CHAPTER 2 REGIONAL SETUP: PHYSICAL AND SOCIO-ECONOMIC

2.1 KUTCH

Kachchh district, located on the westernmost tip of India is the largest district of Gujarat,the total area of the district is 45,652 sq. km, that is more than 23% of the total area of the state, and lies in the extreme western part of the state. The district is bounded on the north and northwest by the Sindh Province of Pakistan and on the northeast by Rajasthan state. The southern boundary of the district is marked by the Gulf of Kachchh and towards west and southwest by the Arabian Sea. There are several small ports all along the coast, which are mainly used as fishing ports. Kandla and Mundra are the two important port in the district and supports the industrial and commercial activities in the state.

2.1.1 Administrative Divisions

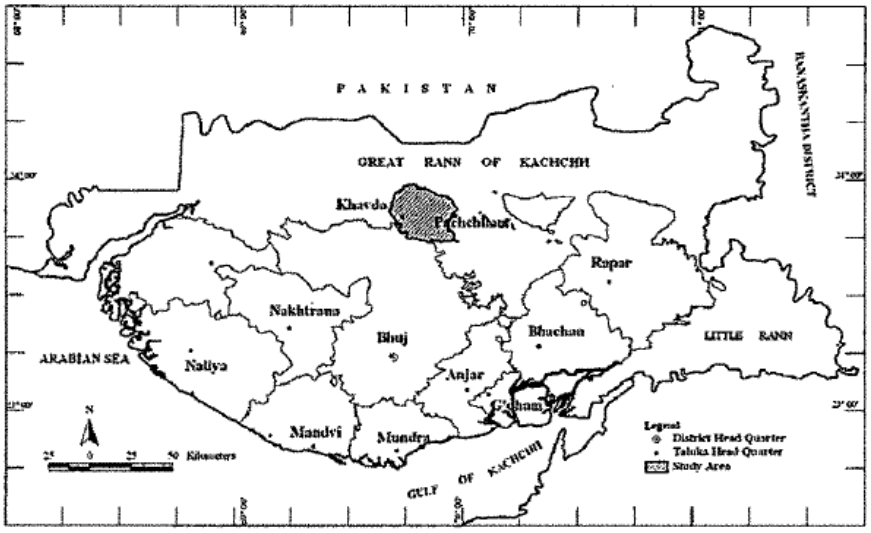


Fig. 2.1 Administrative subdivisions of Kutch

(Source: Source: www.act-india.org)

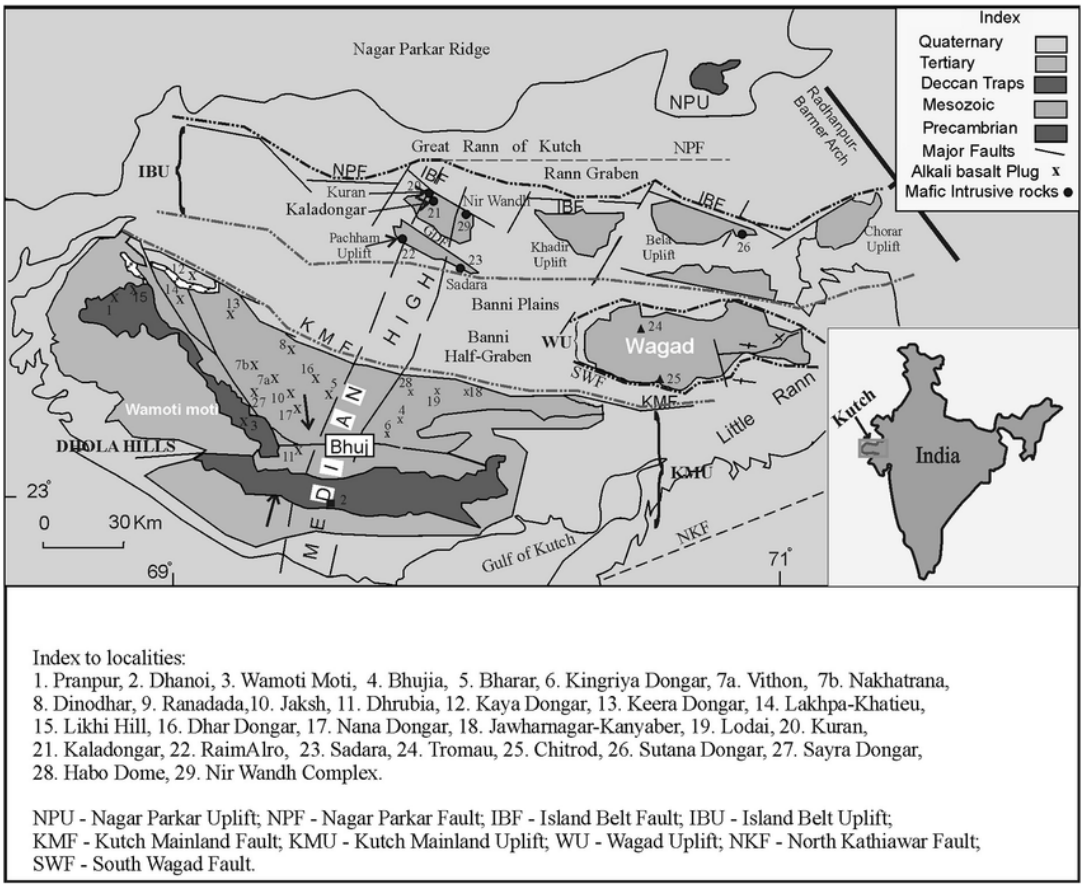
Administratively the district is divided into ten Talukas, Bhuj is the district headquarter.

2.1.2 Physical Aspect

The landscape of Kachchh is unique in its evolution as a result of several phases of tectonic movements since the Late Jurassic (Biswas 1987). A major part of the area is occupied with Pre-Quaternary rocks . The major structural trend of Kutch is marked by an E-W direction that in turn, is reflected in the geological set up of the area.

Physiographicallly, the Kutch region can be divided into five major units. All the five units show considerable diversity within each of them in terms of rock type, mode of occurrence and structural style.

2.1.2.1 Mainland Kachchh: The mainland Kachchh is a rocky terrain with two sub-parallel east west trending hill ranges. The two hill ranges are Northern hill range and Katrol hill range bounded in their north by a fault forming a steep slope towards its north. The southern slope that follows the dip of the strata is gentler. The northern hill range is bounded in the north by Kachchh mainland fault and the Katrol hill range with Katrol hill fault. The Northern hill range comprises of a chain of domes of Jurassic and Cretaceous rocks. On the Kachchh mainland there are several peaks, the Nandungar has the maximum altitude of 430 m (Merh, 1995). This hill range comprises a chain of domes of Jurassic and cretaceous rocks (Biswas and Deshpande, 1970). The various domes associated with the KHF are Ler dome, Gangeshwar dome, Shiv Paras dome, Khatrod dome and Chadwa dome (Thakkar et al., 1999). The central rocky plain occupies the intervening area between the Northern Hill Range and the Katrol Hill Range. The plain is characterized by a gentle slope towards north.



Index to localities:
1. Pranpur, 2. Dhanoi, 3. Wamoti Moti, 4. Bhujia, 5. Bharar, 6. Kingriya Dongar, 7a. Vithon, 7b. Nakhatrana, 8. Dinodhar, 9. Ranadada,10. Jaksh, 11. Dhrubia, 12. Kaya Dongar, 13. Keera Dongar, 14. Lakhpa-Khatieu, 15. Likhi Hill, 16. Dhar Dongar, 17. Nana Dongar, 18. Jawharnagar-Kanyaber, 19. Lodai, 20. Kuran, 21. Kaladongar, 22. RaimAlro, 23. Sadara, 24. Tromau, 25. Chitrod, 26. Sutana Dongar, 27. Sayra Dongar, 28. Habo Dome, 29. Nir Wandh Complex.

