ECOLOGICAL STUDY OF NATURAL AND DEGRADED FORESTS OF CHITREPANI, MAKAWANPUR DISTRICT, NEPAL

BY
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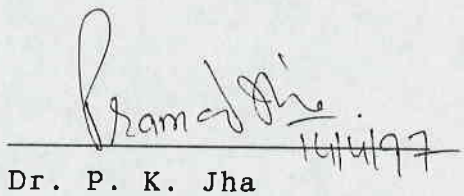

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ABSTRACT

This work was carried out in the forests in Chitrepani site near Hetauda municipality in Makawanpur district of mid-Nepal. This place occurs in and around Siwalik range and both vegetation and soil study was done in the area. There were total 46 species belonging to 27 different families among which 28 were tree species and 18 were shrub and under shrub species. The Natural forests had 8-23 tree species while Degraded forest had only 5 tree species showing a loss of about three-fourth tree species. Number of shrub and under shrub species in Natural forests ranged from 5 to 16 while Degraded forest had 5 species representing only 27.8% out of total shrub species. *Sal* (*Shorea robusta*) was the most dominant species in all the sites. Total tree Density ranged from 57-1326 pl/ha in Natural forests and 8-32 pl/ha in Degraded forest. Sapling density ranged from 5457-17861 pl/ha in Natural forests and 433-2440 pl/ha in Degraded forest while shrub density ranged from 796-7680 pl/ha in Natural forests and 1238-3625 pl/ha in Degraded forest. Total basal area or dominance value ranged from 3.8-59.64 m^2/ha for trees, 5.74-26.16 m^2/ha for saplings and 0.48-7.16 m^2/ha for shrubs in Natural forests while 5.36-11.39 m^2/ha for trees, 0.39-2.15 m^2/ha for saplings and 0.73-1.95 m^2/ha for shrubs in Degraded forest. Total aboveground biomass of trees in September ranged from 337.68-807.83 t/ha in Natural forests while it was 160.63 t/ha in Degraded forest. The biomass of herbaceous plants above ground ranged from 88.9-1154.2 kg/ha in Natural forests while 354.6-2735.4 kg/ha in Degraded forest. The soil of the site had sandy loam texture with 56-68% sand, 25-34 % silt and 7-16 % clay in different forests. Water holding capacity ranged from 36.7-46.3 % and surface soil moisture ranged from 1.6-14.5 % in three seasons. pH range was 5-5.5, Organic matter 1.5-3 %, Nitrogen 0.04-0.09 %, Phosphorus 70.5-94.4 kg/ha and Potash 86.4-262.8 kg/ha.

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1. INTRODUCTION

1.1 Background

The world is facing the problem of deforestation and environmental degradation and Nepal is no exception. Nepal has around 5.5 million hectares of forests representing only about 37% of a total land area ; with the annual rate of deforestation of 0.4% between the period 1964-1986(HMGN/ADB/FINNIDA, 1988; EPC, 1993). It can be attributed to different reasons, viz human population growth, leading to more demand for farming land, fuelwood, fodder, and timber, etc. As a result there is encroachment into the forests and to supplement their needs people are cutting trees and clearing the forests in such a rate that forest degradation has become a serious problem in all places i.e., in hills, valleys and terai. The once dense *"Char Kose Jhadi"* (literally meaning in Nepali, 8 mile wide forest strip) in terai which was present all along the length of the country is now in the form of a mere strip of forest. Different steps taken by the government to preserve our forest wealth have been a mixed success. Various reforestation programmes have been on a small scale with only about 99 thousand hectares including government, community, private and leasehold plantations between 1985-1992(EPC, 1993). This is considerably less than the area lost each year. As a result, it is feared that more and more plant species are being endangered and many more are facing threat of extinction. The present study site is also subjected to the same set of problems. This place occurs in and around the Siwalik range, which is the youngest of the Himalayan mountains formed by the tectonic movement of the Tethys sea. Thus it is very fragile both ecologically as well as geologically. It is made of loosely set gravels, pebbles and sand; and this region gets a high rate of precipitation. Thus it is highly susceptible to soil erosion and the rivers passing through it are loaded with heavy sediments. In this region population pressure has also increased due to migration from hilly regions ever since the

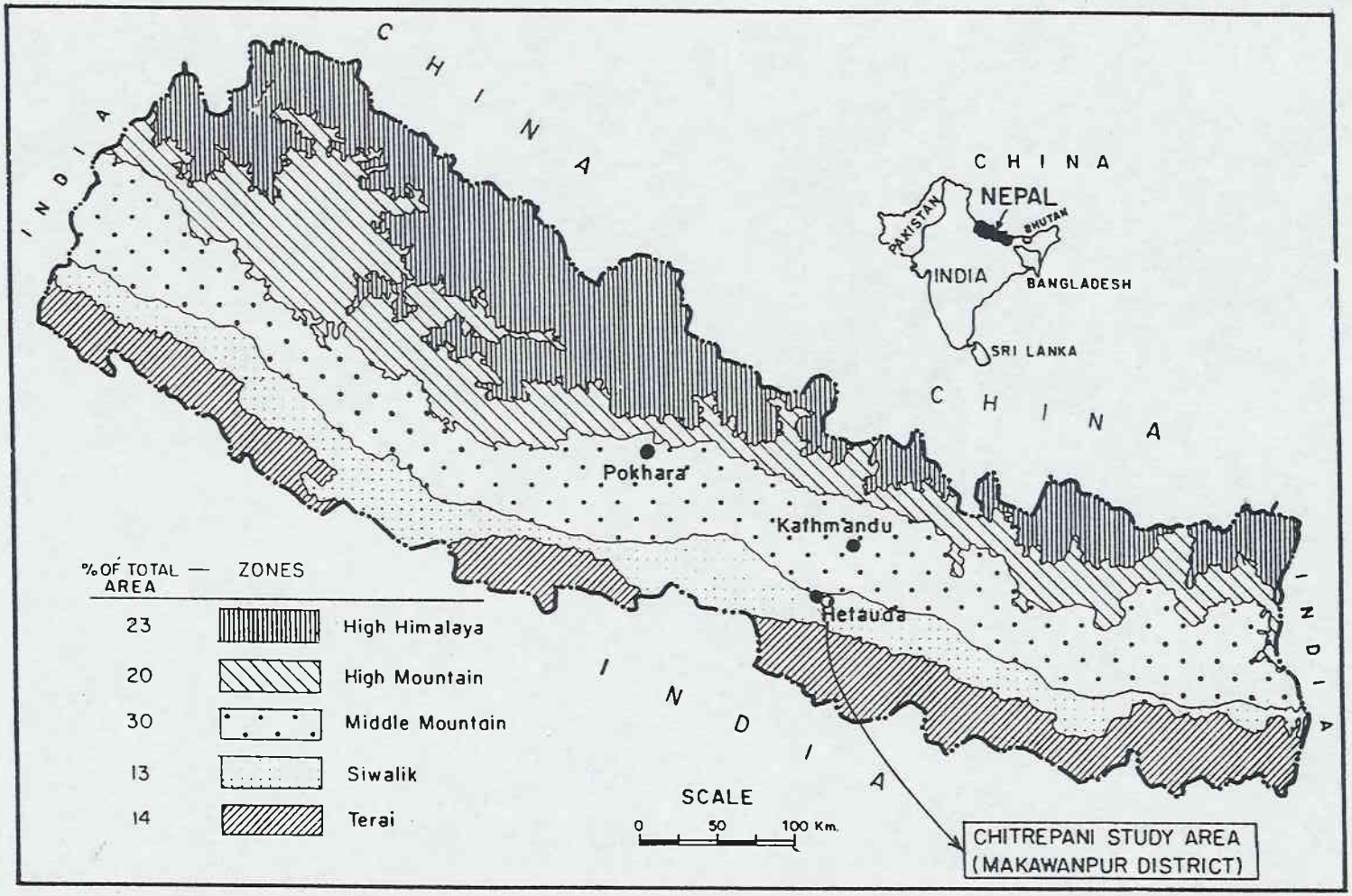
eradication of Malaria during the decade of 1950s(Shrestha and Joshi, 1996), which led to the degradation of forests and clearing it for agriculture. Thus this region is ecologically important to be studied so that it may be useful for taking ameliorative measures to preserve the remaining forests. In this area government has started pilot Leasehold forestry program to rehabilitate and reverse the current process so as to sustain the resource system while assisting the poor farmers raise their income. The present work is an effort to study the forests in the area so as to know its present condition; in which, a degraded(Leasehold forest block), a natural(less disturbed) and a regenerating patches of forests are studied and analyzed. This kind of work, in my knowledge, was not done in this area previously.

1.2 Brief Description of Nepal

Physiography

Nepal, the Himalayan kingdom of south Asia, lies in between the two massive countries ie., China in the north and India in the east, south and west. It lies between the latitudes of $26^0 20'$N and $30^0 10'$N and longitudes of $80^0 15'$E and $88^0 10'$E; thus having a roughly rectangular shape. The east west length is 830 km while the average north south width is 200 km, which varies between 145 km to 242 km. The country is broader in the west than towards the east. The total area of Nepal is 147,181 sq km.

Nepal represents the one third(800 km) of the entire length of the greater Himalayas of 2500 km(Shrestha and Joshi, 1996). Though a very small country, there is a sharply varying altitudinal diversity in a narrow width of 200 km. It ranges from 70 m above sea level in the Terai plains to 8848 m above sea level, the tallest peak of the world, the Mt. Everest. Thus Nepal in a very small area has a wide spectrum of geographical features, elevational ranges and biological diversities.



Map 1 *Physiographic zones of Nepal.*

Nepal can be divided into ten natural zones which occur in the following order from north to south (Hagen, 1969):
(i) Tibetan Plateau, (ii) Tibetan Marginal Range, (iii) Valleys of the Inner Himalaya, (iv) Great Himalaya, (v) Fore-Himalaya, (vi) Midlands, (vii) Mahabharat lekh, (viii) Dun Valleys, (ix) Siwalik Range, and (x) Terai.

The LRMP (Land Resource Mapping Project) divided Nepal into five physical zones, each an essentially horizontal band stretching from west to east which is as follows(HMGN, 1995).

Nepal Physiographic Zones	**Altitude**
Terai	< 500m
Siwaliks	500-1000m*
Midhills	1000-3000m*
High Mountains	3000-5000m*
High Himalayas	> 5000m*

Source: LRMP 1983, IUCN, 1994

* Denotes approximate altitudinal range, higher altitudes may occur.

But depending on topography, altitude and vegetation, Nepal can be broadly divided into three zones or units as follows:
(i) Terai, Bhabar, Siwaliks and Dun valleys
(ii) Mahabharat range, Midlands
(iii) Himalayas and Trans Himalayan region

Climate

Climatically, Nepal can be divided into three distinct seasons which are as follows:
(i) Winter - Cold season from October to February,
(ii) Summer - Hot and dry season from March to mid-June and
(iii) Rainy - Warm and wet season from mid-June to September

The climate of Nepal varies from east to west and also from south to north. The temperature in the country ranges from the

tropical heat of Terai in the south to the Arctic frost of the Himalayas in the north. The temperature rises as one goes from east to west Nepal(Shanker and Shrestha, 1984-85) ; thus the west Nepal is comparatively drier than east Nepal.

The eastern part of Nepal gets a higher rate of precipitation than the western part of Nepal. The bulk of rainfall that the country gets in rainy season depends on the south-west flow of monsoon clouds from the Bay of Bengal. Thus east Himalayan flora is diverse due to heavy rainfall in that area and also the prolongation of the wet season by the early arrival and late departure of the monsoon. Nepal gets a scanty rainfall also in winter due to the cyclonic disturbances in the mediterranean region(Stainton, 1972). The west Nepal receives more winter rainfall than east Nepal.

The rainfall decreases as the altitude increases. The south faces of the mountain ranges receive a heavy rainfall. The upper slopes of this region are mostly covered with drizzling mist and cloud during monsoon. Some parts of country at the base of Himalayas also get a heavy rainfall eg., Pokhara valley which lies close to the southern side of Annapurna range and Arun valley lies south to the Mt. Everest and Mt. Makalu. Precipitation is heavier also over the hills, north of the plains, Mahabharat range and the base of Siwaliks.

Soil

Soil is one of the most important factor affecting the growth of plants. The different zones of the country have different types of soil.

In the Terai, alluvial soil is found which is transported by the river systems from the hills. It is characterised by having rounded and smoothed particles. Soils of Bhabar contain gravel and shingle . The soil is porous and the streams disappear

here to reissue again in the form of springs in Terai.

Siwalik hills are of tertiary in origin or the youngest and contain some of the most easily eroded rocks of the entire Himalayan range. The soil is made up of coarse rocks, clay and conglomerates. Dun valleys have coarse gravels and torrent boulders, generally mixed with ferruginous sand and clay.(Bhatt, 1977).

Mahabharat range is composed of hard rocks like granite, quartzite and limestone(Sharma, 1984-85). The soil is formed by the breakdown of these rocks and contain little organic matter. These rocks are deeply weathered and because of the steep slopes, soils are susceptible to constant erosion.

The Trans Himalayan and the greater Himalayan regions constitute an extremely complex landscape, heavily sculptured by glacial erosion. The rocks range from hard granites to metamorphic rocks to those formed out of the sediments of the ancient Tethys sea(which once separated the Indian landmass from the Asian landmass). The soil of Himalayas is thin, bare and very poor. The Trans Himalayan zone have almost dessert-like soils(Sharma, 1984-85).

1.3 Forests and vegetation pattern in Nepal

Vegetation of Nepal is diverse and rich like its physiography, climate and soil. To date 5988 species of flowering plants(angiosperms) have been recorded(Koba *et. al.*, 1994). "In Nepal, at least 500 species out of a total estimated 7000 plant species, are thought to be endemic to Nepal i.e., 5% of the flora and out of this, 15 % are rare or threatened plant species." (Chalise *et. al.*, 1994).

Stainton(1972) divided Nepal into seven climatic and vegetational divisions based on his extensive explorations

through out the country from 1954 to 1971. He has identified 35 different types of forest occurring in four different zones.

But for convenience, vegetation is described here based on five climatic zones viz., tropical, sub-tropical, temperate, sub-alpine and alpine.

(i) Tropical and Sub-tropical zone

Tropical and sub-tropical type of vegetation is found in Terai, Bhabar, Siwaliks and Dun valleys. This part of the country has long, hot and moist season.

The forests are mainly of the deciduous and semi-deciduous type. *Shorea robusta(Sal)* is the dominant species of this zone except in the freshly formed alluvium and water logged sites(Negi, 1989). Its dominance is broken only along the streams and rivers where the tropical deciduous riverine forests consisting of *Acacia catechu(Khair)* and *Dalbergia sissoo(Sissau)* are found. This region possesses some grasslands which contains 2 m tall grasses of *Saccharum munja*(Elephant grass).

Sal is found also in outer foothills and in the Dun valleys ie., the sub-tropical zone. Here *Sal* is largely confined to the dry south faces while the moist slopes are usually covered with *Schima-Castanopsis* mixed with other deciduous species in the eastern and central Nepal. *Schima wallichii* are found mostly in the ecotones of sub-tropical and temperate zones. In the western region *Pinus roxburghii* is found superseding the hill *Sal* forest. Mixed deciduous forest dominated by *Terminalia* sp. is found in the transition zone between the tropical and sub-tropical forest.

The tropical and sub-tropical evergreen forests occur only as a narrow strips along water courses or in gulleys and it has a marked preference for shady north-facing sites (Stainton, 1972) in the east and central Nepal.

(ii) Temperate Zone

Temperate type of vegetation is found in the Mahabharat range and the Midlands. The climate is cool and humid. This zone is characterised by evergreen oaks, laurels, mixed broadleaved deciduous and Rhododendron forests in the eastern and central Nepal. The temperate zone from 2000-3000 m shows a great deal of diversity in vegetation type(Shrestha and Joshi, 1996). While in the western Nepal, evergreen coniferous forests and deciduous mixed forests are found. The trees are often densely covered by mosses, ferns and epiphytes. *Rhododendron* sp. in Nepal are most widespread and numerous.

(iii) Sub-alpine and Alpine zone

Sub-alpine and alpine type of vegetation is found in the Himalayas and the Trans Himalayan region. Here water is the most limiting factor for the growth of plants.The annuals that flower during the short spell of warm weather in Spring are the most important elements of the vegetation along with the shrubs(Bhatt, 1977).

Juniper, alder, populous forests are the sub-alpine forests. Junipers are found in the sub-alpine zone of Nepal above 3000 m. It is more common in the western half of the country. Poplars are found in between 2700 m to 3100 m.

The alpine zone lies above 3000 m. There are two types of scrub viz., wet alpine scrub and dry alpine scrub. In the wet alpine scrub there are extensive patches of alpine meadows occurring near the snowline in the moister tracts. Winter is very severe here and a short growing period is available for the plants. Rhododendrons are very numerous in the east Nepal while they are less prominent feature in the central and west Nepal. Much of the slopes are dominated by alpine herbs and species of *Primula* are abundant here. The shrubs do not exceed 4 ft in height and form a tight low growing mat in exposed places.

Thus we find that the vegetation of east Nepal is very different from west Nepal. It is due to the combined effect of the factors such as altitude, rainfall, temperature, soil etc. The flora of Nepal in the eastern and central region show some East Himalayan element while the flora of west Nepal show West Himalayan elements. "Stearn had concluded that Nepal is a meeting place of the eastern and western Himalayan floras as regards the high mountain humid area and an extension of tibet as regards high mountain and arid zone, rather than floristic province in its own right."(Bhatt, 1977)

Another important point is that one cannot quite demarcate the forest by altitude. There is always the merging of vegetation. Thus in the transition zone or the ecotones, the species of both the zones may be found.

Thus "the forests of Nepal range from dense sal forests found in the lower hills to the towering deodar forests of the temperate zone and the alpine pastures found near the snowline. "(Negi, 1990)

1.4 Literature Review

Ecological works and findings in Siwalik and Terai region in Nepal are very scarce. Most of the works have been concentrated in the Mahabharat, Midland and Mountain regions.

Botanical exploration in Nepal

History of botanical exploration starts in Nepal from 1803. Later on many explorations were conducted by different people from outside and also by the Nepalese scientists. But most of these explorations did not have the ecological approach. Two ecologists L.W.Swan in 1954 and 1960, and J.F.Dobremez in 1968 had come to explore plants in Nepal. The Department of Medicinal Plants, HMG Nepal(now named as Department of Plant Resources) has been actively exploring Nepalese flora since 1961.

Stainton(1972) studied extensively the vegetation of Nepal and divided Nepal into seven climatic and vegetational zones.

Forests in Nepal

Bhatt(1977) has reported that "hill sides between 1300 m to 2600 m have practically been denuded of forests due to enormous population pressure, loss in productivity in land, soil erosion and poor management. The unprecedented floods of 1954 were the starting point for wide-scale resettlement of the hill people in the Rapti valley which caused the destruction of forests and its wildlife."

Wallace(1981) has pointed out that "since 1964, forest area of Nepal has decreased by one-third, volume has declined by atleast half and the growth rate per hectare has probably gone down as well. Based on the inventory by the Integrated Watershed Management Project(FAO/UNDP project in Department of Soil

Conservation and Watershed Management), the total area of the forest in 1975 was estimated to be 4.1 million ha; with 0.1 million ha in High Himalayas zone, 1.2 million ha in each of the Transition, Middle and Siwalik zones and 0.4 million ha in the Terai. Forest area has gone from over 6.4 million ha in 1964 to about 4.1 million ha in 1975, a decrease of over one-third in just a decade". He also reports that "the volume of the commercial forest was estimated to be 140 million m^3 in hill forest and 114 million m^3 in Terai".

HMG/IUCN(1988) has reported that "according to an inventory of watershed conditions in Nepal, it is estimated that 7% of the total land area(about 10,000 Km^2) is sufficiently devoid of vegetation, to be considered in the process of desertification (Nelson *et al* 1980). In addition, 17% of the land needs immediate conservation attention."

Ascher(1995) has listed forestry trends in developing countries. According to this in Nepal, natural forest was 5023 thousand ha in 1990 with percentage change of -10.5% from 1980 to 1990. India has 51729 thousand ha with -6.2% change, Bangladesh 769 thousand ha with -4.6% change, Pakistan 1855 thousand ha with -39.7% change and in Malaysia 8856 thousand ha with -13.8% change.

Sal Forest

Singh and Ramakrisnan(1983) have reported that the monthly pattern of leaf fall in a 13 year old plant of *Shorea robusta* showed that peak fall(about 65.9% of the total) occurred during February-March while maximum new leaves(about 63.5% of the total) appeared in the month of April.

They have also reported that maximum leaf area for the whole tree was recorded in the middle portion of the canopy(53670 cm^2). Shoot extension of the main leader was maximum in the month of June(1/3 annual extension growth). Height, dbh and basal area increased whereas density decreased with the age of the stands.

Biomass of the individual tree(0.217-12.744 Kg/tree) also increased with the age of the stand and maximum standing crop biomass of 58.5 t/ha was recorded in the oldest, 19 year old stand.

They have concluded that the production was low probably due to slow growth rate production of few leaves in a year and an extended period of dormancy of 4-5 month when growth was arrested; branch production was not simultaneous with new leaf growth but postponed to the following year.

Rana *et al*(1988) have calculated the total biomass of forest by harvest method. They have reported that tree biomass was 455t/ha and 710.2t/ha, respectively, in new growth and old growth stand. In this *Shorea robusta* accounted for 87% in new growth and 94.2% in old growth stand.

Herbaceous biomass amounted to 1.5t/ha and 1.8t/ha, respectively, in new and old growth stand of which aboveground portion accounted for about 55-60%.

They also account that inspite of the higher temperature, the production of the *Sal* forest is not greater than the Himalayan forests located between 1000-2500 m elevation. It seems that advantage of higher temperature at *Sal* forest site is offset by the relatively lower moisture level.

Singh and Singh (1989) have described the structure and functioning of the Central Himalayan sal forest in comparison to major forest types that occur in higher elevations (1000-2300 m) viz., chir pine and oak forests. Relatively higher temperatures and lower climatic moisture regime mainly differentiate the climate of sal forest zone from that of the chir pine - oak zone and they are expected to exert different influences on the development of forest communities.

Agrawal *et al*(1991) studied some dominant forest communities along an elevational gradient 700-2300 m, in the outer Garhwal Himalayas with reference to density, IVI, diversity index, community coefficient and regeneration potential.

Gupta and Shukla(1991) have accounted that species diversity increases as the ecosystem develops and decreases with maturity. Increased diversity and reduced dominance has been shown to be associated with increased stability.

Shorea, Mallotus, Syzygium, Clerodendron and Tilicora have been found to be close associates while *Carissa, Moghania* and *Bauhinia* are weak associates. Absence or very low value of IVI of *Streblus, Carissa, Aegle* and *Diospyros* in mature plantations indicates a higher degree of biotic interference by man and his domesticated animals.

They have concluded that "the growth of associates is also necessary for efficient nutrient recovery and soil conservation in the systems(Kimmins,1987)".

Brown and Iverson(1992) account that "biomass of tropical forests varies considerably over the tropical landscape due to climatic, edaphic and topographic differences as well as history of land use and human and natural disturbances".

Singh and Singh(1992) have accounted that total aboveground biomass of trees of *Sal(Shorea robusta)* old growth forest located in the foothills is 561.5 t/ha out of which *Shorea robusta* alone had 531.8 t/ha.

They have also reported that in the *sal* forests the annual litter fall is 6.6 t/ha with leaf litter accounting for 4.0 t/ha. According to them tree leaves account for 60-80% of the total fall in the Central himalayas forests. Of the total annual litter fall from woody vegetation, more than 50% occurs during summer season and the summer value generally accounts for about 80% of total leaf fall.

Herbohn and Congdom (1993) in their work in disturbed and undisturbed sites in north Queensland wet tropical rain forest have reported that there is no difference in annual litter fall between the sites with annual litter-fall ranging from 5.0 to 6.0 $tha^{-1}v^{-1}$. Litterfall was found to be seasonal with maximum fall from the end of the dry season to the end of the wet season.

Leaves were the dominant component of litter-fall with the average proportion of the total litter-fall ranging from 72% to 76% over the study period at each of the sites. Fall of wood and reproductive materials was significant at certain times only.

Palm *et al.*(1994) has reported that estimates of aboveground inputs as litterfall in tropical moist ecosystem range from a mean of 10.5tha^{-1}yr^{-1} on relatively fertile sites to 8.8tha^{-1}yr^{-1} on infertile sites(Vitousek and Stanford, 1986).

Sejuwal(1994) has reported lower litter production (705 gmm^{-2}yr^{-1}) in Sal forests in Royal Chitwan National Park than in other tropical forests ; probably due to age factor. Tree vegetation constitutes major portion of total above ground biomass in forest ecosystem. The average aboveground biomass was 1038.16t/ha in which *Shorea robusta* covered 96.57%, *Syzygium cumini* 1.83% and *Dillenia pentagyna* covered 1.6%. Density was also maximum with 100% frequency in *Shorea robusta*. The highest volume was recorded for *Shorea robusta*(1157.32m^3/ha) and lowest for *Syzygium cumini*(22.73m^3/ha) in pure Sal forest.

