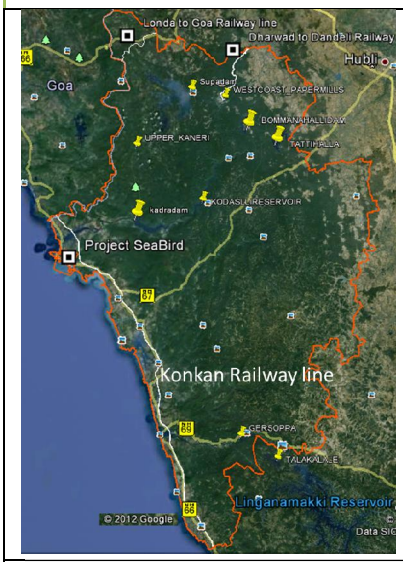
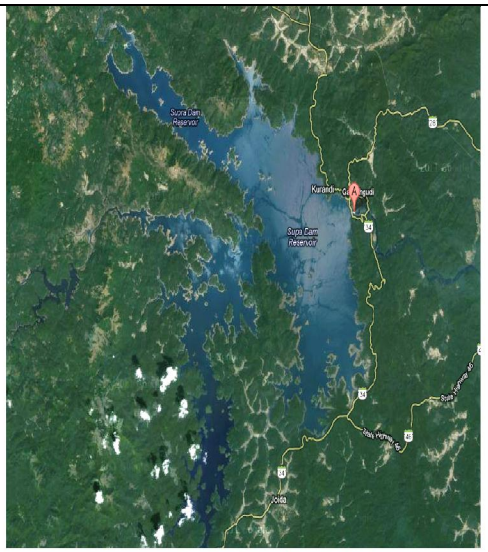
Sahyadri Conservation Series 31

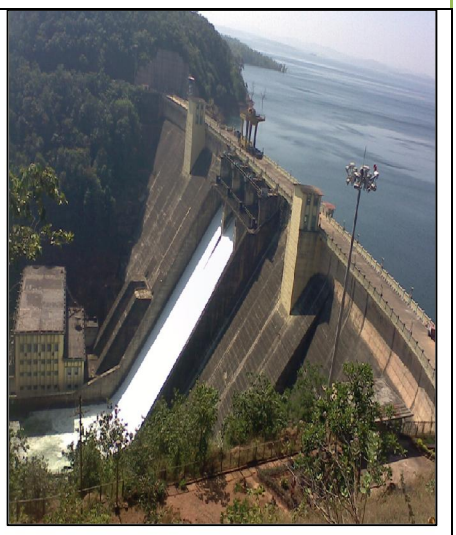
LAND USE CHANGES WITH THE IMPLEMENTATION OF DEVELOPMENTAL PROJECTS IN UTTARA KANNADA DISTRICT

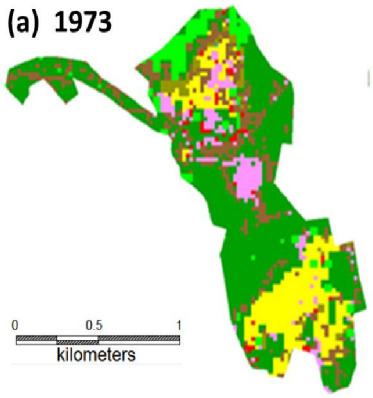
Ramachandra T.V. | Subash Chandran M.D | Joshi N.V.

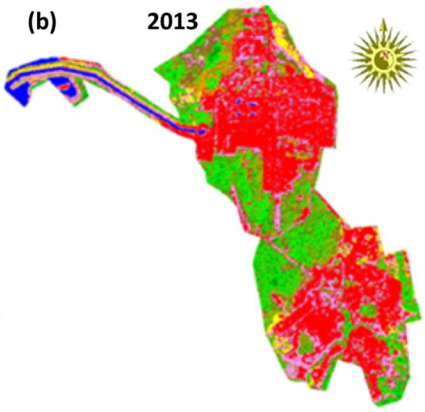
Bharath Setturu











Western Ghats Task Force, Government of Karnataka

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The Ministry of Science and Technology, Government of India

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ENVIS Technical Report: 61

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Environmental Information System [ENVIS]
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LAND USE CHANGES WITH THE IMPLEMENTATION OF DEVELOPMENTAL PROJECTS IN UTTARA KANNADA DISTRICT

Summary:

Forest ecosystems in Uttara Kannada district have witnessed major transformations during the post-independence. Uttara Kannada district has the distinction of having highest forest cover among all districts of Karnataka. Land use analysis using temporal remote sensing data reveal distressing trend of deforestation in the district, evident from the reduction of evergreen - semi evergreen forest cover from 67.73% (1973) to 32.08% (2013). Taluk-wise analyses reveal similar trend for evergreen - semi evergreen forest cover during 1973 to 2013; Ankola (75.66 to 55.33%), Bhatkal (61.37 to 30.38%), Honnavar (70.63 to 35.71%), Karwar (72.26 to 59.70%), Kumta (62.89 to 29.38%), Siddapur (71.42 to 23.68), Sirsi (64.89 to 16.78), Supa (93.56 to 58.55%), Yellapur (75.28 to 18.98%), Haliyal (35.45 to 2.59%), Mundgod (2063 to 1.52). Forest cover has declined from 81.75 (1973) to 60.98% (2013) in the coastal zone, 91.45 (1973) to 59.14% (2013) in the Sahyadrian interior, and 69.26 (1973) to 16.76% (2013) in plains zone. Implementation of developmental activities without taking into account the ecological significance of ecosystems, services provided by them in meeting the livelihood of local population has resulted in the degradation of forests. These changes in the landscape structure (through large scale land use changes) have altered functional abilities of an ecosystem evident from lowered hydrological yield, disappearing perennial streams, higher instances of human –animal conflicts, declined ecosystem goods, etc. This necessitates the restoration of native forests in the region to ensure water and food security apart from livelihood of the local people. About **62814.48 Ha** of forest land is diverted for various non-forestry activities during the post-independence period. About **7071.68 Ha** of forest area has been encroached for agriculture, horticulture activities, etc. Maximum encroachments of forest lands are in Sirsi, Honnavar forest divisions i.e., 3641.66 Ha and 1851.93 Ha respectively. An appropriate policy framework is required to prevent further encroachments of forest land and ensure sustainable management of natural resources.

Keywords: Land use, forest ecosystems, developmental projects,

UTTARA KANNADA DISTRICT: Introduction

Karnataka state comprises of 30 districts, of which Uttara Kannada, Dakshina Kannada and Udupi are in the costal belt. Uttara Kannada (Figure 1) district is bounded between 13.769^{o} to 15.732^{o} north and 74.124^{o} to 75.169^{o} east. It encompasses an area of 10,291 sq km, which is 5.37% of the total area of the State. The district extends to about 328 km north south and 160 km east west. Most of the district is hilly and thickly wooded. The area of the district is 10,222.3 sq km. For administrative purpose, the district has 11 taluks. Supa taluk is the largest with an area of 1890.3 sq km and Bhatkal taluk the smallest in district with 348.9 sq km. The district is surrounded by state of Goa and Belgaum district in the north, Dharward and Haveri in the east; southern neighbours are Udipi and Shimoga districts, the Arabian Sea on the other side. This district takes away maximum portion of the shoreline, i.e., 120 km of 300 km of the total costal belt of Karnataka.

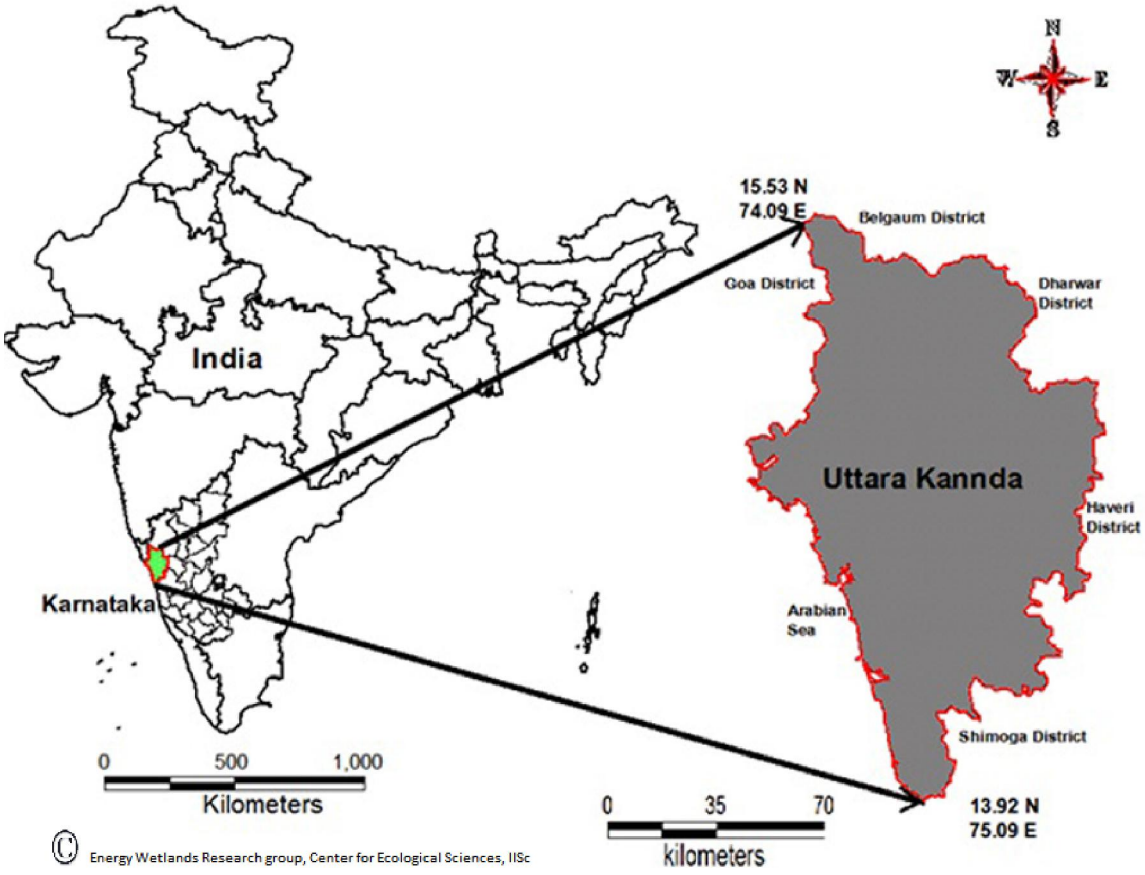


Figure 1: Geographic location of Uttara Kannada district

The west flowing rivers break the shoreline of Uttara Kannada by deep and wide mouthed estuaries. Kalinadi, Bedthi, Aganashini, Sharavathi, Venkatapur, Bhatkal, Belambar, Navgadde halla, Hattikeri halla and Belambar are west flowing rivers (Figure 2). Of these major rivers are Kalinadi, Bedthi, Aganashini, and Sharavathi River. The two east flowing

rivers are Dharma and Varada. The rivers give raise to magnificent waterfalls in the district. The Jog fall in Sharavathi, Lushington falls, where the river Aghanashini drops 116 meters, Magod falls, where the Bedti river plunges 180 meters in two leaps, Shivganga falls, where the river Souda drops 74 meters, and Lalguli and Mailmane falls on the river Kali. The Kali river origins in Joida taluk flows through Karwar taluk, the Gangavali (Bedthi) origins in Dharwad District flows through Yellapur and Ankola taluks. The Aghanashini river origins in Sirsi flows through Siddapur and Kumta taluks. Sharavati origins in Shimoga district, which forms the famous Jog Falls flows through Honnavar. The other rivers of the District are the Venktapur (origins in Bhatkal) and the Varada (origins in Sirsi). All the rivers flow from East to West, whereas Varada river flows eastwards. Uttara Kannada district has five reservoirs such as Supa reservoir, Tattihalla reservoir, Bommanahalli reservoir, Kodsalli reservoir & Kadra reservoir across Kali river and Gersoppa reservoir across Sharavathi river. Also, where these rivers meet the sea, there form some of the finest estuaries of the west coast. The district has varied Geographical features with thick forest, perennial rivers and abundant flora and fauna and a long coastal line of about 140 KM in length.

Brief history: Uttara Kannada was under the rule of Kadambas from the 350 - 525CE, Banavasi was the capital. After the conquest of the Kadambas by the Chalukyas, the district came under successive rule of empires like Chalukyas, Rashtrakutas, Hoysalas and Vijayanagar Empire. Famous Arab traveler Ibn Battuta is said to have stayed for a time in the district under the protection of Nawayath Sultan Jamal al-Din at Hunnur. This place is presently known as Hosapattana and is located in the Honnavar taluk. The district came under the rule of Maratha Empire from around 1700 CE to 1800 CE. It was ceded to the British at the conclusion of the Third Anglo-Maratha War in 1818. The British established North Kanara district as a part of the Bombay Presidency. After India's independence in 1947, Bombay Presidency was reconstituted as Bombay state. In 1956 the southern portion of Bombay state was added to Mysore state, which was renamed as Karnataka in 1972.

The Uttara Kannada has rich diversity in the culture and languages. Languages of the district are Kannada, Konkani, Marathi, Tulu and Urdu. The population is predominantly Hindu comprising of many communities called as Bhandaris, Gramavokkaliga, Havyaka, Konkan Maratha, Goud Saraswat Brahmins, Daivajna Brahmins, Chitrapur Saraswat Brahmins, Vokkaligas, Sherugars, Namadhari naik, Nadavara and Vaishya (Vanis). Muslims in the district are mainly of Nawayath descent. They live mostly in taluks of Bhatkal and Honnavar and speak Nawayathi. The Konkani speaking people include Christians also. 90% of the population of this area speaks Kannada, Konkani and Marathi languages. The cultural pattern of people has thus been influenced both by Maharashtra and Karnataka.

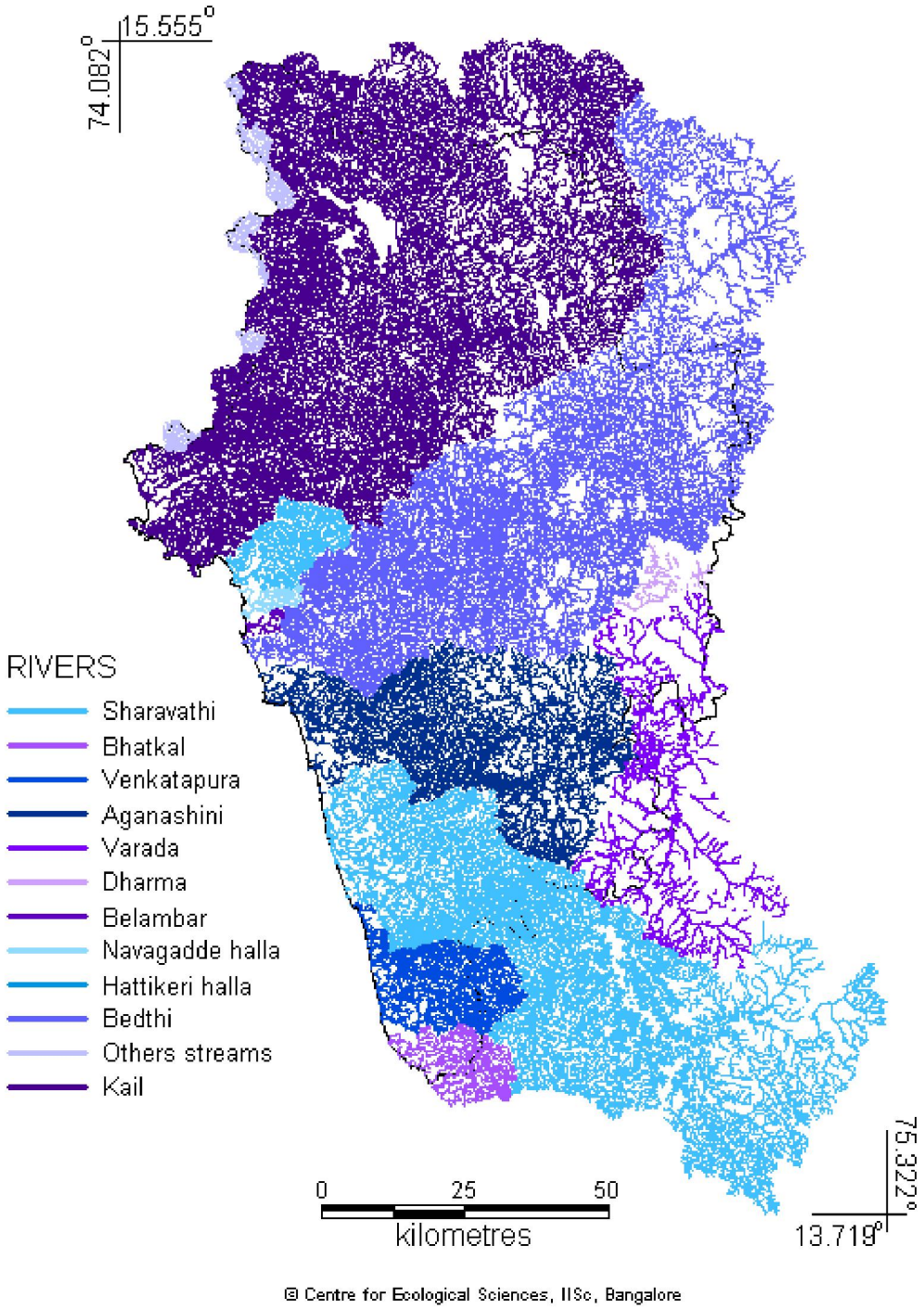


Figure 2: Drainage network in Uttara Kannada

1.1 Administrative Profile:

The district is divided into 11 taluks (Figure 3). The district capital is at Karwar, the northernmost coastal taluk. The Deputy Commissioner is the administrative head of the district. The Chief Executive Officer of the Zilla Panchayat has also his office at Karwar. The Zilla Panchayat consists of the elected representatives of the people. The district has four Assistant Commissioners- at Karwar, Kumta, Bhatkal and Sirsi. The Tahasildar is the administrative head of the taluk. The villages are grouped under Village Panchayats, run by elected representatives. These 11 taluks have been divided into 1336 villages of which 1263 are inhabited and rest of the villages (73) is uninhabited.

The district, being the most forested one in the peninsular India, has a well-organised unit of the Forest Department. Named 'Kanara Circle' its administrative head is the Conservator of Forests. The Circle comprises of five territorial forest Divisions with the headquarters at Haliyal, Yellapur, Karwar, Honavar and Sirsi. Each Division is headed by a Deputy Conservator of Forests / Division Forest Officer (DFO). The entire forest area of the district is divided into 34 forest Ranges, each under a Range Forest Officer, and 131 forest Sections each under a Forester, and 425 Beats each under a Guard.

The Fisheries Department is under the Deputy Director of Fisheries. The department, with headquarters at Karwar, administers matters pertaining to marine, estuarine and inland fish resources. In addition Karwar also has the branch office of Central Marine Fisheries Research Institute (CMFRI), Cochin. Scientists here gather regular data on marine fisheries.

The Agriculture Department is headed by the Joint Director, whose office is at Karwar. The district is well known for horticultural biodiversity. Horticulture is under the jurisdiction of the District Horticultural Officer whose office is at Sirsi.

Senior Geologist heads Mines and Geology department which undertakes mineral investigation in the district. The district officers of the Groundwater Wing are under the administrative control of Zilla Panchayaths and technical guidance is provided by the Directorate.

The district groundwater officers are also carrying out micro watershed studies, studies of any specific groundwater problems identified in the district and also carry out construction of artificial recharge structures in their jurisdiction. They render technical advises for sinking of wells/bore wells and also for taking up rain water harvesting structures.

Karwar even has a Natural Resources Data Management System (NRDMS), launched by the Department of Science and Technology. This is National initiative aimed at developing and inducting such data based approach to planning.

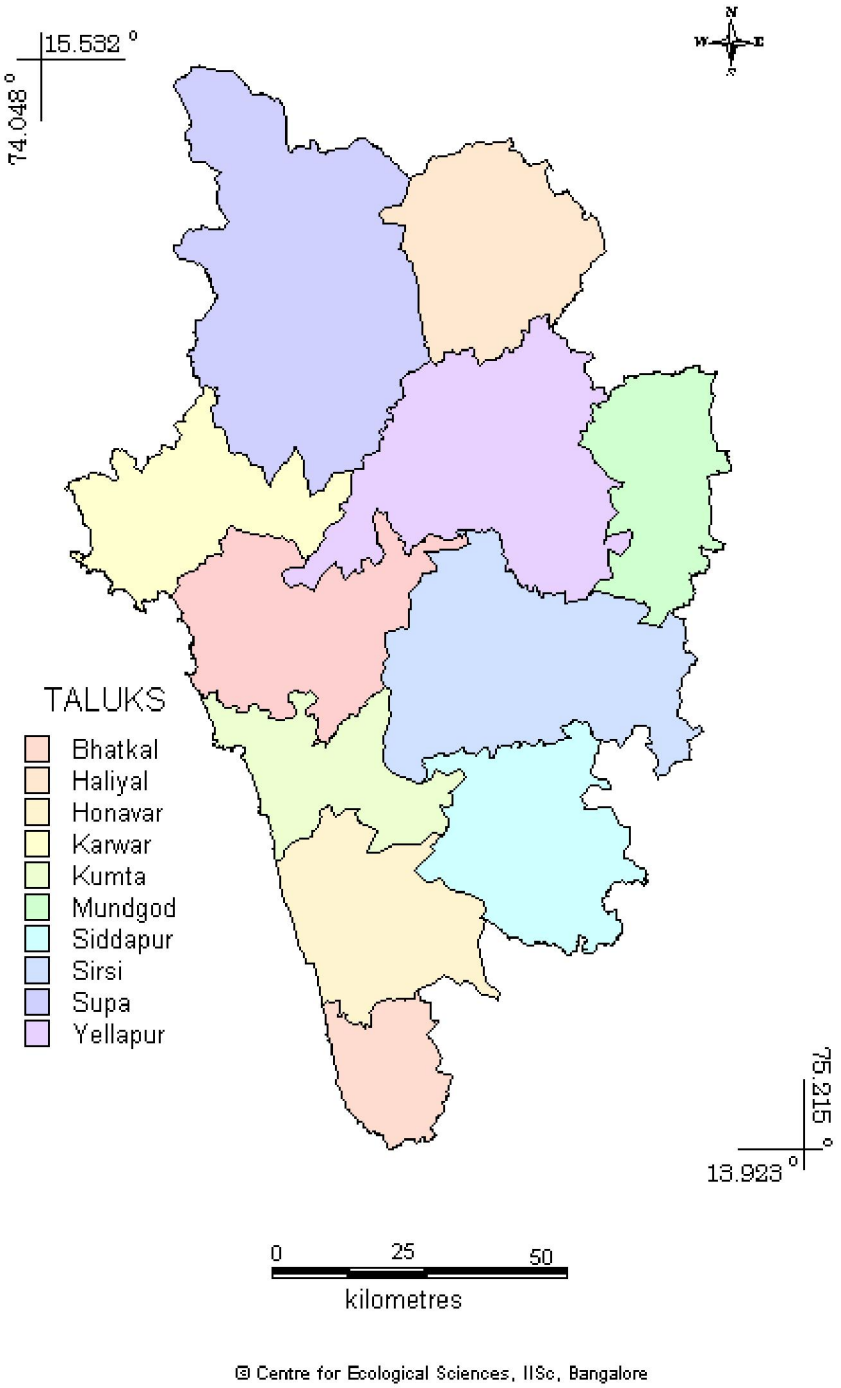


Figure 3: Taluks of Uttara Kannada district

1.2 Population

The population according to 2001 census data was 1,353,644 which amount to a population density of 132.42 per sq km implying a growth of 10.9 % in population data of 1991. The Bhatkal with the maximum and Supa minimum population density as can be seen in table 1 (Figure 4).

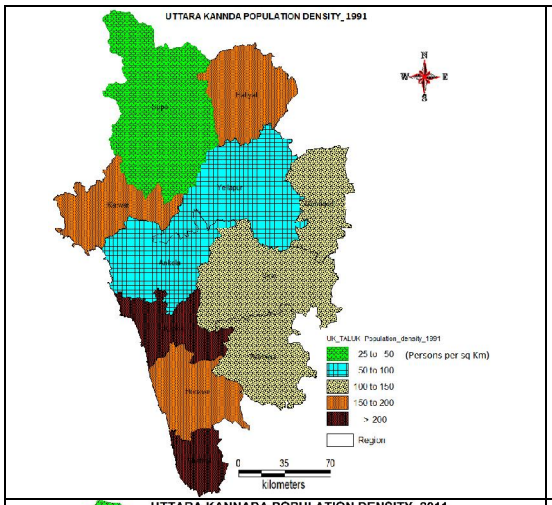
Nearly 75 % of the population of UK district lives in villages and remaining 25 % in small towns. It is estimated that about a fourth of the population lives below poverty line. In terms of gender related health indicators the situation in UK district is significantly better. The life expectancy at birth of females in UK district is 70.Thousands of people in the district have been displaced in the past due to hydel projects, Seabird Naval Base, Kaiga Atomic plant, Konkan Railway etc. (There are of 73 uninhabited villages 26 of the villages are evacuated during these construction activities). The displaced people were mostly resettled in forest lands. A total of at least 5508 ha of forests have been used since 1956 for resettlement of displaced people, which include even Tibetan refugees Forest encroachment is viewed as a serious problem. To regularise encroachments which have taken place before 27.04.1978, a total of 2824.8 ha have been released (Forest Department, 2000-01). Presently there are about 10,000 families of encroachers who are facing eviction. This is a haunting socio-economic and ecological problem.

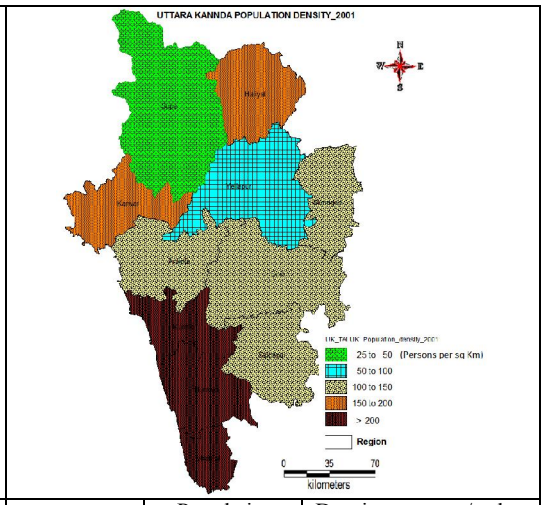
Table 1: **Taluk wise statistics of population, population density (persons/sq.km), number of villages and uninhabited villages.**

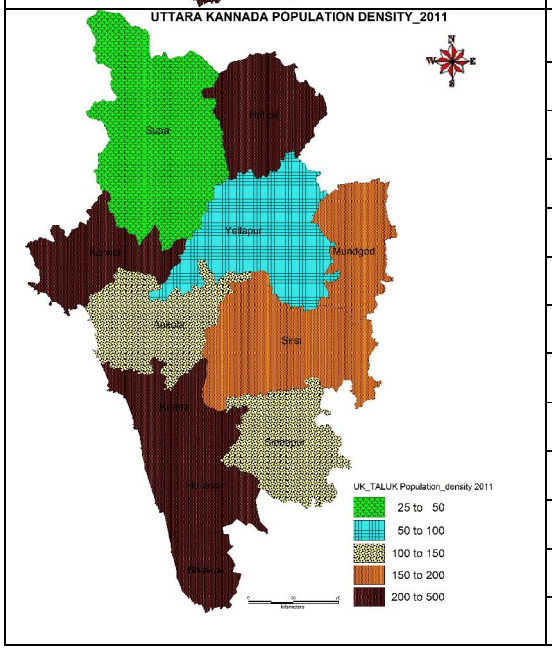
Taluk	Population 1991	Population 2001	Population _density_ 1991	Population _density_ 2001	Number of villages	Uninhabited villages (as per census 2001)
Ankola	91310	101549	97.87	108.84	86	1
Bhatkal	129017	149338	367.57	425.46	61	0
Haliyal	147064	159141	171.80	185.91	133	22
Honnavar	145842	160331	193.17	212.36	94	2
Karwar	140282	147890	188.05	198.24	58	6
Kumta	134144	145826	226.98	246.74	119	8
Mundgod	75046	90738	110.85	134.03	94	6
Siddapur	91646	100870	105.46	116.08	196	0
Sirsi	152935	175550	115.51	132.59	227	4
Supa	46818	48914	24.77	25.88	141	24
Yellapur	66156	73497	50.85	56.49	127	0
Total	**1220260**	**1353644**	**118.55**	**131.51**	**1336**	**73**

+ Without considering the population of taluk headquarters.

The population density of the villages and taluk headquarters has been represented thematically for each taluk in Figure 5. The Bhatkal followed by Kumta are showing the higher density from 1991 to 2001 and Supa has the least population density in the district.

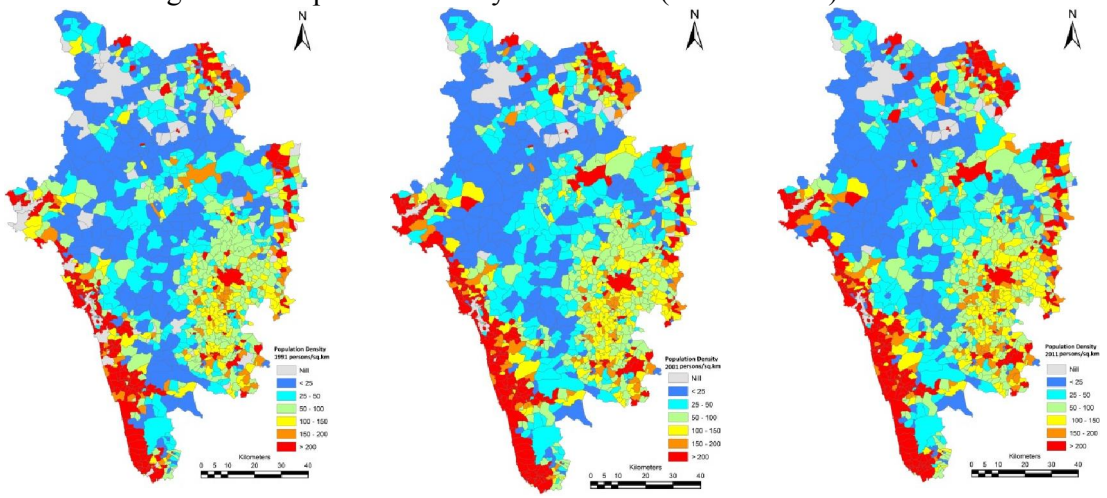






Taluk	Population - 2011	Density persons/sq.km
Ankola	111449	119.954
Bhatkal	170417	487.455
Haliyal	172631	202.406
Honavar	172051	228.587
Karwar	153165	205.998
Kumta	159552	270.770
Mundgod	106952	158.670
Siddapur	111284	128.559
Sirsi	206225	156.470
Supa	54798	29.123
Yellapur	83930	64.005
Total	***1502454***	***146.329***

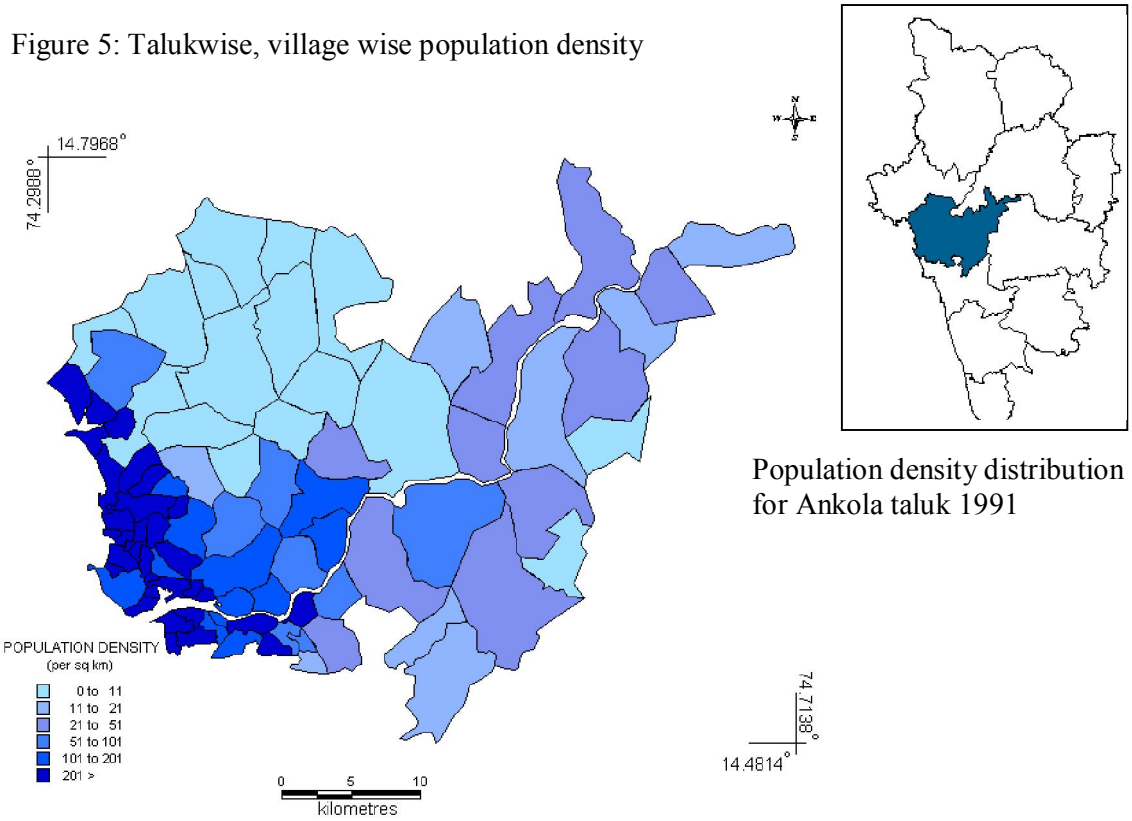
Figure 4.1: Population density distribution (1991 & 2001) across taluks



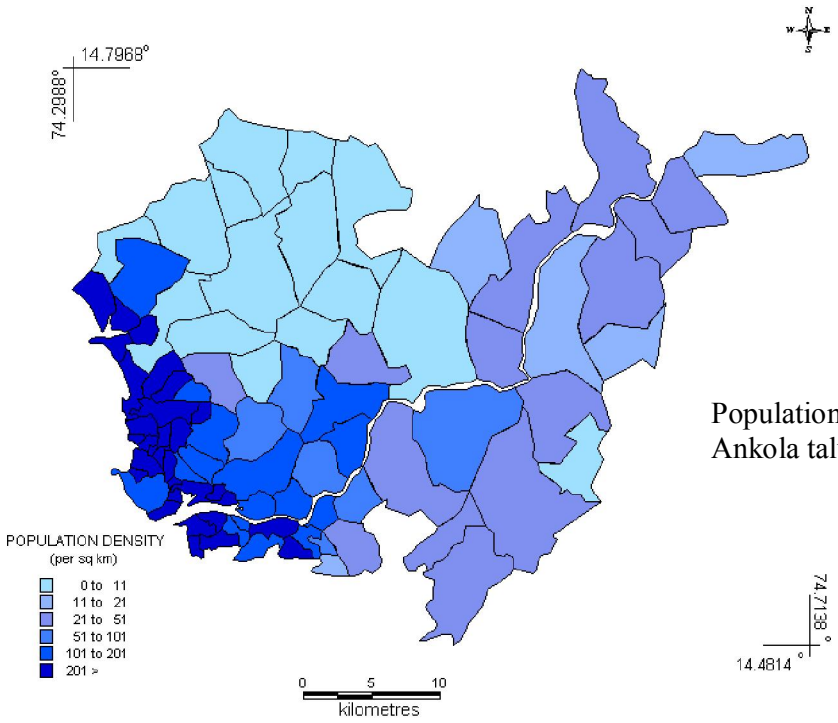
Population Density 1991 Population Density 2001 Population Density 2011

Figure 4.3: Villagewise population density 1991, 2001 and 2011

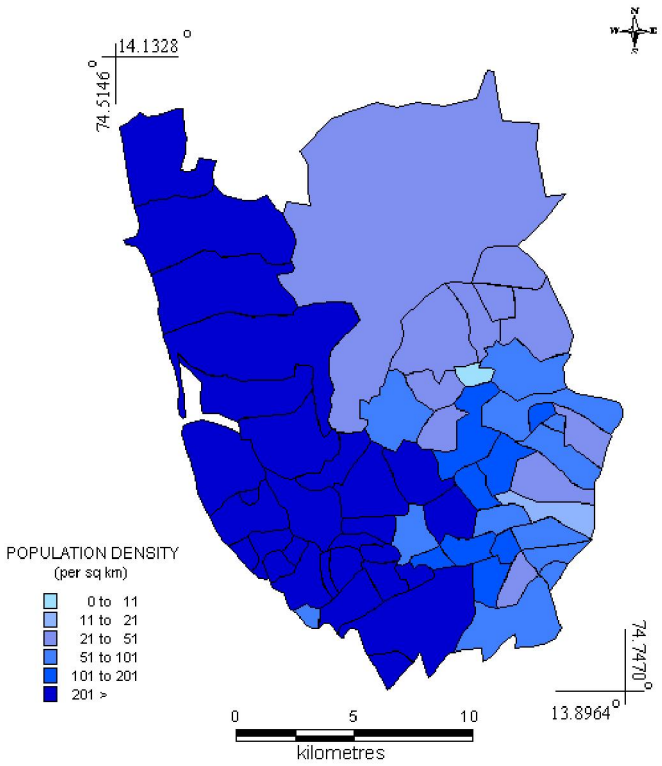
Figure 5: Talukwise, village wise population density