NPU - Nagar Parkar Uplift; NPF - Nagar Parkar Fault; IBF - Island Belt Fault; IBU - Island Belt Uplift; KMF - Kutch Mainland Fault; KMU - Kutch Mainland Uplift; WU - Wagad Uplift; NKF - North Kathiawar Fault; SWF - South Wagad Fault.

Fig: 2.2 Map showing major geomorphic division of Kachchh.

(Source: Arijit Ray, 2016)

2.1.2.2 Island Belt: The island belt comprises of a linear chain of four islands viz. Pachcham, Khadir, Bela and Chorar bounded by an eastwest trending Island Belt Fault. The four islands occurring in the form of disjoined landmasses show comparable geological, structural and geomorphic setup. The islands are bounded in its north by Island Belt Fault forms a sharp slope in the northern side and the southward extension of the islands are following the dip of Mesozoic and Neogene strata exhibit a gentle slope indicating an active tectonic tilting. Also, the presence of marine notches at two different levels of the northern slope of the islands is inferred

as two major uplifts of these islands in the Holocene or Late Holocene period (Chowksey et al. 2010).

2.1.2.3 Wagad Highland: A large upland region towards the south of Bela Island is known as Wagad Highlands. Geologically, the Wagad region contains rocks of Jurassic and Cretaceous age, whereas the northern and southern fringes are covered by Tertiary rocks. Quaternary sediments are mapped within the river valleys and the marginal area. The plain of Banni is flat and slightly uplifted (2 to 10 above MSL), bounded within the highlands of Mainland in the south, rocky Pachcham island in the north and Wagad high in the east

2.1.2.4 Banni plains: The thick Banni sediments are deposited in a tectonically disturbed northern margin of the Kachchh mainland under a fluvio-marine environment. A gradual uplift of the area and a Quaternary regression of the Arabian Sea have brought the plain beyond the reach of tide and grow green grasses and shrubs. However, the lower western margin is periodically flooded by tide during monsoon season.

2.1.2.5 Rann: The Rann is the most remarkable and unique feature of the Kachchh region. It is a flat geomorphic terrain having an aerial extent of 22,000 Sq. km and hardly rising 3 to 4 mtr above mean sea level. The Rann can be divided into two main regions, the Great Rann comprising the northern portion of the Kachchh mainland and the Little Rann comprising the eastern portion of the Mainland.

The Great Rann of Kachchh has been the site of the earthquake which produced surface rupture known as “Allah Bund”resulting in the upliftment of the northern part of the Rann (Macmurdo, 1823).

The Rann is geomorphologically divisible into five units – (i) Bet Zone, (ii) Linear Trench Zone, (iii) Banni Plain, (iv) Great Barren Zone, and (v) the Little Rann of Kachchh (Roy and Merh, 1981; Merh and Patel, 1988). This vast wasteland is about 4mtr above the present high water line. The Rann area mostly remains dry except in the rainy season, when it submerged in the saline water. During summer and winter, the whole area is covered with a hard salt encrustation.

2.1.3 Seismicity

The earliest earthquake recorded in Kutch dates back to 16th June 1819. Since then, over 90 earthquakes of varying intensity have struck the region, but none as severe as the most recent one.

The Kachchh region falls in zone V, an 80-100 km stretch of land bordering Kachchh covering northern parts of Saurashtra and some part of Gujarat mainland comes under zone IV, with the rest of Saurashtra and mainland falling under zone III. A very small area in the eastern part comes under zone II. The Gujarat region has witnessed many destructive earthquakes in the past. Most of these earthquakes occurred in the Kachchh region. Major earthquakes that occurred in the historical past in Kachchh are the 1668 Indus delta (MM X), 1819 Kachchh (Mw 7.9) and 1845 Lakhpat (MM VIII). In the recent times, the region has experienced the 1956 Anjar (Mw 6.0) and the 2001 Bhuj (Mw 7.6) earthquakes.

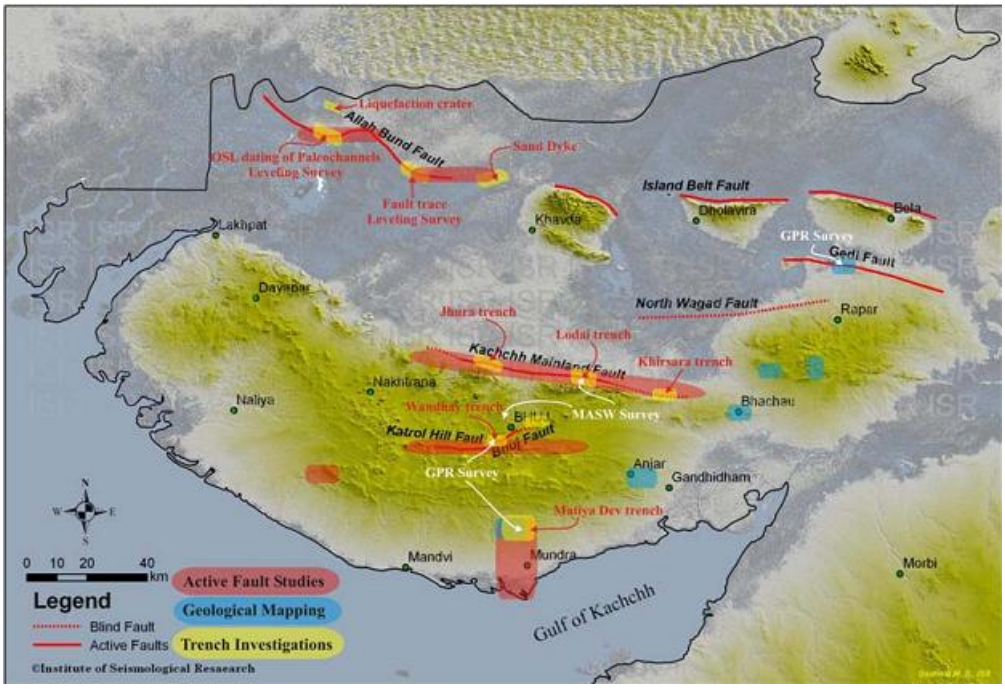


Fig. 2.3 First time ever produced active fault map of Kachchh region. Highlighted areas indicate locations of trench investigations carried out on three major faults of the area.

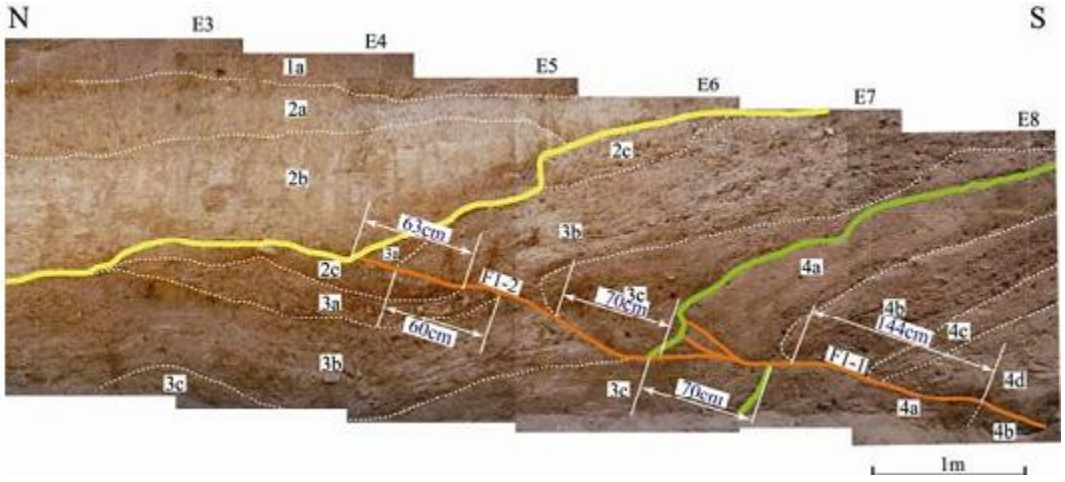


Fig. 2.4 Observed slip along the fault traces in Jhura Trench. Slip of 144 cm observed on fault F1-1 is cumulative slip for the two events.