Tamrakar(1994) has accounted that with some effort, degraded Sal forests have been found regenerated in Nepal. Observation made in the early stages of the establishment of the experiment showed that the regeneration is that of coppice origin and those too from dormant seedlings. According to him degraded sal shrub forests that have been regenerated are from seedlings that have remained dormant period(> 15 years), Sal requires 15-25 years to be established in some cases with a mere effort of protection.

Pesonen and Rautiainen(1995) has accounted that "according to old Indian growth and yield tables the maximum mean annual increment(MAI) of Sal is 3-11 cubic metres/ha, depending on the site quality(Griffith and Sant Ram 1942; Chaturvedi and Sharma 1980).

The MAI of mixed Sal forests in Bara and Makawanpur

operational management planning areas of FMUDP(Forest Management and Utilization Development Project) has been estimated at 3-6 cubic metres/ha(Seppanen and Acharya, 1994; Kornonen *et. al.*, 1991). However, in many places the actual net increment is much less due to rapidly expanding heart rot(Rautiainen, 1994; Skarnen and Thapa, 1994)."

Soil

Bhatnagar(1965) studied the soil of different quality *Sal* forests of Uttar Pradesh, India and has accounted that there is more organic matter in soils from poor *Sal* regeneration areas. According to him in all soils, irrespective of the status of regeneration, the concentration of Nitrogen falls from soil supporting quality I(above 35 m height) to quality IV(below 20 m height) *Sal* trees. Potassium and Phosphorus occurs in highest concentration in quality I soils in both good and bad regeneration areas.The pH is not varied in good and deficient Sal regeneration areas. Also that soils from good *Sal* regeneration areas, have generally a higher moisture content and a higher water holding capacity.

Singh and Singh(1985) have reported that the forest with *Shorea robusta* as a dominant species have 1.7% of organic matter, pH value of 6.8, 0.13% of total Nitrogen and 0.005% of available Phosphorus. While the *Sal* seedling forest have 0.88% of organic matter, pH value of 6.7, 0.07% of total Nitrogen and 0.004% of available Phosphorus.

Napier and Parajuli(1987) have reported that soil analysis made on composite samples taken in January, 1987 in Hetauda contained 0.095% Nitrogen, 353 p.p.m.Phosphorus, 0.11 meq./100g. Potassium, 1.7% Organic mater. pH value was 6.3 and texture was sandy loam.

Howell and Epstein(1992) have accounted that the results of

protection in Siwalik belt show that whilst a large amount of topsoil is lost it is generally of such a poor nutrient status that it has little effect on the ability of the area to repair itself. The fact that the forest can regenerate, albeit slowly , is the important point. It requires little more than protection, but will produce only poor rates of growth generally.

Shrestha(1992) has accounted that water holding capacity is highest on loamy soil with high organic matter contents and lowest on structureless sands and clays with low organic matter and it is around 20% in most Nepalese soils.

In Terai, most of the soils are strongly acidic. He also accounts that high organic matter moderates the negative effects of low pH by absorbing toxic iron and aluminium ions. Organic matter plays a dominant role in Nitrogen supply and to lesser extent in Phosphorus. Higher organic matter levels improve infiltration rates and water holding capacity. According to him, newly deforested area on the Terai may have levels of 4-5% organic matter on initial clearing but after a few years the levels may have dropped to less than 2%.

Suoheimo(1995, b) has concluded in his work in the Manahari pilot area, Makwanpur that the regeneration and early development of the young seedlings is very good provided that the drainage, moisture and, above all, light conditions are satisfactory. He also accounts that chemical characteristics of soil do not have any important effect on the regeneration results of sal.

1.5 Statement of the problem and Objectives

As is evident in most southern parts of Nepal, the present study site also seems to be affected by the too much interference by man in his surrounding forest. Most of the people in the settlements around the forest are the migrants from the different parts of Nepal(mostly hilly regions). So, as the number of people increased in the area, the size and quality of the forest have decreased simultaneously and resulted in the present degraded condition. Thus this study has been done to find out the present condition of the forest here.

Main objectives of this study are as follows :

- To analyze the vegetation by quantitative methods in the degraded and natural(or less disturbed) forest stands.
- To study the different parameters of soil in the sites.
- To correlate the vegetation and soil characters and show its significance.
- To identify the causes of degradation of forest.

2. SITE DESCRIPTION

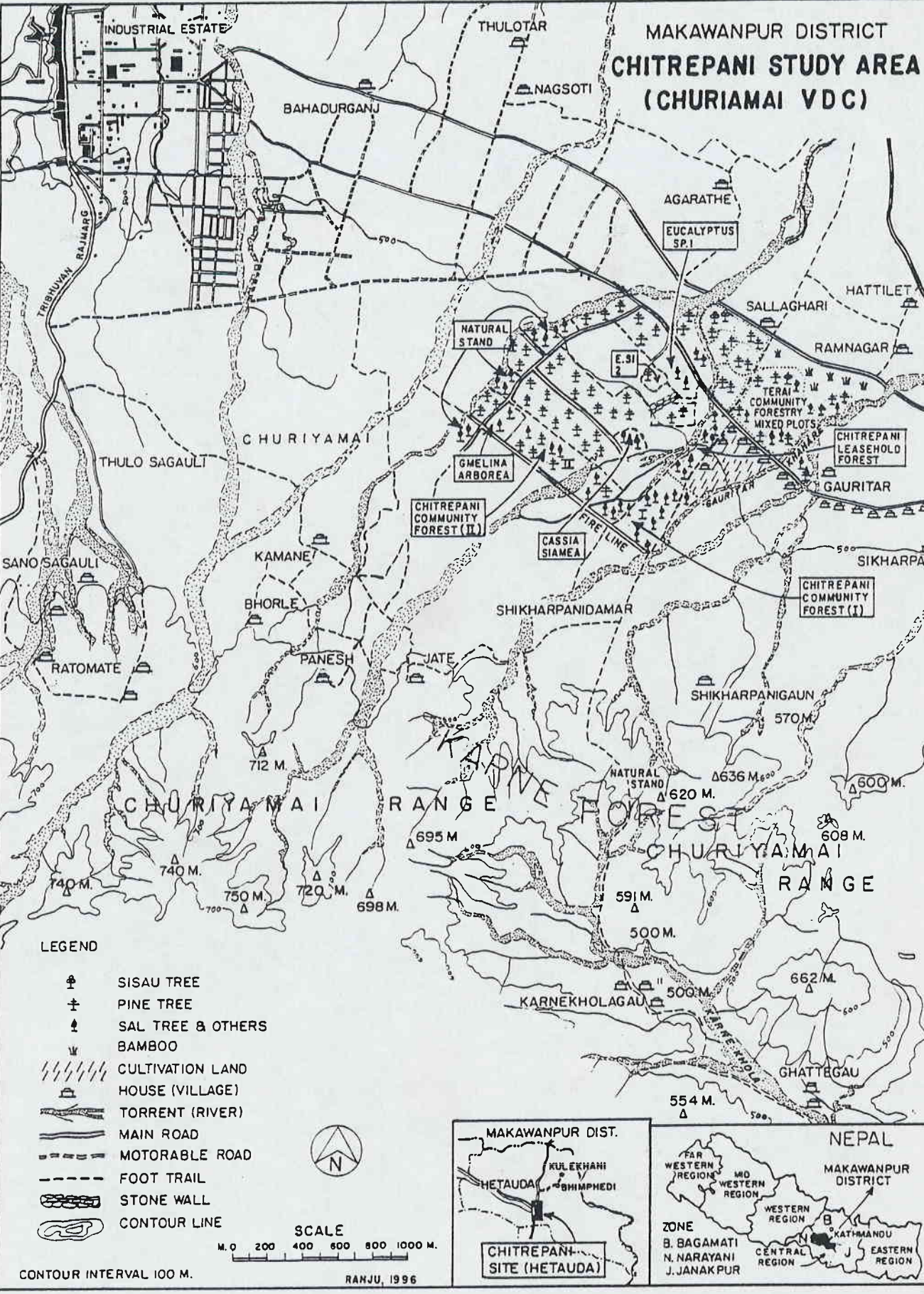
2.1 Physiography

The study site, Chitrepani, is located in Churiamai Village Development Committee of Makwanpur district in Narayani zone of mid-Nepal. It is about 8 km east of Hetauda municipality. The settlement near the forest is accessible by an all weather gravelled road. This area lies in between the latitudes of $27^0$22'N to $27^0$23'N and longitudes of $85^0$04'E to $85^0$03'E.

Among the four sites chosen in the forest for the study, Karne forest lies at an altitude between 420-720 m above the sea level(Fig. 1). The area of the forest is about 200 ha. It is situated on the elevated Churia(Siwalik) hills. At places, the churia hills have been much eroded taking along much of the forest area and leaving behind a narrow ridge. This forest consists of different small hills with an average slope of 50-60^0. A torrent named Karne khola runs in between the hills which is quite broad and dry in most of the season. In the south after going upto 4-5 km, waterspring occurs where rice growing is practised in the middle of the forest. This place is quite near to Amlekhgunj(Bara district).

Other three sites, two in Chitrepani Community forest and one in Chitrepani Leasehold forest, lie at an altitude in between 420 to 460 m above sea level and north to the Karne forest (Fig. 1). Thus these three forests lie in more or less plain area with an average slope of 5-6^0.

The area of the Chitrepani Leasehold forest is 9 ha and is leased out since 1993 to the local users by the Department of Forests (a project jointly implemented by four agencies: Department of Forests, Department of Agriculture, Agricultural Development Bank, Nepal and Nepal Agricultural Research Council; while technically assisted by FAO and financed by IFAD).


MAKAWANPUR DISTRICT
CHITREPANI STUDY AREA
(CHURIAMAI VDC)
INDUSTRIAL ESTATE
THULOTAR
NAGSOTI
BAHADURGANJ
AGARATHE
EUCALYPTUS SP.I
HATTILET
SALLAGHARI
RAMNAGAR
TRIBHUVAN RAJMARG
NATURAL STAND
E.SI
TERAI COMMUNITY FORESTRY MIXED PLOTS
CHITREPANI LEASEHOLD FOREST
GAURITAR
CHURIYAMAI
THULO SAGAULI
GMELINA ARBOREA
CHITREPANI COMMUNITY FOREST (II)
CASSIA SIAMEA
FIRE LINE
SIKHARPA
KAMANE
SANO SAGAULI
BHORLE
CHITREPANI COMMUNITY FOREST (I)
SHIKHARPANIDAMAR
RATOMATE
PANESH
JATE
SHIKHARPANIGAUN
570M.
712 M.
CHURIYAMAI RANGE
NATURAL STAND
Δ636 M.
Δ620 M.
Δ600 M.
608 M.
Δ695 M
740 M.
740 M.
750 M.
720 M.
698 M.
591 M.
500 M.
500 M.
662 M.
KARNEKHOLAGAU
GHATTEGAU
554 M.
LEGEND
SISAU TREE
PINE TREE
SAL TREE & OTHERS
BAMBOO
CULTIVATION LAND
HOUSE (VILLAGE)
TORRENT (RIVER)
MAIN ROAD
MOTORABLE ROAD
FOOT TRAIL
STONE WALL
CONTOUR LINE
N
SCALE
M. 0 200 400 600 800 1000 M.
CONTOUR INTERVAL 100 M.
RANJU, 1996
MAKAWANPUR DIST.
KULEKHANI
HETAUDA
BHIMPHEDI
CHITREPANI SITE (HETAUDA)
NEPAL
FAR WESTERN REGION
MID WESTERN REGION
WESTERN REGION
CENTRAL REGION
EASTERN REGION
MAKAWANPUR DISTRICT
KATHMANDU
ZONE
B. BAGAMATI
N. NARAYANI
J. JANAKPUR

The area of Chitrepani Community Forest is 85 ha in total. But the study was concentrated on the 18-20 ha patches that have a natural growth of vegetation. The remaining area of this forest consists of the Pine and Eucalyptus plantations of research trial plots of HMG/N(26 years old) and mixed trial plots of Terai Community Forestry Development Program(6-7 years old) (Shrestha and Sharma, 1995).

There is one torrent(*khahare*) present in the study site, which is much branched and traverse the forests. It is always dry except in the Monsoon, when the level rises up quite fast. Due to rise in water level there is much erosion and the area of the forest is decreasing slowly. As such the site occurs in the Siwalik range formed of loosely set gravels which is prone to erosion.

2.2 Climate

As obvious from the topography, the site occurs in the tropical zone. Thus the climate there is of the hot Monsoon type. The summer extends from mid-February to May and is very hot. Monsoon starts from June and continues upto September. This place gets a heavy rainfall as it is located near/in the Siwalik range. Winter begins from November and extends upto mid-February, when it is quite cold even though the temperature may not fall down so much. This place often keeps suffering from thunderstorm and lightening which has taken the life of few people.

The temperature recorded from 1985 to 1992(Source:Department of Hydrology and Meteorology) at the nearest meteorological station ie; Hetauda is shown in Figs. 2-3. The area is considerably warm. Average maximum temperature in Summer rises upto 33.5^{0}C in April. In these eight years the hottest day recorded was 7 May, 1989 when the temperature soared upto 40.2^{0}C. The average minimum temperature in Winter fell down to 8^{0}C in

Fig 2: Ombrothermic Graph of Hetauda (1985-92)

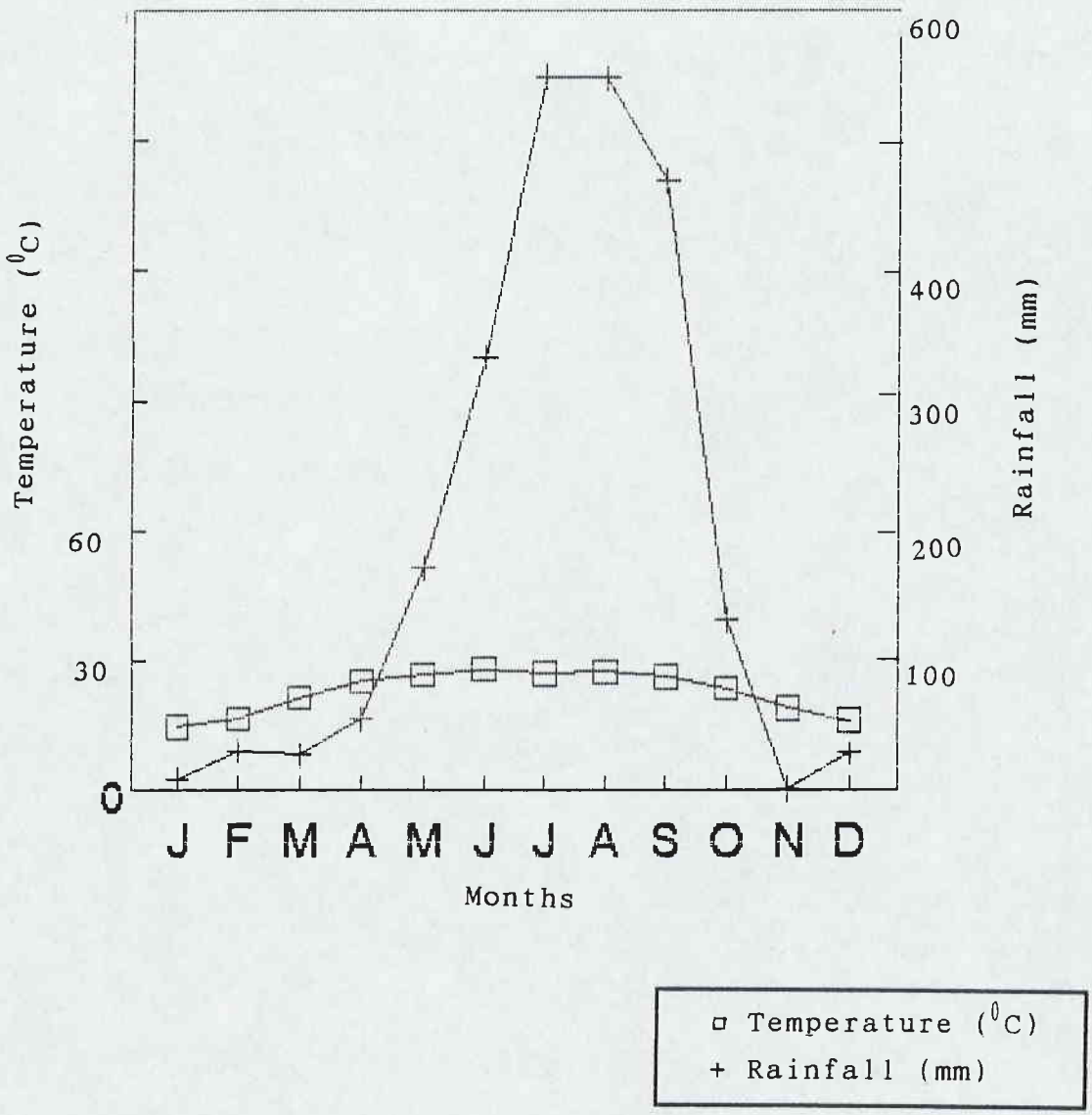
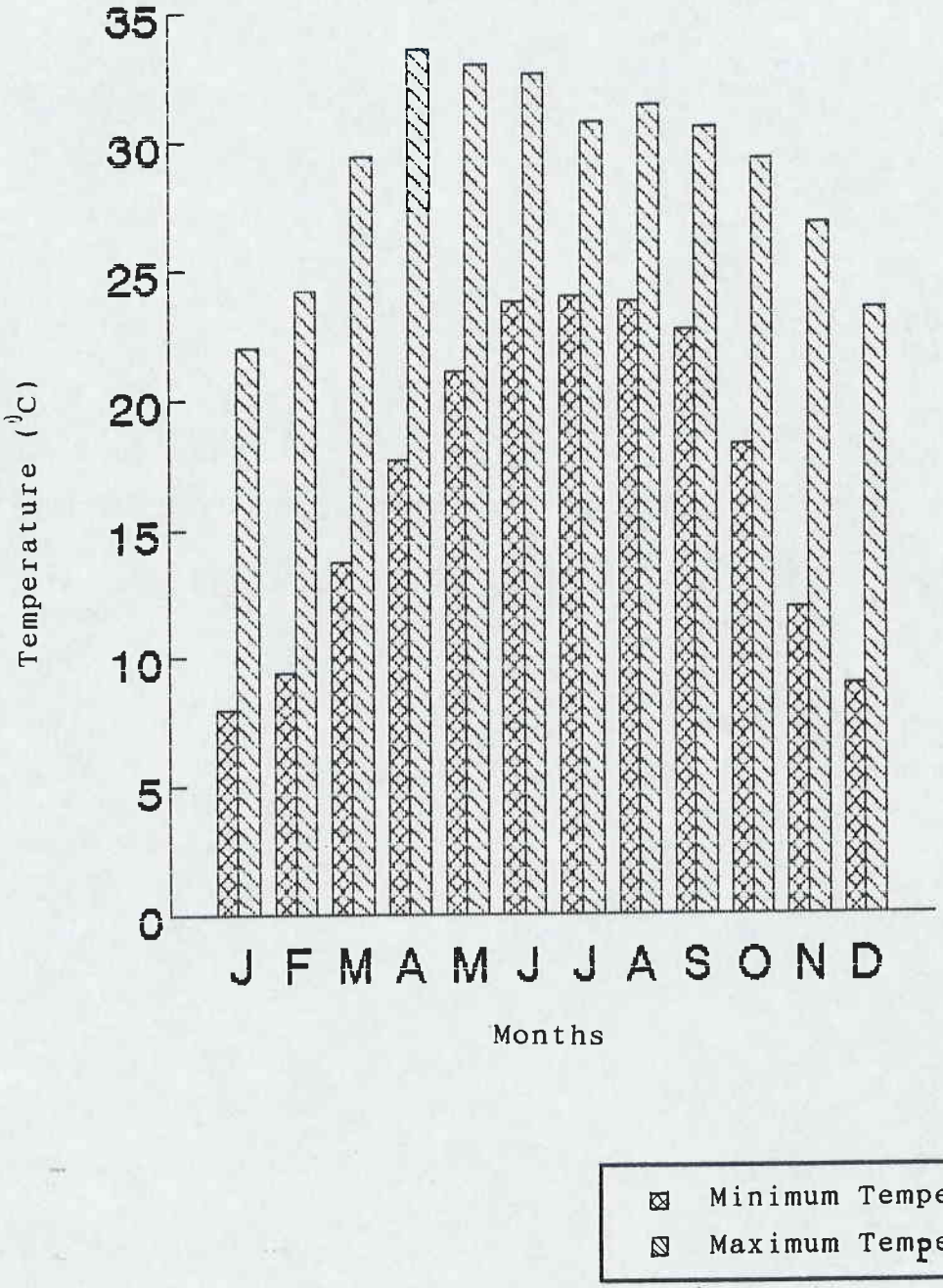


Fig 3: Mean Maximum and Minimum Temperature of Hetauda (1985-92



January; and with the lowest temperature 3.8°C recorded on 15 January, 1985. Both the maximum and minimum temperature remain quite constant in monsoon season.

Relative humidity in air is also quite high. Average annual relative humidity recorded was 75%. Humidity is high in monsoon and winter seasons with average of 83.4% and 81.95% relative humidity, respectively. Summer season is less humid with average of 61.55% relative humidity (Source: Department of Hydrology and Meteorology).

Precipitation recorded from 1985 to 1992(Source: Department of Hydrology and Meteorology) at nearest meteorological station ie., Hetauda is shown in Fig. 2. The average annual rainfall was 2357.84 mm. In the monsoon season alone there was 1899.74 mm of rainfall. In winter there was an average of 151 mm and in summer 168.1 mm of rainfall, respectively. Peak time for rainfall was mid-July to mid-September while the lowest rainfall was in January. Even though this place gets a high amount of rainfall the area seems quite dry. The rainfall does not stay but just runs off and the area immediately seems dry. This is a quite perfect situation for *Sal(Shorea robusta)* growth ie; non-water logged condition(Stainton, 1972).

2.3 Vegetation

The site lies in the Siwalik range and Dun valley thus having a tropical to subtropical type of vegetation. The area supports the deciduous type of forest dominated by *sal(Shorea robusta)*. Much regeneration of sal forest can be seen in this area. Other dominant associates are *dudhe(Wrightia tomentosa)*, *kyamun(Syzygium operculate)*, *Barro(Terminalia belerica)* and *bot dhainyaro(Lagerstroemia parviflora)*.

While in Karne forest mixed type of vegetation is found. The dominant species are *sal(Shorea robusta)*, *kyamun(Syzygium*

operculate), *Barro*(*Terminalia belerica*), *bot dhainyaro* (*Lagerstroemia parviflora*), etc.

The dominant shrub species are *dhurselo*(*Colebrookia oppositifolia*), *bhant*(*Clerodendron infortunatum*), *banmara*(*Eupatorium adenophorum*) and *thakal*(*Phoenix humilis*). *lajwanti*(*Mimosa pudica*) and *aalu zhar*(*Gonostegia hirta*) are dominant herbs in this area.

2.4 Soil

The site has the typical characteristics of the soil of Siwalik range. The area as a whole consists of much gravels and sand with very little or no clay. Thus the soil is very loose and dry. Colour of the soil is mostly brownish to yellow. Karne forest has red coloured soil at the peak of the hills. The soil contains little or no humus. The soil of this area supports many ant hills(Termite houses).

2.5 Human interference

Chitrepani Community Forest is a newly regenerated forest (5 years old) by the efforts of local people. There are some strict rules regarding the use of this forest and they have been protecting and guarding it . But the 9 ha patch of Leasehold Forest area is much degraded.

There is no strict rules for the use of Karne forest where much human interference can be seen. People of this area mostly depend on this forest for fuelwood, fodder and timber. Thus in the long run the size and vegetation of this forest may be affected.

3. MATERIALS AND METHODS

3.1 Survey Reconnaissance

Chitrepani forest area, located in east of Hetauda Industrial District, was chosen as the study site.

Firstly the whole forest area was visited. Then it was divided into four sites according to the villagers' and the forest user group's uses. Accordingly three natural(less disturbed) forest sites were chosen and one degraded forest site were chosen.(Fig. 1)

The degraded forest is located near by the Chitrepani village and is leased out to the local users by the department of forest (HMGN) for a period of 40 years. It is nearest to the village. Among the three natural forest sites(less disturbed), the two sites (Sites I and II) are in the Chitrepani Community Forest. This is a newly regenerated community forest managed by the local user groups. The third site(Site III) is the Karne forest. This is the largest of the three and managed by the local people. The study was focused on these four sites. The study was done in three seasons of the year that is in rainy(September, 1994), winter(December, 1994) and spring(March, 1995).

