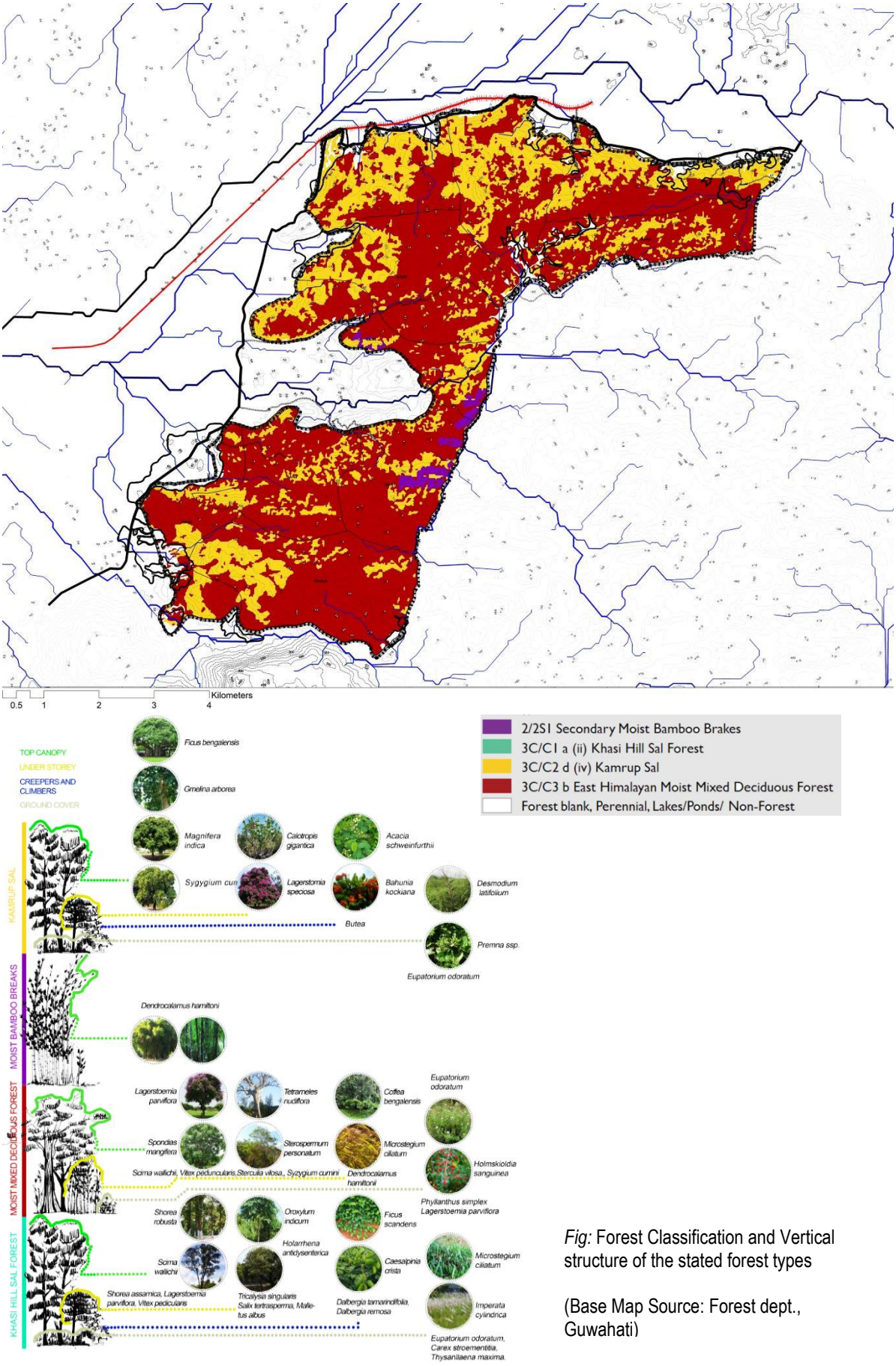


Fig: Forest Classification and Vertical structure of the stated forest types

(Base Map Source: Forest dept., Guwahati)

6.1.9 Forest Fauna

Variety of habitats in Rani Reserved Forest supports specific overlapping communities. These communities are linked by feeding relationships forming a very complex energy transformation system and food web. Important wild mammals found in this reserved forest are Hoolock Gibbon *(Bunopithecus hoolock),* Capped Langur (*Trachypithe cuspileatus),* Assamese Macaque (*Macaca assamensis),* Rhesus Macaque *(Macaca mulata),* Leopard *{Panthera pardus*), Barking Deer *(Muntiacus muntjak),* Indian Mangoose *(Herpestes javanicus),* Wild Boar *(Sus scrofa*) etc.

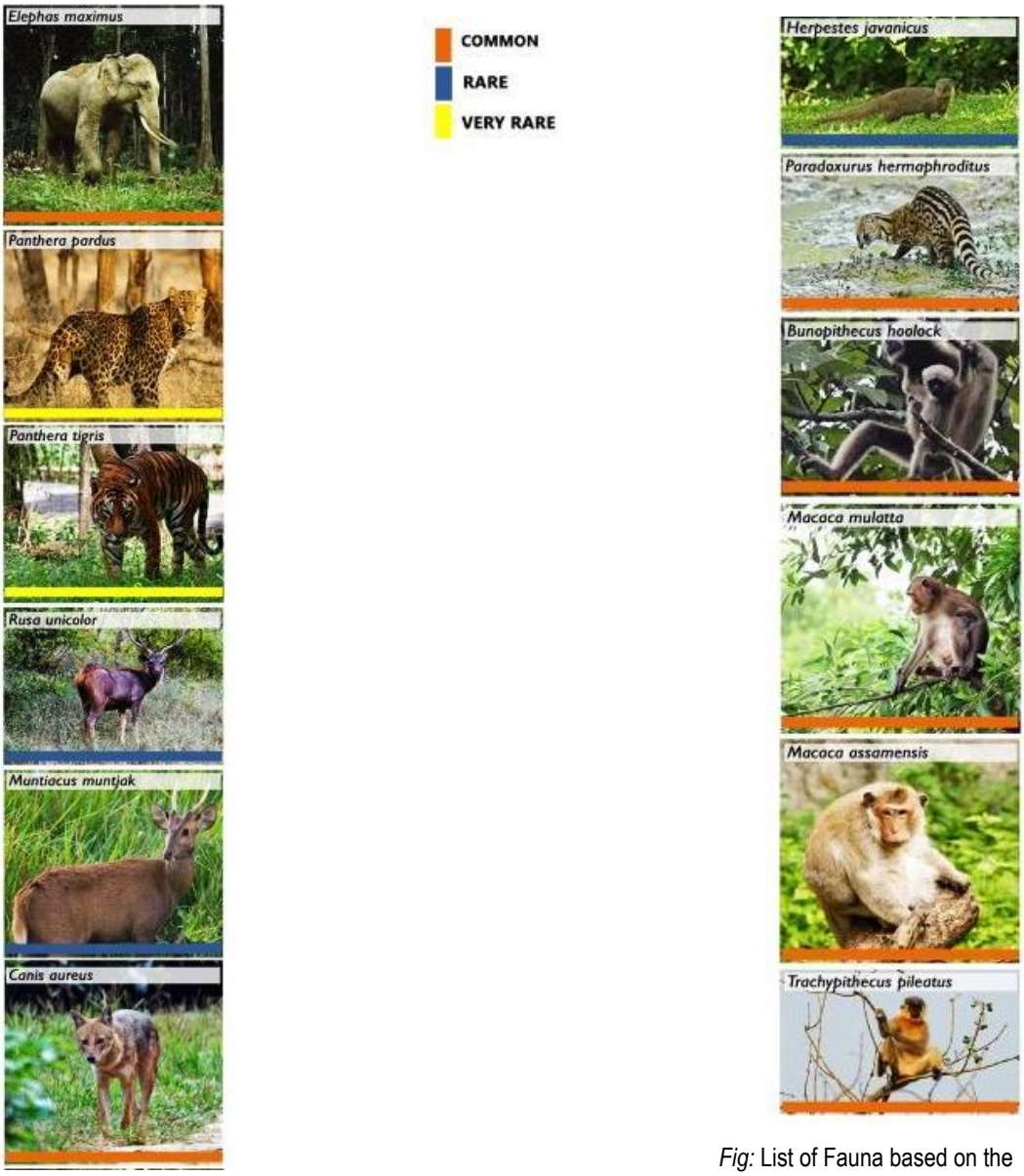


Fig: List of Fauna based on the sightings and conflicts with human

Apart from these, Elephas maximas is one of the important species in the forest fauna. Human-elephant conflicts are common in the area which has led to the decrease in number of the species.

A detailed list of Forest Flora and Fauna is available in the *Annexure 8.1* and *8.2* respectively.