Source: Rastogi B. K.,et. al.

Table 2.1 Seismicity Records of Kutch

Date Time	**Location Mag & Intn**	**Details**
27 Jun 1819	Bhuj	Accompanied by a loud noise like thunder
20 Jul 1828, 1 pm	Bhuj	Nearly emptied water of tumbler which was half full- east to west, violent
19 Apr 1845	Lakput	Sixty six shocks some which were destrictive
10 Jun 1888 18:30:60	Bhachau	Slight Not known Rumbling notice
15 Dec 1882 18:35:05	Bhuj, Anjar, Bachau, Lakadia	Slight, east to west rumbling notice
14 Jan 1903	Kunria area, Ms 6.0	This area is located to the north-east of Bhuj in the Rann of Kachchh
1940	Umia-Luna area, Ms 5.8 VII	This area is located to the east of Lakhpat and to the west of Bhuj
31 Oct 1940	Dhrol-Jamnagar area VI	Maximum observed intensity. This earthquake might bt the same as the previous event reported in kachchh for which no date (day an dmonth) or origin times are available
01 Ju 1890 14:40	Lakhpat, Khavda, Bhuj	Slight thundering sound

26 Jan 2001	Bhachau, Rapar, Richter scale 7.9	The most severe earthquake of the centaury, felt all over the country, lead to severe damage in kachchh, ahmedabad, Jamnaar and Surat district. More then 20000 people killed and 167000 reporte injured. Total property damage was around 500 billion rupees
28 Jan 2001 01:02:10	Suvi-chobari area Mw 5.8; -	A moderate to strong aftershock struck gujarat, at 06:32 am local time causing considerable panic in gujarat. Tremors were also felt in adjoring parts of maharashtra and rajasthan
08 Feb 2001 16:54:42	Suvi-chobari area ML, 5.1;	
05 Aug 2003 11:08:03	Suvi area, Mw 5.0, ----	Minor damage in eastern kachchh and considerable panic elsewhere gujarat, india
07 Mar 2006 10:20:46	Mouna area, Mw 5.5, ----	Causing a few injuries and minor damage to property in rapar taluka
06 Apr 2006 17:59:17	Vondh area, Mw 5.5	Minor damage to property. This is second event of this magnitude in this region since a Mw=5.5 on 7 march 2006
08 Apr 2007 21:50 16:20:13	Gandhidham area, Mb 4.2,	Felt in parts of kachchh and saurashtra

2.1.4 Climate

The Kachchh region in general falls within the arid to hyper arid belt of western India. Average rainfall in the district is between 300 to 400 mm/year. On an average there are very less, approximately 15 rainy days during the entire year that has increased to ~25 days in recent years. The day temperatures particularly in summers are generally low in the coastal region than the interior. In summers the day temperatures go above 46°C. January is the coldest month of the year when the mean daily maximum temperature is 26°C and the mean daily minimum temperature is 11°C. However, during the cold wave conditions due to the NW disturbances,

temperature goes down below the minimum level. Humidity remains high throughout

the year along the coast, generally exceeding 60% on an average.

Table 2.2 Rainfall & Temperature

Month	Max Temp (Deg. C)	Min Temp (Deg. C)	Humidity (%)	Wind Spd. Kmpd	Solar Rad. (MJ/m2/d)	Eto (mm/d)	Rainfall (mm)
Jan.	26.7	9	47	138.2	8.9	3.6	2
Feb.	29.8	12	45.5	149	9.5	4.5	1.1
Mar.	34.9	17.6	43.5	177.7	10.1	6.2	2.9
Apr.	38.7	22.1	44.5	217.2	10.8	7.9	0.7
May	39.5	25.2	53.5	330.3	11.4	9.2	1.7
Jun.	37.1	27	65	375.2	8.7	7.7	33.9
July	33.6	26.2	75	346.5	5.3	5.4	136.3
Aug.	32.5	25.2	77	307	5.4	4.9	120.7

Sept.	33.7	23.8	70.5	229.8	7.9	5.4	54.2
Oct.	35.9	20.6	52.5	141.8	9.6	5.3	15.4
Nov.	32.4	15.5	48	123.9	9.3	4.1	7.7
Dec.	28.1	10.5	49	131	8.9	3.4	1.6
Total	-	-	-	-	-	-	378.2
Avg.	33.6	19.6	55.9	222.3	8.8	5.6	-

Source: IMD

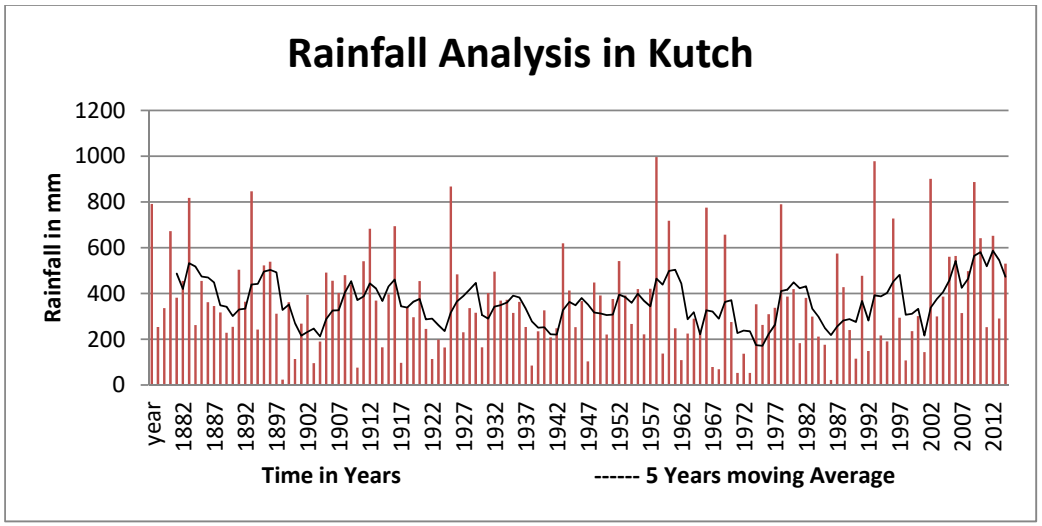


Fig. 2.5 Rainfall Analysis in Kutch

2.1.5 Rivers

There are numerous small rivers in the Kutch region. Those flowing north disappear in the Rann. While the remaining Join either the sea or the Gulf of Kutch. Some of the main rivers are Khari, Kaila, Niruna, Nara, Matiiweriwali, Rukmavati, Kankavati, Bhukhi, etc. There are dams across Khari, Kaila, Niruna etc. and the other rivers are also prepared to be harnessed by having storage schemes to tide over scarcity conditions affecting this region quite frequently.(Merh,1995)