3.2 Vegetation Study

Vegetation study of the area was done by using the circular plots based on IFRI(International Forestry Resources and Institutions Research Program, Indiana University) methodology(1994).

First the elevation and the slope was recorded in each plot by using an Altimeter and Clinometer, respectively. This gave an average elevation and the slope of the area. Each plot consisted of three concentric rings of 10 m, 3 m and 1 m radius, respectively.

Inside the 10 m radius, the trees having dbh(diameter at breast height ie., 1.37 m above ground) equal to or greater than 10 cm were considered. First the individual number of each species of trees were counted. Then the dbh of each of these plants was measured using a diameter tape. Height of each plant was measured using Abney Level.

Shrubs and saplings were considered in 3 m radius plots. The total number of individual of each species of shrubs and saplings were counted. Basal diameter of each plant was measured using a diameter tape. Height of each plant was also recorded using a measuring tape.

After this the coverage of trees and shrubs was estimated. For this the 10 m tape was drawn both in horizontal and vertical direction. Then the total distance shaded by each plant of each species occurring on these two lines was measured. This whole process was repeated many times in all four sites in all three seasons.

The herbs were considered in 1 m radius plots for biomass estimation. All the herb species were clipped above the ground level using a sickle and a cutter; and packed in a polythene bag and weighed by a spring balance. It was then brought to the laboratory of the Central Department of Botany, TU where it was dried in a hot air oven in 80^0C for 24 hours. Then the dry weight was taken using a balance. Leaf litter was also collected in 1 m radius plots and weighed.

Data processing and analysis

Primary field data were processed to get the idea of vegetation pattern of the area. From the field data, Density(D), Relative Density(D), Frequency(F), Relative frequency(RF), Basal

area(BA), Dominance(Do), Relative dominance(RDo), Coverage(C), Relative coverage(RC) and Importance value index(IVI) were calculated. Similarly, Volume(V), Biomass of trees, Species diversity, Similarity index were also calculated (Zobel et al, 1987).

3.2.1 Density(D) :

Density of a species is the total number of individuals per unit are .

$$\text{Density(D)} = \frac{\text{Total no. of individuals of a species}}{\text{Total no. of plots studied X Area}}$$

Relative density(RD) :

Relative density is the proportion of a species to that of the stand as a whole.

$$\text{Relative Density(RD)} = \frac{\text{Total no. of individuals of a species}}{\text{Total no. of individuals of all species}} \times 100$$

3.2.2 Frequency (F) :

Frequency of a species is the degree of dispersion in terms of percentage occurrence.

$$\text{Frequency(F)} = \frac{\text{Total no. of quadrates in which the species occurs}}{\text{Total no. of quadrates studied}} \times 100$$

Relative frequency (RF) :

It is the dispersion of a species in relation to all the

species.

$$\text{Relative Frequency(RF)} = \frac{\text{Frequency of the species}}{\text{Sum of frequency of all species}} \times 100$$

3.2.3 Basal area(BA)

It refers to the ground actually covered by the stems penetrating the soil. Basal area was calculated using the following formula and unit is in meter square or centimetre square.

$$\text{Basal area(BA)} = \frac{(\text{dbh})^2 \times \pi}{4}$$

where, dbh= diameter at breast height in cm. or m.

3.2.4 Dominance (Do) :

It is the total basal area of a species in unit area.

$$\text{Dominance(Do)} = \frac{\text{Total basal area of a species}}{\text{Total no. of plots studied X area}}$$

Relative Dominance (RDo) :

It is the proportion of the basal area of a species to the sum of the basal area of all the species in the area.

$$\text{Relative Dominance(RDo)} = \frac{\text{Dominance of a species}}{\text{Sum of dominance of all species}} \times 100$$

3.2.5 Importance value index (IVI) :

It is the sum of relative values of density, frequency and

dominance. It gives the idea of the relative importance of a species in a community.

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance

3.2.6 Percentage Crown Coverage(C) :

Coverage of a species is the percentage area of ground covered by the shoot parts of a species ie; by the plant canopy.

Relative coverage(RC) :

It is the coverage of a species in relation to all species.

$$\text{Relative Coverage(RC)} = \frac{\text{Coverage of a species}}{\text{Sum of coverage of all species}} \times 100$$

3.2.7 Volume(V)

The volume may be used as an index of its biomass or of its worth as a commercial product.

$$\text{Volume(V)} = \frac{BA \times H}{2}$$

where, BA = Basal area in m^2 and H = height in m

3.2.8 Biomass of Trees

The biomass of tree species was calculated using the following formula (Brown and Iverson, 1992) which is a revised equation of Brown *et.al.*(1989).

$$Y = 38.49 - 11.799(D) + 1.193(D^2)$$

where, Y = biomass in kg/tree, D = dbh in cm

3.2.9 Species diversity(D)

It indicates the two factors ie., number of species and their relative importance in a community. It was calculated using *Simpson's index* of diversity.

$$\text{Simpson's index(D)} = \frac{N(N-1)}{\Sigma ni(ni-1)}$$

where, N = the total number of plants of all species
ni = the total number of plants of a species

3.2.10 Similarity Index(IS)

The simplest similarity indexes compare samples of vegetation in terms of which species are present.

$$\text{Similarity Index(IS)} = \frac{2C}{A + B}$$

where, A = the total number of species in one sample
B = the total number of species in other sample
C = the number of species which occur in both samples

3.3 Soil

In each site four soil samples ie; total 16 soil samples were collected in each season. Soil was collected in a 1 kg polythene bag with the help of garden trowel and pointed spade (*kuto*); and packed air tight. While collecting, soil was taken from upto the depth of 20cm. Then the collected and packed soil samples were brought to the laboratory of Central Department of Botany, TU. The different parameters of soil ie., Soil moisture and Water holding

capacity were experimented and tested in all three seasons. The soil sample of winter season(December, 1994) was tested also in the laboratory of Soil Science Division of NARC in Khumaltar. Here pH, organic matter, N.P.K, and texture were tested.

3.3.1 Soil moisture

It is the amount of water present in the soil. Ten gram of soil was put in previously weighed crucible and heated in hot air oven at 105^0C for 48 hours. Then it was cooled and weighed (Zobel *et. al.*, 1987).

$$\text{Soil moisture \%} = \frac{\text{Weight of soil before heating} - \text{Weight of soil after heating}}{\text{Weight of soil before heating}} \times 100$$

3.3.2 Water holding capacity

It is the amount of water taken by a unit weight of dry soil when immersed in water. First a clean filter paper was taken and placed in a funnel. Then 10 ml of water was poured over it wetting it completely. Amount of water absorbed by the filter paper was measured. Then 10 gm of oven dried soil was put in it. 10 ml of water was dropped over the soil slowly till a drop of water began to come out of the funnel. Then the water absorbed by the soil was measured (Zobel *et. al.*,1987).

$$\text{Water holding capacity} = \frac{\text{Water retained by the soil}}{\text{Weight of dry soil}} \times 100$$

3.3.3 Soil pH

It is the degree of acidity or alkalinity of the soil. It indicates the degree of availability of many soil nutrients to the plants and the fovourability of soil conditions to microbial activity. To determine the pH of soil the Potentiometric method was used (PCARR, 1980).

3.3.4 Soil Texture

Soil texture is the relative proportion of mineral particles of different sizes ie; clay, silt, sand, gravel, etc. present in the soil. According to the International Society of Soil Science, soil is differentiated as follows.

Name	Particle size in mm.
Clay	less than 0.002
Silt	0.002 to 0.02
Fine sand	0.02 to 0.2
Coarse sand	0.2 to 2
Gravel and stones	more than 2

The soil texture was tested by the Hydrometer method(PCARR, 1980).

Silt + Clay % = (First reading in 40 seconds X correlation coefficient) X 2

Clay % = (Second reading in 2 hours X correlation coefficient) X 2

Silt % = (Silt% + Clay %) - Clay %

Sand % = 100 - (Silt% + Clay %)

Then the texture was determined using a texture triangle.

3.3.5 Soil Organic Matter(OM)

It is one of the most important nutrient found in the soil.

High amounts of soil nutrients such as Nitrogen and Phosphorus are in organic form in the soil. Its presence makes the soil fertile.

$$\% \text{ Organic Matter} = 10 \, (S - T) \times 0.0069 \times \frac{100}{\text{wt. of soil}}$$

$$\overline{S}$$

where, S = ml of ferrous solution required for blank

T = ml of ferrous solution required for sample

(PCARR, 1980)

3.3.6 Nitrogen(N)

Nitrogen in the soil is present in different forms and in very small quantities. Here the organic and ammonium forms are tested. It was measured using Modified Kjeldahl Method(PCARR, 1980).

$$\% \text{ Nitrogen} = \frac{(T-B) \times N \times 14}{S} \times 100$$

where, T = sample titration, ml of standard acid

B = blank titration, ml of standard acid

N = normality of standard acid

S = oven dry weight of sample in mg

3.3.7 Phosphorus(P)

The available phosphorus in soil is the measurement of total soil phosphorus which can be utilised by plants. It was measured using Truog method(Ayres-Hagihara)(PCARR, 1980). Spectrophotometer is used in this method.

$$\text{Phosphorus (kg/ha)} = f \times R$$

where, f = coefficient factor, calculated from blank solution

R = reading in Spectrophotometer

3.3.8 Potassium(K)

It was tested by using Flame Photometer(PCARR, 1980).

Potassium (kg/ha) = f x R

where, f = dilution factor

R = reading in Photometer

3.4 Correlation coefficient(r)

Correlation coefficient was calculated between the species diversity and herbaceous biomass ; and different soil parameters. It was calculated using the following formula (Bailey, 1995).

$$r = \frac{\Sigma xy - \frac{\Sigma x . \Sigma y}{n}}{\sqrt{\{\Sigma x^2 - \frac{(\Sigma x)^2}{n}\}\{\Sigma y^2 - \frac{(\Sigma y)^2}{n}\}}}$$

where, r = Correlation coefficient

x = constant

y = variable

n = number of observation

4. RESULTS

4.1 Vegetation

4.1.1 Occurrence of different species in different sites

There were 28 tree species in total. Among the four sites (Table 1), Site III(Karne Forest) had 23 tree species, Site II(Chitrepani Community forest(mixed)) had 10 tree species and Site I(Chitrepani Community Forest(Pure)) had 8 tree species. The least number of tree species ie., 5 were present in Site IV(Chitrepani Leasehold Forest). *Shorea robusta(sal)*, *Syzygium operculate(kyamuno)* and *Wrightia tomentosa(dudhe)* were present in all four sites. *Lagerstroemia parviflora(botdhainyaro)* and *Terminalia belerica(barro)* were present in three sites. *Casearia graveolens(barkaulo)*, *Mangifera indica(amp)*, *Schima wallichii(chilaune)*, *Terminalia alata(saj/asna)* and *Terminalia chebula(harro)* were present only in two sites.

Table 1: Enumeration and Occurrence of different species in different sites

Botanical Name Local Name	Family	Occurrence in the sites				Season of flowering and fruiting
		I	II	III	IV	
Trees						
Adina cordifolia Hook f **karma/haldu**	Rubiaceae	-	-	+	-	fl: Jun-Jul fr: Jan-Mar
Albizzia odoratissima Benth **phadke**	Leguminosae	-	-	+	-	fl: Apr-Jun fr: Dec-Jan
Buchanania lanzen Spreng **piyar**	Anacardiaceae	-	-	+	-	fl: Mar fr: Jun-Jul
Bauhinia purpurea L **tanki**	Leguminosae	-	-	+	-	fl: Sep-Oct fr: Jan-Mar
Careya arborea Roxb **kumbhi**	Myrtaceae	-	-	+	-	fl: Apr-May fr: Jun-Jul
Casearia graveolens D lz **barkaulo**	Flacour--tiaceae	+	+	-	-	fl: Mar-May fr: Jun-Jul

Botanical Name Local Name	Family	Occurrence in the sites				Season of flowering and fruiting
		I	II	III	IV	
Dalbergia sissoo Roxb **sisau**	Leguminosae	-	-	-	+	fl: Mar-Apr fr: Dec-Jan
Dillenia pentagyna L **tantery**	Dilleniaceae	-	-	+	-	fl: Mar fr: May-Jun
Gmelina arborea Roxb **khamari**	Verbenaceae	-	+	-	-	fl: Feb-Apr fr: May-Jun
Grewia hainesiana Hole **harsa pharsa**	Tiliaceae	-	-	+	-	Seeding: Jun-Aug
Lagerstroemia parviflora Roxb **botdhaiyaro**	Lythraceae	+	+	+	-	fl: Apr-Jun fr: Dec-Feb
Leea aspera Wall ex Roxb	Vitaceae	-	-	+	-	fl: Jun-Jul fr: Aug
Mangifera indica L **amp**	Anacardiaceae	-	-	+	+	fl: Feb-apr fr: Jun-Jul
Oegeinia dalbergoides Benth **sandan**	Leguminosae	-	-	+	-	fl: Feb-Mar fr: May-Jun
Phyllanthus emblica L **amala**	Euphorbiaceae	-	-	+	-	fl: Mar-May fr: Nov-Feb
Pinus roxburghii Sarg **khote sallo**	Pinaceae	-	-	+	-	fl: Feb-Apr fr: Apr-May (next year)
Psidium guajava L **amba**	Myrtaceae	+	-	-	-	fl: Mar-Apr fr: Aug-Sep
Schima wallichii Chois **chilaune**	Theaceae	+	-	+	-	fl: Apr-Jun fr: Dec-Jan
Semecarpus anacardium L **bhalayo**	Anacardiaceae	-	-	+	-	fl: May-Jun fr: Nov-Feb
Shorea robusta Gaertn **sal/agrakh**	Diptero--carpaceae	+	+	+	+	fl: Feb fr: Jun
Syzygium cumini L **jamun**	Myrtaceae	-	-	+	-	fl: Mar-May fr: Jun-Aug
Syzygium operculate Roxb **kyamuno**	Myrtaceae	+	+	+	+	fl: Mar-May fr: Jun-Aug
Terminalia alata Heyne ex Roth **saj/asna**	Combretaceae	-	+	+	-	fl: Jul fr: Feb-Mar

Botanical Name Local Name	Family	Occurrence in the sites				Season of flowering and fruiting
		I	II	III	IV	
Terminalia belerica Roxb **barro**	Combretaceae	+	+	+	-	fl: Apr-May fr: Nov-Feb
Terminalia chebula Ratz **harro**	Combretaceae	-	+	+	-	fl: Apr-May fr: Nov-Mar
Wendlandia puberula DC **bankangiyo**	Rubiaceae	-	-	+	-	fl: May-Jun fr: Dec-Jan
Wrightia tomentosa Roem Sch **dudhi**	Apocynaceaea	+	+	+	+	fl: May-Jun fr: Dec-Jan
Unknown sp **birali**	---	-	+	-	-	fl: - fr: -
<u>Shrubs</u>						
Barleria cristata L **bhende kuro**	Acanthaceae	-	-	+	-	fl: Sept-Oct fr: Sept-Oct
Clerodendron infortunatum **bhant**	Verbenaceaea	+	+	+	-	fl: all year
Colebrookia oppositifolia Sm **dhurselo**	Labiatae	+	+	+	-	fl: Dec-May
Cornus oblongum Wall **latte kath**	Cornaceae	-	-	+	-	fl: Jan-Feb fr: Aug-Sep
Desmodium confertum DC	Leguminosae	-	-	+	-	fl: Oct fr: Jan-Feb
Eupatorium adenophorum Spreng **banmara**	Compositae	+	+	+	+	fl: Mar-May fr: May
Inula cappa DC **bakhri kane**	Compositae	-	-	+	+	fl: Jan-Nov fr: Jan-Nov
Lantana camara L **boksi kanda**	Verbenaceae	+	-	-	+	fl: Aug fr: Jan
Murraya koenigii (L) Spreng	Rutaceae	-	-	+	-	fl: fr:
Osbeckia stellata Buch Ham ex D Don **chulesi**	Melasto-mataceae	-	-	+	-	fl: Aug-Sep fr: Oct
Osyris wightiana Wall ex Wight **nundhiki**	Santalaceae	-	-	+	-	fl: Feb-Mar fr: Feb-Mar

Botanical Name Local Name	Family	Occurrence in the sites				Season of flowering and fruiting
		I	II	III	IV	
Pennisetum purpureum napier ghans	Gramineae	-	-	-	+	fl: Sep fr: Sep
Phoenix humilis thakal	Palmae	+	+	+	-	fl: - fr:
Pogostemon glaber Benth rudilo	Labiatae	-	+	+	-	fl: Feb-Mar
Randia dumortorum maitalu	Rubiaceae	-	-	+	+	fl: Apr fr: Aug-Sep
Reinwardtia indica pyauli	Linaceae	-	-	+	-	fl: Nov-Jan
Sida rhombifolia L sano chilya	Malvaceae	-	-	+	-	fl: Aug-Sep Fr: Aug-Sep
Woodfordia fruiticosa (L) Kurz sano dhainyaro	Lythraceae	-	-	+	-	fl: Feb-Mar fr: May
Total species Total in each Site	46	13	15	39	10	

There were 18 shrub species in total(Table 1). Among the four sites, Site III had 16 shrub species while the other three sites had 5 shrub species each. *Eupatorium adenophorum(banmara)* was present in all four sites. *Clerodendron infortunatum(bhant)*, *Colebrookia oppositifolia(dhurselo)* and *Phoenix humilis(thakal)* were present in three sites. *Inula cappa(bakhri kane)*, *Lantana camara (boksi kanda)*, *Pogostemon glaber(rudilo)* and *Randia dumortorum(maitalu)* were present in two sites.

4.1.2 Density and Relative density

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, *Shorea robusta* had the highest density and relative density value in September and March. It ranged from 57.3 pl/ha(100%) to 63.66 pl/ha(80%). In December, *Syzygium operculate* had the highest value of 79.58 pl/ha(52.63%). The lowest value was recorded for *Schima wallichii* in December and *Syzygium operculate* in March; the value being 7.96 pl/ha(5.26%) and 15.92 pl/ha(20%), respectively.(Table 2)

Among the saplings also, *Shorea robusta* had the highest value of density and relative density in all three seasons. It was 5234.43 pl/ha(85.06%) in September, 14589.2 pl/ha(81.68%) in December and 6366.2 pl/ha(77.42%) in March. While the lowest value of 70.74 pl/ha(1.15%) was recorded for *Lagerstroemia parviflora* and *Wrightia tomentosa* in September; 88.42 pl/ha(0.5%) for *Terminalia belerica* in December and 88.42 pl/ha(1.08%) for *Psidium guajava* in March.

Among the shrubs, *Eupatorium adenophorum* had the highest value of density and relative density in all three seasons. It was 6083.26 pl/ha(96.63%) in September, 4774.65 pl/ha(91.53%) in December and 530.52pl/ha(66.67%) in March. The lowest value of 70.74 pl/ha(1.12%) was recorded for *Lantana camara* in September, 88.42 pl/ha(1.69%) for *Colebrookia oppositifolia* and *Phoenix humilis* in December and 265.26 pl/ha(33.33%) for *Phoenix humilis* in March.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, the highest value of density and relative density was 551.74 pl/ha(41.6%) recorded for *Wrightia tomentosa* in September. While in December and March it was 190.99pl/ha(33.8%) and 63.66 pl/ha(42.11%), respectively, recorded for *Syzygium operculate*. The lowest value of 10.61

Table 2 : Density and Relative Density of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Density (pl/ha)			Relative Density (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)						
Trees						
Shorea robusta	57.3	63.66	63.66	100	42.11	80
Schima wallichii	-	7.96	-	-	5.26	-
Syzygium operculate	-	79.58	15.92	-	52.63	20
Total	57.3	151.2	79.58			
Saplings						
Casearia graveolens	282.94	-	-	4.6	-	-
Lagerstroemia parviflora	70.74	-	-	1.15	-	-
Psidium guajava	-	-	88.42	-	-	1.08
Shorea robusta	5234.43	14589.2	6366.2	85.06	81.68	77.42
Syzygium operculate	495.15	1945.23	1061.03	8.05	10.89	12.9

Name of the species	Density (pl/ha)			Relative Density (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Terminalia belerica	-	88.42	-	-	0.5	-
Wrightia tomentosa	70.74	1237.87	707.36	1.15	6.93	8.6
Total	6154	17860.72	8223.01			
Shrubs						
Clerodendron infortunatum	-	265.26	-	-	5.08	-
Colebrookia oppositifolia	-	88.42	-	-	1.69	-
Eupatorium adenophorum	6083.26	4774.65	530.52	96.63	91.53	66.67
Lantana camara	70.74	-	-	1.12	-	-
Phoenix humilis	141.47	88.42	265.26	2.25	1.69	33.33
Total	6295.47	5216.75	795.78			
Site II: Chitrepani Community Forest(mixed forest)						
Trees						
Gmelina arborea	74.27	111.41	55.7	5.6	19.72	36.8
Lagerstroemia parviflora	53.05	47.75	7.96	4.0	8.45	5.26
Shorea robusta	106.1	15.92	-	8.0	2.82	-
Syzygium operculate	31.83	190.99	63.66	2.4	33.8	42.1
Terminalia belerica	498.69	175.07	15.92	37.6	30.99	10.5
Terminalia chebula	10.61	-	-	0.8	-	-
Wrightia tomentosa	551.74	23.87	7.96	41.6	4.22	5.26
Total	1326.29	565.01	150.84			
Saplings						
Casearia graveolens	-	88.42	-	-	0.63	-
Lagerstroemia parviflora	-	707.36	442.1	-	5.03	6.7
Shorea robusta	117.89	1768.39	2122.07	5.88	12.58	32.0
Syzygium operculate	-	530.52	795.78	-	3.77	12.0
Terminalia belerica	235.79	4597.81	707.36	1.76	32.7	10.7
Terminalia chebula	-	88.42	-	-	0.63	-
Terminalia alata	589.46	442.1	88.42	29.41	3.14	1.3
Wrightia tomentosa	1061.03	5747.26	2475.74	52.95	40.88	37.3
Birali	-	88.42	-	-	0.63	-
Total	2004.17	14058.7	6631.47			
Shrubs						
Clerodendron infortunatum	-	530.52	1326.29	-	21.4	29.4
Colebrookia oppositifolia	-	795.75	1149.45	-	32.2	25.4

Name of the Species	Density (pl/ha)			Relative Density (		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar
Eupatorium adenophorum	1061.03	1061.03	1237.87	100	42.8	27.
Phoenix humilis	-	88.42	176.84	-	3.6	3.9
Pogostemon glaber	-	-	618.94	-	-	13.
Total	1061.03	2475.72	4509.42			
Site III: Karne Forest						
Trees						
Adina cordifolia	41.44	-	3.98	2.0	-	3.33
Albizzia odoratissima	-	4.55	-	-	2.0	-
Bauhinia purpurea	4.55	-	-	2.0	-	-
Buchanania lanzen	4.55	-	-	2.0	-	-
Careya arborea	9.1	-	-	4.0	-	-
Lagerstroemia parviflora	9.09	-	-	4.0	-	-
Leea aspera	4.55	-	-	2.0	-	-
Mangifera indica	-	-	3.98	-	-	3.33
Oegenia dalbergiodes	4.55	-	-	2.0	-	-
Phoenix humilis	4.55	-	-	2.0	-	-
Phyllanthus emblica	-	-	7.96	-	-	6.67
Pinus roxburghii	-	4.55	-	-	2.0	-
Randia dumortorum	4.55	-	-	2.0	-	-
Schima wallichii	4.55	4.55	-	2.0	2.0	-
Semecarpus anacardium	4.55	18.19	-	2.0	8.0	-
Shorea robusta	140.97	150.1	71.62	62.0	66.0	60.0
Syzygium cumini	4.55	-	-	2.0	-	-
Syzygium operculate	4.55	40.93	15.92	2.0	18.0	13.33
Terminalia chebula	-	-	3.98	-	-	3.33
Terminalia alata	18.19	4.55	11.94	8.0	2.0	10.0
Total	264.29	227.42	119.38			
Saplings						
Adina cordifolia	-	50.53	-	-	0.49	-
Albizzia odoratissima	-	505.25	-	-	4.93	-
Buchanania lanzen	50.53	50.53	-	0.93	0.49	-
Dillenia pentagyna	-	-	397.89	-	-	7.09
Grewia hainesiana	151.58	-	-	2.78	-	-
Lagerstroemia parviflora	-	50.53	265.26	-	0.49	4.72

Name of the Species	Density (pl/ha)			Relative Density (%		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Leea aspera	151.58	-	-	2.78	-	-
Phyllanthus emblica	50.53	101.1	-	0.93	0.99	-
Schima wallichii	-	151.58	353.68	-	1.48	6.3
Semecarpus anacardium	-	151.58	486.31	-	1.48	8.66
Shorea robusta	4294.66	6871.45	3006.26	79.7	67.0	53.54
Syzygium cumini	50.53	50.53	88.42	0.93	0.49	1.57
Syzygium operculate	-	757.88	530.52	-	7.39	9.45
Terminalia belerica	-	101.1	-	-	0.99	-
Terminalia chebula	404.2	202.1	176.84	7.41	1.97	3.15
Terminalia alata	101.1	707.36	132.63	1.85	6.9	2.36
Wendlandia puberula	202.1	404.2	-	3.7	3.94	-
Wrightia tomentosa	-	101.1	176.84	-	0.99	3.15
Total	5456.81	10256.82	5614.65			
Shrubs						
Barleria cristata	-	-	44.21	-	-	1.28
Clerodendron infortunatum	-	404.2	-	-	5.26	-
Colebrookia oppositifolia	50.53	-	-	1.47	-	-
Cornus oblonga	50.53	303.15	44.21	1.47	3.95	1.28
Desmodium confertum	-	202.1	-	-	2.63	-
Eupatorium adenophorum	1768.39	1768.39	707.36	51.47	23.03	20.5
Inula cappa	303.15	202.1	-	8.82	2.63	-
Murraya koenigii	-	50.53	-	-	0.66	-
Osbeckia stellata	-	50.53	44.21	-	0.66	1.28
Osyris wightiana	151.58	50.53	-	4.41	0.66	-
Phoenix humilis	757.88	4143.08	2077.86	14.02	53.95	60.26
Pogostemon glaber	-	-	88.42	-	-	2.56
Randia dumortorum	50.53	252.63	-	1.47	2.29	-
Reinwardtia indica	-	50.53	-	-	0.66	-
Sida rhombifolia	-	50.53	-	-	0.66	-
Woodfordia fruiticosa	-	151.58	442.1	-	1.97	12.82
Total	3132.59	7679.88	3448.37			
Site IV: Chitrepani Leasehold Forest						
Trees						
Shorea robusta	7.96	31.83	31.83	100	100	100
Total	7.96	31.83	31.83			

Name of the Species	Density (pl/ha)			Relative Density (%		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar
Saplings						
Dalbergia sissoo	-	176.8	88.42	-	6.9	4.3
Mangifera indica	-	88.4	-	-	3.45	-
Shorea robusta	265.26	495.1	1149.45	60	24.14	56.
Syzygium operculate	176.84	1237.87	707.36	40	48.28	34.
Wrightia tomentosa	-	442.1	88.42	-	17.24	4.3
Total	433.1	2440.27	2033.65			
Shrubs						
Eupatorium adenophorum	2652.58	2564.16	1061.03	100	70.73	85.
Inula cappa	-	88.42	-	-	2.44	-
Lantana camara	-	88.42	176.84	-	2.44	14.
Pennisetum purpureum	-	795.78	-	-	21.95	-
Randia dumortorum	-	88.42	-	-	2.44	-
Total	2652.58	3625.2	1237.87			

pl/ha(0.8%) was recorded for *Terminalia chebula* in September, 15.92 pl/ha(2.82%) for *Shorea robusta* in December and 7.96 pl/ha(5.26%) for *Lagerstroemia parviflora* and *Wrightia tomentosa* in March.(Table 2)

Among the saplings, *Wrightia tomentosa* had the highest value of density and relative density in all three seasons; which was 1061.03 pl/ha(52.95%) in September, 5747.26 pl/ha(40.88%) in December and 2475.74 pl/ha(37.3%) in March. The lowest value recorded was 235.79 pl/ha(1.76%) for *Terminalia belerica* in September, 88.42 pl/ha(0.63%) for *Casearia graveolens, Terminalia chebula* and Birali in December and 88.42 pl/ha(1.3%) for *Terminalia alata* in March.