6.2 **THE HUMAN FORCES ON SITE**

6.2.1 **Village Settlements in and around the Reserve Forest**

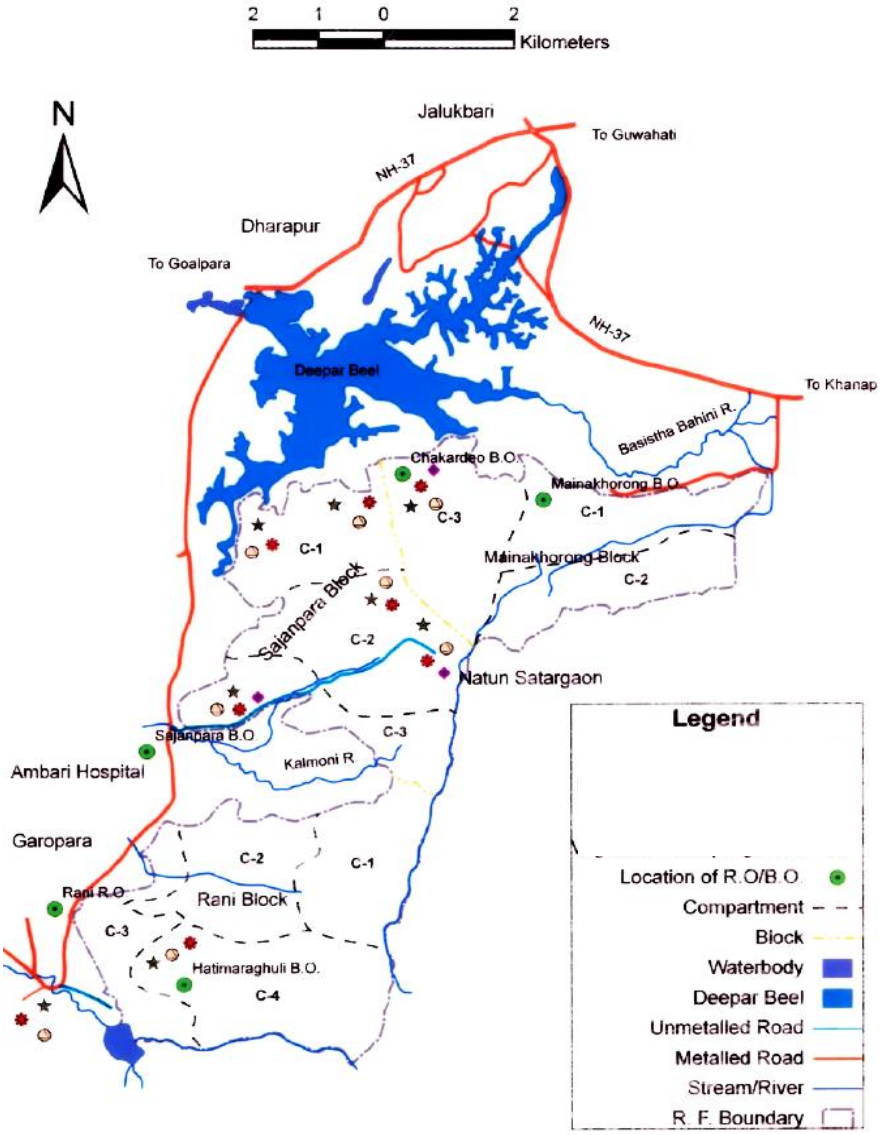


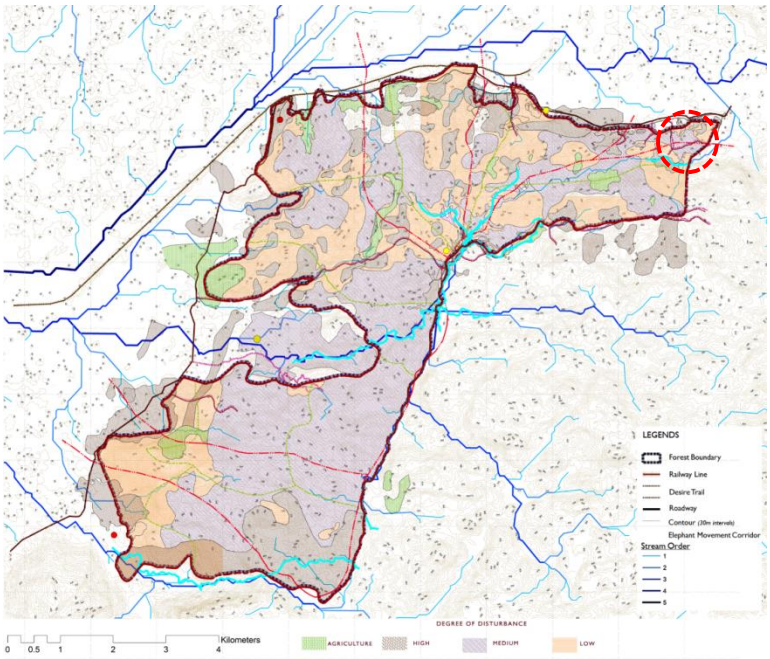
Fig: Map for illustrating Blocks, Village Names and Compartment Boundaries of the Forest along with location of forest offices (Source: Durlav Narayan Singha, Botany Dept., Gauhati University)

ELEVATION (in meters above msl)	NAME	TYPE OF COVER	BIOTIC DISTURBANCE STATUS
150	Satargaon	Natural Forest	Least, selective felling, grazing, logging
200	Chakardeo	Teak Plantations	Moderate, looping, firewood gathering, clear felling of saplings, annual burning
200	Matiya	Exposed area with sparse vegetation	High, new trails/ pathways constructed, earth-cutting, firing, overgrazing
200-250	Matiya & Sajjanpara	Scrub Vegetation	High, overgrazing, firewood collection, earth-cutting
150	Matiya	Grasses	Exposed area (bare soil) with very sparse vegetation

Fig: Table for accessing the impact of settlement and associated activities on forest resources

6.2.2 **Religious Tourism in Dakin Hill**

Bhimeshwar Dham, situated in the outskirts of the city, on a hill inside the forest, just beside



Deepor Beel. There is no constructed temple here. Instead, a Shiva linga (naturally formed) is surrounded by hill stream. Visitors can see continuous water flowing over the linga. This space serves its visitors with serenity, peace of mind and devotion, thus gaining popularity in the recent years which finally has led to unplanned and insensitive development such as concreting trails, monumentalizing natural features etc. catering to the infrastructural needs. Therefore this landscape has been evolving, basically in an unplanned way, through a sequence of implementation of individual activities, losing its character and health.

Fig: Photos of the location illustrating the activities and alterations (Source: Author)

6.2.3 **Quarrying Activities and Infrastructure Development**

Land forms an important component of the environment and is a finite natural resource used by human beings for almost all purposes. It is realized that some natural factors must have some control over the change in the land use pattern being caused by mining and quarrying activities. The long list of impacts includes; land clearing introduction of invasive species, toxins that alter and poison ecosystems etc.

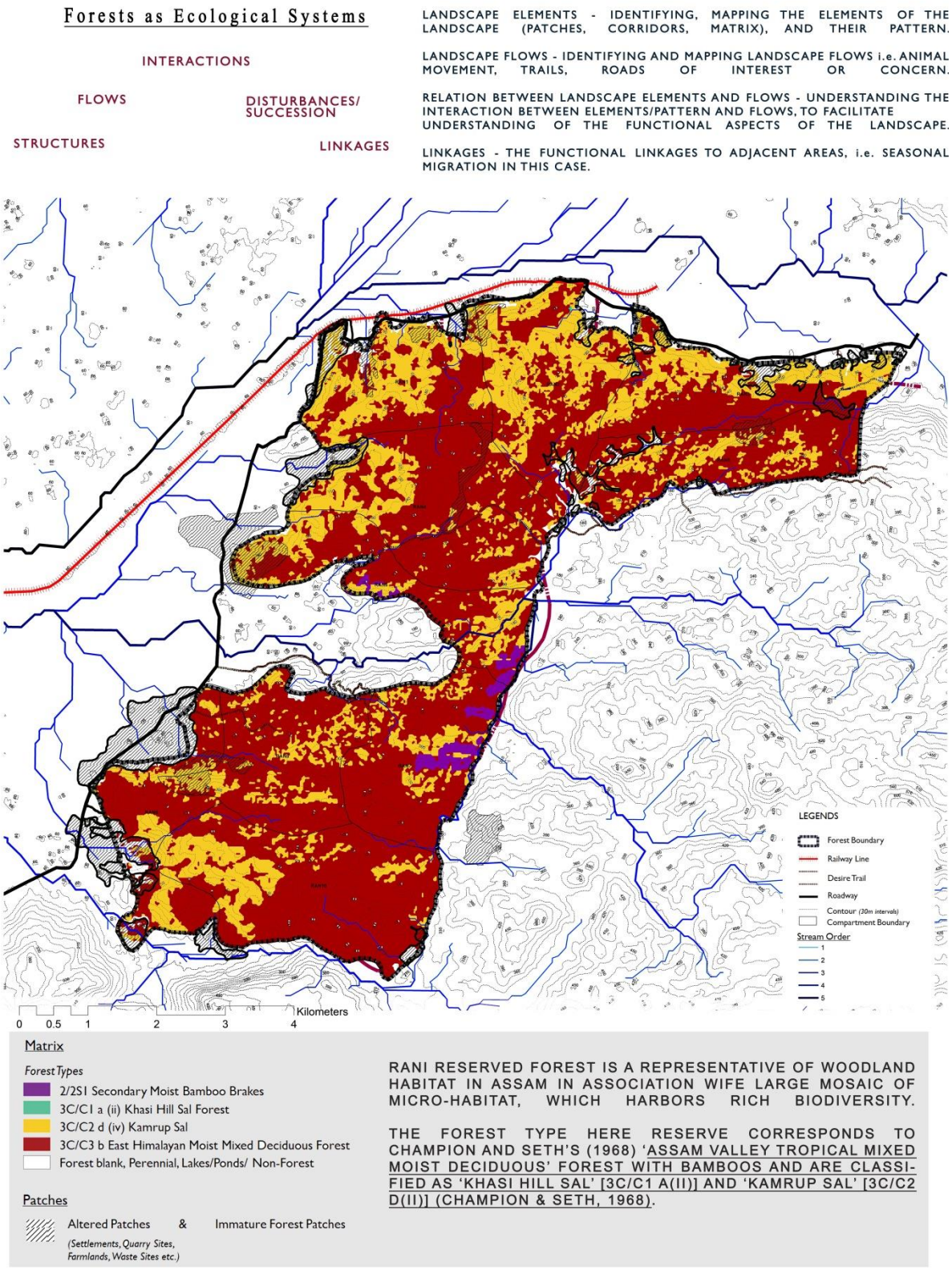
Surface mining completely eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, degrades air quality, alters current land uses, and to some extent permanently changes the general topography of the area mined.