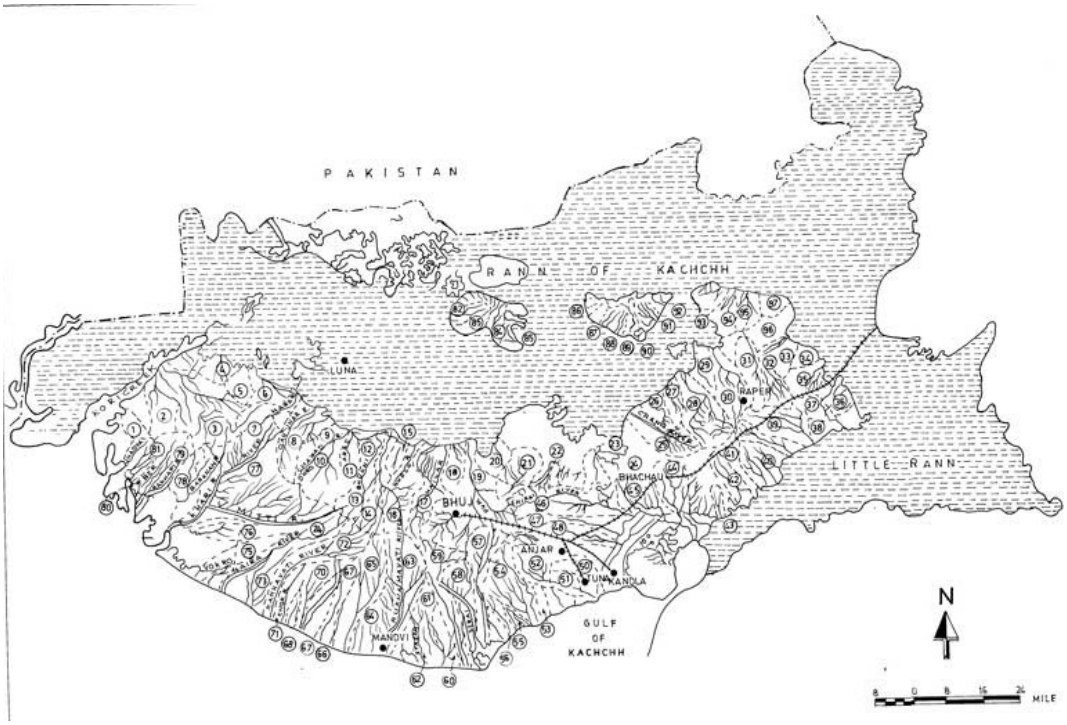


Fig. 2.6 Rivers of Kutch

(Source: guj-nwrws.gujarat.gov.in)

2.1.6 Demography

The changes in the population were analyzed from the census book of 1961, 1971, 1981, 1991, 2001 and 2011. Later on this data was compared with the data collected through the questionnaire regarding the prevailing issues of ground water in those areas.

2.1.6.1 Population Increase according to Census:

Total population of Kachchh District according to 2011 census is 2,090,313 compared to 1,583,225 of 2001.Population Growth for Kachchh District recorded in 2011 for the decade has remained 32.03 percent. Same figure for 1991-2001 decade was 25.40 percent.

2.1.7 Agriculture

Major Crops being produced in Kutch district are: (Crops Of Kutch) oilseed, bajra, jowar, cotton, pulses, date palms and brinjal (Lakhpat Nakhtrana) Among various oilseeds groundnut, castor seeds, rape (Rapar Abdasa Bhuj) and mustard seeds are the most important crops (Bhachau Anjar Mandavi). Kutch is an important producer of psyllium (Isabgul), cumin and coriander Bajra in Gandhidham Mundra. Conventional pesticide-based farming is transforming Jowar into organic cultivation of crops Pulses Around 1,000 cotton producers in Rapar taluka of ~~Cotton Wheat~~ Kutch have been granted 'organic' certification by Agrocel (an agricultural services provider) (DoA, 2006-07)

2.1.8 Economy Drivers

Kutch has emerged as a hub for chemicals, minerals, textiles, engineering, oil & Gas and Port based industries. Kutch is an ideal gateway to Asian, African and American markets as Mundra Port offers shortest landroute from any port to the vast hinterland of western and northern India Presence of Mundra, Kandla and Mandavi ports has made the district a trade and logistics hub. Industries in the district such as minerals, port-based, engineering & auto, steel pipes, cement, salt, textiles, tourism and infrastructure projects are the drivers of economy

Rich mineral wealth of the district is an attraction for investors. Many foreign companies are expected to invest on lignite, limestone and bauxite reserves. Presence of a large number of SEZs, Industrial estates and parks in several sectors such as power, port based, textile and engineering, may further augment the economic growth of the district .The tourism sector is experiencing a strong resurgence. The palaces,

wildlife, fairs and festivals of the district are witnessing a large influx of national and international tourists

2.1.9 Minerals

Kutch is rich in non – metallic minerals. As a mineral rich district of Gujarat, It has largest reserves of limestone, lignite, bauxite, china clay and silica sand in the country. The district has the highest production of Lignite and China clay in Gujarat. Panandhro city has the largest lignite reserve in Gujarat. Because of its high calorific value and low moisture content, Kutch's lignite is favourable for power generation. Yearly production of salt is 2.5 lakh tonnes and is exported to countries like Taiwan, Bangladesh and Korea.

2.1.10 Tourism: Princely Heritage and Handicrafts

Kutch boasts of a culturally rich heritage and vibrant population celebrating traditional fairs and festivals. The district accounts for 2.39 % of total tourist inflow in Gujarat during 2006-07 and has shown a growth of 219 % over the inflow of tourists during 2005-06.

2.1.10.1 Key tourist attractions

Heritage - Aina Mahal (Old Palace), Prag Mahal (New Palace), Kutch Museum, Cenotoph Complex, Indus Valley Civilisation site at Dholavira,

Pilgrimage Sites - Swaminarayan Temple, Lakhpat, Koteshwar, Bhadreshwar temple.

Wildlife - Wildlife Ass Sanctuary, Chinkara Sanctuary, Narayan Sarovar Bird Sanctuary, Kutch Desert Wildlife Sanctuary and Kutch Bustard Sanctuary

Beach/ Resorts - Mandvi Beach

Fairs & Festivals - The Kutch Desert Festival, Ravechi Fair, Navratri Fair, Nakhatrana Fair, Dhrarg Fair

Handicrafts - Block printing including the intricate 'Ajrakh' printing, terracota work, lacquered wood furniture, Bandhani, finest silver ornaments and intrinsic metallic work

2.1.11 Flora

Kachchh has practically no forest and have very few trees. The Kachchh flora is mostly characterized by thorny and non-thorny shrubs and trees. The wild tree growth is almost entirely confined to thorny like Baval, Kher etc. Several varieties of Acacia occur. The coastline exhibit swamps vegetated with mangrove forest and grasses covering dunes and sand flats. The main varieties of flora found in the study area- Avicennia officinalis (Tavar Tarvariyan), Leptadenia spartium (Khip), Casuarina Equisetifolia (Saru), Halopyrum inucronatum (Dariyai Kansdo, Dariyai Kans), Melia azadirachta (Limbdo), Acacia Arabica (baval), Cassia auriculata (Aval), Sporobolus indicus (Velari charchar), Sueda maritime (Lano, Luno), Euphorbia tirucalli (Thor Kharsani Thor, Dandalio Thor), Leucoena glauca (Laso baval, Vilayati baval) etc.

2.1.12 Wild Life

Great Indian bustard, chinkara, blackbuck, fox, hayena, jackal, hare, wolf and panther constitute the wildlife of the district . The forests have rich reserves of date palms, chikoo, guava, mango, pomegranate, ber etc.