Among the shrubs, *Eupatorium adenophorum* had the highest value of density and relative density in two seasons; which was 1061.03 pl/ha(100%) in September and 1061.03 pl/ha(42.8%) in December. While in March, it was 1326.29 pl/ha(29.41%) recorded for *Clerodendron infortunatum*. The lowest value recorded was for *Phoenix humilis* which was 88.42 pl/ha(3.6%) in December and 176.84 pl/ha(3.92%) in March.

Site III : Karne Forest

Among the trees, the highest value of density and relative density was recorded for *Shorea robusta* in all seasons, which ranged from 71.62 pl/ha(60%)

to 150.1 pl/ha(66%). The lowest value recorded was 4.55 pl/ha(2%) in September for *Bauhinia purpurea*, *Buchanania lanzen*, *Leea aspera*, *Oegenia dalbergiodes*, *Schima wallichii*, *Semecarpus anacardium*, *Syzygium cumini* and *S. operculate*, 4.55 pl/ha(2%) in December for *Albizzia odoratissima*, *Pinus roxburghii*, *Schima wallichii* and *Terminalia alata* ; and 3.98 pl/ha(3.33%) in March for *Adina cordifolia*, *Mangifera indica* and *Terminalia chebula*(Table 2).

Among the saplings, *Shorea robusta* had the highest value of density and relative density in all three seasons; which was 4294.66 pl/ha(79.7%) in September, 6871.45 pl/ha(67%) in December and 3006.26 pl/ha(53.54%) in March. The lowest value recorded was 50.53 pl/ha(0.93%) in September for *Buchanania lanzen*, *Phyllanthus emblica* and *Syzygium cumini*, 50.53 pl/ha(0.49%) in December for *Adina cordifolia*, *Buchanania lanzen*, *Lagerstroemia parviflora* and *Syzygium cumini* and 88.42 pl/ha(1.57%) in March for *Syzygium cumini*.

Among the shrubs, the highest density and relative density value recorded was 1768.39 pl/ha(51.47%) in September for *Eupatorium adenophorum*. While in December and March it was recorded for *Phoenix humilis* which was 4143.08 pl/ha(53.95%) and 2077.86 pl/ha(60.26%), respectively. The lowest value recorded was 50.53 pl/ha(1.47%) in September for *Colebrookia oppositifolia*, *Cornus oblonga* and *Randia dumortorum*, 50.53 pl/ha(0.66%) in December for *Murraya koenigii*, *Osbeckia stellata*, *Osyris wightiana*, *Reinwardtia indica* and *Sida rhombifolia*; and 44.21 pl/ha(1.28%) in March for *Barleria cristata*, *Cornus oblonga* and *Osbeckia stellata*.

Site IV : Chitrepani Leasehold Forest

Among the trees, *Shorea robusta* was the only species and its density and relative density value was 7.96 pl/ha(100%) to 31.83 pl/ha(100%).

Among the saplings, the highest density and relative density value recorded was 265.26 pl/ha(60%) in September for *Shorea robusta*, 1237.87 pl/ha(48.28%) in December for *Syzygium operculate* and 1149.45 pl/ha(56.5%) in March again for *Shorea robusta*. The lowest value recorded was 176.84 pl/ha(40%) in September for *Syzygium operculate*, 88.4 pl/ha(3.45%) in December for *Mangifera indica* and 88.42 pl/ha(4.35%) in March for *Dalbergia sissoo* and *Wrightia tomentosa*(Table 2).

Among the shrubs, *Eupatorium adenophorum* had the highest density and relative density value in all three seasons; which was 2652.58 pl/ha(100%) in September, 2564.16 pl/ha(70.73%) in December and 1061.03 pl/ha(85.71%) in March. The lowest value recorded was 88.42 pl/ha(2.44%) in December for *Inula*

cappa, *Lantana camara*, and *Randia dumortorum* ; and 176.84 pl/ha(14.29%) in March for *Lantana camara*.

4.1.3 Frequency and Relative frequency

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, *Shorea robusta* had the highest frequency and relative frequency value in all three seasons; which ranged from 100%(66.67%) to 100%(100%). The lowest value recorded was 25%(16.67%) in December for *Schima wallichii* and *Syzygium operculate*; and 25%(20%) in March for *Syzygium operculate*.(Table 3)

Among the saplings, the highest frequency and relative frequency value recorded was 60%(37.5%) in September for *Syzygium operculate*, 100%(30.77%) in December for *Shorea robusta*, *Syzygium operculate* and *Wrightia tomentosa*; and 100%(40%) in March for *Shorea robusta*. The lowest value recorded was 20%(12.5%) in September for *Casearia graveolens*, *Lagerstroemia parviflora* and *Wrightia tomentosa*, 25%(7.69%) in December for *Terminalia belerica*; and 25%(10) in March for *Psidium guajava*.

Among the shrubs, the highest frequency and relative frequency value recorded in all three seasons was for *Eupatorium adenophorum* ; which was 40%(50%) in September, 100%(57.14%) in December and 75%(75%) in March. The lowest value recorded was 20%(25%) in September for *Lantana camara* and *Phoenix humilis*, 25%(14.29%) in December for *Clerodendron infortunatum*, *Colebrookia oppositifolia* and *Phoenix humilis*; and 25%(25%) in March for *Phoenix humilis*.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees the highest frequency and relative frequency value recorded was 66.67%(18.18%) in September for *Lagerstroemia parviflora*, *Shorea robusta*, *Terminalia belerica* and *Wrightia tomentosa*, 100%(28.57%) in December for *Syzygium operculate* and 50%(28.57%) in March for *Gmelina arborea* and

Table 3: Frequency and Relative Frequency of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Frequency (%)			Relative Frequency(%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)						
Trees						
Shorea robusta	100	100	100	100	66.67	80
Schima wallichi	-	25	-	-	16.67	-
Syzygium operculate	-	25	25	-	16.67	20
Saplings						
Casearia graveolens	20	-	-	12.5	-	-
Lagerstroemia parviflora	20	-	-	12.5	-	-
Psidium guajava	-	-	25	-	-	10
Shorea robusta	40	100	100	25	30.77	40
Syzygium operculate	60	100	50	37.5	30.77	20
Terminalia belerica	-	25	-	-	7.69	-
Wrightia tomentosa	20	100	75	12.5	30.77	30
Shrubs						
Clerodendron infortunatum	-	25	-	-	14.29	-
Colebrookia oppositifolia	-	25	-	-	14.29	-
Eupatorium adenophorum	40	100	75	50	57.14	75
Lantana camara	20	-	-	25	-	-
Phoenix humilis	20	25	25	25	14.29	25
Site II: Chitrepani Community Forest(mixed forest)						
Trees						
Gmelina arborea	33.33	25	50	9.09	7.14	28.57
Lagerstroemia parviflora	66.67	50	25	18.18	14.29	14.29
Shorea robusta	66.67	25	-	18.18	7.14	-
Syzygium operculate	33.33	100	50	9.09	28.57	28.57
Terminalia belerica	66.67	75	25	18.18	21.43	14.29
Terminalia chebula	33.33	-	-	9.09	-	-
Wrightia tomentosa	66.67	75	25	18.18	21.43	14.29
Saplings						
Casearia graveolens	-	25	-	-	5	-
Lagerstroemia parviflora	-	50	75	-	10	15
Shorea robusta	33.33	75	100	25	15	20

Name of the species	Frequency (%)			Relative Frequency (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Syzygium operculate	-	50	100	-	10	20
Terminalia belerica	33.33	100	100	25	20	20
Terminalia chebula	-	25	-	-	5	-
Terminalia alata	33.33	50	25	25	10	5
Wrightia tomentosa	33.33	100	100	25	20	20
Birali	-	25	-	-	5	-
Shrubs						
Clerodendron infortunatum	-	25	50	-	14.3	20
Colebrookia oppositifolia	-	50	50	-	28.6	20
Eupatorium adenophorum	33.33	75	75	100	42.9	30
Phoenix humilis	-	25	25	-	14.2	10
Pogostemon glaber	-	-	50	-	-	20
Site III: Karne Forest						
Trees						
Adina cordifolia	14.29	-	12.5	4.35	-	7.14
Albizzia odoratissima	-	14.29	-	-	6.67	-
Bauhinia purpurea	14.29	-	-	4.35	-	-
Buchanania lanzen	14.29	-	-	4.35	-	-
Careya arborea	14.29	-	-	4.35	-	-
Lagerstroemia parviflora	28.57	-	-	8.69	-	-
Leea aspera	14.29	-	-	4.35	-	-
Mangifera indica	-	-	12.5	-	-	7.14
Oegenia dalbergiodes	14.29	-	-	4.35	-	-
Phoenix humilis	14.29	-	-	4.35	-	-
Phyllanthus emblica	-	-	12.5	-	-	7.14
Pinus roxburghii	-	14.29	-	-	6.67	-
Randia dumortorum	14.29	-	-	4.35	-	-
Schima wallichi	14.29	14.29	-	4.35	6.67	-
Semecarpus anacardium	14.29	42.86	-	4.35	20	-
Shorea robusta	100	100	75	30.46	46.66	42.86
Syzygium cumini	14.29	-	-	4.35	-	-
Syzygium operculate	14.29	14.29	25	1.35	6.67	14.29
Terminalia chebula	-	-	12.5	-	-	7.14
Terminalia alata	28.57	14.29	25	8.69	6.67	14.29

Name of the species	Frequency (%)			Relative Frequency (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Saplings						
Adina cordifolia	-	14.29	-	-	2.78	-
Albizzia odoratissima	-	28.57	-	-	5.56	-
Buchanania lanzen	14.29	14.29	-	5.26	2.78	-
Dillenia pentagyna	-	-	50	-	-	12.5
Grewia hainesiana	28.57	-	-	10.52	-	-
Lagerstroemia parviflora	-	14.29	25	-	2.78	6.25
Leea aspera	42.86	-	-	15.79	-	-
Phyllanthus emblica	14.29	14.29	-	5.26	2.78	-
Schima wallichii	-	42.86	37.5	-	8.33	9.38
Semecarpus anacardium	-	28.57	50	-	5.56	12.5
Shorea robusta	71.43	100	100	26.31	19.44	25
Syzygium cumini	14.29	14.29	12.5	5.26	2.78	3.13
Syzygium operculate	-	71.43	50	-	13.89	12.5
Terminalia belerica	-	28.57	-	-	5.56	-
Terminalia chebula	42.86	42.86	25	15.79	8.33	6.25
Terminalia alata	14.29	57.14	12.5	5.26	11.11	3.13
Wendlandia puberula	28.57	14.29	-	10.52	2.78	-
Wrightia tomentosa	-	28.57	37.5	-	5.56	9.38
Shrubs						
Barleria cristata	-	-	12.5	-	-	5.88
Clerodendron infortunatum	-	14.29	-	-	3.7	-
Colebrookia oppositifolia	14.29	-	-	5.26	-	-
Cornus oblonga	14.29	42.86	12.5	5.26	11.11	5.88
Desmodium confertum	-	14.29	-	-	3.7	-
Eupatorium adenophorum	57.14	85.71	62.5	21.05	22.22	29.41
Inula cappa	57.14	42.86	-	21.05	11.11	-
Murraya koenigii	-	14.29	-	-	3.7	-
Osbeckia stellata	-	14.29	12.5	-	3.7	5.88
Osyris wightiana	14.29	14.29	-	5.26	3.7	-
Phoenix humilis	57.14	85.71	87.5	21.05	22.22	41.18
Pogostemon glaber	-	-	12.5	-	-	5.88
Randia dumortorum	14.29	14.29	-	5.26	3.7	-
Reinwardtia indica	-	14.29	-	-	3.7	-

Name of the species	Frequency (%)			Relative Frequency (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Sida rhombifolia	-	14.29	-	-	3.7	-
Woodfordia fruiticosa	-	14.29	12.5	-	3.7	5.88
Site IV: Chitrepani Leasehold Forest						
Trees						
Shorea robusta	25	75	75	100	100	100
Saplings						
Dalbergia sissoo	-	25	25	-	14.29	16.67
Mangifera indica	-	25	-	-	14.29	-
Shorea robusta	25	25	75	50	14.29	50
Syzygium operculate	25	50	25	50	28.57	16.67
Wrightia tomentosa	-	50	25	-	28.57	16.67
Shrubs						
Eupatorium adenophorum	50	75	75	100	42.86	75
Inula cappa	-	25	-	-	14.29	-
Lantana camara	-	25	25	-	14.29	25
Pennisetum purpureum	-	25	-	-	14.29	-
Randia dumortorum	-	25	-	-	14.29	-

Syzygium operculate. The lowest value recorded was 33.33%(9.09%) in September for *Gmelina arborea*, *Syzygium operculate* and *Terminalia chebula*, 25%(7.14%) in December for *Gmelina arborea* and *Shorea robusta*, and 25%(14.29%) in March for *Lagerstroemia parviflora*, *Terminalia belerica* and *Wrightia tomentosa* (Table 3).

Among the saplings, all the species recorded in September had same frequency and relative frequency value which was 33.33%(25%). While the highest value recorded was 100%(20%) in December for *Terminalia belerica* and *Wrightia tomentosa* and 100%(20%) in March for *Shorea robusta*, *Syzygium operculate*, *Terminalia belerica* and *Wrightia tomentosa*. The lowest value recorded was 25%(5%) in December for *Casearia graveolens*, *Terminalia chebula* and Birali; and 25%(5) in March for *Terminalia alata*.

Among the shrubs, *Eupatorium adenophorum* had the highest frequency and relative frequency value in all three seasons which was 33.33%(100%) in September, 75%(42.9%) in December and 75%(30%) in March. The lowest value recorded was 25%(14.2%) in December for *Clerodendron infortunatum* and *Phoenix humilis*; and 25%(10%) in March for *Phoenix humilis*.

Site III : Karne Forest

Among the trees, *Shorea robusta* had the highest frequency and relative frequency value in all three seasons, which ranged from 75%(42.86%) to 100%(30.46%). Most of the remaining species had quite same value (Table 3).

Among the saplings also, the highest frequency and relative frequency value was recorded for *Shorea robusta* in all seasons; which was 71.43%(26.31%) in September, 100%(19.44%) in December and 100%(25%) in March. The lowest value recorded was 14.29%(5.26%) in September for *Buchanania lanzen*, *Phyllanthus emblica*, *Syzygium cumini* and *Terminalia alata*, 14.29%(2.78%) in December for *Adina cordifolia*, *Buchanania lanzen*, , *Lagerstroemia parviflora*, *Phyllanthus emblica*, *Syzygium cumini* and *Wendlandia puberula* ; and 12.5%(3.13%) in March for *Syzygium cumini* and *Terminalia alata*.

Among the shrubs, the highest frequency and relative frequency value recorded was for *Phoenix humilis* in all seasons which was 57.14%(20.05%) in September, 85.71%(22.22%) in December and 87.5%(41.18%) in March. *Eupatorium adenophorum* also showed the same highest value in September and December. The lowest value recorded was 14.29%(5.26%) in September for *Colebrookia oppositifolia*, *Cornus oblonga*, *Osyris wightiana* and *Randia dumortorum* ; 14.29%(3.7%) in December for most of the species and 12.5%(5.88%) in March for *Barleria cristata*, *Cornus oblonga*, *Osbeckia stellata*, *Pogostemon glaber* and *Woodfordia fruiticosa*.

Site IV : Chitrepani Leasehold Forest

Among the trees, *Shorea robusta* was the only species and the frequency and relative frequency value recorded was 25%(100%) in September, 75%(100%) in December and March (Table 3).

Among the saplings, the highest value recorded was 25%(50%) in September for *Shorea robusta* and *Syzygium operculate*, 50%(28.57%) in December for *Syzygium operculate* and *Wrightia tomentosa* ; and 75%(50%) in March for *Shorea robusta*. Other species had 25%(14.29%) in December and 25%(16.67%) in March.

Among the shrubs, *Eupatorium adenophorum* had the highest frequency and relative frequency value in all seasons, which was 50%(100%) in September, 75%(42.86%) in December and 75%(75%) in March. Other species had 25%(14.29%) in December and 25%(25%) in March(Table 3).

4.1.4 Dominance and Relative dominance

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, the highest dominance and Relative dominance value recorded was for *Shorea robusta* in all seasons, which ranged from 10.98m^2/ha(92.19%) to 52.21m^2/ha(100%). The lowest value recorded was 0.11m^2/ha(0.89%) in December for *Schima wallichii* and 0.19m^2/ha(1.06%) in March for *Syzygium operculate* (Table 4).

Among the saplings, the highest dominance and relative dominance value recorded was for *Shorea robusta* in all seasons, which was 11.11m^2/ha(81.92%) in September, 10.1m^2/ha(68.97%) in December and 4.85m^2/ha(62.93%) in March. The lowest value recorded was 0.04m^2/ha(0.28%) in September for *Wrightia tomentosa*, 0.16m^2/ha(1.09%) in December for *Terminalia belerica* and 0.04m^2/ha(0.56%) in March for *Psidium guajava.*

Among the shrubs, the highest dominance and relative dominance value recorded was for *Eupatorium adenophorum* in all seasons, which was 4.07m^2/ha(94.03%) in September, 2.82m^2/ha(86.25%) in December and 0.27m^2/ha(56.61%) in March. The lowest value recorded was 0.06m^2/ha(1.32%) in September for *Lantana camara*, 0.05m^2/ha(1.44%) in December for *Colebrookia oppositifolia* and 0.21m^2/ha(43.39%) in March for *Phoenix humilis.*

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, the highest dominance and relative dominance value recorded was 18.76m^2/ha(50.43%) in September for *Terminalia belerica*, 3.31m^2/ha(39.89%) in December for *Gmelina arborea* and 1.44m^2/ha(37.43%) in March for *Lagerstroemia parviflora.* The lowest value recorded was 0.24m^2/ha(0.66%) in September for *Terminalia chebula*, 0.13m^2/ha(1.51%) in December for *Shorea robusta* and 0.11m^2/ha(2.99%) in March for *Wrightia tomentosa*(Table 4).