Moreover, it also disrupts virtually all aesthetic elements of the landscape. Alteration of landforms often imposes unfamiliar and discontinuous configurations. New linear patterns appear as material is extracted and waste piles are developed. Different colors and textures are exposed as vegetative cover is removed and overburden dumped to the side. Residents of local communities find such impacts disturbing or unpleasant. This has resulted in a scarred landscape with no scenic value. Owing to such changes, new land-uses are being planned without considering (all its geological and other earth science characteristics) whether the land is capable to support it or not.

Mining and quarrying processes have damaged/ depleted the forests, flora & fauna inviting land degradation and hence altering land use pattern, starting from the fringe areas and ultimately over a larger expanse.

Fig: Photos illustrating various surface mining, excavation and quarry sites (Source: Author)

6.3 **ECOLOGICAL ANALYSIS OF SITE**
(BASED ON PATCH-MATRIX-CORRIDOR MODEL)





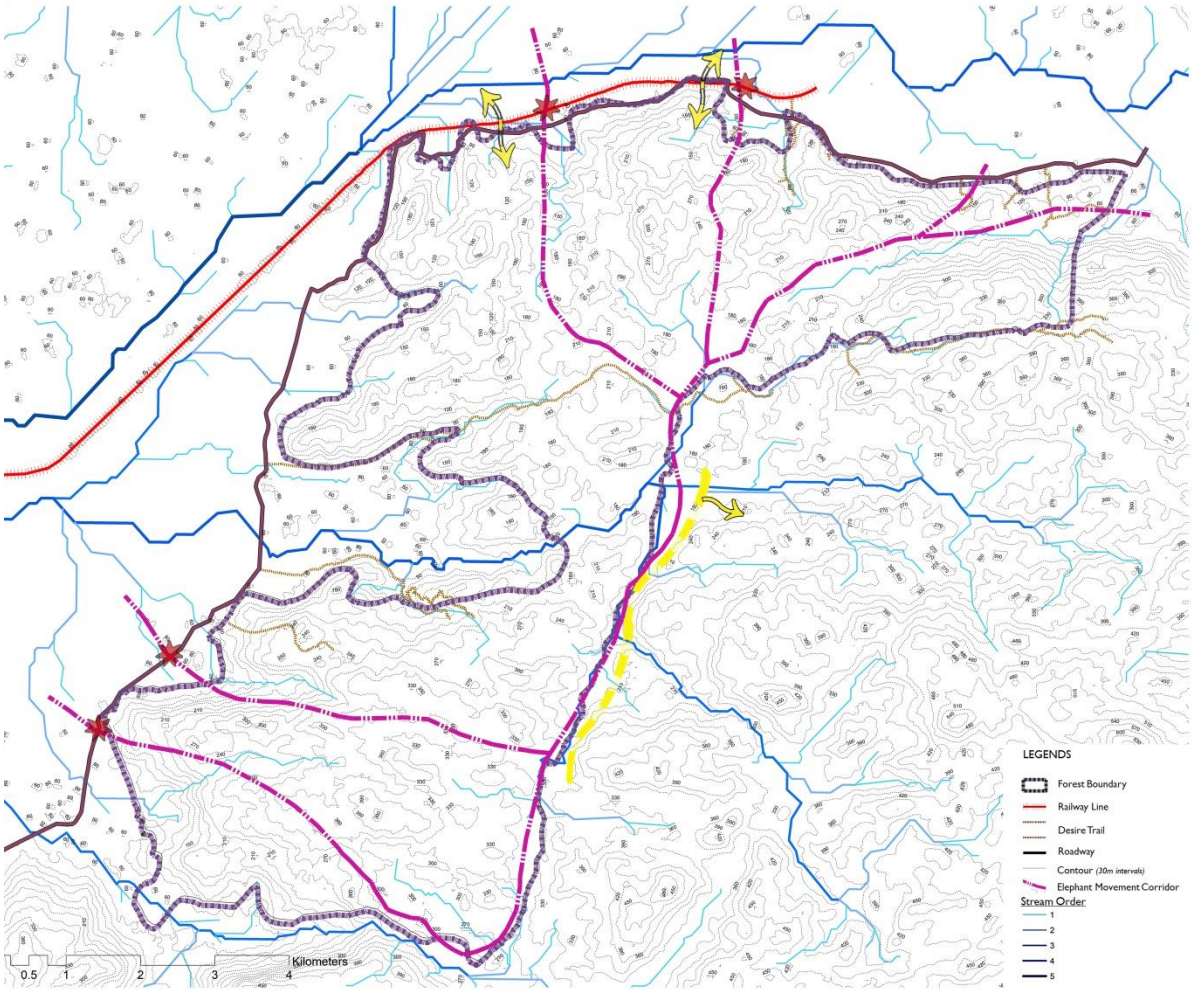

MATRIX - FOREST TYPES



PATCH TYPE - ALTERED

Composition of the mature forest **Matrix** varies from one part of the landscape to another, especially on an elevational gradient. For this reason, the general matrix is subdivided into mapping units based on major vegetation types and its composition.

Non-matrix **Patch** types as mapped are : Immature forest (of varying ecological zones, structural classes and successional stages), rock-dominated patches, wetlands, areas of semipermanent alteration due to human activities (quarrying, farmlands etc.)



Flow phenomena are those things that move across or through landscapes, whether in the air, over land or in the soil. They can be energy or material flows, expressed through living or non-living ecosystem components. Flows may be generalized over large sectors of the landscape, or confined to distinct corridors of a particular patch type or landform feature (e.g., stream corridors). The **Flows** mapped here are most likely affected by management/ human activities.

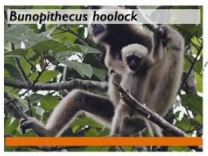
FLOW - HUMAN COMPONENT

FLOW - WATER COMPONENT

Landscape Elements	Landscape Flow			
	 ELEPHANT	 DEER	 WATER	 PEOPLE
MATRIX				
East Himalayan Moist Mixed Deciduous	*Optimal cover, important habitat*	*Optimal cover, important habitat*	*High water retention, slows run-off at higher elevations*	*Visually forested, trail opportunities; commercial value*
Kamrup Sal	*Few forage opportunities*	*Optimal cover, important habitat*	*High water retention*	*Visually forested with clean stands, trail & camping opportunities; commercial value*
Secondary Bamboo Moist Brakes	*Abundant forage*	*Small amount of forage present, little value*	*Relatively less water retention*	*Visually an opening from a distance, little commercial or recreational value*
Khasi Hill Sal	*Little value, access limited*	*Little value*	*Water retention, slows run-off at higher elevations*	*Visually forested, hiking opportunities*
PATCHES				
Immature Forest	*Important if falls under movement corridor*	*Browses depending on forage available*	*Slows run-off & retains in presence of enough ground cover*	*Visually open, may enhance views of distant landscapes*
Aquatic	*Important source of water*	*Important source of water*	*Important storage, filtering, slows run-off*	*Visually attractive; wildlife viewing opportunities*
Altered: Quarry	*Harassment*	*Harassment*	*Rapid run-off, contamination*	*Commercial value, visually offensive*
Altered Wetlands	*Decreased edible vegetation, may impede migration*	*Less forage, harassment*	*Storage/ filtering functions impacted*	*Locals affected due to decrease in aquatic life, recreational value*
Developments	*Conflicts, harassment*	*Conflicts, harassment*	*Rapid run-off, contamination, over exploitation*	*Variety of uses, appears unnatural*
CORRIDORS				
Roads, Railway Lines	*Harassment, major conflicts*	*Harassment, movement corridor when not in use*	*Possibility of instability/ failures in areas with steep slopes*	*Major means of travel through landscape*
Trails	*Little effect*	*Little effect*	*Little effect*	*Dispersed recreational access to un-roaded areas*
Riparian/ Mature forest	*Adjacent to or probably used as movement corridor*	*Adjacent to or probably used as movement corridor*	*Protection of stream banks and stream, run-off retention*	*Enhanced dispersed recreational opportunities*

6.4 **FAUNAL HABITAT MAPPING**

COMMON RARE VERY RARE



The food selected by elephants _ GRASSES, SHRUBS, TREE LEAVES, BARK, AQUATIC PLANTS & SOMETIMES FRUITS.

GRASS constituted by far the most predominant component of the diet.
The major grasses were *IMPERATA CYLINDRICA, LEERSIA HEXANDRA*, ETC. AND THE PLANTS OR TREE LEAVES WERE *FICUS GLOMERATA, MOSA* SPP, etc.

ELEPHANT NUMBERS IN THE LANDSCAPE

150 estimated
79 existing

FOREST TYPE	THREATS	STATUS
Grasslands, tropical Evergreen forests , Semi-evergreen forests, Moist deciduous forests etc.	Degradation, fragmentation, loss of habitat and poaching	IUCN - Endangered
Tropical dry forests, tropical seasonal forests, subtropical mixed forests (Tropical Moist Lowland)	Severe hunting, insurgency, and industrial exploitation of habitat	IUCN - Vulnerable
Bamboo thickets amidst semi-evergreen or deciduous forests	Forest destruction through tree felling, encroachment, jhum, and monoculture tree plantations	IUCN - Endangered

