

INTERIM REPORT

ON

The study of Environmental Carrying Capacity of erstwhile Udipi Taluk in relation to expansion of 2X600MW Udipi power Plant (UPCL).

SUBMITTED BY:

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CHAPTER-1

1. INTRODUCTION:

The survival of human race depends upon the availability of abundant natural resources in a healthy and safe environment. Rapid social and economic development has brought issues of resources and environment, such as excessive resources consumption, environmental degradation and pollution, and the issues have become increasingly prominent across the globe (Liu et al 2013 & Jameson, S.C. and Ammar, M.S.A. 2007).

Carrying capacity is a concept which limits the potential ability of natural resources and species to withstand human intervention. It may be described as a test of the ability of land, water and air to keep itself usable and toxicity free despite pollution and effluent discharges and harmful developments over it.

Carrying capacity also refers to the number of individuals who can be supported in a given area within the limits of natural resources, and without degrading the social, cultural and economic environment for the present and future generations. The carrying capacity for any given area is not fixed. It can be extended to a certain level by improved technology, but mostly it is changed for the worse by pressures which accompany a population increase. As the environment is degraded, carrying capacity actually shrinks, leaving the environment with no ability to support even the number of people who could formerly have lived in the area on a sustainable basis.

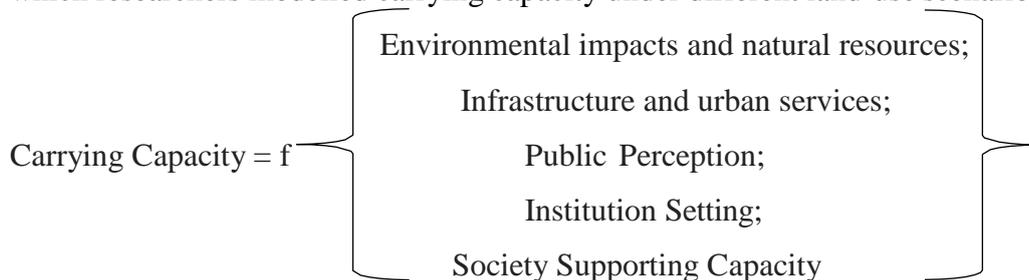
Human activities may not be unsustainable in themselves but the thin line that separates them from being beneficial to mankind and becoming harmful is the environmental recognition of the concept of carrying capacity. If taken beyond carrying capacity, the activities may prove disastrous

The carrying capacity of an environment is the maximum population size of a biological species that can be sustained in that specific environment, given the food, habitat, water, and other resources available for living. Therefore, the environment carrying capacity has become a great concern of research interest. Environmental carrying capacity includes multiple factors such as atmospheric environment, land environment, social economy and dilution related self-purification capacity of water environment, and reflects the threshold of supporting capacity in a region with specific natural resources and ecological environment. The studies indicated that environmental degradation, resource exploitation and utilization

have caused seriously adverse effects on ecological environment, and resource and environment carrying capacity has been substantially reduced.

1.1 THE CONNOTATION OF CARRYING CAPACITY

The concept of carrying capacity is rooted in demography, biology, and applied ecology (Clarke 2002). In ecology, carrying capacity is defined as the maximum population of a species that a habitat can support without permanently impairing the habitat's productivity (Rees 1997). Carrying capacity is an indicator of regional sustainability, and achieving regional sustainability is important because social institutions and ecological functions are closely linked at this scale (Graymore 2009). The concept of a sustainable carrying capacity is defined by a regional ecosystem's characteristics based on two premises. First, it must be possible to sustain the regional ecosystem's normal operations. Therefore, researchers must calculate the quantity of resources and environmental capacity required to sustain these functions. Second, it is necessary to evaluate the regional population and intensity of activities that the natural resources can support after considering the needs of the ecosystem. The theory of environmental carrying capacity has been widely applied in environment planning and management. The carrying capacity depends strongly on environmental resources. However, there have also emerged some theoretical studies of carrying capacity based on regional different resources because this capacity is most often included within the larger theory of sustainable development. For example, Falkenmark and Lundqvist (1998) used estimates of the maximum global use of water resources to study how carrying capacity is determined by regional water resources (Falkenmark, Lundqvist .1998). Another example is a study of the Florida Keys Basin's carrying capacity in the United States (NRC 2002), in which researchers modelled carrying capacity under different land-use scenarios.



Therefore, studying the Environmental Carrying Capacity is always useful and acts as the basis for formulating sustainable development policies. It helps the policy makers to understand the ground reality of environment for a specific region and cause.

1.2 BACKGROUND

As per the directions of the Hon'ble National Green Tribunal, Principal Bench, New Delhi, in Janajagrithi Samithi versus Union of India & others, dated 14/03/2019 and 14/10/2019 in Original Application (O.A) Nos.578/2018, 579/2018, 580/2018, and appeal No. 176/2018 in relation to the expansion of Udupi Power Plant, the department of Forest Ecology and Environment, Government of Karnataka vide order no. FEE08 EAA 2019, dated 12/05/2020, has entrusted Environmental Management and Policy Research Institute (EMPRI) to study the Environmental Carrying Capacity of the project area viz., Udupi Power Corporation Limited erstwhile Udupi Taluk.

The Hon'ble National Green Tribunal, in its order dated 14/03/2019 in the Clause number 124 states that "Before embarking upon it, we deem it appropriate to direct the Ministry of Environment, Forest and Climate Change (MoEF&CC) to ensure that the project proponent carries out an additional EIA study, in terms of additional ToR prepared pursuant to our findings at paras 124 and 125 supra, followed by strict observance of procedure under Stage-III of EIA Notification, 2006 before being finally placed for appraisal by the EAC for consideration for grant of Environmental Clearance. Paras 124 and 125 referred to above are reproduced below for convenience: "124. The question that then requires determination is, should the EC be quashed and set aside? After careful consideration, we find that further studies are unavoidable in order to ensure that the EIA is complete. We, therefore, direct as follows:

(i) Baseline data of the area in relation to the existing project of 2x600 MW shall be scrupulously collected;

(ii) In addition to the above, the State of Karnataka shall get a carrying capacity study of the area carried out.

(iii) The baseline data and the carrying capacity study shall be considered as components for studying the impact in relation to the proposed expansion;

(iv) Fresh public hearing shall be conducted strictly in accordance with the procedure laid down in Appendix IV of EIA Notification, 2006 ensuring wide participation of the people affected by the project "which forms the basis for assigning of this study to EMPRI.

Carrying capacity is a function of environmental inputs, natural resources, infrastructure, urban services, public perception, industrial setting, societal support, the present study deals with base line data of water parameters, data of natural resources including biodiversity hotspots, conduction of public perception survey, etc.

Accordingly, the Environmental Management and Policy Research Institute (EMPRI) has taken up the Carrying Capacity with the following objectives

1.3 Objectives:

1. To collect the existing baseline data of Environmental Parameters and to assess the current environmental status duly considering the industrial and other land use activities.
2. To identify the critical ecosystems and biodiversity hotspots in the region.
3. To determine the carrying capacity of the project area viz Udupi Power Corporation Limited erstwhile Udupi Taluk for the industrial growth and development.

CHAPTER-2

REVIEW OF LITERATURE:

Carrying capacity is an indicator of regional sustainability, and achieving regional sustainability is important because social institutions and ecological functions are closely linked at this scale (Graymore 2009). The concept of a sustainable carrying capacity is defined by a regional ecosystem's characteristics based on two premises. It must be possible to sustain the regional ecosystem's normal operations. Therefore, researchers must calculate the quantity of resources and environmental capacity required to sustain these functions. The concept of environmental carrying capacity in China was first presented in a report about comprehensive environmental research of the Meizhou developing zone in Fujian Province (Wang 1998), which interpreted that the ability of a region to support the threshold of human activities during a definite state or condition for a defined period of time. Since then, the theory of environmental carrying capacity has been widely applied in environment planning and management. The carrying capacity depends strongly on environmental water resources. However, there have also emerged some theoretical studies of carrying capacity based on regional water resources because this capacity is most often included within the larger theory of sustainable development. For example, used estimates of the maximum global use of water resources to study how carrying capacity is determined by regional water resources (Falkenmark and Lundqvist (1998). Another example is a study of the Florida Keys Basin's carrying capacity in the United States (NRC 2002). In which researchers modelled carrying capacity under different land-use scenarios. In China, severe environmental problems have forced the government to initiate a series of studies to determinate carrying capacity based on regional water resources in areas with severe water shortages, such as western China and the North China Plain (Xia J., Zhu Y Z. 2002, and Zhang 2006). These studies mainly focus on the scale of social and economic development that can be sustainably supported by a particular basin's or region's water resources without disturbing the ecosystem's normal operations Zhu et al 2009.

According to Avirneni and Bandlamudi (2013), fossil-fuel coal is abundantly available that is used for power generation in India. This coal is of low calorific value and has high ash content. Many of the coal-based thermal power plants installed in India lack the facility of automatic dry fly ash collecting system and hence the fly ash and bottom ash are discharged in the form of slurry to the ash pond, causing dangerous effects on the environment, economy and the society. The global studies have reported that the coal-based thermal power plants are known

to create hazardous effects on the environmental segments of the surrounding region (Pokale, 2012,). In a study conducted on the effect of pond ash on ground water quality (Suresh et al., 1998) observed that the fly ash leaching had an adverse effect on the water ecosystem while the solid particles were emitted to the atmosphere. Disposal of fly ash is done in wet slurry and in some cases through dry disposal process. In both the disposal methods, the fly ash is dumped in an open land that results in degradation of soil, and eventually causing air and water pollution, ultimately affecting the human health. In a similar study conducted in Kosova it was observed that underground water contamination was due to ash deposits (Avdullahi and Fejza 2010).

No matter how advanced science and technology becomes, human beings consistently rely on natural resources for survival and living. Expansive urbanization associated with rapid industrialization places enormous pressure on the Earth's resources, and humans' requirements for resources have surpassed the planet's regeneration capacity since the 1970s (WWF 2012). Unfortunately, the high ecological pressure in urban areas and almost fully loaded land carrying capacity are even more troublesome as cities continue to experience population expansion, consumption growth, resource overuse, and waste and emission accumulation (WWF 2010). Thus, it is essential to determine land carrying capacity (LCC) to ensure the safety of ecosystems and their sustainable development, or at least to slow down the degradation of natural capital. Currently, more and more regional science programs have been devoted to study the relationship between human beings and land-use situations.

The United States' NASA Land-Cover and Land-Use Change Program was designed to improve the understanding of human interactions with the environment. It is focused on providing foundational knowledge of sustainability, vulnerability, and resilience of land use and on addressing issues related to land-cover and land-use changes for the purpose of human welfare (Justice C, et al 2015).

There are several reasons to conduct a literature review at the beginning of any research projects/works; similarly, we have also done a brief literature review on various carrying capacity studies undertaken within India and in other countries. Carrying Capacity studies of Dakshina Kannada was initiated way back in late 1990's. The Frame Work for conducting Carrying Capacity Studies for Dakshina Kannada was submitted by Prof. D K Subramanian, IISc, Bengaluru under the chairmanship of Prof. Madhav Gadgil and other committee members.

2.1 LAND USE, LAND COVER CHANGES (LULC)

Land cover (LC) refers to the features present on the earth surface. Land cover configuration is stated as a unified reflection of the existing natural resources and natural processes that are dynamic in nature. Mapping, quantifying, and monitoring the physical characteristics of land cover has been widely recognized as a key element for natural resource management and

sustainable planning activities (Nemani & Running, 1996; Barlage et al., 2004). Land use refers to the human induced changes for agricultural, industrial, residential, recreational purposes. The main drivers of land use can be stated as land management policies, population, agricultural production and urban expansion. Land use change alters the homogeneous landscape into heterogeneous mosaic of patches. Almost 40 percent of Earth's land surface had been converted to cropland and permanent pasture by early 1990s. This conversion has occurred largely at the expense of forests and grassland (Ramachandra and Shruthi, 2007). LULC change influences the interaction of ecological, geographical, economic, and social factors (Zang and Huang, 2006; Geist and Lambin, 2006). The impacts of LULC changes on a landscape with respect to wind regime, temperature, soil moisture, water vapor, and cloud development has been accounted through numerous models (Adegoke et al., 2007; Narisma and Pitman, 2003; Gero and Pitman, 2006; Sen Roy et al., 2007; Sen Roy et al., 2011). The structure and composition of landscapes undergoes a rapid change as a result of human related activities. The changes in the mosaic of landscape elements are considered to influence significantly the processes and functions of ecological systems. Quantifying landscape spatial patterns and their changes provide important information for monitoring and assessing the effects of human induced changes on landscape.

Different land use types reflect different ecological sensitivity. Based on the landscape ecology, human activities tend to make the outline of a landscape patch. Thermal power plant and its surroundings are experiencing unprecedented changes in land use and land cover due to concentrated developmental activities due to industries development of the region. The study on rate of urbanization growth process along with LULC changes gives an idea in advance about the infrastructure planning and resource management of the study area. Ramachandra et al, 2012 carried out Land Use Dynamics at Padubidri, Udupi District with the Implementation of large scale Thermal power project. This paper focuses on a land use land cover changes that have occurred due to the establishment of a 1200 MW power plant at Padubidri in the coastal district of Udupi, Karnataka. The results indicate that the vegetation has decreased from 8.1 (2003) to 4.24% (2011) while the area under built-up has increased from 5.26 to 8.1%.

Naik et al. 2018, carried out Impact of Land use Land cover change on coastal tourism in Kundapura, Karnataka, using Multi-temporal remotely sensed data and GIS techniques. Tremendous changes, particularly in mixed urban and agricultural land and proved that RS/GIS have advantages over conventional techniques. Based on the multi-dated satellite data study, assist in decision making and help to take appropriate measures to monitor and regulate coastal development in order to achieve sustainable and integrated coastal

development.

Silambarasan et al., 2014, carried out a study titled “Urban sprawl mapping and land use change detection in and around Udupi Town: A Remote sensing based approach”. In which a significant increase in settlements and built-up land during the study period was observed. The settlement and built-up land increased from 16.7 sq.km to 41.9 sq.km showing an increment of 150% compared to 2003. Agricultural land increased by 22% whereas plantation decreased by 8%, forest by 12% and scrub vegetation by 42%. Barren/waste land also showed decrease due to conversion to settlement and built-up area.

Anchan et al., 2018, carried out Land use and Land cover change detection through spatial approach: A case study of Mangalore Taluk, Karnataka. Study brought to light that the forest area that occupied 37% of the Taluk’s area in 1997 has reduced to 31% in 2017; agricultural land, built up area, water bodies and barren land have also experienced changes. Built-up lands (settlements) have increased from 6 per cent to 23 per cent of the total area. The high land vegetation and forest cover areas are disappearing rapidly; water bodies like lakes are also diminishing.

SCOPE: The study area is erstwhile Udupi Taluk (presently Kapu Taluk) where M/S Udupi Power Corporation limited is located. It includes the assessment of the impact of industrial development in the erstwhile Udupi Taluk (presently Kapu Taluk) and to come out with the calculation of Environmental Carrying capacity of erstwhile Udupi Taluk (Kapu, Karkala and Mangalore Taluks).

CHAPTER- 3

GENERAL DESCRIPTION OF THE UDUPI DISTRICT

Udupi district lies in the coastal region and is situated at the foot of Western Ghats running along the West Coast of Karnataka. Udupi is located at the southwest corner of the Karnataka State. It has the greatest extent of 98 km. from north to south and 66 km. from east to west covering a total geographical area of 3,582 sq.km. The most conspicuous areas of very high and very low area of the district are located at 100 and 500 metres of contour lines above the mean sea level respectively.

Udupi District is one of the thirty districts in Karnataka State. It came into existence as a separate district (District Code 569) on August, 24th 1997. The district comprises administrative subdivisions Brahmavara, Byndoor, Hebri, Kapu, Kundapura, Karkala, Udupi, Taluks. Administratively, the district has 233 villages 3653 sub-villages, 158 Grama Panchayat (GPs), one city municipal Council (Udupi City), three Town Municipal council (Kundapura, Kapu and Karkala) and one Town Panchayat (Brahmavara) (**District At A Glance : Udupi District-Statistical Report - FY 2018-19**).

3.1 Physical features:

3.1.1 Location: Located between the foothills of Western Ghats in the East and Arabian Sea in the West, Udupi is one of the three coastal districts in the State. The district lies between 13^o 34' North latitude and 74^o 75' East longitudes covering an area of 3582 sq. km. It is about 88 km in length and about 100 km in widest part and is bounded by Uttara Kannada district in the North, Shivamogga and Chikamagalur districts in the East and Dakshina Kannada district in the South, while Arabian Sea forms its western boundary. Location of Udupi district and the district map are given in Fig 2.1a and 2.1b (Udupi District-Statistical Report- FY 2018-19).

3.1.2 Physiography: The total geographical area of the district is 3,582 square km, which constitute about 1.86 percent of the total geographical area of the state (Table 1.). Geographically, Kundapura is the largest Taluk with 887 sq.kms (22.29 percent), followed by Karkala, 721 sq.kms (15.32 percent) and Kapu is the smallest, 220 sq.kms (3.96 percent). The district is blessed with diversified endowments of nature. The district has three distinct natural regions; coastal region with a coastal belt of about 98 Kms, rolling midland plain terrain, covering 75 percent of the district and malnad region and the Ghats section with hills and thick forests. Many rivers take birth in the foothills of Western Ghats, flowing westwards and joining the Arabian Sea (Fig 1).

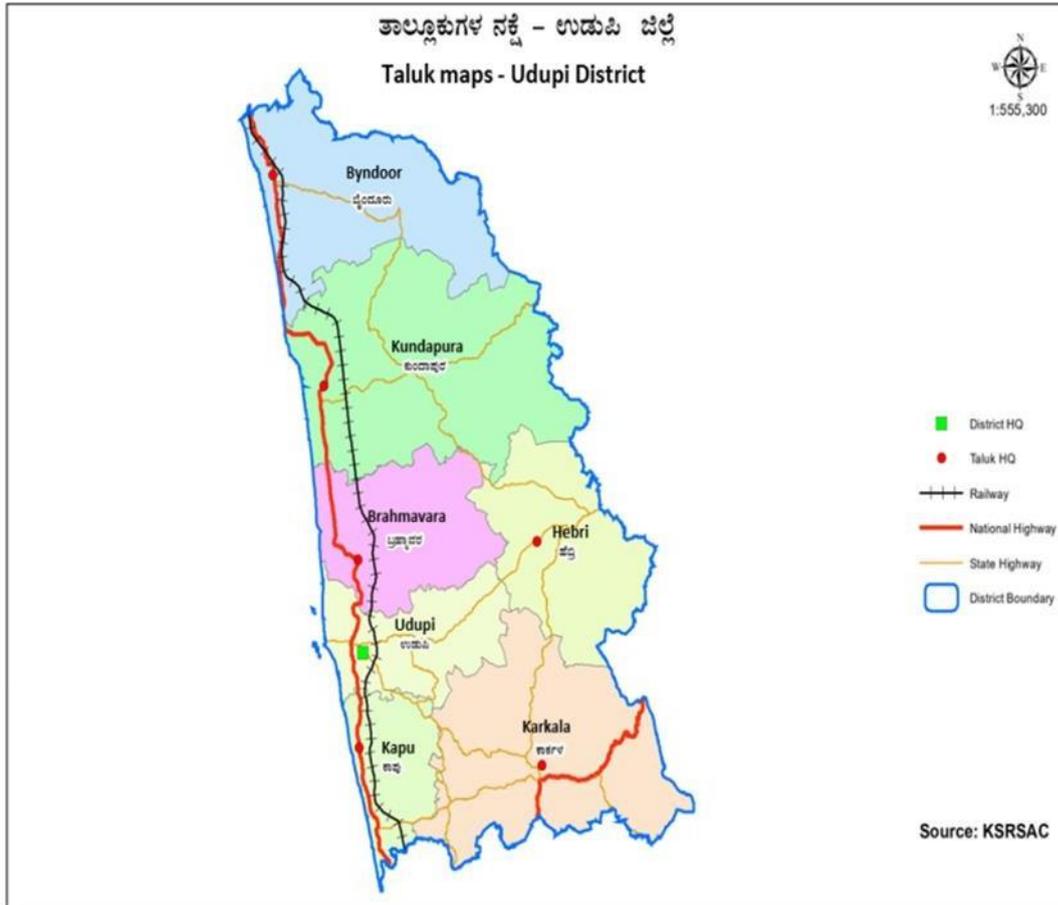


Figure 1: Different Taluks of Udipi Districts

3.1.3 Climate: The district comprises of three distinct physiographic regions: coastal belt, Midland plain terrain and malnad. The midland part between Western Ghats and the coast which constitutes more than 50 percent of geographical area, is upland plain terrain intercepted with forested low hilly topography with valleys. Udupi district has varied climatic zones. It is humid in the coastal region, cool in the Ghat region and warm in eastern region. Humidity is as high as 78 per cent during greater part of the year. The temperature ranges from 220 C in winter to 370 C in summer. Agro-ecology, climate, hydrology and topography are shown in (Table 1.). There are four distinct seasons viz. rainy season from June to September, following withdrawal of monsoon, two months of warm and damp weather during October and November, a pleasant winter season between December and February and a hot and sultry summer season from March to May. The district is blessed with high rainfall from the south-west monsoon. Normal annual rainfall is about 4285mm, which is the highest in the state (Fig 2).

Table 1: Annual Rainfall of Udupi district

Taluks	Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Brahmavara	3252	4638	4411	4680	3974	3968	3205	2962	3742	3994	3682
Byndoor	3677	5126	5242	4994	3736	5136	3775	3469	3428	4974	3354
Hebri	3628	7075	4192	4541	4951	5092	4650	4463	3785	3706	5301
Kapu	2486	3881	4600	4324	4060	3990	3069	3281	3472	2922	3699
Karkala	4465	5791	5196	5469	4464	5145	4600	4381	3710	3938	4810
Kundapura	4013	5749	5176	5075	4283	4864	3909	3573	3529	4231	3382
Udupi	3154	4284	4668	4638	3898	4162	3320	3310	3355	3644	3431

(Source: District At A Glance: Udupi District-Statistical Report - FY 2018-19)

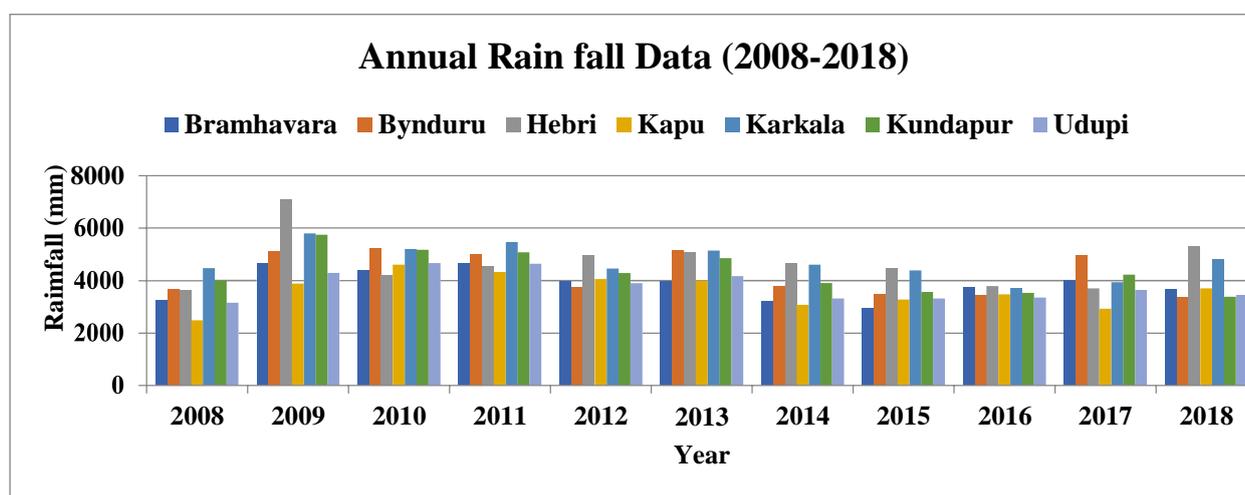


Figure 2: Annual Rainfall of Udupi district

3.1.4 Drainage: The main drainage of the district is westwards. As the Western Ghats are located on the eastern part of the district, the rivers and streams of this district necessarily flow from east to west. Varahi, Gangolli, Sitandi and the Swarna are the important rivers. In the monsoon season all the rivers and streams become swollen due to heavy rains and some of them overflow their banks, inundating the surrounding areas. But they do not last long, for they retrieve to their normal positions within a short period.

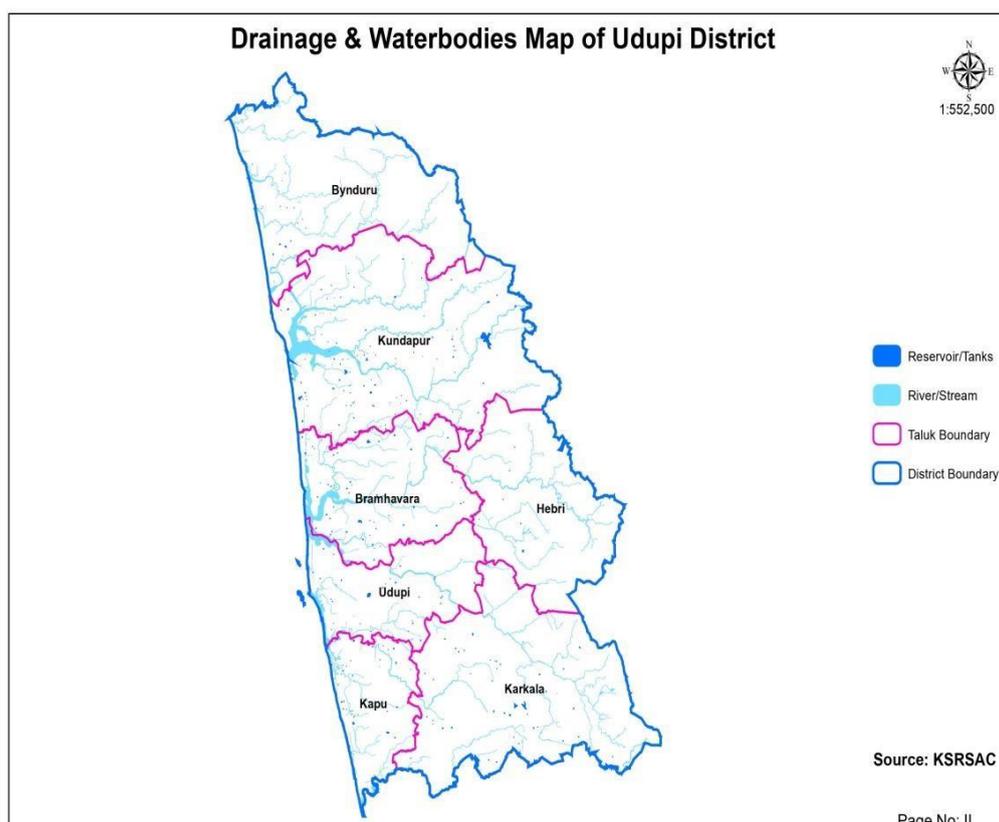


Figure 3. Drainage & Water bodies Map of Udupi District

3.1.5 Land use Pattern: Land utilization pattern in the district reveals that of the total geographical area of 3.56 lakh hectare (ha), the area under forest is one lakh ha (28 percent), area under cultivation, 97827 ha. (27 percent) and fallow land, 13270 ha (3.78 percent). The remaining 41 percent of the land is either not available for cultivation or uncultivable (Table 2.3) (Land Utilization (in Hectares): 2017 – 18 District at Glance).

Table 2. Land Utilization (in Hectares) of Udupi District

Taluks	Geographical Area	Forest	Land not available for Cultivation	Other uncultivated land	Fallow Land	Net cultivated area	Gross cropped area
Brahmavara	39820	2895	8989	9556	-	-	-
Byndoor	58312	28405	7112	7594	-	-	-
Hebri	45691	22917	2863	10230	-	-	-
Kapu	22020	475	4060	7746	-	-	-
Karkala	72081	14973	7690	28513	-	--	-
Kundapura	87563	29121	15203	16244	-	-	-
Udupi	30959	1316	8067	11380	-	-	-

(Source: District At A Glance: Udupi District-Statistical Report - FY 2018-19)

The district has one of lowest percentage of area under cultivation in the state. The net cultivated area in the district is 27 percent of geographical area as compared to state's 55 percent. Talukwise data on land utilization shows that Kundapura has the highest forest area (40 percent) followed by Karkala (30 percent) and Udupi has lowest (5 per cent). As against this, the proportion of net cultivated area is the highest in Udupi Taluk (34 per cent), followed by Kundapura (27 percent) and Karkala has the lowest (22 percent). The gross cropped area in the district is 1.11 lakh ha. The cropping intensity works out to 1.14 as against state average of 1.24 per cent. The low cropping intensity is mainly due to lack of irrigation facilities. There is no much inter-taluk difference in the cropping intensity. With fast urbanization, land use for non-agricultural purposes is increasing and thereby limiting the scope for further increase the net cultivated area. However, there is a good scope to increase the gross cultivated area by increasing the area under irrigation during rabi and summer seasons. There is also considerably a large area (35581 ha) of waste and fallow land which can be brought back under cultivation. The land use map of the district is given in **Fig.2**.