The home of the last remaining population of khur (wild ass) in India. There is also a bird population, particularly of the large flamingos. Both are protected in 5,000 km Little Rann Sanctuary, near Dhangadhra; one has to get permission to enter from the

sanctuary superintendent's office in Dhangadhra. Black Buck-Antelope Cervicapra (Linnaeus) (Kaliar) This variety of deer is to be seen occasionally on alluvial sands along the shores of the Gulf of Kutch, while the Common Red Antelope-Gazella henetui (Chinkara) is found in the same places in much larger numbers. Three varieties of fox found in Kutch are (i) common grey Indian fox ; (ii) white with black belly and legs, and (iii) large English-like fox of a light brown colour with a white point to his brush. Known as lonkadi it is quite active. The striped hyaena though not much of a common wild animal of Kutch, one does come across it in the shrubby semi-desert areas. Panther-Panthera Pardus (Linnaeus) (Dipdo) **t**his species used to be fairly common but of late its numbers have dwindled considerably. Unlike the tiger which prefers heavy cover, the panther is able to live and thrive almost anywhere. In Kutch they have good and plentiful cover among the rocky hills, and except after killing a cow or goat, are difficult to trace. Its natural prey includes deer, monkeys, porcupines, etc.

2.1.13 Connectivity and Communication

Road : National Highway 8A connects Kutch with Ahmedabad (91 km), Vadodara (465 km), Rajkot (218 km) and Surat (632 km) Bhuj is connected with Kandla (45 km from Bhuj) by a State Highway via Anjar Connectivity with major industrial districts: Jamnagar (261 km), Surat (632 km), Bhavnagar (396 km), Valsad (699 km), Ankleshwar (359) and Mehsana (311 km).

Rail : Mumbai is connected with Bhuj by 5 broad gauge stations Mundra and Kandla ports are linked by broad gauge rail to the Delhi-Mumbai Industrial Corridor Bhuj-

Gandhidham-Kandla-Ahmedabad broad guage line provide direct connectivity from Kutch to other parts of country.

Air: Bhuj has the only operational airport in Kutch. Kandla, Mandvi Mundra air strips are under development.

Port: Mundra Port has a total length of 17.5 mts. Other ports in the district include Kandla and Mandvi Mundra Port Project has just established the longest non-government railway line, put up at a cost of INR 160 crore (USD 38 Million), between Adipur and Mundra, totalling a distance of 57 km. Mundra port is connected to Gandhidham by National Highway and a broad gauge railway line Other ports are at Kandla and Mandvi Port.

Fig. 2.7 Connectivity and Communication of Kutch

(Source: www.diet-kutch.org)

2.2 SOCIO-ECONOMIC PROFILE OF STUDY AREA

Socio-economic indicators provide an understanding of the development scenario of any area. As the study area is a focal point of urbanization and groundwater problem, this section on Socio-economic indicators provides data on gender, housing, growth, agriculture and other groundwater related indicators.

2.2.1 Demographic Status of Study Area

Demography can be important indices of socio economic development. Development depends on availability of static and dynamic natural resources of any area. Here the demographic aspects of the study area have been dealt in terms of population, male female ratio, population density and decennial growth based on District Census Handbook (1961, 1971, 1981, 1991, 2001, 2011).

The demographic status of study area point to leap change in population from years 2001 to 2011 and has recorded 61% decennial growth. Similarly analyzing the previous decades also it shows exceptionally high i.e. 44 % in 2001 and 60% in 1991 decadal growth in population. This sharp growth rate in population is attributed to on-going urbanization of the area. Partly, this increase in population can also be ascribed to industrial development of the area, attracting large number of immigrants from within and outside state for employment. This can be visualized from the Table 2.3 and Fig. 2.69 to Fig. 2.71 of Landuse and Landcover map of the study area.

Similarly, population density has increased from 848.24 persons/sqkm (2001) to 1369.81 persons/sqkm in year 2011. Population density of the study area is very high (172.01) compared to districts' density (46).

Looking to M/F ratio, it was close to equal with the ration being 1:09 in the year 1961 however it progressively reduced to 1:0.89 in year 2011. This observed M/F ratio imbalance may be due to immigration of male population from the surrounding area for employment in industrial sector. The changing trends in study area demography for future four decades have been plotted by adopting an average decennial growth of 47.7 % (based on previous census records) to determine projected population in year 2051. The projected population of study area stands at 21.14 lacs.

Table 2.3 Demographic Status of Study Area

Demographic Status of Study Area							
Census year	**Household**	**Total Population**			**M/F Ratio**	**Density per sqkm**	**Decennial Growth**
		Total	**Male**	**Female**			**In %**
1961	13993	64176	32902	31274	1: 0.95	197.92	-
1971	16729	84067	43416	40651	1: 0.94	259.27	31%
1981	22449	119110	61734	57376	1: 0.93	367.34	42%
1991	37266	190858	99072	91786	1: 0.93	588.61	60%
2001	55327	275043	143099	130756	1: 0.91	848.24	44%
2011	97173	444162	234848	209314	1: 0.89	1369.81	61%

Source: Population Census 2011

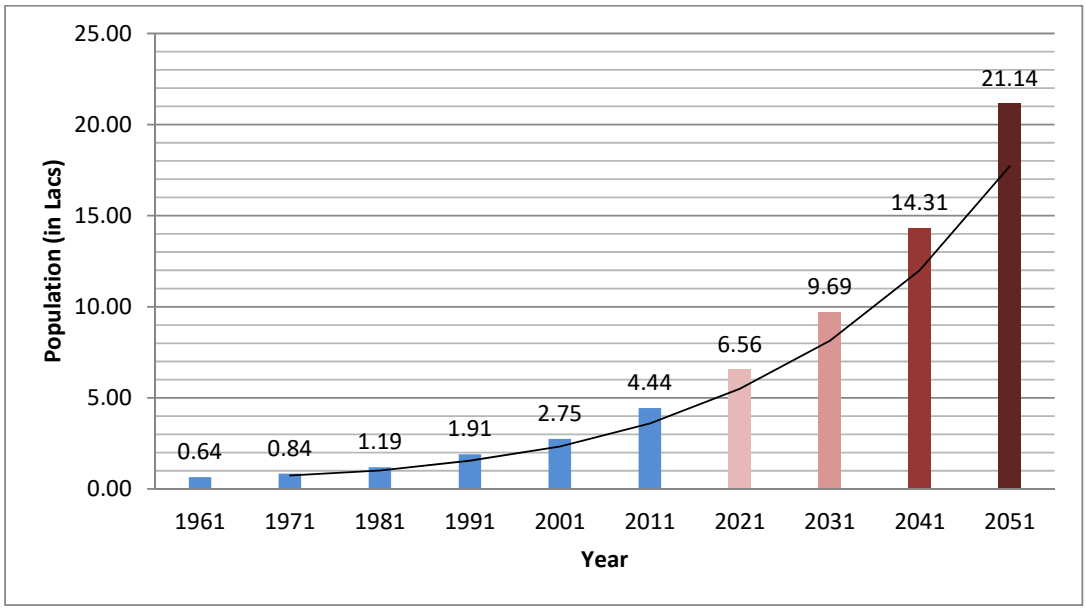


Fig. 2.8 Population Growth in Study Area

2.2.2 Socio- Demographic Status of study area

On the socio-economic status front, study area is dominated by general caste population which constitutes almost 82.90 % of total population. The schedule caste and schedule tribe population is 15.65 % and 1.45 % of total population respectively. M/F ratio more or less remained constant although, female population is marginally less.