Connectivity — GARBHANGA R.F. ⟷ RANI R.F. ⟷ DEEPOR BEEL

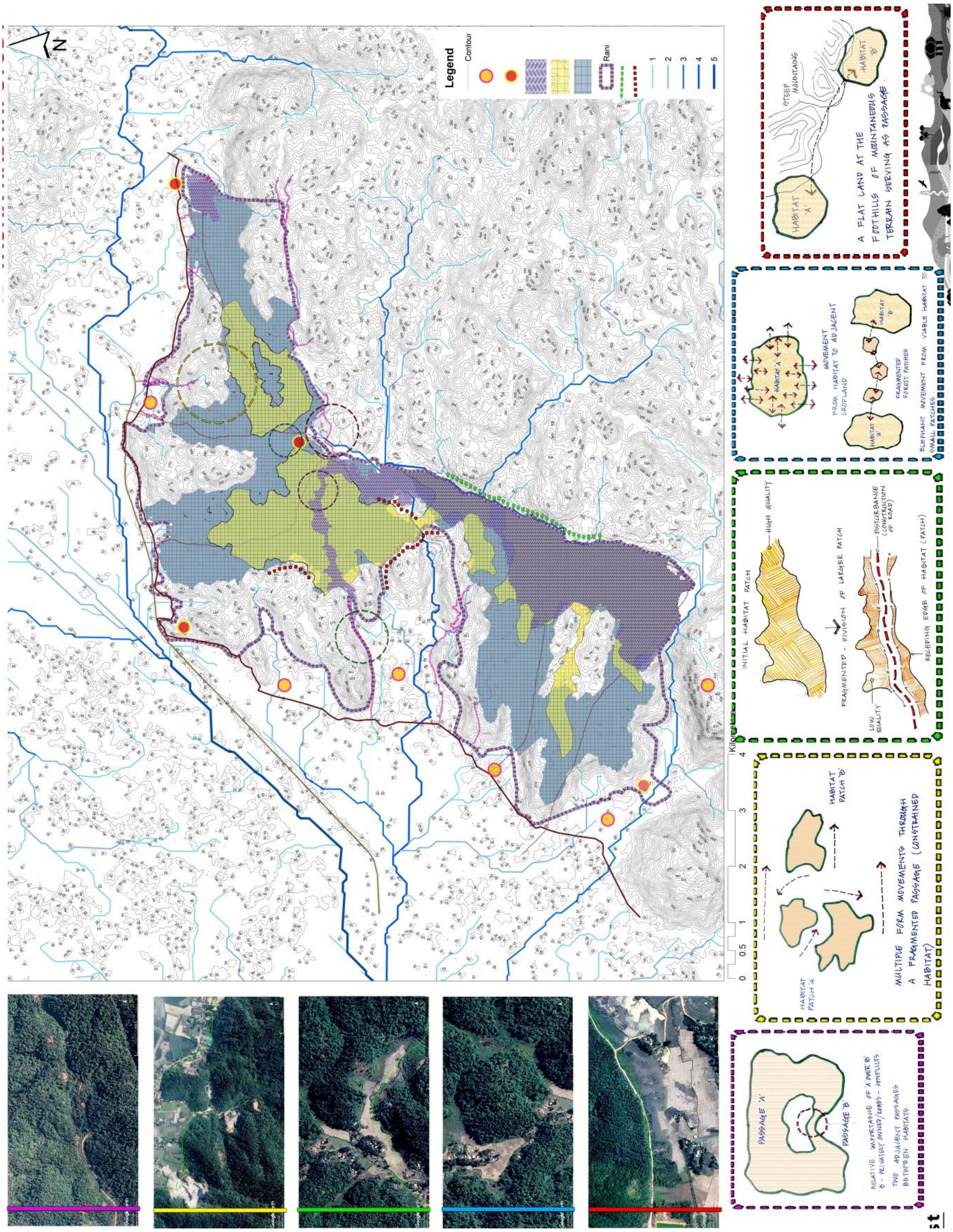
Frequency of Usage — REGULAR (Seasonal, *September – February*)

CONTINUOUS LOSS OF HABITAT _ QUALITATIVELY AS WELL AS QUANTITATIVELY

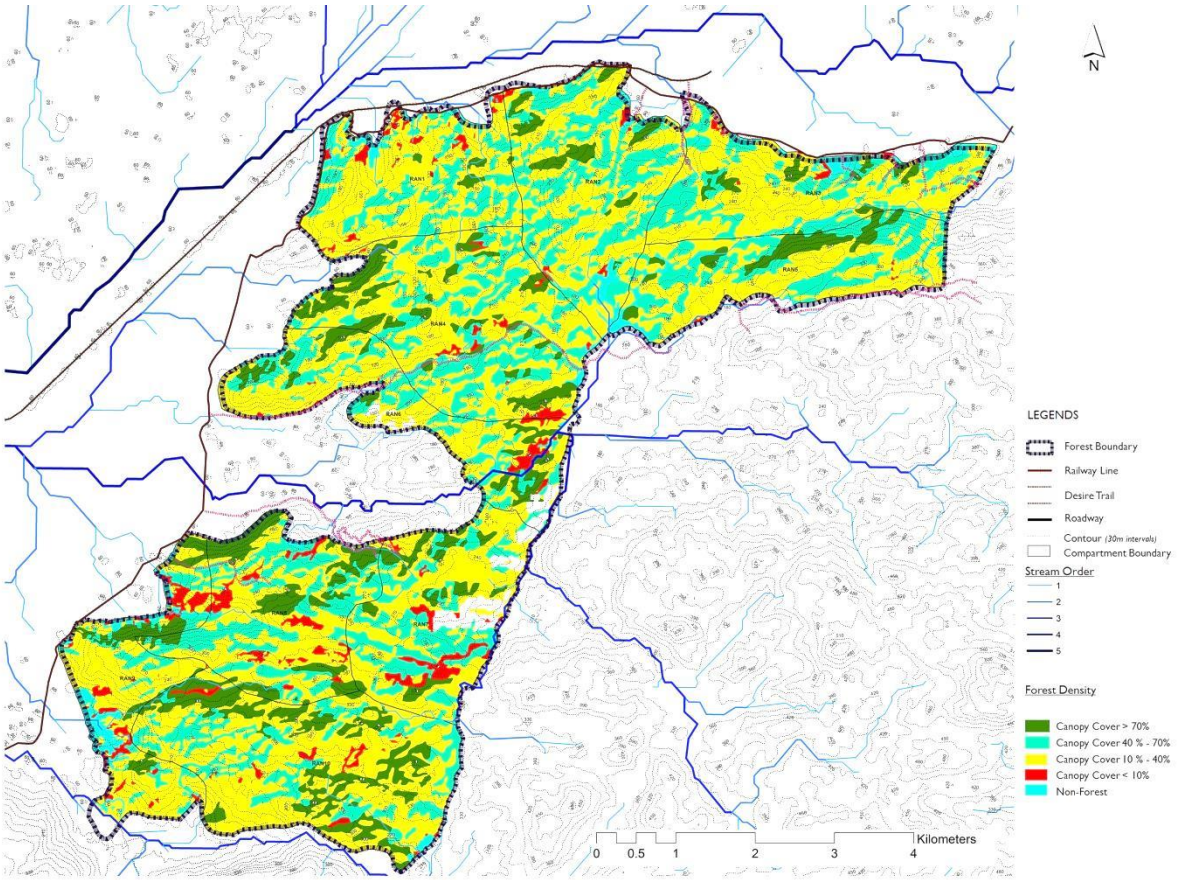
HUMAN DIMENSIONS

Threats –

- SETTLEMENTS + CORRIDOR VILLAGES + ENCROACHMENTS + DEVELOPMENT ACTIVITIES (Roads, Railway tracks etc.)
- CULTIVATION + AGRICULTURAL (Practices in & around the forest)
- INCREASED VEHICULAR TRAFFIC
- HUMAN – CONFLICTS
- QUARRYING ACTIVITIES
- TREE FELLING
- TEA-GARDENS

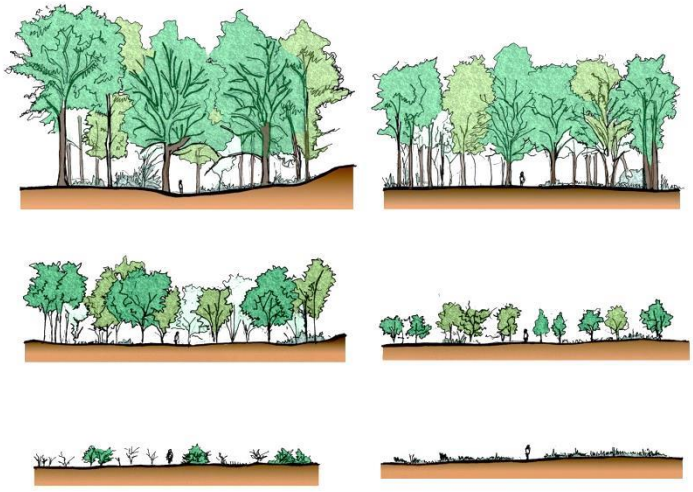


6.5 **VISUAL AND FOREST COVER ANALYSIS**

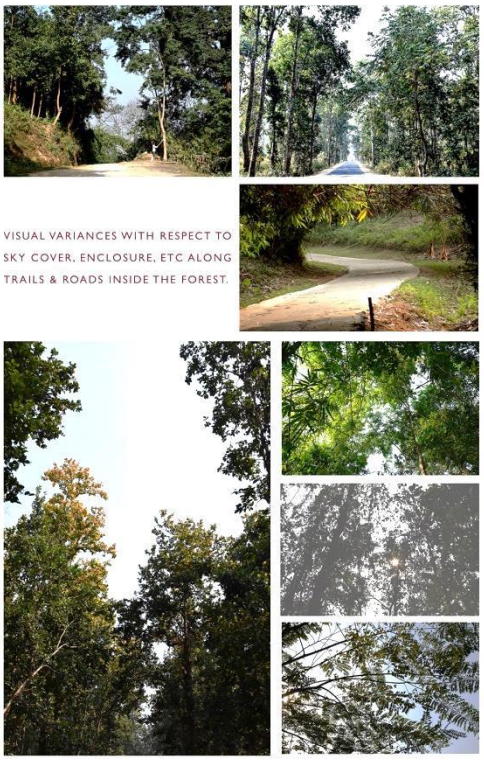


INVASION:

From the Forest Density Map, it can be inferred that large tracts of natural forest are being converted to open forest primarily due to the anthropogenic activities. Thus, there is likelihood of invasion of exotic plants from the surrounding areas. These exotics out-compete die native indigenous species in terms of nutrient, space and different resources. As a result, different exotic species such as Lantana camara, Chromolaena odorata, Mikenia scandem, different grasses etc. establish in the open pockets thereby extracting large pool of nutrients, removes native plant species and brings about instability of ecosystem in long run.