3.1.6 Forestry: Geographically the region is separated from the rest of south interior peninsula by the towering heights of the Western Ghats. The slopes of the Western Ghats are clothed with dense forests containing valuable timber species. The heavy rainfall in this area stimulates the growth of the forests, which sometimes, begin with a few kilometres of the seacoast. Generally, dense forest begins about 30 to 40 km. from the coast. Six types of forests are found in the State. Of these, the district is naturally blessed with evergreen, semi-evergreen and moist forests. As per the statistics provided by the Directorate of Economics and Statistics and Annual Season and Crop Report 2017 - 18, out of the 356446 hectares of the total geographical area, 100102 hectares are covered under forest forming about 27.9 per cent of total geographical area. Dense forest areas are more in Kundapura and Karkala Taluks.

3.1.7 Flora: The climatic and soil conditions of the district have promoted the spontaneous growth of plants and trees in almost all parts. The slopes of Western Ghats are clothed with dense vegetation. In the coastal belt however, the tree-growth is somewhat sparse. The chief timber trees are the teak, rosewood, ben teak, kiralbhogi, Matti maravu and Kada halasu. The flora is luxuriant as well as complex and includes species like casuarinas, cashew trees, mango trees, etc. Climbers, reeds and canebrakes are found in abundance on the slopes of Western Ghats in the district. The pineapple was perhaps introduced into the district by the Portuguese and now it grows in considerable quantity all over the district. Turmeric is chiefly found in the Karkala taluk but is grown in small patches all over the district. Ginger, cardamom, plantains, pepper are some of the crops which are grown in the district.

3.1.8 Fauna: A large extent of forestlands in the districts affords a safe home to wild animals of the type generally found in Southern India. Indian Guar, Sambar, Spotted deer, Wild Boars, Monkeys, Rabbits, Foxes, Porcupine, Mongoose, Squirrels, etc. are amongst the important types of animals found in the district. Among the reptiles, Cobras, Python, Rat Snakes and the harmless green whip snakes are found in all parts of the district. The rivers, streams and the sea abound in a variety of fishes. Among the insects, butterflies and moths are found in great variety. The number of leaf insects and the stick insects is also considerable. The only economically valuable insect is the bee, which builds its nest on the higher branches of the lofty trees or in the clefts of rocks. Birds such as Peafowl, Jungle fowl and Spur fowl are seen in the forests. Partridges are not very common but Pigeons of several kinds are found. Domestic animals reared in this district are cattle, goats, buffaloes, sheep, horses and donkeys. Pigs of the common country breed are reared by some people. Fowls are kept by a large number of households. Particular attention is even now paid to the rearing of gamecocks, since cock fighting is a favourite pastime of the people in the rural sector

3.1.9 Geology and Soils: Geographically, the district contains rock formation belonging to the earliest period of the earth's history, namely the Archean epoch; except on the coastal strip. The coastal region contains recent and sub-recent deposits and the lateritic formations. The older metamorphic rocks constitute mainly the Dharwars and these are represented by the banded ferruginous quartzite and by the talc and hornblende schist. The soils of the district are essentially derived from the coastal strip. Soil structure of the district contains three types: sandy alluvium soil, yellow loamy soil and red lateritic soil. The sandy soils are confined to narrow strip of the coastal belt having width ranging from less than 100 meter to about one km. The fine to medium texture sandy soils is characterized by their extremely high rate of infiltration. Yellow loamy soils, which are mostly found along river banks and lower valleys, are fertile and well suited for irrigation and proved to be responsive to irrigation practices. The red lateritic soils are the most dominant soil type in midland area. The texture of the soils varies from fine to coarse.

3.1.10 Demography: As per 2011 census, the total population of Udupi district is 11.77 lakh, of which 5.62 lakh were males and 6.15 lakh females (Table 3). The proportion of male population works out to 47.7 per cent as against the women's share of 52.3 per cent. The sex Ratio works out to 1094 as against state average of 973. The population of Udupi district has increased by 65118 persons during the decade 2001-11 and in terms of percentage; it has registered a decadal growth of 5.8 per cent. The decadal growth rate of population of the district has recorded declining trend from 1981-1991 onwards; it declined from 9.4 per cent to 7.1 per cent during 1991 -2001 and to 5.8 per cent during 2001-11. The decadal growth of population is lower than state average of 15.7 per cent.

Table 3: Population census area & density of Udupi district (2011 census)

Sl No	Taluks	Geographical Area (Sq.kms)	Population Density	Population		
				Male	Female	Total
1	Brahmavara	398	437	83030	91042	174072
2	Byndoor	583	214	58936	66105	125041
3	Hebri	463	101	22604	24059	46663
4	Kapu	220	614	63595	71457	135052
5	Karkala	721	250	86179	94249	180428
6	Kundapura	887	296	123458	138972	262430
7	Udupi	310	818	124329	129346	253675
	Total	3582	330	562131	615230	1177361

(Source: Distract at a Glance 2017-18)

The district has one of the lowest decadal population growth rates in the state. The district has the lowest percentage of schedule caste (SC) population in the state. As against the state percentage of 17.2 per cent SC population, the district has only 6.4 percentage SC population. Even in the case of schedule tribe (ST) population, the district has 4.5 per cent as compared to state's 7 per cent. Taluk-wise, Kundapura Taluk has the highest population (2.62 lakh), followed by Udupi (2.53 lakh), Karkala (1.80 lakh), Bramhavara (1.74 lakh), Kapu (1.35 lakh), Bynduru (1.25 lakh) and Hebri (0.46 lakh). The population density of the district works out to 330 per sq.km as against the state population density of 319. Udupi taluk has the highest population density (818 per sq. km) and Hebri the lowest (101 per sq. km) Table 2.7. Out of 11.77 lakh population in the district, the rural population is 8.43 lakh (71.6 percent) and urban population, 3.34 lakh (28.4 percent). The share of rural population has declined from 81.5 percent in 2001 to 71.6 percent in 2011 and the share of urban population increased from 18.5 percent to 28.4 percent. In absolute numbers, the

rural population declined by 62590 and the urban population. Taluk-wise, Kundapura has the highest percentage of rural population (2.21 lakh), followed by Karkala (1.47 lakh). Hebri has the lowest (0.46 lakh) rural population.

The literacy rate in the district is 86.24 per cent as against the state average of 75.6 per cent. It has increased from 81.25 per cent in 2001. Next to Dakshina Kannada, the district has the highest literacy rate in the state. The literacy rate among males is 91.41 percent and among females 81.58 percent. In rural areas, the literacy rate is 83.9 percent and urban areas 92.1 percent. In rural areas 89.8 percent of males and 78.6 percent of females are literates, whereas in urban areas, male and female literacy rates are 95.2 percent and 89.2 percent respectively. During 2001 and 2011, the total workforce of the district has increased from 4.88 lakh to 5.13 lakh. While the male workers constitute 60 percent of total male population, the percentage share of female workforce in total female population is only 29 percent. The occupational pattern shows urban trends in rural employment, more workers are engaged in non-farm employment. The cultivators constitute 12.3 percent of workforce and agricultural labourers 12.4 percent. The number of cultivators in the district declined from 92662 in 1991 to 63143 while agricultural labourers declined from 82314 to 63390 (Table 4).

Table: 4 Literacy Rate of Udupi District (2011 Census)

Sl No	Taluks	Rural			Urban			Total		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Brahmavara	57526	55630	113156	10977	10754	21731	68503	66384	134887
2	Byndoor	47244	45374	92618	-	-	-	47244	45374	92618
3	Hebri	17972	16889	34861	-	-	-	17972	16889	34861
4	Kapu	39027	41834	80861	15415	16084	31499	54442	57918	112360
5	Karkala	57579	58280	115859	13842	13916	27758	71421	72196	143617
6	Kundapura	81876	80399	162275	16775	16425	33200	98651	96824	195475
7	Udupi	23085	22531	45616	84386	82609	166995	107471	105140	212611
	Total	324309	320937	645246	141395	139788	281183	465704	460725	926429

(Source: District At A Glance: Udupi District-Statistical Report - FY 2018-19)

3.1.11 Agriculture:

Agriculture and allied activities are the backbone of the district's rural economy, where the majority of the population lives. In the coastal area, fishing is the main occupation. Agriculture and allied activities contributes 17 percent to district GDP. The district witnessed steady deceleration in gross cropped area since 2001. The gross cropped area declined from 133261ha in 2000-01 to 110929 ha in 2014-15. The cropping intensity which was 1.31 was reduced to 1.14 during this period (Table.5)

Table: 5 Agricultural Land Utilization of Udupi district

Taluk/Year	Land Utilization (Hectares)- 2018-19								
	Geo-graphical Area	Forest	Land not Available for cultivation			Other Uncultivated Land			
			Non-agricultural uses	Barren & Uncultivated Land	Total	Cultivable waste	Permanent Pasture	Trees & Groves	Total
Bramhavara	39820	2895	7296	1693	8989	4440	1915	3201	9556
Bynduru	58312	28405	5250	1862	7112	1859	1192	4543	7594
Hebri	45691	22917	1897	966	2863	4333	766	5131	10230
Kapu	22020	475	3593	467	4060	2086	2292	3368	7746
Karkala	72081	14973	4756	2934	7690	14227	1371	12915	28513
Kundapur	87563	29121	12085	3118	15203	2946	2076	11222	16244
Udupi	30959	1316	7511	556	8067	6809	1011	3560	11380
Total	356446	100102	42388	11596	53984	36700	10623	43940	91263

The district has at present no any operational major and medium irrigation projects. Consequently, irrigated area is mainly through wells, tanks and check dams.

3.1.11. I Cropping Patterns: Agriculture is an important livelihood for the people of Udupi besides fishing. The cropping pattern in Udupi is mainly concentrated on paddy. During the crop year 2017-18, total area under paddy was 47095 ha. Paddy crop was mainly raised during Khariff - the rainy season. In Rabi season, mainly pulses and oilseeds are grown. Pulses grown are black gram, horse gram, green gram, cowpeas. The area under pulses was 3195 ha. Groundnut is the main oilseed grown in the district. Groundnut is grown in 1774 ha. Sesamum is grown in 32 ha. and other oilseeds in 29 ha. Paddy accounts for nearly 47 percent of the total gross cropped area, followed by pulses (4.6 percent) and oilseeds (1.8 percent). The area under food grains is steadily declining mainly due to high cost of cultivation and labour scarcity. The area under paddy cultivation has declined from 69892 ha in 1990 to 49555 ha in 2014-15. The area under pulses witnessed a decline from 11759 ha to 3948 ha during this period. Sugarcane, which was grown once in about 2000 ha, is now abandoned with the break-down of Brahmavara sugar factory.

The district has substantial acreage under horticultural crops. In the year 2017-18, the Coconut accounts for 17960 ha, areca nut, 8154 ha, cashew-nut 19373 ha, rubber 4693 ha, banana 992 ha, black pepper 353 ha, and vegetables 1533 ha. The district is also known for growing Mallige in 214 ha. The area under the plantation and horticulture crops also in recent years witnessed stagnation. Small and marginal farmers dominate the agricultural scene. Of the total holdings, 79 per cent are marginal farmers with land-holding less than 1ha. They own 34 per cent of the land area. Small farmers with 1 to 2 ha constitute 13 per cent of farmers and own 23 per cent of land. Marginal and small farmers, together, account for 92 per cent of farming community with less than 2ha holdings. The medium and large farmers with above 2ha, on the other hand, form 8 per cent of farming community and own 42 per cent of the land area cultivated. The average size of land-holding works out to 0.74 ha.

The chief crops grown are cashew nut, mango, banana, sweet potato, sapota, brinjal, papaya, tapioca, lemon, guava, and onion. The other condiments and spices produced in the district are dry chillies, turmeric, dry ginger and black pepper. One special variety of brinjal known locally as “Udupi Gulla” is grown in this district. The district is also known for growing coconut and arecanut in plenty.

3.1.12 Irrigation: There are no major irrigation projects in the district. The district enjoys an average annual rainfall of 4,252 mm and when compared to other districts it ranks first in the state in receiving the highest rainfall. The district is mostly dependent on southwest monsoon, which receives about 86-88 per cent of rainfall. The peculiar formation of the district on account of undulations with deep valleys interspersed with ridges and tablelands makes it difficult for reclamation and cultivation. Moreover, the abundant water available in the rivers and rivulets received from heavy rainfall drains off into the Arabian Sea without being utilized due to lack of facilities for storing the monsoon showers. In the recent past efforts are being made to improve the irrigation facilities and to bring more areas under irrigation. The greatest irony is that even though the district has bountiful rainfall and has many rivers with plenty of waters received through heavy showers during the monsoon; these rivers are emptying into the sea without their waters being properly utilized. In order to prevent the water being discharged into the sea and also to provide irrigation for the agricultural operations, Varahi Irrigation Project was envisaged and was approved by the Government in 1979 as a plan scheme. This project was designed to provide irrigation facility to an extent of 15,702 hectares benefiting Kundapura and Udupi Taluks. The project aims at constructing a pick-up dam across river Varahi at Horiyabbe site near Siddapura village in Kundapura taluk by utilising the daily discharge of tailrace water from Varahi Hydro Electric Project. Initially the height of the dam was proposed at 72 metres but

Table 6; Gross and Net irrigation areas of Udupi District

Gross and Net area Irrigated under different Sources: 2017 - 18											
Sl No	Taluks	Net Area Irrigated Under Difference Sources (Hectares)									
		Tube Wells			Lift Irrigation			Other sources		Total	
		Nos	Gross Irrigated Area	Net Irrigated Area	Nos	Gross Irrigated Area	Net Irrigated Area	Gross Irrigated Area	Net Irrigated Area	Gross Irrigated Area	Net Irrigated Area
1	Brahmavara	38	59	59	724	370	336	642	642	4201	4156
2	Bynduru	32	58	58	73	152	148	699	697	4160	4110
3	Hebri	40	473	473	213	231	231	482	478	1900	1885
4	Kapu	23	40	40	149	32	26	546	524	3397	3359
5	Karkala	240	900	900	504	577	577	159	143	7258	7228
6	Kundapura	116	133	133	339	221	215	1616	1616	7918	7855
7	Udupi	22	33	33	243	202	173	567	556	3238	3194
	Dist. Total	511	1696	1696	2245	1785	1706	4711	4656	32072	31787

(Source : ASCR : 2017-18)

subsequently reduced to 49.5 metres in order to reduce the submergence of forest area to the barest minimum of 275 hectares. In order to provide immediate irrigation facility to the farmers, a Varahi Lift Irrigation Scheme was accorded by the Government in 1992. Under this proposal, an extent of 2,723 hectares will be irrigated through this scheme (Table 6).

3.1.13 Animal Husbandry Livestock rearing plays an important role in the rural economy in the district. It supplements family income from agriculture and also provides employment. It is more vital wherever agriculture is predominant in the society. Farmers are dependent on animal husbandry activities to utilize agricultural by-products and crop residues to convert them into animal products with good returns. Particularly in this district, the climatic and topographical features have not been conducive for livestock rearing. Despite abundance of green vegetation, the livestock wealth of the district is not quite impressive. The table below shows the distribution of various types of livestock in the district. According to Livestock Census, 2007 the total livestock population in the district is 4,71,076 which includes cattle, buffaloes, sheep, goats, pigs, rabbits and dogs. The district is the 4th largest in the State in dogs' population. The total poultry stock is 11,01,159 (Table 7).'

Table 7: Livestock census data of Udupi District

	Livestock	Brahmavara	Byndoor	Hebri	Kapu	Karkala	Kundapura	Udupi
Cattle	Indigenous	10975	29299	13474	2322	28665	51673	18901
	Exotic Breed	0	0	0	0	0	0	0
	Cross Breed	12806	6082	5240	8372	12772	21378	30108
	Total	23781	35381	18714	10694	41437	73051	49009
Buffaloes	Buffaloes	416	966	312	90	1242	4143	1677
Sheep	Indigenous	0	15	3	-	-	5	38
	Exotic Breed	-	-	-	-	-	-	0
	Cross Breed	-	-	3	-	3	3	0
	Total	0	15	6	0	3	8	38
Goats	Goats	81	362	109	446	582	961	4059
Pigs	Indigenous	51	0	0	94	170	67	681
	Exotic Breed	0	0	0	0	0	0	0
	Cross Breed	276	285	130	114	66	655	509
	Total	327	285	130	208	236	722	1190
Rabbits		208	283	6	23	185	431	260
Dogs		7869	6807	7413	5342	18948	29525	16941
Others		0	0	0	0	0	7	4
Total Livestock		32682	44099	26690	16803	62633	108848	73178
Total Poultry		152635	212881	35796	166318	126983	257242	241917

(Source: Udupi District - Statistical Report - FY 2018-19)

3.1.14 Fisheries: Udupi district has rich resources for fisheries development. Its coastal line is about 100 kms. Fishing is a major economic activity in the district. Udupi is known for marine fishing and its exports. The marine fish landing of Udupi district constitutes about 98,217 MT for the year 2008-09. During 2008-09 Udupi district accounted for 49.03% of the total marine fish production. Ten Fish Landing Centres (5 in Udupi taluk and 5 in Kundapura taluk) and Malpe Fishing Harbour and Gangolli Harbour with all necessary infrastructures are located in Udupi district. There are 69 Ice plants, 8 Cold Storage, 5 Freezing Plants and 4 Frozen Storage in the district. Though in the recent past mechanized fishing is being practiced, a vast majority of the fishermen are still using the traditional fishing gears. The statistics on fishery for the year 2008-09 reveals that the district has 9,336 mechanized boats and 22,580 non-mechanized boats are being used for fishing purposes. The district has 10,700 various types of fishing nets for the purpose. Out of 1,19,241 Fishermen population, 60,048 are active fishermen. By way of comparison, it is higher than other districts of the state. The Government has introduced various welfare schemes such as Saving-cum-Relief Scheme, Group Accident Insurance for active

fishermen, Fisher Woman Co-operative Societies, Development of Model Fishermen villages under Matsyashraya Scheme, Motorization of Traditional Fishing Craft, Reimbursement of Central Excise duty on diesel used by mechanized boats, subsidy on Sales Tax on diesel used by mechanized fishing boats and Receipt and Payment of Distress Relief Fund to improve the socio-economic conditions of the fishermen in the coastal districts. The following table highlights in brief the fishing activity in the district (Table 8).

Table 8: Status fishing data of Udupi district

SI No	Taluks	Fish catch (in Tonnes)	Ice Plants		Cold Storage Centres		No. of Fishing Tanks	
			Number	Capacity M. Tonnes / Day	Number	Capacity M. Tonnes / Day	Tanks of Panchayat Raj	Tanks of Minor Irrigation Department
1	Brahmavara	2957	5	200	0	0	6	1
2	Byndoor	9027	4	113	3	1674	8	0
3	Hebri	1	0	0	0	0	3	0
4	Kapu	3939	6	234	0	0	5	1
5	Karkala	3076	0	0	0	0	9	1
6	Kundapura	10500	23	652	9	5031	2	1
7	Udupi	91472	53	1945	5	470	12	1

3.1.15 Industries: Though agriculture is a predominant activity in the district, its growth in industrial sector is fast developing. There are no major industries in the district. However, the district is making all efforts to improve the small-scale industries in the region. The traditional industries around Udupi are tile manufacturing, beedi rolling, and cashew curing. The industrial units comprise of few textiles, chemicals and engineering units in the district. Besides these, there are also other units like automobile, electrical and electronics, chemicals, ferrous and nonferrous, food and intoxicants, glass and ceramics, leather, paper and printing, rubber and plastics and other small-scale industrial units, which have registered their growth. The table below gives the taluk-wise details of major factories for the year 2009-10. There are totally 338 factories in the district providing employment to 29,814 persons.

MATERIALS AND METHODS AND ANALYSIS

4.1 Physiography

The study area is 10 km radius around UPCL (13°9'35"N, 74°48'0"E), situated in Kapu, Karkala and Mangalore Taluks of the Karnataka state. The site is located on the Western coast at a distance of about 6.0 km from the sea front. The site is situated at Yelluru and Santhuru villages, which is about 3 km from Nandikur National Highway, NH 66, which connects Mangalore and Mumbai via Goa running along the western coastline of India. The project site can be approached by state highway connecting SH1 to Karkala town. The site is located adjacent to the new broad gauge line of Konkan Railways connecting Mangalore to Mumbai. The nearest airport is at Mangalore, which is about 35 km from the site. The nearest Sea port is New Mangalore Port Trust (NMPT), which is about 30 km from the site and the nearest Railway Station is Padubidri, which is about 3 km from the site.

M/s. Udupi Power Corporation Limited (UPCL), a subsidiary of Adani Power Limited (APL), has established a 2x600 MW coal-based power plant which is located in notified industrial area at villages Yelluru and Santhuru, Taluk Udupi, Dist. Udupi, in Karnataka state. These existing units of 2x600 MW of UPCL use 100% imported coal and both the units are in operation since November 2010 and August, 2012 respectively. About 2.2 million tons of coal per annum is imported from Indonesia (UPCL website). In August 2014, Lanco Infratech sold this power plant to Adani Power. Its power is distributed to Karnataka (90%) and Punjab (10%).

Memorandum of Understanding (MoU) for expansion of existing power plant has been signed between State Government of Karnataka and the Company, M/s UPCL. Hence the Company has proposed for expansion of existing 1200 MW (2x600 MW– Sub Critical Units in Phase I) coal-based power plant at villages Yelluru and Santhuru to 2800 MW by addition of 1600 MW (2x800 MW – ultra super critical units in Phase II) in the land adjacent to the existing power plant.

4.1.1 Study location The Buffer area mainly consists of revenue areas of 36 villages that fall in 10.0 km periphery of the project site (Fig 4 &5). Majority of the land of the buffer area is occupied by the agriculture fields.

The broad categories of the land use types in the buffer area include agricultural fields, built-up areas, plantations, sandy beach, sea water and Reserve Forest (Pilarkhan RF).

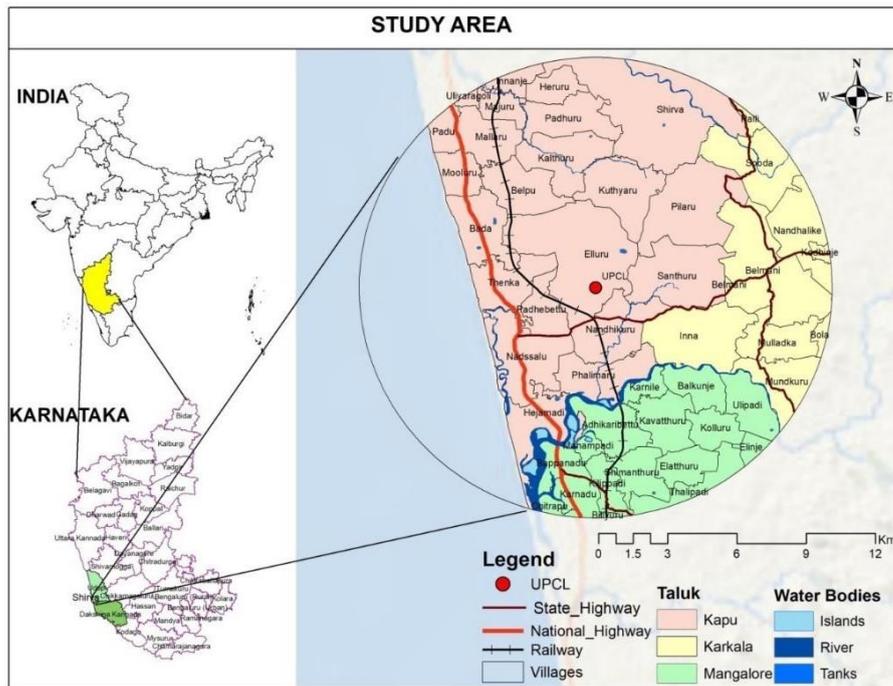


Figure 4: Study area map showing 10.0 km radius of buffer area.

Table 9. List of Villages in the study area

Sl. No	Village Name	Sl. No	Village Name	Sl. No	Village Name
1	Adhikaribettu	13	Yalathuru	25	Padhebetu
2	Balkunje	14	Bada	26	Padhuru
3	Bappanadu	15	Belpu	27	Phalimaru
4	Mulladka	16	Hejamadi	28	Pilaru
5	Belman	17	Heruru	29	Santhuru
6	Karnire	18	Kalthuru	30	Shirva
7	Kavatthuru	19	Kuthyaru	31	Thenka
8	Kilippadi	20	Majuru	32	Yalluru
9	Kolluru	21	Mallaru	33	Inna
10	Manampadi	22	Mooluru	34	Mundkuru
11	Shimanthuru	23	Nadssalu	35	Nandhalike
12	Ulipadi	24	Nandikur	36	Sooda

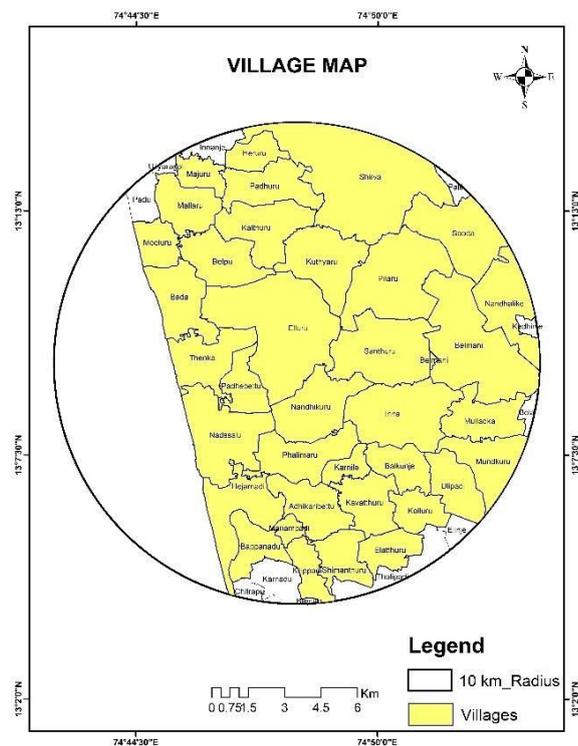


Figure 5: List of Villages in the study area

In order to achieve the objectives envisaged in the Govt. order an integrated approach involving meteorological, remote sensing, geological, ecological, agricultural, biological and related scientific approaches have been followed. The methodology adopted for achieving the objectives is briefly discussed here.

1. Review of literature published by various government departments and other authentic sources and collection of secondary data from various government departments and organizations.
2. Collection of primary data on environmental parameters like air, water and soil being carried out.
3. Assessment of landuse and landcover status and changes noticed between 2002, 2012 and 2019 in the study area by using satellite imageries is completed.
4. Identification of various ecosystems and bio-diversity hotspots is being carried out.
5. Estimation of Carrying Capacity to develop the industrial siting guidelines in the study area is being carried out.

4.2 Objective-1

To collect the existing baseline data of Environmental Parameters and to assess the current environmental status duly considering the industrial and other land use activities.

4.2.1 Description of the Environment

Baseline Environmental parameters status data have been collected within the 10km radius of the project study site to determine the existing status of various Environmental attributes viz., Air, Water, Soil, Land use pattern, Ecological and Socio- Economical environment, this study would help to undertake corrective mitigation measures for protection of the environment on account of any change deviation of attributes due to activities of the proposed project.

Secondary data was collected from various Departments of State/Central Government Organizations, Semi- Government and Public Sector Organizations. Table 11 gives various environmental attributes considered for formulating environmental baseline and Table gives the frequency and monitoring methodology for various environmental attributes.

Table 10: Various Environmental Attributes

Sl. No	Attribute	Parameter	Source of Data
1	Land Use	Trend of land use change for different categories	Digitised LULC 2019 layers using Satellite imagery from NRSC (2019) thematic layers from KSRSAC (2002 & 2012)
2	Water Quality	Physical, Chemical and Biological parameters	Water samples are collected at different locations during this study period
3	Ambient Air Quality	PM2.5, PM10, NO _x & SO _x ,	Secondary data from Karnataka State Pollution Control Board (KPCB)
4	Noise Levels		Secondary data from Karnataka State Pollution Control Board (KSPCB)
5	Ecology	Existing terrestrial flora and fauna within the 10 Kms radius of the study site.	Field survey and secondary sources from KFD.
6	Geology	Geological history	Secondary sources
7	Soil	Soil types and samples analysed for physical and chemical parameters	Field samples and secondary sources
8	Socio economic Aspects	Socio-economic characteristics of 36 different villages	Based on field survey

4.2.2 LAND USE, LAND COVER CHANGES (LULC)

LULC is one of the basic information required for assessing the status of any region. The inventories of various LULC patterns which were existing before and are existing presently will aid in assertion of changes which has occurred over time. This is primary step for identifying, planning and management of areas.

Details of different themes have been collected from Karnataka State Remote Sensing Application Centre (KSRSAC) which is a state nodal agency for all Remote Sensing and GIS works. Data is shared in form of shape files (.shp) for different layers. The layers shared by KSRSAC are prepared by digitizing on Satellite imagery and are verified on ground as well.

All the maps contain the necessary map elements out of which the legend is as per the classification of KRSRAC, which has class level 1 description (Fig 6).

The collected secondary data from KRSRAC is analysed and integrated for each layer. From the integrated data attribute information is extracted, analysed graphs and statistics are generated. From the analysed secondary data, final GIS maps are prepared with the scale of 1:50,000 (table 12).