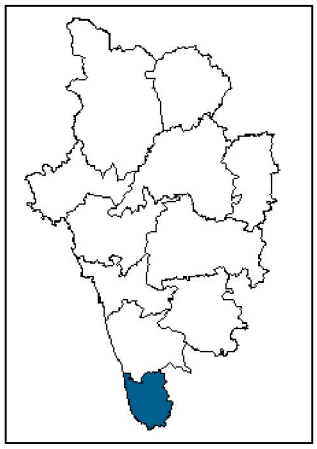


Population density distribution for Ankola taluk 1991

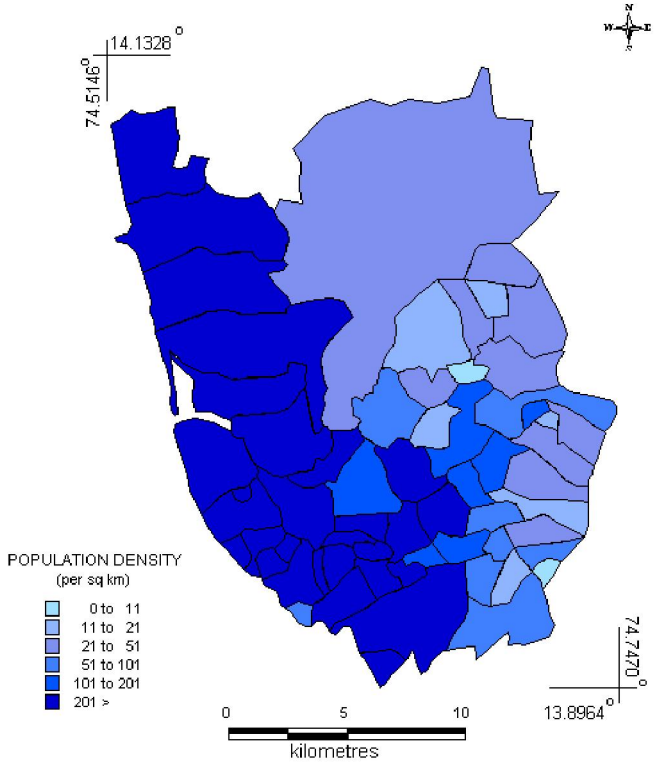


Population density distribution for Ankola taluk 2001

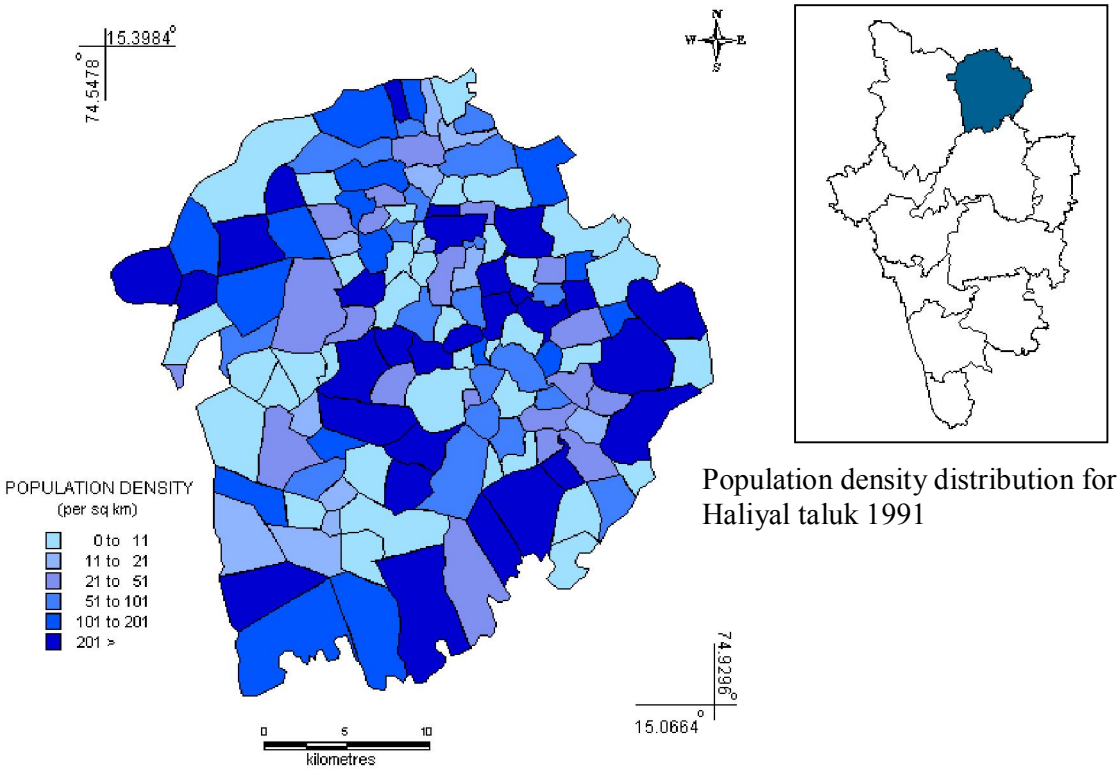




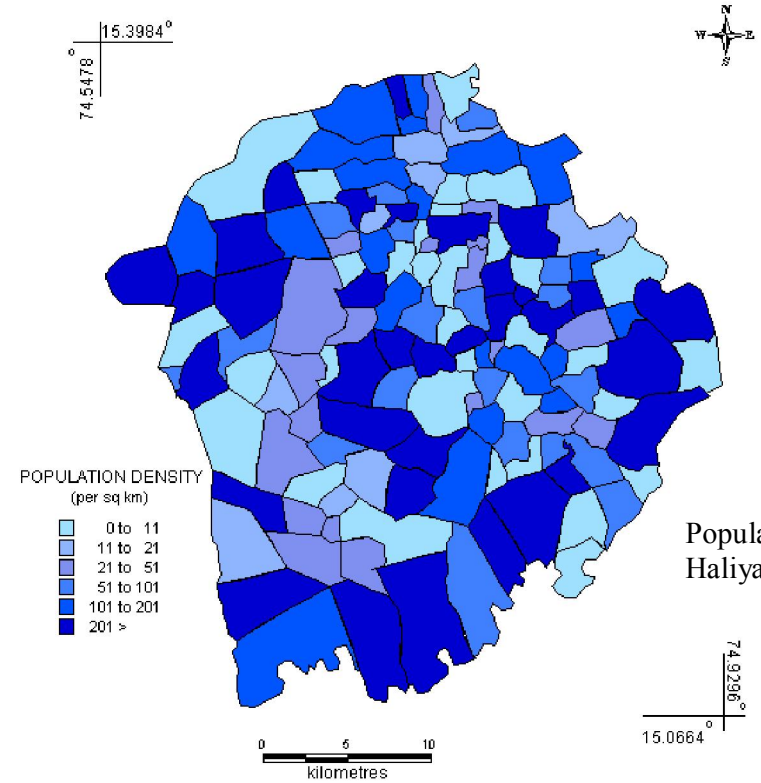
Population density distribution for Batkal taluk 1991



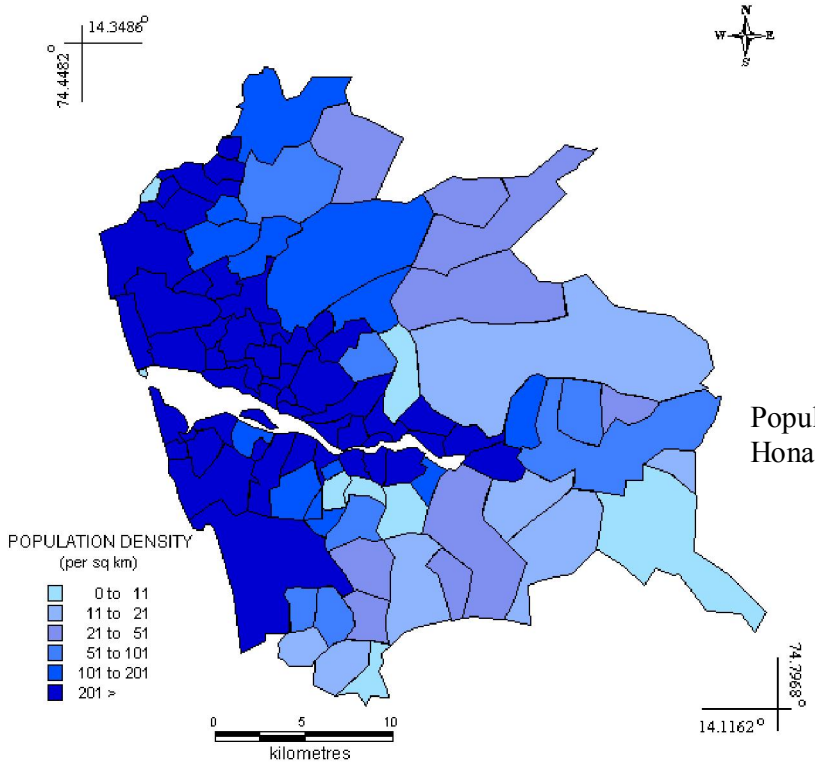
Population density distribution for Bhatkal taluk 2001



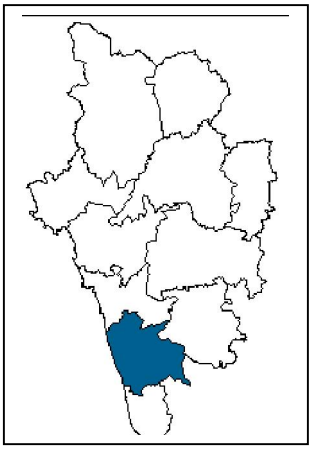
Population density distribution for Haliyal taluk 1991

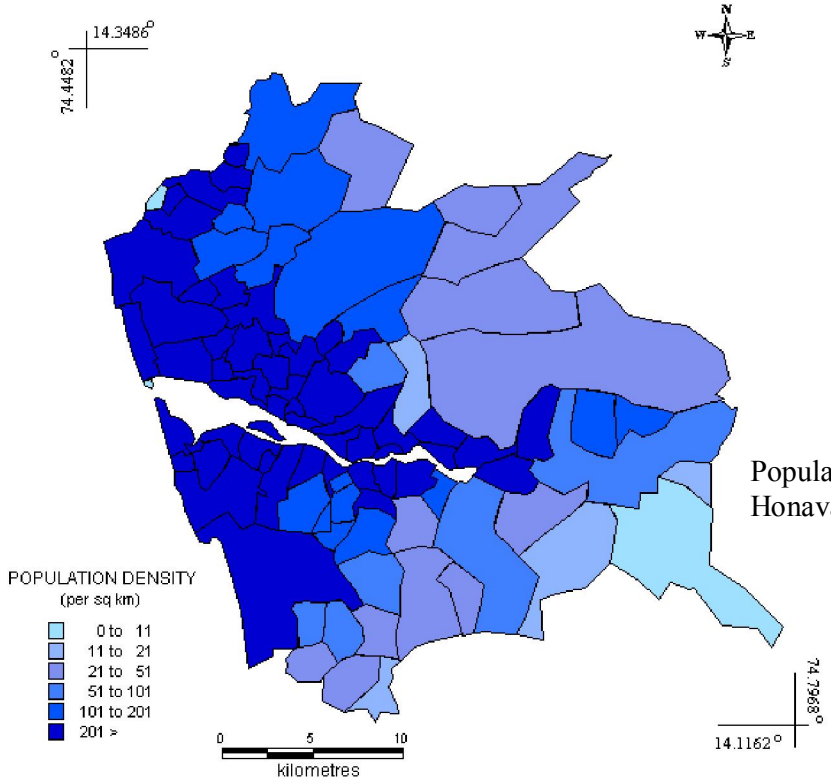


Population density distribution for Haliyal taluk 2001

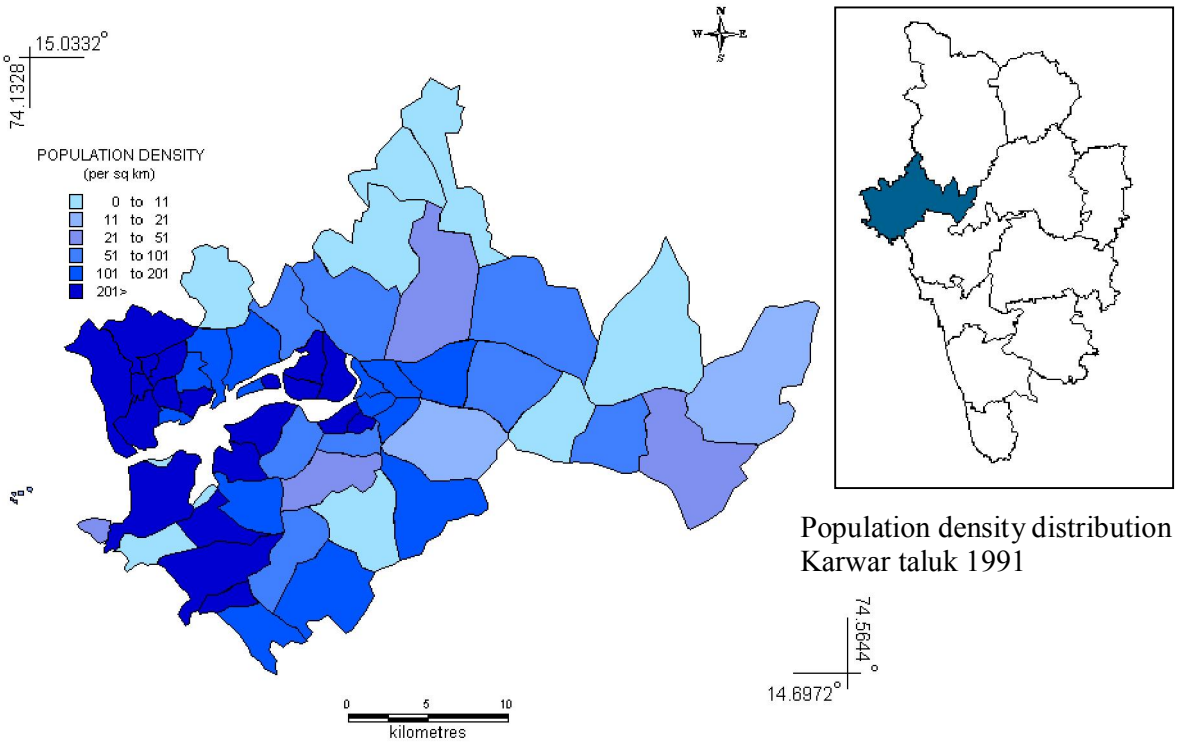


Population density distribution for Honavar taluk 1991

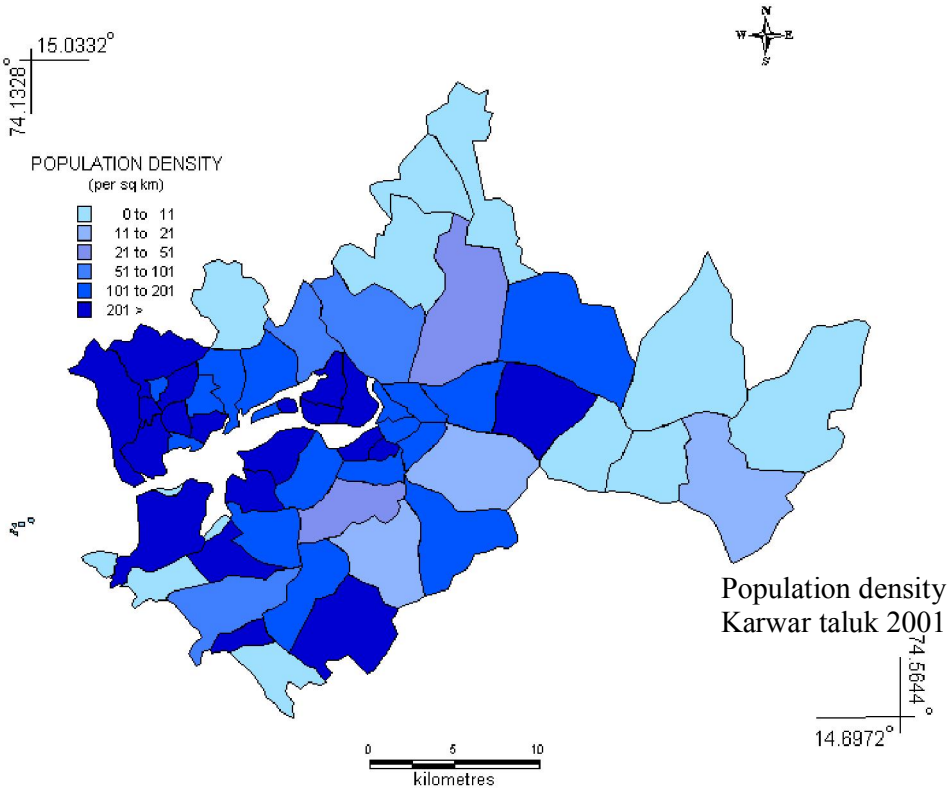




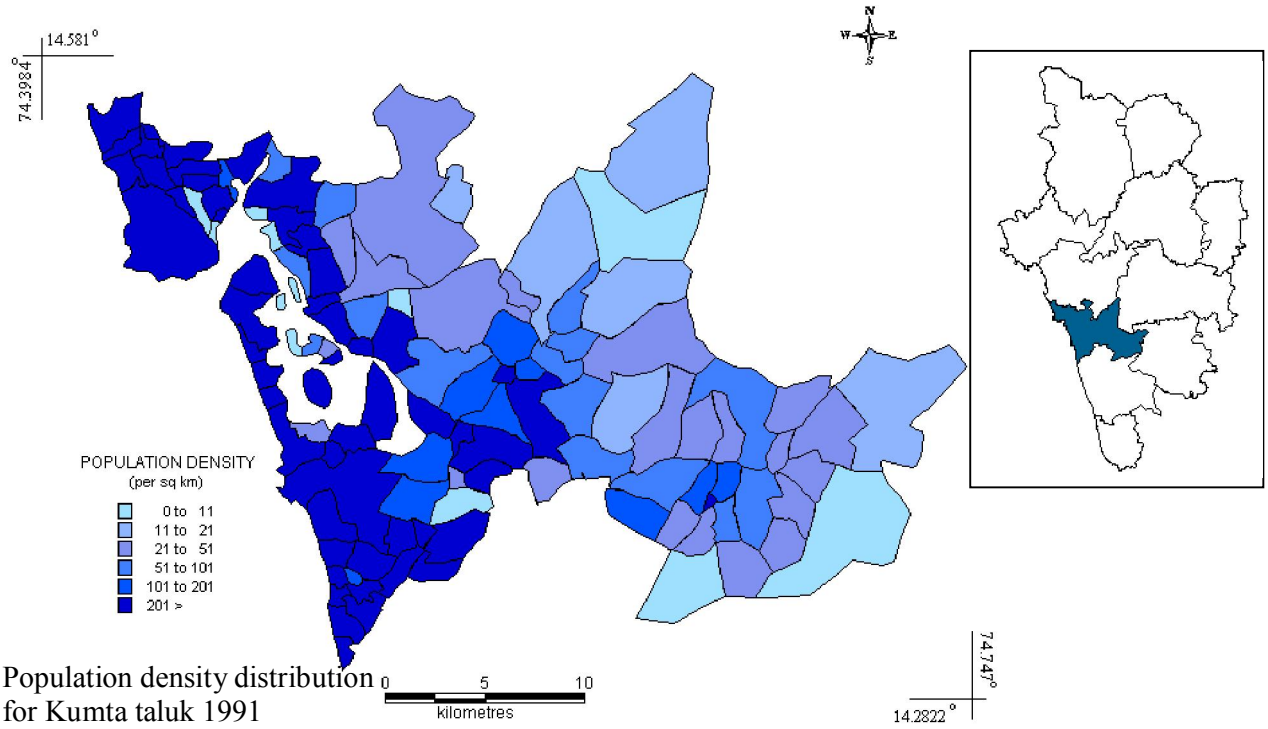
Population density distribution for Honavar taluk 2001



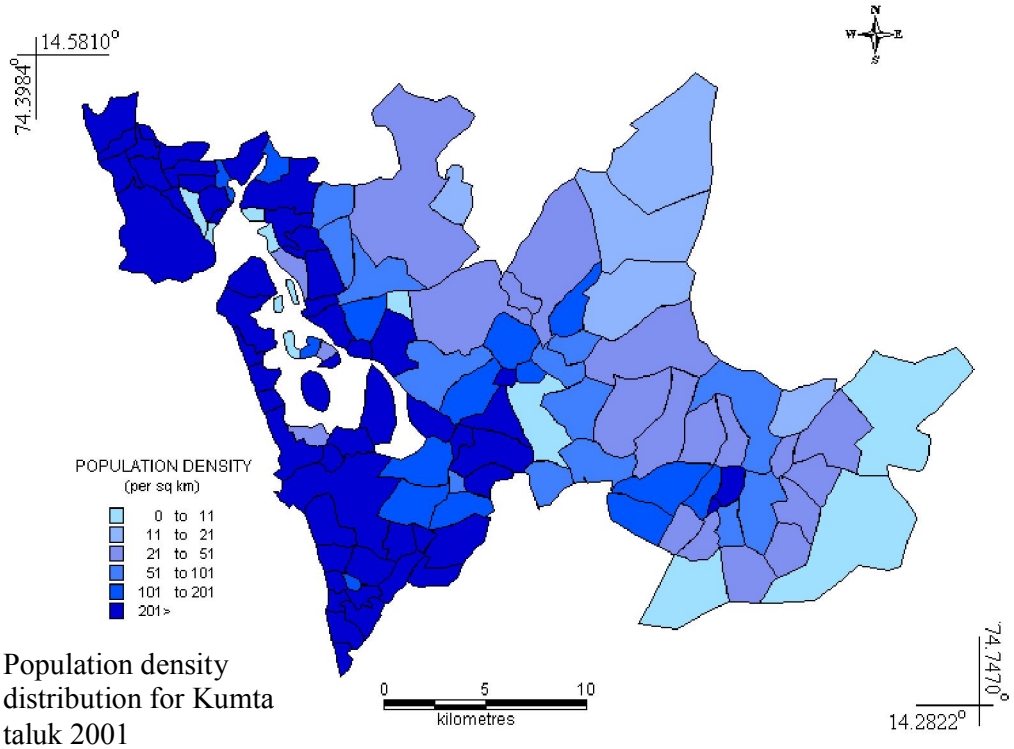
Population density distribution for Karwar taluk 1991



Population density distribution for Karwar taluk 2001



Population density distribution for Kumta taluk 1991



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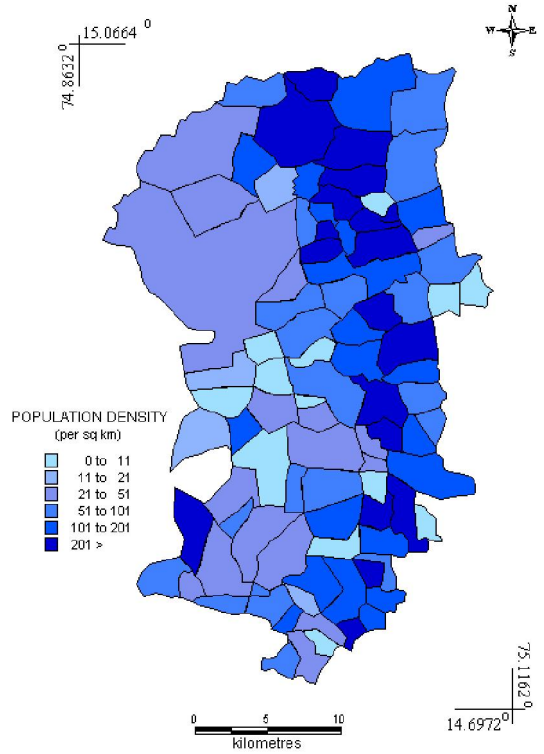
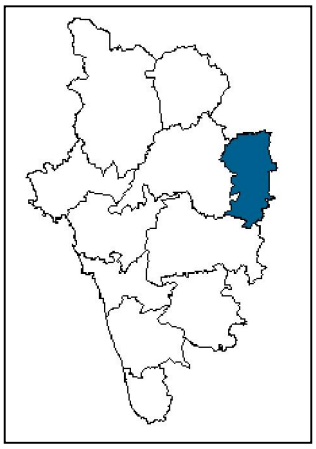
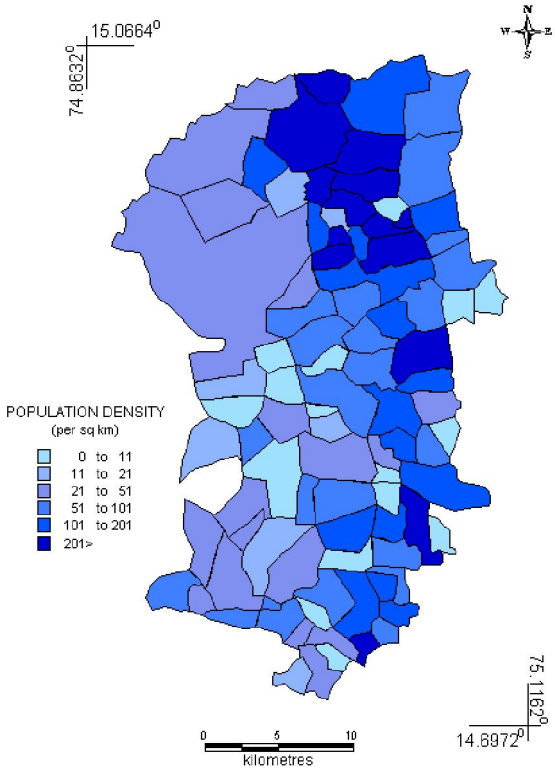
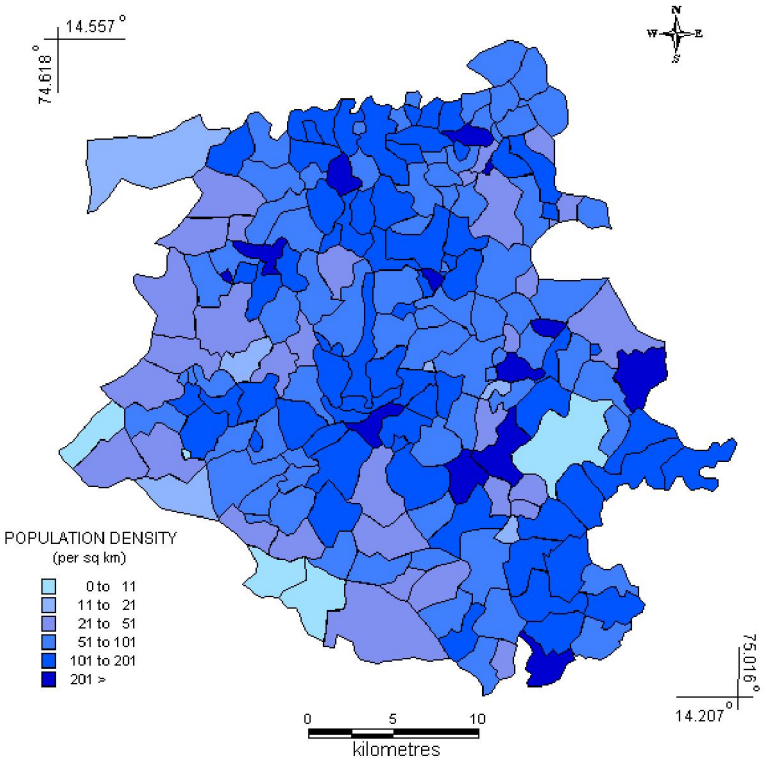


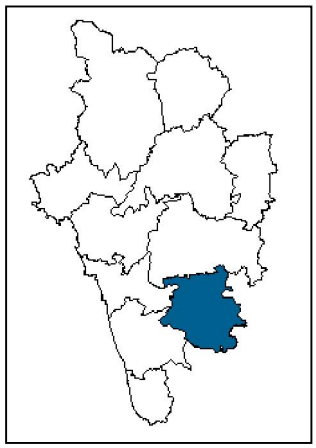


Population density distribution for Mundgod taluk 1991

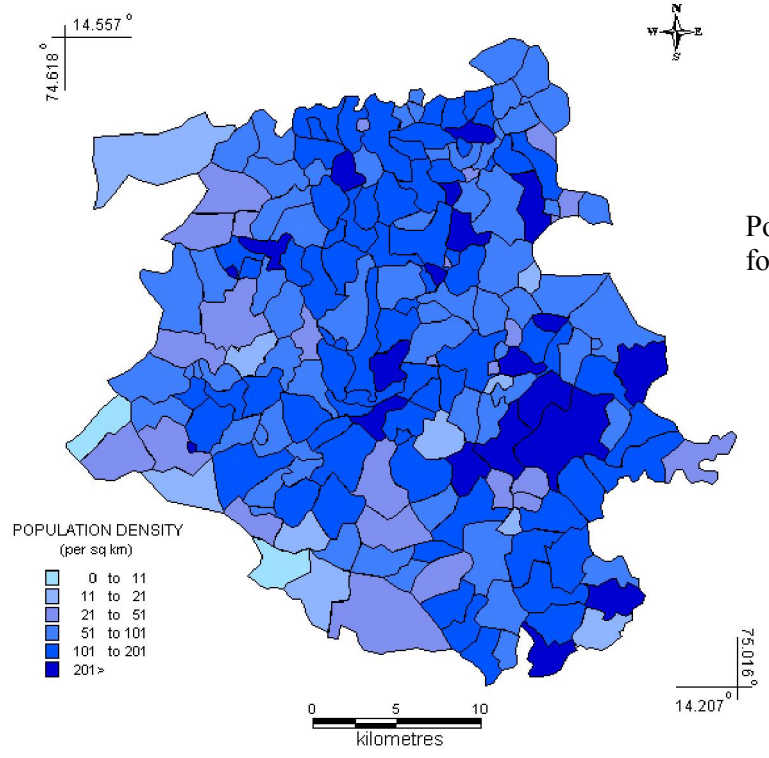


Population density distribution for Mundgod taluk 2001

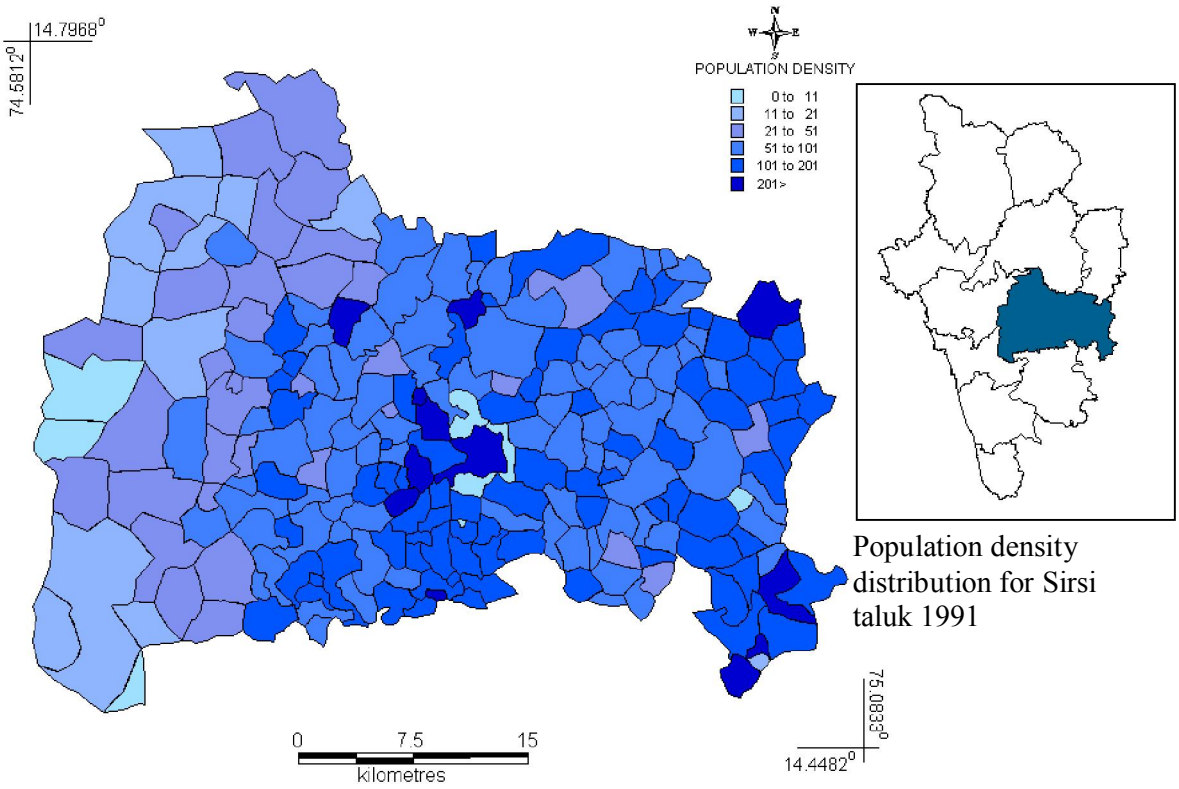




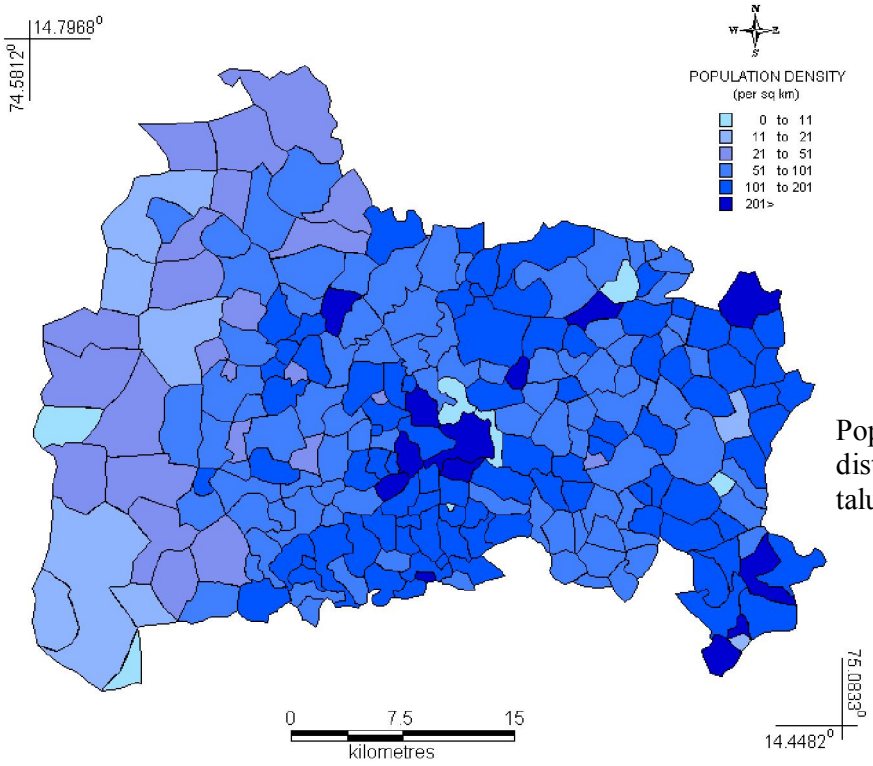
Population density distribution for Siddapur taluk 1991



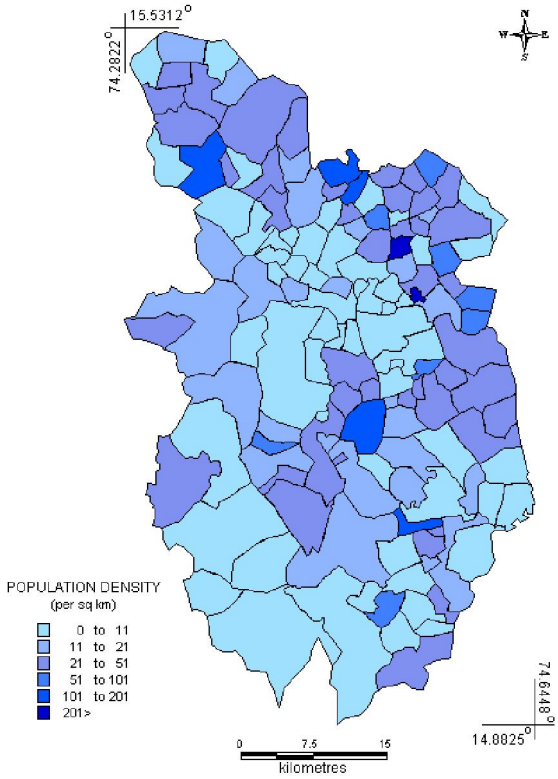
Population density distribution for Siddapur taluk 2001

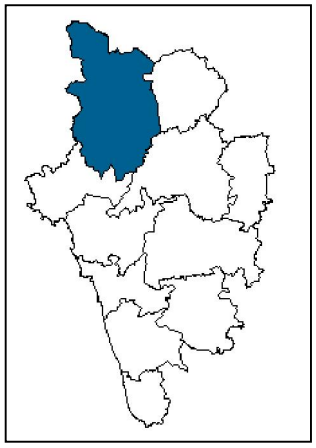


Population density distribution for Sirsi taluk 1991

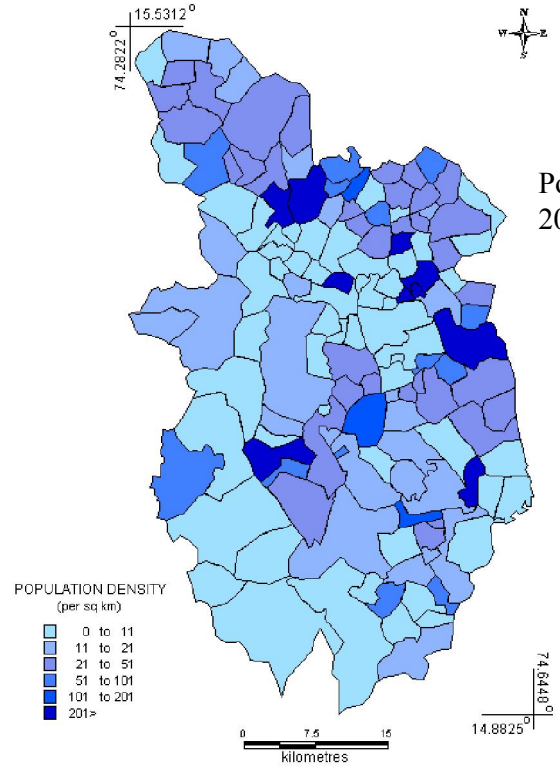


Population density distribution for Sirsi taluk 2001

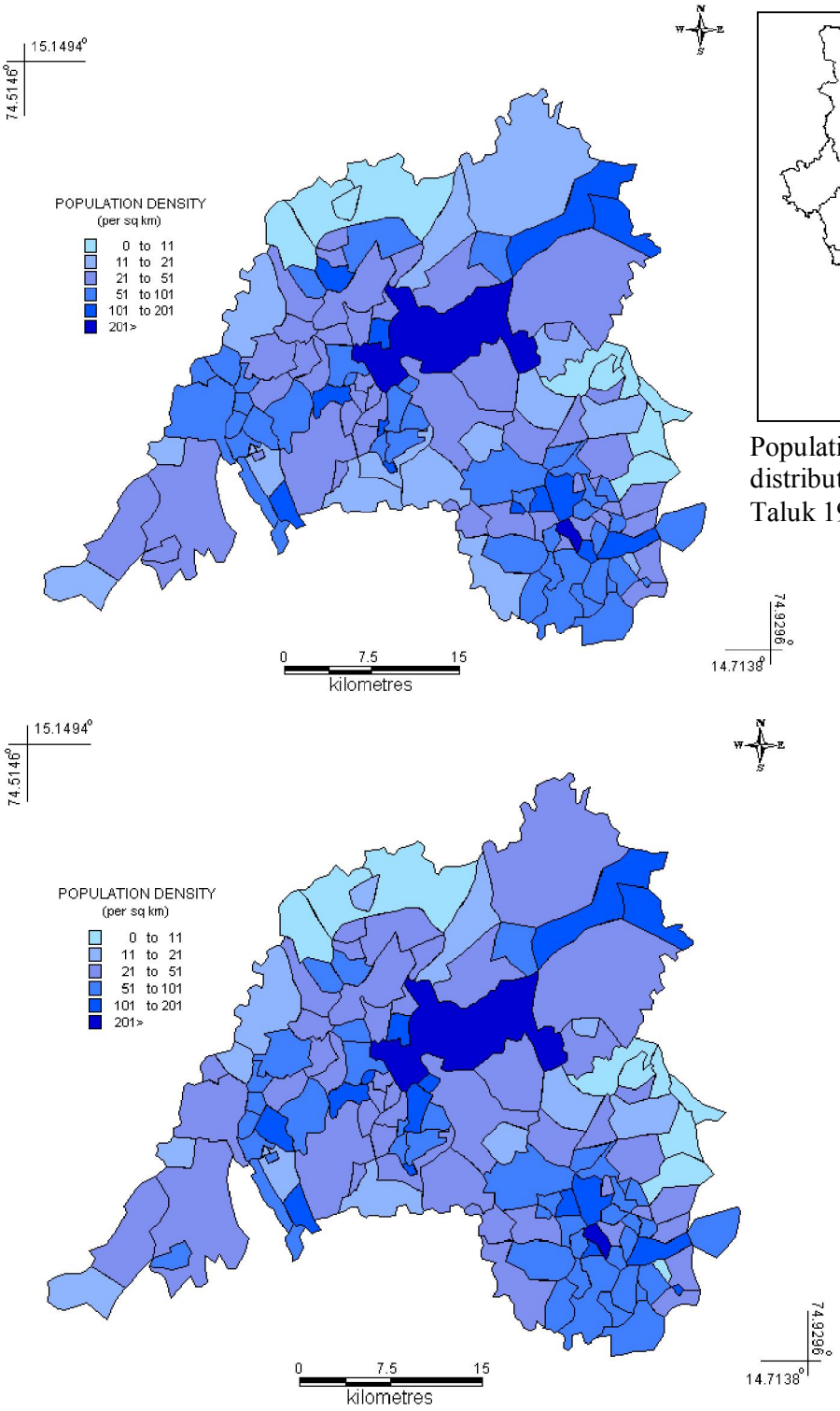


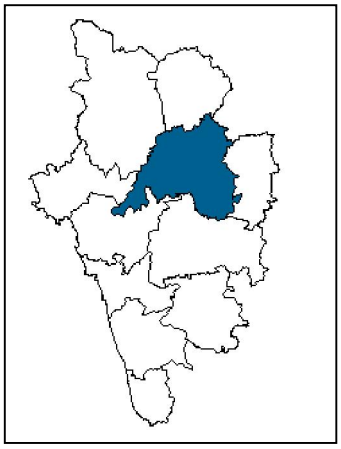


Population density distribution for Supa taluk 1991



Population density distribution for Supa taluk 2001





Population density distribution for Yellapur Taluk 1991

Figure 5: Population density distribution (1991 & 2001) across each taluk of Uttara Kannada district

1.3 Climate

Uttara Kannada has a tropical climate. It has a well-defined rainy season of about five months between June and November when the south west monsoon brings most of the rainfall and the climate remains hot and humid. The winds are predominantly south westerly during the summer monsoon and north easterly during the winter monsoon. The year may broadly be classified into four seasons. The dry season is from January to February with clear and bright weather. It is followed by hot weather from March to May. During this season thunderstorms are common in the month of May. The monsoon season is from June to September. The presence of Western Ghats in Uttara Kannada causes orographic precipitation (Mechanical lifting of moist air masses over natural barriers such as mountains causes orographic precipitation). The district falls under the Hilly agro climatic zone except for western parts of Karwar, Ankola, Kumta, Honnavar and Bhatkal taluks which fall under coastal agro climatic zone. The maximum rainfall is recorded in the coastal region and average rainfall toward the center of the basin and least rainfall toward the plains i.e., west to east. Bhatkal, which is a coastal region, receives high rainfall compared to other stations as can be seen in figure 6. The mean annual rainfall is 4237 mm. Areal rainfall estimation and the analysis show that the land use dynamics has affected rainfall, mean annual rainfall was higher before the construction of reservoir. Average rainfall of 2108 mm was found in Kali river basin before the construction of Supa reservoir. After the construction the average rainfall reduced to 2019 mm. Daily rainfall data of 18 rain gauge stations since 1901 for 112 years (1901-2011) was collected from the Bureau of Economics and Statistics, Govt. of Karnataka. Table 2 lists the rain gauge stations and its location. Mean annual rainfall and the standard deviation were calculated for all the rain gauge stations to know annual variability and areal rainfall for the same was estimated using the kriging technique.