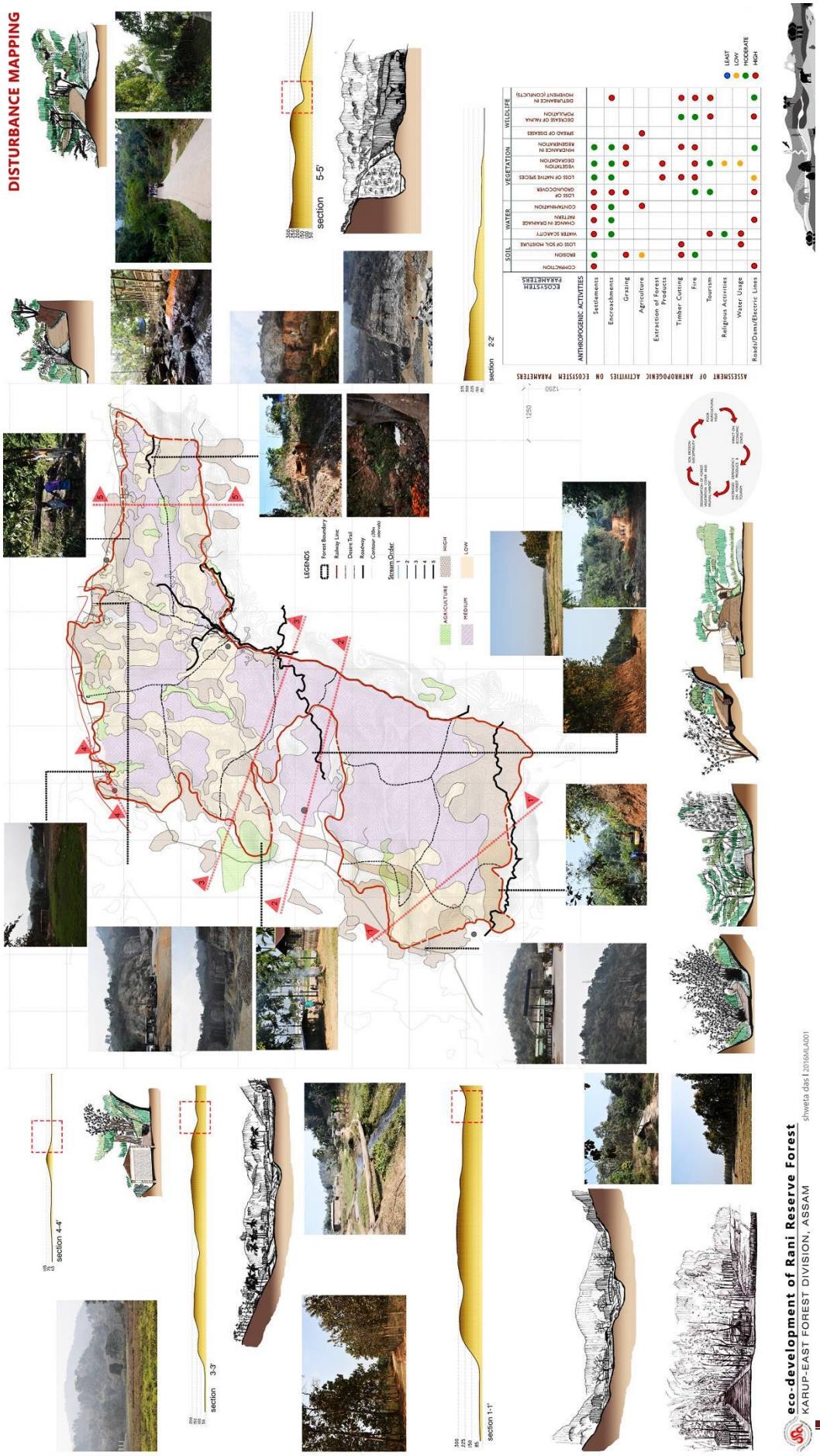


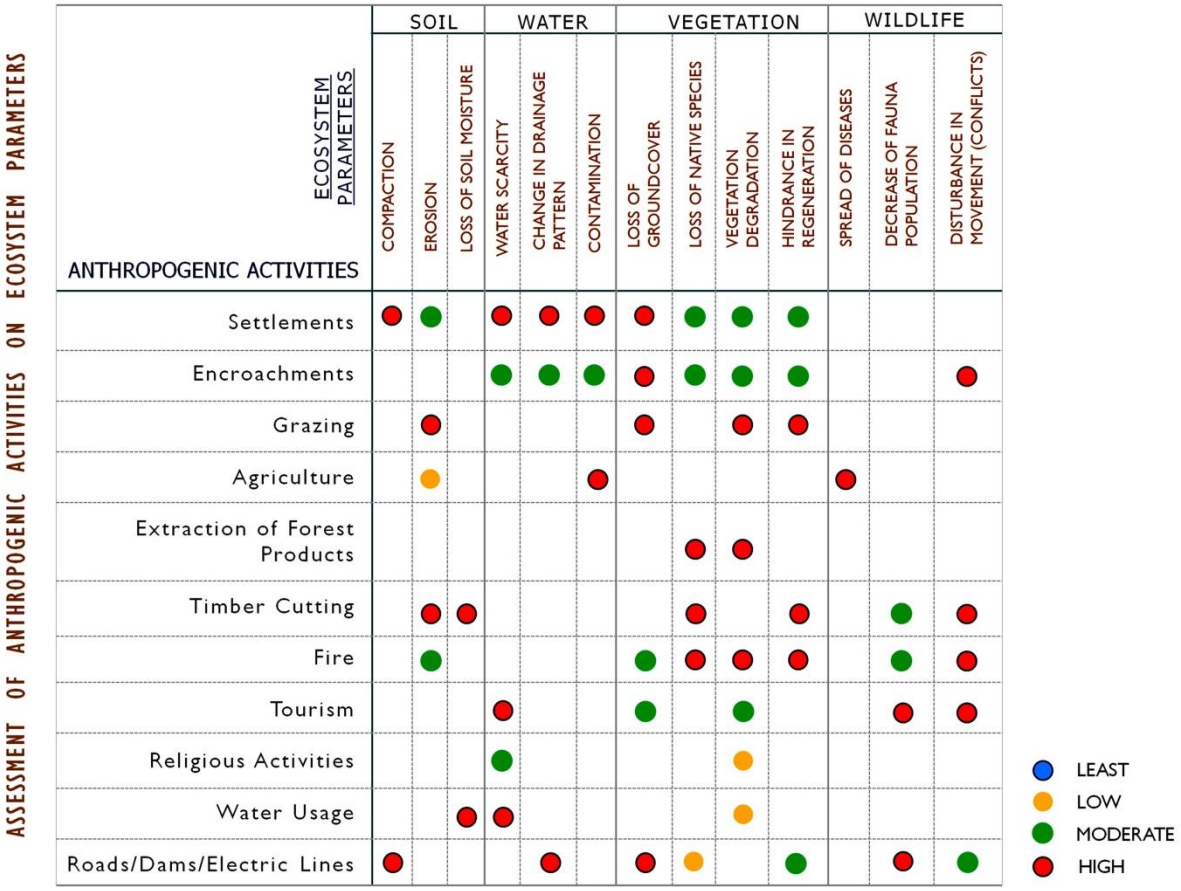
EXPERIENTIAL VALUE OF FOREST IN DIFFERENT STAGES OF ITS GROWTH/ SUCCESSION. BY MANIPULATING THE PLANTING METHOD THE EXPERIENTIAL VALUE CAN BE ALTERED, BY STRUCTURAL VARIATION, CHANGING LIGHT CONDITIONS, ALSO RETAINING VISUAL INTEREST.



VISUAL VARIANCES WITH RESPECT TO SKY COVER, ENCLOSURE, ETC ALONG TRAILS & ROADS INSIDE THE FOREST.