Data Used

Table 11: Data sources for the study

Data	Year	Sources
Thematic Layers	2002 and 2012	KRSRAC
Satellite imagery	2019	NRSC
Toposheets(reference)	2010 and 2011	Survey of India
Google Earth (reference)	2019	Google earth

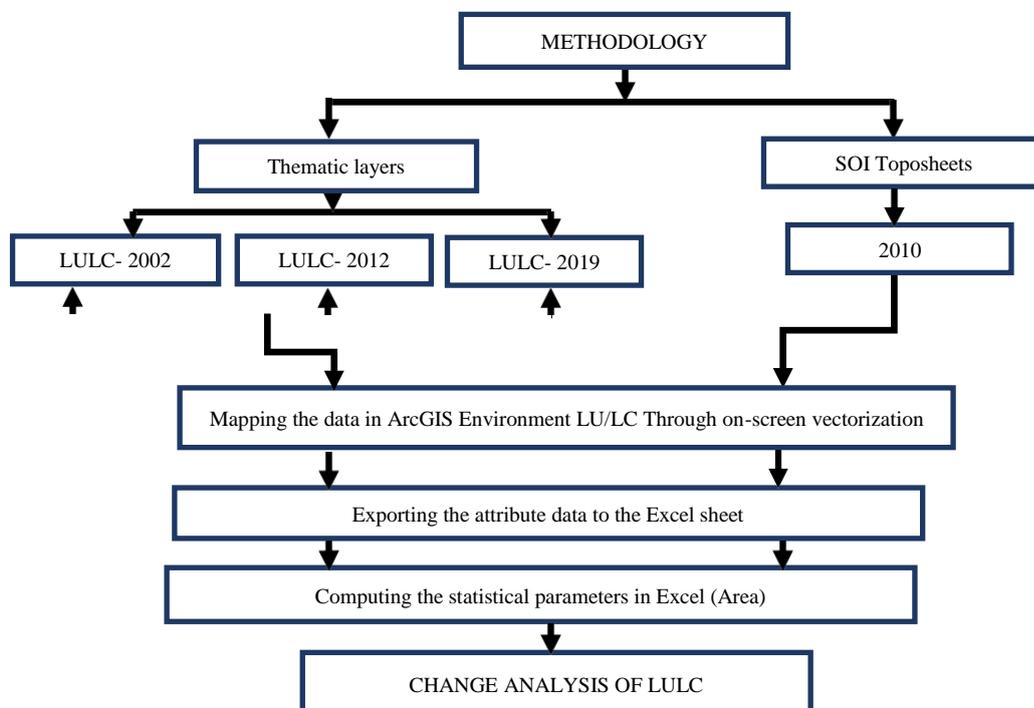


Figure 6: Flow chart for assessing the land use and land cover changes

4.2.2.1 Methodology:

This is primary step for identifying, planning and management of areas. In order to create LULC layer in GIS compatible manner and to provide an organized structure for future spatial analysis LULC layer data model is prepared.

The secondary data of Land use and Land Cover for the year 2002, 2012 and 2019 have been collected from Karnataka State Remote Sensing Application Centre (KSRSAC) which was shared in the form of shape files (.shp). Change detection analysis was carried out for the year 2002, 2012 and 2019 and quantifying the difference that has occurred.

Classification scheme has been adopted, five broad categories which can be applied to LULC. They are:

- Agricultural land
 - Built-up areas
 - Forests
 - Wastelands
 - Water bodies
- **Agriculture land:** It was defined as the land primarily used for farming and for production of food fiber or other commercial and horticultural crops. Agricultural area was again divided into Kharif, double crop and agricultural plantation.
 - **Built-up areas:** Built up land covers buildings, roads, industries, etc., which was the area habituated by the human. In the present study, only important settlement locations are demarcated and considered for mapping.
 - **Forest:** It was defined as an area of trees of species of forestry importance and raised on notified forestlands. It includes Eucalyptus, Casuarina, and Bamboo.
 - **Wastelands:** Wasteland is defined as land which can be brought under vegetation cover with reasonable effort, and which is currently underutilized and deteriorating due to lack of appropriate water and soil management on an account of natural causes. Waste land was grouped into different classes as land with or without scrub and barren rocky/stony waste/sheet rock area.
 - **Water bodies:** It was an area of impounded water, areal in extent and often with a regulated flow of water. It includes man made reservoirs/lakes/canals, besides natural lakes, rivers, streams.

4.2.2.2. Results of Land Use, Land Cover and its Change:

4.2.2.2. I Land use analysis: the Spatio-temporal land use changes during 2002 to 2012 were observed. The results of land-use and land cover changes depicted that the year 2002 (Table 13 & Fig 7) to 2012 ((Table 14 & Fig 8) the agricultural land area were decreased by 44.47%. It was observed that there was a rapid growth in the built-up area by increasing 50% within the study site. In case of forest land, the results show that there were no changes in the forest land from 2002 to 2012 data. Waste land and water body has decreased by 3.82% and 1.72% area respectively (Table 15).

Table 12: land use/land cover –2002

LULC Classification-2002	Area in Sq km	Area in %
Agricultural land	191.62	75.76
Built up	14.83	5.86
Forest	1.45	0.57
Wastelands	38.26	15.12
Water bodies	6.77	2.68
Grand Total	252.93	100

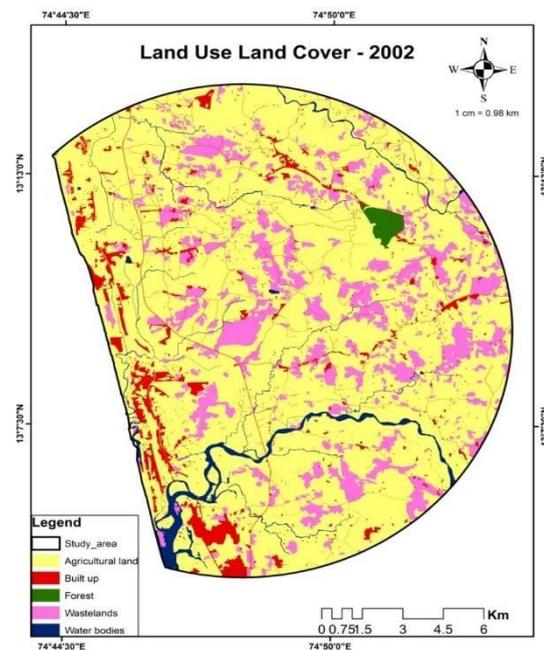


Figure 7: Land use Land Cover map - 2002

Table 13: land use/land cover – 2012

LULC Classification-2002	Area in Sq km	Area in %
Agricultural land	177.88	70.33
Built up	30.28	11.97
Forest	1.45	0.57
Wastelands	37.08	14.66
Water bodies	6.24	2.47
Grand Total	252.93	100

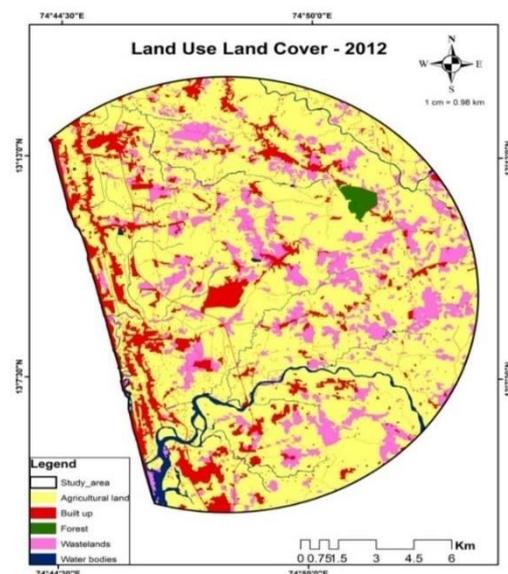


Figure 8. Land use Land Cover map for 2012

Table 14: land use/land cover - 2019

LULC Classification	Area in Sq. km	Area in %
Agricultural land	176.80	69.90
Built up	34.70	13.72
Forest	1.4568	0.57
Wastelands	33.46	13.23
Water bodies	6.53	2.58
Grand Total	252.93	100.00

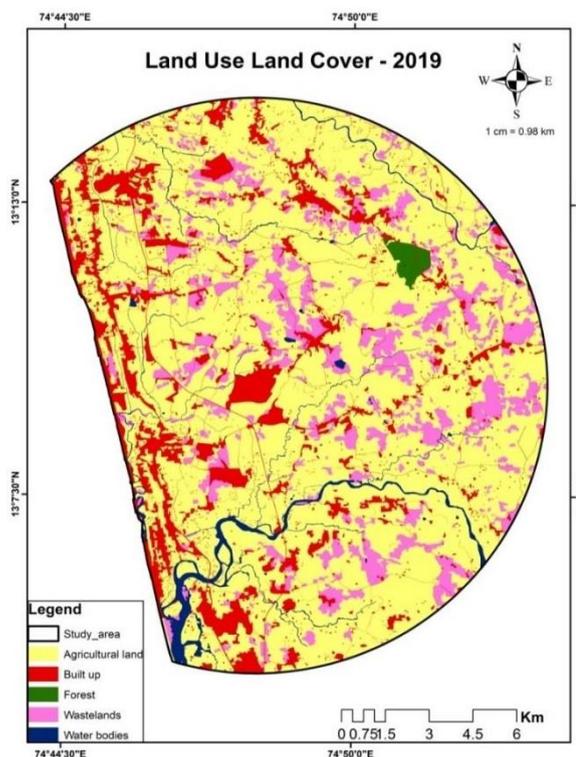


Figure 9: Land use Land Cover map for 2019

Table 15: Land use/land cover changes between the years 2002 and 2012

LULC Classification	Area in Sq. Km		Difference	Difference in %
	2002	2012		
Agricultural land	191.62	177.88	13.74 Decrease ↓	44.47
Built up	14.83	30.28	15.45 Increase ↑	50.00
Forest	1.45	1.45	No changes	-
Wastelands	38.26	37.08	1.18 Decrease ↓	3.82
Water bodies	6.77	6.24	0.53 Decrease ↓	1.72
Grand Total	252.93	252.93		

4.2.2.2. II Land use Land cover changes from 2012 to 2019

The agricultural land was decreased by 11.49% area with the increase in build-up area. The built-up area has increased by 47.02% area (Table 15 & Fig 9). It was observed that there was small decrease in the forest land about 0.02%. Waste lands and water body was decreased by 38.51% and 2.98% respectively (Table 16).

Table 16: Land use/land cover change between 2012 and 2019

LULC Classification	Area in Sq. km		Difference (Sq. Km)	Difference in %
	2012	2019		
Agricultural land	177.88	176.80	1.08 Decrease ↓	11.49
Built up	30.28	34.70	4.42 Increase ↑	47.02
Forest	1.45	1.4468	0.0019 Decrease ↓	0.02
Wastelands	37.08	33.46	3.62 Decrease ↓	38.51
Water bodies	6.24	6.53	0.28 Increase ↑	2.98
Grand Total	252.93	252.93		

4.2.2.2. III Land use Land cover changes from 2002 to 2019

The agricultural, Forest, Waste land, and Water bodies shows that about 14.82 (37.31%), 0.0019 (0.005%), 4.80 (12.08%), and 0.28 (0.60%) sq. km area was decreased respectively and there was much conversion of built up area of about 19.86 sq. km area (50.00%).

The land use and land cover change as a temporal change occurs from the above map of 2002 and 2019. Study area in the year 2012 covered with the agricultural land patches but in the year 2019 agricultural land was drastically decreased.

The built-up area was significantly increased from 2002 to 2019 due to construction of houses, road, small scale industries etc (Table 17).

Table 17 : land use/land cover change between 2002 and 2019

LULC Classification	Area in Sq. km		Difference	Difference in %
	2002	2019		
Agricultural land	191.62	176.80	14.82 Decrease ↓	37.31
Built up	14.83	34.70	19.86 Increase ↑	50.00
Forest	1.45	1.4468	0.0019 Decrease ↓	0.005
Wastelands	38.26	33.46	4.80 Decrease ↓	12.08
Water bodies	6.77	6.53	0.28 Decrease ↓	0.60
Grand Total	252.93	252.93		

It concludes that this study aims to investigate or focuses on land use land cover change detection from 2002, 2012 and 2019 in 10km radius of Kapu, Karkala and Mangalore taluk. The pattern of land cover has changed drastically over the past decade. The Land use types such as, Agricultural land and settlements have dramatically changed, but in different ways. The present study has added to our insight that the changes in land cover of different Land use types did not take similar pattern since the change in one Land use type is favored at the

expense of the other Land use type (for example, compare agricultural land vs. built up or wasteland vs. Built up). Therefore, land managers and conservationists would give due emphasis on understanding how the changes among different land use types are related and act accordingly on devising land use plan, agricultural production and conservation strategies.

4.3 DESCRIPTION OF THE ENVIRONMENTAL COMPONENTS

4.3.1 Air Quality Analysis

The prime objective of collecting the secondary data is to evaluate the existing air quality of the study area. This section describes the results of ambient air monitoring carried out by Karnataka Pollution Control Board (KSPCB) in the different locations of the study area. Various statistical parameters like average, maximum and minimum values have been computed from the observed raw data collected from KSPCB source. The data collected from 15.12.2020 to 18.12.2020 were analysed and following observations were made (Fig 10).

PM10: An average of maximum and minimum value of 50 and 29 $\mu\text{g}/\text{m}^3$ was noticed at R&R Colony Adamar Village and Inna Village respectively.

PM2.5: An average maximum and minimum value of 40 and 20 $\mu\text{g}/\text{m}^3$ was noticed at Mudurangadi Village and Hejmady Village respectively. **SOX** – An average of maximum and minimum value of 11 $\mu\text{g}/\text{m}^3$ was observed at Inna village of study areas (table 18).

Table 18: Analysis Report of Ambient Air Quality parameters (PM 2.5, 10, SO_x, NO_x) of the study site

Sl. No	Parameter Analysed	Standard (24hrs. Avg.)	Stations							
			Mudurangadi Village (GPS location Latitude 13.173659 & Longitude 74.821251)		R&R Colony Adamar Village (GPS location Latitude 13.171574 & Longitude 74.786834)		Hejmady Village (GPS location Latitude 13.097808 & Longitude 74.776902)		Inna Village (GPS location Latitude 13.142498 & Longitude 74.841005)	
			15.12.2020-16.12.2020	17.12.2020-18.12.2020	15.12.2020-16.12.2020	17.12.2020-18.12.2020	15.12.2020-16.12.2020	17.12.2020-18.12.2020	15.12.2020-16.12.2020	17.12.2020-18.12.2020
1	Particulate Matter(PM 10) in μ/m^3	100	38	40	35	50	44	45	38	29
2	PM _{2.5} μ/m^3	60	40	29	33	26	31	20	38	23
3	Sulphur Di-Oxide (SO ₂) μ/m^3	80	8	9	8	8	9	9	11	8
4	Nitrogen Di-Oxide (NO ₂) μ/m^3	80	10	11	10	11	14	15	13	12

4.3.2 Water Quality Analysis

Selected water quality parameters of ground water and surface water resources within the study area have been considered for assessing the water environment. To assess the water quality of the study area, few groundwater sampling and surface water samples were collected and analyzed at Water laboratory, Environmental Management and Policy Research Institute and the results of the water quality samples were explained below.

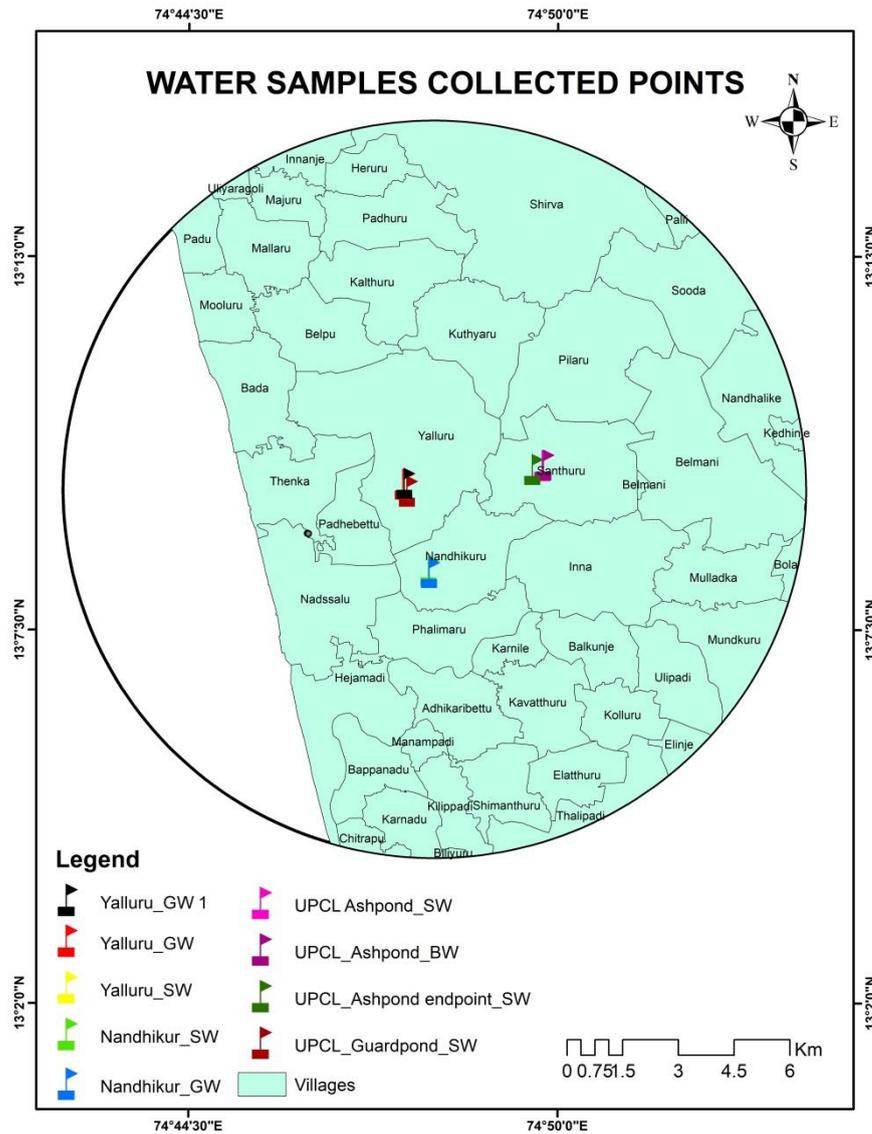


Figure 10: Water samples collected from study site

Fresh water samples were collected to know the quality of both the surface water as well as ground water. Nine water samples that were collected at different places within the study area are as given below.

Sl. No	Location	Type
1	13 ⁰ 09 38.20 -74 ⁰ 47 43.63 Yelluru Village.	Ground Water
2	13 ⁰ 09 38.37 -74 ⁰ 47 43.35 Yelluru Village.	Surface Water
3	13 ⁰ 08 22.28-74 ⁰ 48 05.80 Nandikur Village	Surface Water
4	13 ⁰ 08 20.85-74 ⁰ 48 06.45 Nandikur Village	Ground Water
5	13 ⁰ 09 38.02- 74 ⁰ 47 43.12 Yelluru Village.	Ground Water
6	UPCL Ash Pond End Point.	Surface Water
7	Inside the UPCL Plant.	Ground Water
8	UPCL Ash Pond Starting Point.	Surface Water
9	UPCL Guard Pond.	Surface Water

Inference: The samples from all the above places were analyzed and compared with **Drinking Water Standards - IS 10500, 2012** and the results do not conform to the **stipulated standards**. The analysis reports are indicated in the result form and are given in the Table 19-27.

Table 19: Analysis of surface water of Nandikur Village (13° 08 22.28-74° 48 05.80)

SI No.	Parameters	Units	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		5.6	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B, 4-95 to 4-99
2.	EC µS/cm at 25°C	µs/cm	467	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	11.0	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	324	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	95.64	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	270	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	5.05	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	62.54	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	21	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	BDL	200	400	APHA (23rd Ed.): 2017 4500-SO ₄ -E, 4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	5.6	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C, 4-116
13.	Phosphate as P	mg/L	12.27	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	8.48	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 20: Analysis of Ground water of Nandikur Village (13⁰ 08 20.85-74⁰ 48 06.45)

Sl No.	Parameters	Unit s	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		5.2	6.5 to 8.5	No relaxation	APHA (23rd Ed.,): 2017 4500-H+B,4-95to4-99
2.	EC μ S/cm at 25°C	μ S/cm	1,080	NS	NS	APHA (23rd Ed.,): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	12.8	NS	NS	APHA (23rd Ed.,): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	647	500	2000	APHA (23rd Ed.,): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	352.3	250	1000	APHA (23rd Ed.,): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	369	200	600	APHA (23rd Ed.,): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	5.41	75	200	APHA (23rd Ed.,): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	86.38	NS	NS	APHA (23rd Ed.,): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	21	200	600	APHA (23rd Ed.,): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	16.88	200	400	APHA (23rd Ed.,):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.,): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	5.6	0.5	No relaxation	APHA (23rd Ed.,): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	BDL	NS	NS	APHA (23rd Ed.,): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	8.23	45	No relaxation	APHA (23rd Ed.,): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.,): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 21: Analysis of surface water of Yelluru Village (13⁰ 09 38.37 -74⁰47 43.35)

Sl No.	Parameters	Unit s	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		3.3	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC µS/cm at 25°C	µs/cm	-	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	21.8	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	2,930	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	2,214	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO3	mg/L	180	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	23.08	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	29.74	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO3	mg/L	BDL	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	210.88	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	4.2	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	1.54	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	9.51	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 22: Analysis of ground water of Yelluru Village (13⁰ 09 38.20 -74⁰47 43.63)

Sl No.	Parameters	Unit s	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		6.6	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC µS/cm at 25°C	µs/cm	1,779	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	83.8	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	1,559	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	105.7	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO3	mg/L	144	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	18.03	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	24.05	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO3	mg/L	168	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	BDL	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	2.8	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	11.69	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	0.30	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 23: Analysis of Surface water of UPCL Ash Pond End Point

Sl No.	Parameters	Units	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		7.7	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC μ S/cm at 25°C	μ s/cm	532	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	1.8	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	427	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	201.4	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	59.4	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	8.65	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	9.18	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	73.5	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	184.0	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	7.0	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	0.38	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	11.17	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	0.21	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 24: Analysis of ground water of UPCL

Sl No.	Parameters	Units	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		6.4	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC μ S/cm at 25°C	μ s/cm	151	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	35.0	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	120.8	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	50.33	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	36	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	3.96	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	6.34	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	94.5	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	BDL	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	4.2	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	1.94	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	12.46	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 25: Analysis of ground water of UPCL

Sl No.	Parameters	Units	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		6.1	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC μ S/cm at 25°C	μ S/cm	115	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	351.2	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	85.2	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	50.34	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	54	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	3.60	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	10.93	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	52.5	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	BDL	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	8.4	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	3.26	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	13.10	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 26: Analysis of Surface water of UPCL near Guard Pond

Sl No.	Parameters	Unit s	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		6.4	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC μ S/cm at 25°C	μ S/cm	-	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	3.6	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	12,428	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	6,040	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO ₃	mg/L	424.8	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	13.34	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	96.10	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO ₃	mg/L	63	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	522.7	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.74	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	8.4	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	46.44	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	8.61	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

Table 27: Analysis of Ground water Yelluru Village (13⁰ 09 38.02- 74⁰47 43.12).

Sl No.	Parameters	Units	Result	As per IS 10500: 2012 Drinking water		Methods followed for analysis
				Acceptable limit	Permissible limit in the absence of alternate source	
1.	pH at 25°C		5.6	6.5 to 8.5	No relaxation	APHA (23rd Ed.): 2017 4500-H+B,4-95to4-99
2.	EC µS/cm at 25°C	µs/cm	-	NS	NS	APHA (23rd Ed.): 2017 2510-B, 2-58 to 2-59
3.	Total Suspended Solids at 105°C	mg/L	16.0	NS	NS	APHA (23rd Ed.): 2017 2540-D, 2-70 to 2-71
4.	Total Dissolved Solids at 180°C	mg/L	2,548	500	2000	APHA (23rd Ed.): 2017 2540 C, 2-69 to 2-70
5.	Chloride	mg/L	1,761	250	1000	APHA (23rd Ed.): 2017 4500-Cl-B, 4-75 to 4-76
6.	Total hardness as CaCO3	mg/L	102.6	200	600	APHA (23rd Ed.): 2017 2340-C, 2-48 to 2-50
7.	Calcium as Ca	mg/L	18.03	75	200	APHA (23rd Ed.): 2017 2340-B, 2-48 to 2-50
8.	Magnesium as Mg	mg/L	13.99	NS	NS	APHA (23rd Ed.): 2017 2340-C, 2-37
9.	Alkalinity as CaCO3	mg/L	31.5	200	600	APHA (23rd Ed.): 2017 2320-B, 2-37 to 2-39
10.	Sulphate as SO ₄	mg/L	BDL	200	400	APHA (23rd Ed.):2017 ,4500-SO4-E,4-199 to 4-200
11.	Fluoride as F	mg/L	0.91	1.0	1.5	APHA (23rd Ed.): 2017 4500-F, 4-90 to 4-91
12.	Ammonia NH ₃ -N	mg/L	22.4	0.5	No relaxation	APHA (23rd Ed.): 2017 4500-NH ₃ C , 4-116
13.	Phosphate as P	mg/L	3.16	NS	NS	APHA (23rd Ed.): 2017 4500-P D, 4-163 to 4-164
14.	Nitrate as NO ₃	mg/L	10.67	45	No relaxation	APHA (23rd Ed.): 2017 4500- NO ₃ , 4-127
15.	Nitrite as NO ₂	mg/L	BDL	NS	NS	APHA (23rd Ed.): 2017 4500 NO ₂ - B, 4-124 to 4-125

4.4. PEOPLE'S PERCEPTION SURVEY:

4.4.1 Introduction

A survey was conducted in the 36 villages surrounding the UPCL plant in Udupi district to know the socio-economic, health, environment and ecological aspects of the respondents. The data was collected from a randomly selected 387 respondents in these villages in a prescribed questionnaire. The main objectives were

1. To know the socio-economic conditions of the residents
2. To elicit the opinion of the residents on the impact of the UPCL plant on their environment and their health conditions
3. To know their opinion on the expansion of UPCL plant and on setting up any new industry in the area

4.4.2 Methodology:

A structured questionnaire in Kannada language was used to collect the information. A random sample of 36 villages within a radius of 10Kms was first selected. In the second stage a random sample of 387 families was selected from the 36 villages selected at the first stage. For determining the sample size for the study the small sample techniques as suggested by Robert V. Krejcie and Daryle W Morgan [1] are adopted. The data collected in the prescribed questionnaire were further processed and tabulated using R software. A preliminary analysis is carried out. The summary tables with actual numbers and percentages are presented and used for interpretation. A graphical summary of the tables is also presented.

4.4.3 Results

The results are presented in different sub-sections as per the objectives listed above.

4.4.3.1 Socio-Economic conditions:

Classification of respondents by gender is given in table 28. From this it is observed that 69% of the respondents were males and the remaining were females. Thus there is adequate representation for both genders and hence there may not be any gender bias in the results. In the next Table 29 the distribution of respondents by the level of education. Only a small percent (1%) were illiterate, rest had at least primary education. Occupational classification of respondents is given in Table 30. Large proportions (69.25%) have Agriculture as their primary occupation. Fisheries are the occupation of 10.6%. Monthly income of 39.8% is found to be lesser than Rs. 10,000/- per month, while 50.6% had more than that and 10.8%

did not disclose their income (Table 31). Joint ownership of the property was observed among 57.1% and 27.1% singly owned their property and 15.87% did not disclose the information. Table 31a shows the size distribution of land holdings in the sample. Many did not disclose the size of their land holdings (72.0%).