Table 2.4 Socio- Demographic Status of study area

census year	Category	Total Population			M/F Ratio	% of total Population
		Total	Male	Female		
2011	SC	69515	36068	33447	0.93	15.65
2011	ST	6453	3385	3068	0.91	1.45
2011	Open	368194	195395	172799	0.88	82.90
2011	Total	444162	234848	209314	0.89	100.00

Source: Population Census 2011

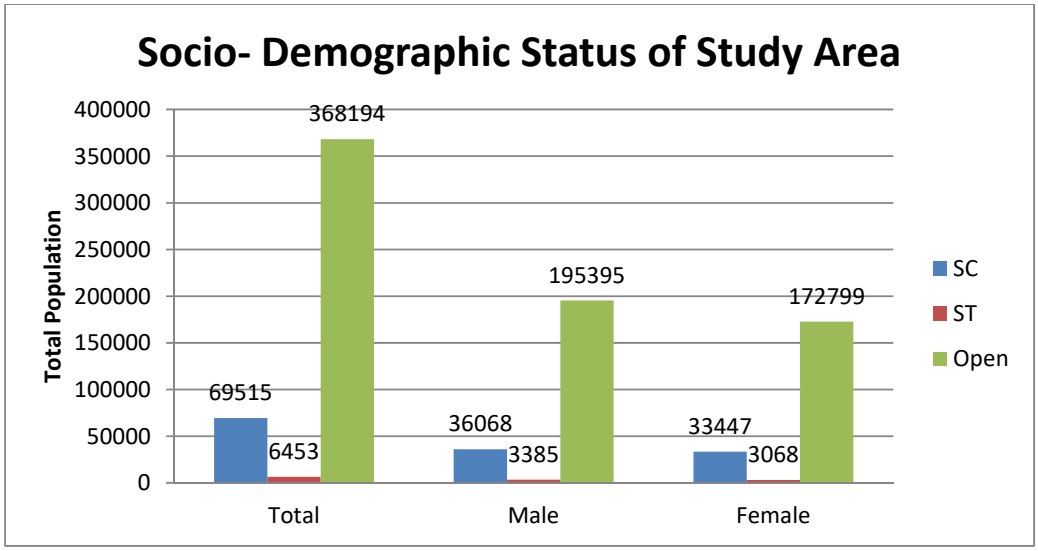


Fig. 2.9 Socio Demographic Status of Study Area

2.2.3 Working Population

As per Census Handbook (1961-2011) total working population of the study area is 35.2 % of total population. Looking to past four decades census data, there is very high growth in working population from 1971 to 2011 which may be due to increased employment opportunities in industrial sector or increase in the agriculture sector. However this number looks even higher with respect to the population increase of 61% in 2011 from previous decade.

Table 2.5 (a) Changes in Working Population within study area (Year 1961 to 2011)

Comparative Analysis of Working Population Growth						
Particulars	Year 1961		Year 1971		Year 1981	
	SDA	%	SDA	%	SDA	%
Total Population	64176	100	84067	100	119110	100
Decennial Growth	-	-	19891	31.0	35043	41.7
Total Workers	20241	31.5	23850	28.4	36125	30.3
Total Non Workers	43935	68.5	60217	71.6	82985	69.7

Table 2.5 (b) Changes in Working Population within study area (Year 1961 to 2011)

Comparative Analysis of Working Population Growth						
Particulars	Year 1991		Year 2001		Year 2011	
	SDA	%	SDA	%	SDA	%
Total Population	191025	100	275043	100	444162	100
Decennial Growth	71915	60.4	84018	44.0	169119	61.5
Total Workers	59428	31.1	87761	31.9	156554	35.2
Total Non Workers	131597	68.9	187282	68.1	287608	64.8

(Source: Population Census 2011)

SDA = Study Area

Working population can be bifurcated as main and marginal worker categories and it can be further classified as cultivators, agriculture labors, house hold industries and other works. Over the period of last five decades, population of main workers in the study area has decreased from 97.97 % (1991) to 93.59 % (2011). On other hand there is an increase in marginal working population from 2.02 % (1991) to 6.40 % (2011). From this it can be inferred that from 1991 to 2011 there has been a rise in total working population whereas percentage of main working population has decreased and population of marginal workers has increased, this indicates that part of workers may have been demoted from main working category to marginal workers. The period between 1961 and 2011, population of cultivators and agriculture labors has

significantly decreased whereas there has been a noticeable increase in house hold industry and other work population. This indicates that people may have migrated from traditional occupations to some local growing occupations.

Table 2.6 Demographic Status of Worker Class in study area

Particulars	1961	1971	1981	1991	2001	2011
Total Main Working Population	20241	23949	32016 (95.62%)	57788 (97.97%)	81821 (94.5%)	146533 (93.59%)
Main Cultivator Population	3362	2751	2452	2605	2137	2344
Main Agriculture Labor Population	1423	2957	2514	4577	2469	4188
Percentage of Total Main cultivator + Agriculture Labour population	23.64 %	23.83%	14.83%	12.176%	5.3204%	4.1724%
Main Household Working Population	892	241	360	531	1351	2053
Main Other Work Population	14560	17901	29331	50075	75864	137948
Percentage of Total Main household and Other work population	76.34%	75.75%	88.67%	85.798%	89.191%	89.427%
Total Marginal Working			1468 (4.38%)	1195 (2.02%)	4752 (5.49%)	10021 (6.4%)

Population						
Marginal Cultivator Population					142	283
Marginal Agriculture Labor Population					419	952
Marginal Household Working Population					1013	395
Marginal Other Work Population					3178	8391

Source: Population Census 2011

2.2.4 Village Level Demographic Analysis of Study Area

The changes in the population were analyzed from the census book of 1971, 1981, 1991, 2001 and 2011. Later on this data was compared with the data collected through the questionnaire regarding the prevailing issues of ground water in those areas.

Methodology:

1. Procurement of the Census data related to Population, Amenities and Agriculture from the Census department, Gandhinagar and government websites.

2. Identifying the study area and digitization of Village Boundary Maps from Census book.
3. Georeferencing the Village maps based on Landmarks identified from the satellite images and field GPS data.
4. Attachment of the village wise Census data to Village census maps.
5. Preparation of Population Census Maps for better visual analysis.
6. Generation of Tables for Demographic, Socio-Demographic, Working Population, Agriculture and changes in wells and tubewells based on census data.
7. Generation of Questionnaire for local level awareness, usages and benefits of recharge structures in the study area.
8. Preparation of Landuse map based on the satellite images for the years 1990, 2000 and 2015 for identifying the changes in the landuse..
9. Identifying the Impact based on the census data on groundwater regime by correlating the changes in population, agriculture area, sources of irrigation, changes in the development of well land tubewells over the years with changes in the agriculture area, settlement, industry and other features identified from Satellite images.

Table 2.7 Village level population in the study area from 1971 to 2011

Villages	Population					Percentage (%) Rise
	1971	1981	1991	2001	2011	2001 to 2011
Chubdak	185	187	267	336	432	28.57%
Gandher	238	263	321	479	537	12.11%
Ratatalav	28	66	32	37	76	105.41%
Ningal	904	1206	1501	1802	2162	19.98%
Sapeda	707	997	1297	1849	2528	36.72%
Maringana	89	377	215	600	460	-23.33%
Varsamedi	1369	1516	1763	2143	10654	397.15%
Mithi Rohar	1397	3211	4960	8409	13712	63.06%
Anjar (M)	27302	33623	51209	68343	87183	27.57%
Meghpar (Kumbhardi)	150	253	652	1564	5123	227.56%
Gandhidham (M)	38824	61415	10458	151693	247992	63.48%
Bhadroi	114	232	600	1201	950	-20.90%
Khambhara	885	1098	1466	1970	2629	33.45%
Sinugra	1372	1593	2005	2292	3077	34.25%
Nagalpar Moti	2848	2507	2929	3918	5421	38.36%
Nagalpar Nani	513	523	675	793	1069	34.80%
Galpadar	2043	2775	3518	5538	13155	137.54%
Meghpar (Borichi)	202	257	550	1320	12637	857.35%
Vidi	1002	1146	1522	2184	3030	38.74%
Kidana	1264	2105	4699	9285	15669	68.76%
Antarjal	1409	1911	3305	6036	11256	86.48%
Shinay	1818	2102	2908	3197	4345	35.91%