6.6 MAPPING BASED ON DEGREE OF DISTURBANCE

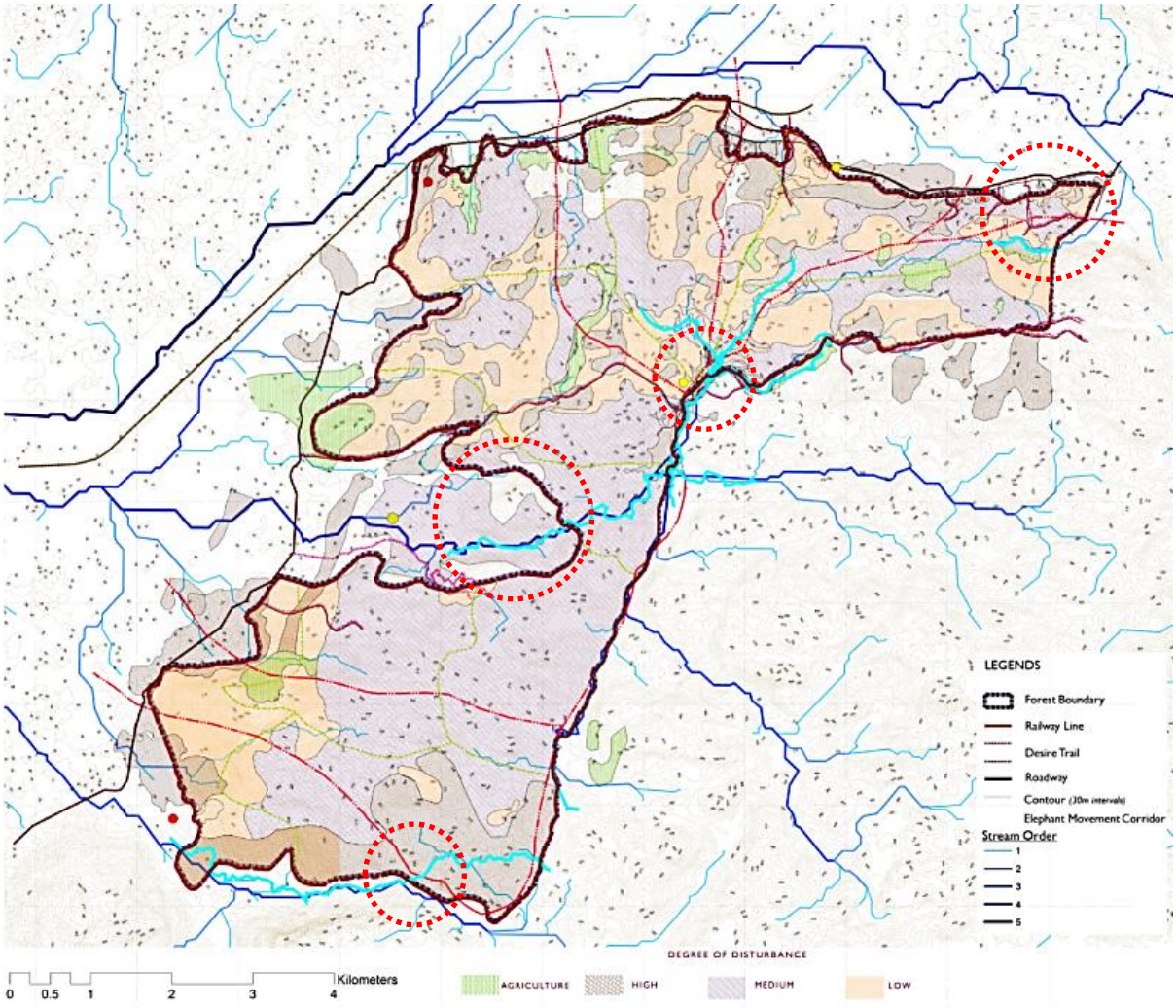




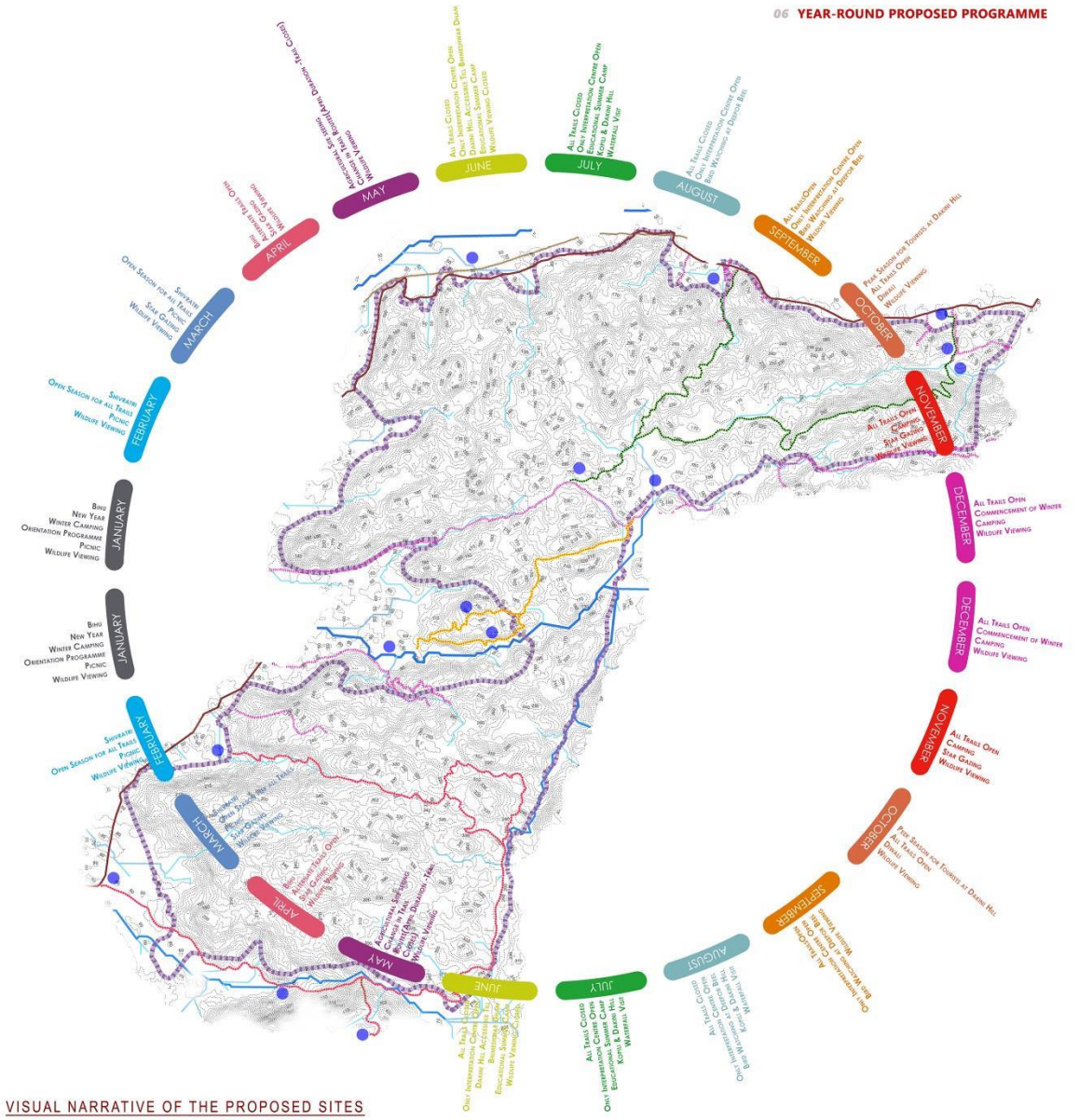
The disturbances are mapped based on all the natural layers, ecological analysis (landscape structures and landscape flows); fauna habitat analysis and forest cover analysis (overlay analysis). Based on these mapping, various disturbances are identified and mapped. The table above summarizes the impact (qualitatively) of all those anthropogenic activities on ecosystem parameters.

6.7 **IDENTIFYING & SUSCEPTIBLE LOCATIONS**

Through the synthesis of all the layers, the vulnerable and susceptible locations are marked and spatial management zones, landscape interventions are thus proposed.



7. DESIGN, MANAGEMENT STRATEGIES AND POLICIES



8. ANNEXURES

8.1 **ANNEXURE 1**

A. GLOSSARY OF LOCAL AND BOTANICAL NAMES OF PLANT SPECIES OF KAMRUP-EAST DIVISION

SL. NO.	VERNACULAR NAME	BOTANICAL NAME
1	Ahol	*Vitexpeduncularis*
2	Ahot	*Ficusreligiosa*
3	Ajhar	*Lagerstoemiaspeciosa (syn Lflosreginae)*
4	Am	*Mangifera Indica*
5	Amari, Lah	*Amoorawallichi*
6	Amlokhi	*Emblica, Officinalis (syn.Phyllanthusemblica)*
7	Amra, Amara	*Spondiaspinnata (syn. S. magifera)*
8	Atha-bor	*Ficuselastica*
9	Autha-dimaru	*Ficusroxburghii*
10	Bagari	*Zizyphusmauritiana (syn. Z. jajuba*
11	Baghnala, Haaluka	*Litseaglutinosa (syn. L. Sebifera)*
12	Bairanali	*Fagarabudrunga (syn Zanthoxylumbudrunga)*
13	Banbagari	*Zizyphusrugosus*
14	Bandardima	*Dysoxylumbinectariferum&Chisochetonpeniculstus*
15	Bar	*Ficusbengalensis*
16	Barthekera	*Garcinia pedunculata*
17	Barun	*Createevanurvala*
18	Bel	*Aegle marmelos*
19	Belphoi, Sakho	*Castonopsispurpurella (syn C hystnx)*
20	Bhadia	*Vitex pinnata (syn. V. pubescens& glabrate)*
21	Bhakul-potol, Phulkat	*Styrax serrulatum*
22	Bharatmuni, Bhoira, Rotha	*Symplocoslaurina (syn. S spicata)*
23	Bhathilla	*Oroxylumindicum*
24	Bhe	*Salix tetrasperma*
25	Bhedeli	*Sapromatematum*
26	Bhela	*Semicarpuisanacardium*

27	Bhelkor	*Trewianudiflora (syn. T polycarpa)*
28	Bhelu, Bolom	*Tetramelesnudiflora*
29	Bhomra, Bahera	*Terminalia belerica*
30	Bhomrati	*Symplocosoxyphylla*
31	Bhotola	*Trevesiapalmata*
32	Bijol-Gach	*Grewiaelastica*
33	Beal, Gabarhuta	*Cordia dichotoma*
34	Boga-Ameri	*Aphanamaxispolystachy (syn. Amoorarohituka)*
35	Boga-Kalti, Bhela	*Canthiumglbrum*
36	Boga-Kotra, Kurol	*Bauhinia variegata*
37	Bogipoma	*Chuckrassiavelutina (syn. C. tabularis)*
38	Bohot	*Artocarpus lakoocha*
39	Bola	*Morus laevigata*
40	Bonbholuka, Poreng	*Olea diocia*
41	Bonhuala, Harupadrai	*Beilschiedia brandisii*
42	Bonpasla, Memoi	*Meliosma pinnata*
43	Buritokon	*Mallotus roxburghii*
44	Chika-maruli, Kodalkania	*Alangium Chinese (syn. A. begoniaefolium)*
45	Choi-parali	*Oreocnide integrifolia*
46	Dainj-jam, Kathalboul	*Carallia brachiata (syn. C. integemium)*
47	Dewa, Cham	*Artocarpus chaplasha*
48	Dhopabar	*Ficus mysorensis Fidrupace*
49	Dhoparani	*Haplopheregma adenophyfium*
50	Dimaru	*Ficus hispida*
51	Dol-pocuk	*Glochidon vetunium*
52	Dudhi	*Wrighita tomenoiosa*
53	Dudhikhuri	*Holanhena antidysentrica*
54	Dukcha	*Dryptes assamica*
55	Gabod`	*Pavetta indica*
56	Gaboth , Gabortura	*Micronelum pubescens*
57	Gadgubar	*Ficus Latifolia*
58		*Premna Latifolia*
59	Gamari	*Gmelina arborea*
60	Garukeuta, rang	*Wend tintoria*
61	Garochaia	*Myristica linfolia*