Table 28: Distribution of respondents by gender

Gender	Number.	Percent
Male	268.00	69.25
Female	119.00	30.75

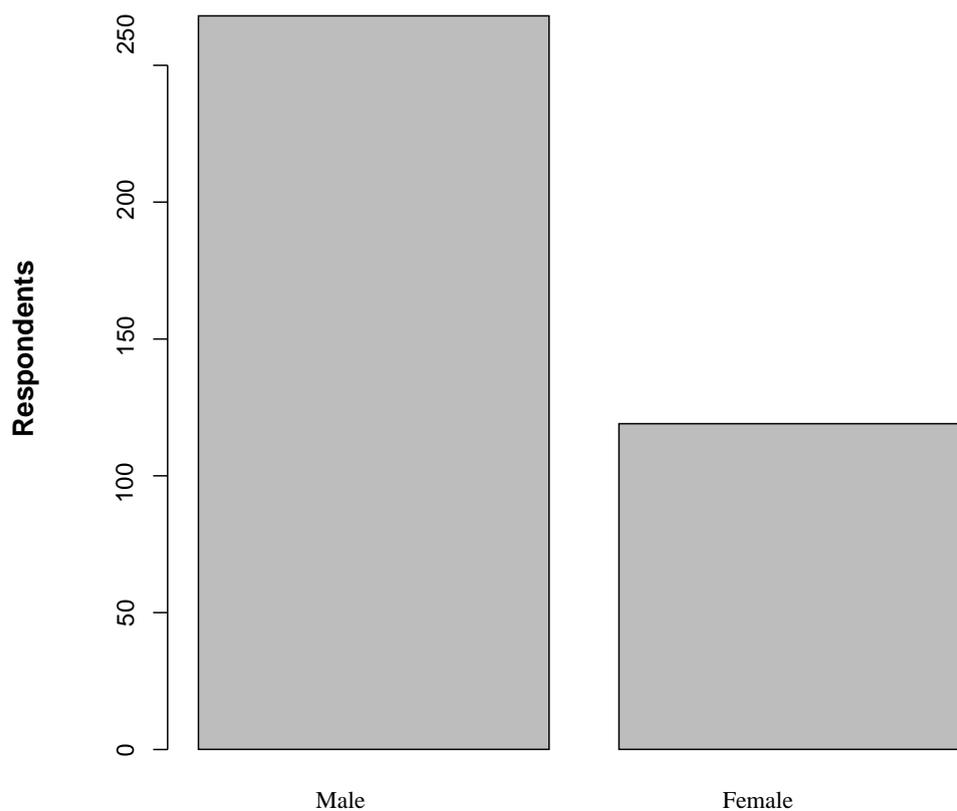


Figure 11: Distribution of respondents by gender

Table 29: Education level of Respondents

Education	Number.	Percent
Primary	104.00	26.87
High school	140.00	36.18
Pre university	56.00	14.47
Degree	64.00	16.54
Illiterate	5.00	1.29
NA	18.00	4.65

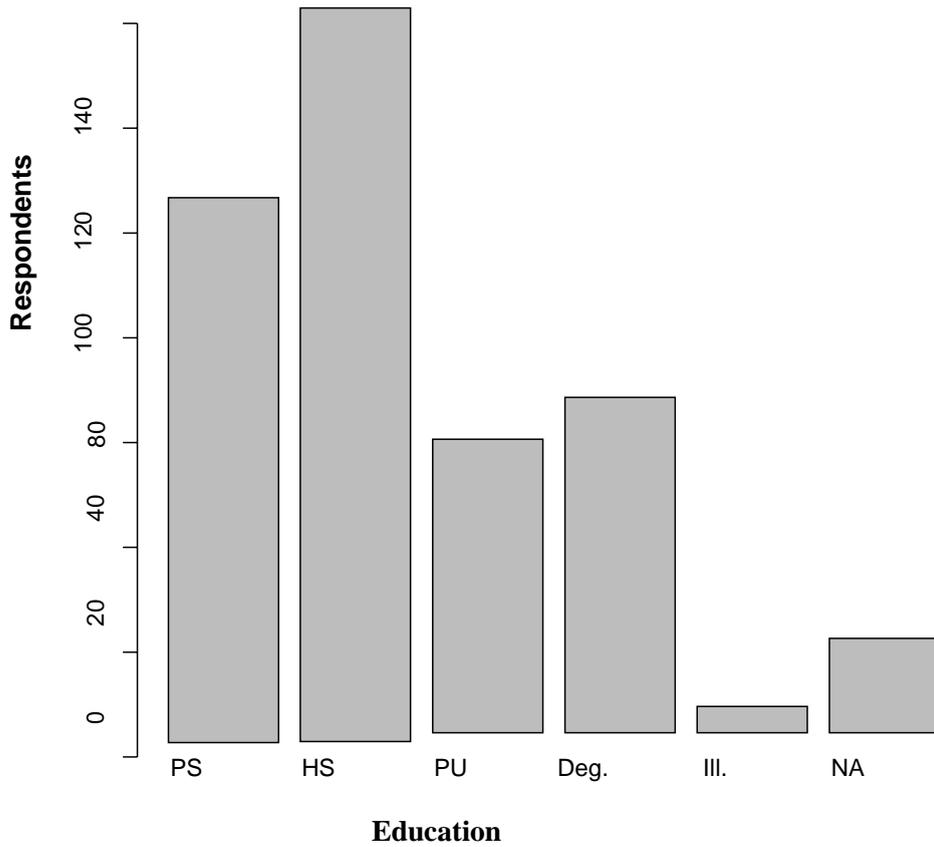


Figure 12: Education level of respondents

Table 30: Occupation of Respondents

Occupation	Number	Percent
Agriculture	268.00	69.25
Agri, Private job	4.00	1.03
Agri,private job,Fishery	1.00	0.26
Agri,Business	14.00	3.62
Agri, Fishery	4.00	1.03
Govt.job	7.00	1.81
Private job	22.00	5.68
Private job,Fishery	2.00	0.52
Business	16.00	4.13
Fishery	41.00	10.59
Other	1.00	0.26
NA	7.00	1.81

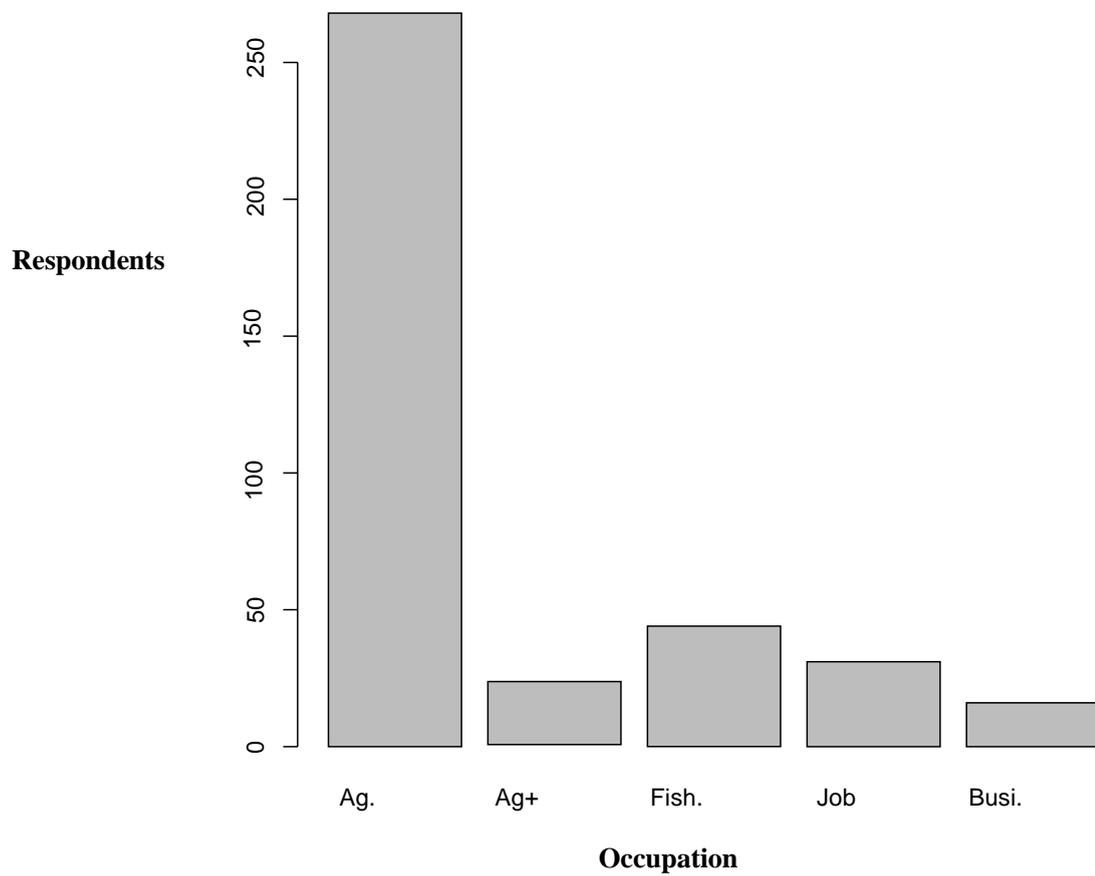


Figure 13: Occupation of Respondents

Table 31: Distribution of monthly income

	Income (Rs./month)	Number.	Percent
1	Lesser than 10000	154.00	39.79
2	More than 10000	196.00	50.64
3	NA	37.00	9.56

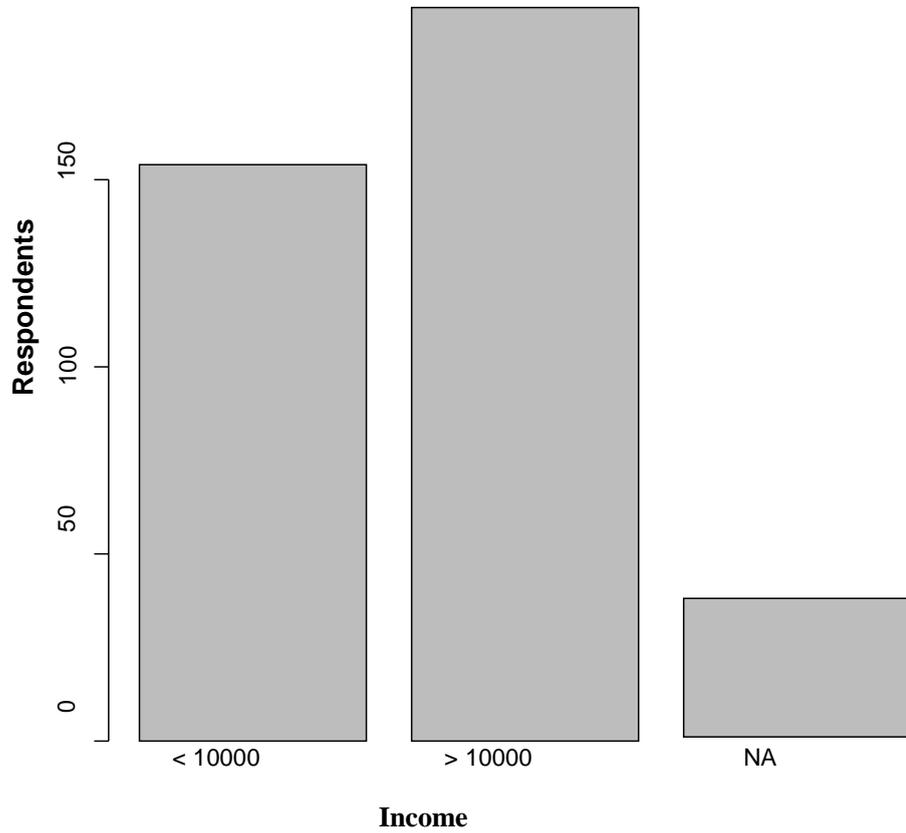


Figure 14: Respondents–Income

Table 32: Size of holdings of respondents

	Size(Acres)	Number.	Percent
1	Less than 1	5.00	1.29
2	1-2	19.00	4.91
3	2-5	50.00	12.92
4	5-10	26.00	6.72
5	10-20	5.00	1.29
6	40	1.00	0.26
7	50	2.00	0.52
8	NA	279.00	72.09

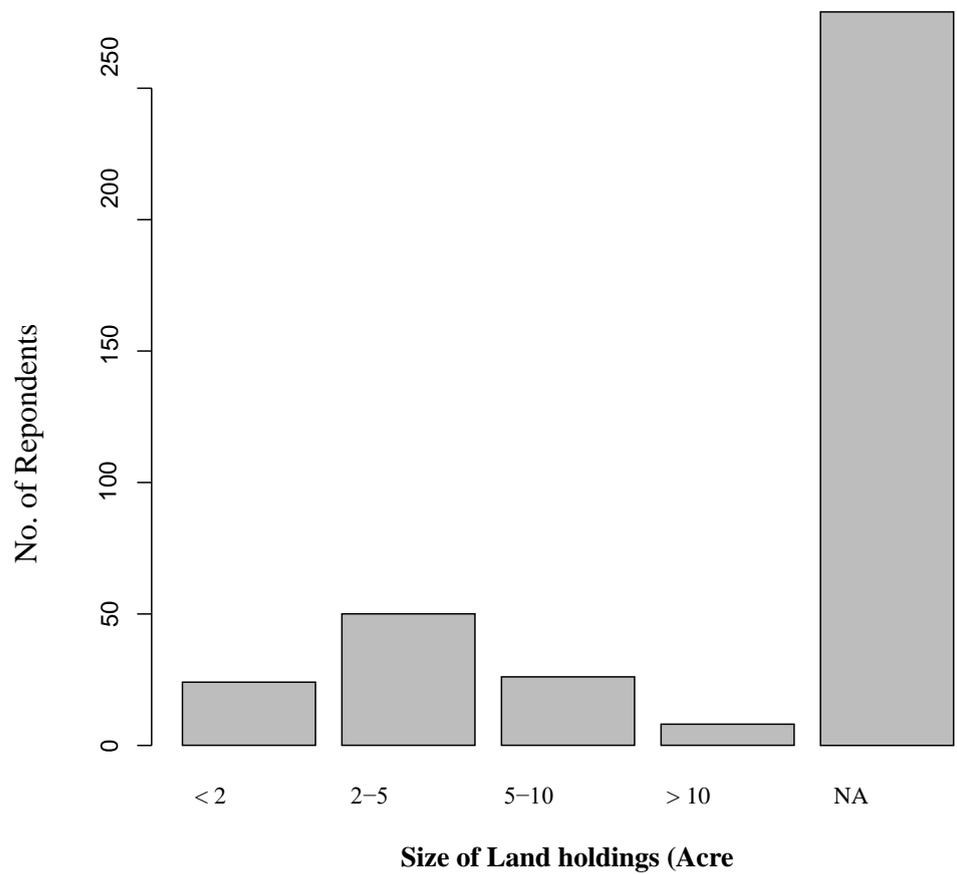


Figure 15: Land holding size in the study area

Table 33: Ownerships of Property by the respondents

	Ownership	Number.	Percent
1	Single	105.00	27.13
2	Joint	221.00	57.11
3	NA	61.00	15.76

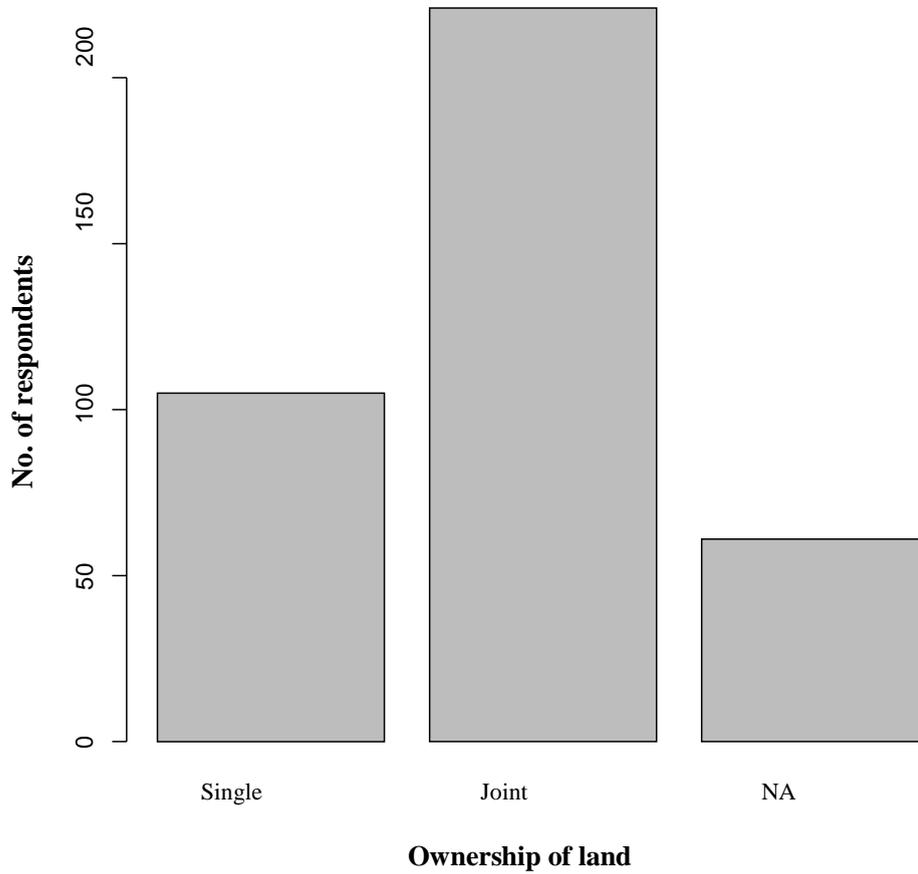


Figure 16: Ownership of lands in the study area

4.4.3.2 Impact of UPCL plant

From Table 35 it is observed that 84.75% suffered loss of their Agricultural land, 9.56% lost their house and land, while 10.85% failed to part with the information. It is observed from Table 34 that 93.5% expressed that there is no benefit from the UPCL plant, only 3.6% expressed on employment and a negligible 0.77% expressed improvement in infrastructure. From Table 36 it is observed that 54.26% had multiple health problems due to UPCL, 39.3%

had respiratory problems and 13.5% suffered from cough fever and head ache. From Table 37, 54.8% expressed their basic needs of air, water and soil was adversely affected by UPCL plant. Some also expressed that their lands and buildings are also adversely affected. Regarding unemployment (Table 38) 68.2% expressed that there is unemployment.

Table 34: Opinion on Benefits due to setting up UPCL

	Benefits	Number	Percent
1	Employment	14.00	3.61
2	Better infra	3.00	0.77
3	No benefits	363.00	93.56
4	Other	4.00	1.03
5	NA	4.00	1.03

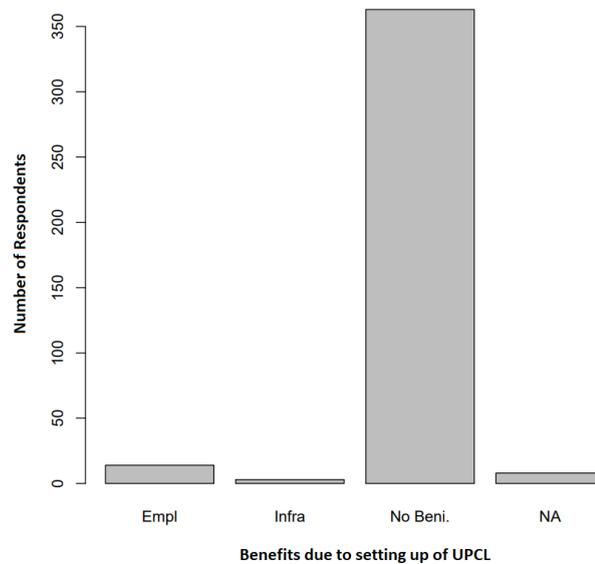


Figure 17: Opinion on Benefits due to setting up UPCL

Table 35: Effect of UPCL-LOSS

	Items	Number.	Percent
1	Agri. land	328.00	84.75
2	House	17.00	4.39
3	Land	20.00	5.17
4	Other	36.00	9.30
5	Fishery	17.00	4.39
6	NA	42.00	10.85

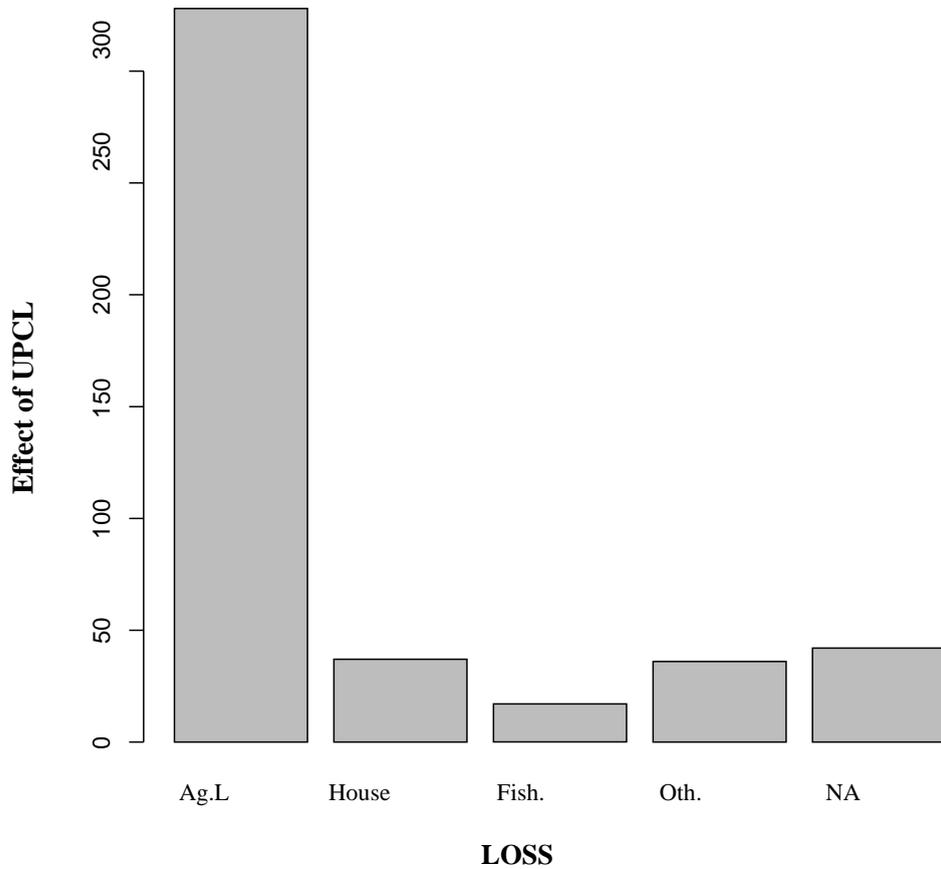


Figure18: Represents the effect of Udupi power Corporation limited (UPCL) loss

Table 36: Health problems of the respondents due to UPCL

	Problems	Number	Percent
1	Cough	3.00	0.78
2	Fever	47.00	12.14
3	Headache	3.00	0.78
4	Breathing trouble	152.00	39.28
5	Others	41.00	10.59
6	Multiple problems	210.00	54.26
7	NA	11.00	2.84

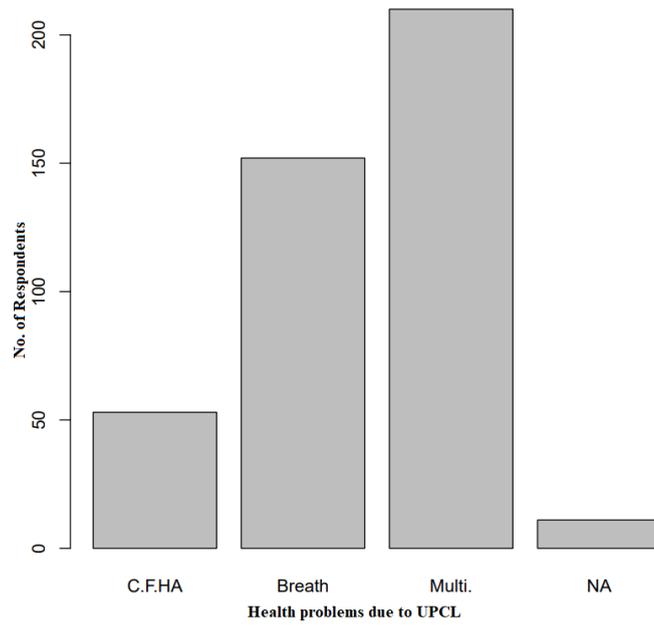


Figure 19: Health problems due to UPCL

Table 37: Problems of Basic needs of respondents due to UPCL (1: Air, 2: Water, 3: Soil, 4: Land, 5: Building)

	Problems	Number.	Percent
1	1	17.00	4.13
2	1,2	39.00	10.08
3	1,2,3	212.00	54.78
4	1,2,3,4	49.00	12.66
5	1,2,3,4,5	36.00	9.30
6	1,2,3,5	2.00	0.52
7	1,2,4	5.00	1.29
8	1,3	2.00	0.52
9	1,3,4	1.00	0.26
10	2	5.00	1.29
11	2,3,4	2.00	0.52
12	2,3,4,5	1.00	0.26
13	2,4,5	1.00	0.26
14	4	2.00	0.52
15	NA	13.00	3.36

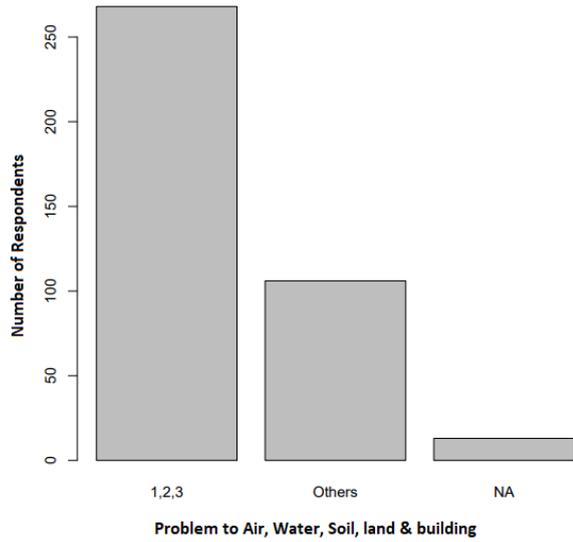


Figure 20: Problems of Basic needs of respondents due to UPCL

Table 38: Opinion about Status of Unemployment due to UPCL

	Status	Number	Percent
1	Yes	264.00	68.22
2	No	1.00	0.26
3	Don't Know	122.00	31.52

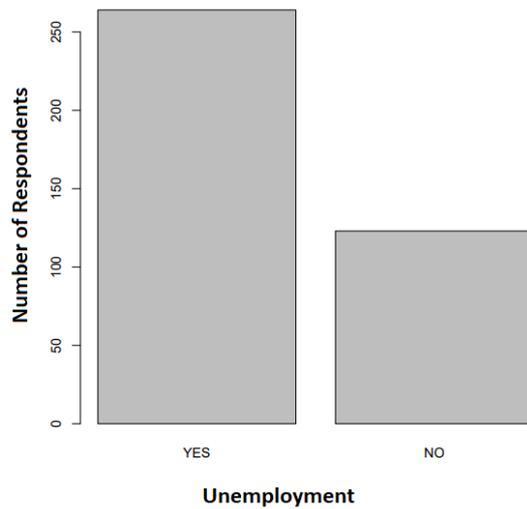


Figure 21: Opinion about Status of Unemployment due to UPCL

Table 39: Source of Cattle feed/fodder (1: Natural grass, 2: Planted grass, 3: Feeds from Market, 4: Crop residues

	Source	Number.	Percent
1	1	72.00	18.60
2	1,2	28.00	7.24
3	1,2,3	41.00	10.59
4	1,2,3,4	74.00	19.12
5	1,2,4	13.00	3.36
6	1,3	45.00	11.63
7	1,3,4	8.00	2.07
8	1,4	10.00	2.58
9	2	7.00	1.81
10	3	3.00	0.78
11	NA	86.00	22.22

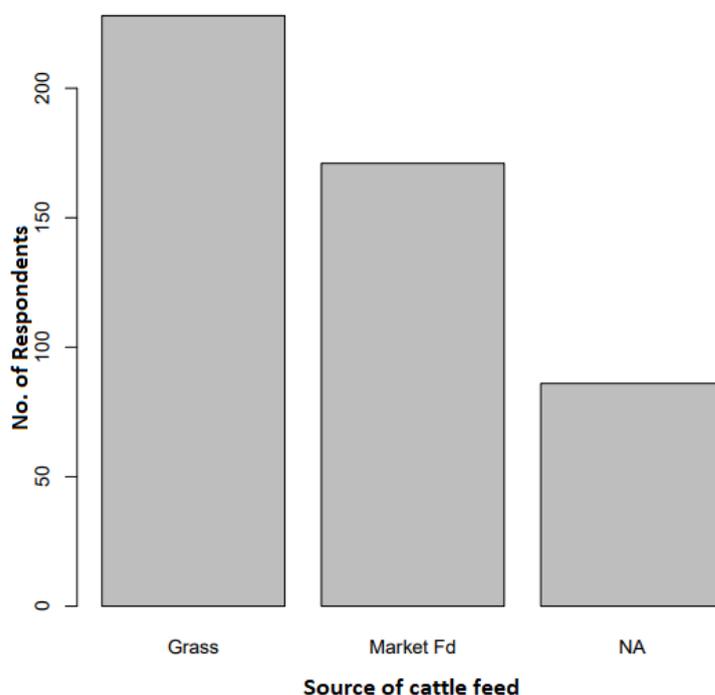


Figure 22: Source of Cattle feed/fodder

4.4.3.3 Other facilities

From Table 41 it is observed that 80.1% resided in “Kachcha” houses while 19.9% in “Pakka” houses. Good quality drinking water is available for 84.75% and remaining 14.25% got polluted and water unfit for drinking (Table 42). Majority (89.7%) got their drinking water from open wells and a small percentage (1.55%) got tap water (Table 43). The area grows crops mainly from rainfall (54%). Some (22.2%) also used bore wells and other

sources for irrigation (Table 44). Cattle are mainly fed with grass, both natural grass and planted grass. Crop residues and cattle feed from markets are also used (Table 39). Among the list of important places include places of worship, lakes, seashore and forest (Table 40).