Table 2: Rain gauge stations and its location

RGS	District	Lat	Long	RGS	District	Lat	Long
Ankola	UK	14.69	74.30	Siddapura#	UK	14.30	74.89
Bhatkal#	UK	13.99	74.59	Sirsi	UK	14.60	74.79
Haliya*	UK	15.33	74.77	Hosanagara#	Shimoga	75.10	13.90
Honnavar#	UK	14.30	74.49	Sagara#	Shimoga	75.00	14.20
Joida*	UK	15.26	74.50	Shikaripura	Shimoga	75.40	14.30
Karwar*	UK	14.79	74.11	Soraba	Shimoga	75.00	14.40
Kumta#	UK	14.39	74.40	Dharwad*	Dharwad	75.00	15.50
Mundgod	UK	15.00	75.00	Kalghatgi	Dharwad	75.10	15.20
Yellapura*	UK	15.00	74.70	Kundgol	Dharwad	75.30	15.30

RGS: Rain gauge Stations, UK: Uttara Kannada, * (rain gauges in Kali river basin), # (rain gauges in Sharavathi river basin) - Stations chosen to analyse variations in rainfall with land-use dynamics with a well-defined rainy season between June and October, when the South-west Monsoon winds bring down on an average 2500 mm rainfall annually. The remaining part of the year has hardly any rains. Whereas the coastal and crest line taluks receive high rainfall, the north-eastern taluks, Haliyal and Mundgod have very low rainfall.

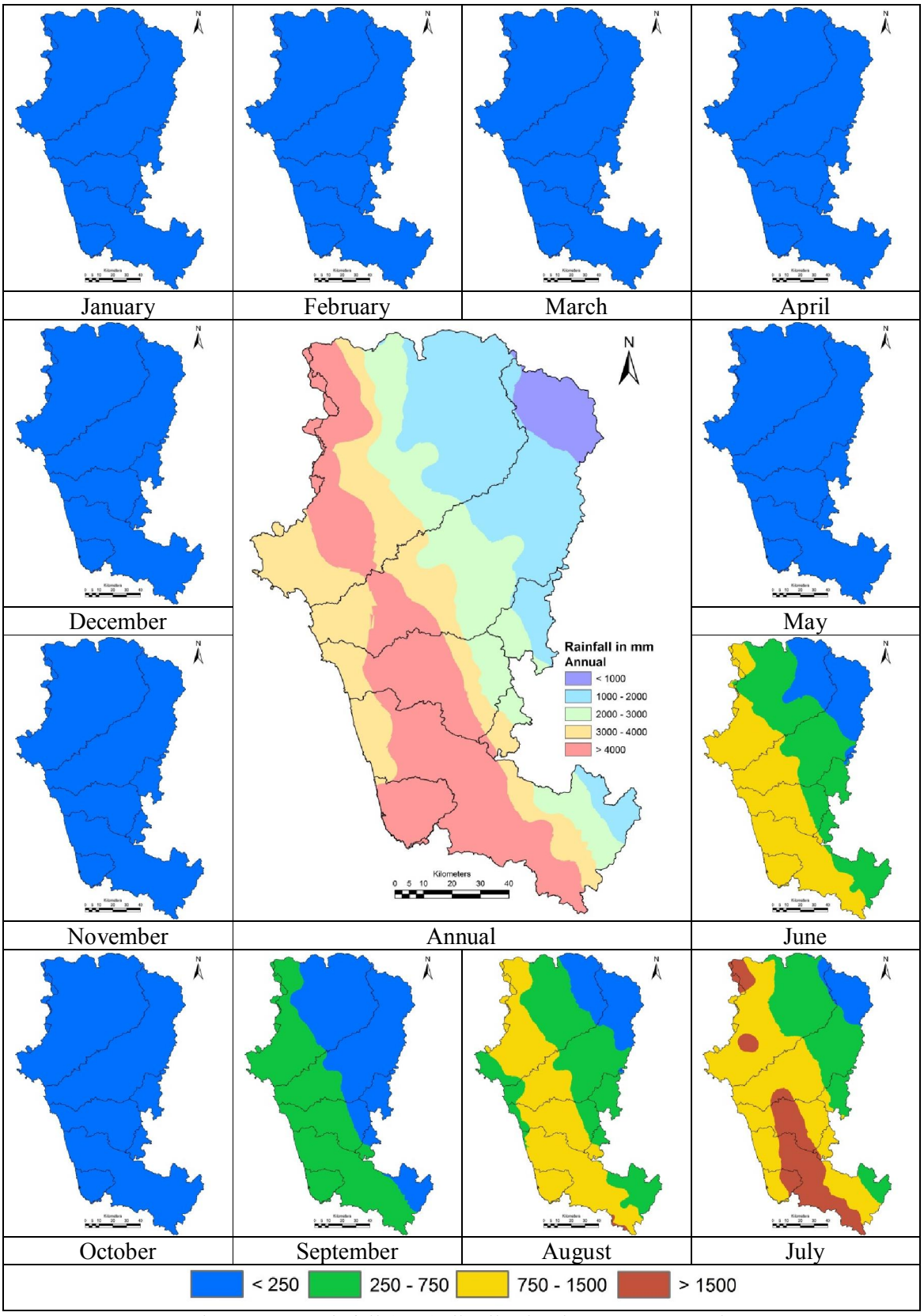


Figure 6.1: Rainfall (mm) distribution in Uttara Kannada

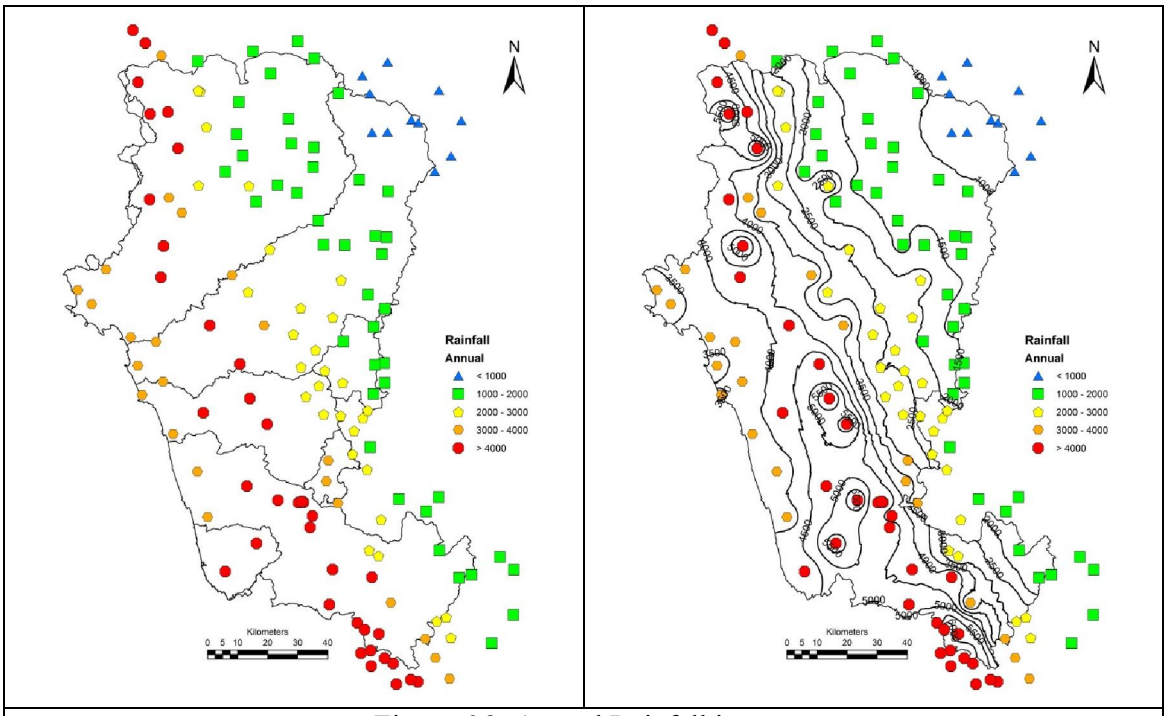


Figure 6.2: Annual Rainfall in mm

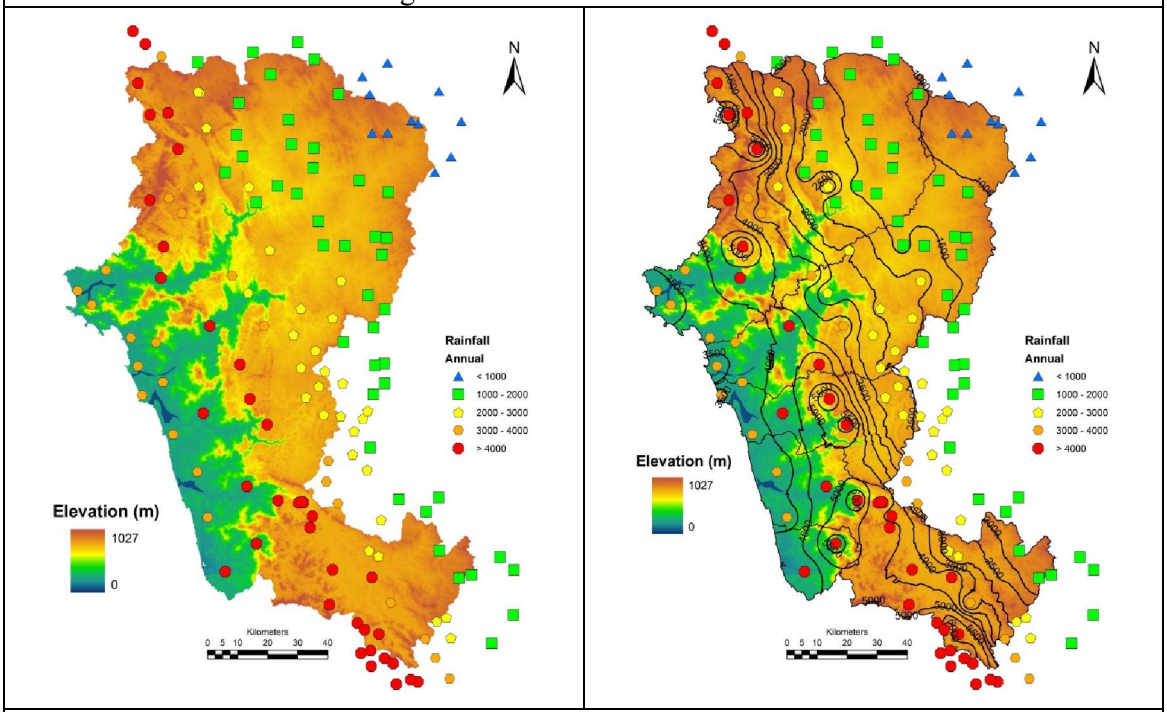


Figure 6.3: Annual Rainfall in mm overlaid on DEM

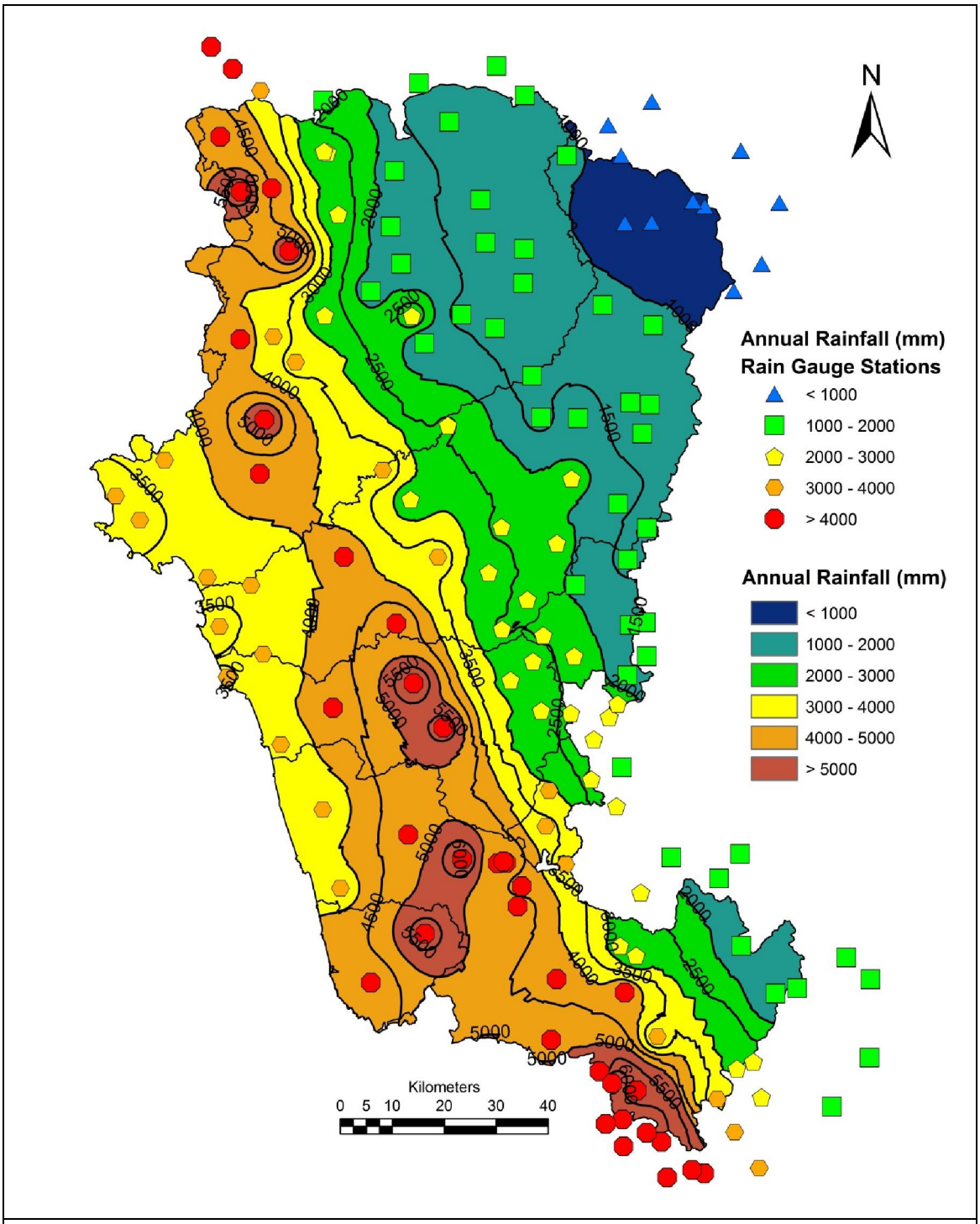


Figure 6.4: Annual Rainfall in mm Interpolated

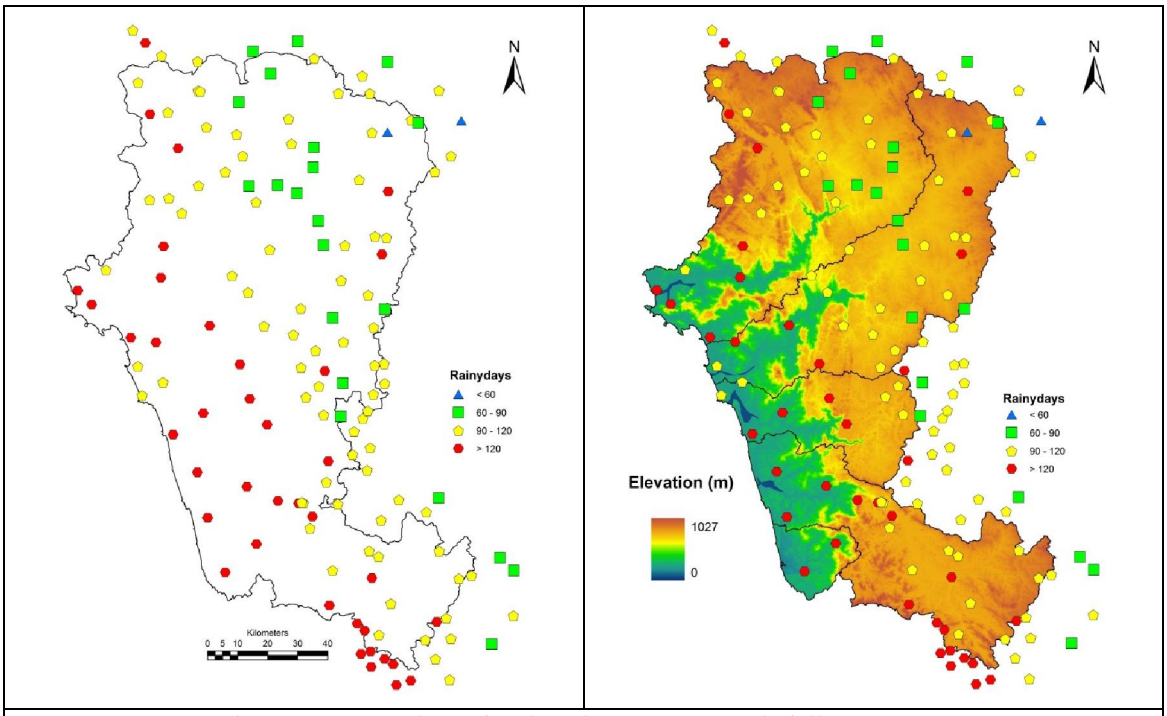


Figure 6.5: Number of Rainy day [Case I: Rainfall > 50 mm]

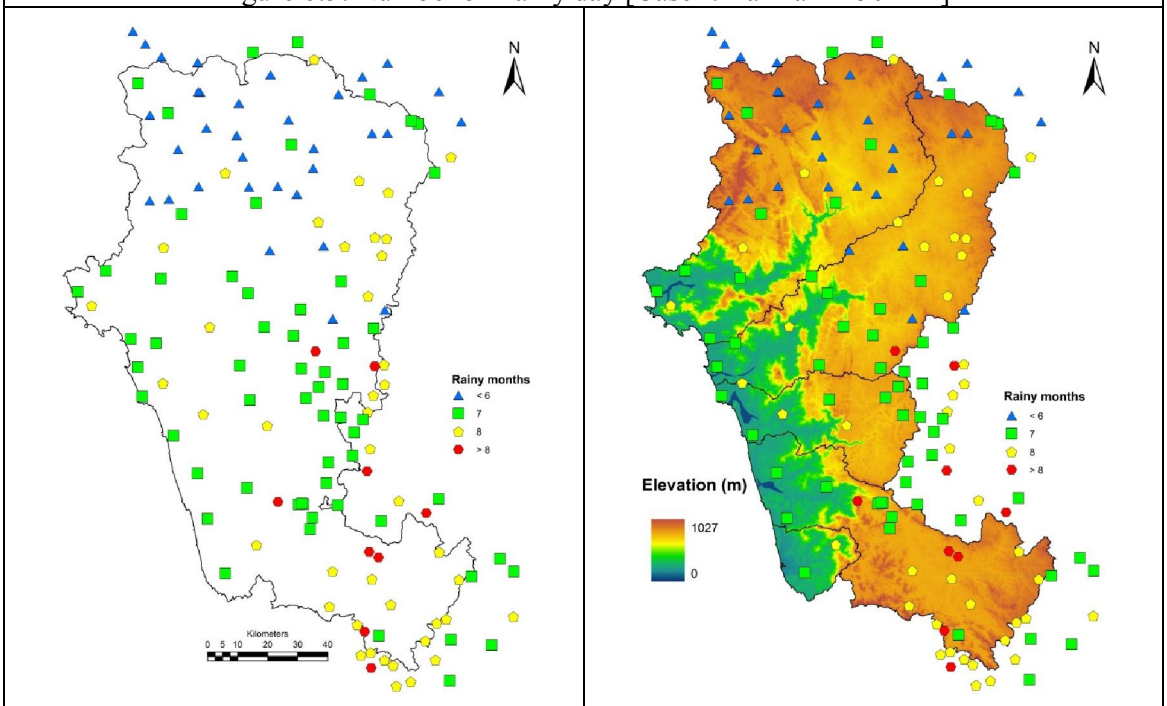


Figure 6.6: Number of Rainy Months [Case I: Rainfall > 50 mm]

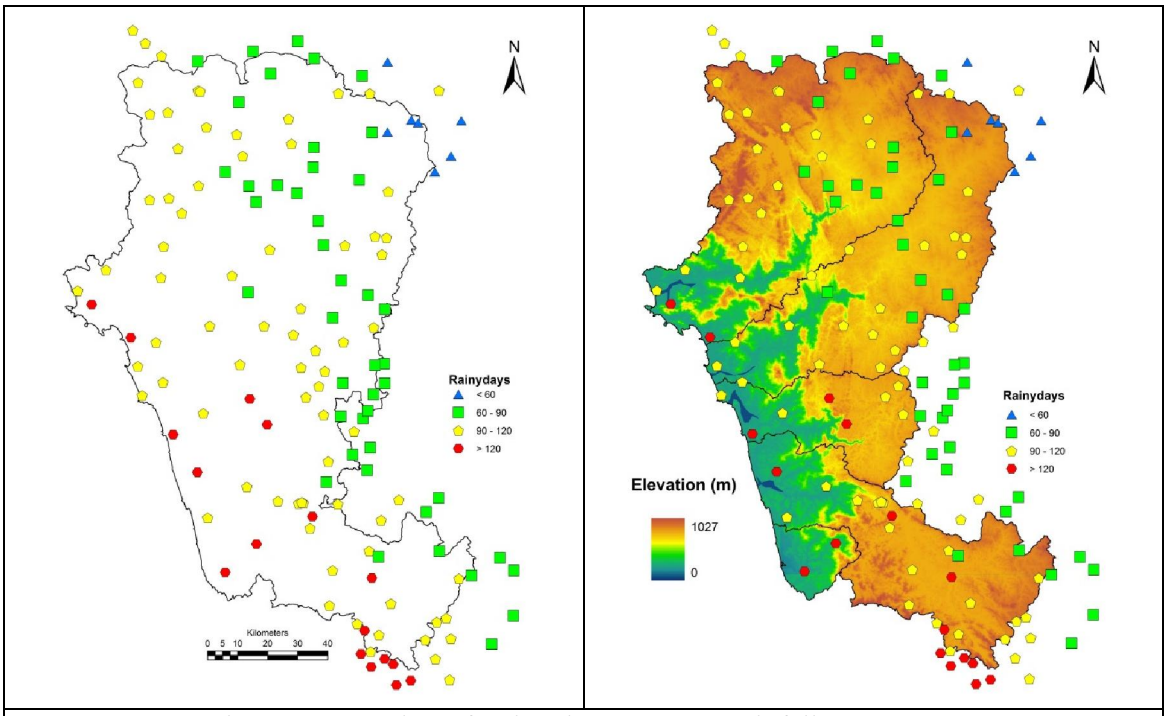


Figure 6.7:Number of Rainy day [Case II: Rainfall > 100 mm]

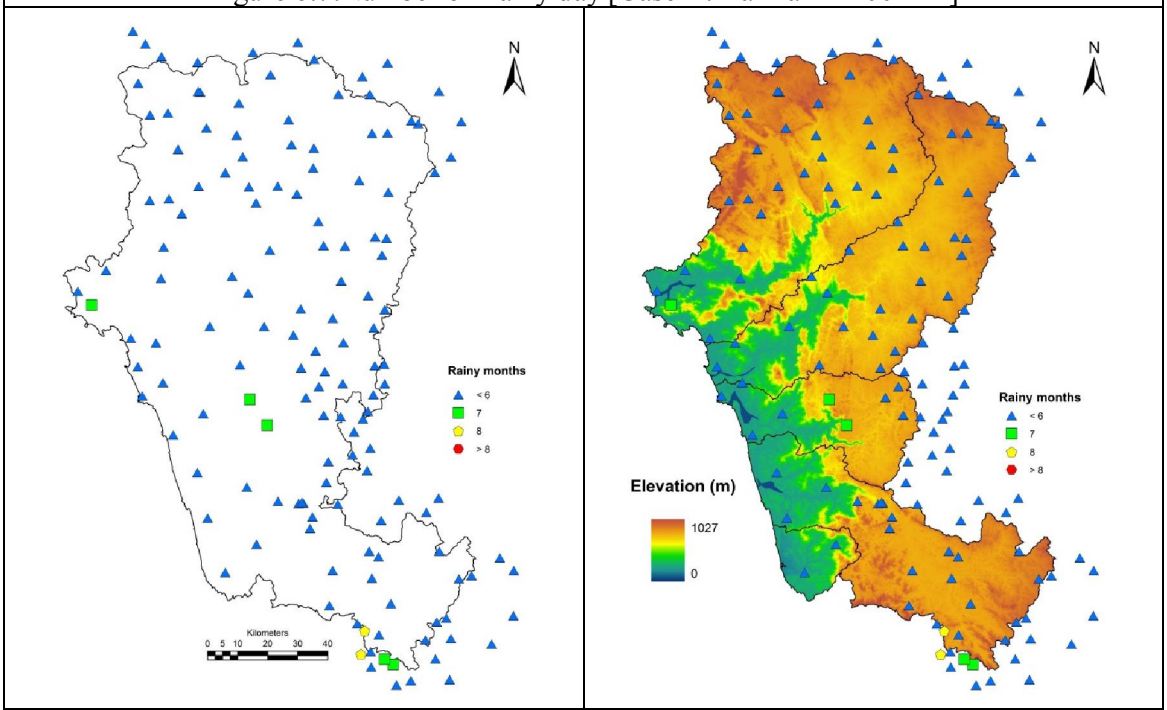


Figure 6.8: Number of Rainfall months [Case II: Rainfall > 100 mm]

1.4 **Topography:**

The district is hilly and thickly wooded in most parts. Its major part is essentially highland, the lowland being restricted to the pockets along the course of rivers. Uttara Kannada is divided in to upland and low land by Sahyadri range (figure 7.1 and 7.2). Uplands are the regions above the ghat with an area near of 7,770 sq km, and 600 to 700 meters above the sea level. Lowlands cover a region of 3,370 sq km. The district has three main and distinctive regions: the costal, the Sahyadrian interior and the eastern margin where the plateau begin. Relief and climate have introduced these regional differences.

- The coast of Uttara Kannada is almost straight line except at the shallow Karwar and Belekeri bay in the north. Karwar, Kumta, Honavar and Bhatkal regions are best developed with high economic development and a high density of population, as can be seen from the figure 4.
- The Sahyadrian region is mostly forested and only the road crossing the ghat sustains human activity, though the valley has special significance as belts of spice and areca gardens for which the district has been famous since yore.
- The eastern margin is undulating land, partly under forest and partly cleared for agriculture. It is a transitional zone between the forests and cultivated up lands of Dharwad district.

The costal tract being in the north form the village Majali on the Goa border and continues in the south up to the Udipi district boundary a little beyond the port of Bhatkal, till Gorte village. It varies from about 16 to 48 km depending upon the nature of estuaries and the intermediate tableland. Contrary to the general impression this is not a 'plain' but a succession of estuarine plains connected by narrow costal strips. Thus the tract in its northern extremity is a narrow coastal strip with large fishing village of Majali, focus of human activity.

A little to the south, Kali river joins the Arabian Sea, forming an estuary and supporting fishing activity. In the Kalinadi basin town of Karwar is located. The port of Karwar is always active as a result of mining activity in the district and nearby district. The Sea Bird project of navy has added one more dimension to this place. Further south of Kalinadi basin lies the Gangavali or Bedthi basin. These two basins are separated by small ghat known as Guddehalli-Baithkol range. This ghat forms horseshoe shape and some small rivers like Belambar, Navagadde and Hattikeri halla originate and join the sea (figure 2). In the catchment (basin) of Navagadde halla, Ankola is situated and is 20 km from Karwar. Bedthi merges in with sea at 3 km southwest of Ankola,.

Bedthi basin is separated from Aganashini or Thadri basin by a narrow range of hills. Kumta town is situated in this basin. South of Aganashini basin coastline is sandy and straight. The coastal line and coastal dunes has considerable influenced local agriculture. In the Sharavathi River basin, Honavar is located. The Sharavathi bridge and fisheries harbor, has contributed to the growth of Honavar. South of Sharavathi River basin, laterite assumes a more forbidden

form and agricultural land is restricted to narrow strips along the coast. Bhatkal is at the southernmost tip of the district and a creek known as Bhatkal flows in the next to the town. In between Bhatkal and Sharavathi River, Venkatapur River flows (figure 2).

On the north, beyond the low level plateaus of the coastal region, lies the Malnadu of the North Karnataka. This is physically an extension of the Sahyadrian main range from Maharashtra in the north, and continues to the south in the districts of Shimoga and Hassan. From Chandgad border in the north to the border of the Siddapur taluk in the south, it has a length of about 110 km. As in the Maharashtra region the, the Sahyadris rise in a series of step from the costal lowlands, but the scrap face is not so bold as in the district of Kolhapur and Ratnagiri. In fact the geological composition gives a greater variety and a definite break which for a more favorable rainfall in the Dharwad district. The 'rain shadow' area is not so sharp and immediate in the northern Karnataka as it is in Maharashtra. Another interesting feature is the eastward shift of the watershed: the Kalinadi and Sharavathi Rivers drain a large the plateau area and through their captured course divert these water to Arabian Sea. Faulted topography is typical is typical of the western Sahyadris. This has given rise to the harnessing of hydropower. Central portion of the Sahyadris mainly consists of the crest line ridges and upper reaches of the rivers developing more mature valley forms before they plunge in to deeper chasms and gorges to join the coastal levels. The eastern margin has a rounded topography and the boarder valley features, which mark the transition from between the main Sahyadrian landscape and the drier plateau of the upghat regions. The three-fold division of Sahyadrian region persists in its features of the vegetation and is well reflected in its regional economy. In the western spurs which touch the low-level laterite plateaus, the red soil favours stunted vegetation, but in the higher terraces, vegetation improves in both density and quality to an astonishing degree. In the central belt, there is a mark of contrast between the hilltops and the backbone of ridges, which support a thinner vegetal cover and the river valleys where luxuriant deciduous growth is to be found. Evergreen strands are frequent features, but the riverbanks almost invariably carry the thickets of bamboo growth. In the eastern part of the Sahyadrian region, increasing dryness is the keynote in the landscape. It is a mellowed landscape with poorer types of forests having parkland scenery. Valleys open out toward the plateau margin of the Uttara Kannada district. Increasing cultivation and receding forest cover is a recurring pattern in the landscape (percentage change).