62	Garobhangra	*Symplocos femuginea*
63	Garo Jine	*Aporosa roxburghi*
64	Garokhuta	*Aporosa aurea*
65	Garo	*Cryptroniapaniculata*
66	Godhajam	*Syzigium cenasoideum*
67	Gohora	*Premna bengalensis*
68	Gonsono	*Cinnamomum glaucesoens (syn.C. cecicodaphne)*
69	Haidu, taraksopa	*Adina cordifolia*
70	Harumoin	*Randia fasciculate*
71	Hatkerapa	*Ilex godajam*
72	Hatipolia	*Pterospemum acerioflium*
73	Heloch, Mikhantenga	*Antidesma ghesaembilla*
74	Helok, Poreng	*Elaeocarpus robusts*
75	Hewra	*Streblus asper*
76	Hiharu	*Albizzia odoratissima*
77	Hilikha	*Terminalia chebula (syn.T.citnina)*
78	Hingori	*Castanopsis Indica*
79	Hoanlu, Muga	*Litsea monopetala (syn. L. polyantha)*
80	Juglo	*Macaranga indica*
81	Jam	*Syzygium cuminl (syn. Eugenia jumbolana)*
82	Jarath, Rohini	*Mallotus phillipinensis*
83	Jari	*Ficus benjamina*
84	Jaribar	*Ficus gobbosa*
85	Jari- udal	*Femiana colorata (syn. Starculia colorata)*
86	Jatipoma	*Toona ciliate (syn. Cedrela toona)*
87	Jia, Jigna	*Lannea coromandelica (syn.L.grandis) andGaruga pinnata*
88	Joba hingon	*Sloanea assamica(syn. Echinocarpus assamica)*
89	Jobha, Lewa	*Engeinardita spicata*
90	Kadam	*Anthocephatus cadamba*
91	Kanchan	*Bauhinia sp.*
92	Kanthalpatia, Amchoi	*Beilschmiedia assamica*
93	Kathal	*Artocarpus heterophyllus(syn.A. integrifolia)*
94	Kathia- Koroi, Datbijli	*Demis robusta*
95	Kaunla	*Machilus globosa*

96	Kau-thekera	*Gracinia cowa*
97	Kendu	*Diospyros peregrine (syn.D.embryopteris, D.toposia and D. lanceaefolia)*
98	Ketkora, Moin	*Vanguiera spinosa*
99	Kharipati Dimaru	*Ficus nervosa*
100	Khokon	*Duabanga grandifglora(syn. D. sonneratioides)*
101	Khukru, Garokhukru	*Tricaiysia singularis*
102	Kolti, koliari	*Mitrephora tomentosa*
103	Korha	*Sapiumeuginaefolium*
104	Koroi	*Albizzia procera*
105	Koronda,Keseru,Karangiya	*Hteropanax fragrans*
106	Kotoki	*Ilex sulcate*
107	Kotra, Tengakotra	*Bauhinia malabarica (syn. Pilostigma malabarica)*
108	Kotra	*Cordia grandis*
109	Kuhir	*Bridelia retusa*
110	Kuji-thekera	*Gareinia kydia*
111	Kum	*Careya arborea*
112	Kurial	*Bauhinia purpurea*
113	Kunila	*Brassiopsis speciosa (syn. Glomerata)*
114	Larubandha	*Mailotus albus*
115	Leteku	*Baccaurea spaida*
116	Lohajam	*Eugenia Formosa*
117	Mahudi	*Croton joufia*
118	MakriSal	*Scima wallichii*
119	Maksi	*Calliacarpa aborea*
120	ManiSal	*Sapindus mukorosii*
121	Manuk	*Ulmus lancifolia*
122	Maskoita	*Callicarpa macrophylla*
123	Mauhita, Hukotia	*Celtis tetranda*
124	Mejankari	*Litsea Citrata*
125	Mirtenga, Neoli	*Protium serratum (Syn. Bursera serrata)*
126	Modar	*Erythrina variegate (Syn. E. Indica)*
127	Moin, Bihmoin	*Xeromphis spinosa (syn. Randia dumetorum)*
128	Moj	*Albizza lucide*
129	Morolia	*Macaranga denticulate*

130	Mota ameri	*Turpina pomifera*
131	Naga-dalchini	*Cinnamomum obtusifolium*
132	Nagini	*Elaeocarpus aristatus*
133	Nahaor	*Mesua ferra*
134	Odal	*Sterculia villosa*
135	Okshi, Oxi	*Dillenia pentagyna*
136	Owtenga	*Dillenia indica*
137	Pajihuta	*Actinodaphne obovata*
138	Pakri bor	*Ficus rumphii*
139	Palas	*Butea monospema (syn.B.frondocsa)*
140	Panial	*Flacourita Cataphracta(syn. F. jangomas)*
141	Panikadam, bhukhundi	*Hymenodictyon excelsum*
142	Pareng	*Linoceria macrophylla(syn. L. ramiflora)*
143	Parali	*Sterospermum personatum (syn. S. chelonoides)*
144	Pasatia	*Buddleria asiatica*
145	Patkuhir, markuhir	*Bridelia tomentosa(syn, Vitex negundo)*
146	Petarichawa	*Actinodaphne augustifolia*
147	Phakdima, sobaigach	*Trema orientialis (syn.T. cannabina& T. ambionensis)*
148	Phoko, Dhapapatia	*Meliosma simplicifolia*
149	Phulgamari	*Endospermum chinense*
150	Pichala Bankaphi	*Kydia Calycina*
151	Pisoli	*Grewik microcos (syn. Microcos paniculata)*
152	Raman-bih	*Aesculus panduana*
153	Rangkoli	*Diospyros nigricans*
154	Rudraksha	*Elaeocarpus ganitrus*
155	Rumu, sutrong	*Lophopetalum fimbriatum*
156	Sal	*Shoera robusta*
157	Salkali Kolonthi	*Diospyros variegate*
158	Satiana	*Alstonia scholaris*
159	Sau	*Albizzia chinensis (syn.A. stipulate)*
160	Segun	*Tectona grandis*
161	Seleng	*Sapium Baccatum*
162	Sida	*Lagerstoemia parviflora*
163	Silubar	*Ficus retusa*

164	Simul	*Salmalia malabarica(syn.Bombax malabricum, B.ceiba)*
165	Sirish	*Albizzia lebbeck*
166	Som	*Persea bombycina(syn Machilus Bombycina)*
167	Sonaru	*Cassia fistula*
168	Taruakadam	*Accacia farensiana*
169	Telbhurki	*Caesaria glomerata*
170	Temi-Sakho	*Lithocarpus spicatus(syn Pasania spicata)*
171	Tengabor	*Ficus infectoria(syn. F.lucescens)*
172	Tepora	*Garcinia zanthochymus*
173	Teta	*Vitex canescens*
174	Tetuli	*Tamarindus indica*
175	Tespat	*Cinnamomum tamala*
176	Tezranga	*Myristica angustifolia*
177	Titasopa	*Talauma phellocarpa (syn. Paramichelia bailionii)*
178	Uriam	*Bischofia javanica*

B. SHRUBS, HERBS ETC.

1	Abutenga, Nikhontenga	*Antidesma diandrum*
2	Agra	*Urena lobata*
3	Akalbih	*Clerodendron indicum (syn. C. siphonanthu)*
4	Akan	*Calotropis gigantean& calotropis acia*
5	Anchukath, Asugach, Akalbih	*Morinda angustifolia*
6	Arakchantita	*Rauvolfia serpenitha*
7	Athubhanga	*Leea sp.*
8	Awuapat, Machpora	*Maesa indica*
9	Baghanchora, Tezmoi	*Zanthoxylum hamiltonium (syn. Z. nitidum)*
10	Bahak	*Adhatoda vasica*
11	Bhang	*Cannabis sativa*
12	Bhedelilata	*Hedyotis scandens*
13	Bhekuri	*Solanum indicum*
14	Bhit-tita	*Solanum torvum*
15	Biringa,Birng-guli	*Rhamnus nepalensis*
16	Bishalyakarani, Titabahak	*Justica gendarussa*
17	Bitmora, Dhubiokhla	*Gardenia campanulata*

18	Biyonihaputa	*Desmodium labumifolium (syn.D. candatum)*
19	Bogitora	*Alpinia allughas*
20	Bonbaberi	*Phyllanthus simplex*
21	Bonjora	*Paramignya griffithi(syn.P. sacndans& Elaeganus latifollia)*
22	Bonkapahi	*Abroma augusta*
23	Bontila	*Anisomeles ovate(syn.A.indica)*
24	Bontulasi	*Geniosporum strobilferium(syn.G. coloatum)*
25	Boriala	*Sida carpinifollia(syn.S.acuta&S. rhombifolia)*
26	Bormanmuni	*Hdrocotyle asiatica(syn.Centellaasiatic)*
27	Chagal- ladi	*Glycosmis pentaphylla*
28	Chaul-doha	*Ardisia solanacea(syn.A.humilis)*
29	Chirata	*Exacum tetragonum*
30	Daridiga,bonmedeula	*Cassia tora*
31	Dhopat-tita	*Clerodendron viscosum (syn.C. inforyunatum)*
32	Dighalti	*Litsaea Salicifolia*
33	Doukhiguti	*Elaeganus pyrifomis*
34	Eragach	*Bicinus communis*
35	Gachbionihaputa	*Desmodium latifolium(syn.D.velutinum*
36	Genderi, Gainoli	*Premna croymbosa*
37	Gohoralota	*Myxopyrum smilacifolium*
38	Nankha ojar mons	*Dischidia raffesiana*
39	Haru-manimuni	*Hydrocotyle rotundifolia*
40	Haut-tenga	*Cassia occidentalis*
41	Heko-toko	*Aphania rubra*
42	Hil Kadam	*Homonia riparia*
43	Hoklati	*Sambucus javanica*
44	Hukta puta	*Grewia hirsute*
45	Jarmaniban	*Eupatorium odoratum*
46	Jhapipat	*Acanthopana trifoliatum(syn.A.aculeatum)*
47	Jor- lewa	*Unona longiflora(syn. Desmos longiflours)*
48	Kana=dimaru	*Ficus heterophylla*
49	Kathandaphul	*Coffea bengaiensis*
50	Kath-tenga, kukurtenga	*Leea acuminata*
51	Katurui	*Curcuma aromatic*