Table 40: Opinion about Places of importance (1: Places ofworship, 2: Lake, 3: Seashore, 4: Forest, 5: Others)

	Places	Number	Percent
1	1	196.00	50.65
2	1,2	23.00	5.94
3	1,2,3	7.00	1.81
4	1,2,3,4	3.00	0.78
5	1,2,4	21.00	5.43
6	1,2,5	2.00	0.52
7	1,3	30.00	7.75
8	1,4	23.00	5.94
9	1,4,5	2.00	0.52
10	1,5	37.00	9.56
11	2	5.00	1.29
12	3	20.00	5.17
13	4	2.00	0.52
14	5	5.00	1.29
15	NA	11.00	2.84

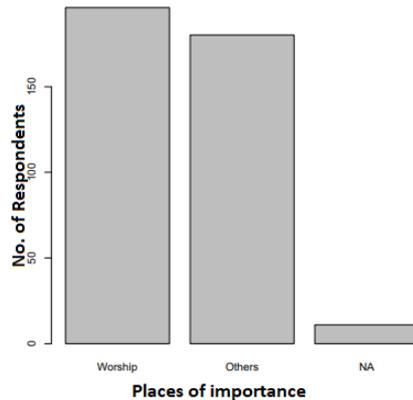


Figure 23: Opinion about Places of importance

Table 41: Condition of residential house of respondents

	Quality	Number	Percent
1	Pakka	77	19.90
2	Kachcha	310	80.10

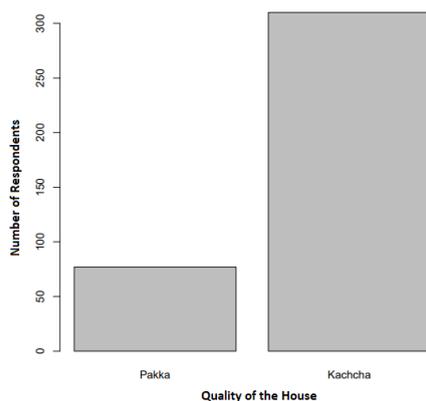


Figure 24: Condition of residential house of respondents

Table 42: Opinion about quality of Drinking water

	Quality	Number	Percent
1	Good	328.00	84.75
2	Polluted	33.00	8.53
3	Polluted, unfit	3.00	0.78
4	Unfit	23.00	5.94

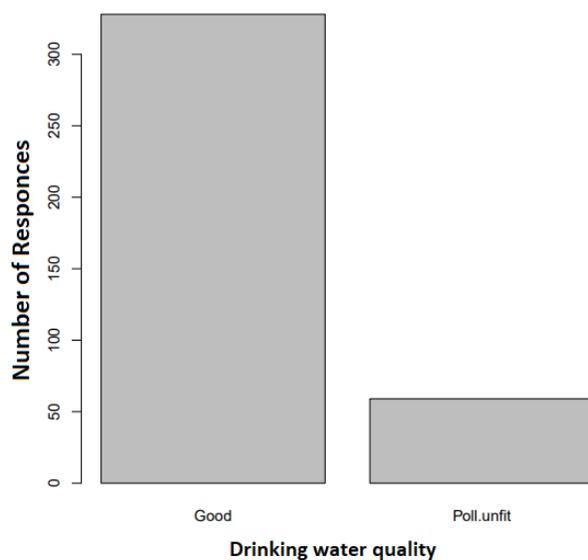


Figure 25: Opinion about quality of Drinking water

Table 43: Source of drinking water

	Source	Number	Percent
1	Bore well	8.00	2.07
2	Open well	347.00	89.66
3	Tap water	6.00	1.55
4	Bore/Open well	19.00	4.91
5	Other	4.00	1.03
6	NA	3.00	0.78

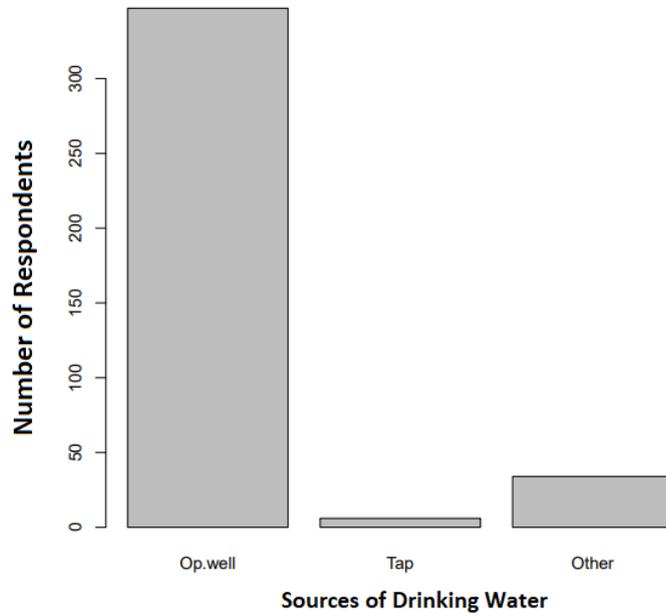


Figure 26: Source of drinking water

Table 44: Source of irrigation water (1:Rain, 2:Ground water, 3:Tanks, 4:Borewell, 5:Other)

	Source	Number.	Percent
1	1	203.00	52.45
2	1,2	4.00	1.03
3	1,2,3	4.00	1.03
4	1,2,5,	1.00	0.26
5	1,3	8.00	2.07
6	1,3,5	2.00	0.52
7	1,4	30.00	7.75
8	1,4,5	5.00	1.29
9	1,5	86.00	22.22
10	2	5.00	1.29
11	3	3.00	0.78
12	4	5.00	1.29
13	5	5.00	1.29
14	NA	26.00	6.72

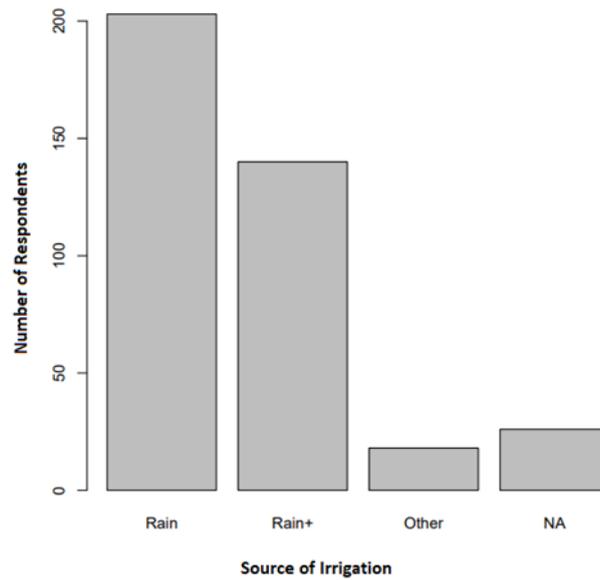


Figure 27: Source of irrigation water

4.4.3.4 Environment condition

The opinion on general environmental condition is given in Table 45. Opinion of 26.36% was water pollution, air pollution and health problems persisted. Problems of health, land/soil erosion loss of trees in addition to air, water pollution was also observed (52.4%). Local environmental condition (Table 46) was moderate (69.25%) and was healthy (21.45%). In Table 47, 64.4% felt no health facility and 23.25% felt otherwise. From Table 48 it is observed that 95% of respondents saw a change in the landscape of the district. Many did not respond (75%) regarding suffering from ill health in the family (Table 49).

Table 45: Opinion about Environmental pollution problems (1:Water pollution, 2:Airpolltion, 3:Health problem, 4:Land/Soil erosion, 5:Loss of trees)

	Opinion	Number	Percent
1	1,2,3	102.00	26.36
2	1,2,3,4	54.00	13.95
3	1,2,3,4,5	203.00	52.45
4	2,3,4,5	24.00	6.20
5	NA	4.00	1.03

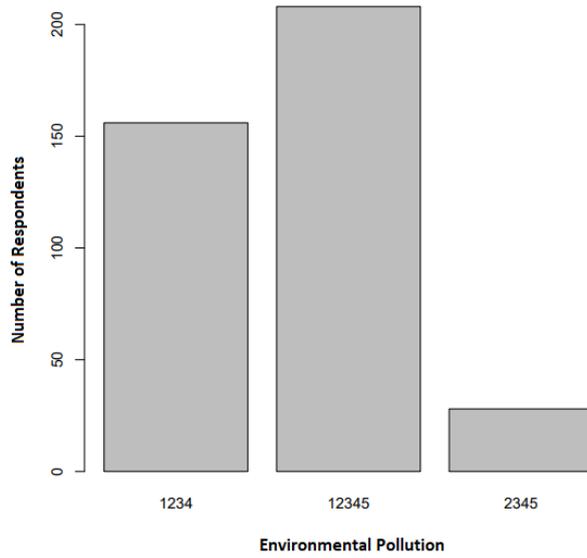


Figure 28: Opinion about Environmental pollution problems

Table 46: Opinion about your local environment (1: Very ugly, 2: Ugly, 3: Moderate, 4: Clean, 5: Healthy)

	Opinion	Number	Percent
1	1	5.00	1.29
2	2	15.00	3.88
3	3	268.00	69.25
4	4	6.00	1.55
5	4,5	3.00	0.78
6	5	83.00	21.45
7	NA	7.00	1.81

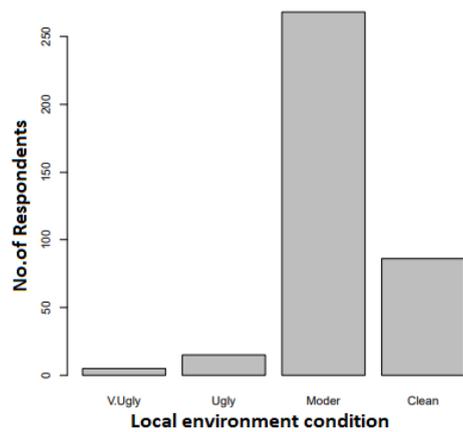


Figure 29: Opinion about your local environment

Table 47: Opinion about availability of health facilities

	Opinion	Number	Percent
1	Yes	90	23.25
2	No	257	66.41
3	NA	40	10.33

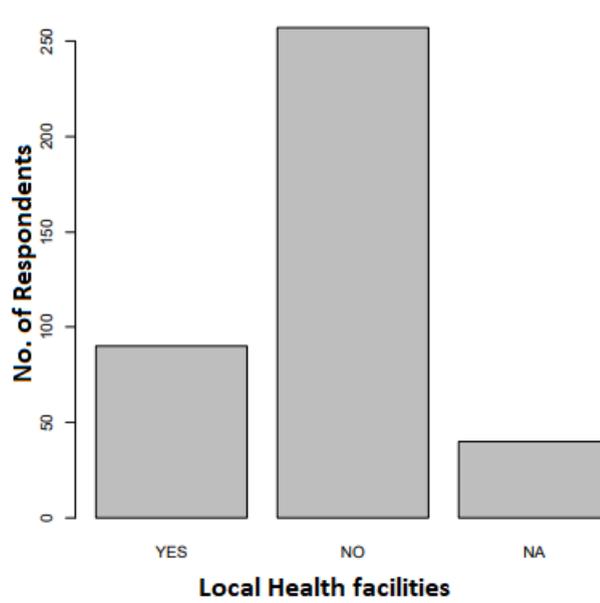


Figure 30: Opinion about availability of health facilities

Table 48: Opinion about change in the landscape of your district

	Opinion	Number	Percent
1	Change	367	94.82
2	No change	6	1.55
3	NA	14	3.62

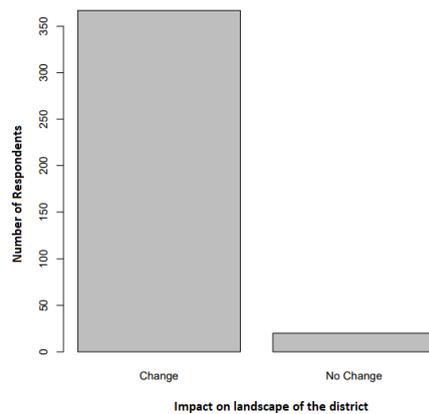


Figure 31: Opinion about change in the landscape of your district

4.4.3.5 Opinion on expansion of UPCL and setting up new industry

The opinion about expansion of UPCL was against (97.4%). For new industry 93.4% expressed against setting up of any new industry in the region (Tables 50 & 51).

Table 49: Anyone in the family suffering from ill health

	Opinion	Number	Percent
1	Yes	62	16.20
2	No	36	9.30
3	NA	289	74.67

Table 50: Opinion about the Expansion of UPCL plant

	Opinion	Number.	Percent
1	Yes	9	2.32
2	No	377	97.41
3	NA	1	0.26

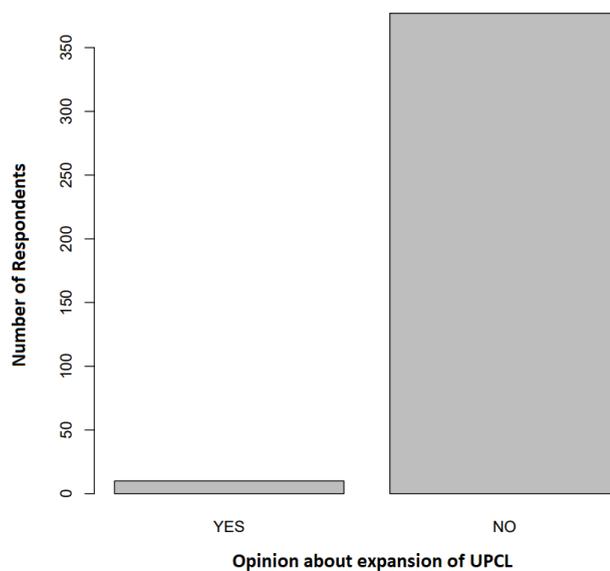


Figure 32: Opinion about the expansion of UPCL

Table 51: Opinion about starting new industries in the area

	Opinion	Number.	Percent
1	Yes	23	5.94
2	No	361	93.28
3	NA	3	0.77

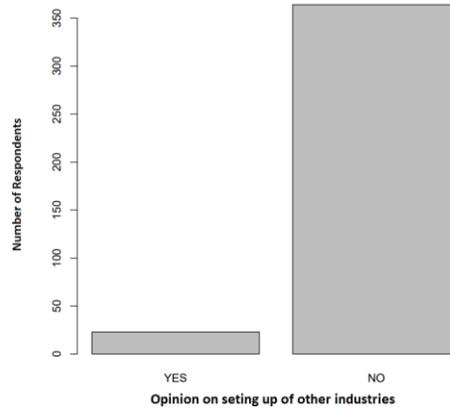


Figure 33: Opinion about starting new industries in the area

4.4.4 Conclusion

Based on the analysis of the survey data following conclusions emerge. This is purely a opinion or perception based socio-economic survey and the opinions on the quality of air, water and soil have to be corroborated on the basis of scientific analysis.

- 1 A large number of respondents who are primarily agriculturists have lost their agricultural land due to setting up of UPCL plant. People have also lost their houses and land.
- 2 Majority of the respondents are of the opinion that there are nobenefits from the UPCL plant and there is no improvement in the infrastructure also.
- 3 Health conditions of the residents of the area were adversely affected by the UPCL plant. Many people (54.25%) are of the opinion that people are suffering from multiple health problems and 39 percent expressed that people suffered from respiratory problems.
- 4 People were of the opinion that environmental pollution occurred with respect to Air, Water and Soil. According to 69.25 percent of respondents local Environmental conditions were moderate.
- 5 Most of the respondents (97.4%) expressed their opinion against the expansion of UPCL plant and 93.4% expressed their opinion against setting up of any new industry in the region.

4.5 Objectives 2: To identify the critical ecosystems and biodiversity hotspots in the region.

DESCRIPTION OF THE STUDY SITE

4.5.1 Vegetation:

The characteristic features of secondary evergreen or semi-evergreen forests are the preservation of a dense cover and structure, which are very similar to the initial climax forest but lacking the characteristic species of the initial climax forest (Pascal 1988). These forests, found in regions where anthropogenic pressure was initially very high, were protected after they were designated as reserve forests. In India, one such secondary forest is the Pilarkan Reserve Forest (74° 51' E and 13°12' N), covering an area of 124.32 hectares situated 3 km south-east of Shirva in Udupi District of Karnataka.

Bhat (1993) reported 160 species of angiosperms belonging to 135 genera and 75 families as well as the soil and climatic characteristics of this reserve forest. The soil is lateritic with an underlying rock of peninsular gneiss. The climate is of wet monsoon type with an annual rainfall of about 3500mm. This reserve forest is partly natural and partly the result of massive planting of *H. parviflora* and other species after the First World War (Bhat 1993) (Fig 34).

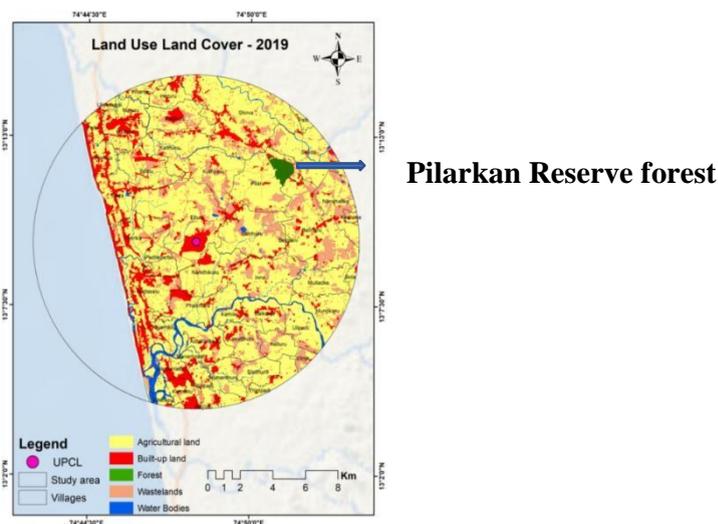


Figure 34: Location map of Pilarkan Reserve Forest at the study area

4.5.1.1 Sampling area

The entire reserve forest comes under a *kan* or *Devara kadu* (sacred grove) containing a small temple in the middle. The people around this forest consider this forest a sacred place and they are against any felling of trees. They strongly believe that any felling inside the forest will result in unforecastable happenings.

There is a small stream in the middle of the forest which dries up during the summer. There are

fewer number of trees towards the exterior, which may be due to the collection of dry leaves and branches, which is permitted to the locals.

4.5.1.2 Sampling design

The study was conducted in Pilarkan Reserve Forest (74° 51' E and 13°12' N), covering an area of 124.32 hectares located in 3 km south-east of Shirva in Udupi District of Karnataka.

The area has an average altitude of 28 meters above sea level, average annual rainfall of about 4285mm and the temperature ranges from 22⁰ C in winter to 37⁰ C in summer. The area is mainly covered by an irregular topography with depressions, numerous chain mountains, flat lands, gorges scattered trees and dense shrubs of patch natural vegetation.

4.5.1.3 Floristic data collection

Afield visit was carried out in the month of October 2020 to understand and assess the status of flora and fauna and natural habitats.

Reconnaissance survey was made across the natural forest in order to obtain vegetation patterns and determine representative sampling site. The vegetation data were collected using a systematic sampling method. One quadrate was laid in on 0.01sampling percentage such a way so as to include the areas with variation in the density. The woody species specimens were collected by laying quadrates of 38.1×38.1 m (1451.61m²) and within the plot laid 5X5m for shrubs and 1X1m for regeneration study. The coordinates of the quadrates all corners and centre of the plot were recorded using a GPS and the coordinates are 13⁰1150' 1" 74⁰5109'09", 13⁰1149'03" 74⁰5108'51", 13⁰1149'24" 74⁰5107'10", 13⁰115'15" 74⁰5107'60" and E mid-point 13⁰1149'55" 74⁰5108'16" (Fig;35).

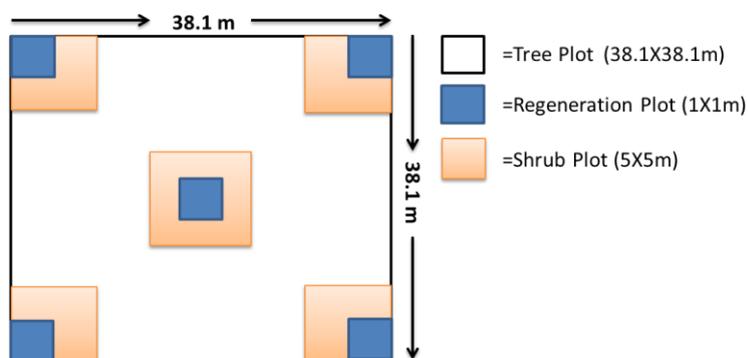


Figure 35: Layout of the quadrants for floristic assessment

All the trees >10 cm at 1.37-meter height (gbh) within the transect were botanically identified to the species level by using field guides (Pascal and Ramesh, 1987) and local floras (Saldanha, 1996; Keshavmurthy and Yoganarasimhan, 1990; Bhat, 2003). The regeneration and shrub growth of tree species was enumerated using measuring tape.

4.5.1.4 Data Analysis

Vegetational analysis was conducted using descriptive statistics to determine the relative dominance, relative frequency, relative density and the importance value of each species in the study site. Trees with the highest importance value will be those that exist in the greatest number or are of the greatest size. Once importance value is determined, a specific community can be described in terms of its most important species. Thus, communities are often described by the species or genera that are determined to be the most dominant in the community (Smith and Smith, 2002).

Various estimates of diversity were calculated using PAST (Hammer et al 2001). A simple estimate of diversity is species richness (number of species).

Basal area was estimated as an area of a circle (πr^2); the sum of the individual basal area was represented as a basal area of the plot and expressed as square meters.

Biomass of each individual was estimated allometrically using equation developed for calculation of biomass for CTFS forest dynamics plots by J. Chave based on Chave et al 2014. This equation estimates biomass based on the diameter of an individual. Half of biomass is considered as carbon content based on IPCC definition.

4.5.1.5 Observations of Floristic analysis

Tree, shrubs and herbs population were enumerated by direct counting method. Different species were identified by referring the key provided and measured the height, girth of each species. Using some basic formulas, estimated the biomass and carbon of tree species of the forest. Total 474 individuals were identified, out of which 40 species of Angiosperms have been documented belonging to 36 genera and 32 families. Two species of Pteridophytes were also seen. Later the individuals were categorised as an Herb, Shrub, Trees, and Climbers etc. The complete list of floral diversity is as follows (Table 52) (Table 53).

Table 52: List of floral species in Pilarkan Reserve Forest and IUCN classification

Sl. No	Species	Family	Category	Threat Status
1	<i>Adenia hondala</i> (Gaertn.) W.J. de Wilde	Passifloraceae	Climber	-
2	<i>Anamirta cocculus</i> (L.) Wight. & Arn.	Menispermaceae	Climber	-
3	<i>Artocarpus hirsutus</i> Lam.	Moraceae	Tree	Endemic & Threatened
4	<i>Bulbophyllum sterile</i> (Lam.) Suresh	Orchidaceae	Orchid	-
5	<i>Canthium coromandellicum</i> (Burm.f.) Alston	Rubiaceae	Herb	-
6	<i>Carissa spinarum</i> L.	Apocynaceae	Shrub	-
7	<i>Cissus javana</i> DC.	Haloragaceae	Climber	-
8	<i>Clerodendrum infortunatum</i> L.	Verbenaceae	Shrub	-
9	<i>Combretum latifolium</i> Blume	Combretaceae	Climber	-
10	<i>Dichapetalum gelonioides</i> (Roxb.) Engl.	Dichapetalaceae	Shrub	-
11	<i>Dillenia pentagyna</i> Roxb.	Dilleniaceae	Tree	-
12	<i>Diospyros buxifolia</i> (Blume.) Hiern.	Ebenaceae	Tree	-
13	<i>Dracaena terniflora</i> Roxb.	Asparagaceae	Herb	-
14	<i>Drynaria quercifolia</i> (L.) J. Sm.	Polypodiaceae	Fern	-
15	<i>Flacoutia montana</i> J. Graham	Flacourtiaceae	Tree	-
16	<i>Garcinia Morella</i> (Gaertn.) Desr.	Clusiaceae	Tree	-
17	<i>Holigarna ferruginea</i> Marchand	Anacardiaceae	Tree	Endemic
18	<i>Hopea parviflora</i> Bedd.	Dipterocarpaceae	Tree	Endemic
19	<i>Hopea ponga</i> (Dennst.) Mabb.	Dipterocarpaceae	Tree	Endemic
20	<i>Ixora brachiata</i> Roxb.	Rubiaceae	Tree	Endemic
21	<i>Ixora coccinea</i> L.	Rubiaceae	Shrub	
22	<i>Knema attenuata</i> (Hook.f. & Thoms) Warb.	Myristicaceae	Tree	Endemic & Least Concern
23	<i>Leea indica</i> (Burm.f.) Merr.	Leeaceae	Shrub	-
24	<i>Mammea suriga</i> (Buch.-Ham.ex Roxb.) Koesterm.	Clusiaceae	Tree	-
25	<i>Memecylon edule</i> Roxb.	Melastomataceae	Tree	-
26	<i>Memecylon randerianum</i> S.M.Almedia & M.R.Almeida	Melastomataceae	Shrub	-
27	<i>Myristica malabarica</i> Lam	Myristicaceae	Tree	Endemic
28	<i>Naregamia alata</i> Wight. & Arn.	Meliaceae	Herb	-
29	<i>Olea dioica</i> Roxb.	Oleaceae	Tree	-
30	<i>Piper nigrum</i> L.	Piperaceae	Climber	-
31	<i>Pothos scandens</i> L.	Aeraceae	Shrub	
32	<i>Psychotria dalzellii</i> Hook.f	Rubiaceae	Shrub	Endemic
33	<i>Psychotria flavida</i> Talbot.	Rubiaceae	Shrub	Endemic
34	<i>Rhynchosyris retusa</i> (L.) Blume	Orchidaceae	Orchid	-
35	<i>Scleropyrum pentandrum</i> (Dennst.) Mabb.	Santalaceae	Tree	-
36	<i>Smilax zeylanica</i> L.	Smilacaceae	Shrub	-
37	<i>Strychnos minor</i> Dennst.	Loganiaceae	Shrub	-
38	<i>Syzygium caryophyllatum</i> (L.) Alston.	Myrtaceae	Tree	-
39	<i>Tectaria polymorpha</i> (Wall. ex Hook.) Copel.	Tectariaceae	Fern	-
40	<i>Ventilago maderaspatana</i> Gaertn.	Rhamnaceae	Shrub	-
41	<i>Wendlandia notoniana</i> Wall. ex Wight & Arn	Rubiaceae	Tree	-
42	<i>Xylia xylocarpa</i> (Roxb.) Taub.	Fabaceae	Tree	-

4.5.1.5. I Regeneration (1X1M)

Sl.No.	Species Name	No. of Individuals	Family	Status
1	<i>Psychotria thwaitesii</i>	7	Rubiaceae	
2	<i>Piper nigrum</i>	6	Piperaceae	
3	<i>Grass spp.</i>	56	Poaceae	
4	<i>Epiphyte spp.</i>	1	Orchidaceae	
5	<i>Hopea parviflora</i>	1	Dipterocarpaceae	Endemic
6	<i>Wild Climber</i>	3	-	

4.5.1.5. II Shrub Plot (5X5m)

Sl.No.	Scientific name	No. of Individuals	Family	Status
1	<i>Artocarpus hirsutus</i>	2	Moraceae	Endemic & Threatened
2	<i>Diospyros buxifolia</i>	3	Ebenaceae	
3	<i>Hopea parviflora</i>	9	Dipterocarpaceae	Endemic
4	<i>Myristica malabarica</i>	4	Myristicaceae	Endemic
5	<i>Wendlandia notoniana</i>	8	Rubiaceae	
6	<i>Psychotria thwaitesii</i>	145	Rubiaceae	
7	<i>Leea indica</i>	27	Leeaceae	
8	<i>Ixora brachiata</i>	1	Rubiaceae	Endemic

Table 53. Biomass and carbon estimation at Pilarkan reserve forest

Girth Class	Species Name	No. of Individuals	Basal Area Cm ²	Biomass (Kg)	Carbon (Kg)
1 to 10	<i>Holigarna arnottiana</i>	3	89.5358	2.72	1.36
	<i>Flacourtia montana</i>	1	71.69	1.67	0.83
	<i>Artocarpus hirsutus</i>	1	15.61	0.65	0.32
	<i>Wendlandia notoniana</i>	8	245.18	7.45	3.72
	<i>Hopea ponga</i>	1	76.55	1.75	0.87
	<i>Hopea parviflora</i>	3	112.55	3.2	1.6
	<i>Mundelu</i>	1	71.69	1.67	0.83
	<i>Mundi</i>	1	13.46	0.6	0.3
	<i>Vitex altissima</i>	3	54.88	2.07	1.04
	<i>Diospyros buxifolia</i>	62	2274.56	64.5	32.25
	<i>Memecylon edule</i>	7	219.62	6.53	3.26
	<i>Myristica malabarica</i>	27	851.86	25.54	12.77
<i>Mimusops elengi</i>	11	250.206	8.59	4.29	
10.1 to 20	<i>Holigarna arnottiana</i>	1	127.45	2.62	1.31
	<i>Ficus drupacea</i>	1	109.05	2.31	1.15
	<i>Alstonia scholaris</i>	1	249.808	4.76	2.38
	<i>Artocarpus hirsutus</i>	1	161.307	3.2	1.6
	<i>Dillenia pentagyna</i>	1	97.58	2.11	1.05
	<i>Hopea parviflora</i>	11	1674.256	33.57	16.78
	<i>Diospyros buxifolia</i>	8	978.601	20.28	10.14
	<i>Myristica malabarica</i>	2	201.77	4.33	2.17
<i>Mimusops elengi</i>	1	92.08	2.02	1.01	
20.1 to 40	<i>Holigarna arnottiana</i>	1	718.915	14.06	7.03
	<i>Artocarpus hirsutus</i>	2	1453.76	28.63	14.32
	<i>Hopea parviflora</i>	19	13925.05	277.15	138.57
	<i>Mangifera indica</i>	1	630.97	12.18	6.09
	<i>Myristica malabarica</i>	1	718.91	14.06	7.03
40.1 to 60	<i>Artocarpus hirsutus</i>	1	1913.78	44.79	22.39
	<i>Hopea parviflora</i>	17	29515.6	680	340
> 60	<i>Hopea parviflora</i>	3	9264.25	250.55	125.27

4.5.1.5. III Mangroves

Mangrove vegetation provides nursery ground for a number of commercially important fishes, shrimps, crabs and molluscs (both fresh water and marine) it enhances the fishery production by enriching coastal water by providing nutrients. Mangroves are important in maintaining and building the soil, act as a reservoir in the tertiary assimilation of waste and in the global cycle of carbon dioxide, nitrogen and sulphur. In addition, mangroves support a large number of birds and other biodiversity.

Table: 54. List of mangroves Floral Species

SI No.	Name	Family
1	<i>Acanthus ilicifolius</i>	Acanthaceae
2	<i>Acrostichum aureum</i>	Pteridaceae.
3	<i>Aegiceras corniculatum</i>	Myrsinaceae
4	<i>Avicennia alba</i>	Avicenniaceae
5	<i>Avicennia officinalis</i>	Avicenniaceae
6	<i>Bruguiera gymnorhiza</i>	Rhizophoraceae
7	<i>Excoecaria agallocha</i>	Euphorbiaceae
8	<i>Kandelia candel</i>	Rhizophoraceae
9	<i>Rhizophora mucronata</i>	Rhizophoraceae

Table 55: The list of fauna documented in the study site.