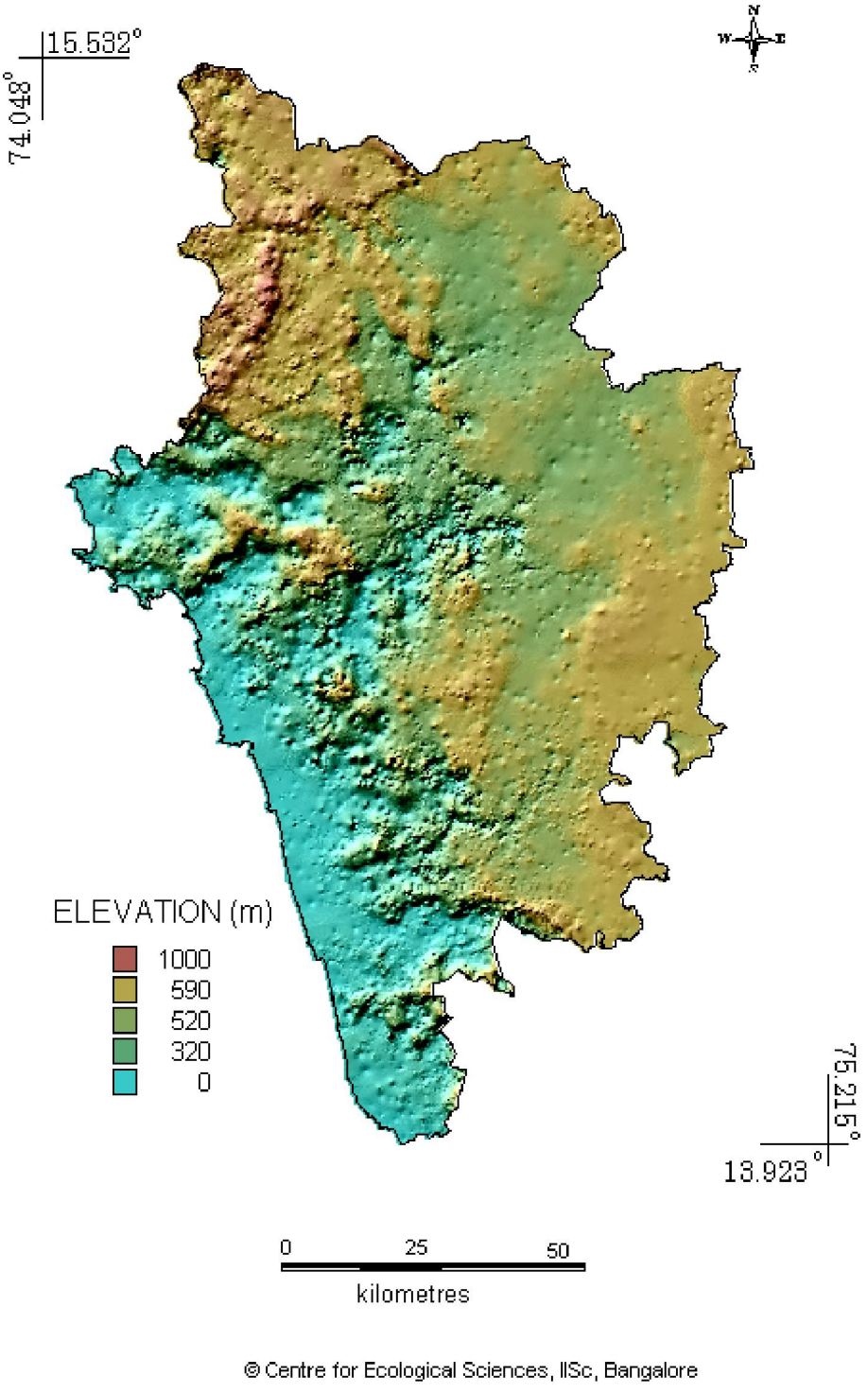


Figure 7.1: Shade relief map of Uttara Kannada district

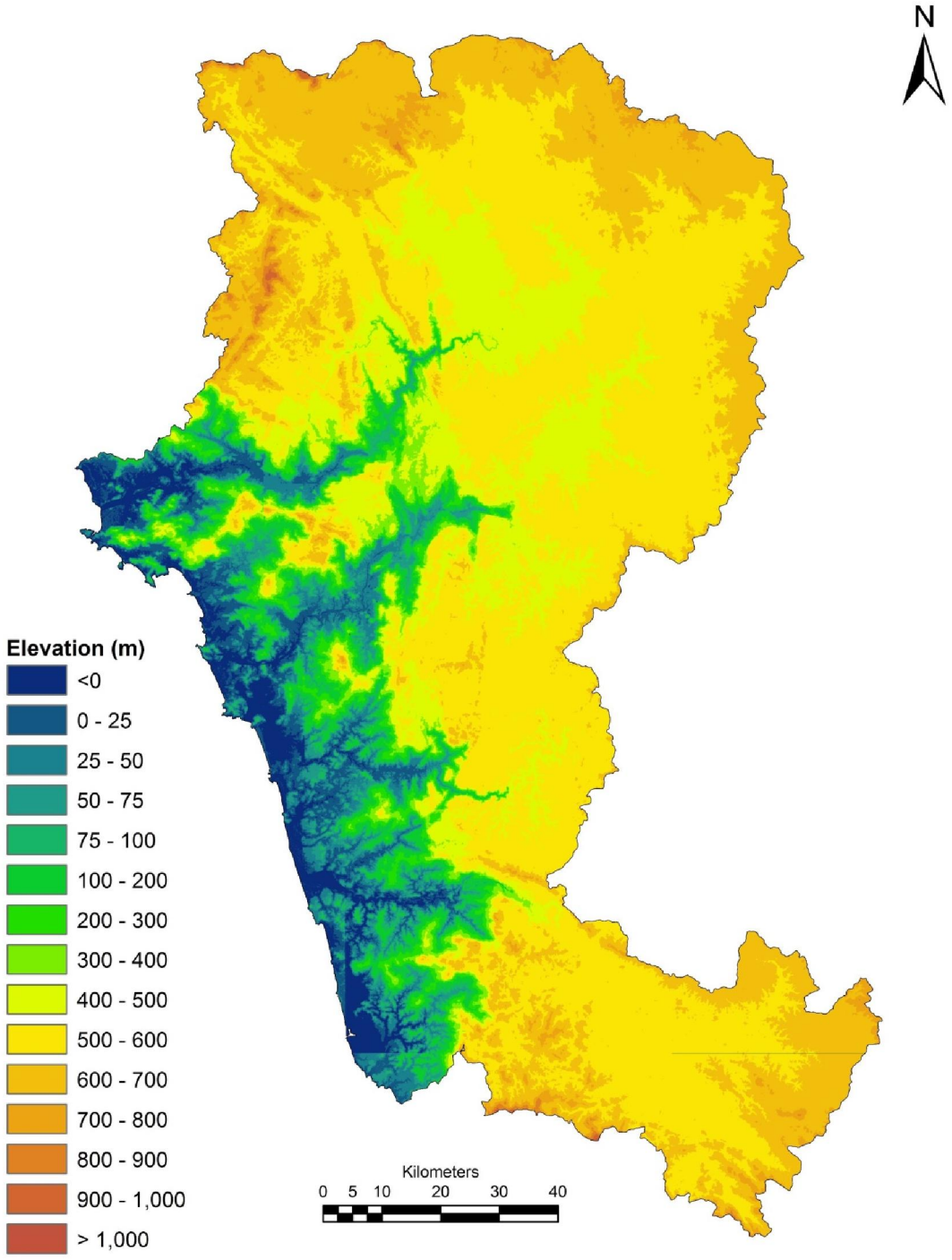


Figure 7.2: Digital elevation Model – DEM of Uttara Kannada district

Hills: The district is almost covered with hill, which may be arranged in to three groups:

- The bare flat –topped blocks of laterite from 60 to 90 meters high which roughen the coast belt,
- The westerly spurs from the central hills from 300 to 600 meters high stretch rugged and woody to the coast, and
- The main range and eastern spurs, of the central hills.

The west face of the Sahyadris in Uttara Kannada unlike the Sahyadris in Konkan does not rise in a single scarp, but is approached by numerous spurs and lower ridges. Locally the hills in the district are considered a break between two main ranges, the Sahyadris to the north that end at the Kalinadi near Karwar and the Malabar hills which stretches south from the Sharavathi River. Of the 11 peaks in the Sahyadris of the district, varying in height from 458 to 1050 meters, the Gudehalli and Shirvegudda are in Karwar taluk, the Bhedasgaon in Mundgod, the Menshingudda in Sirisi, the Hukali, Rakshasa and Mavinguddain Siddapur, Mothigudda, Kaltigudda, Darshanigudda and Nishanigudda are respectively in Ankola, Kumta, and Yellapur taluks. Suktale gudda and Sido Dongra gudda are the highest peaks with altitude of 1043 and 1049 meters in Supa taluk Darshanigudda in Supa (figure 8), about 1025 meters above the sea, rises near the meeting of the boundaries of Goa and Belgaum with Uttara Kannada.

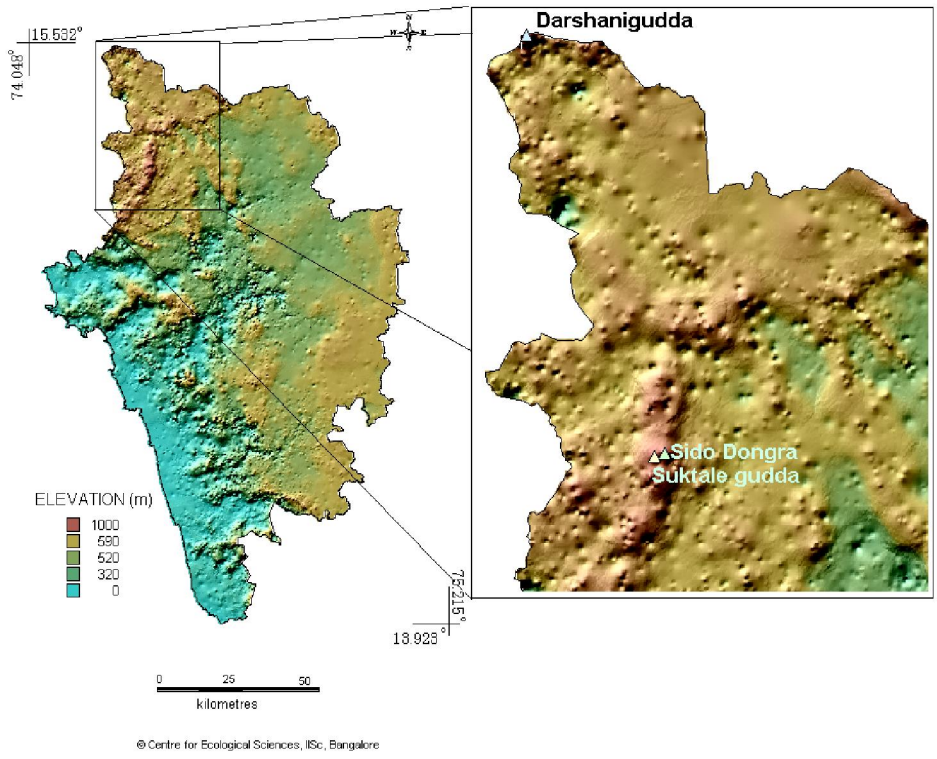


Figure 8: Highest peaks of Uttara Kannada district

1.5 Rivers:

Kalinadi: The Kalinadi (figure 9) or Sadashivagad River originates near the village Diggi in the Supa taluk, and is known as Dagi in its upper reaches. It is also known as Karihole. Its total length is 184 km. To this river there are 6 major hydroelectric dams that have submerged over 32,000 acres of the rich forests area. The Supa Dam built in 1985 is one of the biggest dams across Kali. The other dams across Kalinadi: Kodasalli Dam, Kadra Dam, Kaneri Dam, Tattihalla Dam, Bommanahalli Dam. After winding in the southeastern course for about 55km, it takes a sharpe turn to the south-west near the village Devikop. Beyond this point, it flows 66 km till the village Kadra. From here, it takes an east-west course and falls into the sea, three km north of Karwar. Of the two branches of the main stream, the Pandri or Ujli originates in the extreme north. The two streams join at Supa, about 32 km south east of the source of Pandri, which is a larger stream. The banks of the Kalinadi are comparatively high and those of the Pandri are sloping. From Supa, under the name Kalinadi, it flows about 32 km south east till about 12 km north of Yellapur where it joined by left bank by the Tattihalla, a stream with a southerly course of about 56 km from the north of Haliyal. Near the confluences is the famous stepped Lalguli falls. The Kalinadi flows down to be joins by Kaneri and the Vaki are its two tributaries. Kaneri originates near the village Kundal in Supa taluk, and flowing mostly in the Supa taluk, taking a southeast direction and joins the kali to the south of Sannamaga village. Below the Kadra, for about 32 km, the Kalinadi is navigable by steamers. The mouth the river has a depth of about 4.5 meters at low water and 6.5 meters at high tide. Near Kadra, the Thananala, originating from Goa, joins the river.

Bedthi: The course of Bedthi River (figure 10) is 161 km long. The Bedthi is formed by confluence of two streams, Bedthi and Shamala. Bedthi originates in Hubli tank and Shamala has it origin near Someshwara temple, south of Dharwad. Two join near Kalghatgi and then, it is named Bedthi and it flows 25 km westwards and enters the Uttara Kannada district, and after a fairly straight south-westerly course of about 32 km, falls into the sea about 32 km south of Kalinadi. The Bedthi after joining Shamala passes along the border Uttara Kannada - Dharwad for about eight km before flowing 96 km in the district. Small streams, which join Bedthi River, are Mogaddehalla, Sonda River, Bill halla and Kaulgi halla. But none of them are notable feeders.

Aganashini (figure 11): This River rises at Manjuguni near Sirsi and after a course of 70 km merges with the sea. The streams, which join Aganashini River, are Kanasur hole, Soma nadi, Benne hole, and Chindrika nadi. Kanasur hole, which originates near Sirsi, joins Aganashini River near Mutthalli. Yana the famous rock structure is located in Benne hole catchment. At Uppinapattana, the Aganashini River meets the tide and from here no it winds southwest and then northwest about 13 km to Mirjan an old seat of trade. From Mirjan, it forms a lagoon or a backwater that runs parallel to the coast, about 13 km long and 2 to 6 km broad, cut from the sea by a belt of land with nearly uniform breadth of about a mile. The outlet to the sea is about five km from the north end of the lagoon. It is between two hills, one 91 and other 122 meters high.

Sharavathi: The Sharavathi River (figure 12) originates at Ambutirtha in Tirthalli taluk of Shimoga district. After northerly course of about 64 km from Nagar, it forms the southeast boundary of Uttara Kannada for about 13 km and it passes 32 km to west or 128 km in all to join the sea at Honavar. On the upper reaches of the Sharavati river is the large Linganmakki reservoir, which is the source of much of the hydroelectric power supply of the State of Karnataka. Apart from the Linganmakki dam, another dam across Sharavathi River is at Gersoppa. Badagani River rises in the peak of Kaltigudda, and flows west south, falling into the estuary of the Sharavathi River.

Other rivers: Beside the above four major rivers, there are many minor streams flowing in the district. Of the many, the Varada River, tributary to the Tungabhadra River, originating in the north–east part of Shimoga district and flowing north and east, is an east flowing river in the district and passes through a corner of Uttara Kannada near the town of Banavasi, which stands on its northern or left bank and finally joins the Tungabhadra at Galaganath in the Haveri taluk of Dharwad district. Another river, which flows east in the district, is Dharma River, which originates at Islur, Sirsi taluk, from a tank. It passes through Mundgod taluk and joins the Varada in Dharwad district. Hattikeri halla and Navagadde halla are limited to Ankola taluk. Hattrikeri halla is joined by two minor tributaries, joining it before the Shikliturli village on the northeast corner of the taluk. The town of Kumta is situated on the banks of a small stream Kumta. The Venkatapur River rises in the Sahyadris near the village of Kanti about 20 km near Venkatapur. Chitti and Katagari are its two tributaries, joining it from the north. This river merges in sea few kilometers north of Bhatkal Rivers merging in sea. The Bhatkal River is another westerly flowing river and town of Bhatkal is situated on its banks.

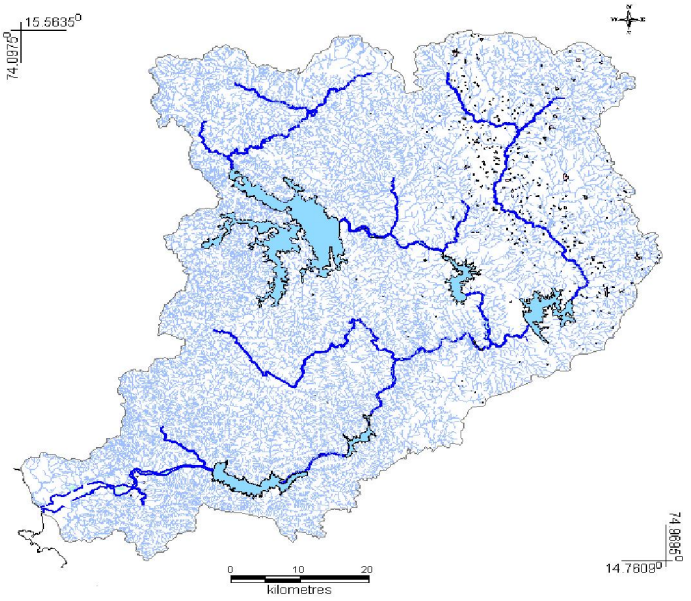


Figure 9: Drainage pattern of Kalinadi showing the reservoirs.

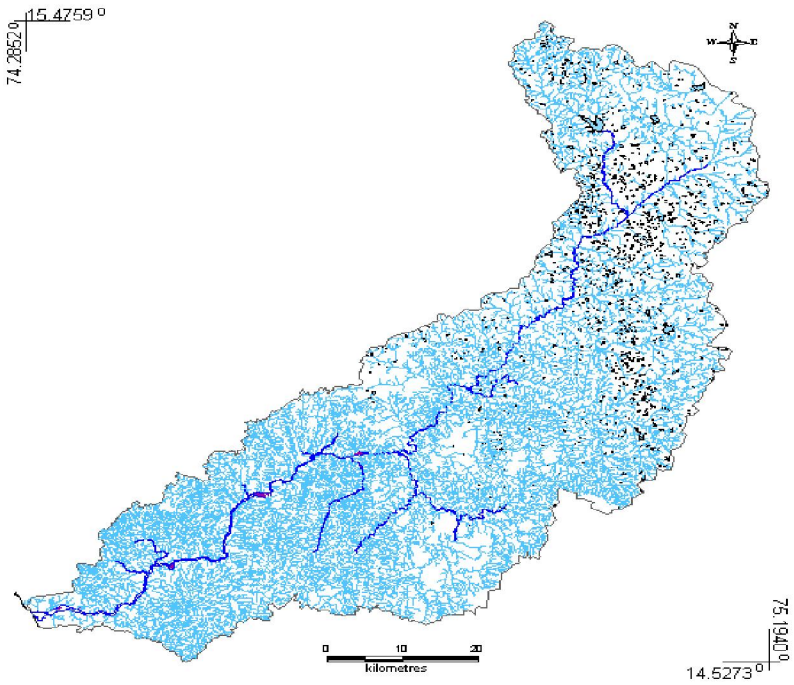


Figure 10: Drainage network of Bedthi River

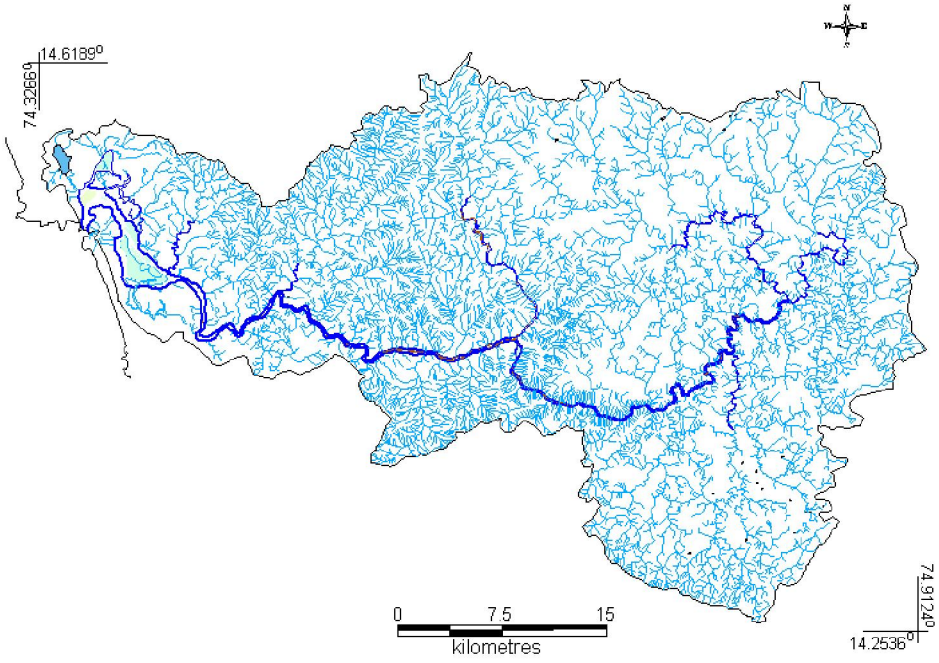


Figure 11: Drainage network of Aganashini River

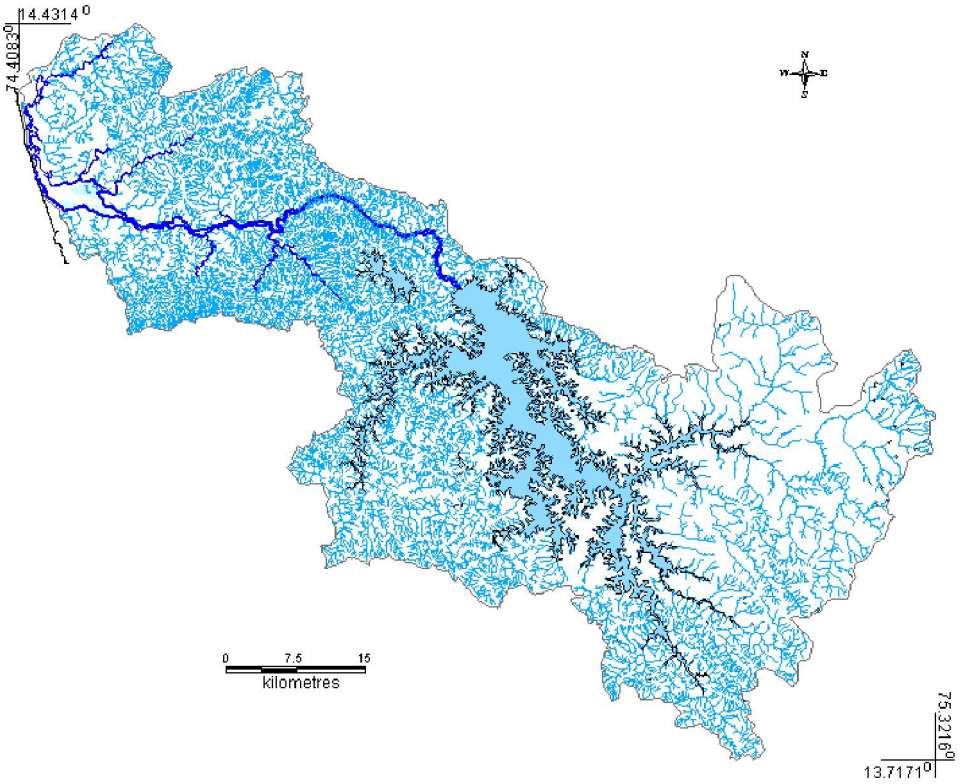


Figure 12: Drainage network of Sharavathi River with is reservoirs

1.6 Geology:

The district consists of rock formation of Archaean complex, the oldest rock of the earth crust. Rocks of the Archaean era occur over the whole of the district. They have not been submerged under the great lava flows known as the Deccan Traps, which have overspread most of the central India forming the great plateau with steep precipices. The district is characterized by a system of ridges and a plateau on the west descending rapidly to a narrow strip of low land covered by alluvium, which with the abundant annual rainfall supports cultivation. The low land appears to be the creation of later period than the upghat region. It emerged from the sea during the glacial and inter glacial period due to the changes in the sea level. The Archaean formations are divisible in to an older group of sediments and igulous viatrusives, all very highly metamorphosed, which are classified as the Dharwar system and a younger group of plutonic intrusive termed the peninsular geisses (figure 13). A capping of laterite, which is locally the source of iron and magnesium ores, frequently overlies both the Dharwar and the peninsular gneisses. In the western part of the district, nearly parallel to the coastline, there is a range of hills with several peaks over 700m high descending westwards gradually in broken country to the coast. This consists of varied assemblage of granite and schists. These ridges separate the Sahyadris, consisting of Dharwar schist in the south. Eastwards in the interior, the district is almost entirely hilly and consists of both the Dharwar and the Peninsular gneisses, the latter frequently occupying the low grounds. In this district the Dharwars are typically represented by chlorite-schists as opposed to the areas in the

southern Karnataka where hornblende rocks predominate. The chloritic types are considered to be younger than the hornblend types. Other rock formations belonging to this system are quartzite, magnetic-quartzite, limestone-quartzite, senicite-quartz-schist, phyllite fine-grained grey limestone, dolomite, epidiorite and other basic igneous rocks. The Dharwar rocks generally out crop as narrow lenses and shingers, elongated nearly NS enclosed in the intrusive peninsular gneisses, which have invaded them after their folding. Most of the Dharwar are highly pilcated. Their folding is clearly seen in the limestone, which is thought to be the youngest in the Dharwar sequences. These limestones are well exposed as larger, highly contorted masses in the Nagjhari valley, south of Kulgi and in the valley of the river Kalinadi below its confluence with the Nagjhari. Dolomite bands are known to occur in the western parts of district (figure 13).

The peninsular gneisses consist mostly of the fine-grained granite-gneisses outcropping in the lower levels of the central and southern boundary of the district. The best exposure of these gneisses is near the southern boundary of the district where the Sharavathi River plunges down a vertical precipice in the magnificent Jog falls. They generally show a lower degree of metamorphism than the Dharwars, as they have been emplaced subsequent to the Dharwars folding. Usually there is great diversity of types amongst these rocks with frequent modification caused by assimilation of disintegrated Xenocrysts of the Dharwar stopped out during intrusion. There are, however, two main types of these rocks; one granitrid, highly crystalline, massive type and the other a schistose, less crystalline, highly foliated, distinctly banded type, but each group includes a number of distinct variations. It is not moreover quite certain if all these granitic rocks belong to the peninsular gneisses and granites characterize the lower levels of the north district. Highly granitoid types are reported to occur to the north Dharwar outcrops in the neighbourhood of Shinargaon and Kudalgaon, but their precise age is unknown.

The Archaean granites and gneisses with their sparse bounds of Dharwars are capped by laterite at many places in the district. They are typical tropical rocks resulting from the alteration under tropical condition of the basement rocks. They are found capping flat topped ridges and bluffs all along the coast of a hundred feet in thickness and occasionally show local enrichment of iron and manganese ore.

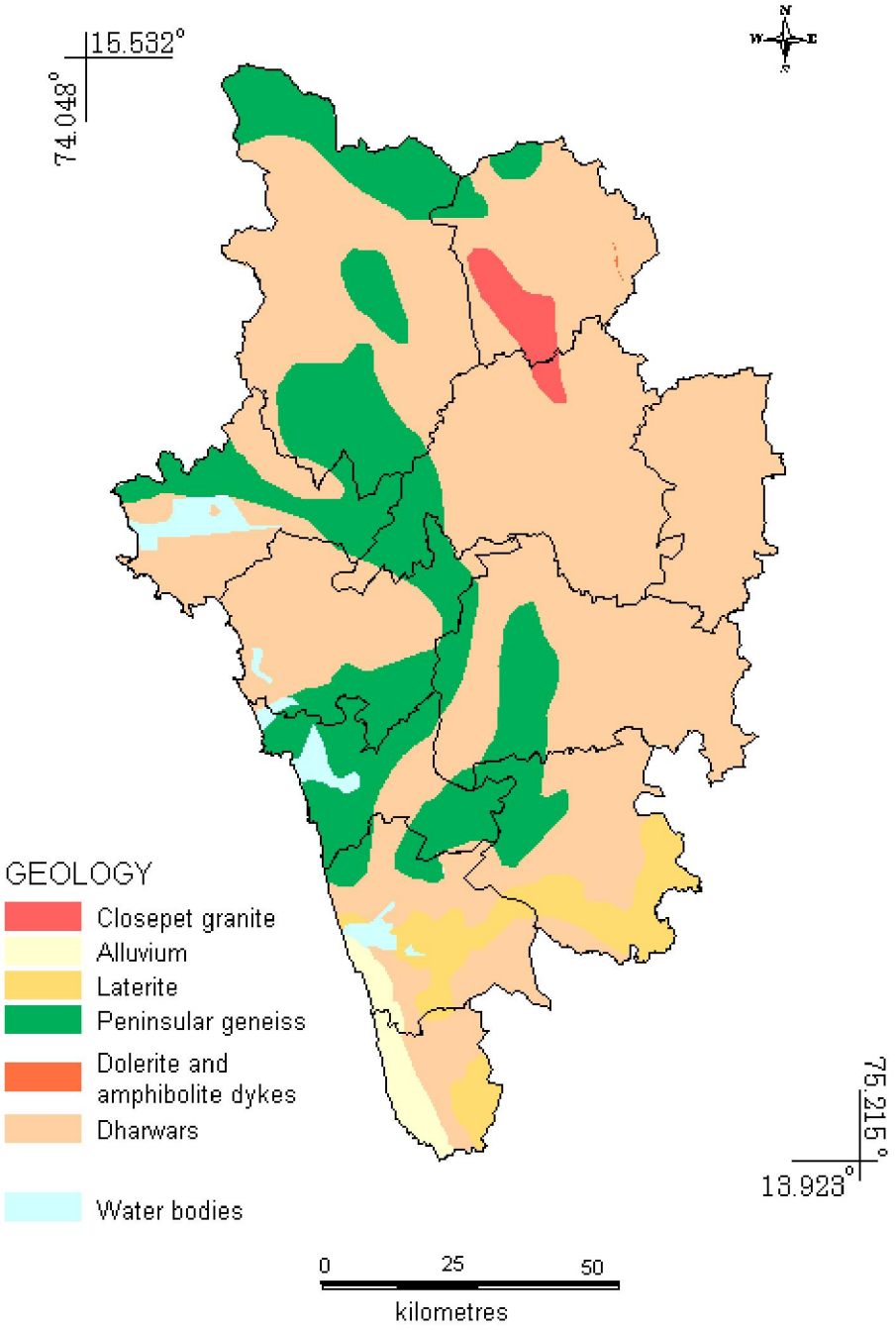


Figure 13: Geology of Uttara Kannada

1.7 **Soils:**

The soils of UttaraKannada belong to six orders (figure 14). Of the total area of UttaraKannada Alfisols cover 51 percent, Ultisols 27 percent, Inceptisols another 8 percent, Mollisols 7 percent, Entisols 3 percent, and 0.2 percent of Vertisols.

Types of Soils seen in Uttara Kannada are basically divided into forest brownsoil, alluvial soil, coastal laterite soil, alluvial colluvio soil, laterial soil, and red soil. These have been further divided (figure 15). Red soil is divided into two i.e., gravelly clay soil and non-gravelly clay soil. Laterite is also divided into two gravelly clay soil and non-gravelly clay soil. Soil depth of the soil determines the effective rooting for plants and, in accordance with texture, mineralogy and gravel content, the capacity of the soil column to hold water. Figure 16 gives the understanding of how the soil depth is varying at different places. Surface soil texture (figure 17) indicates the relative proportion of the primary particles of sand, silt and clay. The textural class guides us to understand soil water retention availability, workability of the soil, infiltration and drainage conditions and crop suitability.

1.8 MINERALS AND ORES:

The district is rich in many minerals. Investigations have been conducted in the district by the Atomic Mineral Division of the Geological Survey of India and the State Department of Mines and Geology. Some investigations are yet to be completed. The economically important minerals available in the district are the iron ore, manganese ore, limestone, quartz, bauxite, limeshell, silica, sand and clays. The district is an important exploitation centre for iron, and manganese ores and it is second only to Bellary district in the State in the production of these minerals.

Iron Ore: Iron ore deposits are found in varying extents in the western half of the district, particularly in several places of Ankola, Honavar and Yellapur taluks. The ores are of different types, like haematite, limonite and litariferous iron ores. These deposits have been surveyed, mapped and prospected in detail by the Department of Mines and Geology of the State and the Geological Survey of India, has also conducted surveys in the district. These surveys have disclosed a reserve at 95.26 million tonnes of float and reef ore (about 58 to 65 per cent of Fe) in the district. In addition, there are several deposits of low to medium grade ores of content ranging from 44 to 54 per cent of Fe.

Manganese Ore: Manganese is one of the chief mineral of the district. The manganese ore of this district occurs associated with the shelf sedimentaries of rocks equivalent to Chitradurga group and is characterised by high Mn content with low phosphorous of low electro-negative elements. It is found in near Castle Rock region of Supa taluk and Yellapur, Sirsi, Kumta and Ankola also have deposit of Mn.

Limestone: Supa, Yellapur and Kumta taluks possess several band of limestone of varying extent and ranging in composition from high calcium to dolomitic types. A small band of high calcium limestone is exposed close to Kali river about four km ESE of Supa and this deposit is not of much importance. High calcium type greyish crystalline lime stone is found in Yellapur. Kumta taluk has medium to coarse grained greyish limestone in discontinuously patches. Kankar limestone is another limestone present in Uttara Kannada.

Bauxite: Aluminous laterite with 42 per cent Aluminum oxide is found all along the coast line of the district. Bauxite containing more than 50 per cent alumina and low percentage of silica and titanium is found to occur in a reddish brown laterite covering an area of about 5.18 sq km at Mundolli and Talgod villages near Bhatkal. Small deposits are also found at (1) Swarnagudda, (2) Kumta plateau, (3) Haldipur and (4) Nirthadgi.

Copper: Copper is found in a small patch in Kaiga which is associated with ultramafics and meta-volcanics of Dharwar super-group.

Clay: Deposits of China clay (Kaolin) are reported to occur at the following places in the district: near Castle rock, Motigudda in Supa taluk, Hervatta extention in Kumta, near Hadinbal village in Honavar taluk and certain parts of Bhatkal taluk (sothern bank of Venkatapura river). Ankola also has deposit of clay which is slightly reddish in colour.

Mineral pigments: Among mineral pigments, only ochre of different grades occurs in the district. Yellow and red ochres are the two chief types that are commonly found. Ochres of fairly good quality have been reported to occur in the neighborhood of Castle Rock. The occurrence of yellow ochre of inferior quality is reported in Kallemane and Kumbaragadde villages in Ankola taluk.

Vanadium Ore: Titaniferous-Vanadiferous magnetite occurs as late magnetic deposits intimately associated with the ultramafic rocks like pyroxenite and peridotite. The important deposits are found at Santepet, Mulemane, Surya Kalyanigudda, Kanlal hill, Hiregutti, Madangeri, Motigudda, Sariyasigpdda, Angudibail, Kodemane, Kantgani, Kanchinkere and Achavegudda area.

Other ores: A small deposit of; asbestos associated with talc is reported to occur near Dhareshwar in Kumta taluk of the district and it is not of much economic importance. Partially developed rock crystals showing pyramidal termination at one end found encrushing the drusy cavities in a vein or reef of quartz in the .granite near Nidgod in the Siddapur taluk. In Kumta taluk near Ramgundi, a band of good quality steatite is found, exposed for a length of about 75 m along the western flanks and on foot of the hill. Weathered and impure steatite is reported to occur as small bands near Karwar. The dolerite dyke rocks of coastal area of the district have made a name in Germany for its standard quality and for the nearness of ports. The deposits are reported from Aversa, Herwada Bagribail, Amdalli and Kodur. Granite gneisses and laterites are the chief building stones of the district. They are quarried at some places in the granitic regions and are being used as building stones. In the coastal belt of the district glass sand (medium grained white silica sand) and ilmenite sands is found. Ilmenite sand caontains ilmenite and zircon and also monazonite, rutile, apatite, haematite, amphibole, epidote and chlorite in much smaller proportion.