Among the saplings, the highest dominance and relative dominance value recorded was for *Wrightia tomentosa* in all seasons, which was 4.51 m^2/ha (51.48%) in September, 11.37m^2/ha(43.47%) in December and 4.67$m^2$11/ha(35.1%) in March. The lowest value recorded was 0.54m^2/ha(6.19%) in September for *Terminalia belerica*, 0.04m^2/ha(0.17%) in December for *Terminalia chebula* and 0.21m^2/ha(1.6%) in March for *Terminalia alata.*

Among the shrubs, the highest dominance and relative dominance value recorded was for *Eupatorium adenophorum* in all seasons, which was

Table 4 : Dominance and Relative Dominance of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Dominance (m^2/ha)			Relative Dominance(%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)						
Trees						
Shorea robusta	52.21	10.98	17.71	100	92.19	98.94
Schima wallichi	-	0.11	-	-	0.89	-
Syzygium operculate	-	0.82	0.19	-	6.92	1.06
Total	52.21	11.91	17.9			
Saplings						
Casearia graveolens	0.9	-	-	6.63	-	-
Lagerstroemia parviflora	0.09	-	-	0.66	-	-
Psidium guajava	-	-	0.04	-	-	0.56
Shorea robusta	11.11	10.1	4.85	81.92	68.97	62.93
Syzygium operculate	1.43	2.85	2.27	10.52	19.47	29.41
Terminalia belerica	-	0.16	-	-	1.09	-
Wrightia tomentosa	0.04	1.53	0.55	0.28	10.46	7.1
Total	13.57	14.64	7.71			
Shrubs						
Clerodendron infortunatum	-	0.15	-	-	4.67	-
Colebrookia oppositifolia	-	0.05	-	-	1.44	-
Eupatorium adenophorum	4.07	2.82	0.27	94.03	86.25	56.61
Lantana camara	0.06	-	-	1.32	-	-
Phoenix humilis	0.34	0.25	0.21	4.66	7.64	43.39
Total	4.47	3.27	0.48			
Site II: Chitrepani Community Forest(mixed)						
Trees						
Gmelina arborea	2.33	3.31	1.42	6.26	39.89	37.43
Lagerstroemia parviflora	1.22	1.44	1.44	3.29	17.36	37.87
Shorea robusta	1.76	0.13	-	4.74	1.51	-
Syzygium operculate	2.27	1.73	0.66	6.12	20.84	17.28
Terminalia belerica	18.76	1.50	0.17	50.43	18.13	4.43
Terminalia chebula	0.24	-	-	0.66	-	-
Wrightia tomentosa	10.60	0.19	0.11	28.5	2.27	2.99
Total	37.18	8.3	3.8			

Name of the species	Dominance (m^2/ha)			Relative Dominance(%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Saplings						
Casearia graveolens	-	0.06	-	-	0.21	-
Lagerstroemia parviflora	-	4.25	0.75	-	16.26	5.6
Shorea robusta	0.89	1.8	3.84	10.14	6.87	28.8
Syzygium operculate	-	2.58	1.29	-	9.88	9.7
Terminalia belerica	0.54	5.41	2.56	6.19	20.68	19.2
Terminalia chebula	-	0.04	-	-	0.17	-
Terminalia alata	2.82	0.57	0.21	32.19	2.17	1.6
Wrightia tomentosa	4.51	11.37	4.67	51.48	43.47	35.1
Birali	-	0.08	-	-	0.29	-
Total	8.76	26.16	13.32			
Shrubs						
Clerodendron infortunatum	-	0.27	0.68	-	17.76	27.64
Colebrookia oppositifolia	-	0.43	0.63	-	28.59	25.61
Eupatorium adenophorum	1.19	0.7	0.69	100	46.26	27.84
Phoenix humilis	-	0.11	0.12	-	7.39	4.74
Pogostemon glaber	-	-	0.35	-	-	14.17
Total	1.19	1.51	2.47			
Site III: Karne Forest						
Trees						
Adina cordifolia	0.20	-	0.70	0.34	-	3.79
Albizzia odoratissima	-	0.29	-	-	0.94	-
Bauhinia purpurea	0.07	-	-	0.12	-	-
Buchanania lanzen	0.93	-	-	0.02	-	-
Careya arborea	0.21	-	-	0.36	-	-
Lagerstroemia parviflora	0.23	-	-	0.38	-	-
Leea aspera	0.06	-	-	0.09	-	-
Mangifera indica	-	-	2.15	-	-	11.61
Oegenia dalbergiodes	0.09	-	-	0.14	-	-
Phoenix humilis	0.04	-	-	0.06	-	-
Phyllanthus emblica	-	-	0.18	-	-	0.99
Pinus roxburghii	-	1.24	-	-	4.03	-
Randia dumortorum	0.93	-	-	0.02	-	-
Schima wallichi	0.04	0.69	-	0.07	2.25	-

Name of the species	Dominance (m^2/ha)			Relative Dominance(%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Semecarpus anacardium	0.04	0.45	-	0.07	1.47	-
Shorea robusta	53.87	25.84	13.16	90.37	83.98	70.95
Syzygium cumini	0.04	-	-	0.06	-	-
Syzygium operculate	0.07	1.59	0.3	0.11	5.15	1.59
Terminalia chebula	-	-	0.18	-	-	0.97
Terminalia alata	2.82	0.67	1.88	4.73	2.19	10.11
Total	59.64	30.77	18.55			
Saplings						
Adina cordifolia	-	0.05	-	-	0.49	-
Albizzia odoratissima	-	0.72	-	-	7.74	-
Buchanania lanzen	0.08	0.17	-	0.74	1.8	-
Dillenia pentagyna	-	-	0.39	-	-	6.82
Grewia hainesiana	0.29	-	-	2.66	-	-
Lagerstroemia parviflora	-	0.08	0.31	-	0.86	5.34
Leea aspera	0.26	-	-	2.36	-	-
Phyllanthus emblica	0.03	0.05	-	0.29	0.58	-
Schima wallichii	-	0.31	0.47	-	3.28	8.1
Semecarpus anacardium	-	0.1	0.38	-	1.05	6.68
Shorea robusta	9.0	5.76	2.89	82.58	61.67	50.29
Syzygium cumini	0.05	0.12	0.05	0.45	1.29	0.92
Syzygium operculate	-	0.72	0.97	-	7.76	16.94
Terminalia belerica	-	0.06	-	-	0.6	-
Terminalia chebula	0.32	0.23	0.11	2.93	2.49	1.97
Terminalia alata	0.16	0.62	0.08	1.49	6.59	1.36
Wendlandia puberula	0.71	0.21	-	6.51	2.19	-
Wrightia tomentosa	-	0.15	0.09	-	1.61	1.58
Total	10.9	9.35	5.74			
Shrubs						
Barleria cristata	-	-	0.02	-	-	0.66
Clerodendron infortunatum	-	0.21	-	-	2.95	-
Colebrookia oppositifolia	0.03	-	-	0.53	-	-
Cornus oblonga	0.17	0.2	0.06	3.08	2.79	1.68
Desmodium confertum	-	0.12	-	-	1.62	-
Eupatorium adenophorum	1.25	0.95	0.35	22.95	13.29	10.67
Inula cappa	0.27	0.1	-	4.95	1.39	-

Name of the species	Dominance (m^2/ha)			Relative Dominance(%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Murraya koenigii	-	0.03	-	-	0.35	-
Osbeckia stellata	-	0.03	0.02	-	0.35	0.71
Osyris wightiana	0.1	0.03	-	1.81	0.44	-
Phoenix humilis	2.67	5.20	2.41	52.8	72.87	72.9
Pogostemon glaber	-	-	0.06	-	-	1.65
Randia dumortorum	0.04	0.14	-	0.66	1.89	-
Reinwardtia indica	-	0.05	-	-	0.68	-
Sida rhombifolia	-	0.03	-	-	0.35	-
Woodfordia fruiticosa	-	0.07	0.39	-	1.04	11.73
Total	4.53	7.16	3.31			
Site IV: Chitrepani Leasehold Forest						
Trees						
Shorea robusta	11.39	8.43	5.36	100	100	100
Total	11.39	8.43	5.36			
Saplings						
Dalbergia sissoo	-	0.1	0.04	-	4.53	3.23
Mangifera indica	-	0.06	-	-	2.9	-
Shorea robusta	0.25	0.35	0.66	63.9	16.36	48.75
Syzygium operculate	0.14	1.36	0.59	36.1	63.3	43.67
Wrightia tomentosa	-	0.28	0.06	-	12.91	4.35
Total	0.39	2.15	1.35			
Shrubs						
Eupatorium adenophorum	1.55	1.37	0.52	100	70.08	71.1
Inula cappa	-	0.07	-	-	3.64	-
Lantana camara	-	0.05	0.21	-	2.4	28.9
Pennisetum purpureum	-	0.42	-	-	21.66	-
Randia dumortorum	-	0.04	-	-	2.22	-
Total	1.55	1.95	0.73			

1.19m^2/ha (100%) in September, 0.7m^2/ha (46.26%) in December and 0.69m^2/ha (27.84%) in March. The lowest value recorded was 0.11m^2/ha (7.39%) in December and 0.12m^2/ha(4.74%) in March for *Phoenix humilis*.

Site III : Karne Forest

Among the trees, the highest dominance and relative dominance value

recorded was for *Shorea robusta* in all seasons, which ranged from 13.16m^2/ha(70.95%) to 53.87m^2/ha(90.37%). The lowest value recorded was 0.04m^2/ha(0.06%) in September for *Schima wallichii*, *Semecarpus anacardium* and *Syzygium cumini* ; 0.29m^2/ha(0.94%) in December for *Albizzia odoratissima* ; and 0.18m^2/ha(0.97%) in March for *Phyllanthus embilica* and *Terminalia chebula*(Table 4).

Among the saplings also, the highest dominance and relative dominance value recorded was for *Shorea robusta* in all seasons, which was 9.0m^2/ha (82.58%) in September, 5.76m^2/ha(61.67%) in December and 2.89m^2/ha(50.29%) in March. The lowest value recorded was 0.03m^2/ha(0.29%) in September for *Phyllanthus emblica*, 0.05m^2/ha(0.58%) in December for *Adina cordifolia* and *Phyllanthus emblica* ; and 0.05m^2/ha(0.92%) in March for *Syzygium cumini*.

Among the shrubs, the highest dominance and relative dominance value recorded was for *Phoenix humilis* in all seasons, which was 2.67m^2/ha(52.8%) in September, 5.2m^2/ha(72.87%) in December and 2.41m^2/ha(72.9%) in March. The lowest value recorded was 0.03m^2/ha(0.53%) in September for *Colebrookia oppositifolia*, 0.03m^2/ha(0.35%) in December for *Murraya koenigii*, *Osbeckia stellata*, *Osyris wightiana* and *Sida rhombifolia* ; and 0.02m^2/ha(0.71%) in March for *Barleria cristata* and *Osbeckia stellata*.

Site IV : Chitrepani Leasehold Forest

The only tree species, *Shorea robusta*, had dominance and relative dominance value ranging from 5.36m^2/ha(100%) to 11.39m^2/ha(100%).(Table 4)

Among the saplings, the highest dominance and relative dominance value recorded was 0.25m^2/ha(63.9%) in September for *Shorea robusta*, 1.36m^2/ha(63.3%) in December for *Syzygium operculate* and 0.66m^2/ha(48.75%) in March again for *Shorea robusta*. The lowest value recorded was 0.14m^2/ha(36.1%) in September for *Syzygium operculate*, 0.06m^2/ha(2.9%) in December for *Mangifera indica* and 0.04m^2/ha(3.23%) in March for *Dalbergia sissoo*.

Among the shrubs, the highest dominance and relative dominance value recorded was for *Eupatorium adenophorum* in all seasons, which was 1.55m^2/ha(100%) in September, 1.37m^2/ha(70.08%) in December and 0.52m^2/ha(71.1%) in March. The lowest value recorded was 0.04m^2/ha(2.22%) in December for *Randia dumortorum* and 0.21m^2/ha(28.9%) in March for *Lantana camara*.

4.1.5 Importance Value Index

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, *Shorea robusta* had the highest Importance value which ranged from 200.97 to 300. The lowest value recorded was 22.82 in December for *Schima walichii* and 41.06 in March for *Syzygium operculate* (Table 5).

Among the saplings also, *Shorea robusta* had the highest Importance value in all seasons, which was 191.98 in September, 181.42 in December and 180.35 in March. The lowest value was 13.93 in September for *Wrightia tomentosa*, 9.28 in December for *Terminalia belerica* and 11.64 in March for *Psidium guajava*.

Among the shrubs, *Eupatorium adenophorum* had the highest Importance value in all seasons, which was 240.66 in September, 234.92 in December and 198.28 in March. The lowest value was 27.44 in September for *Lantana camara*, 17.42 in December for *Colebrookia oppositifolia* and 101.72 in March for *Phoenix humilis*.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, the highest Importance value was 106.21 in September for *Terminalia belerica*, 83.21 in December for *Syzygium operculate* and 102.74 in March for *Gmelina arborea*. The lowest value was 10.53 in September for *Terminalia chebula*, 11.47 in December for *Shorea robusta* and 22.54 in March for *Wrightia tomentosa* (Table 5).

Among the saplings, *Wrightia tomentosa* had the highest Importance value in all seasons which was 129 in September, 104.35 in December and 92.4 in March . The lowest value was 41 in September for *Shorea robusta*, 5.8 in December for *Terminalia chebula* and 7.9 in March for *Terminalia alata*.

Among the shrubs, *Eupatorium adenophorum* had the highest Importance value in all seasons, which was 300 in September, 132.96 in December and 85.29 in March. The lowest value was 25.19 in December and 18.66 in March for *Phoenix humilis*.

Site III : Karne Forest

Among the trees, *Shorea robusta* had the highest Importance value in all seasons, which ranged from 173.81 to 196.64. The lowest value was 6.37 in September for *Buchanania lanzen*, 9.61 in December for *Albizzia odoratissima* and 11.44 in March for *Terminalia chebula*(Table 5).

Among the saplings also, *Shorea robusta* had the highest Importance value

Table 5 : Importance Value of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Importance Value Index		
	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)			
Trees			
Shorea robusta	300	200.97	258.94
Schima wallichii	-	22.82	-
Syzygium operculate	-	76.22	41.06
Saplings			
Casearia graveolens	23.73	-	-
Lagerstroemia parviflora	14.31	-	-
Psidium guajava	-	-	11.64
Shorea robusta	191.98	181.42	180.35
Syzygium operculate	56.07	61.1	62.31
Terminalia belerica	-	9.28	-
Wrightia tomentosa	13.93	48.16	45.7
Shrubs			
Clerodendron infortunatum	-	24.04	-
Colebrookia oppositifolia	-	17.42	-
Eupatorium adenophorum	240.66	234.92	198.28
Lantana camara	27.44	-	-
Phoenix humilis	31.91	23.62	101.72
Site II: Chitrepani Community forest(mixed forest)			
Trees			
Gmelina arborea	20.95	66.75	102.74
Lagerstroemia parviflora	25.47	40.0	57.42
Shorea robusta	30.92	11.47	-
Syzygium operculate	17.61	83.21	87.96
Terminalia belerica	106.21	70.55	29.25
Terminalia chebula	10.53	-	-
Wrightia tomentosa	88.28	27.92	22.54
Saplings			
Casearia graveolens	-	5.84	-
Lagerstroemia parviflora	-	31.29	27.3
Shorea robusta	41	34.47	80.8
Syzygium operculate	-	23.65	41.7

Name of the species	Importance Value Index		
	Sept.	Dec.	Mar.
Terminalia belerica	43	73.38	49.9
Terminalia chebula	-	5.8	-
Terminalia alata	86	15.31	7.9
Wrightia tomentosa	129	104.35	92.4
Birali	-	5.92	-
Shrubs			
Clerodendron infortunatum	-	53.46	77.05
Colebrookia oppositifolia	-	89.39	71.1
Eupatorium adenophorum	300	132.96	85.29
Phoenix humilis	-	25.19	18.66
Pogostemon glaber	-	-	47.9
Site III: Karne Forest			
Trees			
Adina cordifolia	6.69	-	14.26
Albizzia odoratissima	-	9.61	-
Bauhinia purpurea	6.47	-	-
Buchanania lanzen	6.37	-	-
Careya arborea	8.71	-	-
Lagerstroemia parviflora	13.07	-	-
Leea aspera	6.44	-	-
Mangifera indica	-	-	22.08
Oegenia dalbergiodes	6.49	-	-
Phoenix humilis	6.41	-	-
Phyllanthus emblica	-	-	14.8
Pinus roxburghii	-	12.7	-
Randia dumortorum	6.37	-	-
Schima wallichii	6.42	10.92	-
Semecarpus anacardium	6.42	29.47	-
Shorea robusta	182.83	196.64	173.81
Syzygium cumini	6.41	-	-
Syzygium operculate	6.46	29.82	29.21
Terminalia chebula	-	-	11.44
Terminalia alata	21.42	10.86	34.4

Name of the species	Importance Value Index		
	Sept.	Dec.	Mar.
Saplings			
Adina cordifolia	-	3.76	-
Albizzia odoratissima	-	18.23	-
Buchanania lanzen	6.93	5.07	-
Dillenia pentagyna	-	-	26.41
Grewia hainesiana	15.96	-	-
Lagerstroemia parviflora	-	4.13	16.31
Leea aspera	20.93	-	-
Phyllanthus emblica	6.48	4.35	-
Schima wallichii	-	13.09	23.78
Semecarpus anacardium	-	8.09	27.84
Shorea robusta	188.59	148.11	128.83
Syzygium cumini	6.64	4.56	5.62
Syzygium operculate	-	29.04	38.89
Terminalia belerica	-	7.15	-
Terminalia chebula	26.13	12.79	11.37
Terminalia alata	8.6	24.6	6.85
Wendlandia puberula	20.73	8.91	-
Wrightia tomentosa	-	8.16	14.11
Shrubs			
Barleria cristata	-	-	7.82
Clerodendron infortunatum	-	11.91	-
Colebrookia oppositifolia	7.26	-	-
Cornus oblonga	9.81	17.85	8.84
Desmodium confertum	-	7.95	-
Eupatorium adenophorum	95.47	58.54	60.59
Inula cappa	34.82	15.13	-
Murraya koenigii	-	4.71	-
Osbeckia stellata	-	4.71	7.87
Osyris wightiana	11.48	4.8	-
Phoenix humilis	87.87	149.04	174.34
Pogostemon glaber	-	-	10.09
Randia dumortorum	7.39	7.88	-
Reinwardtia indica	-	5.04	-

Name of the Species	Importance Value Index		
	Sept.	Dec.	Mar.
Sida rhombifolia	-	4.71	-
Woodfordia fruiticosa	-	6.71	30.43
Site IV: Chitrepani Leasehold Forest			
Trees			
Shorea robusta	300	300	300
Saplings			
Dalbergia sissoo	-	15.72	24.25
Mangifera indica	-	20.64	-
Shorea robusta	173.9	54.79	155.25
Syzygium operculate	126.1	140.15	95.11
Wrightia tomentosa	-	58.72	25.37
Shrubs			
Eupatorium adenophorum	300	183.67	231.81
Inula cappa	-	20.37	-
Lantana camara	-	19.13	67.19
Pennisetum purpureum	-	57.9	-
Randia dumortorum	-	18.95	-

in all seasons, which was 188.59 in September, 148.11 in December and 128.83 in March. The lowest value was 6.48 in September for *Phyllanthus emblica*, 3.76 in December for *Adina cordifolia* and 5.62 in March for *Syzygium cumini*.

Among the shrubs, *Phoenix humilis* had the highest Importance value in all seasons, which was 87.87 in September, 149.04 in December and 174.34 in March. The lowest value was 7.26 in September for *Colebrookia oppositifolia*, 4.71 in December for *Murraya koenigii*, *Osbeckia stellata* and *Sida rhombifolia*; and 7.82 in March for *Barleria cristata*.

Site IV : Chitrepani Leasehold Forest

The only tree species, *Shorea robusta*, had Importance value 300 in all seasons (Table 5).

Among the saplings, the highest Importance value was 173.9 in September for *Shorea robusta*, 140.15 in December for *Syzygium operculate* and 155.25 in March again for *Shorea robusta*. The lowest value was 126.1 in September for *Syzygium operculate*, 20.64 in December for *Mangifera indica* and 24.25 in March

for *Dalbergia sissoo*.

Among the shrubs, *Eupatorium adenophorum* had the highest Importance value in all seasons, which was 300 in September, 183.67 in December and 231.81 in March. The lowest value was 20.37 in December for *Inula cappa* and 67.19 in March for *Lantana camara*.

4.1.6 Average Basal area

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, the highest average basal area and relative basal area value recorded was for *Shorea robusta* in all seasons, which ranged from $1.37m^2$/ha(87.91%) to $5.8m^2$/ha(100%). The lowest value recorded was $0.12m^2$/ha(6.78%) in December for *Schima wallichii* and $0.1m^2$/ha(7.88%) in March for *Syzygium operculate* (Table 6).

Among the saplings, the highest average basal area and relative basal area value recorded was $0.25m^2$/ha(20.95%) in September for *Shorea robusta*, $0.16m^2$/ha(34.78%) in December for *Terminalia belerica* and $0.19m^2$/ha(51.38%) in March for *Syzygium operculate*. The lowest value recorded was $0.04m^2$/ha(%) in September for *Casearia graveolens*, $0.06m^2$/ha(13.26%) in December for *Shorea robusta* and $0.04m^2$/ha(11.79%) in March for *Psidium guajava*.

Among the shrubs, the highest average basal area and relative basal area value recorded was 0.17 m^2/ha(49.05%) in September for *Phoenix humilis*, $0.47m^2$/ha(53.32%) in December for *Colebrookia oppositifolia* and $0.07m^2$/ha(63.64%) in March again for *Phoenix humilis*. The lowest value recorded was for *Eupatorium adenophorum* in all seasons which was $0.08m^2$/ha(23.27%) in September, $0.05m^2$/ha(13.05%) in December and $0.05m^2$/ha(39.45%) in March.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, the highest average basal area and relative basal area value recorded was $0.76m^2$/ha(32.16%) in September for *Syzygium operculate*, $1.44m^2$/ha(74.15%) in December and $1.44m^2$/ha(74.86%) in March for *Lagerstroemia parviflora*. The lowest value recorded was $0.2m^2$/ha(8.66%) in September for *Wrightia tomentosa*, $0.06m^2$/ha(3.22%) in December for *Shorea robusta* and $0.08m^2$/ha(4.27%) in March for *Syzygium operculate* (Table 6).

Among the saplings, the highest average basal area and relative basal area value recorded was $0.89m^2$/ha(39.95%) in September for *Shorea robusta*,

Table 6 : Average Basal Area and Relative Basal Area of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Average Basal Area (m^2/ha)			Relative Basal Area (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)						
Trees						
Shorea robusta	5.8	1.37	2.21	100	87.91	92.12
Schima wallichii	-	0.12	-	-	6.78	-
Syzygium operculate	-	0.08	0.1	-	5.28	7.88
Saplings						
Casearia graveolens	0.04	-	-	31.41	-	-
Lagerstroemia parviflora	0.15	-	-	12.45	-	-
Psidium guajava	-	-	0.04	-	-	11.79
Shorea robusta	0.25	0.06	0.07	20.95	13.26	18.25
Syzygium operculate	0.20	0.13	0.19	29.94	28.25	51.38
Terminalia belerica	-	0.16	-	-	34.78	-
Wrightia tomentosa	0.06	0.11	0.09	5.25	23.71	18.58
Shrubs						
Clerodendron infortunatum	-	0.05	-	-	6.1	-
Colebrookia oppositifolia	-	0.47	-	-	53.32	-
Eupatorium adenophorum	0.08	0.05	0.05	23.27	6.1	36.36
Lantana camara	0.1	-	-	27.68	-	-
Phoenix humilis	0.17	0.25	0.07	49.05	30.49	63.64
Site II: Chitrepani Community forest(mixed forest)						
Trees						
Gmelina arborea	0.33	0.24	0.20	14.13	12.17	10.57
Lagerstroemia parviflora	0.24	1.44	1.44	10.35	74.15	74.86
Shorea robusta	0.18	0.06	-	7.47	3.22	-
Syzygium operculate	0.76	0.07	0.08	32.16	3.71	4.27
Terminalia belerica	0.4	0.07	0.08	16.93	3.52	4.38
Terminalia chebula	0.24	-	-	10.35	-	-
Wrightia tomentosa	0.20	0.06	0.11	8.66	3.24	5.91
Saplings						
Casearia graveolens	-	0.05	-	-	30.43	-
Lagerstroemia parviflora	-	0.33	0.15	-	23.12	12.99
Shorea robusta	0.89	0.09	0.16	39.95	6.37	13.91

Name of the species	Average Basal Area (m^2/ha)			Relative Basal Area (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Syzygium operculate	-	0.43	0.14	-	30.43	12.46
Terminalia belerica	0.27	0.10	0.32	12.19	7.37	27.83
Terminalia chebula	-	0.04	-	-	3.07	-
Terminalia alata	0.56	0.11	0.21	25.36	8.06	18.29
Wrightia tomentosa	0.50	0.18	0.17	22.52	12.37	14.53
Birali	-	0.08	-	-	5.34	-
Shrubs						
Clerodendron infortunatum	-	0.05	0.05	-	17.04	18.07
Colebrookia oppositifolia	-	0.05	0.05	-	18.29	19.33
Eupatorium adenophorum	0.01	0.06	0.05	100	22.17	19.5
Phoenix humilis	-	0.11	0.06	-	42.51	23.24
Pogostemon glaber	-	-	0.05	-	-	19.86
Site III: Karne Forest						
Trees						
Adina cordifolia	0.2	-	0.7	3.68	-	13.04
Albizzia odoratissima	-	0.29	-	-	7.31	-
Bauhinia purpurea	0.07	-	-	1.26	-	-
Buchanania lanzen	0.93	-	-	16.74	-	-
Careya arborea	0.11	-	-	1.91	-	-
Lagerstroemia parviflora	0.11	-	-	2.02	-	-
Leea aspera	0.06	-	-	1.01	-	-
Mangifera indica	-	-	2.15	-	-	40.0
Oegenia dalbergiodes	0.09	-	-	1.55	-	-
Phoenix humilis	0.04	-	-	0.65	-	-
Phyllanthus emblica	-	-	0.92	-	-	17.04
Pinus roxburghii	-	1.24	-	-	31.24	-
Randia dumortorum	0.93	-	-	16.74	-	-
Schima wallichii	0.44	0.69	-	7.83	17.45	-
Semecarpus anacardium	0.04	0.11	-	0.7	2.85	-
Shorea robusta	1.74	0.78	0.73	31.31	19.74	13.58
Syzygium cumini	0.04	-	-	0.65	-	-
Syzygium operculate	0.07	0.18	0.07	1.17	4.44	1.38
Terminalia chebula	-	-	0.18	-	-	3.34
Terminalia alata	0.71	0.67	0.63	12.7	16.97	11.61

Name of the Species	Average Basal Area (m^2/ha)			Relative Basal Area (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Saplings						
Adina cordifolia	-	0.05	-	-	4.74	-
Albizzia odoratissima	-	0.07	-	-	7.42	-
Buchanania lanzen	0.07	0.17	-	7.8	17.32	-
Dillenia pentagyna	-	-	0.04	-	-	10.63
Grewia hainesiana	0.08	-	-	9.35	-	-
Lagerstroemia parviflora	-	0.08	0.05	-	8.35	12.32
Leea aspera	0.08	-	-	8.35	-	-
Phyllanthus emblica	0.27	0.03	-	30.29	2.78	-
Schima wallichii	-	0.1	0.06	-	10.52	14.01
Semecarpus anacardium	-	0.03	0.04	-	3.4	8.45
Shorea robusta	0.09	0.04	0.04	10.36	4.33	10.15
Syzygium cumini	0.04	0.12	0.03	4.79	12.37	6.28
Syzygium operculate	-	0.05	0.08	-	4.95	19.57
Terminalia belerica	-	0.03	-	-	2.89	-
Terminalia chebula	0.04	0.06	0.03	3.9	5.98	6.76
Terminalia alata	0.07	0.04	0.03	7.91	4.54	6.28
Wendlandia puberula	0.16		-	17.26		-
Wrightia tomentosa	-	0.03	0.02	-	2.68	5.56
Shrubs						
Barleria cristata	-	-	0.02	-	-	9.13
Clerodendron infortunatum	-	0.03	-	-	6.33	-
Colebrookia oppositifolia	0.03	-	-	4.35	-	-
Cornus oblonga	0.15	0.33	0.06	25.57	8.03	23.24
Desmodium confertum	-	0.03	-	-	7.06	-
Eupatorium adenophorum	0.03	0.03	0.02	5.39	6.57	9.13
Inula cappa	0.04	0.03	-	6.78	6.08	-
Murraya koenigii	-	0.02	-	-	6.08	-
Osbeckia stellata	-	0.03	0.02	-	6.08	9.96
Osyris wightiana	0.03	0.03	-	5.04	7.54	-
Phoenix humilis	0.17	0.06	0.05	29.22	15.57	21.16
Pogostemon glaber	-	-	0.03	-	-	11.2
Randia dumortorum	0.03	0.03	-	5.39	6.57	-
Reinwardtia indica	-	0.05	-	-	11.92	-

Name of the Species	Average Basal area (m^2/ha)			Relative Basal Area (%)		
	Sept.	Dec.	Mar.	Sept.	Dec.	Mar.
Sida rhombifolia	-	0.02	-	-	6.08	-
Woodfordia fruiticosa	-	0.03	0.04	-	6.08	16.18
Site IV: Chitrepani Leasehold Forest						
Trees						
Shorea robusta	11.39	2.11	1.34	100	100	100
Saplings						
Dalbergia sissoo	-	0.05	0.04	-	15.4	19.2
Mangifera indica	-	0.06	-	-	20	-
Shorea robusta	0.08	0.05	0.05	53.33	16	22.4
Syzygium operculate	0.07	0.1	0.07	46.67	30.9	32.5
Wrightia tomentosa	-	0.06	0.06	-	17.7	25.9
Shrubs						
Eupatorium adenophorum	0.05	0.05	0.04	100	18.4	29
Inula cappa	-	0.07	-	-	27.8	-
Lantana camara	-	0.05	0.11	-	18.4	71
Pennisetum purpureum	-	0.05	-	-	18.4	-
Randia dumortorum	-	0.04	-	-	17	-

$0.43m^2$/ha(30.43%) in December for *Syzygium operculate* and $0.32m^2$/ha(27.83%) in March for *Terminalia belerica*. The lowest value recorded was $0.27m^2$/ha(12.19%) in September for *Terminalia belerica*, $0.04m^2$/ha(3.07%) in December for *Terminalia chebula* and $0.14m^2$/ha(12.46%) in March for *Syzygium operculate*.