55.a: List of Birds				
No	Family	SI No	Common Name	Scientific Name
1	Accipitridae	1	Black Kite	<i>Milvus migrans</i>
		2	Black-winged Kite	<i>Elanus caeruleus</i>
		3	Brahminy Kite	<i>Haliastur indus</i>
		4	Crested Serpent Eagle	<i>Spilornis cheela</i>
		5	Oriental Honey Buzzard	<i>Pernis ptilorhynchus</i>
		6	Shikra	<i>Accipiter badius</i>
		7	Short-toed Eagle	<i>Circaetus gallicus</i>
		8	White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>
		9	White-eyed Buzzard	<i>Butastur teesa</i>
2	Acrocephalidae	10	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>
3	Aegithinidae	11	Common Iora	<i>Aegithina tiphia</i>
4	Alaudidae	12	Ashy-crowned Sparrow Lark	<i>Eremopterix griseus</i>
5	Alcedinidae	13	Common Kingfisher	<i>Alcedo atthis</i>
		14	Pied Kingfisher	<i>Ceryle rudis</i>
		15	White-throated Kingfisher	<i>Halcyon smyrnensis</i>
6	Anatidae	16	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>
		17	Lesser Whistling Duck	<i>Dendrocygna javanica</i>
7	Anhingidae	18	Great Thick-knee	<i>Esacus recurvirostris</i>
		19	Oriental Darter	<i>Anhinga melanogaster</i>
8	Apodidae	20	Asian Palm Swift	<i>Cypsiurus balasiensis</i>
		21	Little Swift	<i>Apus affinis</i>
		22	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>

9	Ardeidae	23	Cattle Egret	<i>Bubulcus ibis</i>
		24	Great Egret	<i>Ardea alba</i>
		25	Grey Heron	<i>Ardea cinerea</i>
		26	Indian Pond Heron	<i>Ardeola grayii</i>
		27	Intermediate Egret	<i>Ardea intermedia</i>
		28	Little Egret	<i>Egretta garzetta</i>
		29	Purple Heron	<i>Ardea purpurea</i>
		30	Western Reef Egret	<i>Egretta gularis</i>
10	Artamidae	31	Ashy Woodswallow	<i>Artamus fuscus</i>
11	Bucerotidae	32	Great Hornbill	<i>Buceros bicornis</i>
		33	Malabar Grey Hornbill	<i>Ocyroceros griseus</i>
		34	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i>
12	Campephagidae	35	Large Cuckooshrike	<i>Coracina javensis</i>
		36	Scarlet Minivet	<i>Pericrocotus flammeus</i>
		37	Small Minivet	<i>Pericrocotus cinnamomeus</i>
13	Caprimulgidae	38	Indian Nightjar	<i>Caprimulgus asiaticus</i>
14	Charadriidae	39	Little Ringed Plover	<i>Charadrius dubius</i>
		40	Red-wattled Lapwing	<i>Vanellus indicus</i>
		41	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>
15	Chloropseidae	42	Golden-fronted Leafbird	<i>Chloropsis aurifrons</i>
		43	Jerdon's Leafbird	<i>Chloropsis jerdoni</i>
16	Ciconiidae	44	Asian Openbill	<i>Anastomus oscitans</i>
		45	Painted Stork	<i>Mycteria leucocephala</i>
		46	Woolly-necked Stork	<i>Ciconia episcopus</i>
17	Cisticolidae	47	Ashy Prinia	<i>Prinia socialis</i>
		48	Common Tailorbird	<i>Orthotomus sutorius</i>
		49	Plain Prinia	<i>Prinia inornata</i>
18	Columbidae	50	Blue Rock Pigeon	<i>Columba livia</i>
		51	Emerald Dove	<i>Chalcophaps indica</i>
		52	Laughing Dove	<i>Streptopelia senegalensis</i>
19	Coraciidae	53	Indian Roller	<i>Coracias benghalensis</i>
20	Corvidae	54	House Crow	<i>Corvus splendens</i>
		55	Large-billed Crow	<i>Corvus macrorhynchos</i>
		56	Rufous Treepie	<i>Dendrocitta vagabunda</i>
		57	White-bellied Treepie	<i>Dendrocitta leucogastra</i>
21	Cuculidae	58	Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>
		59	Common Hawk Cuckoo	<i>Hierococcyx varius</i>
		60	Common Koel	<i>Eudynamys scolopaceus</i>
		61	Greater Coucal	<i>Centropus sinensis</i>
22	Dicaeidae	62	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>
		63	Thick-billed Flowerpecker	<i>Dicaeum agile</i>
23	Dicruridae	64	Ashy Drongo	<i>Dicrurus leucophaeus</i>
		65	Black Drongo	<i>Dicrurus macrocercus</i>
		66	Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>
		67	White-bellied Drongo	<i>Dicrurus caerulescens</i>
24	Estrildidae	68	Black-headed Munia	<i>Lonchura malacca</i>
		69	Scaly-breasted Munia	<i>Lonchura punctulata</i>
25	Hirundinidae	70	Barn Swallow	<i>Hirundo rustica</i>
		71	Red-rumped Swallow	<i>Cecropis daurica</i>
		72	Wire-tailed Swallow	<i>Hirundo smithii</i>
26	Irenidae	73	Asian Fairy-bluebird	<i>Irena puella</i>
27	Jacanidae	74	Bronze-winged Jacana	<i>Metopidius indicus</i>
28	Laniidae	75	Bay-backed Shrike	<i>Lanius vittatus</i>
		76	Long-tailed Shrike	<i>Lanius schach</i>
29	Laridae	77	River Tern	<i>Sterna aurantia</i>
30	Leiothrichidae	78	Jungle Babbler	<i>Turdoides striata</i>

31	Megalaimidae	79	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>
		80	Malabar Barbet	<i>Psilopogon malabaricus</i>
		81	White-cheeked Barbet	<i>Psilopogon viridis</i>
32	Meropidae	82	Blue-bearded Bee-eater	<i>Nyctyornis athertoni</i>
		83	Blue-tailed Bee-eater	<i>Merops philippinus</i>
		84	Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>
		85	Green Bee-eater	<i>Merops orientalis</i>
33	Monarchidae	86	Indian Paradise-flycatcher	<i>Terpsiphone paradisi</i>
34	Motacillidae	87	Paddyfield Pipit	<i>Anthus rufulus</i>
		88	White-browed Wagtail	<i>Motacilla maderaspatensis</i>
		89	Yellow Wagtail	<i>Motacilla flava</i>
35	Muscicapidae	90	Asian Brown Flycatcher	<i>Muscicapa dauurica</i>
		91	Asian Verditer Flycatcher	<i>Eumyias thalassinus</i>
		92	Blue-capped Rock Thrush	<i>Monticola cinclorhyncha</i>
		93	Indian Robin	<i>Saxicoloides fulicatus</i>
		94	Malabar Whistling Thrush	<i>Myophonus horsfieldii</i>
		95	Oriental Magpie Robin	<i>Copsychus saularis</i>
		96	Pied Bush Chat	<i>Saxicola caprata</i>
36	Nectariniidae	97	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>
		98	Loten's Sunbird	<i>Cinnyris lotenius</i>
		99	Purple Sunbird	<i>Cinnyris asiaticus</i>
37	Oriolidae	100	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>
		101	Black-hooded Oriole	<i>Oriolus xanthornus</i>
38	Paridae	102	Indian Golden Oriole	<i>Oriolus kundoo</i>
39	Paridae	103	Cinereous Tit	<i>Parus cinereus</i>
40	Passeridae	104	House Sparrow	<i>Passer domesticus</i>
41	Pellorneidae	105	Puff-throated Babbler	<i>Pellorneum ruficeps</i>
41	Phalacrocoracidae	106	Great Cormorant	<i>Phalacrocorax carbo</i>
		107	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>
		108	Little Cormorant	<i>Microcarbo niger</i>
42	Phasianidae	109	Grey Francolin	<i>Francolinus pondicerianus</i>
		110	Grey Junglefowl	<i>Gallus sonneratii</i>
		111	Indian Peafowl	<i>Pavo cristatus</i>
43	Picidae	112	Common Flame-backed Woodpecker	<i>Dinopium javanense</i>
		113	Heart-spotted Woodpecker	<i>Hemicircus canente</i>
44	Ploceidae	114	Baya Weaver	<i>Ploceus philippinus</i>
45	Podicipedidae	115	Little Grebe	<i>Tachybaptus ruficollis</i>
46	Psittaculidae	116	Malabar Parakeet	<i>Psittacula columboides</i>
		117	Rose-ringed Parakeet	<i>Psittacula krameri</i>
		118	Vernal Hanging Parrot	<i>Loriculus vernalis</i>
47	Pycnonotidae	119	Red-vented Bulbul	<i>Pycnonotus cafer</i>
		120	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>
		121	White-browed Bulbul	<i>Pycnonotus luteolus</i>
48	Rallidae	122	Common Coot	<i>Fulica atra</i>
		123	Common Moorhen	<i>Gallinula chloropus</i>
		124	Purple Swamphen	<i>Porphyrio porphyrio</i>
		125	White-breasted Waterhen	<i>Amauromis phoenicurus</i>
49	Recurvirostridae	126	Black-winged Stilt	<i>Himantopus himantopus</i>
50	Rhipiduridae	127	White-spotted Fantail	<i>Rhipidura albogularis</i>
51	Scolopacidae	128	Common Redshank	<i>Tringa totanus</i>
		129	Common Sandpiper	<i>Actitis hypoleucos</i>
52	Sittidae	130	Velvet-fronted Nuthatch	<i>Sitta frontalis</i>
53	Stenostiridae	131	Grey-headed Canary-flycatcher	<i>Culicicapa ceylonensis</i>
54	Strigidae	132	Spotted Owlet	<i>Athene brama</i>
		133	Common Myna	<i>Acridotheres tristis</i>
		134	Hill Myna	<i>Gracula religiosa</i>

		135	Jungle Myna	<i>Acridotheres fuscus</i>
55	Threskiornithidae	136	Black-headed Ibis	<i>Threskiornis melanocephalus</i>
56	Trogonidae	137	Malabar Trogon	<i>Harpactes fasciatus</i>
57	Turdidae	138	Orange-headed Thrush	<i>Geokichla citrina</i>
58	Tytonidae	139	Common Barn Owl	<i>Tyto alba</i>
59	Upupidae	140	Common Hoopoe	<i>Upupa epops</i>
60	Zosteropidae	141	Oriental White-eye	<i>Zosterops palpebrosus</i>

55.b: List of Butterflies

No	Family	SI No	Common Name	Scientific Name
1	Blues	1	Angled Pierrot	<i>Caleta decidia</i>
		2	Apefly	<i>Spalgis epeus</i>
		3	Blue-bordered Plane	<i>Bindahara moorei</i>
		4	Common Cerulean	<i>Jamides celeno</i>
		5	Common Guava Blue	<i>Virachola isocrates</i>
		6	Common Hedge Blue	<i>Acytolepis puspa</i>
		7	Common Imperial	<i>Cheritra freja</i>
		8	Common Lineblue	<i>Prosotas nora</i>
		9	Common Pierrot	<i>Castalius rosimon</i>
		10	Common Silverline	<i>Spindasis vulcanus</i>
		11	Dark Grass Blue	<i>Zizeeria karsandra</i>
		12	Gram Blue	<i>Euchrysops cnejus</i>
		13	Grass Jewel	<i>Freyeria trochylus</i>
		14	Grass Jewel	<i>Freyeria putli</i>
		15	Indian Sunbeam	<i>Curetis thetis</i>
		16	Lesser Grass Blue	<i>Zizina otis</i>
		17	Lime Blue	<i>Chilades lajus</i>
		18	Metallic Cerulean	<i>Jamides alecto</i>
		19	Monkey Puzzle	<i>Rathinda amor</i>
		20	Pale Grass Blue	<i>Pseudozizeeria maha</i>
		21	Pea Blue	<i>Lampides boeticus</i>
		22	Plains Cupid	<i>Chilades pandava</i>
		23	Red Pierrot	<i>Talicauda nyseus</i>
		24	Tailless Lineblue	<i>Prosotas dubiosa</i>
		25	Tiny Grass Blue	<i>Zizula hylax</i>
		26	Zebra Blue	<i>Leptotes plinius</i>
2	Brushfooted	27	Angled Castor	<i>Ariadne ariadne</i>
		28	Anomalous Nawab	<i>Charaxes agrarius</i>
		29	Baron	<i>Euthalia aconthea</i>
		30	Baronet	<i>Symphaedra nais</i>
		31	Black Rajah	<i>Charaxes solon</i>
		32	Blackvein Sergeant	<i>Athyma ranga</i>
		33	Blue Tiger	<i>Tirumala limniace</i>
		34	Chestnut-streaked Sailer	<i>Neptis jumbah</i>
		35	Chocolate Pansy	<i>Junonia iphita</i>
		36	Clipper	<i>Parthenos sylvia</i>
		37	Commander	<i>Moduza procris</i>
		38	Common Bushbrown	<i>Mycalesis perseus</i>
		39	Common Castor	<i>Ariadne merione</i>
		40	Common Crow	<i>Euploea core</i>
		41	Common Evening Brown	<i>Melanitis leda</i>
		42	Common Five-ring	<i>Ypthima baldus</i>
		43	Common Four-ring	<i>Ypthima huebneri</i>
		44	Common Lascar	<i>Pantoporia hordonia</i>
		45	Common Leopard	<i>Phalanta phalantha</i>
		46	Common Sailer	<i>Neptis hylax</i>
		47	Common Treebrown	<i>Lethe rohria</i>
		48	Cruiser	<i>Vindula erota</i>
		49	Danaid Eggfly	<i>Hypolimnas misippus</i>
		50	Dark Blue Tiger	<i>Tirumala septentrionis</i>
		51	Double-branded Crow	<i>Euploea sylvester</i>
		52	Gaudy Baron	<i>Euthalia lubentina</i>

		53	Glad-eye Bushbrown	<i>Mycalesis junonia</i>
		54	Glassy Tiger	<i>Parantica aglea</i>
		55	Great Eggfly	<i>Hypolimnas bolina</i>
		56	Grey Count	<i>Tanaecia lepidea</i>
3	Skipper	57	Grey Pansy	<i>Junonia atlites</i>
		58	Indian Nawab	<i>Charaxes bhārata</i>
		59	Lemon Pansy	<i>Junonia lemonias</i>
		60	Malabar Tree-Nymph	<i>Idea malabarica</i>
		61	Map Butterfly	<i>Cyrestis thyodamas</i>
		62	Medus Brown (Nigger)	<i>Orsotriaena medus</i>
		63	Painted Lady	<i>Vanessa cardui</i>
		64	Peacock Pansy	<i>Junonia almana</i>
		65	Plain Tiger	<i>Danaus chrysippus</i>
		66	Rustic	<i>Cupha erymanthis</i>
		67	Sahyadri (Tamil) Lacewing	<i>Cethosia mahratta</i>
		68	Small Leopard	<i>Phalanta alcippe</i>
		69	Striped Tiger	<i>Danaus genutia</i>
		70	Tamil Yeoman	<i>Cirrochroa thais</i>
		71	Tawny Coster	<i>Acraea terpsicore</i>
				72
3	Skipper	73	African Marbled Skipper	<i>Gomalia elma</i>
		74	Brown Awl	<i>Badamia exclamationis</i>
		75	Bush Hopper	<i>Ampittia dioscorides</i>
		76	Chestnut Bob	<i>Iambrix salsala</i>
		77	Common Banded Awl	<i>Hasora chromus</i>
		78	Common Branded Redeye	<i>Matapa aria</i>
		79	Common Snow Flat	<i>Tagiades japetus</i>
		80	Dark Palm-Dart	<i>Telicota bambusae</i>
		81	Giant Redeye	<i>Gangara thyrsis</i>
		82	Grass Demon	<i>Udaspes folus</i>
		83	Grizzled Skipper	<i>Spialia galba</i>
		84	Karwar Swift	<i>Caltoris canaraica</i>
		85	Pygmy Scrub Hopper	<i>Aeromachus pygmaeus</i>
		86	Suffused Snow Flat	<i>Tagiades gana</i>
4	Swallowtail	87	Blue Mormon	<i>Papilio polymnestor</i>
		88	Common Banded Peacock	<i>Papilio crino</i>
		89	Common Jay	<i>Graphium doson</i>
		90	Common Mormon	<i>Papilio polytes</i>
		91	Common Rose	<i>Pachliopta aristolochiae</i>
		92	Crimson Rose	<i>Pachliopta hector</i>
		93	Five-bar Swordtail	<i>Graphium antiphates</i>
		94	Lime Butterfly	<i>Papilio demoleus</i>
		95	Malabar Banded Peacock	<i>Papilio buddha</i>
		96	Narrow-banded Bluebottle	<i>Graphium teredon</i>
		97	Paris Peacock	<i>Papilio paris</i>
		98	Red Helen	<i>Papilio helenus</i>
		99	Sahyadri Birdwing / Southern Birdwing	<i>Troides minos</i>
5	Whites & Yellows	100	Tailed Jay	<i>Graphium agamemnon</i>
		101	Common Albatross	<i>Appias albina</i>
		102	Common Grass Yellow	<i>Eurema hecabe</i>
		103	Great Orange-tip	<i>Hebomoia glaucippe</i>
		104	Indian Jezebel	<i>Delias eucharis</i>
		105	Indian Wanderer	<i>Pareronia hippia</i>
		106	Lemon Emigrant	<i>Catopsilia pomona</i>
		107	Mottled Emigrant	<i>Catopsilia pyranthe</i>
		108	Painted Sawtooth	<i>Prioneris sita</i>
		109	Psyche	<i>Leptosia nina</i>
		110	Small Grass Yellow	<i>Eurema brigitta</i>
		111	Three-spot Grass Yellow	<i>Eurema blanda</i>
112	Yellow Orange-tip	<i>Ixias pyrene</i>		

55.c: List of Odonates			
Family	SI No	Scientific Name	Common Name
Calopterygidae	1	<i>Neurobasis chinensis</i>	Stream Glory
	2	<i>Vestalis apicalis</i>	Black-tipped Forest Glory
	3	<i>Vestalis gracilis</i>	Clear-winged Forest Glory
Chlorocyphidae	4	<i>Heliocypha bisignata</i>	Stream Ruby
Coenagrionidae	5	<i>Agriocnemis pygmaea</i>	Pygmy Dartlet
	6	<i>Agriocnemis splendidissima</i>	Splendid Dartlet
	7	<i>Amphiallagma parvum</i>	Azure Dartlet
	8	<i>Ceriagrion cerinorubellum</i>	Orange-tailed Marsh Dart
	9	<i>Ceriagrion coromandelianum</i>	Coromandel Marsh Dart
	10	<i>Ceriagrion olivaceum</i>	Rusty Marsh Dart
	11	<i>Ceriagrion rubiae</i>	Orange Marsh Dart
	12	<i>Ischnura rubilio</i>	Western Golden Dartlet
	13	<i>Ischnura senegalensis</i>	Senegal Golden Dartlet
	14	<i>Pseudagrion rubriceps</i>	Saffron-faced Blue Dart
Euphaeidae	15	<i>Euphaea fraseri</i>	Malabar Torrent Dart
Gomphidae	16	<i>Ictinogomphus rapax</i>	Indian Common Clubtail
Lestidae	17	<i>Lestes elatus</i>	Emerald Spreadwing
Libellulidae	18	<i>Acisoma panorpoides</i>	Trumpet-Tail
	19	<i>Brachydiplax sobrina</i>	Little Blue Marsh Hawk
	20	<i>Brachythemis contaminata</i>	Ditch Jewel
	21	<i>Bradinyopyga geminata</i>	Granite Ghost
	22	<i>Cratilla lineata</i>	Emerald-Banded Skimmer
	23	<i>Crocothemis servilia</i>	Scarlet Skimmer
	24	<i>Diplacodes lefebvrii</i>	Black Ground Skimmer
	25	<i>Diplacodes trivialis</i>	Blue Ground Skimmer
	26	<i>Neurothemis fulvia</i>	Fulvous Forest Skimmer
	27	<i>Neurothemis tullia</i>	Pied Paddy Skimmer
	28	<i>Orthetrum chrysis</i>	Brown-Backed Marsh Hawk
	29	<i>Orthetrum glaucum</i>	Blue Marsh Hawk
	30	<i>Orthetrum luzonicum</i>	Tri-coloured Marsh Hawk
	31	<i>Orthetrum pruinosum</i>	Crimson-tailed Marsh Hawk
	32	<i>Orthetrum sabina</i>	Green Marsh Hawk
	33	<i>Pantala flavescens</i>	Wandering Glider
	34	<i>Rhyothemis variegata</i>	Common Picturewing
	35	<i>Tramea basilaris</i>	Red Marsh Trotter
	36	<i>Tramea limbata</i>	Black Marsh Trotter
	37	<i>Trithemis aurora</i>	Crimson Marsh Glider
	38	<i>Trithemis festiva</i>	Black Stream Glider

4.5.1.5. IV Marine and Coastal Ecosystems

All organisms live on a blue planet, with oceans and seas covering more than 70 per cent of the Earth's surface. Oceans and seas feed us, regulate our climate and generate most of the oxygen we breathe. They also serve as the foundation for much of the world's economy, supporting sectors from tourism, fisheries to international shipping.

But despite their importance, oceans and seas are facing unprecedented threats as a result of human activity. Our oceans and seas are being degraded by human activities that harm marine life, undermine coastal communities and negatively affect human health. **Every year an estimated 8 million tonnes of plastic waste end up in the world's oceans and seas.** At the same time, climate change is damaging coral reefs and other key ecosystems; overfishing is

threatening the stability of fish stocks; nutrient pollution is contributing to the creation of dead zones; and nearly **80 per cent of the world's wastewater is discharged without treatment to the oceans and seas**. Fishes and Molluscs provide nutritious food to mankind and livelihood for fisherman. **They are known as the best bio indicators of water.**

Some of the fishes and molluscs recorded in the ECC study areas are listed below.

55.d: List of Marine Fishes		
SL No.	Species	Common Name
1	<i>Anchoiella commersonii</i>	Anchovy
2	<i>Anchoiella spp.</i>	Anchovy
3	<i>Stolephorus commersonii</i>	Anchovy
4	<i>Epinephelus areolatus</i>	Areolated reef cod
5	<i>Sphyraena jello</i>	Baracuda
6	<i>Rachycentron canadam</i>	Black king fish/ Cobia
7	<i>Parastomateus niger</i>	Black pomfret
8	<i>Metapenaeus monoceros</i>	Brown shrimp
9	<i>Priacanthus cruentatus</i>	Bull's eye -blood coloured
10	<i>Priacanthus hamrur</i>	Bull's eye -Dusky finned
11	<i>Arius thalassinus</i>	Cat fish
12	<i>Pampus chinensis</i>	Chinese Pomfret
13	<i>Leiognathus equalus</i>	Commen pony fish
14	<i>Atrabucca nibe</i>	Croaker
15	<i>Johnieops voglari</i>	Croaker
16	<i>Johnius dussumeriri</i>	Croaker
17	<i>Johnius sp.</i>	Croaker
18	<i>Sciaena aneus</i>	Croaker
19	<i>Charybdis feriatius</i>	Crucifix crab
20	<i>Sepia sp</i>	Cuttel fish
21	<i>Sardinella brachysoma</i>	Deep bodied sardinella
22	<i>Puerulus sewlii</i>	Deep sea lobster
23	<i>Solenoeero sp.</i>	Deep sea shrimp
24	<i>Coryphaena hippurus</i>	Dolphin fish
25	<i>Conger cinereus</i>	Eel
26	<i>Ablennes hians</i>	Flat needle fish
27	<i>Penaeus semisulcatus</i>	Flower prawn
28	<i>Protonibea diacanthus</i>	Ghol
29	<i>Sphyraena baracuda</i>	Great Baracuda
30	<i>Rhinobatos djiddensis</i>	Guitar fish
31	<i>Tenulosa ilisha</i>	Hilsa
32	<i>Megalaspis cardyla</i>	Horse mackerel
33	<i>Psettodes erumei</i>	Indian Halibut
34	<i>Rastelliger kanagurta</i>	Indian mackerel
35	<i>Sardinella longiceps</i>	Indian Oil sardine
36	<i>Polynemus tetradactylus</i>	Indian salmon
37	<i>Decapterus russelli</i>	Indian scad
38	<i>Alectis indicus</i>	Indian thread fish
39	<i>Nemipterus japonicus</i>	Japanese thread fin bream
40	<i>Acetes indicus</i>	Jawala
41	<i>Metapenaeus affinis</i>	King prawn
42	<i>Aluterus monoceros</i>	Leather jacket
43	<i>Scomberoides iysan</i>	Leather skin Queen fish
44	<i>Euthynus affinis</i>	Little tunny
45	<i>Saurida tumbil</i>	Lizard fish
46	<i>Thryssa malabarica</i>	malabar anchovy
47	<i>Parapenaeopsis stylifera</i>	Marine shrimp Karkadi
48	<i>Makaira indica</i>	Marlin black
49	<i>Mixed fishes</i>	Mixture
50	<i>Mene Maculata</i>	Moon fish
51	<i>Scylla serata</i>	Mud crab
52	<i>Mugil cephalus</i>	Mullet
53	<i>Hemiraphus fara</i>	Needle fish
54	<i>Canthidermis maculata</i>	Ocean trigger fish
55	<i>Octopus sp</i>	Octopus
56	<i>Leiognathus berbis</i>	Orange fin pony fish

57	<i>Sarda orientalis</i>	Oriental bonito
58	<i>Pinctada sp.</i>	Pearl oyster
59	<i>Etroplus surantensis</i>	Peral spot
60	<i>Metapenaeus affinis</i>	Pink shrimp
61	<i>Odonus niger</i>	Red toothed file fish
62	<i>Epinephelus diacanthus</i>	Reef cod
63	<i>Epinephelus malabaricus</i>	Reef Cod
64	<i>Epinephelus sp</i>	Reef cod
65	<i>Lepturacanthus savala</i>	Ribbon fish
66	<i>Trichirus lepturus</i>	Ribbon Fish
67	<i>Istiophorus platypterus</i>	Sail fish
68	<i>Alepes mate</i>	Scad
69	<i>Charybdis cruciata</i>	Sea crab
70	<i>Portunus pelagicus</i>	Sea crab
71	<i>Portunus sanguinolentus</i>	Sea crab
72	<i>Scomberomorus commersoni</i>	Seer fish
73	<i>Scomberomorus guttatus</i>	Seer fish
74	<i>Scomberomorus lineolatus</i>	Seer fish
75	<i>Metapenaeus dobsoni</i>	Shrimp Poovalan
76	<i>Pampus argenteus</i>	Silver pomfret
77	<i>Lutjanus sanguineus</i>	Snapper
78	<i>Lutjanus sp.</i>	Snapper
79	<i>Cynoglossus macrostomus</i>	Sole Fish
80	<i>Cynoglossus arel</i>	Sole Fish
81	<i>Cynoglossus dubius</i>	Sole fish
82	<i>Cynoglossus macrolepidotus</i>	Sole fish
83	<i>Paraplagusia Bilineata</i>	Sole Fish
84	<i>Doryteuthis sibogae</i>	Squid
85	<i>Loligo duvacelii</i>	Squid
86	<i>Abalistes stellatus</i>	Starry trigger fish
87	<i>Dasyatis bleekeri</i>	Sting ray
88	<i>Scomberoides commersonianus</i>	Talang queen fish
89	<i>Opisthopterus tardoore</i>	Tardore
90	<i>Thryssadussumieri</i>	Thryssa
91	<i>Terapon jarbua</i>	Tiger perch
92	<i>Penaeus monodon</i>	Tiger prawn
93	<i>Trash landings</i>	Trash fish
94	<i>Carangoides malabaricus</i>	Travelly
95	<i>Lactarius lacterius</i>	Travelly
96	<i>Seriolina nigrofasciata</i>	Travelly
97	<i>Auxis thazard</i>	Tuna
98	<i>Katsuwonus pelamis</i>	Tuna
99	<i>Thunnus albacores</i>	Tuna
100	<i>Himanture bleekeri</i>	Whip tail sting ray
101	<i>Penaeus indicus</i>	White prawn
102	<i>Esculosa thorucata</i>	White sardine
103	<i>Chirocentrus dorab</i>	Wolf herring
104	<i>Atule mate</i>	Yellow tail scad

55.e. List of Other Marine Fauna:

	<i>Rhopilema Spp.</i>	<i>Jelly Fish</i>
	<i>Crambionella Spp.</i>	<i>Jelly Fish</i>
	<i>Lepidochelys olivacea</i>	<i>Olive ridley</i>
	<i>Sousa Spp.</i>	<i>Dolphin</i>

55.f. List of Molluscs:

Sl. No.	Species
1	<i>Purpura bufo</i>
2	<i>Tibia sp</i>
3	<i>Macra cheminitzii</i>
4	<i>Macrinula striatula</i>
5	<i>Mytilopsis sp</i>

6	<i>Anandara granosa</i>
7	<i>Anandara pilula</i>
8	<i>Donax scrotum</i>
9	<i>Sunetta scripta</i>
10	<i>Turitella sp</i>
11	<i>Natica picta</i>
12	<i>Anandara indica</i>
13	<i>Sunetta meroe</i>
14	<i>Natica vitellus</i>
15	<i>Cyprea sp</i>
16	<i>Indothias lacera</i>
17	<i>Tellina virgata</i>
18	<i>Agaronia gibbosa</i>
19	<i>Marcia opima</i>
20	<i>Hiatula diphos</i>
21	<i>Sunetta sp</i>
22	<i>Donax incarnatus</i>
23	<i>Meretrix casta</i>

4.6. Objectives- 3: To determine the carrying capacity of Udupi Taluk for the industrial growth and development.

4.6.1 Industries

4.6.1.1 Distribution of industries Profile of Udupi District:

Udupi is located within the state of Karnataka in India, lying amidst the Arabian Sea and the Western Ghats, was formed in August 1997. Udupi which is well known for its religious & cultural heritage has the highest density of banking branch offices in the state (Scheduled Commercial Banks). It is the birthplace of the Syndicate Bank, Corporation Bank and Harsha Retail, the leading retailer of coastal Karnataka Udupi's economy also consists of agriculture and fishing. It is home to over more than 6 Large Scale Industries, 6 Medium Scale industries and 11,283 small-scale industries (Table 9. Presently there are four major industrial areas viz Manipal, Nandikoor, Belapu and Miyar industrial areas. Two more industrial areas (Bola) and (Mulladka) are proposed to set up and they are under progress.