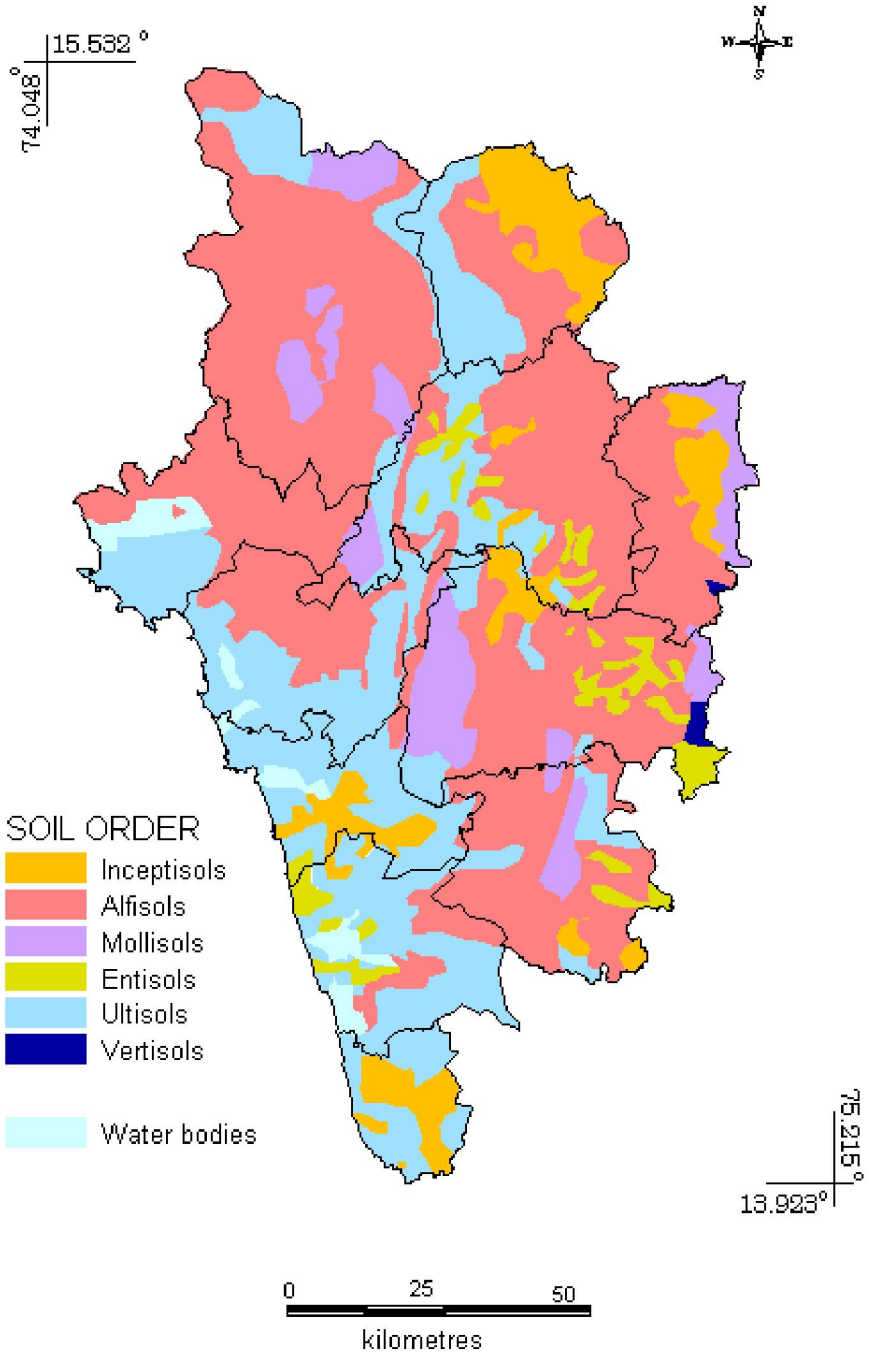


Figure 14: Soil order of Uttara Kannada

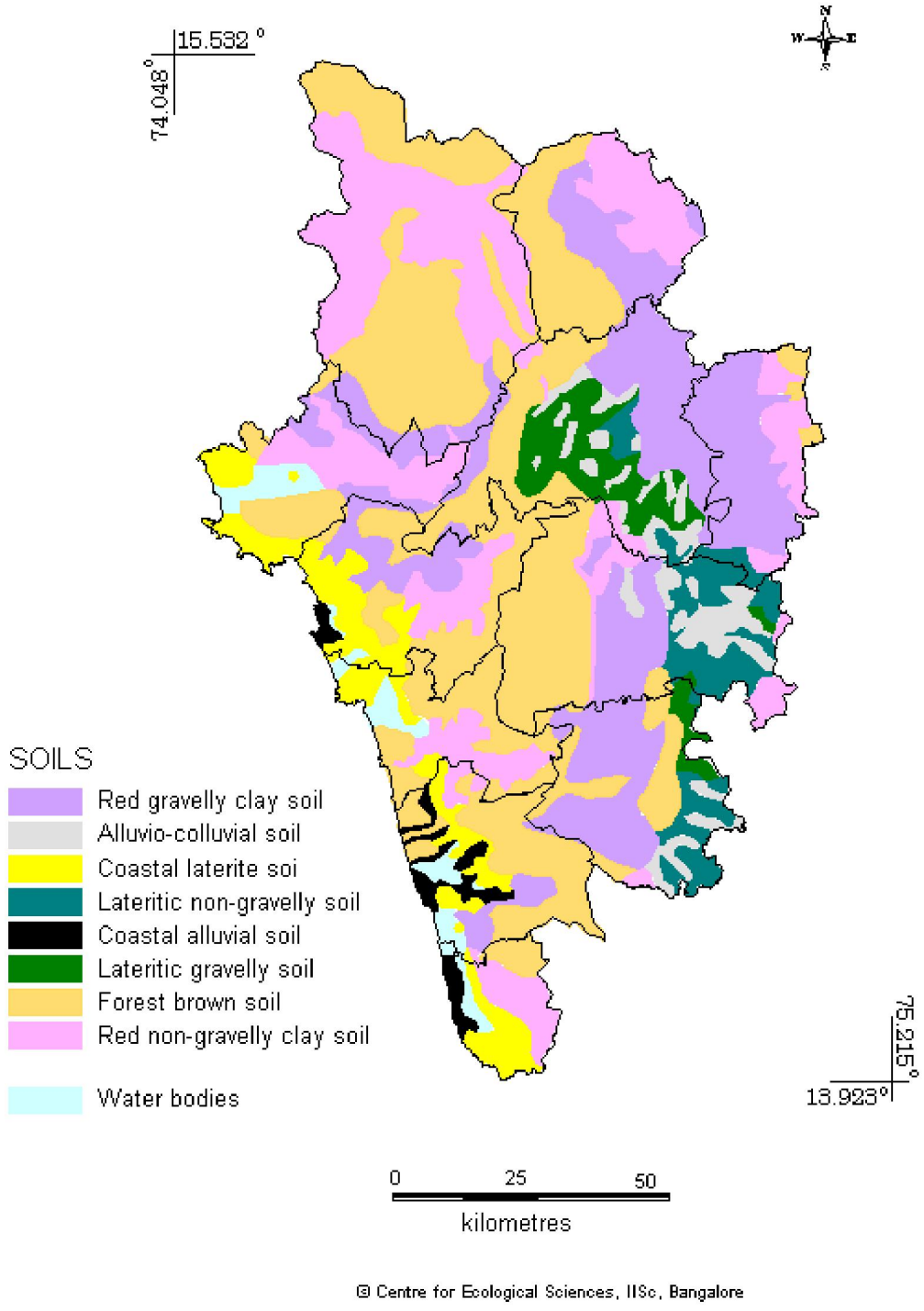


Figure 15: Soil of Uttara Kannada

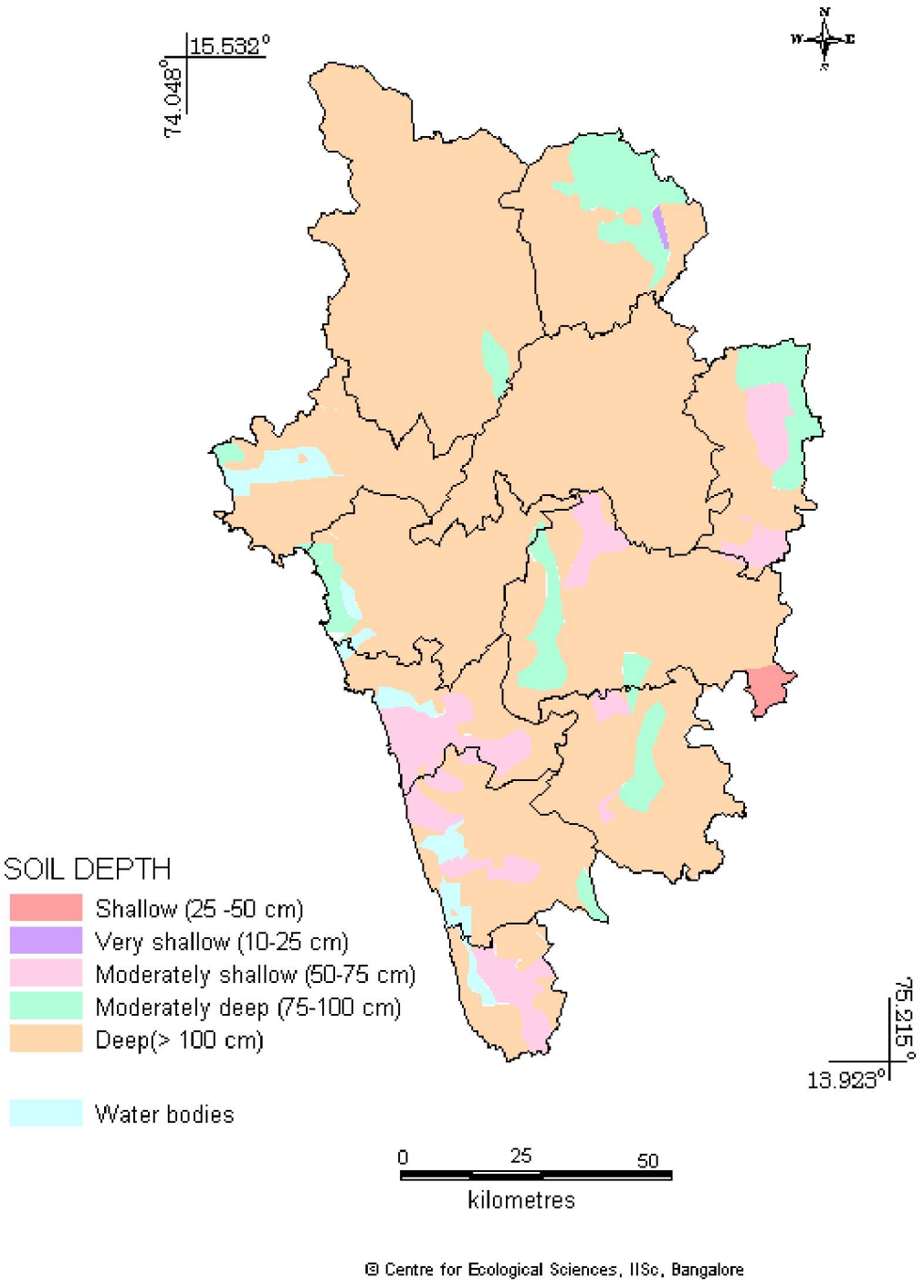


Figure 16: Soil depth of Uttara Kannada

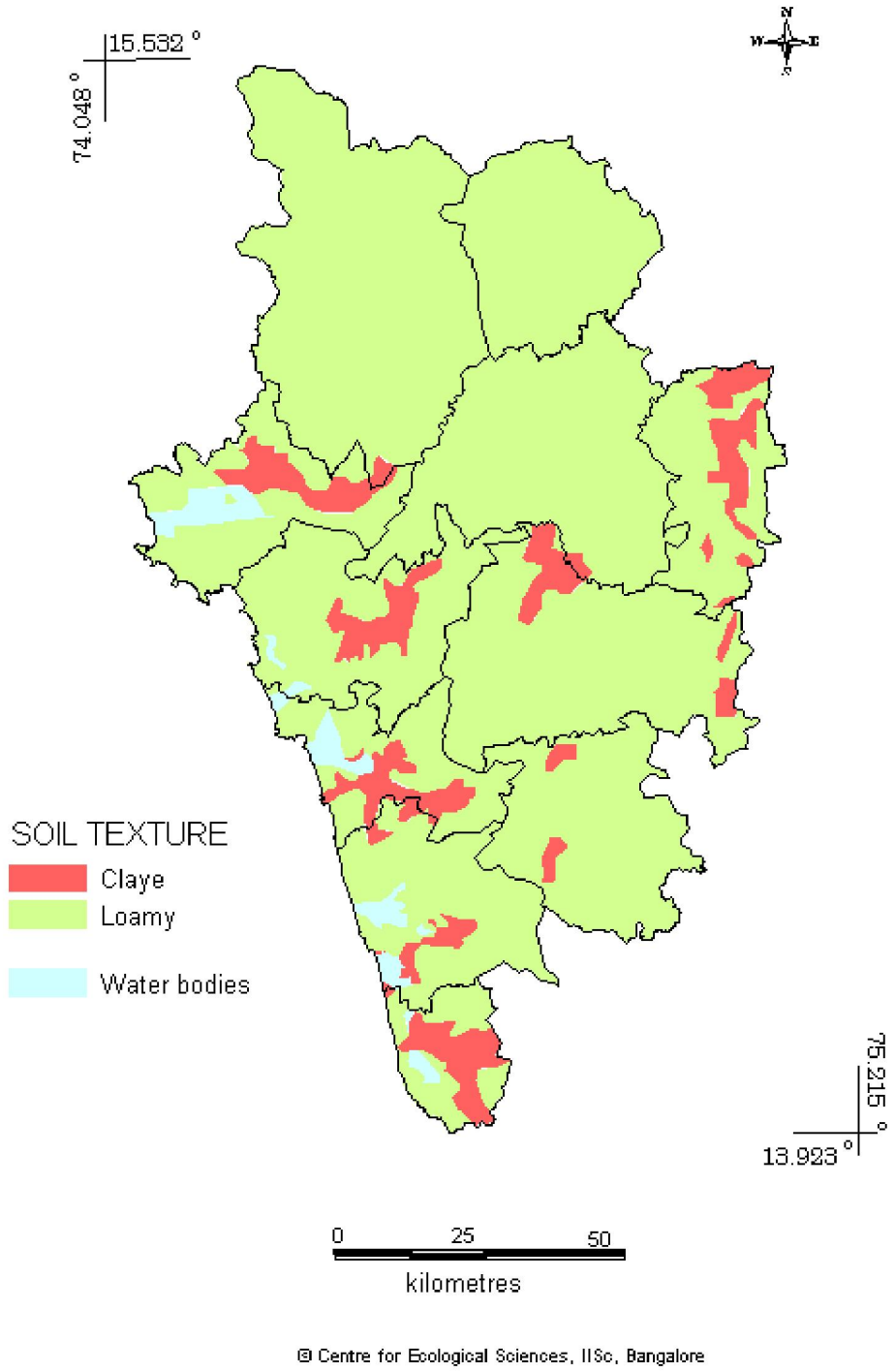


Figure 17: Soil texture of Uttara Kannada

The geomorphology of the Uttara Kannada (figure 18) is divided in to 30 categories considering the soil, topography, geology etc.

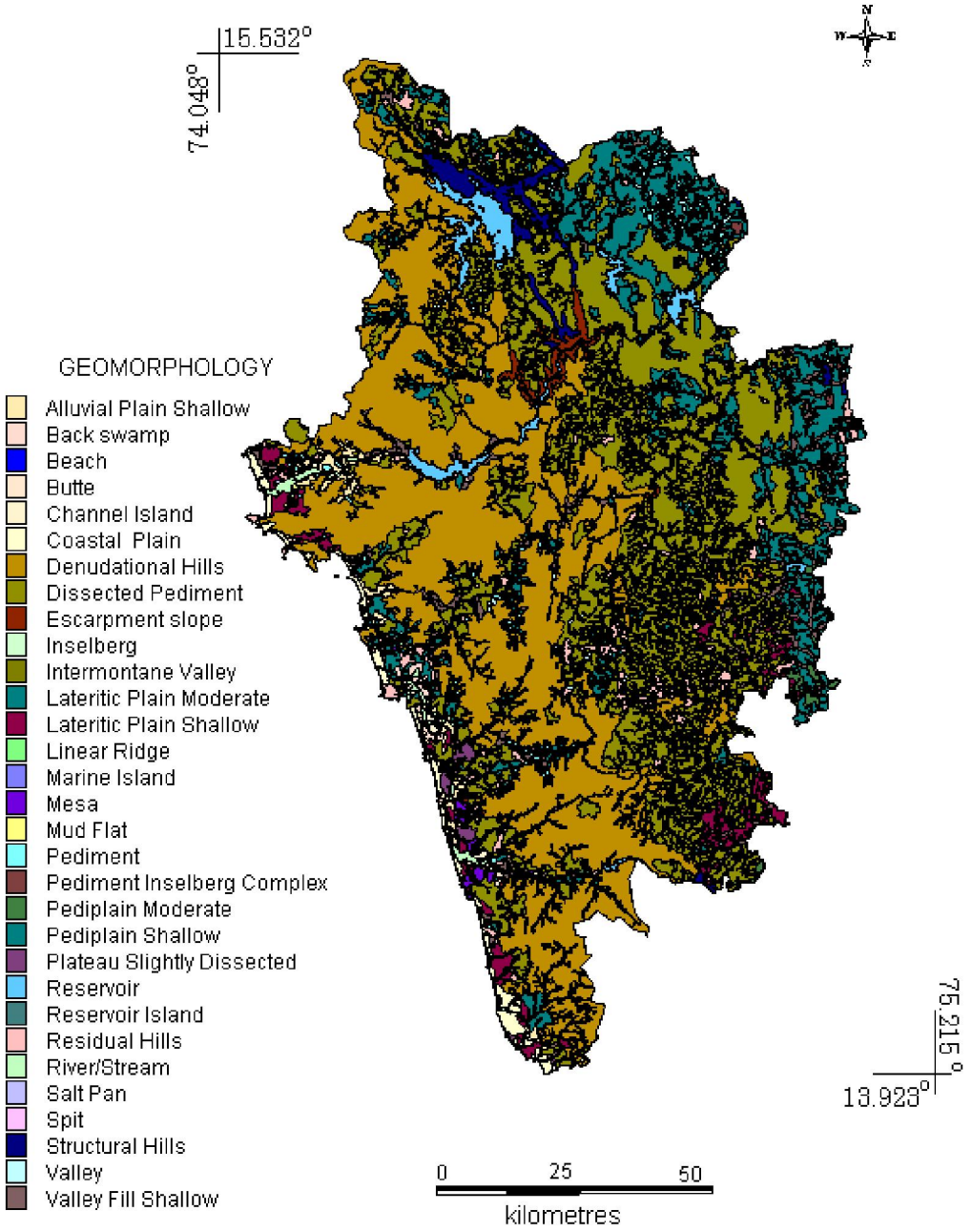


Figure 18: Geomorphology of Uttara Kannada
*** source: NRDMS centre**

1.9 Ground Water:

Uttara Kannada district consists of rock formations of a system of ridges and a plateau on the west, main aquifers are weathered and fractured zones of metavolcanic, metasedimentary, granites and gneisses, laterites, along with the alluvial patches found along the major stream courses. Laterites occur overlying the schist and granites, and alluvium along the rivers and lagoons of the coast. Ground water in the above aquifer material generally occurs under unconfined to semi-confined and confined conditions, in the shallower zones under phreatic condition and under semi-confined and confined condition in the deeper zones. The ground water is being exploited from within the depth range of 3.00 to 31.00mbgl through dug wells and 30.00 to 200.00 mbgl through dug-cum-bore wells and Bore wells (CGWB, 2006). The area that drives ground water are under dugwells (7302 Ha), borewells (2090 Ha), lift (596 Ha) for agricultural activities. Ground water in the district occurs under water table conditions in the weathered mantle and jointed and fissured in bed rocks. Along the costal belt ground water occurs in the sandy alluvium. Major part of Uttara Kannada district is covered by a thick capping of laterite mantle on granites, schistose rocks and sand stones. These laterites are highly porous and hold and transmit good quantity of ground water. The ground water recharge is mainly a result of infiltration of rain water and little extent through seepage from streams, tanks, reservoirs and water applied for irrigation. It is discharged artificially by abstraction of water from dug wells. The fluctuation of water table varies in the district from 3 to 12 m for hard rock area and alluvium, the specific yield varies from 2 to 3 per cent (Table 3). The figure 19 shows the taluk wise ground water and its condition and potential areas for recharging. The district is almost under safe condition and there is a lot of scope for recharging areaas.

Table 3: Ground Water level at taluk wise

SI. No	Taluk	Topography	Latitude (D M S)	Longitude (D M S)	Mean Sea Level (Mts)	Ground Water level (Mts)	
						Min	Max
1	Ankola	Coastal	$14^0$39'50"	$74^0$19'44"	17.34	11.4	0.8
2	Bhatkal	Coastal	$15^0$59'	$74^0$33'25"	12.24	4.27	0
3	Haliya	Hilly	$15^0$19'30"	$74^0$46'	540.63	13.25	7.5
4	Honnavar	Coastal	$14^0$18'30"	$74^0$28'30"	20.36	14.1	5.15
5	Karwar	Coastal	$14^0$48'25"	$74^0$07'54"	2.88	2.8	0.3
6	Kumta	Coastal	$14^0$25'30"	$74^0$24'40"	15.43	6.93	1.5
7	Mundgod	Plain	$14^0$58'10"	$75^0$02'30"	570.8	7.29	0.54
8	Siddapur	Hilly	$14^0$21'05"	$74^0$50'05"	598.69	11.73	9.28
9	Sirsi	Hilly	$14^0$37'05"	$74^0$50'05"	596.8	14.75	8.75
10	Supa	Hilly	$15^0$10'20"	$74^0$29'15"	591.7	6.1	1.72
11	Yellapura	Hilly	$14^0$54'45"	$74^0$39'45"	444.73	9.87	1.95

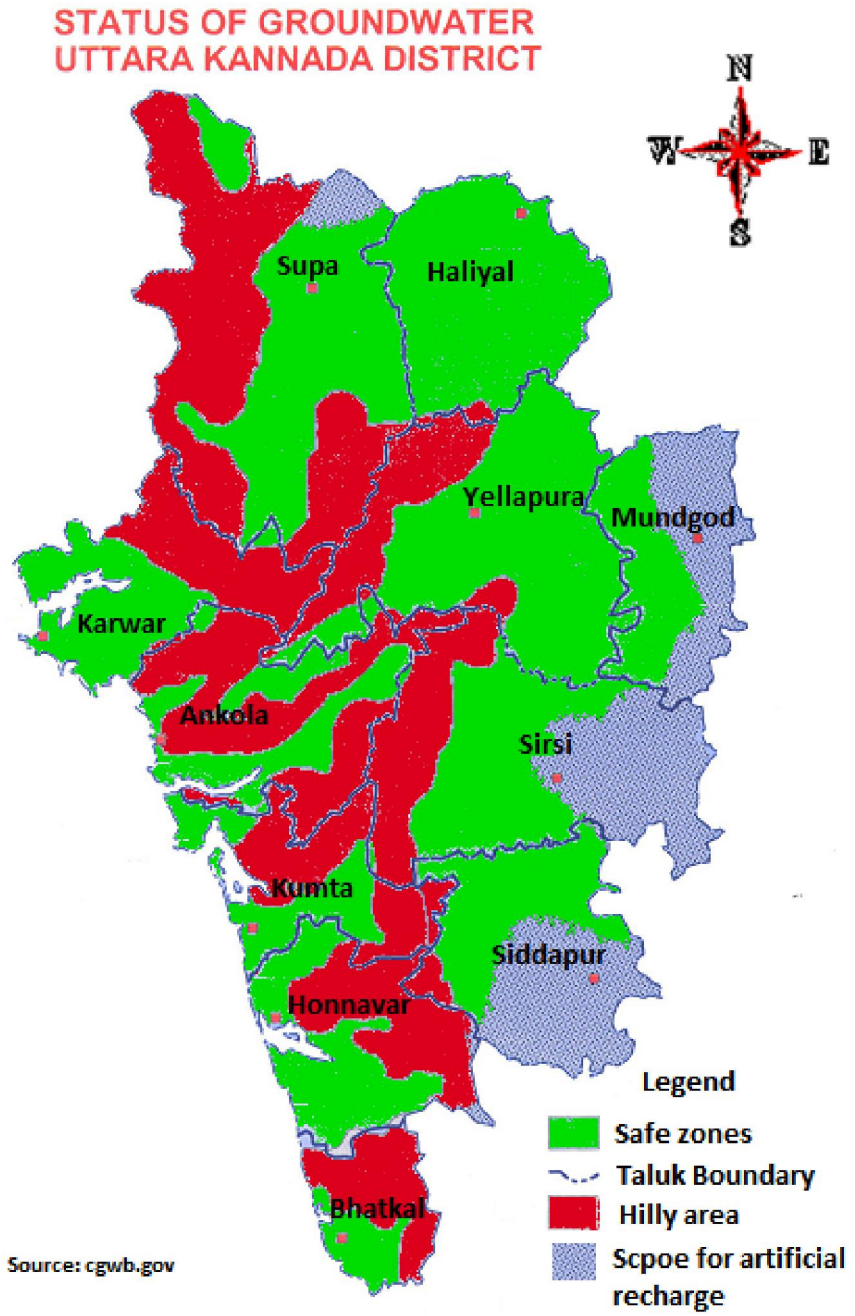


Figure 19: Ground water status and potential areas for recharge

1.10 Vegetation:

In the slopes of Western Ghats from north to south of Uttara Kannada district, there is beautiful cover of dense forests. The forests, stimulated by heavy rainfall, start growing within a few kilometers from the coast. They are generally lofty, dense and characteristics by large number of trees which occurs together with fine canopies of tree crowns and shrub growth. As one moves from coast from ghats, the forests are semi-evergreen with grassy banks along the coast, interspersed with stunted growth of secondary species and scrub and also Acacia catechu.

The evergreen forests are found in places where the rainfall is more than 225 cm and from a narrow strip along the Western Ghats (figure 20 & 21). The soil types of these evergreen forests are mostly laterite but along the river basin, it is alluvial. The semi-evergreen forests are in the places where the rainfall is from 150cm to 25cm. The deciduous forests are situated in the rainfall areas of 100 cm and more. In the areas where the rainfall is below 90 cm, the dry deciduous forests are found.

Uttara Kannada has 12 % of its land under cultivation and has happened because of hilly terrain. This rugged terrain is nurtures the forests. In Uttara Kannada both primary and secondary forests can be seen. Secondary forests has emerged because pre-colonial and early colonial period passed through phases of slash and burn cultivation by various local communities. This practice has cleared vast primary forest and now the secondary forest has come in to existence. This change from a cultivable land to forest occurs in various successions. The cultivable land first shows the sign of vegetation with the arrival of deciduous species. The deciduous specious are replaced over a period of time by evergreen trees. The study have shown that at many parts of Uttara Kannada evergreen have returned and the forests which were deciduous has become moist deciduous i.e., the percentage evergreen trees in the forest has increased over the time. Mangrove forests can be found in the river estuaries, and the sandy beaches are home to groves of Calophyllum inophyllum, coconut and screw pine (*Pandanus spp*.).The rocky beaches at Binaga, Arga, Belekeri, Tadadi, Ankola Keni, Kadle, Kumta, Dhareshwar, Kasarkod, Murdeshwar, Bhatkal and Belke of the district is rich with marine fauna diversity.

Apart from these types of forests, there are many places we can see monoculture plantation. These plantations without diversity have caused more harm to the eco system than the good. The best example is Acacia which has a thick leaf with a layer of thick cuticle which rebukes the rain water to infiltrate. This monoculture does not even invite or help flora or fauna to thriving in them. The district is also home to patches of savanna and degraded scrub jungles, which are often the result of over-use for logging or grazing. Much of the lowland has been cleared for agriculture. French Institute map (1985) show that about 7.1 thousand km² is under forest in various stages plus tree crops such as coconut and areca nut. Deducting from this 0.13 thousand km² under orchards, we are left with a figure of 6.9 thousand km² under some kind of vegetation, at least of scrub type (figure 20). It shows the regions of primeval forest patches and other types.

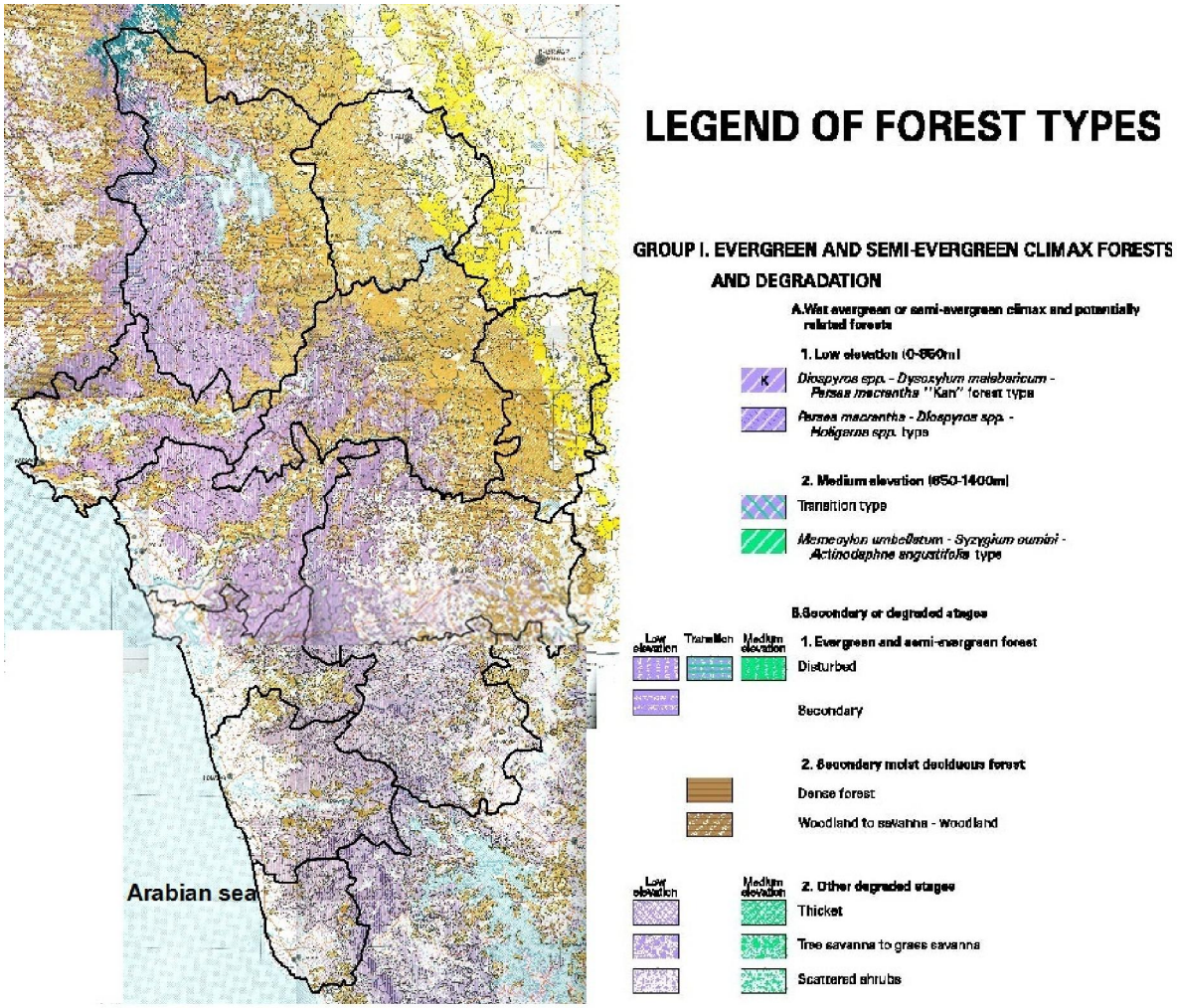


Figure 20: French Institute map (1985) at taluk wise distribution

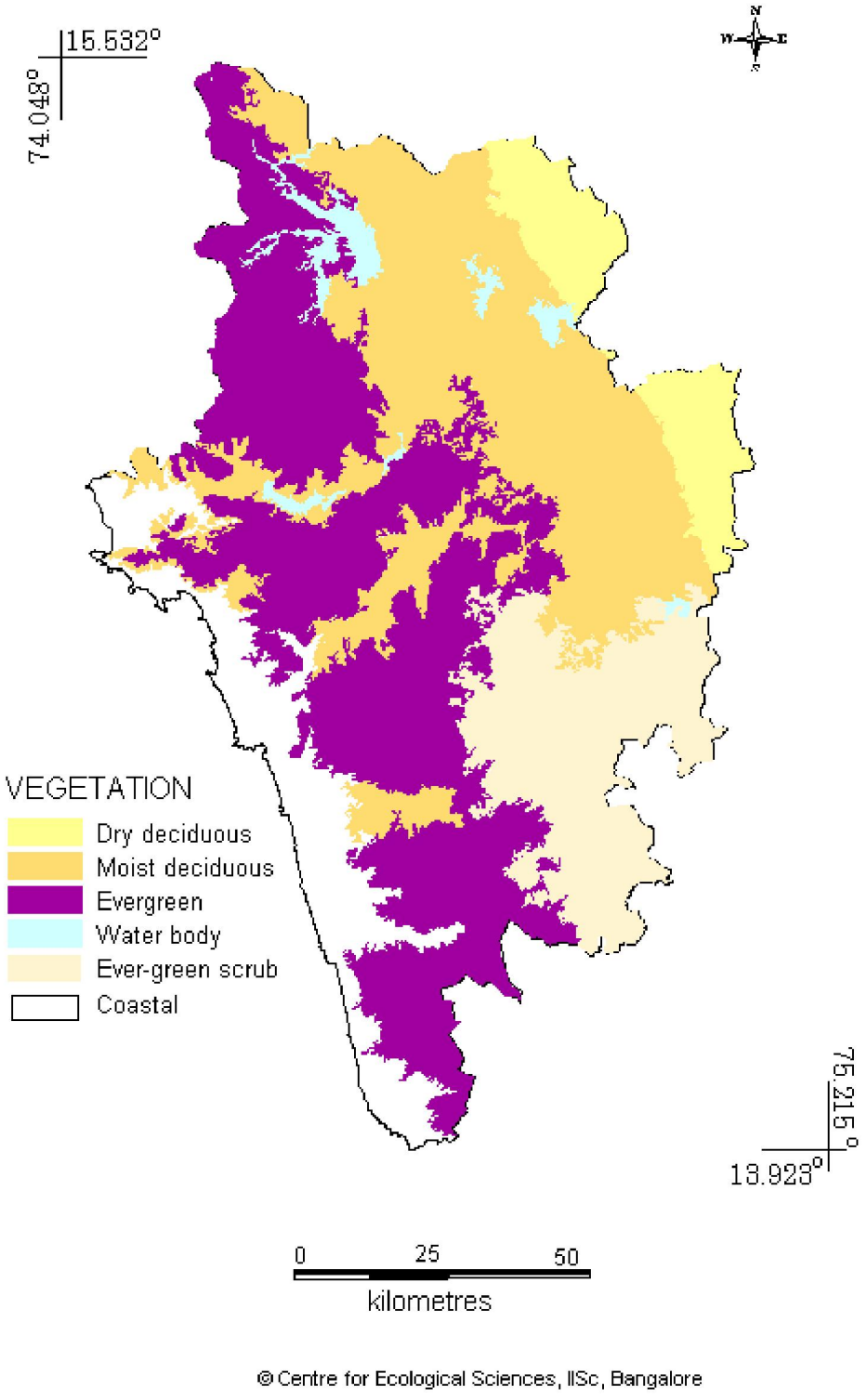


Figure 21: Vegetation distribution for Uttara Kannada District.

Types of forests found in various taluks of the district are as follows:

Ankola taluk: In Ankola taluk, as one move from one east to west, the forest types change from scrub to moist deciduous, semi-evergreen in stream pockets and interior depression. The western part which is adjoining the coastal is also denuded to unrestricted exercise of privileges and due to *Kumri* cultivation (shifting cultivation) in the past. The inland areas of moist deciduous and semi-evergreen are closed as fuel forest and high forest area, yielding firewood and timber respectively. Round about Hattikeri, in scrub, one can come across the Acacia catechu which yield valuable economic forest product called katha. The Bedthi River valley area supports valuable teak forests having the most common undergrowth, bamboo.

Bhatkal taluk: The type of forest in this taluk changes from laterite thorn to laterite evergreen. There is very little of moist deciduous forests. The barren hills around Murdeshwar and Bhatkal are a testimony to the acts of unrestricted feelings. As one goes in the interior, the vegetation improves gradually. The evergreen forests round Kop village in the northeast part of the taluk contain a large situated in the northwest and south west of the taluk contain a large number of Acacia catechu trees. These are bigger in the girth in the Bale forests in the southwest part of the border of Udipi district.

Haliyal taluk: The eastern and northwestern parts of Haliyal taluk comprise teak pole area tending to scrub towards the border of Darward district. The forest towards western half of this taluk are constituted at High forests, yielding valuable teak timber. The timber extracted from these high forest areas are transported to Dhandeli and Alnuvar forest depots. The drier parts of the area have sandalwood and are extracted annually on a sustainable basis. There are patches of evergreen forests towards the western side in the lower portions of the valley of the rivers and perennial streams. Bamboo is considered as one the most valuable constituent of economic forest produce.

Honavar taluk: In this taluk, the forest type changes from semi-evergreen and evergreen. There is very little of the moist deciduous type which can be seen only on top of forests small hills in the western part of the belt. The coastal strip of the forests is all denuded and in many parts, the land has become unfit even to bear poor grass. As one advances in the interior, the forest growth improves gradually. These forests contain valuable timber trees like *poon, ganjan, bobbi, honne, kindal, jamba, nandi, bharangi* and others, suitable for matches and plywoods. The laterite semievergreen forests and evergreen forests in the northeast corner, in Mahime and Jankadkal villages of the taluk, contain *tale* palms. The belt of *Acacia catechu* also passes in this taluk, mostly confined to the southwest part of the taluk. The evergreen forests of Gersoppa contain varieties of canes which are exported outside the district.

Karwar taluk: In Karwar taluk, as one goes from west to east the forest types gradually change from laterite thorn to moist deciduous and laterite semi-evergreen to evergreen. The forest to the west of Honkane village has been depleted due to the unrestricted exercise of privileges. The deciduous forests in lower slopes tend to be towards high forests, yielding valuable timber of teak, *sissum, honne, kindal,* etc. *Jamba* is the predominant species of this tract. The upper slopes and lower valleys and banks of perennial streams contain patches of evergreen forests and large quantities of canes *(calamum)* that are exported to various places.

The upper slopes are not worked due to their inaccessibility. Reserved forests of the moist deciduous type in the patches of laterite semi-evergreen in the interior situated on the steep hills round Karwar had been classified as "Karwar Town Five Miles Special Reserves".

Kumta taluk: In the Kumta taluk types of forests change from laterite thorn to moist deciduous, laterite semi-evergreen and evergreen as one advances from west to east as is the case in other taluks. The timber bearing high forests are confined to (he southeast part of the taluk at the foot of the Nilkund and Dodmane ghats round about the Soppinahosahalli village. Round about Mirjan, the laterite thorn forests contain khair trees which yield valuable *catechu*. Bamboos occur in the Aghanashini valley round about Soppinahosahalli.

Mundgod taluk: The forest type in Mundgod taluk changes from scrub in the southwest near the Sirsi taluk boundary. The stock improves as one advances from east to west. The eastern half is comprised of teak pole area and the western in the high forest area. The deep valleys, in the southwest and the perennial streams belts are covered with patches of semi-evergreen forests. The drier parts of the teak pole arch towards the border of the Dharwad district contain sandalwood. The forests also contain bamboos.

Siddapur taluk: Going to the scanty growth in the eastern side and also to the major part of Siddapur taluk being very hilly, no part is organized except the area covered by sandalwood trees towards the north-east, east and south-east. This sandalwood belt extends to Sirsi, Mungod taluks also. The eastern part is drier and as one advances form east to west towards the ghats, the forest type improves to semi-evergreen. There are many large patches of evergreen forests callad *kans* in this taluk mostly confined to the west round about Dodmane, Nilkund and Malemane ghats. These contain valuable matchwood, the extraction of which will be economical only when communications are improved.

Sirsi taluk: The forests of Sirsi taluk are firstly semi-evergreen and evergreen types. The evergreen forests are attached here and there all over the area. The belt of sandalwood forest of Siddapur taluk runs over this taluk and is mostly confined to the southeastern part bordering Siddapur taluk and Shimoga district.

Supa taluk: The greater part of the Supa tract is very hilly and preciphorous. The forest area falls into *two* different types of forests. The southeastern part of this taluk contains high forests, near about Gund and portions of the Nagjhari valley and the Kalinadi and the Kaneri slope forests, yielding mainly timber of valuable species. Gund has the finest teak plantations. Evergreen patches, are also found in the valleys. The forests of the northern point near about Castlerock yields only fuel and it merges into scrub forests, wherever the soil is very poor. Bamboo grows abundantly in this taluk.

Yellapur taluk: The northern part of the Yellapur taluk is a, valuable forests of teak. Bamboo is also plenty here, confined to the catchment area of Gangavali. The bamboo belt extends to Ankola taluk also.

1.11 Agro climatic zones:

Agro-climatic zoning is done on taking into consideration the rainfall pattern, quantum and distribution, soil types, texture, depth and physio-chemical properties, elevation, topography, major crops and type of vegetation. It helps in raising the production and productivity of the agricultural and livestock sector, and of arresting and reversing the deterioration of renewable natural resources involved in agricultural and livestock production and even comparative crop estimation.

Argo-climatic zones can correspond to two principal types-- general and specific--of agro climatic zoning. General types to agro-climatic zoning systems often refer to broad geographic regions (district, state, country, continent, or the entire world). The object is to identify zones of possible crops as related to the length of the vegetative cycles, the choice of crop and varieties, and the possibility of obtaining satisfactory levels of production. Specific types of agro-climatic zoning studies are done on a more detailed scale and refer to a particular crop. Specific requirements of the particular variety can be compared with existing climate conditions in each zone. Eventually, this type of zoning can narrow down to a single aspect of the crop: disease development, utilization of one cultivation technique, the demands of a particular phenological phase (term or period of photosynthesis, necessity of a dry period for maturation or of intense cold for germination, etc.). One of the most interesting tasks of agro-climatic zoning is the comparative analysis of productive ability of various ecosystems.
Uttara Kannada has three types of agro-climatic zones (figure 21), coastal and hilly. District contributes for 160817 lack tones or just 1.47% of the food grains production of the state for 2000-2001(Department of Agriculture, Govt. of Karnataka). Processing units are available for cashew, pineapple, coconut and vanilla. Long coastline, suitable agro climatic conditions and availability of water offer huge scope. The table 4 explains cropping pattern with respect to each taluk of the district. Major contribution is from Paddy cultivation followed by Groundnut. Sugar Cane and groundnut are major commercial crops grown in Uttara Kannada. Bengal gram, Green gram and Cowpea are the major pulses grown in the district. Groundnuts, Soyabean are major oilseeds.