Among the shrubs, the highest average basal area and relative basal area value recorded was $0.01m^2$/ha(100%) in September for *Eupatorium adenophorum* , $0.11m^2$/ha(42.51%) in December and $0.06m^2$/ha(23.24%) in March for *Phoenix humilis*. The lowest value recorded was $0.05m^2$/ha(17.04%) in December and $0.05m^2$/ha(18.07%) in March for *Clerodendron infortunatum*.

Site III : Karne Forest

Among the trees, the highest average basal area and relative basal area recorded was $1.74m^2$/ha(31.31%) in September for *Shorea robusta*, $1.24m^2$/ha(31.24%) in December for *Pinus roxburghii* and $2.15m^2$/ha(40.0%) in March for *Mangifera indica*. The lowest value recorded was $0.04m^2$/ha(0.65%) in

September for *Phoenix humilis* and *Syzygium cumini* ; 0.11m^2/ha(0.7%) in December for *Semecarpus anacardium* ; and 0.07m^2/ha(1.38%) in March for *Syzygium operculate* (Table 6).

Among the saplings, the highest average basal area and relative basal area value recorded was 0.27m^2/ha(30.29%) in September for *Phyllanthus emblica*, 0.17m^2/ha(17.37%) in December for *Buchanania lanzen* and 0.08m^2/ha(19.57%) in March for *Syzygium operculate*. The lowest value recorded was 0.04m^2/ha(3.9%) in September for *Terminalia chebula*, 0.03m^2/ha(2.68%) in December and 0.02m^2/ha(5.56%) in March for *Wrightia tomentosa*.

Among the shrubs, the highest average basal area and relative basal area value recorded was 0.17m^2/ha(29.22%) in September and 0.06m^2/ha(15.57%) in December for *Phoenix humilis* and 0.06m^2/ha(23.24%) in March for *Cornus oblonga*. The lowest value recorded was 0.03m^2/ha(4.35%) in September for *Colebrookia oppositifolia*, 0.02m^2/ha(6.08%) in December for *Murraya koenigii* and *Sida rhombifolia* ; and 0.02m^2/ha(9.13%) in March for *Barleria cristata* and *Eupatorium adenophorum*.

Site IV : Chitrepani Leasehold Forest

The only tree species, *Shorea robusta*, had average basal area and relative basal area value of 1.34m^2/ha(100%) to 11.39m^2/ha(100%) (Table 6).

Among the saplings, the highest average basal area and relative basal area value recorded was 0.08m^2/ha(53.33 %) in September for *Shorea robusta*, 0.1m^2/ha(30.9%) in December and 0.07m^2/ha(32.5%) for *Syzygium operculate* in March. The lowest value recorded was 0.07m^2/ha(46.67%) in September for *Syzygium operculate*, 0.05m^2/ha(15.4%) in December and 0.04m^2/ha(19.2%) in March for *Dalbergia sissoo*.

Among the shrubs, the highest average basal area and relative basal area value recorded was 0.05m^2/ha(100%) in September for *Eupatorium adenophorum*, 0.07m^2/ha(27.8%) in December for *Inula cappa* and 0.11m^2/ha(71%) in March for *Lantana camara*. The lowest value recorded was 0.04m^2/ha(17%) in December for *Randia dumortorum* and 0.04m^2/ha(29%) in March for *Eupatorium adenophorum*.

4.1.7 Volume

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, the highest volume was recorded for *Shorea robusta* in

all seasons, which ranged from 91.97m^3/ha to 839.14m^3/ha. The lowest value recorded was 0.42m^3/ha in December for *Schima wallichii* and 0.76m^3/ha in March for *Syzygium operculate* (Table 7).

Among the saplings also, the highest volume recorded was for *Shorea robusta* in all seasons, which was 11.05m^3/ha in September, 5.95m^3/ha in December and 3.02m^3/ha in March. The lowest value recorded was 0.02m^3/ha in September for *Wrightia tomentosa*, 0.26m^3/ha in December for *Terminalia belerica* and 0.03m^3/ha in March for *Psidium guajava*.

Among the shrubs, the highest volume recorded was for *Eupatorium adenophorum* in all seasons, which was 4.17m^3/ha in September, 2.25m^3/ha in December and 0.11m^3/ha in March. The lowest value recorded was 0.03m^3/ha in September for *Lantana camara*, 0.02m^3/ha in December for *Colebrookia oppositifolia* and 0.06m^3/ha in March for *Phoenix humilis*.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, the highest volume recorded was 55.04m^3/ha in September for *Terminalia belerica* ; and 21.84m^3/ha in December and 6.16m^3/ha in March for *Gmelina arborea*. The lowest value recorded was 0.49m^3/ha in September for *Terminalia chebula* ; and 0.69m^3/ha in December and 0.29m^3/ha in March for *Wrightia tomentosa* (Table 7).

Among the saplings, the highest volume recorded was for *Wrightia tomentosa* in all seasons, which was 2.95m^3/ha in September, 20.28m^3/ha in December and 7.49m^3/ha in March. The lowest value recorded was 0.32m^3/ha in September for *Terminalia belerica*, 0.004 m^3/ha in December for Birali and 0.13m^3/ha in March for *Terminalia alata*.

Among the shrubs, the highest volume recorded was for *Eupatorium adenophorum* in all seasons, which was 0.78m^3/ha in September, 0.71m^3/ha in December and 0.38m^3/ha in March. The lowest value recorded was 0.02m^3/ha in December and 0.04m^3/ha in March for *Phoenix humilis*.

Site III : Karne Forest

Among the trees the highest volume recorded was for *Shorea robusta* in all seasons, which ranged from 106.5m^3/ha to 438m^3/ha. The lowest value recorded was 0.01m^3/ha in September for *Phoenix humilis*, 1.45m^3/ha in December for *Semecarpus anacardium* and 0.45m^3/ha in March for *Terminalia chebula* (Table 7).

Among the saplings also, the highest volume recorded was for *Shorea*

Table 7 : Volume of Trees, Saplings and Shrubs in Site I to IV

Name of the species	Volume (m^3/ha)		
	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(Sal forest)			
Trees			
Shorea robusta	839.14	91.97	164.43
Schima wallichii	-	0.42	-
Syzygium operculate	-	3.05	0.76
Saplings			
Casearia graveolens	0.82	-	-
Lagerstroemia parviflora	0.04	-	-
Psidium guajava	-	-	0.03
Shorea robusta	11.05	5.95	3.02
Syzygium operculate	1.07	2.53	2.52
Terminalia belerica	-	0.26	-
Wrightia tomentosa	0.02	2.05	0.3
Shrubs			
Clerodendron infortunatum	-	0.03	-
Colebrookia oppositifolia	-	0.02	-
Eupatorium adenophorum	4.17	2.25	0.11
Lantana camara	0.03	-	-
Phoenix humilis	0.18	0.15	0.06
Site II: Chitrepani Community Forest(mixed forest)			
Trees			
Gmelina arborea	17.48	21.84	6.16
Lagerstroemia parviflora	2.73	1.37	1.51
Shorea robusta	3.88	2.11	-
Syzygium operculate	6.43	6.91	2.04
Terminalia belerica	55.04	6.28	0.64
Terminalia chebula	0.49	-	-
Wrightia tomentosa	25.21	0.69	0.29
Saplings			
Casearia graveolens	-	0.02	-
Lagerstroemia parviflora	-	14.56	1.47
Shorea robusta	0.67	0.44	6.27
Syzygium operculate	-	6.88	1.7

Name of the species	Volume (m^3/ha)		
	Sept.	Dec.	Mar.
Terminalia belerica	0.32	10.28	5.66
Terminalia chebula	-	0.04	-
Terminalia alata	2.13	0.59	0.13
Wrightia tomentosa	2.95	20.28	7.49
Birali	-	0.004	-
Shrubs			
Clerodendron infortunatum	-	0.33	0.17
Colebrookia oppositifolia	-	0.12	0.17
Eupatorium adenophorum	0.78	0.71	0.38
Phoenix humilis	-	0.02	0.04
Pogostemon glaber	-	-	0.12
Site III: Karne Forest			
Trees			
Adina cordifolia	1.53	-	6.67
Albizzia odoratissima	-	1.89	-
Bauhinia purpurea	0.35	-	-
Buchanania lanzen	3.25	-	-
Careya arborea	0.21	-	-
Lagerstroemia parviflora	0.4	-	-
Leea aspera	0.06	-	-
Mangifera indica	-	-	17.22
Oegenia dalbergiodes	0.13	-	-
Phoenix humilis	0.01	-	-
Phyllanthus emblica	-	-	0.92
Pinus roxburghii	-	12.39	-
Randia dumortorum	3.25	-	-
Schima wallichii	0.15	5.19	-
Semecarpus anacardium	0.04	1.45	-
Shorea robusta	438.0	202.77	106.5
Syzygium cumini	0.02	-	-
Syzygium operculate	0.13	9.57	1.22
Terminalia chebula	-	-	0.45
Terminalia alata	20.71	4.37	14.51

Name of the species	Volume (m^3/ha)		
	Sept.	Dec.	Mar.
Saplings			
Adina cordifolia	-	0.03	-
Albizzia odoratissima	-	0.5	-
Buchanania lanzen	0.01	0.18	-
Dillenia pentagyna	-	-	0.39
Grewia hainesiana	0.08	-	-
Lagerstroemia parviflora	-	0.10	0.57
Leea aspera	0.10	-	-
Phyllanthus emblica	0.02	0.02	-
Schima wallichii	-	0.33	0.68
Semecarpus anacardium	-	0.02	0.25
Shorea robusta	5.94	4.18	3.03
Syzygium cumini	0.02	0.13	0.04
Syzygium operculate	-	0.53	0.91
Terminalia belerica	-	0.02	-
Terminalia chebula	0.18	0.32	0.11
Terminalia alata	0.05	0.51	0.05
Wendlandia puberula	0.33	0.13	-
Wrightia tomentosa	-	0.15	0.05
Shrubs			
Barleria cristata	-	-	0.02
Clerodendron infortunatum	-	0.22	-
Colebrookia oppositifolia	0.02	-	-
Cornus oblonga	0.07	0.09	0.04
Desmodium confertum	-	0.11	-
Eupatorium adenophorum	1.08	1.01	0.42
Inula cappa	0.06	0.05	-
Murraya koenigii	-	0.01	-
Osbeckia stellata	-	0.01	0.02
Osyris wightiana	0.03	0.03	-
Phoenix humilis	2.87	2.61	1.0
Pogostemon glaber	-	-	0.06
Randia dumortorum	0.003	0.13	-
Reinwardtia indica	-	0.03	-

Name of the species	Volume (m^3/ha)		
	Sept.	Dec.	Mar.
Sida rhombifolia	-	0.01	-
Woodfordia fruiticosa	-	0.04	0.6
Site IV: Chitrepani Leasehold Forest			
Trees			
Shorea robusta	132.21	70.74	36.7
Saplings			
Dalbergia sissoo	-	0.05	0.01
Mangifera indica	-	0.02	-
Shorea robusta	0.09	0.13	0.32
Syzygium operculate	0.26	0.82	0.39
Wrightia tomentosa	-	0.16	0.03
Shrubs			
Eupatorium adenophorum	0.67	0.4	0.02
Inula cappa	-	0.02	-
Lantana camara	-	0.02	0.07
Pennisetum purpureum	-	0.43	-
Randia dumortorum	-	0.03	-

robusta in all seasons, which was 5.94m^3/ha in September, 4.18m^3/ha in December and 3.03m^3/ha in March. The lowest value recorded was 0.01m^3/ha in September for *Buchanania lanzen*, 0.02m^3/ha in December for *Phyllanthus emblica*, *Semecarpus anacardium* and *Terminalia belerica* ; and 0.04m^3/ha in March for *Syzygium cumini*.

Among the shrubs, the highest volume recorded was for *Phoenix humilis* in all seasons, which was 2.87m^3/ha in September, 2.61m^3/ha in December and 1.0m^3/ha in March. The lowest value recorded was 0.003m^3/ha in September for *Randia dumortorum*, 0.01m^3/ha in December for 0.01m^3/ha in December for *Murraya koenigii*, *Osbeckia stellata* and *Sida rhombifolia* ; and 0.02m^3/ha in March for *Barleria cristata* and *Osbeckia stellata*.

Site IV : Chitrepani Leasehold Forest

The only tree species, *Shorea robusta*, had the volume ranging from 36.7m^3/ha to 132.21m^3/ha (Table 7).

Among the saplings, the highest volume recorded was for *Syzygium*

operculate in all seasons, which was 0.26m^3/ha in September, 0.82m^3/ha in December and 0.39m^3/ha in March. The lowest value recorded was 0.09m^3/ha in September for *Shorea robusta*, 0.02m^3/ha in December for *Mangifera indica* and 0.01m^3/ha in March for *Dalbergia sissoo*.

Among the shrubs, the highest volume recorded was 0.67m^3/ha in September for *Eupatorium adenophorum*, 0.43m^3/ha in December for *Pennisetum purpureum* and 0.07m^3/ha in March for *Lantana camara*. The lowest value recorded was 0.02m^3/ha in December for *Inula cappa* and *Lantana camara* ; and 0.02m^3/ha in March for *Eupatorium adenophorum*.

4.1.8 Crown Coverage and Relative Coverage

Site I : Chitrepani Community Forest(Sal forest)

In December, *Shorea robusta* had the highest crown coverage and relative coverage of 81.19%(80.03%) and *Clerodendron infortunatum* had the lowest value of 0.25%(0.25%). In March also, *Shorea robusta* had the highest crown coverage and relative coverage of 73.75%(87.15%) ; and *Phoenix humilis* had the lowest value of 0.38%(0.44%) (Table 8).

Site II : Chitrepani Community Forest(mixed forest)

In December, *Wrightia tomentosa* had the highest crown coverage and relative coverage of 41.03%(39.82%) and *Phoenix humilis* had the lowest value of 0.38%(0.36%). In March also, *Wrightia tomentosa* had the highest crown coverage and relative coverage of 14.5%(22.35%) ; and *Pogostemon glaber* had the lowest value of 0.75%(1.16%) (Table 8).

Site III : Karne Forest

In December, *Shorea robusta* had the highest crown coverage and relative coverage of 66.93%(59.58%) and *Colebrookia oppositifolia* and *Dalbergia sissoo* had the lowest value of 0.21%(0.19%). In March also, *Shorea robusta* had the highest crown coverage and relative coverage of 41.69%(51.54%) ; and *Dillenia pentagyna* had the lowest value of 0.13%(0.16%) (Table 8).

Site IV : Chitrepani Leasehold Forest

In December, *Shorea robusta* had the highest crown coverage and

Table 8: Crown Cover of Trees, Saplings and Shrubs in Site I to IV

Name of species	Cover (%)		Relative Cover(%)	
	Dec.	Mar.	Dec.	Mar.
Site I:Chitrepani Community Forest(pure)				
Clerodendron infortunatum	0.25	-	0.25	-
Eupatorium adenophorum	2.06	1.63	2.03	1.92
Phoenix humilis	1.81	0.38	1.79	0.44
Schima wallichii	0.5	3.25	0.49	3.84
Shorea robusta	81.19	73.75	80.03	87.15
Syzygium operculate	7.75	4.38	7.64	5.17
Terminalia belerica	4.58	-	4.51	-
Terminalia chebula	0.31	-	0.31	-
Wrightia tomentosa	3.0	1.25	2.96	1.48
Site II: Chitrepani Community Forest(mixed)				
Clerodendron infortunatum	0.5	1.75	0.49	2.7
Colebrookia oppositifolia	-	1.0	-	1.54
Eupatorium adenophorum	1.25	2.5	1.21	3.85
Gmelina arborea	25.5	15.0	24.75	23.12
Lagerstroemia parviflora	5.38	4.63	5.22	7.19
Phoenix humilis	0.38	-	0.36	-
Pogostemon glaber	-	0.75	-	1.16
Shorea robusta	6.13	10.63	5.95	16.38
Syzygium operculate	5.5	6.63	5.34	10.21
Terminalia belerica	15.38	7.5	14.92	11.56
Terminalia alata	2.0	-	1.94	-
Wrightia tomentosa	41.03	14.5	39.82	22.35
Site III: Karne Forest				
Adina cordifolia	-	7.06	-	8.73
Albizzia odoratissima	4.14	-	3.7	-
Bauhinia purpurea	-	0.19	-	0.23
Clerodendron infortunatum	1.5	-	1.34	-
Colebrookia oppositifolia	0.21	0.81	0.19	1.01
Cornus oblonga	1.07	-	0.96	-
Dalbergia sissoo	0.21	-	0.19	-
Desmodium confertum	0.86	-	0.77	-
Dillenia pentagyna	-	0.13	-	0.16

Name of species	Cover (%)		Relative Cover(%)	
	Dec.	Mar.	Dec.	Mar.
Eupatorium adenophorum	4.43	2.94	3.95	3.63
Lagerstroemia parviflora	-	2.69	-	3.32
Mangifera indica	-	6.56	-	8.11
Osbeckia stellata	-	1.19	-	1.47
Phoenix humilis	9.36	3.25	8.35	4.02
Randia dumortorum	1.86	-	1.66	-
Schima wallichii	0.71	1.44	0.63	1.78
Semecarpus anacardium	3.5	7.81	3.13	9.66
Shorea robusta	66.93	41.69	59.58	51.54
Sida rhombifolia	0.36	-	0.32	-
Syzygium cumini	1.14	-	1.02	-
Syzygium operculate	7.36	3.06	6.57	3.79
Terminalia belerica	0.29	-	0.26	-
Terminalia chebula	3.29	0.19	2.93	0.23
Terminalia alata	2.43	0.31	2.17	0.39
Wendlandia puberula	0.5	-	0.45	-
Woodfordia fruiticosa	0.43	1.56	0.39	1.93
Wrightia tomentosa	1.43	-	1.28	-
Site IV: Chitrepani Leasehold Forest				
Barleria cristata	-	1.13	-	2.47
Colebrookia oppositifolia	-	1.38	-	3.02
Dalbergia sissoo	3.13	0.63	4.17	1.37
Eupatorium adenophorum	8.13	5.13	10.85	11.26
Lantana camara	2.25	1.25	3.01	2.75
Mimosa pudica	1.0	-	1.34	-
Pennisetum purpureum	2.0	-	2.67	-
Plectranthes sp.	-	0.13	-	0.28
Randia dumortorum	0.63	-	0.84	-
Shorea robusta	41.25	23.75	55.09	52.2
Syzygium operculate	10.0	12.13	13.36	26.65
Terminalia chebula	0.5	-	0.67	-
Wrightia tomentosa	6.0	-	8.01	-

relative coverage of 41.25%(55.03%) and *Terminalia chebula* had the lowest value of 0.5%(0.67%). In March also, *Shorea robusta* had the highest crown

coverage and relative coverage of 23.75%(52.2%) ; and *Plectranthes* sp. had the lowest value of 0.13%(0.28%) (Table 8).

4.1.9 Aboveground Biomass of Trees

Site I : Chitrepani Community Forest(Sal forest)

The total aboveground biomass of trees in this forest was 698.88 t/ha in September. In this *Shorea robusta* accounted for 100% value (Table 9).

Site II : Chitrepani Community Forest(mixed forest)

The total aboveground biomass of trees in this forest was 337.68 t/ha in September. In this, highest value recorded was 183 t/ha for *Terminalia belerica*. The lowest value recorded was 1.97 t/ha for *Terminalia chebula* (Table 9).

Site III : Karne Forest

The total aboveground biomass of this forest was 807.83 t/ha in September. The highest value recorded was for *Shorea robusta* which was 741.55 t/ha. While the lowest value was 0.18 t/ha for *Syzygium cumini* (Table 9).

Site IV : Chitrepani Leasehold Forest

The total aboveground biomass of trees in this forest was 160.63 t/ha in September. This was accounted for the only tree species, *Shorea robusta* in this forest(Table 9).

Table 9 : Biomass of Trees in Site I to IV

Name of the species	Total Aboveground Biomass (t/ha)
	Sept.
Site I: Chitrepani Community Forest(Sal forest)	
Shorea robusta	698.88
Total	698.88
Site II: Chitrepani Community Forest (mixed forest)	
Gmelina arborea	21.34
Lagerstroemia parviflora	10.37
Shorea robusta	12.95
Syzygium operculate	24.53
Terminalia belerica	183.0
Terminalia chebula	1.97
Wrightia tomentosa	83.51
Total	337.68
Site III: Karne Forest	
Adina cordifolia	1.99
Bauhinia purpurea	0.49
Buchanania lanzen	11.55
Careya arborea	1.73
Lagerstroemia parviflora	1.99
Leea aspera	0.25
Oegenia dalbergiodes	0.65
Phoenix humilis	0.18
Randia dumortorum	11.55
Schima wallichii	0.25
Semecarpus anacardium	0.21
Shorea robusta	741.55
Syzygium cumini	0.18
Syzygium operculate	0.44
Terminalia alata	34.82
Total	807.83
Site IV: Chitrepani Leasehold Forest	
Shorea robusta	160.63
Total	

4.1.10 Biomass of Herbs

Site I : Chitrepani community forest(Sal forest)

The average biomass of herbaceous plants was 1154.2 kg/ha, 818 kg/ha and 237.2 kg/ha, respectively, in September, December and March (Table 10).

Site II : Chitrepani Community Forest(mixed forest)

The average biomass of herbaceous plants was 805.2 kg/ha, 488.4 kg/ha and 148.2 kg/ha, respectively, in September, December and March(Table 10).

Table 10 : Biomass of Herbaceous Plants in Site I to IV

Name of the Forests	Biomass (kg/ha)		
	Sept.	Dec.	Mar.
Natural Forests			
Site I: Chitrepani Community Forest(Sal forest)	1154.2 ± 50.6	818 ± 171.5	237.2 ± 116.1
Site II: Chitrepani Community Forest(mixed forest)	805.2 ± 46.6	488.4 ± 396.7	148.2 ± 24.6
Site III: Karne Forest	144.1 ± 38.7	210.5 ± 152.3	88.9 ± 88.5
Average	701.2 ± 418.9	505.6 ± 248.3	158.1 ± 60.9
Degraded Forest			
Site IV: Chitrepani Leasehold Forest	2735.4 ± 1322.6	635.95 ± 143.6	354.6 ± 122

Site III : Karne Forest

The average biomass of herbaceous plants was 144.1 kg/ha, 210.5 kg/ha and 88.9 kg/ha, respectively, in September, December and March (Table 10).