Source: Agricultural Census 2011

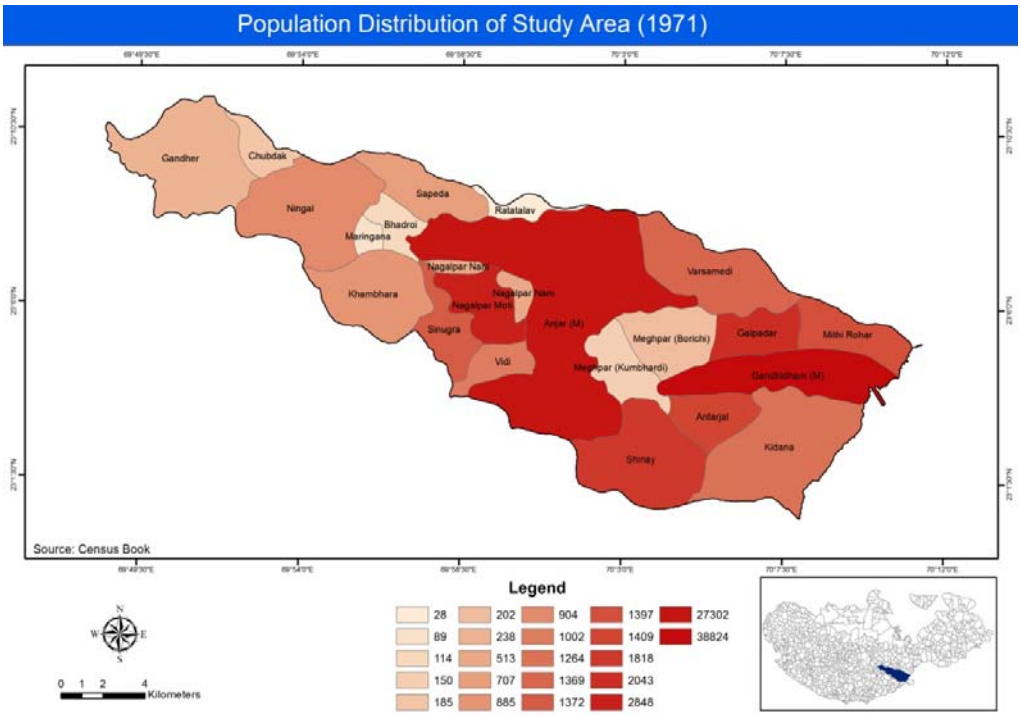


Fig. 2.10 (a) Population Distribution of Study Area (1971)

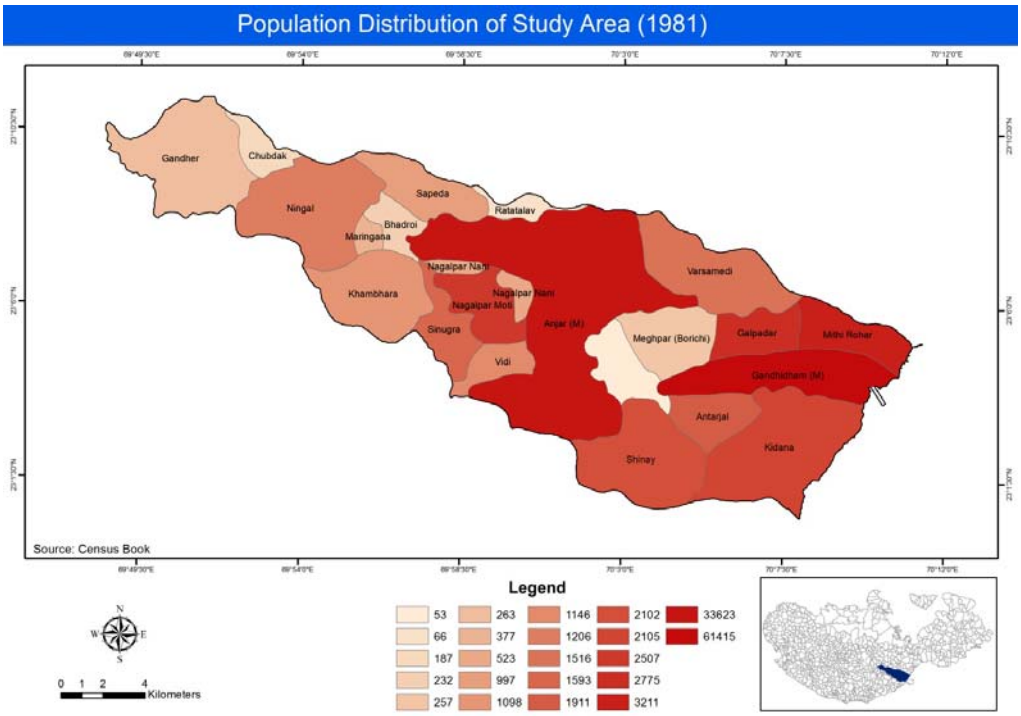


Fig. 2.10 (b) Population Distribution in Study Area (1981)

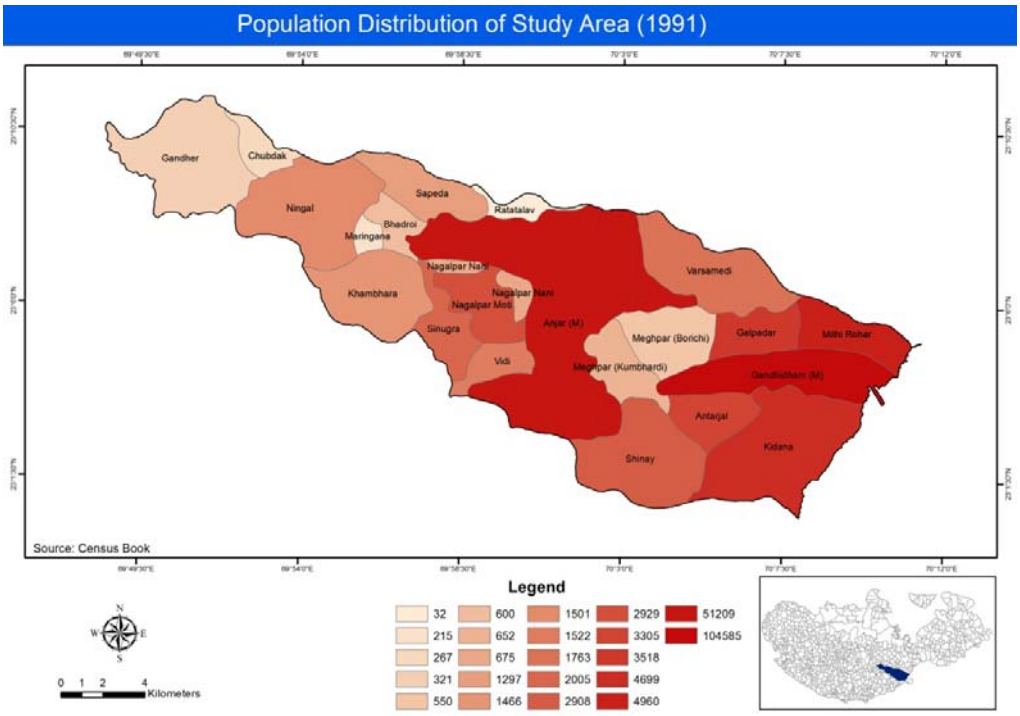


Fig. 2.10 (c) Population Distribution in Study Area (1991)