Table 4: Cropping pattern at taluk wise

Taluk	Cropping Pattern
Karwar, Ankola, Kumata, Honnavar, Bhatkal	Paddy, Paddy–Pulses, Paddy–Groundnut, Sugarcane
Sirsi and Yellapur	Paddy, Paddy-Pulses, Paddy-Groundnut. Cotton, Sugarcane
Siddapur and Joida	Paddy,Paddy-Pulses,Paddy-Groundnut, Sugarcane
Haliyal and Mundgod	Paddy, Paddy-Pulses, Maize, Cotton, Sugarcane

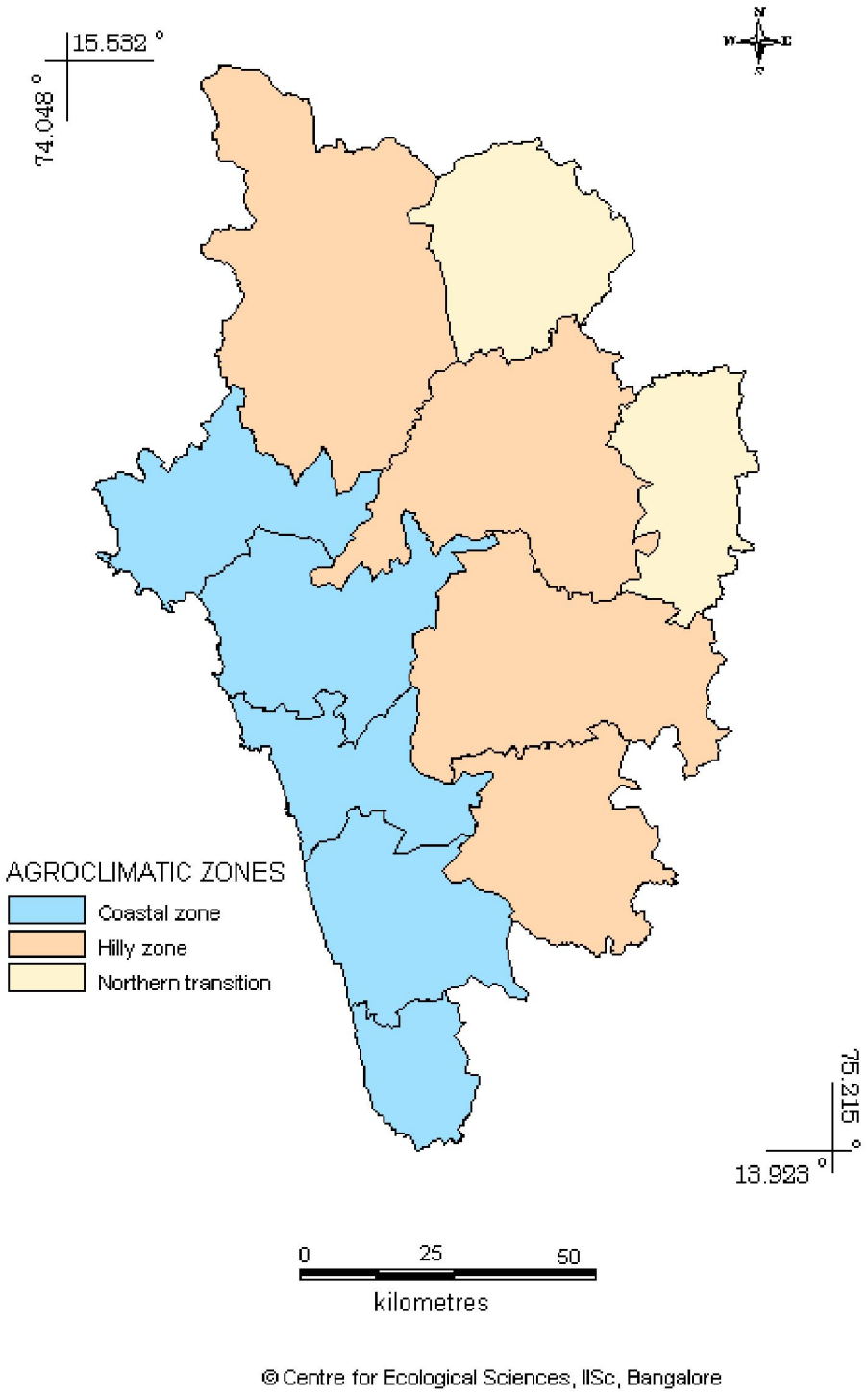


Figure 22: Agro-climatic zonation of Uttara Kannada district

1.12 Industrialisation:

Apart from forest based industries already referred to other industries were established in the district, having ecological and socio-economic consequences. The district constitutes of 6 medium & large scale industries and 8 industrial estates. The district also has 9,154 MSME units (Micro, small, Medium Enterprise). The Ballarpur Industries Ltd., Binaga at Karwar was established in 1975. Nearly 1200 hectares of estuarine areas of Aghanashini river in Kumta taluk were allotted to the factory for producing salt to prepare caustic soda. This caused displacement of several families of estuarine farmers. Subsequently the factory found the lands not very suitable for salt making, and returned the lands to the Government. Since the farmers evacuated from these estuarine lands were already paid compensation by the Government, the latter refused to restore the lands to the farmers. It is alleged that the industry is discharging treated effluents of sodium tri-poly-phosphate and mercury into the Arabian Sea through a pipeline, causing marine pollution (Hegde, 1999).

The Uttara Kannada district is rich in minerals such as iron, lime-stone, quartz, manganese, bauxite, molluscan shells, silica etc. These minerals were exported since pre-independence days or used within the country itself. In 1955 the Dandeli Ferro Allies Pvt Ltd. was established. The factory uses manganese ore extracted from the forest belt for production of ferro alloys. By 1981, as many as 98 mining leases were given in the catchment area of Kali river itself, covering an area of 125.6 sq km. Total mining area within the district, mostly situated in the forests of Joida, Yellapur and Karwar taluks are reported to be 148.94 sq km. The mining operations cause various disturbances to the ecosystems. Erosion by runoff causes damage to forests, agriculture and rivers. The increased silt load in the river Kali was considered as detrimental to many aquatic organisms.

1.13 Developmental projects

The recently completed Sharavati Tail Race produces 120 MW power (annual report 2001-02 Govt of India) at the expense of submerged 575 ha of biodiversity rich forests; another 125 ha of lands were given for other associated works.

Kaiga atomic energy plant which is a Pressurized Heavy Water Reactor (P.H.W.R) with a capacity 2x220 MWe was commissioned in 2000 and another two units are under construction (Nuclear power Corporation of India limited).

This project has taken away 732 ha of forest lands, which were rich in biodiversity. Nearly 450 species belonging to 338 genera have been recorded of which two monotypic genera viz. Carvia with a single species, C. callosa (Nees) Bremek. (Acanthaceae) and Moullava, again with a solitary species M. spicata (Dalz.) Nicolson (Caesalpiniaceae), and 28 species are endemic to the Western Ghats region (Krishnakumar et al., 1998). Environmentalists fear that the project will have severe consequences on the biodiversity of the region. About 677 ha forest lands were affected for making power transmission lines.

Table 5: Power generated by Hydel power stations across Kalinadi

Power station	No of units	MW	Total (MW)
Supa	2	50	100
Nagihari	3	135	855
	3	150	
Kadra	3	50	150
Kodasalli	3	40	120
*Karnataka state power corporation limited			

The construction of more power projects are under consideration in the hitherto untapped rivers Bedthi and Aghanashini, despite organized protests from environmental activists and the farmers (Hegde, 1999).

The creation of rehabilitation centres for affected was also attended with forest clearance and ecological consequences. Ramnagar rehabilitation centre meant for settlement of Kali project evacuees was already deforested in 1975 creating severe erosion and desertification.

Project Seabird and Konkan Railways: The construction of Project Seabird Naval Base involved eviction of thousands of families of fishermen and farmers from the coastline of Karwar and Ankola taluks. Environmental modifications of great magnitude, such as building of breakwaters, dredging of the sea, filling up of coastal swamps, intensified construction activities and other landscape changes are being executed in the Project Seabird area. The rehabilitation of the evacuees brought greater pressure in other coastal villages as well as in the forest areas of hinterland. The construction of the Konkan Railway through the west coast, while revolutionising coastal transportation had also its own inevitable environmental impact in the form of landscape changes, diversion of agricultural and forest lands etc.

Encroachments as a major causal factor of degradation: Encroachments of land belonging to forest department and public communities have become widespread in Uttara Kannada. Especially it is due to the higher price value of lands, large areas of Government land. Many reports from Government and nongovernment agencies emphasized the same. The identification and removal of encroachment of public lands is an immense task. It involves a serious action by Government, especially by the Departments of Forest and Revenue. The Task force report by Government of Karnataka concludes that encroachment lands according to the details furnished by the Forest Department, the forest area of Karnataka state under encroachment is 69075 Ha. The forest land that has been encroached in Uttara Kannada is 11483 Ha. This issue is posing a serious challenge to decision makers.

Road and Rail network: Uttara Kannada is well connected with road network even though the terrain is rugged and hilly. Four National highways running across Uttara Kannada (figure

23). State highways connection different places of state connecting Uttara Kannada are five in number. State highways and National highway are connected with smaller towns with district road network of length 3645 km (table 6 & 7). The following are major National highways and State highways details in the district. NH 206 connecting Honnavar and Tumkur, NH 17 connection Panvel and Trichur, NH 63 Ankola to Gooty, and NH 4A between Panaji to Belgam. State highways are SH 69 Kumta with NH4 via Sirsi, Mundagod and Thadas. SH 48 Kumta with Pavagada via Siddapur, SH 6 Karwar with Hanumasagar-Il - Kaiga-Yellapur-Mundagod. Sh 93 Siddapur with Khanapur in NH 4A with Talaguappa via Haliyal Yellapur and Sirsi. SH 95 Khanapur with Sadasivagad via Londa and Supa.

Table 6: Road & Railways length of district

District details of Road length				
(As on 31-03-2010)				
Name Of The District	Road Length (in Kms)			Total Road Length
	National Highways	State Highways	Major District Roads	
Uttara Kannada	331	1246	2068	3645
State Total	**4490**	**20528**	**50436**	**75454**

Railways length (km)	
Konkan Railways	**130.6**
Belgaum to Goa	**20.71**
Dharwad to Haliyal	**24.39**

Table 7: Road length of district at taluk level

Taluk wise road length (in Km) as on 31-03-2010				
Taluk Name	**National Highways**	**State Highways**	**Major District Roads**	**Total**
Karwar	37	107	141	285
Ankola	70	38	161	269
Kumta	31	67	232	330
Honnavara	77	36	162	275
Bhatkal	25	27	158	210
Supa	16	223	138	377
Sirsi	0	229	263	492
Yallapura	49	91	170	310
Haliyala	0	108	152	260
Siddapura	26	230	338	594
Mundugodu	0	90	153	243
Uttara Kannada Dt	**331**	**1246**	**2068**	**3645**
State Total	**4490**	**20528**	**50436**	**75454**

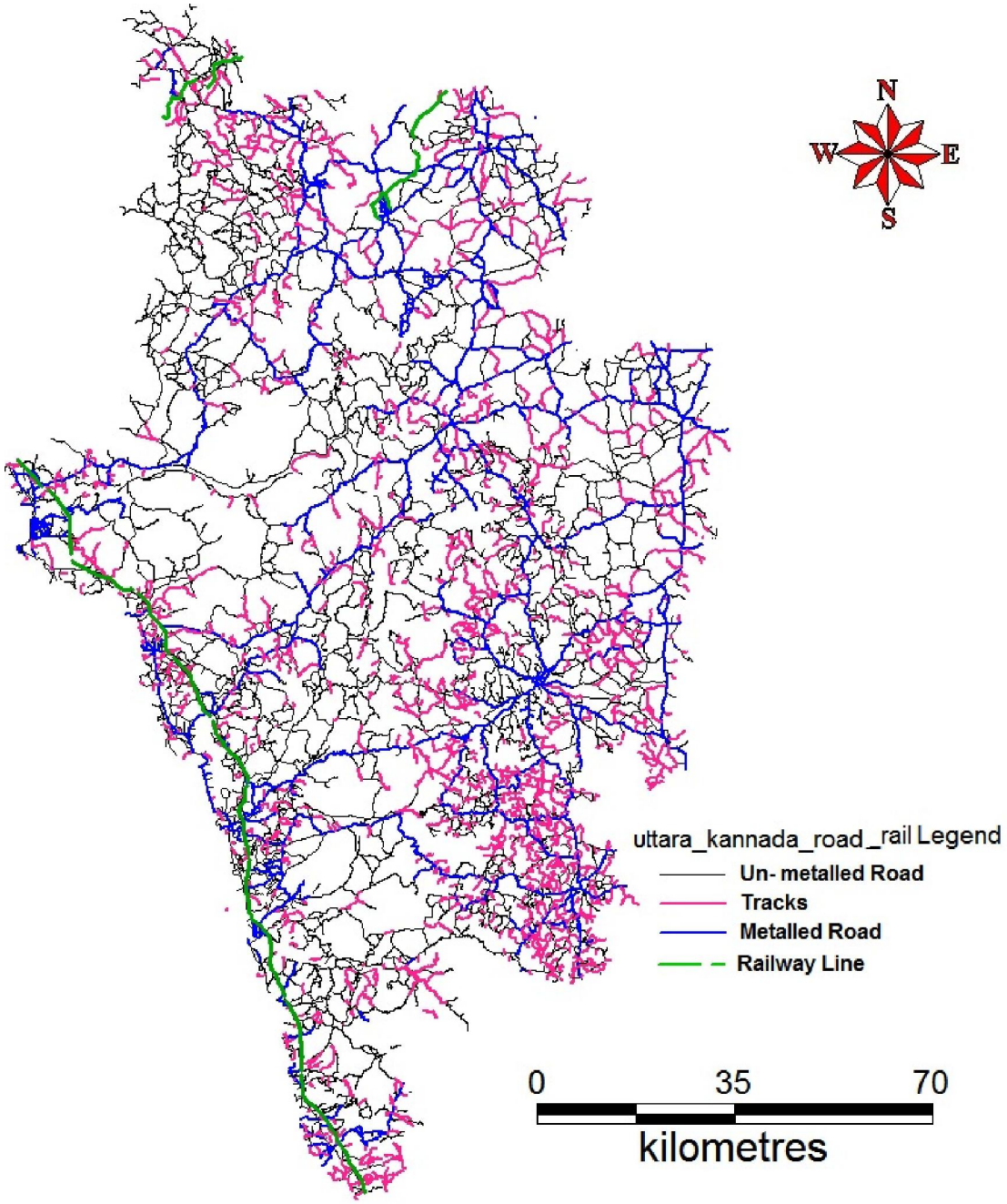


Figure 23: Road and rail network of Uttara Kannada district

1.14 **Biodiversity:**

Amidst the development activities still Uttara Kannada has rich biodiversity even though most flowering plants, mammals and birds are documented, more diversity remains to be uncovered: especially lower plants, microorganisms, reptiles, moths, beetles, other insects and various other invertebrates. There is also very little documentation on diversity of traditional varieties of cultivated crops; much remains to be understood about the traditional agricultural systems and their intrinsic relationship with the environment, although

agriculture is the lifeline of about 75% of the people. The earliest documented evidence of the agricultural practices is by British men Francis Buchanan and D. Brandis. Our group at Centre for Ecological Sciences (CES, IISc) has conducted some ecological studies in natural resource management in various ecological zones. The existing agricultural systems have been also documented by Prakruti, a NGO based in Sirsi. Another NGO, Parisara Samrakshana Kendra has collected information on the paddy varieties of the district.

State of natural ecosystems

Plants: Daniels, *et al*. (1993) estimated that the district is known to shelter 1741 recorded species of flowering plants, a good number of them are endemic to the Western Ghats. The district is also a mosaic of different habitat types. A typical grid of forest area of 5 KM x 5 KM is likely to consist of six or more major types. The district has tremendous diversity of lower plants and animals. Unfortunately much remains to be done in inventorying such great diversity. P.K. Rajagopal (personal communication) has listed 70 species of Pteridophytes (ferns) from Uttara Kannada. A study by Naik (1992) in the Sharavati river estuary reveal the presence of 87 species of diatoms, 21 species of Dinoflagellates, 11 species of Cyanophytes and about 80 species of Green Algae (Chlorophytes). Naik et al (2000) have reported 55 species of phytoplankton from Kali estuary, 37 of them being diatoms. Phytoplanktons are the producers of the estuarine ecosystems and undoubtedly play vital role in making estuaries one of the highest productive ecosystems of the world. Nothing much is known about many of the lower plants such as Bryophytes and Lichens. A recent survey by Nayaka (2002) in the Western Ghats of the neighboring Shimoga district shows the presence of 143 lichens. Most of them are expected to be present in Uttara Kannada as well.

Animals: According to Daniels (1989) Uttara Kannada district has 419 taxa of birds. About 55% of these birds are residents in the district while 34% are winter visitors. Among the wintering birds 40% are water birds. The bird fauna of 419 taxa is considered remarkable for the size of the district (10,291 km²). The state of Kerala which is 3 times as large as the district has only 375 taxa and the state of Maharashtra which is 30 times larger, has 540 taxa. Of the 63 taxa of birds endemic to the Malabar province (Western Ghats-west coast region) Uttara Kannada has 34 of these. The list of the endemic birds of Uttara Kannada are given in Table 7

Table 7: The endemic and rare bird species of Western Ghats-Sri Lanka found in Uttara Kannada

Sno	Common name	Scientific name	Remarks
1	White-bellied blue flycatcher	*Musicapa pallipes*	Evergreen forests
2	Large Indian parakeet	*Psittacula eupatoria*	
3	Scalybellied green woodpecker	*Picus myrmecophoneus*	
4	Orange-breasted green pigeon	*Trecron bicinata*	
5	Nilgiri thrush	*Zoothera dauma*	
6	Yellow-backed sunbird	*Aethopyga siparaja*	Southern limit

7	Rufous-belleid hawk-eagle	*Hieraaetus kinierii*	Evergreen forest
8	Blue-winged parakeet	*Psittacula columboides*	
9	Ceylon frogmouth	*Batrachostomus moniliger*	Rare, Malabar & Sri Lanka
10	White-bellied treepie	*Dendrocitta leucogastra*	
11	Greyheaded bulbul	*Pycnonotus priocephalus*	
12	Wyanad laughing thrush	*Garrulax delesserti*	Small population in Castle Rock
13	Black-headed babbler	*Ropocichla atriceps*	Rare. Nests in holes of large trees
14	Great Indian hornbill	*Buceros bicornis*	
15	Ruby-throat bulbul	*Pycnonotus melanicterus*	
16	White-headed myna	*Sturnus malabaricus*	
17	Malabar crested lark	*Galerida malabaricus*	Resident of humid forest & non-forest
18	Nilgiri wood pigeon	*Columba elphinstonii*	Endangered
19	Shaheen falcon	*Falco perigrinus perigrinator*	Rare; Lushington falls
20	Black eagle	*Ictinaetus malayensis*	

The district is rich in wild mammal diversity. These include elephants, tigers, leopards and the endangered mammal Lion-tailed macaque. The details regarding the bats of Uttara Kannada are shown in Table 8 and the list of other wild mammals, reptiles and amphibian in Table 9. The 25 species of bats from the district account for 62.5% of the total number of bat species recorded from the Karnataka region by Paul Bates and David Harrison. Of these the Gersoppa-Jog Falls region alone has 10 species.

Naik et al (2000) have reported 45 zooplankton spcies from the Karwar coast. There are 14 species of bivalves (clams) associated with the Aghanasihini river estuary, which is unique to the entire west coast (P.K. Bhat personal communication). It is notable that the collection of bivalves for food is a major employment for hundreds of women in the estuarine villages. They also gather empty shells for lime making and industrial purposes. The bivalves form an abundant and cheap source of good nutrition in coastal Uttara Kannada.

Table 8: The bats reported from Uttara Kannada (Bates and Harrison)

Sno	Name	Places reported
1	Fulvous fruit bat	Gersoppa, Muroor
2	Indian flying fox	Devikoppa
3	Lesser dog-faced fruit bat	Gokarna
4	Dawn bat	Muroor
5	Lesser mouse-tailed bat	Gokarna
6	Long winged tomb abt	Sirsi
7	Black-bearded tomb bat	Jog
8	Naked-rumped tomb bat	Sirsi
9	Pouch bearing bat	Malg. Sirsi, Gersoppa, Yellapur
10	Greater false vampire	Honavar, Sirsi, Jog, Devikoppa

11	Lesser false vampire	Sirsi, Hulekal, Gersoppa
12	Rufous horse-shoed bat	Barchi, Hulekal, Sirsi, Yellapur
13	Blyth's horse-shoe bat	Jog, Gersoppa
14	Lesser wooly horse-shoe	Sirsi
15	Fulvous leaf-nosed bat	Honavar
16	Kantor's leaf-nosed bat	Honavar
17	Schneider's leaf-nosed bat	Gersoppa, Honavar
18	Kelaart's leaf-nosed bat	Gersoppa, Muroor
19	Burmese whiskered bat	Gersoppa
20	Asiatic greater yellow house bat	Sirsi
21	Asiatic greater yellow house bat	Sirsi, Hulekal
22	Bamboo bat flat-headed bat	Sirsi, Hulekal
23	Least pipistrelle	Honavar
24	Kelart's pipistrelle	Sirsi, Honavar
25	Tickelle's bat	Yellapur, Potolli, Hulekal

Table 9: Wild Mammals of Uttara Kannada

1. Bonnet Macaque (*Macaca radiata*)
2. Lion-tailed Macaque (*Macaca silenus*)
3. Common Langur (*Presbytes entellus*)
4. Nilgiri Langur (*Trachypithecus johnii*)
5. Slender Loris (*Loris tardigradus*)
6. Tiger (*Panthera tigris*)
7. Leopard (*Panthera pardus*)
8. Leopard Cat (*Felis bengalensis*)
9. Fishing cat (*Felis viverrina*)
10. Jungle Cat (*Felis chaus*)
11. Malabar Civet (*Viverra civettina*)
12. Small Indian civet (*Viverricula indica*)
13. Common Palm Civet (*Paradoxurus hermaphroditus*)
14. Brown palm civet (*P, jerdoni*)
15. Common Indian Mongoose (*Herpestes mungo*.)
16. Stripe-necked Mongoose (*H. vitticolis*)
17. Striped hyena (*Hyaena hyaena*)
18. Jackal (*Canis aureus*)
19. Indian Fox (*Vulpes bengalensis*)
20. Indian Wild Dog (*Cuon alpinus*)
21. Sloth bear (*Melursus ursinus*)
22. Common Otter (*Lutra vulgaris*.)
23. Giant Squirrel (*Ratufa indica*)
24. Three Striped Squirrel (*Funambulus palmarum*)
25. Grizzled Giant Squirrel
26. Large Brown Flying Squirrel (*Pteromys oral*)
27. Grey Musk Shrew (*Cercidura caerulea*)
28. Common Indian Rat (*Mus rattus*)
29. Bandicoot rat (*Nesocia bandocoota*)
30. Porcupine (*Hystrix indica*)
31. Black-naped Hare (*Lepus nigricollis*)

32. Elephant (*Elephas maximas*)
33. Gaur (*Bos gaurus)*
34. Sambar (*Cervus unicolor*)
35. Spotted Deer (*Axis axis*)
36. Barking Deer (*Muntjacus muntjacus*)
37. Mouse Deer (*Tragulus memimna*)
38. Wild Boar (*Sus scrofa*)

Reptiles of Uttara Kannada

1. Crocodilus palustris
2. Heidactylus glea devii (house gecko)
3. Varanus bengalensis (Monitor lzard)
4. Lygosma guentheri
5. Chamaeleon calcaratus
6. Tylopus braminus
7. Python
8. Silybura elloti
9. Lycodon striatus
10. Hydrophobus nympha
11. Abalabes calmaria
12. Oligodon subgriseus
13. Zamensis mucosus (Rat snake)
14. Coluber helena
15. Tropidonotus monticola
16. T. plumbicolor
17. Dipsas ceylonensis
18. Dryophis perroteti
19. D. mycterizans
20. Callophis nigrescens
21. Naja naja (Cobra)
22. N. bungarus
23. Ancistrocladon hypnale
24. Trimeresurus strigatus

Amphibians of Uttara Kannada

1. Rana hexadactyla
2. R. cyanophyletis
3. R. tigrina
4. R. limnocharis
5. R. brevipes
6. R. malabaricus
7. R. curtipes
8. Micrixalus fuscus
9. Ixalus leucorhinus
10. Bufo melanostictus
11. Icthyophis monochorus (limbless Amphibian)

Table 10: Endemic fresh water fishes of Uttara Kannada rivers (Prakash Pandit, personal communication)

Sno	Species	Endemism	
		Western Ghats	South India
1	Puntius carnaticus	**	
2	P. bovanicus		**
3	P. dorsalis		**
4	P. fasciatus		**
5	P. curmuca	**	
6	P. jerdonii	**	
7	P. narayani	**	
8	P. lithopidas	**	
9	P. melanompyx	**	
10	P. sayadrensis	**	
11	P. pulchellus	**	
12	P. thomasii	**	
13	Gonoproktopterus wynadensis	**	
14	G. dubius		**
15	Tor khudree		**
16	Labeo procellus	**	
17	L. kawrus	**	
18	Garra Mulya		**
19	G. gotyla-stenorhynchus	**	
20	Cirrhinus fulungee	**	
21	Osteobrahma bakeri	**	
22	Esomus thermoicus		**
23	E. barbataus	**	
24	Salmostoma boopis	**	
25	Barilius gatensis	**	
26	B. canarensis	**	
27	Osteochilus thomassi	**	
28	Nemacheilus semiarmatus	**	
29	N. sinuatus	**	
30	N. anguilla	**	
31	N. altipedunculatus	**	
32	Mystus malabaricus	**	
33	M. oculatus	**	
34	M. vittatus	**	
35	M. montanus		**
36	Horabagus brachysoma	**	
37	Batasio travancoria	**	
38	Ompok malabaricus	**	
39	Glyptothorax madraspatana	**	
40	G. anamalaiensis	**	
41	Clarias dussumieri	**	
42	Aplocheilus lineatus		*
43	Etroplus surettensis		*
44	E. maculatus		*

Uttara Kannada traditionally is very rich in biodiversity of marine and estuarine fishes. The details regarding the commercial fishes of the district are given in Table 11.

Table 11: Details regarding the marine and estuarine fishes of commercial importance from Uttara Kannada

No	Common name	*Scientific name*	Kannada	Konkini
1	Mackerel	*Rastrelliger kanagurta*	Bangade	Bangade
2	Oil sardine	*Sardinella longiceps*	Trale, Tori	Tarle, Bhutai
3	Tuna	*Euthynus affinis*		
4	Sole	*Cyanoglossus spp.*	Leppe, Nangu	Lenga
5	Lady fish	*Sillago spp.*	Nogali, Kane	Nogali
7	Ghol	*Protonibea diacanthus*	Goli, Balvi	Ghol
8	Jew fish	*Scianea aneus*	Balvi	
9	Croaker	*Johnius solidado*		Dodi, Dantya dodi
10	Dhoma	*J. dussumieri*	Kodvi	Dodi
11	Brown lined reef cod	*Epinephelus undulosus*	Kallmurya, Gobro	Gobro
12	Giant reef cod	*E. argenti-maculatus*	Patte kallmurya	
13		*Lutjanus rivulatus*	Arthala	Arhtala
14		*Diagramma griseum*	Aadaga	Aadaga
15	Gar fish	*Strongylura strongylura*	Kande tole, Havu meenu	Tole
16	Wolf herrings	*Chirocentrus dorab*	Karli	Karli
17		*Chanos chanos*	Hoomeenu	
18		*Megalops cyprinoides***	Selakku	
19	Bombay duck	*Harpodon nehereus*	Bombil	
20	Sardine	*Sardinella fimbriata*	Pedi	Pedi
21	Sardine	*S. albella*		
22	Sardine	*S. longiceps*	Baige	
23	Sardine	*S. gibbosa*	Pedi	Pedi
24	Sardine	*Dussumieria acuta*		
25	Sardine	*D. basseltir*		
26	White sardine	*Kewala coval*	Swadi	
27		*Escualosa thoracata*	Belenji	Beleni
28		*Hilsa ilisha****	Paliya	
29		*H. toli*		
30		*Selipinna taty***		
31	Anchovies	*Anchoviella commersonii*		
32	Anchovies	*A. indica*		
33	Anchovies	*A. tri***		
34	Anchovies	*Stolephorus devisi*	Dinasi	Dinasi, Motyala
35	Anchovies	*S. bataviensis*	-do-	-do-
36	Anchovies	*Thryssa mystax***	Oenchli	Enaga,

				Onaga
37	Anchovies	*T, malabaricus*		
38	Anchovies	*T. purava***		
39	Pony fish	*Leignathus bindus*	Gurkku,	Kampa
40	Lactarices		Savandale	Savandale
41	Silver bellies	*L. splendens*	Guruku	Kampa
42	Threadfin bream	*Nemipterus japonicus*	Rani meenu	Rani
43	Threadfins		Ravese	Ravns
44	Tuna	*Auxis thazard*	Bugudi	Tokke
45	Tuna	*A. rochei*	Bugudi	
46	Tuna	*Euthynnus affinis*	Bugudi	
47	Seer fish	*Scomberomerus commerson*	Surmai, Ison	Surumai
48	Seer fish	*S. guttatus*	Surmai	Surmai
49	Seer fish	*S. lineolatus*	Srumai	Surmai
50	Pomfret, white	*Pampus argenteus*	Paplet, Bili manji	Dave Paplet
51	Pomfret, Chinese	*P. chinensis*	Paplet	Paplet
52	Pomfret, black	*Parastromateus niger*	Kari paplet	Kal paplet
53	Cat fish	*Arius maculatus*	Shyade	Sangat
54	Giant cat fish	*A. thalassinus*	Shyade	Sangale
55	Giant cat fish	*A. thalassinus*	Shyade	Sangale
56	Pearl spot	*Etroplus surattensis*	Kaagalsi	Kaleram Kagalsi
57	Shark	*Scoliodon laticaudus*	Sorrah, Mori	Mori
58	Grey dog shark	*S. palasorrah*		
59	Grey dog shark	*S. sorrakowah*		
60	Tiger shark	*Stegostoma varius*		
61	Whale shark	*Rhinocodon typus*		Rare
62	Shark	*Sphyrna blochii*	Kebichatte	
63	Shark	*S. zygaena*		
64	Shark	*Carcharhinus melanopterus*	Sorrah, Mori	Mori
65	Shark	*C. limbatus*		
66	Shark	*C. temminckii*		
67	Shark	*C. menisorrah*		
68	Shark	*Galeocerdo tigrinus*	Pil thatte	
69	Shark	*Chiloscyllium griseum*		
70	Shark, balck-tip	*Eulamia spallanzani*		
71	Shark, hammerheaded	*Sphyrna zygaena*		
72	Painted sawfish	*Pristis cuspidatus*		
73	Small-toothed sawfish	*P. microdon*		
74	Guitar fish	*Rhinobatus djiddensis*	Haradatte, Fadka	Yelar
75	Skate	*R. granulatus*		
76	Whip tail sting ray	*Himantura bleekeri*		Wagala
77	Ray fish	*Dasyatis sephen*	Kottai thorake	
78	Javanese cow-ray	*Rhinoptera javanica*		Wagala

79	Painted eel	*Gymnothorax favagineus*	Kolaav	
80		*Narcine brunnea*		
81	Ribbon fish	*Lepturcantus savala*	Kamble, Hambli	
82	Ribbon fish	*Lepturus sp*	Baale	
83		*Mugil sp.*		
84		*Gerrus sp.*		
85		*Polynemus sp.*		
86	Mud-skipper	*Pterythalmus sp.*		
87		*Caraux sp.*		
88		*Therapon sp.*		
89		*Sciaenid sp.*		

**Estuarine and fresh water; ***Marine, estuarine and fresh water

1.15 State of domesticated/semi-domesticated species/varieties

Uttara Kannada has various ecological zones in the district and the cultivated diversity is different in each of these ecological zones. Uttara Kannada is somewhat representative of the state of Karnataka having the humid coastal region and the *Malenadu* or the hill region, and the drier eastern plains with rolling hills merging with the semi-arid to arid Deccan Plateau. These three regions are three different agro-climatic zones and account for the tremendous domesticated diversity of the district.

i. *Coastal region:* The coastal region where saline water intrusion is present with mangrove ecosystems is unique. In this region sustainable traditional prawn cultivation is done. In addition to this the farmers grow saline resistant paddy varieties known as *' Kagga'* Similarly the coastal Kumta town is well known for its coconuts. This is a special variety with aroma and taste.
ii. *Foot hills of Western Ghats:* The foothills in Bhatkal taluka are well known for cultivation of scented paddy variety. Similarly Yana village in Kumta region is well known for good quality of coconuts with good yield and size. The foothills are also the resource base of NTFP collectors.
iii. *Crestline region:* This region mainly consists of Sirsi, Siddapur and Yellapur taluks. While the evergreen forest belt of this region is rich in wild biodiversity, the small narrow valleys are cultivated by farmers with arecanut, spices and paddy. The cardamom, pepper, areca, nutmegs and cocoa are the crops of the spice gardens.
iv. *Edge of ghats and plains:* The eastern parts of the district on the edge of Western Ghats are unique for horticultural crops and rained paddy varieties. In horticultural crops, the Pala region is a famous for growing mangoes.
v. *Riverine forests:* The forests on the banks of the small streams/ rivers in the district produce a unique ecosystem with diverse plant spices. The special wild mango varieties used for pickles known as *appemidi* is found in this belt.
vi. *Livestock*: Livestock is an integral part of the agricultural system in the region. Farmers keep cattle for ploughing and to meet the demand of milk. The local *Malenad Gidda* varieties of oxen and cow are the indigenous stock of the region. In recent years the cross breeding with the jersey stock has resulted in evolution of a cross bred

stock that is used as draught as well as for milk. The farmers also keep goat and poultry. The local varieties are popular in the region. The Gawli tribes are specialised in rearing the buffalo which is popularly known as 'Gawli Buffallo.' Very little is done on the indigenous poultry of the district.

vii. *Honey bees:* Bee keeping is one of the important components of cultivated diversity. Bees play major role in conservation of biodiversity through pollination of crops, especially horticultural crops such as areca, mango, guava etc. There are three major species of honeybees in Uttara Kannada, namely the Rock bee (*Apis dorsata*), Indian bee (*Apis cerana indica*) and sting less bees (*Apis florea*)

viii. Paddy, legumes and sugarcane are important agricultural crops of the district. There are traditional varieties as well as modern HYV (High Yielding Varieties) in each of these crops, which are adopted by the farmers. The diversity within each of these crops and several others is quite high though most of it is yet to be surveyed systematically. Despite small area under rice the local varieties grown are many, despite our incomplete documentation, as shown in Table 12

Numerous horticultural crops are important in the economy of the region. The spice gardens in the narrow valleys in the Ghats have played key role through ages in the prosperity of the district. The pepper varieties known to be cultivated in the district during the past and present times are *Dadiga, Giddakare, Kudrugutta*, Mallisara*, Tirpagare*, Waddakare.*[*] The decline of the traditional varieties due to disease has made farmers resort to growing of hybrid pepper. The evergreen-semievergreen forests are rich in different species of wild pepper; although over the years, due to neglect and unplanned exploitation it is difficult to sight good yielding pepper in the wild.

Banana is widely cultivated in the district. the notable varieties are *Boodibale, Chipsbale, Currybale(Anbale) Karibale, Mitka, Mysore mitka, Nenibale, Rasabale, Pachebale, Sakkarebale.* Some exotics and hybrids are also grown in the district. Over the last ten years also, mainly due to the "Bunchy-top disease" the bananas are on the decline.

Table 12: The traditional rice varieties of Uttara Kannada

Ajaga	Kannuru
Arya	Karabele
Aryahalaga	Karibatta
Aryakempi	Karichitka
Banka	Koondooru
Bantavala	Kumbharjaddu
Bilibatta	Masakaai
Biliekka	Mottahalaga
Bilikabagga	Mugenbelaga
Chitka	Mullare
Dasala	Pandya
Dasapatte	Rangoona
Doddapandya	Ratnachooda

Gowri	Sannabatta
Halaga	Sannamalaga
Halagempi	Sannamullarya
Hurutaga	Sannapandya
Jaddikempi	Shetgi
Jadduhalaga	Siddasali
Jattu	Sundari
Kagga (both black and yellow husked)	Tebbal
Kanchutti	Theppadarya

Arecanut is a major crop in the district, being cultivated in nearly 10,000 ha. As paddy cultivation today is nearly unprofitable many farmers have taken to arecanut. As arecanut needs more water there has been, of late, a wave of encroachment into the forests, along the streamsides, to raise small-scale areca gardens, causing further decline and endangerment of the already threatened Myristica swamps and decline of the climax streamside vegetation. Watershed value of stream catchments are negatively affected too.

The diversity of fruit trees in the region is high. They can be found in domesticated and wild ecosystems. Mention may be made of the wild *'appemidi' mango* variety, which is favourite for pickling. Similarly the jack fruit varieties are also many in the district. There are numerous varieties of wild fruits that are used by forest dwellers and children. These include wild mangoes, kokum, *uppage* jackfruits, jujube, black berries (*neerilu*), gooseberries etc. These are on the decline due to the decrease in forest diversity.

The Western Ghats has divided the district in to coastal, hilly, and north transition agro-climatic zone. Due to varied zones in the Uttara Kannada it has rich biodiversity. Apart for biodiversity other natural resource are also rich. This has attracted many players like hydle power stations, a nuclear power station, mining industries, paper industries are exploiting the natural resources and further disturbing the delicately balancing nature. The studies indicate that, in further if disturbance is avoided the evergreen species which are endemic to the region and which had depleted can come back increasing the richness in biodiversity. Every decision taken has to keep nature and the consequences of unnatural act.

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LAND USE CHANGES WITH THE IMPLEMENTATION OF DEVELOPMENTAL PROJECTS IN UTTARA KANNADA DISTRICT

Forest ecosystems in Uttara Kannada district have witnessed major transformations during the post-independence. Uttara Kannada district has the distinction of having highest forest cover among all districts of Karnataka. Land use analysis using temporal remote sensing data reveal distressing trend of deforestation in the district, evident from the reduction of evergreen - semi evergreen forest cover from 67.73% (1973) to 32.08% (2013). Taluk-wise analyses reveal similar trend for evergreen - semi evergreen forest cover during 1973 to 2013; Ankola (75.66 to 55.33%), Bhatkal (61.37 to 30.38%), Honnavar (70.63 to 35.71%), Karwar (72.26 to 59.70%), Kumta (62.89 to 29.38%), Siddapur (71.42 to 23.68), Sirsi (64.89 to 16.78), Supa (93.56 to 58.55%), Yellapur (75.28 to 18.98%), Haliyal (35.45 to 2.59%), Mundgod (2063 to 1.52). Forest cover has declined from 81.75 (1973) to 60.98% (2013) in the coastal zone, 91.45 (1973) to 59.14% (2013) in the Sahyadrian interior, and 69.26 (1973) to 16.76% (2013) in plains zone. Implementation of developmental activities without taking into account the ecological significance of ecosystems, services provided by them in meeting the livelihood of local population has resulted in the degradation of forests. These changes in the landscape structure (through large scale land use changes) have altered functional abilities of an ecosystem evident from lowered hydrological yield, disappearing perennial streams, higher instances of human –animal conflicts, declined ecosystem goods, etc. This necessitates the restoration of native forests in the region to ensure water and food security apart from livelihood of the local people. About **62814.48 Ha** of forest land is diverted for various non-forestry activities during the post-independence period. About **7071.68 Ha** of forest area has been encroached for agriculture, horticulture activities, etc. Maximum encroachments of forest lands are in Sirsi, Honnavar forest divisions i.e., 3641.66 Ha and 1851.93 Ha respectively. An appropriate policy framework is required to prevent further encroachments of forest land and ensure sustainable management of natural resources.