Site IV : Chitrepani Leasehold Forest

The average biomass of herbaceous plants was 2735.4 kg/ha, 635.95 kg/ha and 354.6 kg/ha, respectively, in September, December and March (Table 10).

4.1.11 Leaf Litter

Site I : Chitrepani Community forest(Sal forest)

Leaf litter was found to be 795.8 kg/ha in December and in March, it was 1141.08 kg/ha (Table 11).

Site II : Chitrepani Community Forest(mixed forest)

In December, leaf litter was found to be 827.6 kg/ha ; while in March it was 1114.08 kg/ha (Table 11).

Table 11 : Leaf Litter in Site I to IV

Name of Forests	Leaf Litter (Kg/ha)	
	Dec.	Mar.
Natural Forests		
Site I: Chitrepani Community Forest(Sal forest)	795.8	1114.08
Site II: Chitrepani Community Forest(Mixed forest)	827.6	1114.08
Site III: Karne Forest	848.8	2238.8
Degraded Forest		
Site IV: Chitrepani Leasehold Forest	238.7	795.8

Site III : Karne Forest

In December, the leaf litter was 848.8 Kg/ha while in March it was 2238.8 Kg/ha(Table 11).

Site IV : Chitrepani Leasehold Forest

In December, leaf litter was found to be 238.7 Kg/ha; while in March, it was 795.8 Kg/ha(Table 11).

4.1.12 Species Diversity

Site I : Chitrepani Community Forest(Sal forest)

Among the trees, Simpson's Index value was 1.0 in September, 2.34 in December and 1.55 in March (Table 12). While among the saplings, Simpson's Index value was 1.37 in September, 1.47 in December and 1.61 in March ; and among the shrubs, Simpson's Index value was 1.07 in September, 1.19 in December and 2.0 in March.

Site II : Chitrepani Community Forest(mixed forest)

Among the trees, Simpson's Index value was 3.07 in September, 4.03 in December and 3.42 in March (Table 12). While among the saplings, Simpson's Index value was 2.89 in September, 3.4 in December and 4.01 in March ; and among the shrubs, Simpson's Index value was 1.0 in September, 3.47 in December and 4.34 in March.

Site III : Karne Forest

Among the trees, Simpson's Index value was 2.47 in September, 2.15 in December and 2.7 in March. Among the saplings, Simpson's Index value was 1.36 in September, 2.09 in December and 2.95 in March while among the shrubs, Simpson's Index value was 4.15 in September, 3.03 in December and 2.76 in March (Table 12).

Site IV : Chitrepani Leasehold Forest

Among the trees, Simpson's Index value was 0.0 in September and 1.0 both in December in March. Among the saplings, Simpson's Index value was 2.33 in September, 3.3 in December and 2.39 in March ; and among the shrubs, Simpson's Index value was 1.0 in September, 1.86 in December and 1.36 in March (Table 12).

Table 12 : Species Diversity of Trees, Saplings and Shrubs in Site I to IV

Sites	Simpson's Index			
	September	December	March	Average
Natural forests				
Site I: Chitrepani Community Forest(Sal forest)				
Trees	1.0	2.34	1.55	1.63 ± 0.55
Saplings	1.37	1.47	1.61	1.48 ± 0.1
Shrubs	1.07	1.19	2.0	1.42 ± 0.41
Site II: Chitrepani Community Forest(mixed forest)				
Trees	3.07	4.03	3.42	3.51 ± 0.4
Saplings	2.89	3.4	4.01	3.43 ± 0.46
Shrubs	1.0	3.47	4.34	2.94 ± 1.41
Site III: Karne Forest				
Trees	2.47	2.15	2.7	2.44 ± 0.23
Saplings	1.36	2.09	2.95	2.13 ± 0.65
Shrubs	4.15	3.03	2.76	3.31 ± 0.6
Degraded Forest				
Site IV: Chitrepani Leasehold Forest				
Trees	0.0	1.0	1.0	0.67 ± 0.47
Saplings	2.33	3.3	2.39	2.67 ± 0.44
Shrubs	1.0	1.86	1.36	1.41 ± 0.35

4.1.13 Similarity Index

Similarity Index value was highest between the Site I and Site II which was 0.71. While it was lowest between Site III and Site IV the value being 0.29. While it was 0.33 between Site I and III, 0.43 between Site I and IV, 0.44 between Site II and III ; and 0.32 between Site II and IV (Table 13).

Table 13 : Similarity Index between the different species

Similarity Index between the Sites	Site I	Site II	Site III	Site IV
Site I	-	0.71	0.33	0.43
Site II	-	-	0.44	0.32
Site III	-	-	-	0.29
Site IV	-	-	-	-

4.2 Soil

4.2.1 Water holding Capacity

Site I : Chitrepani Community Forest(sal forest)

The water holding capacity of soil was 44.05%, 42.3% and 39.3%, respectively, in September, December and March. The average value was 41.9% (Table 14).

Site II : Chitrepani Community Forest(Mixed forest)

The water holding capacity of soil was 41%, 33.4% and 35.7%, respectively, in September, December and March; with an average value of 36.7% (Table 14).

Site III : Karne Forest

The water holding capacity of soil was 49.6%, 51.15% and 38.2%, respectively, in September, December and March with the average value of 46.3% (Table 14).

Site IV : Chitrepani Leasehold Forest

The water holding capacity of soil was 47.2%, 44.4% and 38.9%, respectively, in September, December and March. The average value was 43.5% (Table 14).

4.2.2 Surface Soil Moisture

Site I : Chitrepani Community Forest(Sal forest)

The surface soil moisture was 12.4% in September and 1.6% both in December and March(Table 14).

Site II : Chitrepani Community Forest(Mixed forest)

The surface soil moisture was 14.5% in September, 1.5% in December and 1.6% in March(Table 14).

Site III : Karne Forest

The surface soil moisture was 13% in September, 5.7% in December and 2.1% in March(Table 14).

Site IV : Chitrepani Leasehold Forest

The surface soil moisture was 22% in September, 1.8% both in December and March(Table 14).

Table 14 : Water Holding Capacity and Soil Moisture

Name of the forests	Water Holding Capacity (%)				Surface Soil Moisture (%)		
	Sep.	Dec.	Mar.	Average	Sep.	Dec.	Mar.
Natural Forests							
Chitrepani Community Forest (Sal forest)	44.05 ± 0.5	42.3 ± 3.0	39.3 ± 2.2	41.9 ± 2.0	12.4 ± 1.3	1.6 ± 0.9	1.6 ± 0.6
Chitrepani community Forest (Mixed forest)	41 ± 1.0	33.4 ± 4.0	35.7 ± 2.4	36.7 ± 3.2	14.5 ± 5.0	1.5 ± 0.9	1.6 ± 0.9
Karne Forest	49.6 ± 15.9	51.15 ± 6.6	38.2 ± 11.6	46.3 ± 5.8	13 ± 6.7	5.7 ± 4.3	2.1 ± 2.2
Degraded Forest							
Chitrepani Leasehold Forest	47.2 ± 1.9	44.4 ± 5.8	38.9 ± 7.2	43.5 ± 3.4	22 ± 1.5	1.8 ± 2.0	1.8 ± 1.9

4.2.3 Soil Texture

The three natural forests ie., Site I, II and III, had the sandy loam type of soil, with 60.2% sand, 29% silt and 10.8% clay in average. The degraded forest ie., Site IV, also had the sandy loam type of soil with 56.5% sand, 33.3% silt and 10.3% clay (Table 15).

4.2.4 Soil pH

The three natural forest sites had the average pH value of 5.3; with 5.3 in Site I, 5.5 in site II and 5 in Site III. The soil of site IV had the pH value of 5.(Table 15)

4.2.5 Organic matter

The soil of Site I, II and III had 2%, 1.5% and 3% Organic matter, respectively. The average value was 2.2%. The soil of Site IV had 2.87% Organic matter(Table 15).

4.2.6 Nitrogen

The soil of Site I, II and III had 0.04%, 0.05% and 0.09% Nitrogen, respectively. The average value was 0.06%. The soil of Site IV had 0.08% Nitrogen.(Table 15)

4.2.7 Phosphorus

The soil of sites I, II and III had 94.4 Kg/ha, 71.4 Kg/ha and 74.1 Kg/ha of Phosphorus, respectively. The average value was 80 Kg/ha. The soil of site IV had 70.5 Kg/ha of Phosphorus.(Table 15)

Table 15 : Texture and Chemical Characteristics of Soil

Parameters of Soil tested	Natural Forests				Degraded forest
	Site I	Site II	Site III	Average	Site IV
pH	5.3 ± 0.7	5.5 ± 0.3	5 ± 0.2	5.3 ± 0.2	5 ± 0.1
Organic Matter (OM) %	2 ± 0.6	1.5 ± 1.3	3 ± 0.5	2.2 ± 0.6	2.87 ± 0.7
Nitrogen (N) %	0.04 ± 0.03	0.05 ± 0.04	0.09 ± 0.01	0.06 ± 0.02	0.08 ± 0.02
Phosphorus (P_2O_5) kg/ha	94.4 ± 33.2	71.4 ± 15	74.1 ± 22.4	80 ± 10.3	70.5 ± 20.2
Potash (k_2O) kg/ha	90 ± 12.9	86.4 ± 34.4	262.8 ± 128.8	146.4 ± 82	103.2 ± 29.1
Sand %	56.5 ± 7.9	68 ± 4.6	56 ± 11.3	60.2 ± 5.5	56.5 ± 12.8
Silt %	34 ± 6.1	25 ± 3.7	28 ± 2.7	29 ± 3.7	33.3 ± 10.6
Clay %	9.5 ± 2.2	7 ± 1	16 ± 8.6	10.8 ± 3.8	10.3 ± 2.5
Texture	SL	SL	SL	SL	SL

Note: Soil sample collected in December, 1994.
SL = Sandy Loam

4.2.8 Potassium

The soil of sites I, II and III had 90kg/ha, 86.4kg/ha and 262.8 kg/ha of potash, respectively. The average value was 146.4kg/ha. The soil of site IV had 103.2 kg/ha of potash(Table 15).

4.3 Correlation coefficient

4.3.1 Correlation Coefficient Between Species Diversity and Soil

The correlation coefficient was calculated in between the species diversity of trees, saplings and shrubs and the different parameters of soil.

Table 16 : Correlation Coefficient values between soil parameters and Species Diversity of Trees, Saplings and Shrubs

Soil Parameters	Correlation coefficient(r)		
	Species Diversity		
	Trees	Saplings	Shrubs
Water Holding Capacity	- 0.46	- 0.61	0.14
Soil Moisture	0.15	- 0.25	0.02
Soil pH	0.59	0.34	- 0.11
Organic Matter	- 0.60	- 0.33	- 0.02
Nitrogen	- 0.26	0.09	0.34
Phosphorus	- 0.19	- 0.81*	- 0.47
Potassium	0.14	- 0.25	0.65

Note: Significance level = 0.05, * Significant

Species diversity of trees was positively correlated with soil moisture, pH and Potassium while Species diversity of saplings was positively correlated with soil pH and Nitrogen (Table 16). Species diversity of shrubs was positively correlated with Water holding capacity of soil, soil moisture, soil pH, Nitrogen

and Potassium. Correlation coefficient value between Species diversity of saplings and Phosphorus was significant.

4.3.2 Correlation Coefficient Between Biomass of Herbs and Soil

Biomass of herbs was positively correlated to soil pH and phosphorus while it was negatively correlated to all other parameters of soil. The correlation coefficient value between herbaceous biomass and soil moisture was significant (Table 17).

Table 17 : Correlation Coefficient values between soil parameters and Biomass of Herbs

Soil Parameters	Correlation coefficient(r)
Water Holding Capacity	- 0.4
Soil Moisture	- 0.84*
Soil pH	0.31
Organic Matter	- 0.4
Nitrogen	- 0.71
Phosphorus	0.63
Potassium	- 0.48

Note: Significance level = 0.05, * Significant

5. DISCUSSION

In the present study, the vegetation and soil parameters of the four sites have been studied. Among the four sites, Site I, II and III represent Natural (or less disturbed) forest and Site IV represent Degraded forest.

Vegetation

Regarding the Species Richness, it is very different in the four sites. Site III had the highest value for Species Richness with 18 species of trees, 18 species of saplings and 16 species of shrubs. Next to this, Site II had the highest value with 7 species of trees, 9 species of saplings and 5 species of shrubs. While the lowest value was in degraded site with 1 species of tree, 5 species of saplings and 5 species of shrubs which was nearly similar to Site I with 3 species of trees, 7 species of saplings and 5 species of shrubs. They are different regarding the number of tree species, thus Sites I, II and IV have the same number of shrub sp. but different Species diversity. Degraded forest did not have much Species Richness. Out of the total 18 tree species, it had only one tree species representing 5.6 % and 7 sapling out of 18 sapling species representing 38 %. So this forest is highly degraded in context of species richness as well. Thus the result show a very high rate of species loss in the degraded site and it has lost nearly three fourth of the tree species. It had only 21.7 % species out of total species. Among the natural sites, Site I also had very low Species Richness representing 28.3 % and if the immediate conservation measures are not applied, this forest may very soon become similar to the degraded site.

Among the four sites, Site II had the highest value for total tree density while the degraded forest had the lowest value. *Shorea robusta* was found to be the dominant species regarding the number

in all types of plant community except in Site II(Natural) in which *Terminalia belerica* was dominant. This must be because of the sandy loam texture of the soil found in the area which makes the soil porous. As according to Stainton (1972) *Sal* forest grows in non water logged condition. Site II had 68% sand in soil and according to Suoheimo(1995, a) regeneration of *sal* is poor in such condition of high sand percentage as in Site II. Regarding the density, *Shorea robusta* had the highest value in all three sites, but the value was much lower in degraded site than in the natural sites. Among the two natural sites, Site III had much higher value than the Site I. Degraded site had no other species other than *Sal*. Here the effect of human interference can be easily seen as it is adjacent to the village and the people may have grazed animals, lopped and cut the trees freely in past before the leasing of this forest. The values here are higher than the findings of Gupta and Shukla(1991) in Gorakhpur Forest Division(12.9-19.1 pl/ $100m^2$). In all the seasons the values were quite similar in all the sites. The remaining species had the less and quite similar values. This shows that the number of plants of *Sal* was much higher in comparison to other species. But the values of total density of Sal trees (except Site II) in the present study was lower than the findings of Sejuwal(1994) in RCNP(440 t/ha) and Agrawal *et. al.* (1991) in sal forest site in Garhwal Himalayas (340-460 pl/ha). Among the saplings, Site III had the highest value for total density showing that at present it has the highest rate of regeneration ; the soils of which have higher soil moisture and water holding capacity in comparison to other sites. According to Bhatnagar(1965) soils supporting sal regeneration have higher soil moisture and water holding capacity. *Shorea robusta* was dominant regarding the number in Site I and III with the higher value being in Site III, while in Site II *Wrightia tomentosa* was dominant. According to Tamrakar(1994), mostly the degraded *sal* shrub forest that have regenerated are from seedling that have remained dormant(> 15 years) and *sal* require 15-25 years to be established in some cases

with an effort of protection. In the degraded Site, *Syzygium operculate* were dominant in the two later seasons ie., in December and March. This may be because *Syzygium operculate* occurs in soil with high humus content and here soil of this site has high organic matter.

Regarding the frequency, trees of *Shorea robusta* was less frequent in degraded site than in the natural sites except in Site II in which the frequency value was quite similar for most of the species showing the equal competition among the species. According to Singh and Singh(1989), the competitive interactions with the dense population of common undercanopy tree species and shrubs is deleterious to sal sapling. The saplings of *Shorea robusta* were the most frequent in all the natural sites with almost 100% frequency which is quite similar to the findings of Sejuwal(1994) in RCNP. Along with the saplings of *Sal*, other species having higher frequency value were *Syzygium operculate* in all the sites and *Wrightia tomentosa* in Site I and II. This shows that dispersion of saplings of *Shorea robusta* and *Syzygium operculate* was uniform in all types of forest eventhough the value was lower in degraded forest.

The values of total basal area in the present study was very low in all sites in comparison to the findings of Sejuwal(1994) in RCNP and also Rana *et. al.*(1988) in Submontane indian Himalayas. This may be because the total density in the present study is also very low. But the values of total basal area of trees in Site I and III are quite similar to the findings of Singh and Singh (1992) in Siwaliks of Central Himalayas (57.1-70.4 m^2/ha). Site II and IV had lower values which must be because Site II is a newly regenerating forest and Site IV is a degraded forest, both having few big trees. Among the trees the basal coverage or the dominance value was highest for *Shorea robusta* in two natural sites and also the degraded site though the degraded site had lower value in

comparison which may be attributed to the lower value of density in this site. But in Site II, *Terminalia belerica*, *Syzygium operculate* and *Gmelina arborea* had the highest dominance value in the three seasons, respectively. Among the saplings also, *Shorea robusta* had highest dominance value in the two natural sites(I and III) and also the degraded site. But the value was higher in Site I than in Site III which shows that *Sal* regeneration was higher in Site I. Degraded site had the lower value than the two. In this site, saplings of *Syzygium operculate* also had higher value of dominance, which was quite same as for *Shorea robusta*, in December and March. It may be because this species grew faster in these seasons in comparison to *Shorea robusta*. But the values here are less than the findings of Rana *et. al.* (1988) in *Sal* seedling coppice forest.

The importance value was highest for *Shorea robusta* in two natural sites(I & III) and the degraded site. But the value is highest in the degraded site which can be explained as the relative values were 100% for there was only one species of tree in this site, IVI equalled to 300. Among the two natural sites, Site I had higher value in comparison to Site III which is because as there were more species in Site III, relative values became less. The value of IVI were quite similar in all the seasons in all sites except Site II and were similar to the findings of Singh and Singh (1992) in Siwaliks of Central Himalayas. In Site II, *Terminalia belerica*, *Syzygium operculate* and *Gmelina arborea* had the highest value in three seasons, respectively. This can be explained as the Site II is a newly regenerating forest(< 10 year old), most of the species are in growing phase resulting in the above values. The values are similar to Agrawal *et. al.*(1991)'s finding in Garhwal Himalayas which may be because the soil texture composition and pH value were nearly similar to their observation. The results here are quite similar to the findings of Rana *et.al.*(1988) in submontane Indian Himalayas with IVI value of 174 for trees and 199 for saplings. But it is higher than Gupta and Shukla(1991) which

may be because they calculated IVI considering all types of plant forms i.e., trees, shrubs and herbs together.

Among the shrubs, *Eupatorium adenophorum* was dominant throughout except in Site III in which *Phoenix humilis* was dominant. The density value of *Eupatorium adenophorum* was highest in Site I, a little lower in degraded site and lowest in Site III. But the total density value was highest in Site I and III in Rainy and Winter season, a little lower in Degraded site (IV) and lowest in Site II. But unlike other sites, Site II had higher shrub density in Spring which may be because it must be the period of growth for shrubs. The frequency value was quite similar in all three sites thus showing that it was uniformly dispersed. But the average basal area value was low which may be because it is a herbaceous plant and the basal diameter of the plants were low. Schaffner(1987) had accounted that *banmara* can spread widely in the absence of competition with other species and equilibrium occurs if there is competition with other plants. In the present study sites, the species number and their dominance is very low in Site I and the degraded site. Thus *Eupatorium adenophorum* had to compete less with other species. But Site II is a newly regenerating forest and there were more species ; so it had to compete more and the value was lower in comparison to the two sites. According to Suoheimo(1995, b), the high density of banmara grass may hamper and delay the establishment of Sal, especially in open flat regeneration areas. In Site III *Eupatorium adenophorum* was dominant only in September while in December and March, *Phoenix humilis* was dominant. This too can be explained as there was highest number of shrub species in this forest, competition for *banmara* was highest in this Site.

In December, *Shorea robusta* had the highest percentage crown coverage in the degraded site and two natural sites(Site I and III) but the values were higher in the natural sites. This may be due to

the presence of old *Sal* trees in these sites. But in Site II *Wrightia tomentosa* had the highest value which can be explained as it is a newly regenerated forest and there were no old *Sal* trees in this site. In March, the percentage coverage was less than in December. This can be explained as according to Singh and Ramakrisnan (1983), maximum number of leaves(about 63.5% of the total) appear in the month of April. Thus in March the lower value of percentage coverage is because the new leaves still remain to appear and most of the leaves were shed by the plant as it is a deciduous type of forest. In March also *Shorea robusta* had the highest coverage value in degraded and two natural sites. But the degraded site had lower value than the natural site with Site I having higher value than Site III. Thus, in both seasons, *Shorea robusta* had the highest percentage coverage in the three studied sites(one degraded and two natural) which may be because these three sites had old and big trees of *Shorea robusta* with 75-100% frequency and high density value.

Percentage Coverage can be related with Leaf litter. In the present study only leaf litter was considered as it is the dominant component of litterfall which is similar to the findings of Herbohn and Congdom(1993). Singh and Singh(1992) report that tree leaves account for 60-80% of total litter fall. In both December and March, it was higher in natural sites than in degraded site. Among the three natural sites, Site III had the highest value of leaf litter which is because this forest had highest tree density value.

Among the two type of forests, Degraded site had less leaf litter in both seasons which can be attributed to the lower density value in this forest. It was found that leaf litter was higher in March than in December. According to Herbohn and Congdom(1993), litterfall is seasonal with maximum fall occurring from the end of dry season to the end of the wet season and leaves were the dominant component of litterfall. Singh and Singh(1992) also report

the same type of findings. As previously mentioned, it can be compared with crown cover. In December when crown cover was higher, leaf litter was less; and in March when crown cover was less, leaf litter was more. This is due to the deciduous nature of the forests in the site.

Among the natural sites, Site III had the highest value for the total volume of trees, saplings and shrubs while the degraded site had the lowest value for volume. But the volume of trees in Site IV was higher than the volume of trees in Site II which may be due to the presence of old *Sal* trees in this Site while Site II is a newly regenerating forest without such old trees. In both types of forest, *Shorea robusta* had the highest value, except in Site II, in which *Gmelina arborea*, *Terminalia belerica* and *Wrightia tomentosa* had the highest value. Pesonen and Rautianen(1995) have accounted that in Bara and Makawanpur operational management planning areas of FMUDP, MAI(Maximum mean annual increment) is 3-6 cubic m/ha. In the present study the values are less than this. It is also less than the findings of Sejuwal(1994) in Royal Chitwan National Park ; thus showing that the forests in the present study site is disturbed and degraded.

The total aboveground biomass(TAGB) of trees was higher in Natural forest than in Degraded forest. Among the Natural forests, Site III had the highest value and lowest in Site II. *Shorea robusta* accounted for greater portion of TAGB in both types of forest which is quite similar to the findings of Singh and Singh (1992) in Central Himalayas with Shorea robusta accounting for 87-94% of total tree biomass. In Degraded forest, the total TAGB recorded was only for *Shorea robusta*. While among the Natural forests, *Shorea robusta* had the highest value in Site I and III. In Site II, *Terminalia belerica*, *Gmelina arborea* and *Lagerstroemia parviflora* had the highest value.

The values here are greater than Singh and Ramakrisnan

(1983)'s findings in 19 year old stand but less than the findings of Rana *et al.*(1988)in forests of Submontane Indian Himalayas(455 t/ha to 710.2 t/ha) and Sejuwal(1994) in Royal Chitwan National Park(1038.16 t/ha). From this it can be concluded that the forests are quite disturbed in the present study site in comparison to RCNP, which is a protected area, and the density is also less than RCNP(440 pl/ha).

The biomass of herbs was highest in September and lowest in March in all four sites. But it was higher in degraded site than in natural sites, among which highest value was in Site I and lowest value was in Site III. This can be explained as there is less density of trees and shrubs in degraded site, the herbs had to compete less for light and water and could grow luxuriantly as the open canopy caused greater light to reach the under storey(Gupta and Shukla, 1991). While in Site III, there were many tall trees and shrubs with higher value of density, frequency and dominance which shaded the ground vegetation resulting in less growth of the ground cover.

Rana *et al.*(1988) have recorded 1.5 and 1.8 t/ha of herbaceous biomass in new and old growth stands of Sal in sub-montane Indian Himalayas from January to December. The value of 1.5 t/ha is greater than in the present study(0.51 t/ha in December) which may be because they had considered the seedlings of trees and shrubs as well. While in the present study it was excluded ; and these forests had higher percentage of seedlings. Herbaceous biomass was lowest in March in all four sites which may be because it is the dry and pre-monsoon season when the annuals still remain to grow and flower in want of water.