4.6.1.2. Industrial Profile of Dakshina Kannada District:

Is a district located in the southern and coastal part of Karnataka, which is spread across in 5 Taluks - Mangalore, Puttur, Belthangady, Bantwal and Sullia is sheltered by the soaring Western Ghats on the east and bordered by the blue waters of the Arabian Sea. It is the only city in Karnataka to have all modes of transport — air, road, rail and sea. The fastest growing non-metro (Indian city of population less than 1 million) in South India is Mangalore. Mangalore is one among the 5 cities in the country to have both a Major Port and an International Airport. Mangalore has some of the tallest buildings in South India; with many more under construction. Mangalore is the 2nd largest business centre in Karnataka. Around 75% of India's coffee, timber and cashew nuts exports are handled by the New Mangalore Port. Currently there are 24,072 operating MSMEs operating in the district with 6 industrial areas, 5 industrial estates and two more proposed industrial areas (Niddodi and Badag mijar) and the list of industries is enclosed at annexure.

Table 13; list of Industries

Industries within Study Area			
Taluk	Large	Medium	Small
Karkala	4	1	188
Udupi	10	4	147
Mangalore	7	4	136

(Source: District at a Glance 2016).

Chapter -5

Scope of further work

The scope of carrying capacity study includes Source Emission Dispersion Modelling, AAQM and Water & Wastewater Elemental Analysis and Soil Analysis. The Source dispersion and apportionment study includes arriving at ground level concentration as well as dispersion concentration at 2km, 5km and 10km radius at Udupi Power Corporation using AERMOD 5.2 as per the EPA/CPCB guidelines and using the sampling and analysis as per international standard methods like USEPA, IS, ASTM. In addition to the above the work documenting and analysis of the critical biodiversity and critical ecosystems in the study area would be continued.

In order to carry out the carrying capacity modelling estimation of the atmospheric assimilation capacity, documentation of biodiversity and critical ecosystems is very much needed. The detailed data collection from the field is absolutely essential for which six months of extension time is required.

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ANNEXURE-I: Proceedings of the Govt. of Karnataka

Proceedings of the Government of Karnataka.

Sub: Undertaking environmental carrying capacity study of Udupi Taluk in terms of the orders of the Hon'ble National Green Tribunal, Southern Bench, Chennai dated 14th March 2019 and 14th October 2019 in relation to expansion of existing 2x600 MW Udupi power plant-reg.

Read: 1. The orders of the Hon'ble National Green Tribunal, Southern Bench, Chennai in Original Application No. 578/2018 and connected matters dated 14th March 2019 and 14th October 2019.
2. Letter No. CCC/CR-2/NSCC-EMPRI//2019-2020/02, dated 17.04.2020 of Environment Management and Policy Research Institute (EMPRI).
3. Government Notification No. ಅಇ 267 ವೆಚ್ಚ-12/2020, dated 04.05.2020.

Preamble:

The Ministry of Environment and Forest and Climate Change, Government of India had accorded Environmental Clearance for expansion of Udupi Power project by Udupi Power Corporation Limited by 2X 800 MW capacity vide the letter dated 1.8.2017. A corrigendum has been issued vide letter dated 26.02.2018 for incorporating the CRZ recommendations for laying the pipeline facilities. The Hon'ble National Green Tribunal vide order dated 14.3.2019 in O.A. No. 578 of 2018 in the matters of Janajagrithi Samithi Versus Union of India & Others have suspended the above said Environmental Clearance. The Hon'ble National Green Tribunal have also directed the State Government to get a carrying capacity study of the area carried out.

A decision has been taken to entrust the task of undertaking carrying capacity study in terms of the orders of the Hon'ble National Green Tribunal, Southern Bench, Chennai dated 14th March 2019 and 14th October 2019 in relation to expansion of existing 2x600 MW Udupi power plant to the Environment Management and Policy Research Institute (EMPRI), Bengaluru. The EMPRI vide their letter dated 17.04.2020 have submitted a proposal with regard to conducting "the study of environmental carrying capacity of Udupi Taluk". The said institute have indicated a total budget requirement Rs. 17.00 Lakhs for the study envisaged.

The Government in the Finance Department have accorded exemption under section 4(g) of Karnataka Transparency in Public Procurement Act, 1999 vide Notification No. ಅಇ 267 ವೆಚ್ಚ-12/2020, dated 04.05.2020 for availing the services of EMPRI, Bengaluru to get the aforementioned study conducted.

In view of the above facts and circumstances a decision has been taken by the Government to entrust the task of conducting "environmental carrying capacity study" in terms of the orders of the Hon'ble National Green Tribunal dated 14th March 2019

and 14th October 2019 in relation to expansion of existing 2x600 MW Udupi power plant to the EMPRI, Bengaluru.

Hence this order.

**Government Order No. FEE 08 EAA 2019 , Bangalore,
Dated: 12.05.2020.**

Pursuant to the facts and circumstances explained in the preamble, the Government are pleased to entrust the task of conducting "environmental carrying capacity study" to Environment Management and Policy Research Institute (EMPRI), Bengaluru in terms of the orders of the Hon'ble National Green Tribunal, dated 14th March 2019 and 14th October 2019 in relation to expansion of existing 2x600 MW Udupi power plant at an estimated cost of Rs.17.00 Lakhs (Rupees Seventeen Lakhs only) subject to the following terms and conditions:

1. The EMPRI shall conduct the environmental carrying capacity study in terms of the orders of the Hon'ble National Green Tribunal, dated 14th March 2019 and 14th October 2019 and submit the report within the period of six months.
2. The EMPRI shall be abide to undertake any additional studies that would be suggested by the State Government/ the Hon'ble NGT upon submission of the final report and provide the required clarification /information with regard to the study.
3. The EMPRI shall submit 10 copies of the final study report and a soft copy of the same to the Government along with all the reports, material evidences, satellite imageries, photographs , videographs, etc collected as part of the carrying capacity study to the Government.
4. The expenditure towards the study of carrying capacity shall be borne by the EMPRI.

This order is issued in concurrence with the Finance Department vide Note No. ಅಇ 134 ವಜ್ಜ-5/2020, dated 06.05.2020.

By order and in the name of
Governor of Karnataka

(Muralidhar S. Tallikeri) 12/05/2020
Under Secretary to Government,
(Ecology and Environment),
Forest, Ecology and Environment Dept.



To:

1. The Accountant General (Accounts & Audit), Karnataka, Bengaluru.

2. The Secretary, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhavan, Jor Bagh Road, Aliganj, New Delhi- 110003.
3. The Registrar, National Green Tribunal, Faridkot House, Copernicus Marg, New Delhi - 110001.
4. The Registrar, National Green Tribunal, Southern Zone, Kalas Mahal. Chennai.
5. The Director General, Environment Management & Policy Research Institute, Hasiru Bhavan, Dorsanipalya Forest Campus, Vinayaka Nagara, JP Nagara 5th Phase, Bengaluru - 78.
6. The Director - IA 1, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhavan, Jor Bagh Road, Aliganj, New Delhi- 110003.
7. M/s Udupi Power corporation, Lotus Tower, 1st Floor, 34 , Devraj Urs Road, Race Course, Bengaluru- 560001.
8. SG.file/Spare copies

Copy to:

1. PS to the Chief Secretary to Government, Government of Karnataka, Vidhana Soudha, Bengaluru. *US 19/5/20*
2. PS to the Additional Chief Secretary to Government, Forest, Ecology and Environment Department, M.S. Building, Bengaluru. *19/05/2020*
3. PS to the Principal Secretary to Government, Forest, Ecology and Environment Department (Ecology and Environment), M.S. Building, Bengaluru. *B 19/05/2020*
4. PS to the Special Director (Technical Cell), Forest, Ecology and Environment Department, M.S. Building, Bengaluru. *19/5/20*
5. Under Secretary to Government, Finance Department (Expenditure-5), Vidhana Soudha, Bengaluru. *19.5.20*

ANNEXURE-II: CPCB methodology used for Environmental Modelling

Methodology and Framework for Calculating Environmental Carrying Capacity:

There are different methods available to estimate the carrying capacity of an area. The following steps have been adopted to assess the Environmental carrying capacity of the study area.

Carrying capacity is the maximum number of activities like domestic, agriculture, transport, Industries- that can be done continuously over a period of time without affecting:

- a) The existing quality of life (from the point of view of existing traditional practices, access to resources, health and pollution levels.
- b) The overall balancing of resources (Renew ability/regeneration).
- c) The fact that activities can be done on a sustainable manner.
- d) Neighbouring systems.
- e) Existing ecological systems like agriculture, horticulture, forest etc.

Water Resource Carrying Capacity: Amount of available water resources (AWR), and the amount of surface water withdrawal (SWW). These can be estimated by the following equations:

$$AWR = AGWR + ASWR + OAWR$$

- AGWR is the available ground water resource,
- ASWR is the available surface water resource,
- OAWR is other available water resources, mainly wastewater reuse and collection of rainwater.

$$SWW = TWS - GWS - OSWS$$

- TWS is total water supply,
- GWS is ground water supply,
- OSWS is other sources of water.

Water demand Carrying Capacity: Gross water amount consumed by all types of water users. The gross amount of water demand includes the conveyance loss of water, domestic water demand, industrial water demand, agricultural water demand, and "other" water demand (Water Resources Bulletin of Tieling 2011).

- **Domestic water** demand includes urban domestic water demand, made up of the residential use of water and the public use of water (including the water use by tertiary industry and the construction industry),
- **Industrial water demand** consists of the demand for fresh water, excluding water recycling within enterprises.
- **Agricultural water demand** is made up of irrigation water demand water recharge.
- **Other water demand** consists mainly of the demand for sanitation water in the urban area and the water restoration requirements of rivers, lakes and wetlands.

Water resource carrying capacity (WRCC) depends on the water availability and water demand, and is given as,

$$WRCC = WA/WD$$

Where, WA = water availability

WD = water demand

Widodo et al., 2015 stated that for WRCC < 1 capacity is overshoot, WRCC 1 - 3 capacities is conditionally safe and WRCC > 3 capacity is safe.

Rivers Carrying Capacity: The water environmental capacity is the maximum pollutant loading that the water body can hold under a certain water environment quality target. The dominant water pollutant is BOD. The length and width of the computed river is relatively large, so we can ignore the horizontal changes of pollutant concentration, and only take into account changes of pollutant concentration along the river, so we select one-dimensional water quality model to calculate the Surface water environmental capacity. The water environment capacity can be calculated with following equation as per Qingchun Yang et al; 2019

Assuming stream and waste water discharge are at steady state and instantaneous full mixing of all flows.

$$W_R = [C_s - C_o \exp(-KL/u)] \times Q$$

- W_R represents the river's pollutant carrying capacity, g/s;
- C_s represents the water quality target concentration at the downstream cross-section of the river, mg/L;
- C_o represents the actual water quality concentration at the upstream cross-section of the river, mg/L;

- K represents the pollutant degradation coefficient, d⁻¹;
- L represents the length of river, m; u represents the average flow velocity at the river's cross section, m/s;
- Q represents the designed flow at the river's cross section, m³/s

Note: As per Yingrong Wen et al; 2017, the reported range for laboratory-measured k values is from 0.3 to 0.5 day at a temperature of 20 °C, which is considered representative of field conditions

Lakes Carrying capacity

Pollutant carrying capacity of the lake:

Considering, Lake is of small size with equilibrium of multi-year average in flowing water and outflowing water, it is desirable to adopt the uniform mixture model to calculate the pollutant carrying capacity.

Based on the material balance equation, the pollutant carrying capacity

$$W_L = (C_s - C_o) V + KC_sV + C_s q_{out}$$

In this equation,

- W_L represents the pollutant carrying capacity of the lake, t/a;
- C_s represents the water quality target concentration, mg/l;
- C_o represents the actual water quality concentration, mg/l;
- V represents the average storage capacity of the lake in dry seasons, m³;
- q_{out} represents multi-year outflowing water of the lake in dry seasons, m³/a;
- K represents the pollutant degradation coefficient, d⁻¹ 'mainly BOD parameters under consideration

Ground Water Carrying capacity

For estimating the level of groundwater pollution with low-hazard pollutants the following formula can be used as per Anna Belousova, 2006

$$C_1/MPC_1 + C_2/MPC_2 \pm \dots \pm C_n/MPC_n = 1$$

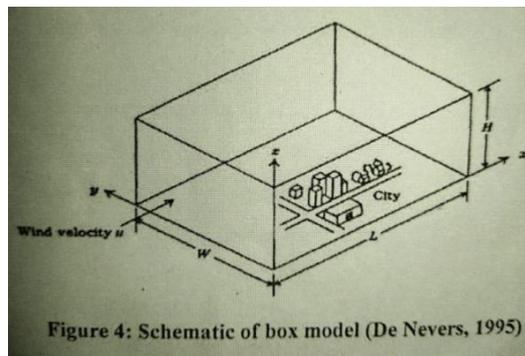
Where C₁, C_n are concentration of separate pollutants, and MPC₁, MPC_n represent maximum permissible concentration.

If the sum of the concentration ratios is more than 1, then the groundwater is polluted. For all cases, pH must not be outside the limit 6.5-8.5.

Atmospheric Assimilation Capacity:

Various approaches are described in the literature for estimating the atmospheric assimilative capacity of a region. (Goyal et al. (2006) propose two approaches, one based on a ventilation coefficient, the other through pollution potential. SEPA (2003) recommend an A-P value method and multi-source simulation model to estimate atmospheric assimilative capacity in China.

Here we are discussing the atmospheric assimilative capacity using simple Box Model: A simple box model based on mass balance and assuming that all pollutants in the box are uniformly mixed (Figure 2) is used for preliminary estimates for step (ii) in Fig 1(a). It is a simple model and has several limitations; however, for the purpose of demonstrating the framework and preliminary analysis, the model may provide broad estimates of carrying capacity. Mathematically, the model can be described as below:



Mathematically

$$V \frac{dc}{dt} = qC_{in} - qC_{out} + S - K_{dd} CLW - K_{cr} C_{out}V \quad (1)$$

Where, q = volumetric flow rate (m^3/sec)

C_{in} = influent concentration of a pollutant (g/m^3)

C_{out} = effluent concentration of a pollutant (g/m^3)

K_{dd} = dry deposition velocity (m/sec)

K_{cr} = First order chemical reaction constant ($1/sec$)

S = source emission rate(g/sec)

$K_{dd} C.L.W$ = the amount of pollutants removed by dry deposition (g/sec)

$K_{cr} C.V$ = the amount of pollutants converted by chemical reaction (g/sec)

u = wind speed (m/sec)

In equation, $V=L*W*H$ volume of City m^3 (L: length (m), W: Width (m). H; height (m))

The model is further simplified with the following assumptions:

- Steady state condition (i.e. concentration is time invariant); $dc/dt = 0$
- Pollutant does not have any deposition in the box; $K_{dd} = 0$
- Pollutant does not undergo any chemical transformation: $K_{cr} = 0$

One can estimate the carrying capacity, Q_{cc} as per the following equation:

$$Q_{cc} = (C-C_0) \times u.W.H \quad (2)$$

In this calculation,

Area (A) of system boundary, Width (W) of the System boundary, mixing height (H) (average for winter and summer) within the system boundary, Wind Speed (s) within the system boundary is required.

Background concentration (C_0) into the system boundary: Alternatively, the multi-source simulation model may be used to estimate atmospheric assimilative capacity based on air quality modelling which takes into consideration region-specific meteorological conditions, terrain characteristics, and emission loads from different sources.

Following Goyal and Chalapati Rao (2007), the discharged emission load at which the maximum allowable concentration is reached under predefined critical conditions is taken to be the assimilative capacity of the region. Prediction of ground-level concentrations of pollutants is carried out using the US EPA approved ISCST-3 simulation model (EPA, 1995a, 1995b). It should be noted that the atmospheric assimilative capacity has a range of values, depending on the variation of emission characteristics with given meteorological and topographical conditions.

ANNEXURE- III: List of Industries at Udupi district

SI. No	Name of the Industry	Taluk	District	Products	Size (L/M/S)
1	Lamina Foundries Limited., Kuntadi Road, Nitte, Karkala	Karkala	Udupi	Foundry	Large
2	Kudluteer tha Mini Hydel Scheme,	Karkala	Udupi	hydel power	Large
3	Upper Sitanadi Mini Hydel Scheme,	Karkala	Udupi	hydel power	Large
4	Bola Surendra Kamath & Sons,	Karkala	Udupi	Cashew Kernels	Large
5	Mookambika Industries,	Karkala	Udupi	stone crusher	Medium
6	Markala Mini Hydel Scheme,	Karkala	Udupi	hydel power	Small
7	Carla cashew chemi India ltd,	Karkala	Udupi	CNS oil	Small
8	Raithasev a Gramodyoga ,	Karkala	Udupi	boiled rice	Small
9	Gajanana Rice Mill,	Karkala	Udupi	boiled rice	Small
10	Sri Ramanjaneya Industries,	Karkala	Udupi	boiled rice	Small
11	Tsubosaka Aiv India (P) Ltd., Tq Udupi Dt	Karkala	Udupi	tomb stone	Small
12	Vikram Industries,	Karkala	Udupi	boiled rice	Small
13	Sri Vinayaka Cashew Exports,	Karkala	Udupi	Cashew Kernels	Small
14	Sri Durgambika Industries, Tq udupi	Karkala	Udupi	CNS oil	Small
15	A.S stone crusher,	Karkala	Udupi	stone crusher	Small
16	Adarsh Industrial Chemicals, Tq,	Karkala	Udupi	CNS oil	Small
17	Akshaya Chemicals,	Karkala	Udupi	turpentine & varnishes	Small
18	Anugraha Stone Cruser Industry, Tq,	Karkala	Udupi	stone crusher	Small
19	Avinash Enterprises,	Karkala	Udupi	stone crusher	Small
20	B.Surendra Kamath & Company,	Karkala	Udupi	CNS oil	Small
21	Chamundeshwari Stone Crusher,	Karkala	Udupi	stone crusher	Small
22	Delta Industries,	Karkala	Udupi	stone crusher	Small
23	Durgaparameshwari crushers,	Karkala	Udupi	stone crusher	Small
24	Earth Line Trading Company, Tq, Udupi Dt.	Karkala	Udupi	stone crusher	Small
25	D Govardan Babu Stone Crusher, Tq, Udupi.	Karkala	Udupi	stone crusher	Small
26	J&P Enterprises, s,	Karkala	Udupi	stone crusher	Small
27	Kandan Stone Crusher,	Karkala	Udupi	stone crusher	Small
28	Karla Constructions,	Karkala	Udupi	Hot mix plant	Small
29	Kiran Stone Crusher,	Karkala	Udupi	stone crusher	Small
30	Krishna Industries,	Karkala	Udupi	stone crusher	Small
31	Leslee Crusher (J.L),	Karkala	Udupi	stone crusher	Small
32	Lime Kiln : Louis D'Douza, Tq,	Karkala	Udupi	lime kiln	Small
33	Lewis Stone Crushers,	Karkala	Udupi	stone crusher	Small
34	Mahaveer Metal Works, Tq, Udupi Dt	Karkala	Udupi	lead recycling	Small
35	Maruthi Industry,	Karkala	Udupi	CNS oil	Small
36	Mookambika Crushers,	Karkala	Udupi	stone crusher	Small
37	Mount Mary Industries,	Karkala	Udupi	stone crusher	Small

38	Damodar Infra (Navanidhi Enterprises),	Karkala	Udupi	stone crusher	Small
39	Oriental Granites & Crusher, Tq, Udupi Dt.	Karkala	Udupi	stone crusher	Small
40	P.R. Ibrahim - Hot Mix Plant,	Karkala	Udupi	Hot mix plant	Small
41	Sanoor Cashew,	Karkala	Udupi	CNS oil	Small
42	Santhosh Industries, Tq, Udupi Dt.	Karkala	Udupi	CNS oil	Small
43	Sanur Stone Crushers,	Karkala	Udupi	stone crusher	Small
44	Sathyashree Industries,	Karkala	Udupi	CNS oil	Small
45	Chandramangal Associates,	Karkala	Udupi	stone crusher	Small
46	Shell Lime Industries,	Karkala	Udupi	lime kiln	Small
47	Shiney Industries,	Karkala	Udupi	stone crusher	Small
48	St. Joseph Industries,	Karkala	Udupi	stone crusher	Small
49	Stone Crusher: B.M. Zakariaq,	Karkala	Udupi	stone crusher	Small
50	Tar Mixing Plant: M.G.Hussain,	Karkala	Udupi	Hot mix plant	Small
51	Venkateshwar Industries, Tq,	Karkala	Udupi	stone crusher	Small
52	Vishal Industries,	Karkala	Udupi	stone crusher	Small
53	Vks Crusher	Karkala	Udupi	stone crusher	Small
54	Adishakti Rice Industries,	Karkala	Udupi	boiled rice	Small
55	Ananthapadmanabha Rice Mills,	Karkala	Udupi	boiled rice	Small
56	B. Pundalika Sarvothama Kini	Karkala	Udupi	boiled rice	Small
57	Bhagyodaya Agro Inds,	Karkala	Udupi	boiled rice	Small
58	Canara Feeds,	Karkala	Udupi	Cattle Feed	Small
59	Chethana Rice Mill,	Karkala	Udupi	boiled rice	Small
60	Girishri Rice Mill, Dt.	Karkala	Udupi	boiled rice	Small
61	Green Vision Industries, Tq, Udupi Dt.	Karkala	Udupi	bitter guard	Small
62	Hegde Rice Mills,	Karkala	Udupi	boiled rice	Small
63	Kamat Phova & Rice Mills,	Karkala	Udupi	boiled rice	Small
64	Kamath Industrial Enterprises,	Karkala	Udupi	boiled rice	Small
65	Komal Feeds, Tq, Udupi Dt.	Karkala	Udupi	Cattle Feed	Small
66	New Canara Feeds,	Karkala	Udupi	Cattle Feed	Small
67	Raithaseva Dryers, Tq,	Karkala	Udupi	boiled rice	Small
68	Rajashree Rice Mill,	Karkala	Udupi	boiled rice	Small
69	Sanoor Phova & Rice Mills,	Karkala	Udupi	boiled rice	Small
70	Shetty Traders & Rice Mills,	Karkala	Udupi	boiled rice	Small
71	Sri Ganesh Industries.	Karkala	Udupi	boiled rice	Small
72	Sri Vidya Industries, Udupi	Karkala	Udupi	boiled rice	Small
73	Veeravittala Rice Inds,	Karkala	Udupi	boiled rice	Small
74	Vijaya Aharodhama (Jaishree Dryers),	Karkala	Udupi	boiled rice	Small
75	Allen Inds,	Karkala	Udupi	Cashew Kernels	Small
76	Amithi Cashew Inds,	Karkala	Udupi	Cashew Kernels	Small
77	Anantha Padmanabha Tyre Retreaders, Tq, Udupi Dt.	Karkala	Udupi	tyre retreading	Small
78	Anitha Cashew,	Karkala	Udupi	Cashew Kernels	Small

79	Bahubali Exports,	Karkala	Udupi	Cashew Kernels	Small
80	Balaji Exports, Dt.	Karkala	Udupi	Cashew Kernels	Small
81	Benaka Industries,	Karkala	Udupi	plastic cups & printing on it	Small
82	Bharti Mobile Ltd.,	Karkala	Udupi	telephone tower	Small
83	Bola Raghaven dra Kamath & Sons., .	Karkala	Udupi	CNS oil	Small
84	Bolkar Industries,	Karkala	Udupi	Cashew Kernels	Small
85	Ganapath y Cashew,	Karkala	Udupi	Cashew Kernels	Small
86	Greenland Industries.	Karkala	Udupi	roofing tiles	Small
87	H. Sudheendra Oil Products,	Karkala	Udupi	coconut oil & gingili oil	Small
88	Hutchison Essar South Ltd.,	Karkala	Udupi	telephone tower	Small
89	Kamakshi Cashew Industries	Karkala	Udupi	Cashew Kernels	Small
90	Kamakshi Exports	Karkala	Udupi	Cashew Kernels	Small
91	Kamakshi Gramodyoga Sangha	Karkala	Udupi	Cashew Kernels	Small
92	Kamath Cashew Ind,	Karkala	Udupi	CNS oil	Small
93	Laxmi Kripa Kalyanam antapa,	Karkala	Udupi	DG Set kalynama antapa	Small
94	Laxmi Ravalnatha Cashews,	Karkala	Udupi	Cashew Kernels	Small
95	Madhavprakash Enterprises	Karkala	Udupi	Cashew Kernels	Small
96	Mahalaxmi Cashew Inds.	Karkala	Udupi	Cashew Kernels	Small
97	Mahamaya Exports	Karkala	Udupi	Cashew Kernels	Small
98	Mangala Gowri Exports	Karkala	Udupi	Cashew Kernels	Small
99	Manjunatha Enterprises	Karkala	Udupi	General engg	Small
100	Muddu Krishna Inds,	Karkala	Udupi	Cashew Kernels	Small
101	Nagaraj Cashew Inds	Karkala	Udupi	Cashew Kernels	Small
102	Navadurga Oil & Flour Mills	Karkala	Udupi	coconut oil & flour mill	Small
103	New Damodar Cashew	Karkala	Udupi	Cashew Kernels	Small
104	New Ramanath Cashew Industries	Karkala	Udupi	Cashew Kernels	Small
105	New Sridevi Cashew Ind	Karkala	Udupi	Cashew Kernels	Small
106	New Varadaraj Cashew Inds	Karkala	Udupi	Cashew Kernels	Small
107	Palashree Industries	Karkala	Udupi	hollow bricks	Small
108	Palashree Industries	Karkala	Udupi	hollow bricks	Small
109	Panchami Cashew	Karkala	Udupi	Cashew Kernels	Small
110	Paradise Bottling	Karkala	Udupi	soft drinks	Small
111	Prabhu Oil Mills	Karkala	Udupi	oil expellers	Small
112	Prakash Cashew Inds.	Karkala	Udupi	Cashew Kernels	Small
113	Reliance Infocomm Ltd,	Karkala	Udupi	telephone tower	Small
114	Reliance Infocomm Ltd,	Karkala	Udupi	telephone tower	Small
115	Sanoor Umesh Kamath & Co.	Karkala	Udupi	Cashew Kernels	Small
116	Santhosh Cashews,	Karkala	Udupi	Cashew Kernels	Small
117	Sapthagiri Gramodyoga Sangha,	Karkala	Udupi	Cashew Kernels	Small
118	Sarala Saw Mill, Nandalike, Karkal Tq.	Karkala	Udupi	saw mill	Small
119	Shah Steels,	Karkala	Udupi	processing waste sand	Small
120	Shah Steels,	Karkala	Udupi	processing waste sand	Small
121	Sree Durga Cashew Industries.	Karkala	Udupi	Cashew Kernels	Small