2.0 Introduction:

Development is process of improving the quality of all human lives with economic advancement considering social, ecological, psychological and political processes. More than 1.6 billion global populations depend to varying degrees on forests for their livelihoods (World Bank 2006c). Local livelihood either through goods of either aquatic or terrestrial ecosystems depend on the health of the respective ecosystems. Altering the ecological integrity would impact the ecological services and hence affect the livelihood of the dependent population. Unplanned developmental activities though succeeded in providing the handful of jobs and resources to the influential sections of the society but have deprived ecosystem people of their livelihood. The adverse effects of the developmental activities are evident from alteration of natural topography, deforestation, soil erosion, loss of nutrients in the soil, sedimentation, soil compaction, spread of invasive exotic species, fragmentation forests, enhanced human-animal conflicts, etc. This emphasizes the need for ecosystem approach involving all stakeholders in the management of natural resources. The ecosystem approach will take into account ecologically sensitive areas, habitats of endangered (threatened) species, rare and “keystone” (ecologically important) species while formulating policies.

The cumulative effects of adverse developments are evident from the extent of fragmentation of forests, which is the manifestation of the landscape pattern changes (Ramachandra and Uttam Kumar, 2011). Disturbance corridors created by forest fragmentation alter the natural mix of habitats and species by providing conditions suitable for early succession in plants and animals. They replace forest trees with grasses and shrubs, eliminating nesting habitat for forest-interior species. The ecosystem approach in ecosystem management will help in addressing the impacts of habitat fragmentation through the analysis of both habitat pattern and connectivity. The Uttara Kannada district has the distinction of having highest forest cover in the State. However, without proper valuation of natural resources extracted the State administration has branded the district as backward district. Many projects such as paper and pulp based industries, plywood Industries, power projects, mining etc. were taken up in the district without proper planning. The unplanned developmental activities led to the large scale changes in land cover affecting the hydrology, productivity of soil and has affected livelihood of people. Table 1 explains the land allotments made for various developmental activities by the forest department due to the pressure from the State government since 1956.

Large reservoirs for hydroelectricity generation of Kali and Sharavathi have submerged vast tracts of natural forest and displaced large number of families. Large scale migration to the catchment area of these projects due to availability of water, led to the large scale land cover changes with retreat of forests, soil erosion, loss of productive top soil layer, alterations in hydrologic regime in each basin leading to lowered catchment yield in the respective sub-basins. Encroachment of forest lands, conversion of natural forests to monoculture plantations of exotic species, etc. led to fragmentation of forests with higher instances of human-animal conflicts. All these cumulative effect is evident from the disappearance of endemic species and erosion of biodiversity. Any afforestation project will fulfill the goals only when the underlying causes for deforestation are adequately addressed. The compensatory afforestation programmes in arid areas do not compensate for the loss of rich evergreen and moist deciduous forests of the Western Ghats. In 1970's the State Government acquired about 1800 acres of estuarine lands of Aghanashini River, in the Hiregutti-Madnagiri villages of Kumta, and handed over the same for salt production to the Ballarpur Industries Ltd., Binaga (Karwar taluk). These lands were mostly estuarine rice fields (gajnis) and mangrove areas aiding in nutrient cycling and productivity of the coastal ecosystems. Subsequently the Ballarpur Industries Ltd. abandoned salt production in these lands. And these lands remain fallow now. Kali river with 6 major dams has submerged about **14602 ha** of prime forests in Uttara Kannada district. At peak construction activities, the work force was around 50,000. Housing colonies were set up after denuding the surrounding hills. During the Kali stage I, the township of Ambika nagar in Uttara Kannada was located in an area that still then was covered by dense forests. Before handing over the area to Karnataka Power Corporation, the forest department removed all the trees and handed over a totally denuded area. A similar denudation occurred at Ramanagara, the rehabilitation area for the Supa reservoir onsets.

Main objective of the current work is to assess the temporal land use dynamics with the implementation of developmental projects during 1973 to 2013. Figure 1 show the major

developmental projects in the district. Temporal land use analyses have been done considering the project region with 1 km buffer to account for changes in the vicinity due to the implementation of the project. The length of railway line in the district is 176 km and for railway project buffer of 0.5 km was considered

Table 1: The extent of forest areas released for other purposes from 1956

S.No.	Particulars.	Area in Ha.
1	The forest area released for cultivation by 3 member committee from 1964 to 1969	6042.500
2	Forest area released as per special G.O.No.AFD.116 of 16/4/69.	11593.342
3	Forest area released as per G.O.No.AFD-282-FGL74 of 17/19-12-1974.	3399.400
4	Forest area released for long lease.	162.100
5	Hangami Lagan in Notified area.	8034.450
6	Extension of Gouthana.	390.400
7	Forest area released for township.	1096.900
8	Mining area leased & area actually in operation.	1591.250
9	Released to House sites to Houseless (1972-1979)	366.000
10	Rehabilitation of Tibetans displaced Ryots of Sharavathi Ghataprabha & Malaprabha, Gowli families etc.	4548.170
11	Area under submersion & other Project. 1. Kali Hydro Project. 2. Bedti Project (for colony) 3. Other irrigation tanks etc.	14602.000 300.000 303.365
12	Released to KSFIC for Napier Hybrid grass cultivation (Sirsi Division)	441.450
13	Released to KAMCO (Dairy & fruit processing Unit)	153.993
14	Released to KSFIC for Pineapple cultivation.	163.320
15	Karnataka State Veneers Ltd.	24.000
16	Power transmission lines.	677.979
17	For establishment of Industries.	95.000
18	Area released to Horticulture department (1969-70).	71.847
19	Released to Agricultural University, Dharwad.	214.000
20	Sharavathi Tail Race.	700.000
21	Kaiga Atomic Power Project.	732.000
22	Sea Bird Naval Base Project.	2259.000
23	Rehabilitation of Sea Bird out seas.	643.720
24	Area released for non-agriculture & other purposes.	394.870
25	Konkan Railway.	272.140
26	Area released for improvement & widening of Ankola-Hubli Road.	49.431
27	Area released for rehabilitation of displaced persons of KHEP & Kaiga Project.	316.410
28	Area released to regularise the encroachments, which have taken place before 27-04-1978.	2845.446
29	Area released to construction of 400 KVDC alternate transmission line between Kaiga NPP and 200 KV sub-station at Narendra in favour of M/s. P.G.C.I.L, Karnataka.	330.00
	TOTAL	**62814.483**

*Source: Forest working plan of Kanara circle (year 2009-10)

Figure 1: Developmental projects of Uttara Kannada district

SUPA DAM: Supa Dam is the second largest dam in the state of Karnataka, built across the Kali river in Supa (Joida) Taluk of Uttara Kannada District in India. Supa Dam (figure 2(a, b)) is 101 Mtrs high and 332 Mtrs long concrete gravity dam for power generation. The Supa dam was perceived in 1972 by the clearance of Central Water and Power Commission (CWPC) and the Planning Commission. According to the statistics provided by the KPCL, 10,692 hectares of forest land; 2,248 hectares of private land and 466 hectares of revenue land were acquired for construction of the Supa dam. That accounts to a total of 13,406 hectares. Out of this, the reservoir stretches to 123 km^2. The construction started in 1974 and ended in 1987. The power house was commissioned in 1985. It has a catchment area of 1057 km^2 and the live storage capacity is 145 Tmcft. (Thousand Million Cubic Feet). Three radial gates of size 15 x 10 Mtrs are provided to regulate the flood discharge. The reservoir has two saddle dams of length 705 Mtrs and 940 Mtrs. The power house at the foot of the dam has two electricity generators of fifty megawatt each. The electricity generated is supplied to different parts of Karnataka. The total area submerged under Kali stage-I was 36000 acres of which 25000 acres were forests. Stage-II involved construction of dams at Kodsalli, Kadra and Dandeli. Supa was a town which is now in the deep water of this reservoir. This was an area called Sangam (where two river met) the river Kali (black) and Pandri (White) joined. This Supa dam project refugee's settlement was established at a place called Ramanagar near Londa on the border of Belgaum and Uttara Kannada districts of Karnataka. This tract of land was earlier under reserved forest, and was taken over for resettlement around 1975. At the time of' handing over; the entire tree crop was removed, and the land was allowed to lie fallow without the institution of any soil conservation measures at least till 1979. The displaced population is not being rehabilitated in the irrigated command area, but rather in the catchment area, including places right on the fringes of the reservoir. The contribution of' such settlements to increased si1tation of' the river is not documented, but appears to be significant. Land use analysis at Supa hydroelectric dam with buffer

is shown in figure 3 and table 2. The Supa dam submerged thick evergreen forests which was covered 94.7% (1973) of region. The current cover remained is only 42.79%. The evergreen forest in 1km buffer of project area declined from 94.55% (1973) to 49.02% (2013). The land use analyses for the period 1973 and 2013 illustrate the increase in built-up area (human habitations) from 0.03% to 0.12% with the implementation of the project. The built-up area has increased in project area. Many small agglomerations for work force colonies can be seen in the buffer region.

Table 2: Land use at Supa dam region from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**15.30**	**0.03**	**60.49**	**0.12**	**20.70**	**0.04**	**163.82**	**0.28**
Water	142.05	0.1	10126.05	20.57	52.48	0.09	10940.05	19.00
Agriculture	421.81	0.86	2101.20	4.27	594.27	1.03	2661.38	4.62
Open space	277.24	0.56	2169.70	4.41	341.33	0.59	2292.37	3.98
Moist deciduous forest	869.27	1.77	9100.07	18.49	992.05	1.72	11127.87	19.33
Evergreen to Semi evergreen forest	**46522.08**	**94.7**	**21063.30**	**42.79**	**54426.84**	**94.55**	**25216.00**	**43.80**
Scrub/Grass lands	530.09	1.08	1341.39	2.73	608.59	1.06	1466.80	2.55
Acacia/Eucalyptus plantations	275.08	0.56	1545.72	3.14	309.11	0.54	1698.85	2.95
Teak / Bamboo plantations	79.57	0.16	1072.34	2.18	102.44	0.18	1263.11	2.19
Coconut/Areca nut plantations	0.00	0	263.56	0.54	0.00	0	342.40	0.59
Dry deciduous forest	87.58	0.18	376.26	0.76	117.65	0.2	392.80	0.68
Total area	49220.08				57565.45			

Kaneri dam: Upper Kaneri reservoir (figure 4) is constructed across the Kaneri river, a tributary to Kali river near Kumbarwada village in Joida Taluk, Uttara Kannada District. Kaneri reservoir draining a small area of 98 sq km, will supplement the storage of water in the Supa dam. The construction of this reservoir left an immense and unrecoverable foot print on the farmers who dependent on this river. Since the river has become seasonal, this led to agriculture activities seasonal. The temporal land use analysis of Kaneri reservoir (figure 5 & table 3) shows that evergreen forest declined from 94.82% (1973) to 42.68%. In the buffer region, evergreen cover is about 63.83% (2013). It is also observed the plantation activities have increased from 1973 to 2013 and area under scrub lands have increased from 0.72% (1973) to 57.88% (2013).

Table 3: Land use in Kaneri reservoir region from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	0.00	0.00	12.25	**4.76**	0.00	0	23.86	**2.01**
Water	0.00	0.00	93.24	36.23	0.99	0.08	147.54	12.41
Agriculture	9.88	3.84	7.74	3.01	6.12	0.51	35.74	3.01
Open space	0.00	0.00	6.48	2.52	0.45	0.04	24.57	2.07
Moist deciduous forest	0.00	0.00	7.29	2.83	0.00	0	70.79	5.96
Evergreen to Semi evergreen forest	244.03	**94.82**	109.83	**42.68**	1171.89	**98.58**	758.73	**63.83**
Scrub/Grass lands	3.45	1.34	9.90	3.85	8.46	0.72	57.88	4.87
Acacia/Eucalyptus plantations	0.00	0.00	6.48	2.52	0.00	0	48.63	4.09
Teak / Bamboo plantations	0.00	0.00	1.08	0.42	0.00	0	11.62	0.98
Coconut/Areca nut plantations	0.00	0.00	2.88	1.12	0.00	0	6.93	0.58
Dry deciduous forest	0.00	0.00	0.18	0.07	0.81	0.07	2.43	0.20
Total area	257.36				1188.73			

Kodasalli dam: Kodasalli Dam was built across the Kali River (Kali nadi) in Yellapura taluk of Uttara Kannada district of Karnataka state, India (figure 6). The Kodasalli Power house (3x40 MW) commissioned in 1998, is located on the right bank of the Kodasalli Dam - utilising an average yield of 647 M cum of water. The Catchment area of this reservoir is about 1049 Sq. Km. The average annual energy available from this project is about 511 MU. The reservoir formed behind Kodasalli dam has a water spread area of 17.35 Sq. Km. at F.R.L. with a gross storage capacity of 286.49 M cum. The total area of the river's course is 123.71 ha. and the area under various islands is 12.31 ha. The Kodsalli dam submerged 1214 Ha of forests and 485 Ha of cultivated lands. The land use at Kodasalli dam region is given in figure 7 and table 4 for 1973 and 2013. Evergreen forest cover has declined from 97.6 (1973) to 30.95% (2013) and considering a buffer of 1 km the change is 97.57% (1973) to 52.91% (2013). The agricultural activities constitute 4.14% and plantations about 9.17%(2013).

Table 4: Land use at Kodasalli dam location in 1973 and 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	0.72	0.01	11.07	0.2	0.72	0.01	7.74	0.23
Water	25.47	0.46	795.72	14.37	34.21	0.38	885.33	2.51
Agriculture	36.01	0.65	229.36	4.14	48.88	0.55	409.91	3.24
Open space	13.95	0.25	102.35	1.85	15.84	0.18	130.60	0.9
Moist deciduous forest	24.57	0.45	1555.26	28.08	47.35	0.53	1838.66	24.71
Evergreen to Semi evergreen forest	**5405.26**	**97.6**	**1714.23**	**30.95**	**8714.08**	**97.57**	**2595.33**	**52.91**
Scrub/Grass lands	7.83	0.14	267.97	4.84	22.05	0.25	2065.36	4.87
Acacia/Eucalyptus plantations	**13.68**	**0.26**	**507.77**	**9.17**	**26.10**	**0.29**	**538.22**	**5.9**
Teak / Bamboo plantations	9.63	0.17	189.57	3.42	19.98	0.22	219.63	3.53
Coconut/Areca nut plantations	0.00	0	163.74	2.96	0.00	0	240.06	1.18
Dry deciduous forest	0.81	0.01	0.90	0.02	2.16	0.02	0.54	0.02
Total area	5537.94				8931.38			

Kadra dam: Kadra power house commissioned in 1997,has been built on the left bank of the river Kali with an installed capacity of 150 MW. Work on the Kadra dam and power house in Uttar Kannada started in February 1986 and the project was to finish by 1997. The power house integrates three 50 MW turbines which are coupled to the generating units. The annual generation is 570 MU. The design head is 32 metres. The Kadra Dam is an integral part of the Kaiga Project, provides adequate water to meet the total plant water requirement (figure 8). Due to Kaiga NPH activity this region's aquatic fauna is intensely affected. The plankton diversity showed high sensitivity to elevated temperature, resulting in decreased diversity and similarity indices near the discharge point (Zagar et al., 2006).

Land use at Kadra dam (figure 9 & table 5) region and buffer region show decline of evergreen forest from 69.92% (1973) to 50.98% (2013). The built-up area is increased from 0.63% (1973) to 1.51% (2013). Similar trends of increase from 0.48% to 2.23% (2013) are noticed in the buffer region due to construction of roads and infrastructure. This reservoir was constructed in 2000 mainly to provide enough water resources to Kaiga NPH project. There is intensive plantation activities observed in 2013. The evergreen forest has reached to 47.40% by 2013 at project location with 1km buffer.

Table 5: Land use at Kadra dam region during 1973 and 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**72.55**	**0.63**	**172.56**	**1.51**	**80.02**	**0.48**	**371.65**	**2.23**
Water	112.16	0.98	2239.28	19.55	124.13	0.75	2961.79	17.81
Agriculture	225.85	1.97	322.34	2.81	335.12	2.01	644.94	3.88
Open space	47.26	0.42	303.71	2.65	65.17	0.39	409.26	2.46
Moist deciduous forest	1936.11	16.91	816.16	7.13	2377.54	14.3	1854.84	11.15
Evergreen to Semi evergreen forest	**8008.19**	**69.92**	**5839.40**	**50.98**	**12342.46**	**74.21**	**7882.77**	**47.40**
Scrub/Grass lands	542.25	4.73	809.41	7.07	660.88	3.97	989.23	5.95
Acacia/Eucalyptus plantations	222.52	1.94	359.88	3.14	303.71	1.83	687.16	4.13
Teak / Bamboo plantations	168.33	1.47	485.27	4.24	205.32	1.23	689.30	4.14
Coconut/Areca nut plantations	0.00	0	102.89	0.90	0.00	0	138.80	0.83
Dry deciduous forest	118.46	1.03	2.79	0.02	137.36	0.83	1.99	0.01
Total area	11453.66				16631.73			

Bommanalli reservoir: Bommanahalli reservoir built across the Kali River is situated in Haliyal taluk of Uttara Kannada District (figure 10). This pick-up dam is constructed to cater water to Supa dam, is 2,896 m high and 1,025 m long, with a catchment area of 1,683 km^2. Monoculture plantations of exotic species has increased from 1.10 (1973) to 43.04% (2013) highlight the large scale changes of forests at Bommanalli, Tattihalla project regions. The land use analysis (figure 11 & table 6) at temporal scale with respect to Bommanalli pick up reservoir highlight the fragmentation of forests during 1973 to 2013. The crop land has increased from 2.21% to 6.22% by 2013. Deforestation is evident with the decline of evergreen forests from 41.18 to 2.90% (2013).

Table 6: Land use at Bommanalli reservoir region during 1973 and 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	45.73	0.46	96.55	0.97	61.84	0.43	277.56	1.94
Water	49.24	0.49	1070.99	10.76	60.40	0.42	1179.99	8.24
Agriculture	246.73	2.48	822.73	8.27	316.31	2.21	994.34	6.94
Open space	58.42	0.59	213.37	2.14	92.63	0.65	256.62	1.79
Moist deciduous forest	4085.38	41.04	1007.08	10.12	5760.27	40.2	1006.06	7.02
Evergreen to Semi evergreen forest	3989.15	40.08	394.17	3.96	5900.24	41.18	428.37	2.99
Scrub/Grass lands	767.73	7.71	14.67	0.15	1094.12	7.64	5.40	0.04
Acacia/Eucalyptus plantations	109.46	1.10	4284.22	43.04	177.96	1.24	6680.02	46.62
Teak / Bamboo plantations	377.07	3.79	1919.19	19.28	592.47	4.14	3261.64	22.76
Coconut/Areca nut plantations	0.00	0.00	3.87	0.04	0.00	0	12.43	0.09
Dry deciduous forest	225.13	2.26	127.19	1.28	271.39	1.89	225.20	1.57
Total area	9954.03				14327.64			

Tattihala reservoir: Tattihalla is a tributary of Kali river and a dam at Tattihalla (across the Tattihalla river, near Tatwal village in Haliyal Taluk) helps to generate power at Nagjhari Power House (3 X 135 MW + 3 X 150MW). Tattihala dam is constructed (figure 12) to divert the bulk of the monsoon flows of the river into the Bommanahalli Pick-up reservoir. Tattihalla dam is a composite dam in nature with concrete spillway in the gorge and earther flanks on either side 42.4m high 1225 m long. Four radial gates of size 15m x 12m are provided to regulate the flood discharge. The temporal land use analysis (figure 13 & table 7) in the locality of Tattihalla pick up reservoir indicates the forests in the region getting fragmented. The land use analysis in the region with 1km Buffer shows the loss of forest land and increase of area under agriculture and plantations. The crop land has increased from 4.29 (1973) to 11.96% in 2013 and human habitations constitute 2.98%.

Table 7: Land use at Tattihalla from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**20.08**	**0.25**	**123.49**	**1.56**	**34.39**	**0.31**	**334.30**	**2.98**
Water	67.02	0.85	1747.65	22.14	11.34	0.1	1869.00	0.03
Agriculture	**222.60**	**2.82**	**748.13**	**9.48**	**481.04**	**4.29**	**1192.81**	**11.96**
Open space	80.83	1.02	769.99	9.75	138.53	1.24	829.73	12.76
Moist deciduous forest	**2331.46**	**29.53**	**123.80**	**1.57**	**3069.39**	**27.36**	**247.26**	**4.37**
Evergreen to Semi evergreen forest	4117.54	52.16	11.08	0.14	5829.85	51.97	14.86	0.14
Scrub/Grass lands	336.56	4.26	86.50	1.10	499.85	4.46	215.84	0.47
Acacia/Eucalyptus plantations	**175.26**	**2.22**	**2615.27**	**33.13**	**224.32**	**2**	**3960.57**	**43.37**
Teak / Bamboo plantations	**134.66**	**1.71**	**1537.71**	**19.48**	**268.51**	**2.39**	**2370.10**	**23.73**
Coconut/Areca nut plantations	0.00	0.00	2.43	0.03	0.00	0	11.35	0.04
Dry deciduous forest	408.66	5.18	128.63	1.63	659.71	5.88	171.11	2.11
Total area	7894.69				11216.93			

Gerusoppa Dam: Gerusoppa dam was constructed across the river Sharavathi before entering Arabian Sea in Uttara Kannada District. Four generating units of 60 MW each, totalling to 240 MW

is installed at the Gerusoppa Dam (figure 14) which is functional since 2001. Sharavati Tail Race project submerged 575 ha of biodiversity rich forests; another 125 ha of lands were acquired for other associated works for the township, roads, etc. Before the construction of the dam on Sharavathi, the river used to be more active during the monsoon compared during summer. The tidal water would extend up to Gerusoppa village making the water saline after the monsoon to support estuarine ecosystem. After impoundment at Linganamakki, Talakalale and Gerusoppa dam the consequent constant flow in the river, the impact of tidal water has pushed saline water leading to the damage of mangroves and associated estuarine ecosystem. Figure 15 and table 8 details land uses in Gerusoppa dam region, which shows the decline of evergreen forest from 87.15 (1973) to 43.17% (2013). Increase in built-up from 2.07% to 7.38% (dam region with 1km buffer) during 1973 to 2013.). Cash crops like coconut have increased due to water availability in region. The current spatial extent of coconut plantation is 6.06% with in project area and 5.34% (the dam region with 1km buffer). Also a fraction of workforce of this project settled in the buffer region occupying forest lands.

Kaiga Nuclear power plant: Kaiga Nuclear power generating station located at 14°51′55.16″N 74°26′22.71″E in Kaiga, on the branches of river Kali, in Uttar Kannada district of Karnataka, India. Kaiga is located in the green environs of Western Ghats about 60 Km east of the beach town of Karwar (figure 16). The plant has been in operation since March 2000 and is operated by the Nuclear Power Corporation limited (NPCIL) of India. Annual generation is 2,231 GWh. Pressurized Heavy Water Reactor (PHWR) for producing saturated steam to drive a double stage Turbo Generator. Natural Uranium bundles are used as fuel for the reactors. Heavy water is used to transport the heat generated in reactors to steam generators. It is also used, as a moderator for neutrons, to aid the process of fission reaction. Because of these biochemical properties of stocked tritium heavy water, the process of cleaning up the spills and recovering the heavy water or flushing it into the environment almost invariably leads to radiation doses to workers and, potentially, the general public (Harrison et al., 2002; Ramana et al., 2010). The forest land of 732 ha was released for the Kaiga Atomic Energy Plant. The dome of the first reactor unit collapsed in May 1994 delaying its construction by a few more years. In 1999 and again in 2001, people of Sirsi and Yellapur taluks staged a protest against the laying of a high tension power line from Kaiga through the thick forest region. About 677 ha forest lands were cleared for power transmission lines. Now there is a proposal to establish two more units at the site. Villagers of Bare, Malavalli, Vajralli and Kalache in Yellapur taluk have reported more cancer cases after the establishment of the Kaiga project. Studies have demonstrated adverse effect on aquatic diversity due to water discharge from power plant to Kali river (Zargar et al., 2006). Figure 17 and table 9 provides the picture of land use dynamics in the region due to Kaiga NPH. Evergreen forests have declined from 63.27 (1973) to 21.93%(2013) due to setting up of power house and employee quarters and associated developments (8.91%).

Table 8: Land use analysis of Gerusoppa dam from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**0.00**	**0.00**	**48.79**	**1.67**	**4.30**	**0.10**	**138.51**	**3.13**
Water	59.41	2.03	529.28	18.12	99.52	2.25	686.27	15.49
Agriculture	61.32	2.10	153.94	5.27	91.92	2.07	326.75	7.38
Open space	9.45	0.32	32.95	1.13	89.46	2.02	137.18	3.10
Moist deciduous forest	72.33	2.48	247.65	8.48	297.35	6.71	644.75	14.55
Evergreen to Semi evergreen forest	**2545.06**	**87.15**	**1260.56**	**43.17**	**3565.06**	**80.47**	**1437.43**	**32.44**
Scrub/Grass lands	**16.92**	**0.58**	**217.95**	**7.46**	**96.92**	**2.19**	**380.75**	**8.59**
Acacia/Eucalyptus plantations	11.80	0.40	174.54	5.98	11.88	0.27	268.66	6.06
Teak / Bamboo plantations	14.85	0.51	77.68	2.66	44.85	1.01	173.36	3.91
Coconut/Areca nut plantations	**128.99**	**4.42**	**176.97**	**6.06**	**128.99**	**2.91**	**236.77**	**5.34**
Dry deciduous forest	0.18	0.00	0.00	0.00	0.18	0.00	0.00	0.00
Total area	2920.31				4430.43			

Table 9: Land use analysis of Kaiga NPH from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**32.50**	**1.75**	**165.41**	**8.91**	**66.02**	**1.03**	**222.86**	**4.01**
Water	60.65	3.27	128.77	6.94	115.22	0.33	354.93	6.38
Agriculture	95.67	5.15	88.27	4.75	165.80	4.21	227.36	4.09
Open space	74.76	4.03	133.02	7.16	145.49	0.35	335.11	6.02
Moist deciduous forest	191.79	10.33	441.96	23.80	736.92	21.57	867.42	15.60
Evergreen to Semi evergreen forest	1174.72	63.27	407.23	21.93	3919.04	58.84	2615.07	47.02
Scrub/Grass lands	183.50	9.88	110.97	5.98	267.24	4.3	382.51	6.88
Acacia/Eucalyptus plantations	42.94	2.31	273.66	14.74	83.35	5.34	355.27	6.39
Teak / Bamboo plantations	0.00	0.00	0.00	0.00	48.07	3.08	88.89	1.60
Coconut/Areca nut plantations	0.00	0.00	107.30	5.78	0.00	0	112.15	2.02
Dry deciduous forest	0.09	0.00	0.00	0.00	14.76	0.95	0.36	0.01
Total area	1856.62				5561.92			

Konkan Railway: The construction of the Konkan Railway through the west coast, while revolutionising coastal transportation had also its own inevitable environmental impact in the form of landscape changes, diversion of agricultural and forest lands etc. The Konkan Railway line was commissioned in phases from 1993 onwards in 11 sectors and finally fully commissioned in 1998. Total Railway track is 179 KM with fifteen numbers of Railway Stations (figure 18). First time Indian Railways built tunnels longer than 2.2 kms are prepared with more than 1000 cuttings in the track. Land use analysis of Konkan railway (figure 19 and table 10) show fragmentation of forests though it provides connectivity of many regions. In the buffer region (0.5km), built-up area has increased from 1.65% (1973) to 17.06% (2013). The increase in open fields (11.13%) is due to the clearance along the track. Moist deciduous forests in Konkan railway project region show a decline from from17.80 (1973) to 4.55% (2013). Cutting of the hills, removal of vegetation cover and vibrations due to frequent movement of rail has enhanced landslide susceptibility in the region.

Table 10: Land use analysis of Konkan railway line from 1973 to 2013

Year / Land use Category	Project area			
	1973		2013	
	Ha	%	Ha	%
Built-up	**214.23**	**1.65**	**2205.62**	**17.00**
Water	331.97	2.56	626.05	4.82
Agriculture	2619.86	20.19	4438.78	34.21
Open space	486.26	3.75	1444.28	11.13
Moist deciduous forest	**2310.03**	**17.80**	**589.77**	**4.55**
Evergreen to Semi evergreen forest	4142.00	31.92	942.09	7.26
Scrub/Grass lands	618.04	4.76	720.03	5.55
Acacia/Eucalyptus plantations	1240.57	9.56	486.44	3.75
Teak / Bamboo plantations	58.51	0.45	68.77	0.53
Coconut/Areca nut plantations	933.63	7.19	1452.92	11.20
Dry deciduous forest	21.16	0.16	1.53	0.01
Total area	12976.26			

Project Sea Bird: Indian Navy established a major Naval Base at Karwar (Karnataka), about 120 km south of Goa on the west coast of India under 'Project Seabird' also known as 'INS Kadamba' in 1986 (figure 20), for creation of infrastructure and facilities for the basing of ships/ submarines, with all associated operational/support facilities. Phase I of Project Seabird has been completed in 2005, spread over an area of 45 square kilometres with a 26km-long coastline, which is 5.5 km of breakwaters, reclaimed areas for development of ship lift and berthing facilities, aircraft carrier berthing facilities, large onshore developments with residential complexes, admin facilities etc.. It is a larger naval base in Asia and has an exclusive military harbour and the base has 1,200 officers and sailors. The construction of Project Seabird Naval Base involved eviction of thousands of families of fishermen and farmers from the coastline of Karwar and Ankola taluks. Environmental modifications of great magnitude, such as building of breakwaters, dredging of the sea, filling up of coastal swamps, intensified construction activities and other landscape changes are being executed in the Project Seabird area. The rehabilitation of the evacuees brought greater pressure in other coastal villages as well as in the forest areas of hinterland. Project Seabird Phase IIA work, commissioned in 2011 involves construction of a wide range of new facilities and augmentation of certain existing facilities which spans 4km over 50 Ha land. Land use in the project Seabird region is given in table 11 and figure 21 show an increase of built-up area from 1.77% (1973) to 32.09% (2013) due to marine ship basements and port construction. Evergreen forests have declined from 34.63 (1973) to 5.22% (2013).

Table 11: Land use analysis of Project Sea Bird from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	**12.78**	**1.77**	**231.58**	**32.09**	**52.39**	**2.88**	**383.75**	**21.09**
Water	**110.16**	**15.26**	**6.77**	**0.94**	**130.15**	**7.15**	**63.94**	**3.51**
Agriculture	95.52	13.24	115.43	15.99	254.74	14.00	163.87	9.01
Open space	216.65	30.02	109.33	15.15	255.99	14.07	187.75	10.32
Moist deciduous forest	36.67	5.08	33.03	4.58	394.49	21.68	126.97	6.98
Evergreen to Semi evergreen forest	**249.93**	**34.63**	**37.64**	**5.22**	**586.87**	**32.26**	**408.73**	**22.47**
Scrub/Grass lands	0.00	0.00	116.56	16.15	35.38	1.94	290.08	15.94
Acacia/Eucalyptus plantations	0.00	0.00	19.83	2.75	104.84	5.76	88.53	4.87
Teak / Bamboo plantations	0.00	0.00	0.00	0.00	0.81	0.04	12.70	0.70
Coconut/Areca nut plantations	0.00	0.00	51.54	7.14	0.00	0.00	92.58	5.09
Dry deciduous forest	0.00	0.00	0.00	0.00	3.69	0.20	0.45	0.02
Total area	721.71				1819.35			

West Coast Paper Mills, Dandeli: Situated in the heart of thick forests on the banks of Kali river with the assured supply of raw materials, water from Kali river, power supply from the state grid; vicinity of rail and road linkages (figure 22). Capacity of the mill was initially 18,000 metric tonnes (MT) per annum of writing, printing and packaging paper (1959), which were augmented to the current production level of 185000 (MT) per annum. The present raw material consumption is 400000 (MT) per annum of wood. Bamboo from Uttara Kannada forests was allotted at the rate of Rs. 3.12 per tonne of paper pulp produced, with periodic marginal revision in prices. The extraction limit of bamboo was fixed at 100,000 tonnes of bamboo per year. Bamboo, which was considered almost a weed in the timber forests, by the Forest Department, was nearly eliminated within four decades of the factory's operations. The depletion of bamboo known as "poor man's timber" caused great hardships to basket and mat weavers and rural people. Land use (table 12 & figure 23) in region due to the implementation of paper mills show a decline of evergreen forests from 29.46 (1973) to 2.24% (2013). The region is turning to more moist deciduous forest from semi evergreen forest. Built-up has increased from 17.17(1973) to 44.04% in 2013.

Table 12: Land use analysis of West Coast Paper Mills from 1973 to 2013

Year / Land use Category	Project area				Project area with 1km buffer			
	1973		2013		1973		2013	
	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	30.42	17.17	78.04	44.04	40.33	3.96	175.27	17.21
Water	2.07	1.17	3.24	1.83	13.32	1.31	27.99	2.75
Agriculture	21.15	11.94	23.58	13.31	88.21	8.65	167.55	16.45
Open space	0.63	0.36	20.61	11.63	13.50	1.33	50.25	4.93
Moist deciduous forest	23.58	13.31	3.87	2.18	271.84	26.69	93.65	9.19
Evergreen to Semi evergreen forest	52.21	29.46	3.96	2.24	458.71	45.03	98.79	9.70
Scrub/Grass lands	4.68	2.64	19.53	11.02	30.06	2.95	24.05	2.36
Acacia/Eucalyptus plantations	14.50	8.18	19.86	11.21	24.48	2.4	246.28	24.18
Teak / Bamboo plantations	5.00	2.82	0.45	0.25	1.08	0.11	98.39	9.66
Coconut/Areca nut plantations	0.00	0.00	4.05	2.29	0.00	0	5.87	0.58
Dry deciduous forest	22.95	12.95	0.00	0.00	77.14	7.57	30.60	3.00
Total area	177.21				1018.69			

Figure 2: the location of Supa dam (a) Google Earth (b) Dam site

Figure 3 (a, b): Supa dam Project area

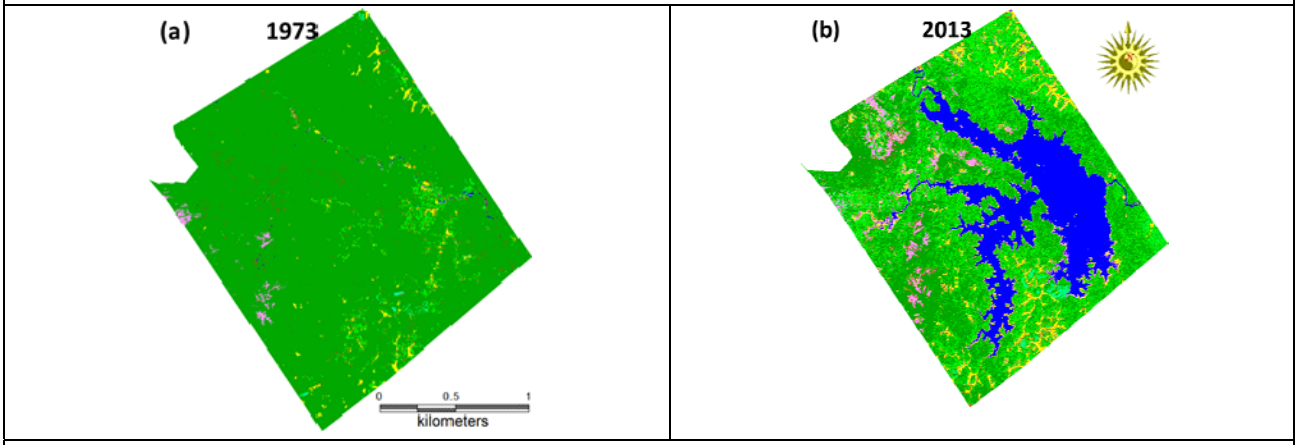
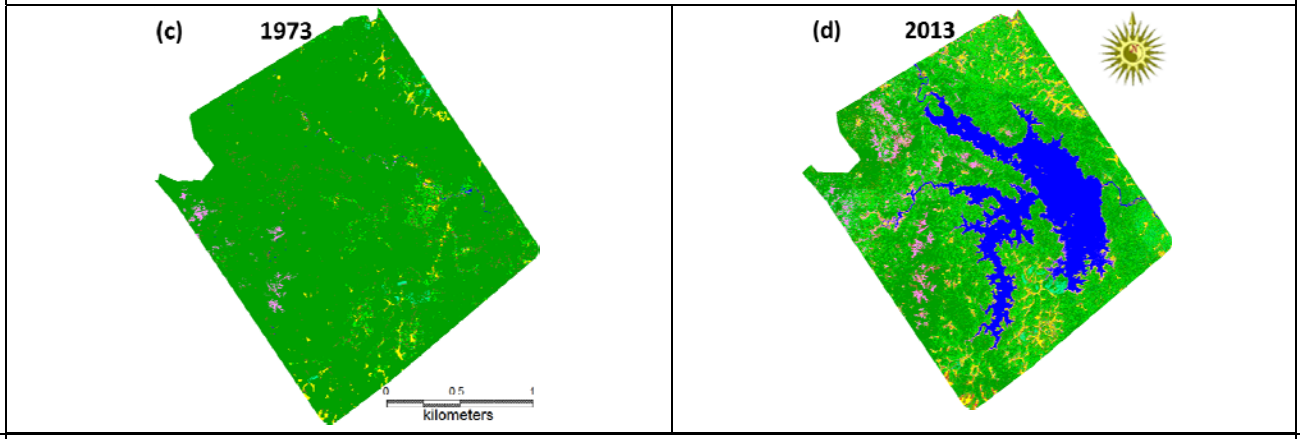