52	Kaupat	*Phrynium imbrecatum*
53	Kaurikata	*Mimosa Himalayana*
54	Kho jo	*Pouzoizia viminea*
55	Kol	*Musa sanguine*
56	Kuhila	*Aeschynomene indica*
57	Kuhum Kenta	*Argemone Mexicana*
58	Makhiloti	*Desmodium Cephalotes*
59	Makhiati	*Fleminga strobilifera(syn Moghania strobilifera)*
60	Manmani, Mathak-thuka	*Derringea amranthoides*
61	Manukataphul	*Holmskiodia sanguine*
62	Matijam	*Premna herbacea*
63	Matikatota	*Bauhinia acuminata*
64	Mesaki	*Sarcochlamys pulchemima*
65	Moiratikoni	*Reidia hamiltoniana*
66	Nangalbhabga	*Clerodendron serratum*
67	Narasimha	*Murraya koenigii*
68	Ogra	*Xanthium strumarium*
69	Owa	*Leea crispa*
70	Panimundi	*Glochidion sp.*
71	Paniphuti	*Vibrunum colebrookainum*
72	Patidol	*Clinogyne dichotoma*
73	Phul-jeleng	*Baliospemum montanum*
74	Phutki	*Osbeckia rostrafa*
75	Phutkola	*Melastome malabathricum*
76	Pulikaint	*Curdrania javanensis (syn C.cochinchinensis)*
77	Soklati	*Mussaenda roxburghii*
78	Sorotgach	*Dendrocnide sinuate (syn. Laportea crenulata)*
79	Tara	*Costus speciosus*
80	Thaljimura	*Cycus Petinata*
81	Thowraguti	*Grewia sapida*
82	Thukurakhamal	*Dischidia nimmularia*
83	Titaphul	*Phlogacanthus thyrsiflorus*
84	Tit-bhakuri	*Solanum verbascifolium*
85	Ulti-hot	*Achyranthes aspera*
86	Ulucha	*Desmodium trigutrum*

87	Ursi, Takamala	*Desmodium pulchellum*

C. CLIMBERS

1	Bakal-bih	*Derris elliptica*
2	Bandar kekowa	*Mucuna prurita & Dysolobium grande*
3	Barkhi lata	*Embelia ribes*
4	Bhedelata	*Paederia tomentosa(syn.P scandens)*
5	Bokul-lata	*Embelia cadmia*
6	Bon marich	*Clematis cadmia*
7	Bonpui	*Embelia nagushia*
8	Chagallata, Gorapchai	*Naravelia zeylanica*
9	Chagalsingalata	*Myriopteron extensum*
10	Chowrasi-lewa, Bonmirica	*Embelia nutans*
11	Dat bijli	*Dalbergia tamarindifolia & dalbergia stipulacea*
12	Deo jakhala	*Bauhinia anguinea*
13	Dhekia lata	*Stenochleana palustre*
14	Dhindaubagarilata	*Tapiria hirsute(syn. Pegia nitida)*
15	Ghahelewa	*Croton caudatus*
16	Ghilla lata	*Entada phaseoloides(syn. E scandens)*
17	Gobanglata, Latadimaru	*Conocephalus suaveolens*
18	Hatibandhalata	*Butea parviflora(syn. Spatholobus roxburghii)*
19	Helolokha	*Millettia auriculata*
20	Jokhuni-lata, Dhobalata	*Heptaleurum venulosum (syn. Scheffera venulosa)*
21	Katagach	*Dalbergia rimosa*
22	Khamal lata	*Wattakaka volubillis(syn.Mersdemia volubilis)*
23	Kharika lata	*Jasminum coarctatum*
24	Kirkirilata	*Jasminum scandens & Jasminum laurifolium*
25	Kolilata	*Merremia Umbellata*
26	Kuchai, Kuchialata	*Accacia pinnata*
27	Kukualata	*Thunbergia grandiflora*
28	Kusia-Kaint, suselwa	*Accacia concinna(syn.A. rugata)*
29	Lata-dimaru	*Ficus scandens*
30	Lataguti	*Caesalpinia crista*
31	Latasali	*Combretum decanfrum*

32	Loti sorot	*Cnesmone javanica*
33	Nakkatilewa	*Bauhinia vahlii*
34	Ow lata	*Delima samentosa*
35	Padri lewa	*Paederia foetida(syn.P.scandens)*
36	Pahari lata	*Dalhousia bracteate*
37	Pani lata	*Cissus repanda(syn.Vitis repanda)*
38	Pichola lata	*Hibiscus fragrans*
39	Sonarupa	*Mussaenda glabra*
40	Theboulata, topouguti	*Hodgsonia hiteroclita*

8.2 **ANNEXURE 2**

GLOSSARY OF LOCAL, ENGLISH AND SCIENTIFIC NAMES OF FAUNAL SPECIES OF KAMRUP-EAST DIVISION

SL No	Local Names	English Names	Scientific Name
1	Hati	Indian Elephant	*Elephas maximus*
2	Bonoria Gahori	Indian Wild Boar	*Sus cirstatus*
3	Dhekia patia Bagh	Royal Bangal Tiger	*Panthera Tigris*
4	Nahar Phutiki Bagh	Pather or Leopard	*Panthera pardus*
5	Jaha Mal	Indian Cirat	*Viverra zibetha*
6	Gash Bhaluk	Malayan Bear	*Malurus arsines*
7	Xugori Pohu	Barking Deear	*Muntiacus muntiak*
8	Xial	Jackal	*Canis aureus*
9	Bandar	Monkey	*Macca Inulata*
10	Hollo Bandar	White Browed Gibbon	*Hylobetes hoolock*
11	Neul	Mongoose	*Herpestes spp*
12	Ud	Common otter	*Lutra lutra*
13	Xoha Pohu	Hare	*Lepus ruficaudatus*
14	Kerkettua	Squirrels	*Dremnomys lokriah*
15	Kemtal Pohu/Bonoru	Pangolin	*Manis crassicaudata*
16	Kaori	House Crow	*Corvus splendence*
17	Dhura Kaori	Jungle Crow	*Corvus macrohynchos*
18	Kolakhati or Chakcheki	Tree Pie	*Dandrocitta vagabunda*
19	Bulbuli, Petuluka	Bulbul	*Molpastes cafer*
20	Dohikotora	Magpie Robin	*Copsychus caularis*
21	Phesu	Black drongo or King Crow	*Dicrurus macrooarus*
22	Bhimraj	Racket tailed Drongo	*Dissomurus paradiseus*
23	Hokhioti, Patmadoi	Golden Oriole	*Oiolus oriolus*
24	Moina	Grackle, Hill Myna	*Gracula religiosa*
25	Kath halika	Gery headed Myna	*Sturnia malabarica*
26	Chuti Halika	Bank Myna	*Acridotheres ginginianus*

27	Kankurika	Pied Myna	*Sturnopaster contra*
28	Tokora Charai	Baya or Weaver Bird	*Ploceus Phillipinus*
29	Bota charai	Munia	*Uroloncha striate*
30	Ghan Chirika	House Sparrow	*Passer domesticus*
31	Bali Mahi, Khojjan	Wagtail	*Motacilla alba*
32	Barhoitpka, Kathkhola	Wood pecker	*Dryobates mahrattensis*
33	Heteluka	Barbet or copper smith	*Xantholoema haemacophal*
34	Keteki	Cuckoo	*Hierococcyx various*
35	Kuli	Koel	*Eudynamis scolopaccus*
36	KuKuha	Crow- Pheasant	*Centropus sinerisis*
37	Kaocharai	Roller or Blue jay	*Coracias bengalansis*
38	Bhatow	Indian Parakeet	*Psittacula cupatria*
39	Machuruka	Pied King fisher	*Caryle rudis*
40	Machuruka	Common King fisher	*Alcado atthis*
41	Dhanesh	Hornbill	*Dickoceros bicornis*
42	Gubar Khusara	Hoopoe	*Upupa epops*
43	Hudu	Great Horned owl	*Bubo bubo*
44	Phesa	Spotted owlet	*Athens brama*
45	Roja hogun	King vulture	*Sarcogyps calvus*
46	Hogun	Bengal vulture	*Pseudogyps Bengalensis*
47	Chilani	Brahminy Kite	*Haliastur Indus*
48	Heh	Tawny eagles	*Aquila rapox*
49	Moukhap	Serpent eagle	*Haematernus cheela*
50	Haitha	Green Pigeon	*Crocopus Phoenicopterus*
51	Kopow	Ring dove	*Streptopeila dacapcto*
52	Dorik	Partridge	*Francolinus francolinus*
53	Dauk	White breasted	*Amauvornis phoenicurus*
54	Ganga Chiloni	River tern	*Sterna aurantia*
55	Pani kaori	Littile cormorant	*Phalacrocorax carbo*
56	Bortokola	Adjutant stork	*Leptoptilos dubius*
57	Horu bortokola	Lesser adjutant	*Leptoptilos javanticus*
58	Bogoli	Cattle Egret	*Bubulcus ibis*
59	Konaamussari	Pond heron or paddy bird	*Ardeola grayii*

60	Ghila Hanh	Cotton teal	*Nettapus, Coromandelianus*
61	Xorali Hanh	Whistling teal	*Dendrocygna javncia*
62	Chakoi Chokua	Brahminy duck	*Casarca Farruginea*
63	Digholi Hanh	Pin tail duck	*Amauvor*
64	Mugi Hanh	Common Teal	*Anus cracca*

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