122	Sri Devi Cashew Industries,	Karkala	Udupi	Cashew Kernels	Small
123	Sri Ganesh Cashew Ind,	Karkala	Udupi	Cashew Kernels	Small
124	Sri Gururaj Industries, Main Road,	Karkala	Udupi	Cashew Kernels	Small
125	Sri Jagadeesh wara Rice Mill,	Karkala	Udupi	rice milling	Small
126	Sri Krishikar mikara Seva Gramodyo ga,	Karkala	Udupi	Cashew Kernels	Small
127	Sri Krishna Exports,	Karkala	Udupi	Cashew Kernels	Small
128	Sri Thirumal Cashew (Unit-2)	Karkala	Udupi	Cashew Kernels	Small
129	Sri Shanthara m Cashew Industries.	Karkala	Udupi	Cashew Kernels	Small
130	Sri Vinayaka Hollow Bricks, Main Road,	Karkala	Udupi	hollow bricks	Small
131	Sri Vinayaka Agro Products,	Karkala	Udupi	gingelly oil	Small
132	Sri Vinayaka Stores,	Karkala	Udupi	oil expellers	Small
133	St. Lawrence Industries,	Karkala	Udupi	coconut oil	Small
134	Tara Cashews,	Karkala	Udupi	Cashew Kernels	Small
135	Tata Tele Service Ltd,	Karkala	Udupi	telephone tower	Small
136	Tata Teleservic es Ltd.,	Karkala	Udupi	telephone tower	Small
137	Thirumala Cashew Industries,	Karkala	Udupi	Cashew Kernels	Small
138	Veekay Pvc Profiles, Sy.no.522 /1, Hirgana village, Karkala Tq, Udupi.	Karkala	Udupi	Cashew Kernels	Small
139	Veera Vittala Exports,	Karkala	Udupi	Cashew Kernels	Small
140	Vijaya Cashews,	Karkala	Udupi	Cashew Kernels	Small
141	Vinayaka Cashew,	Karkala	Udupi	Cashew Kernels	Small
142	R&G Enterprise s	Karkala	Udupi	stone crusher	Small
143	Sulochana Exports,	Karkala	Udupi	Cashew Kernels	Small
144	St. Joseph Inds,	Karkala	Udupi	stone crusher	Small
145	Shah Steels,	Karkala	Udupi	processin g waste sand	Small
146	HLN nayak &sons,	Karkala	Udupi	Cashew Kernels	Small
147	Komal pellets,	Karkala	Udupi	Cattle Feed	Small
148	Sri Durga crusher, t	Karkala	Udupi	stone crusher	Small
149	Xcell telecom pvt ltd,	Karkala	Udupi	telephone tower	Small
150	Xcel telecom private ltd,	Karkala	Udupi	telephone tower	Small
151	Vintel Industries (Celina Industries),	Karkala	Udupi	coconut oil	Small
152	Rocksand minerals,	Karkala	Udupi	stone crusher	Small
153	Sapthagiri Industries,	Karkala	Udupi	CNS oil	Small
154	Shri Mahisham ardhini stone crusher,	Karkala	Udupi	stone crusher	Small
155	paduthiru pathi biofuels,	Karkala	Udupi	Agro based fuel briquette	Small
156	Shri panchavat i Inds,	Karkala	Udupi	Boiled rice	Small
157	Nithyanan da wood Inds & furnitures, t	Karkala	Udupi	saw mill& wooden furniture	Small
158	Wireless TT info services ltd,	Karkala	Udupi	telephone tower	Small
159	Adishakth i Exports,	Karkala	Udupi	Cashew Kernels	Small
160	Indus Towers,	Karkala	Udupi	telephone tower	Small
161	Indus Towers,	Karkala	Udupi	telephone tower	Small
162	Viom Networks ltd,	Karkala	Udupi	telephone tower	Small
163	Sri Ganesh Cashews	Karkala	Udupi	Cashew Kernels	Small
164	Rose Agro Tech,	Karkala	Udupi	Desiccate d coconut	Small

				powder	
165	Sri Vishnumurthy Designers,	Karkala	Udupi	wooden furniture	Small
166	Kamakshi Industries,	Karkala	Udupi	Soft Drinks	Small
167	Suprem Stone Crusher,	Karkala	Udupi	Stone crusher	Small
168	N-lite food Industry,	Karkala	Udupi	Bakery Products	Small
169	Sri Devi Shilpakala,	Karkala	Udupi	Granite cutting & polishing	Small
170	Megha Industries,	Karkala	Udupi	Drinking Water	Small
171	Billava Interlock Industries,	Karkala	Udupi	Hollow Blocks & Interlocks	Small
172	Global Hollow Blocks,	Karkala	Udupi	Hollow Block	Small
173	New Megha Industries,	Karkala	Udupi	Drinks &	Small
174	Kiran Stone Crusher,	Karkala	Udupi	Stone crusher	Small
175	Sai Stone Crusher,	Karkala	Udupi	Stone crusher	Small
176	Boiler Poultry Farm,	Karkala	Udupi	Poultry	Small
177	Kiran Stone Crushers,	Karkala	Udupi	Stone Crusher	Small
178	Raychel Industries,	Karkala	Udupi	Hollow Blocks	Small
179	Rishal Cashew Industry,	Karkala	Udupi	Cashew Kernels	Small
180	OM Enterprise s, t	Karkala	Udupi	Stone Crusher	Small
181	Sri Ramachandra Wood Works,	Karkala	Udupi	Wooden furniture	Small
182	Deepthi Cashew Co,	Karkala	Udupi	Cashew Kernels	Small
183	Durgapara meshwari Stone Crusher,	Karkala	Udupi	Stone Crusher	Small
184	Primary Health Center-	Karkala	Udupi	Clinic	Small
185	Primary Health Center-	Karkala	Udupi	Clinic	Small
186	Primary Health Unit-	Karkala	Udupi	Clinic	Small
187	Primary Veterinary Clinic-	Karkala	Udupi	Clinic	Small
188	Primary Veterinary Clinic-	Karkala	Udupi	Clinic	Small
189	Veterinary Dispensary,	Karkala	Udupi	Clinic	Small
190	Sri Sai Dental Clinic,	Karkala	Udupi	Clinic	Small
191	Aithal Clinic,	Karkala	Udupi	Clinic	Small
192	Sri Sai Dental Clinic,	Karkala	Udupi	Clinic	Small
193	Aithal Clinic,	Karkala	Udupi	Clinic	Small
194	Mangalore power company,	Udupi	Udupi	Thermal power	Large
195	Udupi Power Corporation,	Udupi	Udupi	Thermal power	Large
196	Suzlon wind International,	Udupi	Udupi	Wind energy product	Large
197	SE Composites,	Udupi	Udupi	Wind energy product	Large
198	TA Pai management Institute,	Udupi	Udupi	organisation	Large
199	Maharaj Infra,	Udupi	Udupi	Apartment	Large
200	SKE & C KCT Joint Venture Strategic Ltd,	Udupi	Udupi	Crude oil storage & handling facility	Large
201	Mandavi Real Estate Developers,	Udupi	Udupi	STPs Established at Residential apartments, with wastewater generation more than 100KLD	Large
202	Sarvada Distilleries,	Udupi	Udupi	IML Bottling	Large

203	Sri Chakra Containers Pvt Ltd,	Udupi	Udupi	Woven fabrics and sacks(PP/ HDPE) labour accommodation with 20 kld STP	Large
204	Town Municipal Council, Kaup, Udupi Tq & District	Udupi	Udupi	LB	LB
205	Supreme Feeds, Post Tq & District	Udupi	Udupi	Cattle Feed	Medium
206	SKE & C KCT Joint Venture Stratargic Ltd,	Udupi	Udupi	stone crusher	Medium
207	Bremels Rubber Industries Pvt Ltd,	Udupi	Udupi	Solid Tyre Plants	Medium
208	Grand Riviera ,	Udupi	Udupi	residential apartment (builtup area - 2438.92 sq.m with 44 flats) & 30 KLD STP	Medium
209	Sri Vinayaka Industries. , Tq & Dist.	Udupi	Udupi	boiled rice	Small
210	Akai Industries Dt	Udupi	Udupi	imitation jewellery	Small
211	Algitech Chemicals,	Udupi	Udupi	Algi proofing compounds	Small
212	Anantha Padmanabha Stone Crusher,	Udupi	Udupi	stone crusher	Small
213	Anish Stone Crushing Industries,	Udupi	Udupi	stone crusher	Small
214	Annappa foods (Annappa) Industries, Tq & Dist	Udupi	Udupi	Prawn shell cleaning	Small
215	Anup Inds, Putthige,	Udupi	Udupi	CNS oil	Small
216	B.M.T. Fish Peeling Shed, Tq & Dt.	Udupi	Udupi	fish peeling	Small
217	Brahma Baidarkala Industries, Tq, Udupi Dt.	Udupi	Udupi	stone crusher	Small
218	MG Construction, Sy No. 382/1, 383/1 & 385/1,	Udupi	Udupi	stone crusher	Small
219	Ennar Enterprises, Nandikoor Village,	Udupi	Udupi	stone crusher	Small
220	Magnum Granites,	Udupi	Udupi	stone crusher	Small
221	Oxford Industries,	Udupi	Udupi	stone crusher	Small
222	Saritha Enterprises,	Udupi	Udupi	stone crusher	Small
223	Seethalaxmi Stone Crushing Industry,	Udupi	Udupi	stone crusher	Small
224	Shree Durga Distillery,	Udupi	Udupi	Fenny & IMFL bottling	Small
225	Sri Madanthe shwara Stone Crusher,	Udupi	Udupi	stone crusher	Small
226	Sri Padma Crusher,	Udupi	Udupi	stone crusher	Small
227	Abharan Motors	Udupi	Udupi	service station	Small
228	Kinara Food Products,	Udupi	Udupi	fruit processing	Small
229	L.M. Motors, Dt.	Udupi	Udupi	service station	Small
230	Prathvi Motors,	Udupi	Udupi	service station	Small
231	Sri Maruthi Mills,	Udupi	Udupi	boiled rice	Small
232	Sri Sai Durgi Auto Service,	Udupi	Udupi	service station	Small

233	Madhura Food Products,	Udupi	Udupi	fruit processin g	Small
234	Vinayaka Rice Inds,	Udupi	Udupi	boiled rice	Small
235	Alsafa Fabricatio ns, Udupi.	Udupi	Udupi	fabricatio n	Small
236	Bharath Tile Co. ,	Udupi	Udupi	roofing tiles	Small
237	Bharathi Airtel Ltd, Udupi.	Udupi	Udupi	telephone tower	Small
238	Canara Cashew Industires,	Udupi	Udupi	Cashew Kernels	Small
239	Canara Ice Plant,	Udupi	Udupi	Ice Block manufact uring	Small
240	Gurugane sh Industries,	Udupi	Udupi	Cashew Kernels	Small
241	Hangyo Ice creams Pvt ltd, (Sri krishna frozen Desserts pvt ltd),	Udupi	Udupi	Ice Cream	Small
242	Kiran Tyre Resoling Works,	Udupi	Udupi	tyre retrading	Small
243	Laxmi Farms,	Udupi	Udupi	poultry farm	Small
244	Medline Transcript ions	Udupi	Udupi	oil expellers	Small
245	Natural Ice Cream	Udupi	Udupi	ice cream	Small
246	Navaneet h Cashews	Udupi	Udupi	Cashew Kernels	Small
247	Navyug Cashew Industries	Udupi	Udupi	Cashew Kernels	Small
248	Prabhath Inds	Udupi	Udupi	coconut oil & flour mill	Small
249	Prakash Saw Mills Ltd,	Udupi	Udupi	saw mill	Small
250	Robosoft Technolog ies,	Udupi	Udupi	software unit	Small
251	Sealine Products.,	Udupi	Udupi	Ice Block manufact uring	Small
252	Shanthala Cashew Ind,	Udupi	Udupi	Cashew Kernels	Small
253	Shetty Ice & Cold Storage,	Udupi	Udupi	Ice Block manufact uring	Small
254	Shivapras ad Bottling Company,	Udupi	Udupi	soft drinks	Small
255	Sri Durga food and bewarages ,	Udupi	Udupi	mineral water	Small
256	Sri Durga Oil Mills,	Udupi	Udupi	coconut oil	Small
257	Sri Ganesh Auto Works,	Udupi	Udupi	automobil e repair	Small
258	Sri Hariprasa d mills,	Udupi	Udupi	coconut oil	Small
259	Sri Laxmi Cahsew Industries,	Udupi	Udupi	Cashew Kernels	Small
260	Sri Mookamb ika Poly Products,	Udupi	Udupi	fiber glass molding	Small
261	Sri Vinayaka Cashew Ind,	Udupi	Udupi	Cashew Kernels	Small
262	Sri Vruddhi Industries,	Udupi	Udupi	plastic carry bag unit	Small
263	Srilatha Softdrinks ,	Udupi	Udupi	mineral water &soft drinks	Small
264	Veerabha draswamy Wood Ind,	Udupi	Udupi	wooden furniture	Small
265	Shalet Rice mill,	Udupi	Udupi	boiled rice	Small
266	Mathaes poultry farm	Udupi	Udupi	poultry farm	Small
267	Diamond concrete bricks,	Udupi	Udupi	concrete bricks	Small
268	Noorani Cashew Inds, Vada rse panchayat h, Kavadi Udupi Tq & Dist.	Udupi	Udupi	Cashew Kernels	Small
269	Sri Ramprasa d Inds,	Udupi	Udupi	coconut oil	Small
270	Sri Shantheri oil and floor mill,	Udupi	Udupi	coconut oil	Small
271	Agro Manipal foods,	Udupi	Udupi	fruit processin g	Small
272	Sri Vinayaka cashew Industries, Sy.No:220 /1P11,	Udupi	Udupi	Cashew Kernels	Small

	Nalkur, Udipi Tq & Dist				
273	Sharada Enterprises	Udupi	Udupi	paint formulation	Small
274	Consolidated Construction consortium limited,	Udupi	Udupi	concrete batch mixing	Small
275	Concure concrete blocks,	Udupi	Udupi	Hollow Blocks	Small
276	Tata teleservices ltd,	Udupi	Udupi	telephone tower	Small
277	SP Bricks,	Udupi	Udupi	Wire cut bricks	Small
278	Unity rock Industry,	Udupi	Udupi	stone crusher	Small
279	GTL Infrastructure ltd,	Udupi	Udupi	telephone tower	Small
280	Wireless TT info services ltd,	Udupi	Udupi	telephone tower	Small
281	Wireless TT info services ltd	Udupi	Udupi	telephone tower	Small
282	Wireless TT info services ltd,	Udupi	Udupi	telephone tower	Small
283	Wireless TT info services ltd, Syno: 129/20/A, perdoor, brahmavara, hebri, udupi	Udupi	Udupi	telephone tower	Small
284	Aircel ltd,	Udupi	Udupi	telephone tower	Small
285	Aircel ltd,	Udupi	Udupi	telephone tower	Small
286	Indus towers ltd,	Udupi	Udupi	telephone tower	Small
287	ATC India Tower corporation pvt ltd, ltd,	Udupi	Udupi	telephone tower	Small
288	Viom Networks,	Udupi	Udupi	telephone tower	Small
289	Siddhi vinayaka cashew industries,	Udupi	Udupi	Cashew Kernels	Small
290	Century Hollow Blocks,	Udupi	Udupi	Cement Hollow Blocks	Small
291	Navyuga Engineering Comply Ltd,	Udupi	Udupi	Hot Mix Plant	Small
292	Navyuga Engineering Comply Ltd,	Udupi	Udupi	wet mix plant	Small
293	Akshya cashew Industries,	Udupi	Udupi	Cashew Kernels	Small
294	Coelho Construction Pvt Ltd,	Udupi	Udupi	Interlocks & Pavers	Small
295	Udupi Royal Soda & Soft Drinks,	Udupi	Udupi	Soft drinks	Small
296	D P Enterprises	Udupi	Udupi	Hollow Blocks	Small
297	Arya Industries	Udupi	Udupi	Interlock & Hollow Blocks	Small
298	Hindusthan Durgs	Udupi	Udupi	Ayurvedic Medicine	Small
299	Sarveshwar Minerals,	Udupi	Udupi	Resine coated sand	Small
300	Vintech India corporation,	Udupi	Udupi	fly ash bagging	Small
301	Vansh Blocks,	Udupi	Udupi	Hollow Blocks	Small
302	Ayush Envirotech Pvt Ltd,	Udupi	Udupi	Common Bio-Medical Waste Treatment	Small
303	Deva Rice Industries,	Udupi	Udupi	Boiled rice without Boiler	Small
304	Sri Nidhi Blocks,	Udupi	Udupi	Hollow Blocks	Small
305	Sri Damodar Construction,	Udupi	Udupi	Solid Blocks	Small
306	ATC Telecom tower,	Udupi	Udupi	15KVA DG Set	Small
307	Sri Ram Bricks Industries,	Udupi	Udupi	Fly ash bricks	Small
308	Adith Packers,	Udupi	Udupi	cotton & non woven plastic bags	Small
309	Chamundi Stone Crusher,	Udupi	Udupi	Stone Crusher	Small
310	Keerthi Resine & Paints,	Udupi	Udupi	Resine	Small

311	Zenith Die Makers Pvt Ltd,	Udupi	Udupi	Die Making	Small
312	Hangyo Ice Cream Pvt Ltd (Unit-II)	Udupi	Udupi	Ice Block manufacturing	Small
313	Royal Industries,	Udupi	Udupi	cashew Nut Shell Oil	Small
314	Abhiman Ice and cold storage,	Udupi	Udupi	Ice Block manufacturing	Small
315	Star Cement Pipes Co,	Udupi	Udupi	Cement Pipes	Small
316	SLG Stone Crusher,	Udupi	Udupi	Stone crusher	Small
317	Alupa Foods Private Limited, C/o Dhanyala xmi Rice Mills,	Udupi	Udupi	Boiled Rice	Small
318	Intaglio Engraving Systems,	Udupi	Udupi	printing rollers	Small
319	Sri Brahmalingeshwara Interlocks & Blocks,	Udupi	Udupi	Interlocks & Solid Blocks	Small
320	Sri Chakra Containers Pvt Ltd,	Udupi	Udupi	Woven fabrics	Small
321	Nandikur Polymers,	Udupi	Udupi	PVC Pipes	Small
322	Padur Enterprises,	Udupi	Udupi	Paper cup	Small
323	S.L.G Stone Crusher,	Udupi	Udupi	Stone Crusher	Small
324	Aradhya Cashew Industries,	Udupi	Udupi	Cashew Kernels	Small
325	Udaya Aqua Products,	Udupi	Udupi	Mineral water	Small
326	Sristi Ventures,	Udupi	Udupi	Eco Wall (prefabricated structural panel)	Small
327	Color Park,	Udupi	Udupi	Formulation and blending of all types of textile dyestuffs and textile chemicals	Small
328	Anchan Ayurvedic Industries,	Udupi	Udupi	urveda Khas	Small
329	Vishal Sand,	Udupi	Udupi	silica sand wash	Small
330	Anjana Packaging	Udupi	Udupi	Household Plastic Articles & Blow Moulded	Small
331	Hotel Amar,	Udupi	Udupi	Hotel	Small
332	Karavali Hospital,	Udupi	Udupi	Clinic	Small
333	Nayaks Hospital,	Udupi	Udupi	Hospital	Small
334	Padubidri Hospital,	Udupi	Udupi	Hospital	Small
335	Primary Health Centre,	Udupi	Udupi	Clinic	Small
336	Primary Health Centre,	Udupi	Udupi	Clinic	Small
337	Primary Health Unit-	Udupi	Udupi	Clinic	Small
338	Primary Health Unit-	Udupi	Udupi	Clinic	Small
339	Primary Veterinary Clinic-	Udupi	Udupi	Clinic	Small
340	Primary Veterinary Clinic-	Udupi	Udupi	Clinic	Small
341	Primary Veterinary Clinic-	Udupi	Udupi	Clinic	Small
342	Shantheri Pallavi Maternity Hospital,	Udupi	Udupi	Clinic	Small
343	Shree Ravalnath, Medical, Surgical & Maternity	Udupi	Udupi	Clinic	Small

	Centre,				
344	Sri Siddhi Vinayak Hospital,	Udupi	Udupi	Clinic	Small
345	Veterinary Hospital,	Udupi	Udupi	Clinic	Small
346	Govt. Ayurvedic Dispensary,	Udupi	Udupi	Clinic	Small
347	Rural Maternity & Child Welfare Home,	Udupi	Udupi	Clinic	Small
348	Medi- Tech Diagnostic s,	Udupi	Udupi	Clinic	Small
349	Astanga Clinic,	Udupi	Udupi	Clinic	Small
350	Veterinary Hospital,	Udupi	Udupi	Clinic	Small
351	Govt. Ayurvedic Dispensary,	Udupi	Udupi	Clinic	Small
352	Rural Maternity & Child Welfare Home,	Udupi	Udupi	Clinic	Small
353	Medi- Tech Diagnostic s,	Udupi	Udupi	Clinic	Small
354	Astanga Clinic,	Udupi	Udupi	Clinic	Small
355	Prabha Clinic Kuthyar	Udupi	Udupi	Clinic	Small

ANNEXURE-IV

**SOCIO-ECONOMIC SURVEY ON PEOPLE'S PERSPECTIVE REGARDING
INDUSTRIAL GROWTH AND DEVELOPMENT OF UDUPI**

ಸಾಮಾಜಿಕ-ಆರ್ಥಿಕ ಸಮೀಕ್ಷೆಯ ಪ್ರಶ್ನೆಗಳು

I. ಸಾಮಾನ್ಯ ಮಾಹಿತಿ

ವ್ಯಕ್ತಿಯ ಹೆಸರು :

ಗ್ರಾಮದ ಹೆಸರು:

ಅಂಚೆವಿಳಾಸ: _____

ಹೋಬಳಿ/ತಾಲೂಕು ಮತ್ತು ಜಿಲ್ಲೆ _____

1. ಮಾತೃ ಭಾಷೆ: ಕನ್ನಡ ತುಳು ಬ್ಯಾರಿ /ಉರ್ದು ಕೊಂಕಣಿ ಇತರೆ

2. ಕುಟುಂಬ ಸದಸ್ಯರ ಸಂಖ್ಯೆ: _____

3. ಶಿಕ್ಷಣದ ಮಟ್ಟ: ಪ್ರಾಥಮಿಕ ಪ್ರೌಢಶಾಲೆ ಪೂರ್ವಪದವಿ ಪದವಿ ಅನಕ್ಷರಸ್ಥ

4. ಕುಟುಂಬದ ಮುಖ್ಯಸ್ಥನ ಉದ್ಯೋಗ:

ರೈತ ಸರಕಾರಿ ನೌಕರ ಖಾಸಗಿ ಉದ್ಯೋಗಿ ಸ್ವಂತ ವ್ಯಾಪಾರ ಇತರೆ

5. ಕುಟುಂಬದ ಮುಖ್ಯಸ್ಥನ ಪ್ರತಿ ತಿಂಗಳ ಕುಟುಂಬದ ಆದಾಯ:

< 10,000 > 10,000 10,000- 20,000 20,000 - ಇದಕ್ಕಿಂತ ಹೆಚ್ಚು

6. ಯು.ಪಿ.ಸಿ.ಎಲ್ ಯೋಜನೆಯಿಂದಾದ ಪರಿಣಾಮಗಳು:

a) ಕೃಷಿ ಭೂಮಿ ಲಾಭ ನಷ್ಟ b) ಮನೆ ಜಾಗ ಇತರೆ

7. ಮಾಲೀಕತ್ವದ ಆಸ್ತಿ: ವೈಯಕ್ತಿಕ ಜಂಟಿ ಖಾತಾ ನಂ: ವಿಸ್ತಾರ (ಎಕರೆಗಳಲ್ಲಿ):

8. ಯು.ಪಿ.ಸಿ.ಎಲ್ ಸ್ಥಾವರ ವಿಸ್ತರಣೆಯ ಕಡೆಗೆ ನಿಮ್ಮ ಅಭಿಪ್ರಾಯ: ಧನಾತ್ಮಕ ಋಣಾತ್ಮಕ

9. ಬೇರೆ ಯಾವುದೇ ಯೋಜನೆಗಳ ಬಗ್ಗೆ ನಿಮ್ಮ ಅಭಿಪ್ರಾಯ: ಬೇಕು ಬೇಡ

10. ಯು.ಪಿ.ಸಿ.ಎಲ್ ಯೋಜನೆಯ ಸಮಯದಲ್ಲಿ ಎದುರಾದ ಪ್ರಯೋಜನಗಳು ಮತ್ತು ತೊಂದರೆಗಳು:

ಪ್ರಯೋಜನಗಳು: ಉದ್ಯೋಗಾವಕಾಶ ಮೂಲಸೌಕರ್ಯಗಳ ಸುಧಾರಣೆ ಯಾವುದೂ ಇಲ್ಲ ಇತರೆ

ತೊಂದರೆಗಳು:

a) ಆರೋಗ್ಯದ ಸಮಸ್ಯೆಗಳು - ಕೆಮ್ಮು ಜ್ವರ ತಲೆನೋವು ಉಸಿರಾಟದ ತೊಂದರೆಗಳು ಇತರೆ

b). ಮೂಲ ಸೌಕರ್ಯಗಳ ಕೊರತೆ - ಗಾಳಿ ನೀರು ಮಣ್ಣು ನೆಲ ಜಾಗ ಕಟ್ಟಡ

c). ನಿರುದ್ಯೋಗ

11. ಸಾರಿಗೆ ಸೌಲಭ್ಯಗಳು: (a) ಖಾಸಗಿ ಇದೆ ಇಲ್ಲ (b) ಸರ್ಕಾರಿ ಇದೆ ಇಲ್ಲ

II. ಆರ್ಥಿಕ ಸ್ಥಿತಿ;

12. ಮನೆ: ಪಕ್ಕಾ ಕಚ್ಚಾ

13. ವಿದ್ಯುತ್ ಸಂಪರ್ಕ: ಇದೆ ಇಲ್ಲ
14. ಕುಡಿಯುವ ನೀರಿನ ಗುಣಮಟ್ಟ ? ಶುದ್ಧ ಕಲುಷಿತ ಸೂಕ್ಷ್ಮವಲ್ಲ
15. ಕುಡಿಯುವ ನೀರಿನ ಮೂಲ: ಕೈಪಂಪು ಮೇಲ್ಮೈನೀರು ತೆರೆದಬಾವಿ ನೀರು ಸರಬರಾಜು
16. ಕೃಷಿಗೆ ನೀರಿನ ಮೂಲ:- ಮಳೆ ನೀರು ಅಂತರ್ಜಲ ಕೆರೆ ಬೋರ್ವೆಲ್ ಇತರೆ
17. ಜಾನುವಾರುಗಳ ಆಹಾರ; ನೈಸರ್ಗಿಕ ಹುಲ್ಲು ನೆಟ್ಟ ಹುಲ್ಲು ಖರೀದಿಸಿದ ಆಹಾರ ಬೆಳೆ ಉಳಿಕೆಗಳು
18. ಸ್ವಂತ ವಾಹನಗಳು: ದ್ವಿಚಕ್ರ ನಾಲ್ಕು ಚಕ್ರ ಇತರೆ
19. ಅಡುಗೆ ಮಾಡಲು ಬಳಸುವ ಇಂಧನ ಪ್ರಕಾರ:
 ಎಲ್ಪಿಜಿ ಸಿಲಿಂಡರ್ ಕಟ್ಟಿಗೆ ಜೈವಿಕ ಅನಿಲ ಸೀಮೆಎಣ್ಣೆ ಇತರೆ
20. ಯಾವುದಾದರೂ ಕೃಷಿ ಉಪಕರಣ ಹೊಂದಿದ್ದಾರೆಯೇ?:
 1. ಟ್ರ್ಯಾಕ್ಟರ್ , ಟಿಲ್ಲರ್
 2. ಎತ್ತಿನ ಬಂಡಿ
 3. ಇತರೆ

III. ಇತರ ಮಾಹಿತಿ;

21. ವಿಶಿಷ್ಟ ಸ್ಥಳಗಳು: ಧಾರ್ಮಿಕ ಸ್ಥಳ ಕೆರೆ ಕಡಲತೀರ ಅರಣ್ಯ ಇತರೆ
22. ಪರಿಸರ ಸಮಸ್ಯೆಗಳ ಬಗ್ಗೆ ನಿಮ್ಮ ಅಭಿಪ್ರಾಯ:
 ಜಲ ಮಾಲಿನ್ಯ ವಾಯು ಮಾಲಿನ್ಯ ಆರೋಗ್ಯದ ಪರಿಣಾಮ ಭೂ ನಾಶ ಮರಗಳ ನಷ್ಟ ತೆರೆದ ಜಾಗ
23. ನಿಮ್ಮ ಸ್ಥಳದ ಪರಿಸರದ ಸ್ಥಿತಿಯ ಬಗ್ಗೆ ನಿಮ್ಮ ಅಭಿಪ್ರಾಯವೇನು?
 ಚೊಕ್ಕಟು ಕೊಳಕು ಬಹಳ ಕೊಳಕು ಆರೋಗ್ಯಕರ ಸಾಧಾರಣ ಪರಿಸರ
24. ನಿಮಗೆ ಆರೋಗ್ಯ ಸೌಲಭ್ಯಗಳ ಲಭ್ಯತೆಯನ್ನು ಹೊಂದಿದ್ದೀರಾ? ಇದೆ ಇಲ್ಲ
25. ನಿಮ್ಮ ಜಿಲ್ಲೆಯ ಭೂದೃಶ್ಯ ಕಾಲಾನಂತರದಲ್ಲಿ ಬದಲಾಗಿದೆ ಎಂದು ನೀವು ಭಾವಿಸುತ್ತೀರಾ?
 ಹೌದು ಇಲ್ಲ
 ಹೌದಾದರೆ ಅವು ಯಾವುವು:-
 1.
 2.
 3.
 4.
26. ಕುಟುಂಬದಲ್ಲಿ ಯಾವುದೇ ಸದಸ್ಯರು ಯಾವುದಾದರೂ ಕಾಯಿಲೆಗಳಿಂದ ಬಳಲುತ್ತಿದ್ದಾರೆಯೇ?

ವೈಯಕ್ತಿಕ ಅಭಿಪ್ರಾಯ:

-
-
-

ಸಂದರ್ಶನದ ದಿನಾಂಕ:

ಎಂಪಿ ಮಾಹಿತಿ ಸಂಗ್ರಹಣೆ
ಬೆಂಗಳೂರು

ANNEXURE- V – Floral Species encountered outside the quadrat

Sl. No	Species	Family	Status
1.	<i>Alangium salvifolium</i> (L.F) Wangerin sub sp. <i>hexapetalum</i> (Lamk.) Wangerin	Cornaceae	-
2.	<i>Alstonia scholaris</i> (L.) R.Br.	Apocynaceae	-
3.	<i>Caryota urens</i> L.	Aeracaceae	-
4.	<i>Cinnamomum verum</i> J.Presl	Lauraceae	-
5.	<i>Dalbergia horrida</i> (Dennst.) Mabb.	Fabaceae	-
6.	<i>Diospyros malabarica</i> (Desr.) Kostel.	Ebenaceae	-
7.	<i>Garcinia xanthochymus</i> Hook.f.ex.T.Anderson	Clusiaceae	-
8.	<i>Getonia flouribunda</i> Roxb.	Combretaceae	-
9.	<i>Gnetum ula</i> Brongn	Gnetaceae	Least Concern
10.	<i>Ixora polyantha</i> Wight	Rubiaceae	-
11.	<i>Madhuca nerifolia</i> (Moon) H.J.Lam.	Sapotaceae	-
12.	<i>Mangifera indica</i> L.	Anacardiaceae	-
13.	<i>Mimusops elengi</i> L.	Sapotaceae	-
14.	<i>Naringi crenulata</i> (Roxb.) Nicolson	Rutaceae	-
15.	<i>Uvaria narum</i> (Dunal) Blume	Annonaceae	-