Figure 3 (c, d): Supa dam with 1km buffer



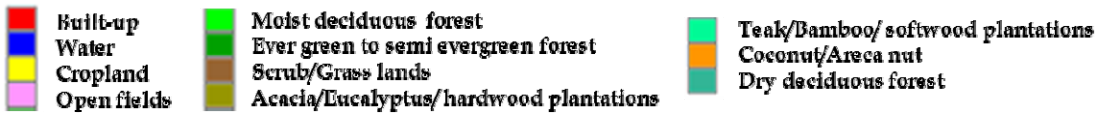


Figure 4: the location of Upper Kaneri dam as shown in Google Earth

Figure 5 (a, b): Kanei dam Project area

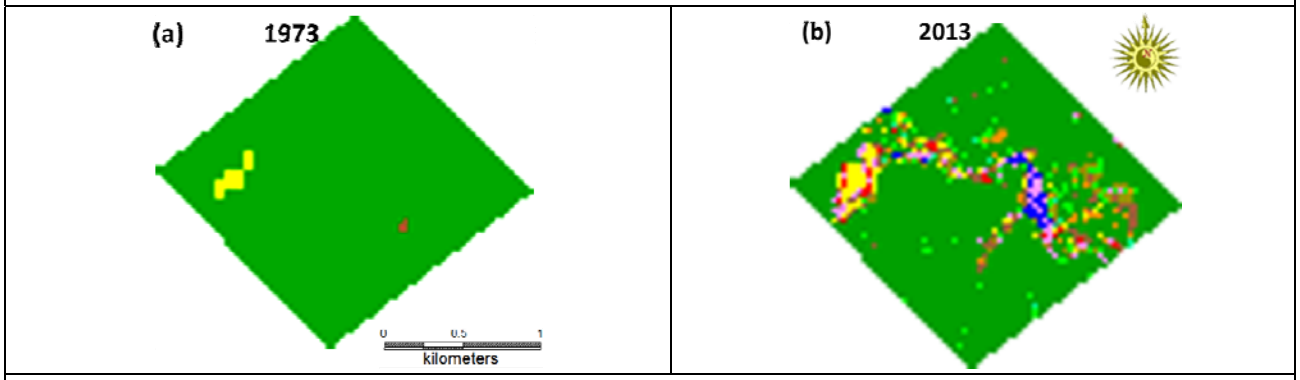


Figure 5 (c, d): Kaneri dam with 1km buffer

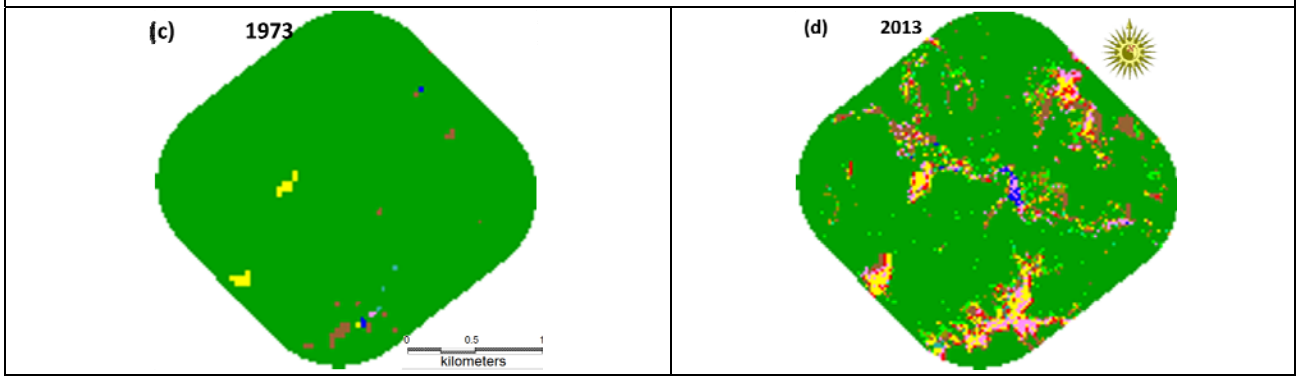
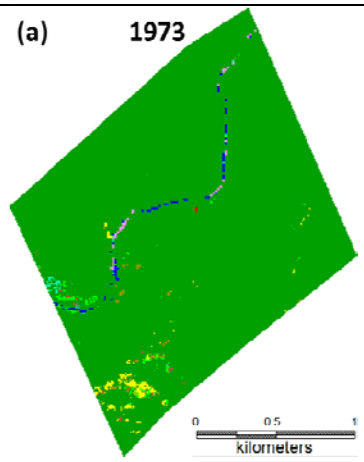


Figure 6: the location of Kodasalli dam as shown in Google Earth

Figure 7(a, b): Kodasalli dam Project area



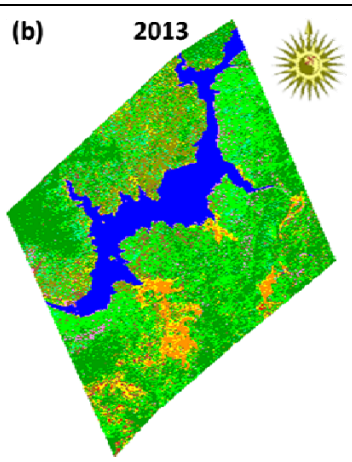
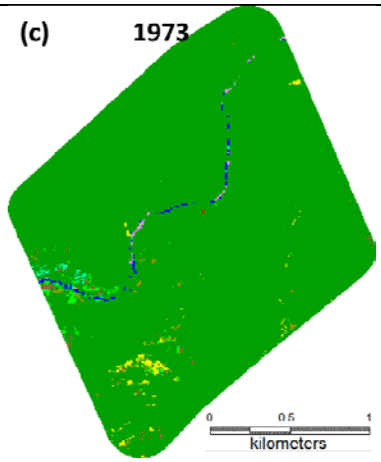


Figure 7(c, d): Kodaslli dam with 1km buffer



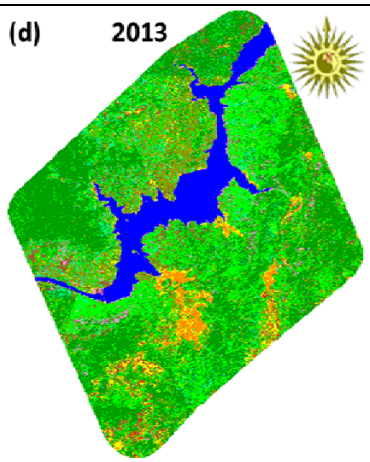


Figure 8: the location of Kadra dam as shown in Google Earth

Figure 9 (a, b): Kadra dam Project area

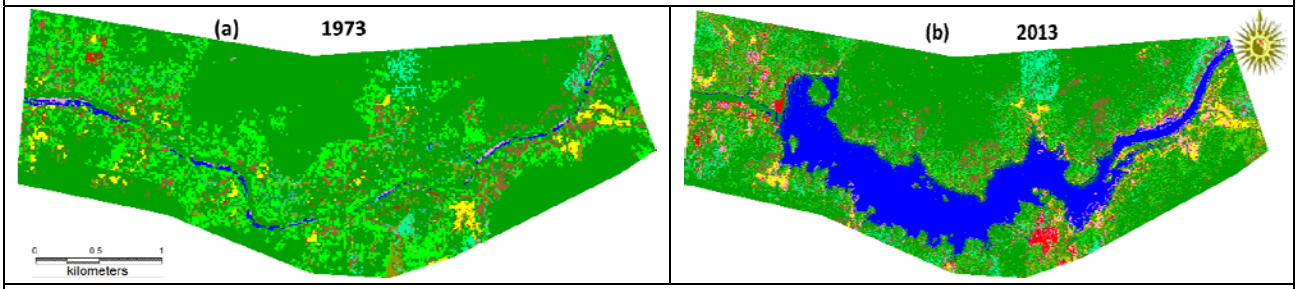


Figure 9 (c, d): Kadra dam with 1km buffer

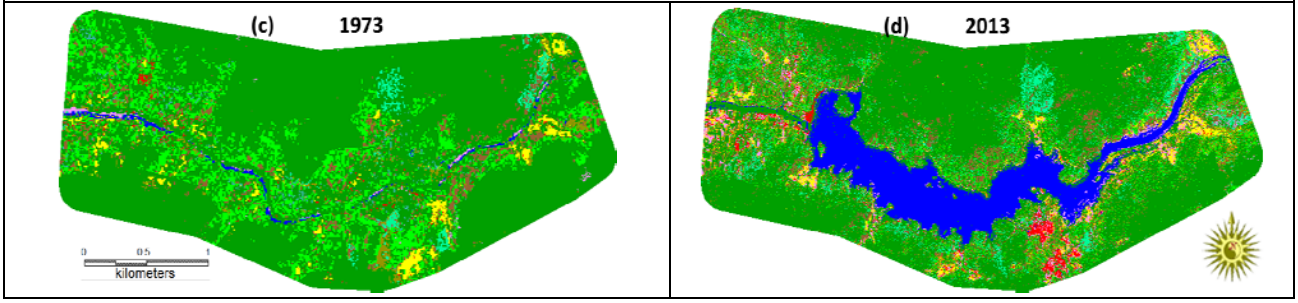
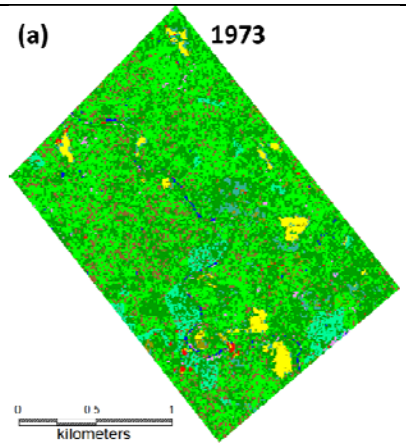


Figure 10: the location of Bommanalli reservoir as shown in Google Earth

Figure 11: Bommanalli reservoir Project area (a, b)



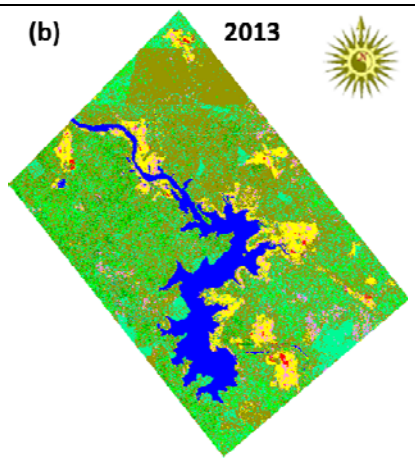
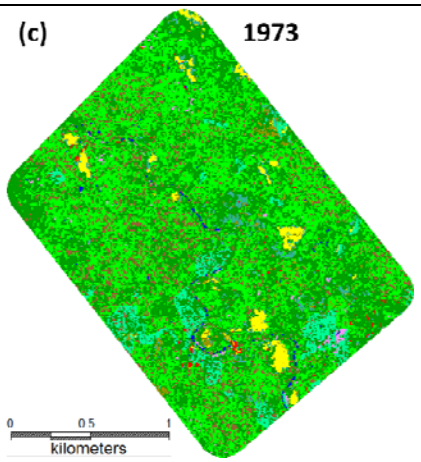


Figure 11 (c, d): Bommanahalli reservoir with 1km buffer



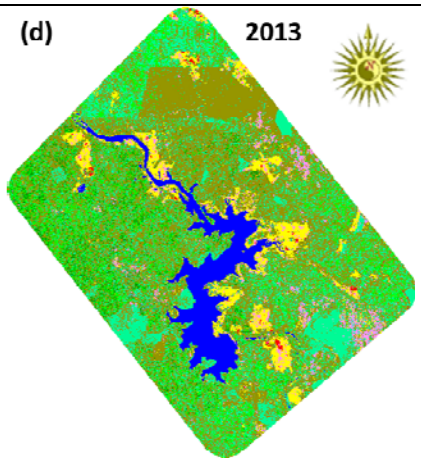


Figure 12: the location of Tattihalla reservoir as shown in Google Earth

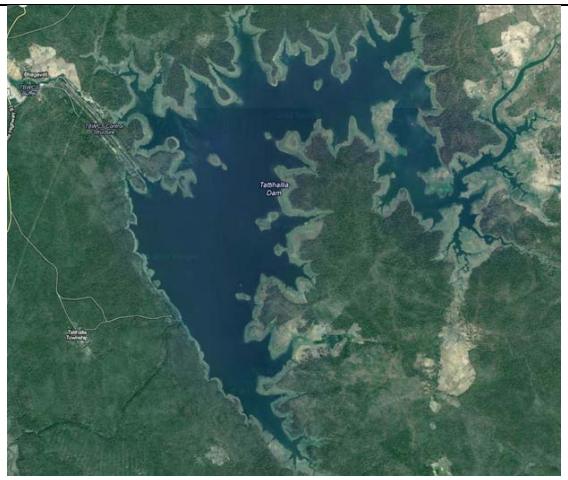
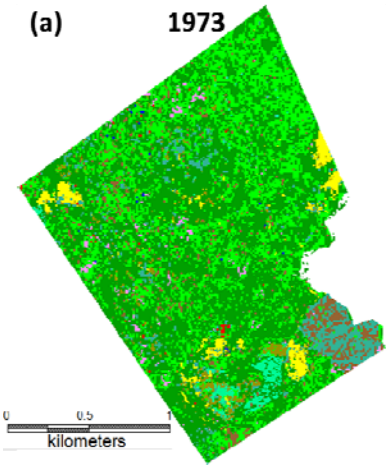


Figure 13: Tattihalla reservoir Project area (a, b)



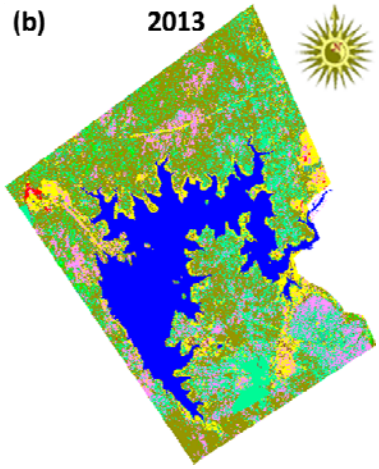
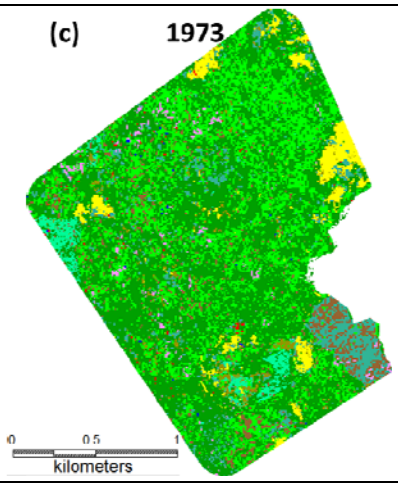


Figure 13 (c, d): Tattihalla reservoir with 1km buffer



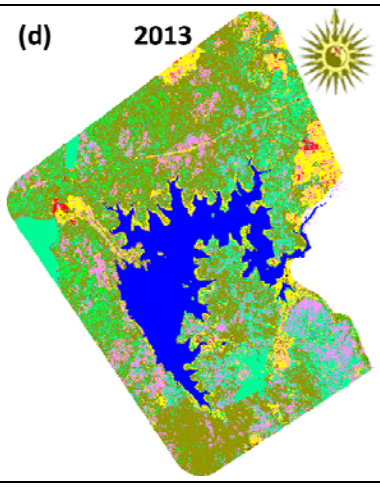


Figure 14: the location of Gerusoppa dam as shown in Google Earth

Figure 15: Gerusoppa dam Project area (a, b);

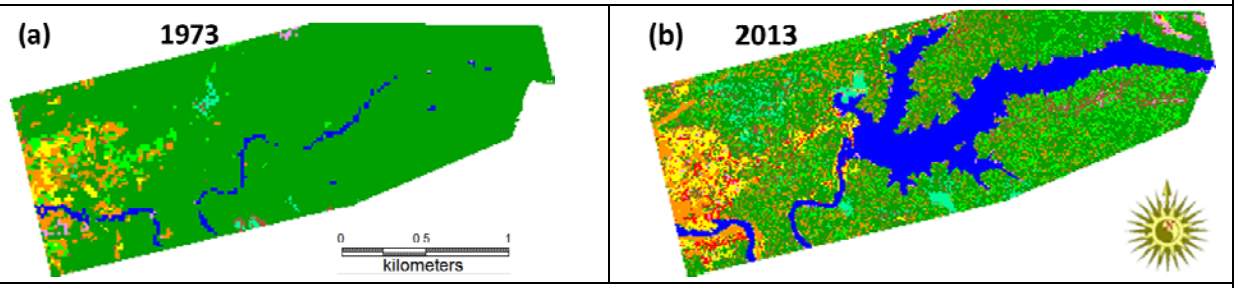


Figure 15(c, d): Gerucoppa dam with 1km buffer

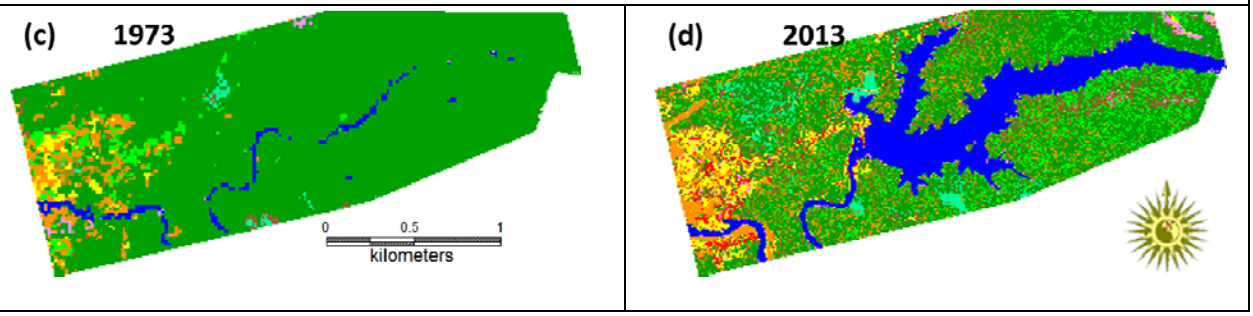
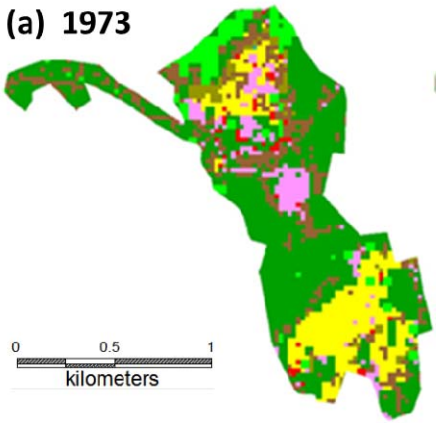


Figure 16: the location of Kaiga NPH as shown in Google Earth

Figure 17: Kaiga NPH Project area (a, b); with 1 km buffer (c, d)



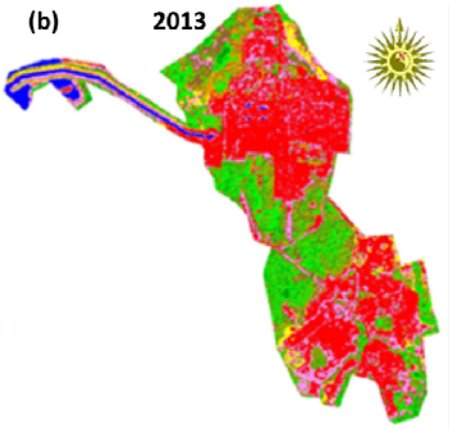
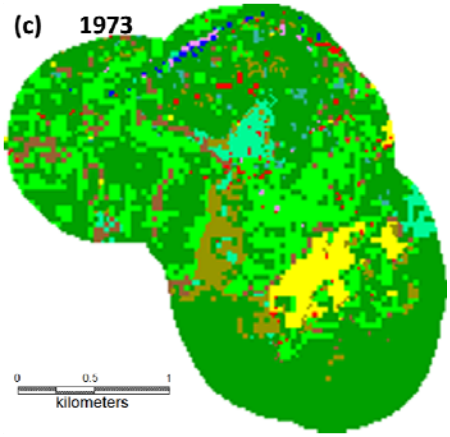


Figure 17 (c, d) : with 1 km buffer



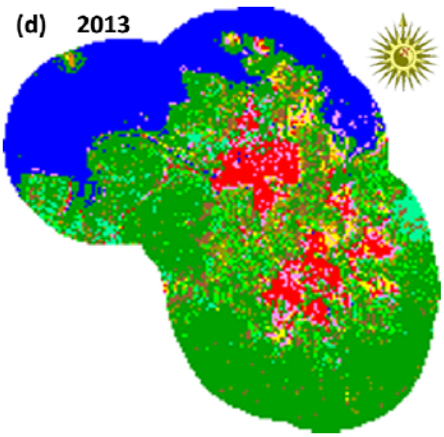


Figure 18: the location of Project seabird as shown in Google Earth and other

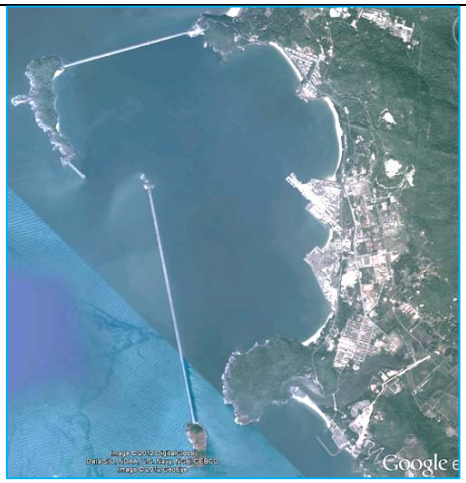
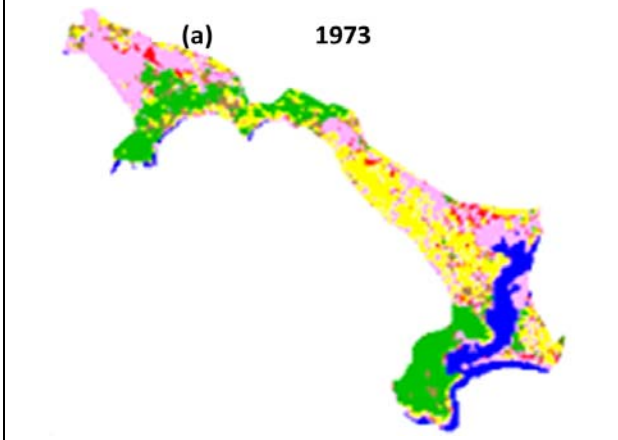


Figure 19: Project seabird area (a, b);



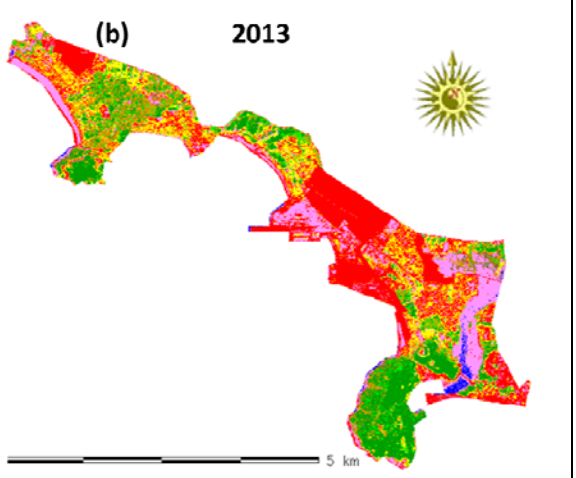
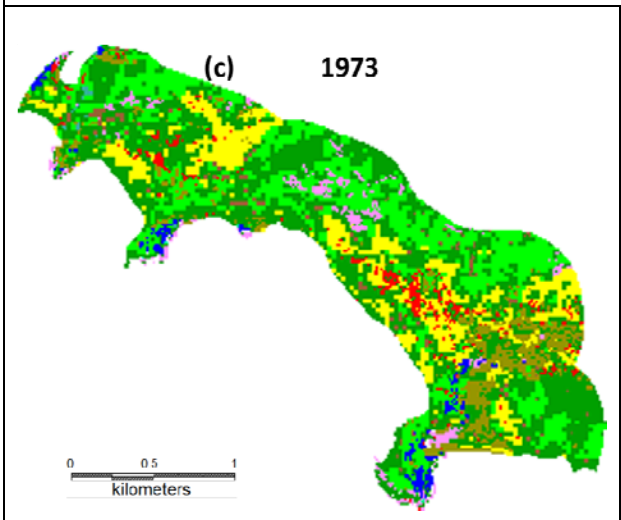


Figure 19 (c, d): project Seabird with 1km buffer



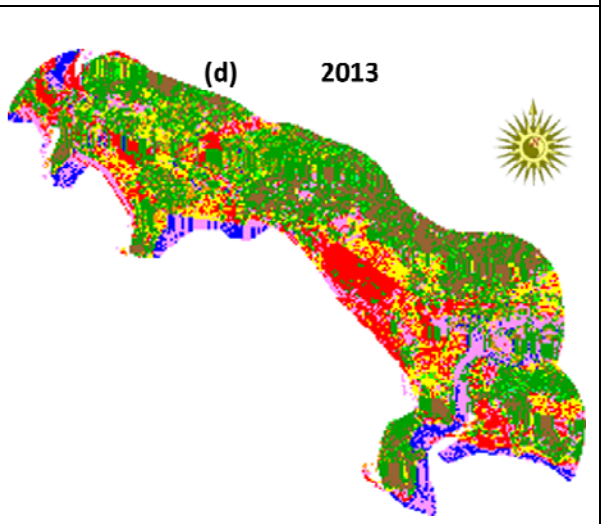


Figure 20: the location of West coast paper mills as shown in Google Earth and project site

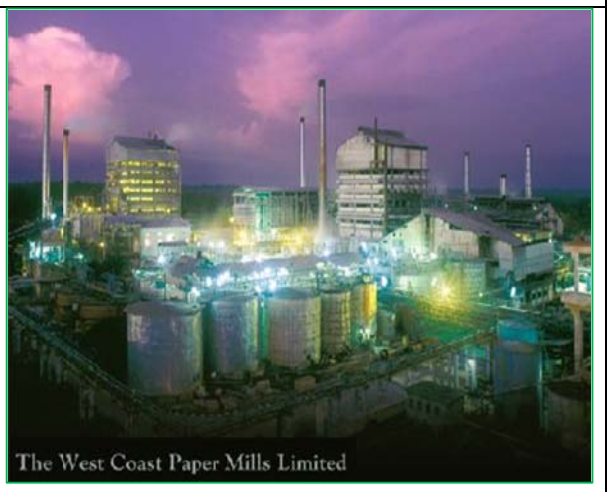
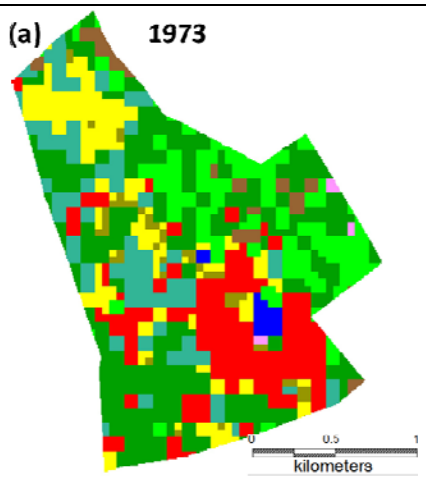


Figure 21: West coast paper mills area (a, b);



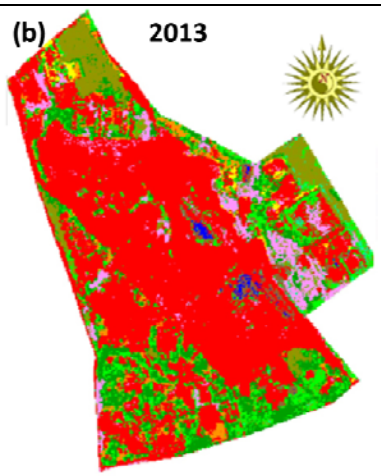
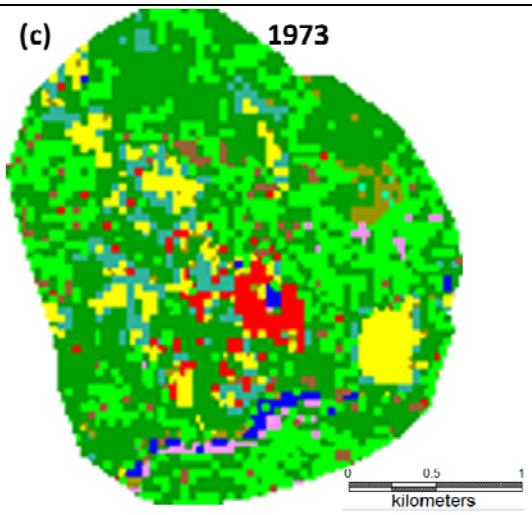


Figure 21(c, d): West coast paper mills with 1km buffer



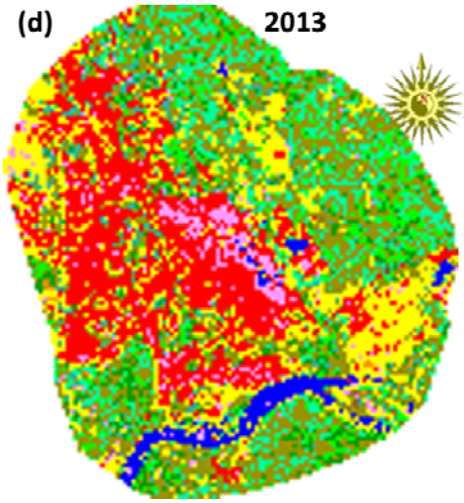
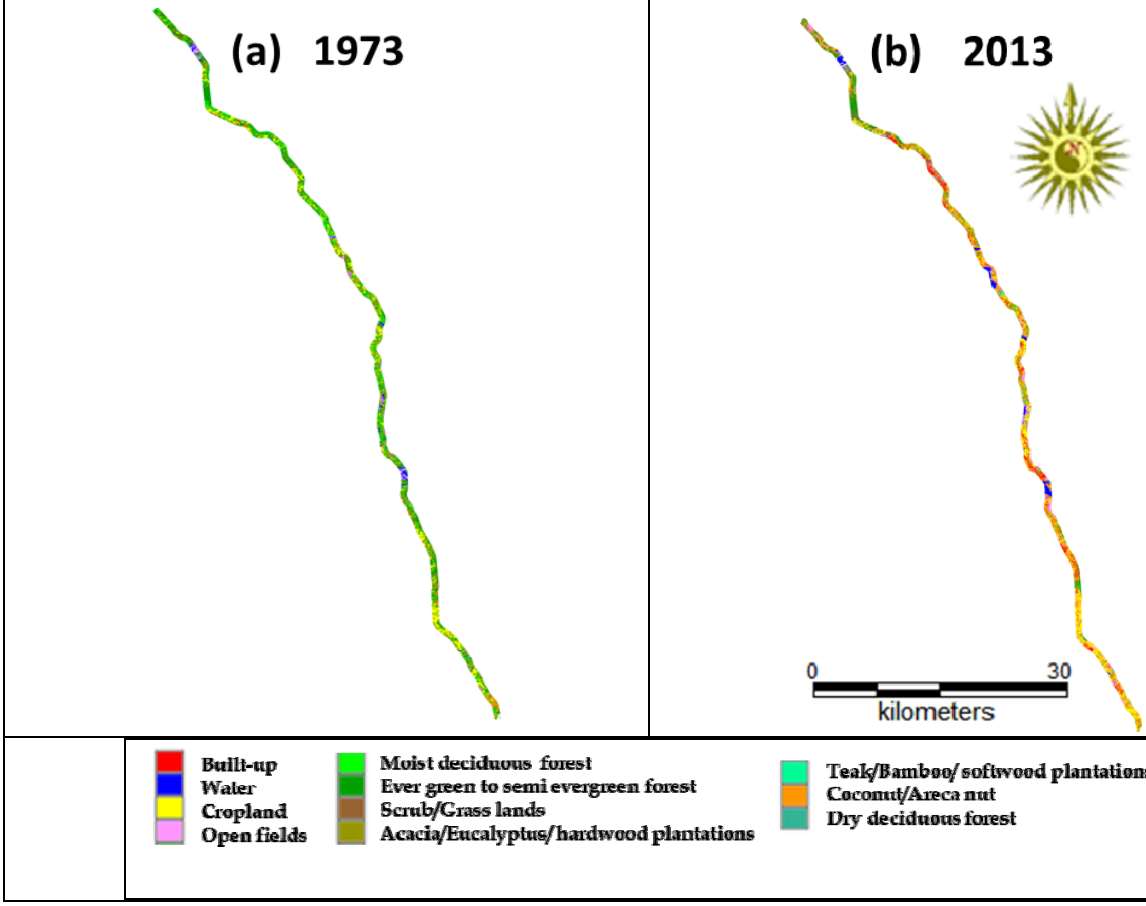


Figure 22: Rail way line of Konkan as seen in Google Earth

Figure 22: Konkan railway area (a, b)



The dominant developmental thrust in U.K. has traditionally favored industrialization and natural resources such as forest, land, water were given at free of cost. Some infrastructure developments include the paper mills, the caustic soda factory, the Kali and Sharavathi Hydel projects, the manganese and limestone mining, establishment of a nuclear plant at Kaiga, establishment of a naval base at Karwar, and the Konkan Railway. Harihar Polyfibres is quite intensively dependent on Uttara Kannada forests for its pulpwood needs. These projects have dramatically altered the structure of fragile ecosystems in the region with sustainable impacts.

Conclusion:

Development is process of improving the quality of all human lives with economic advancement considering social, ecological, psychological and political processes. The rapid development efforts have failed in many ways evident from the enhanced process of deforestation, erosion of productive top soil, enhanced instances of human-animal conflicts, forest fires, declined sustained flow of water in streams. This emphasises the need for development that retains its harmony with nature, by aiming at environmentally sound development. The economically harmonic and sustainable development effort obviously enriches the region. Mitigation measures for ecological impacts are to be considered throughout the project period i.e. planning, designing, construction, operation. There is an urgent need for a strengthening of the interface between science and policy efforts to ensure that scientific findings are implemented towards conserving ecosystems in Western Ghats.

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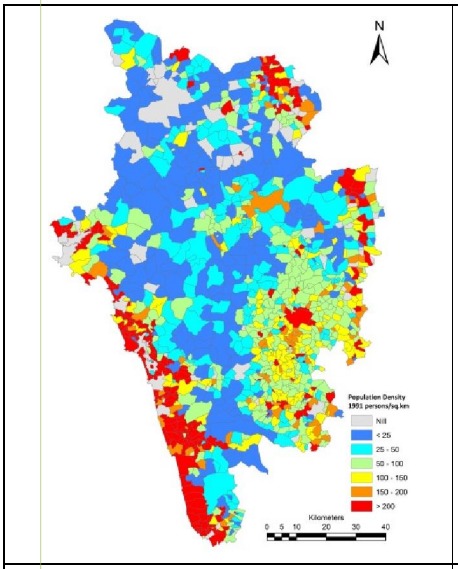
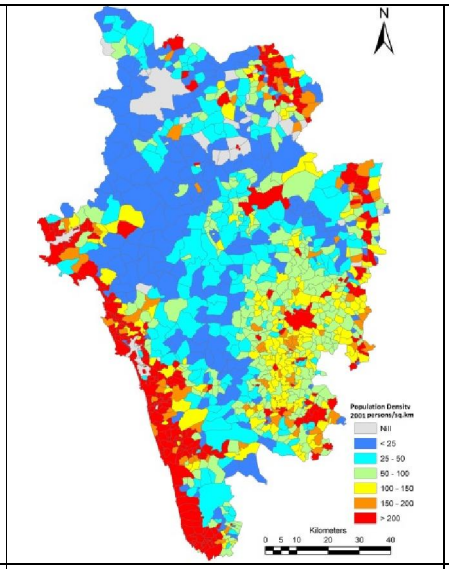
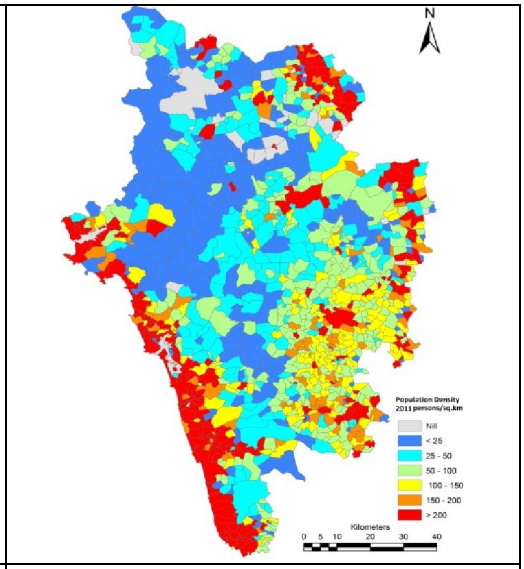


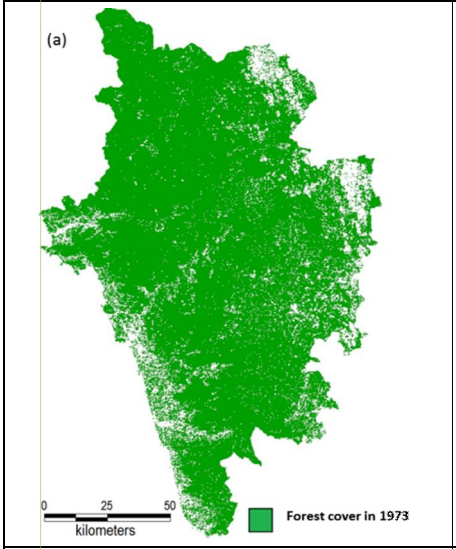
Population Density 1991



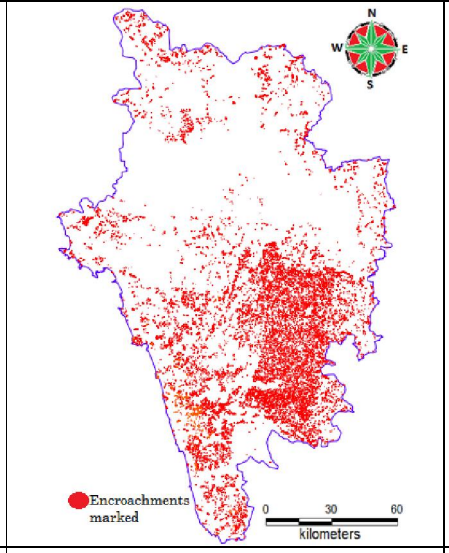
Population Density 2001



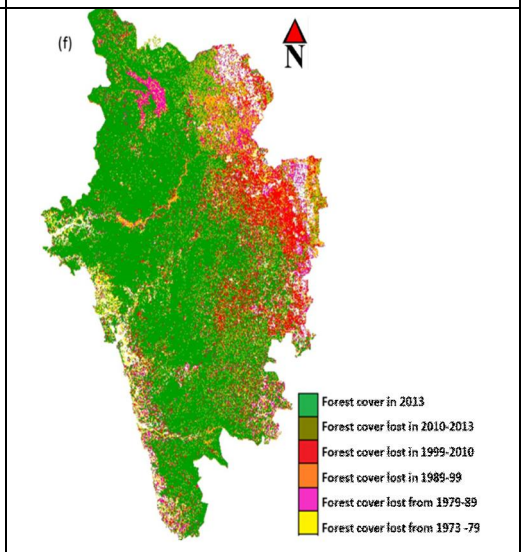
Population Density 2011



Forest Cover 1973



Encroachments



Forest Cover 2013

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