Simpson's Index, the species diversity index was highest for trees and saplings in Site II while it was highest for shrubs in Site III in all seasons. The lowest value for tree and shrub was in

Degraded forest and for sapling it was in Site I. According to Gupta and Shukla(1991), Species Diversity increases as the ecosystem develops and decreases with maturity. Here Site II is a newly regenerating forest and thus has highest Species Diversity. According to Singh and Singh (1989), tree species diversity of the Siwalik sal forest range from 1.54 to 1.72. In the present study only Site I falls in this range while Site II and III have higher value similar to sal-tun - chir-pine forest and Site IV have lower value. It can be seen that though the Site III has highest Species Richness, the diversity index is not highest for tree and sapling. The reason may be as the total density of tree and saplings was highest in Site II, Simpson's index was also highest in this Site eventhough the Species Richness is highest in Site III as the index is dependent on the number of species. While for shrubs, total density was highest in Site III thus giving the highest Species Diversity in this site.

Similarity Index was calculated regarding the number of species present in the sites. The value was highest between Site I and II. This may be because both the sites are regenerating and part of the same forest. The lowest value was recorded between Site IV and Site III which can be easily explained as the Site IV had one fourth the number of species found in Site III thus reducing the similarity value simultaneously.

Soil

The soil texture of all the four sites is sandy loam. This is similar to the findings of Rana *et al.*(1988) ; and Gupta and Shukla(1991) in Sal forests in India. Napier and Parajuli(1987) had the similar findings in Hetauda in January, 1987. But the percentage composition of soil varied in the different sites. Among the natural site, Site II had the highest percentage of sand(68%) and lowest percentage of clay(7%) with 25% silt. While Site III had

the highest percentage of clay(16%) with 56% sand and 28% silt. Site I had 56.5% sand, 34% silt and 9.5% clay ; which is quite similar to the degraded site with 56.5% sand, 33.3% silt and 10.3% clay. This may be because these two sites(Site I and IV) are nearby and the degraded site was once the part of the Site I(Natural forest) before it was leased out by the Government to local people. The sandy loam texture is very common in the Siwalik and Dun valleys which support dense forests of Sal and other valuable timber trees. The texture of soil is related to its moisture retaining capacity and aeration ; as a result it has a strong influence on the natural regeneration and the regeneration of Sal was poorest in soil with 70% sand(Suoheimo, 1995, a). In the present study also Site II with 68% sand had the poorest Sal regeneration.

Water holding capacity(WHC) of soil was not very different in the four Sites. Among the natural sites, Site III had the highest value(46.3%) and Site II had the lowest value(36.7%). While Site I had 41.9% WHC which shows similarity with the degraded site(43.5%). As previously mentioned this may be due to the nearness of the two sites. The results here are similar to the findings of Bhatnagar(1965), which says that WHC of soils from good *Sal* regeneration areas is higher. Here Site III and I having higher WHC support highest number of *Sal* saplings per hectare. Also according to Lokna(1995), soils which support more Organic matter have higher Water holding capacity. Shrestha (1992) accounts similar type of observation and according to him high organic matter improve infiltration rate and Water holding capacity. Daubenmire(1967) accounts that organic matter may hold as much as nine times its own weight of water. Here Site IV has highest value for Organic matter(%) and Water holding capacity(%) is also high. In all the four sites, Water holding capacity was highest in September and lowest in March and may be because in rainy season there was luxuriant growth of herbs which retain water in the soil.

Soil moisture was highest in the soil in September in all sites showing a direct effect of Monsoon. The other two seasons showed a very low moisture content in soil ; this may be attributed to the texture of soil which is sandy loam having a very high percentage of sand and silt. Site III had a little higher moisture content which may be due to the higher percentage of clay(16%) in this Site (III) than the other three sites which have more sand and silt ; and clay retains more water in the soil while water just disappears in the sand.

The pH of soil was quite similar in all the four sites in having medium acidic nature. Shrestha(1992) accounts that in Terai most of the soils are acidic. Site II had the highest value(5.5) and next was Site I(5.3), among the Natural forest. While Site III(Natural forest) and Degraded forest had the same pH value(5). This is lower than Singh and Singh(1985)'s finding of 6.7-6.8 pH in the forests having *Shorea robusta* as a dominant species and Napier and Parajuli(1987)'s findings of 6.3 pH in Hetauda. It is also lower than Rana *et al.*(1988) who had accounted a value of 6.6-6.8 in forests in sub-montane Indian Himalayas. But it tends to be nearer to Bhatnagar(1965)'s findings of 5.8 pH in good sal regeneration area in Uttar Pradesh, India and 5.79 pH in Manahari pilot area, Makawanpur(Suoheimo, 1995, b). The higher acidic nature in the present site may be attributed to the extensive pine plantations found in the nearby area. Usually soils of pine forest have acidic soil. According to Singh and Singh (1989), pH range of 4.5-5.5 is good for the saplings and the value of present study falls in this range. Soils with higher pH generally have poorer regeneration results but several other factors in the soil also are more important in determining the distribution and regeneration of Sal (Suoheimo, 1995, a).

Organic matter in the soil was highest in Site III(3%) and lowest in Site II(1.5%), among the Natural forest. Site I had 2%

organic matter. According to Suoheimo (1995, a) the value of 1.7-2.33% of organic matter is an indicator of a low fertility status of the soils and in present study Site I and II fall in this range. Degraded forest had 2.8% organic matter which tends to be nearer to the value for Site III. It can be explained as the herb biomass was very high in Degraded forest, this may have contributed in the formation of organic matter. It is similar to the findings of Bhatnagar(1965) in which Organic matter was greatest in soils from poor regeneration areas. While in Site III, the total density of plants was higher which must have produced more litter and eventually the soil Organic matter. Singh and singh (1985) have observed 1.7 % organic matter in forest with sal as dominant species which tends to be near to the value in Site I & II. The organic matter in the forests here is higher than the findings of Napier and Parajuli(1.7%) in Hetauda, Rana *et al.*(1988)(0.67-1.08%) in submontane forests in India and also Suoheimo(1995, b) (0.7%) in Manahari pilot area, Makawanpur. But the values here are near to findings of Shrestha(1992) of 2.5% organic matter in deforested area in the Terai after a few years of clearing.

The percentage of Nitrogen in soil was highest in Site III(0.09%) of Natural forest and Degraded forest(0.08%). This is similar to the findings of Singh and Singh(1985) of 0.75% Nitrogen in Sal forest and also to findings of Napier and Parajuli(1987) of 0.09% in Hetauda and Singh and Singh (1989)'s findings of 0.12% in Central Himalayas. While Site I had 0.04% and Site II had 0.05% Nitrogen. The higher values in Site III and IV may be due to the presence of more leguminous plants in these two sites; which trap the atmospheric Nitrogen in the soil through their root nodules.

Highest amount of Phosphorus in soil was found in Site I(94.4 Kg/ha) and Site III(74.1 Kg/ha). While Site II had 71.4 Kg/ha of Phosphorus which was quite similar to the Degraded forest (70.5 Kg/ha). According to Bhatnagar(1965), Phosphorus is present in

higher amounts in soils from good *Sal* regeneration areas. In the present study, Site I and III having high amount of Phosphorus have highest number of *Sal* saplings.

Among the Natural forests, Potash was highest in the soil of Site III(262.8 Kg/ha) and lowest in Site II(86.4 Kg/ha) with Site I having 90 Kg/ha. The Degraded forest had 103.2 Kg/ha of Potash. The lowest value in Site II may be due to its young age (newly regenerated and < 10 years.); as according to Bhatnagar (1965), Potash in soil is higher in good Sal regeneration areas. Here Site I and III have highest number of Sal saplings showing higher rate of regeneration in these two sites. According to Daubenmire (1967) deciduous trees are non-acid forming and contain considerable quantities of minerals like Potassium.

Correlation Coefficient

Soil pH showed positive correlation with the species diversity of trees and saplings, thus showing that regeneration and growth of plants highly depend on pH value of soil. Soil moisture was positively correlated with species diversity of trees and shrubs while species diversity of saplings was negatively correlated. Singh and Singh (1989) account that excessive moisture is deleterious to saplings. Nitrogen was positively correlated with species diversity of saplings and shrubs while it was negatively correlated with Species diversity of trees. Thus it seems that smaller plants need more Nitrogen in comparison to big trees. The negative value with water holding capacity reaffirms that Sal forest grow on non water-logged conditions(Stainton, 1972).
The negative value with Organic matter and Phosphorus shows that growth of Sal forest do not depend much on chemical characters of soil which is similar to the findings of Suoheimo(1995, a) in Manahari pilot area, Makawanpur. It is a light demander and grow and regenerate best under the unfair systems. Biomass of Herbaceous

plants was positively correlated with soil pH and Phosphorus showing that it depends on these for growth. But according to Daubenmire (1967) the soil factor deserves much attention as plant and soil are strongly influenced by each other.

6. CONCLUSION AND RECOMMENDATIONS

The present work was aimed at studying ecologically two types of forest ie., Natural and Degraded forests ; and compare them.

Shorea robusta was found to be the dominant species of the plant community throughout except in Site II, Chitrepani Community forest(mixed forest), which is a newly regenerating forest where *Syzygium operculate, Terminalia belerica* and *Wrightia tomentosa* were found to be dominant. But the values for different vegetation analysis(density, dominance, IVI, volume, biomass) were different and mostly lower in degraded site, Chitrepani Leasehold Forest. The range of total density was higher for trees and saplings but for shrubs, it was not so different between the two types of forest. Total basal area for saplings and shrubs was also less in Degraded forest than in Natural forests. The biomass of trees was higher in Natural forests than in Degraded forests. But the herbaceous biomass was higher in Degraded forest and in one Natural forest (Site I) than in the other two Natural forest sites. Leaf litter showed seasonal pattern in having high value in Spring and it was higher in Natural forests than in Degraded forest.

Karne Forest had the highest species richness (39) among the natural forests with the value being lowest in degraded forest (10). While species diversity was highest in Site II, Chitrepani Community Forest(mixed forest) which is a regenerating forest. The degraded forest was found to have lost three-fourth species with having only 21.74 % out of total tree and shrub species.

The soil condition was not so different in the two types of forest regarding water holding capacity and soil texture. But the percentage composition of sand, silt and clay was different in Site III, Karne Forest, having highest percentage of clay and Site II,

Chitrepani Community Forest(mixed), having highest percentage of sand. This can be attributed to the presence of a torrent in the study site which traverses through the forests. This problem is more pronounced in Site II which was inundated with sediment load from the flash floods in the torrent (*khahare*) in rainy season. The soil in the forests are acidic in nature with pH value ranging from 5-5.5 which can be attributed to the *Pine* plantations in the nearby area. The Degraded site, Chitrepani Leasehold Forest, had more organic matter and Nitrogen than the natural sites, except Site III. Regarding Potassium, Site III had highest value while Phosphorus was found to be highest in Site I.

Among the three sites in Natural forests, Site I and II both were a newly regenerating forests. But the regeneration rate was higher in Site II, Chitrepani Community Forest, in which more types and number of sapling species were found to be growing ; while in Site I most of the saplings were of *Shorea robusta*. Site III, Karne forest, seems to be the climax forest which had the highest number of species. The people in the surrounding area are mostly dependent on this forest for fuelwood, fodder, leaf litter, animal grazing, etc. It is situated in the elevated Chure range (Siwalik) between 500-720 m elevation and at many places erosion was found to be a serious problem. So it seems that the forest may start to degrade if it is not protected and managed well by restricting the harvesting of forest products.

In the Degraded forest, Chitrepani Leasehold forest, seedlings of *Shorea robusta* and some other species were found to be growing. Thus if it were to be protected well it may regenerate in few years. This forest needs to be preserved, protected well and appropriate agroforestry practices should be applied immediately else it will turn into a bare land very soon.

Thus making the people aware about the need to protect forests and its long term benefits to mankind should be the first step towards preserving the forests and plant species diversity. Restrictive rules, about animal grazing, fodder, fuelwood and timber cutting, need to be strictly implemented. Encroachment into the forest by people for agriculture should be stopped. As mentioned earlier people should be encouraged to practice agroforestry and other alternatives to meet their household needs. Reforestation programmes should be launched and also preserving the regenerating forests should also be done as in one of the patches in Chitrepani Community forest (protection of regenerating forest for the last 5 years by restrictive harvesting) which is a good example that it can be done with the cooperation of the users themselves.

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APPENDIX

Appendix 1

Diameter Range of plants in Site I to IV

Name of the species	Diameter Range (cm)		
	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(pure)			
Trees			
Schima wallichi	-	13	-
Shorea robusta	46-184	37-57.4	34-78.2
Syzygium operculate	-	10-14	11-13.5
Saplings			
Casearia graveolens	3.5-9.9	-	-
Lagerstroemia parviflora	4.0	-	-
Psidium guajava	-	-	2.5
Shorea robusta	2.5-9.9	2.5-6	2.5-5.5
Syzygium operculate	4-9	2.6-8.9	2.6-9
Terminalia belerica	-	4.8	-
Wrightia tomentosa	2.6	2.5-8.5	2.5-4
Shrubs			
Clerodendron infortunatum	-	2-5.3	-
Cloebrookia opositifolia	-	2.6	-
Eupatorium adenophorum	2.5-4.5	2.5-5	2.5-2.7
Lantana camara	3.2	-	-
Phoenix humilis	4.0-4.5	6	2.5-4
Site II: Chitrepani Community forest(mixed)			
Trees			
Gmelina arborea	13.6-29.5	14.2-25	11-28.2
Lagerstroemia parviflora	10.7-25.5	10-48	48
Shorea robusta	10-17.4		-
Syzygium operculate	26-34.4	10-15	10.2-15
Terminalia belerica	10.3-40.8	10-11.4	11-12.2
Terminalia chebula	17.1	-	-
Wrightia tomentosa	10-26.8	10.1	13.5

Name of the species	Diameter Range (cm)		
	Sept.	Dec.	Mar.
Saplings			
Casearia graveolens	-	2.8	-
Lagerstroemia parviflora	-	2.6-5.2	2.5-7.2
Shorea robusta	9.8	2.5-7.2	2.5-9.5
Syzygiun operculate	-	3-9.8	2.5-7
Terminalia belerica	5-5.8	2.5-9.5	3.2-9.9
Terminalia chebula	-	2.5	-
Terminalia alata	5.2-9.9	2.6-5.7	5.5
Wrightia tomentosa	4.3-9.7	2.5-9.9	2.5-9.9
Birali	-	3.3	-
Shrubs			
Clerodendron infortunatum	-	2.5-7	2.5-3
Colebrookia oppositifolia	-	2.5-2.8	2.5-3.4
Eupatorium adenophorum	2.6-5.5	2.5-4	2.5-2.8
Phoenix humilis	-	4.0	2.8-3
Pogostemon glaber	-	-	2.5-3.5
Site III: Karne Forest			
Trees			
Adina cordifolia	23.9	-	47.4
Albizzia odoratissima	-	28.5	-
Bauhinia purpurea	14.0	-	-
Buchanania lanzen	51.0	-	-
Careya arborea	17-17.5	-	-
Lagerstroemia parviflora	10-23	-	-
Leea aspera	12.5	-	-
Mangifera indica	-	-	83.0
Oegenia dalbergiodes	15.5	-	-
Phoenix humilis	10.0	-	-
Phyllanthus emblica	-	-	16-18.2
Pinus roxburghii	-	58.9	-
Randia dumortorum	51.0	-	-
Schima wallichii	11.1	44.0	-

Name of the species	Diameter Range (cm)		
	Sept.	Dec.	Mar.
Semecarpus anacardium	10.5	11.4-24.2	-
Shorea robusta	10-188.5	21-76.6	22-77
Syzygium cumini	10.0	-	-
Syzygium operculate	13.5	10-43	10.5-18.2
Terminalia chebula	-	-	24.0
Terminalia alata	24.2-68.5	43.4	23.6-68.2
Saplings			
Adina cordifolia	-	3.4	-
Albizzia odoratissima	-	2.5-9.4	-
Buchanania lanzen	4.5	6.5	-
Dillenia pentagyna	-	-	2.6-7
Grewia hainesiana	3-5.8	-	-
Lagerstroemia parviflora	-	4.5	2.5-5
Leea aspera	2.6-7	-	-
Phyllanthus emblica	2.8	2.5-2.7	-
Schima wallichii	-	4-6	2.6-8.5
Semecarpus anacardium	-	2.5-3.5	2.5-4.5
Shorea robusta	2.5-9.8	2.5-7	2.5-8.5
Syzygium cumini	3.5	5.5	2.6-2.9
Syzygium operculate	-	2.5-6	2.5-8.6
Terminalia belerica	-	2.5-2.8	-
Terminalia chebula	2.5-4.2	2.5-5.0	2.6-3
Terminalia alata	4-5	2.5-6.4	2.6-3
Wendlandia puberula	3-8.2	2.5-2.6	-
Wrightia tomentosa	-	4.2-4.5	2.5-2.6
Shrubs			
Barleria cristata	-	-	2.5
Clerodendron infortunatum	-	2.5-2.6	-
Colebrookia oppositifolia	2.7	-	-
Cornus oblonga	6.5	2.5-4.3	4.0
Desmodium confertum	-	2.5-2.8	-
Eupatorium adenophorum	2.5-4.8	2.5-3	2.5-2.6
Inula cappa	2.6-5.1	2.5	-
Murraya koenigii	-	2.5	-

Name of the species	Diameter Range (cm)		
	Sept.	Dec.	Mar.
Osbeckia stellata	-	2.5	2.6
Osyris wightiana	2.6-3	2.8	-
Phoenix humilis	3.5-9	2.5-9.3	2.5-9.5
Pogostemon glaber	-	-	2.6-3
Randia dumortorum	3.0	2.5-3	-
Reinwardtia indica	-	3.5	-
Sida rhombifolia	-	2.5	-
Woodfordia fruiticosa	-	2.5	2.6-4.8
Site IV: Chitrepani Leasehold Forest			
Trees			
Shorea robusta	30-135	42.8-81	43.5-49
Saplings			
Dalbergia sissoo	-	2.6-2.7	2.5
Mangifera indica	-	3.0	-
Shorea robusta	3.4-3.5	2.5-3	2.5-3.2
Syzygiun operculate	2.9-5.8	2.5-5.9	2.5-4
Wrightia tomentosa	-	2.6-3.2	2.9
Shrubs			
Eupatorium adenophorum	2.5-3.8	2.5-3	2.5
Inula cappa	-	3.2	-
Lantana camara	-	2.6	3.2-4.5
Pennisetum purpureum	-	2.5-2.8	-
Randia dumortorum	-	2.5	-

Appendix 2

Height Range of plants in Site I to IV

Name of the species	Height Range (m)		
	Sept.	Dec.	Mar.
Site I: Chitrepani Community Forest(pure)			
Trees			
Schima wallichi	-	8.0	-
Shorea robusta	15-20	13-23	14-22
Syzygium operculate	-	7-9	8.0
Saplings			
Casearia graveolens	0.8-1.2	-	-
Lagerstroemia parviflora	1.0	-	-
Psidium guajava	-	-	1.5
Shorea robusta	0.3-2	0.3-4.6	0.4-2.7
Syzygium operculate	0.7-1.6	0.9-3	0.5-4.3
Terminalia belerica	-	3.2	-
Wrightia tomentosa	1.0	0.5-4.5	0.7-1.4
Shrubs			
Clerodendron infortunatum	-	0.6-1.3	-
Cloebrookia opositifolia	-	0.8	-
Eupatorium adenophorum	0.5-2	0.6-2.5	0.2-1.6
Lantana camara	0.9	-	-
Phoenix humilis	1.1	1.2	0.2-0.7
Site II: Chitrepani Community forest(mixed)			
Trees			
Gmelina arborea	15.0	8-16	5-10
Lagerstroemia parviflora	3-5	7-19	15.0
Shorea robusta	2-6	7.0	-
Syzygium operculate	5.2-6	7-10	6-7
Terminalia belerica	3-5.0	7-10	7-8
Terminalia chebula	4.0	-	-
Wrightia tomentosa	3-6	6-8	5.0

Name of the species	Height Range (m)		
	Sept.	Dec.	Mar.
Saplings			
Casearia graveolens	-	0.8	-
Lagerstroemia parviflora	-	1.0-3.5	0.7-5.3
Shorea robusta		0.6-4.0	0.8-6.2
Syzygiun operculate	-	1.2-6.4	0.7-4.1
Terminalia belerica	1-1.3	0.3-8.0	0.9-6.1
Terminalia chebula	-	1.6	-
Terminalia alata	1.2-2.0	0.9-2.6	1.2
Wrightia tomentosa	0.5-6.2	0.8-6.3	0.9-5.1
Birali	-	8.6	-
Shrubs			
Clerodendron infortunatum	-	0.5-6.3	0.3-1.2
Colebrookia oppositifolia	-	0.4-0.7	0.4-0.7
Eupatorium adenophorum	1.0-2.5	1.1-2.8	0.4-1.6
Phoenix humilis	-	0.4	0.5-0.8
Pogostemon glaber	-	-	0.3-1.2
Site III: Karne Forest			
Trees			
Adina cordifolia	15.0	-	19.0
Albizzia odoratissima	-	13.0	-
Bauhinia purpurea	10.0	-	-
Buchanania lanzen	51.0	-	-
Careya arborea	17-17.5	-	-
Lagerstroemia parviflora	1.2-4	-	-
Leea aspera	2.0	-	-
Mangifera indica	-	-	16.0
Oegenia dalbergiodes	3.0	-	-
Phoenix humilis	0.8	-	-
Phyllanthus embilica	-	-	10.0
Pinus roxburghii	-	20.0	-
Randia dumortorum	7.0	-	-
Schima wallichi	7.0	15.0	-

Name of the species	Height Range (m)		
	Sept.	Dec.	Mar.
Semecarpus anacardium	2.0	4-7	-
Shorea robusta	0.5-26	10-22	8-20
Syzygium cumini	1.0	-	-
Syzygium operculate	4.0	2-18	5-11
Terminalia chebula	-	-	5.0
Terminalia alata	9-23	13.0	13-16
Saplings			
Adina cordifolia	-	1.5	-
Albizzia odoratissima	-	0.6-1.8	-
Buchanania lanzen	0.3	2.1	-
Dillenia pentagyna	-	-	1-2.9
Grewia hainesiana	0.4-0.6	-	-
Lagerstroemia parviflora	-	2.4	0.4-6
Leea aspera	0.2-1.0	-	-
Phyllanthus emblica	1.2	0.4-0.7	-
Schima wallichii	-	1.7-2.5	0.7-4.0
Semecarpus anacardium	-	0.4-0.5	0.3-3.6
Shorea robusta	0.1-6.0	0.3-3	0.5-4.2
Syzygium cumini	0.9	2.0	1-2
Syzygium operculate	-	0.3-2.5	0.8-2.7
Terminalia belerica	-	0.5-0.7	-
Terminalia chebula	0.1-2.2	0.7-3.8	1.6-2.3
Terminalia alata	0.5-0.8	0.8-2.4	1.1-1.3
Wendlandia puberula	0.5-1.3	0.4-2.6	-
Wrightia tomentosa	-	1.7-2.3	0.8-1.5
Shrubs			
Barleria cristata	-	-	1.5
Clerodendron infortunatum	-	1.8-2.6	-
Colebrookia oppositifolia	1.9	-	-
Cornus oblonga	1.0	0.3-1.4	1.4
Desmodium confertum	-	1.5-2.8	-
Eupatorium adenophorum	0.9-2.2	0.4-4.0	1.4-3.4
Inula cappa	0.2-1.1	0.7-1.5	-
Murraya koenigii	-	0.8	-

Name of the species	Height Range (m)		
	Sept.	Dec.	Mar.
Osbeckia stellata	-	0.9	1.6
Osyris wightiana	0.2-0.7	2.0	-
Phoenix humilis	0.5-9.5	0.4-2.2	0.4-1.5
Pogostemon glaber	-	-	1.5-2.5
Randia dumortorum	0.2	1.6-2.4	-
Reinwardtia indica	-	1.4	-
Sida rhombifolia	-	0.7	-
Woodfordia fruiticosa	-	0.8-1.1	1.2-4
Site IV: Chitrepani Leasehold Forest			
Trees			
Shorea robusta	12-18	15-18	11-17
Saplings			
Dalbergia sissoo	-	0.9-1.1	0.6
Mangifera indica	-	0.6	-
Shorea robusta	0.5-1.1	0.5-1.1	0.5-1.4
Syzygiun operculate	0.5-1.0	0.5-1.9	1.1-1.6
Wrightia tomentosa	-	0.7-1.3	1.1
Shrubs			
Eupatorium adenophorum	0.3-1.5	0.2-1.6	0.5-1.2
Inula cappa	-	0.5	-
Lantana camara	-	1.0	1.2-1.4
Pennisetum purpureum	-	1.4-2.7	-
Randia dumortorum	-	1.3	-

PHOTO PLATE

Plate I: Chitrepani Community Forest (Sal forest) - Si
Big trees of *Sal* with much regeneration

Plate II: Chitrepani Community Forest(Mixed forest) -
Newly regenerated forest with much inundation by torre

Ranju

PHOTO PLATE

Plate III: Karne Forest - Site III
Natural Forest with mixed vegetation

Plate IV: Chitrepani Leasehold Forest - Site IV
Few trees of *Sal* seen on the almost bare land

Ranju Shrestha, 1997