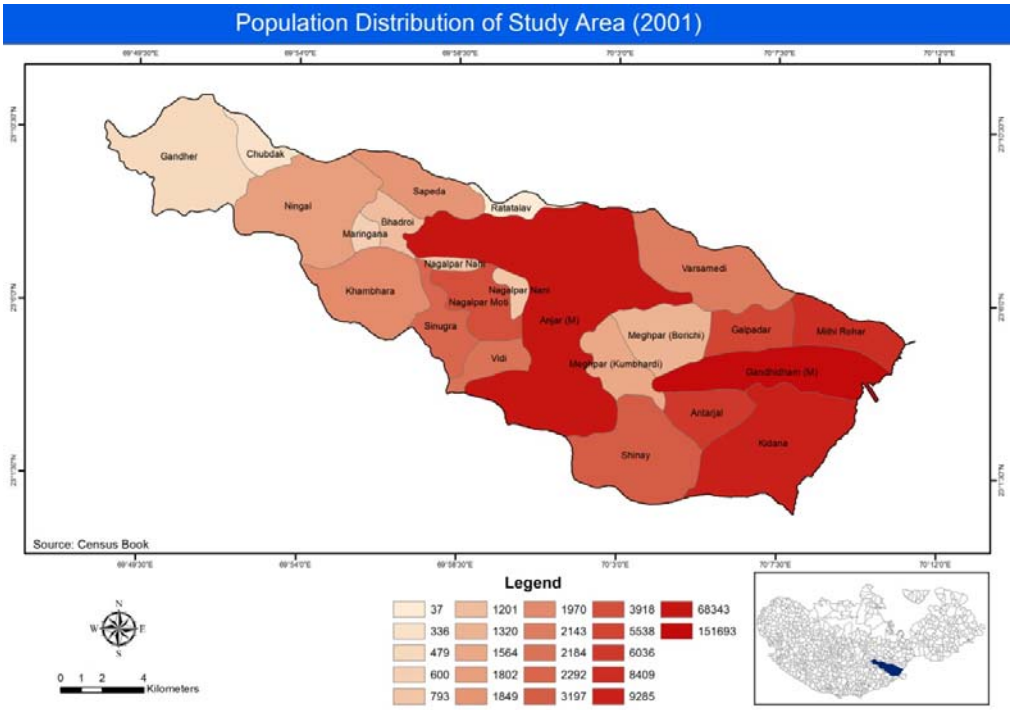


Fig. 2.10 (d) Population Distribution in Study Area (2001)

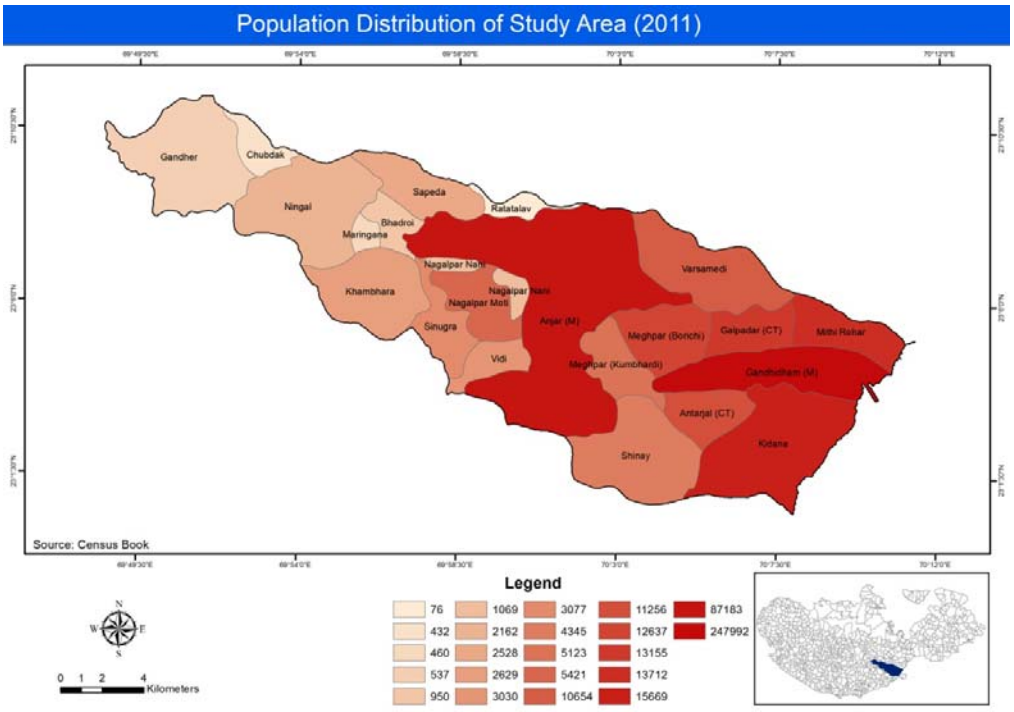


Fig. 2.10 (e) Population Distribution in Study Area (2011)

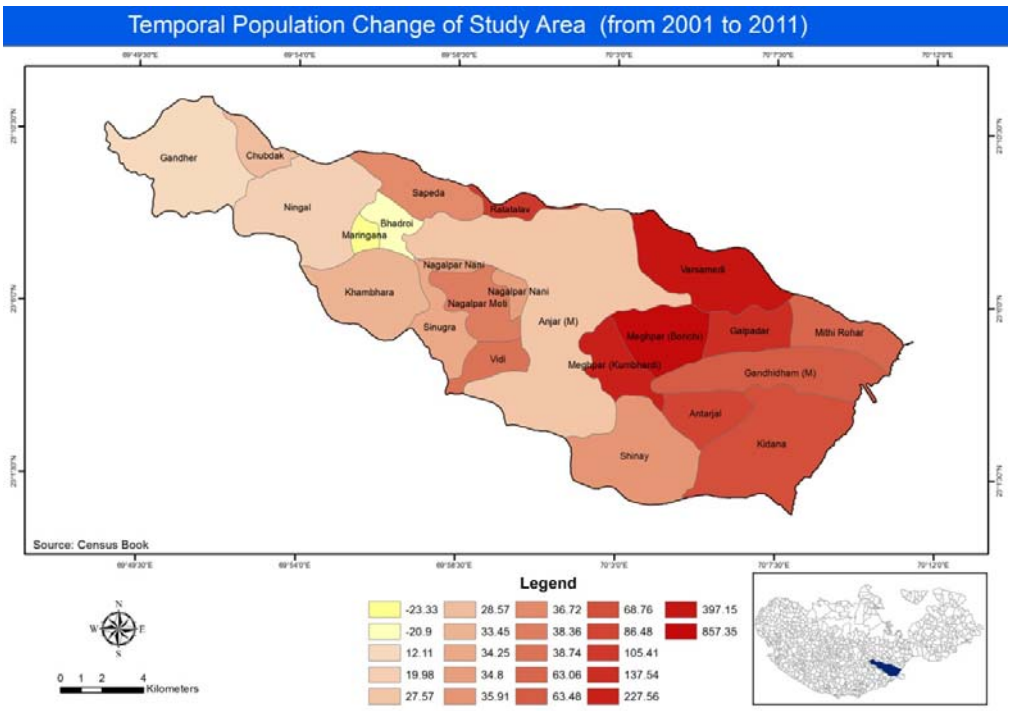


Fig. 2.11 Temporal Population Change in Study Area (2001 to 2011)

From the above data based on census book it can be inferred that atleast two villages i.e. Malingna and Bhadroi of Anjar Taluka shows decreasing trend in the population from 2001 to 2011. These can be directly related to the scarcity of water prevailing over there. While other villages like Gandher and Ningal shows less then 20% increase in population compared to other villages, if compared to the water quality issues present over there, the reason of low poplation growth can be easily understood. Hence from this analysis we can understand the impact of groundwater on the residents of the villages.

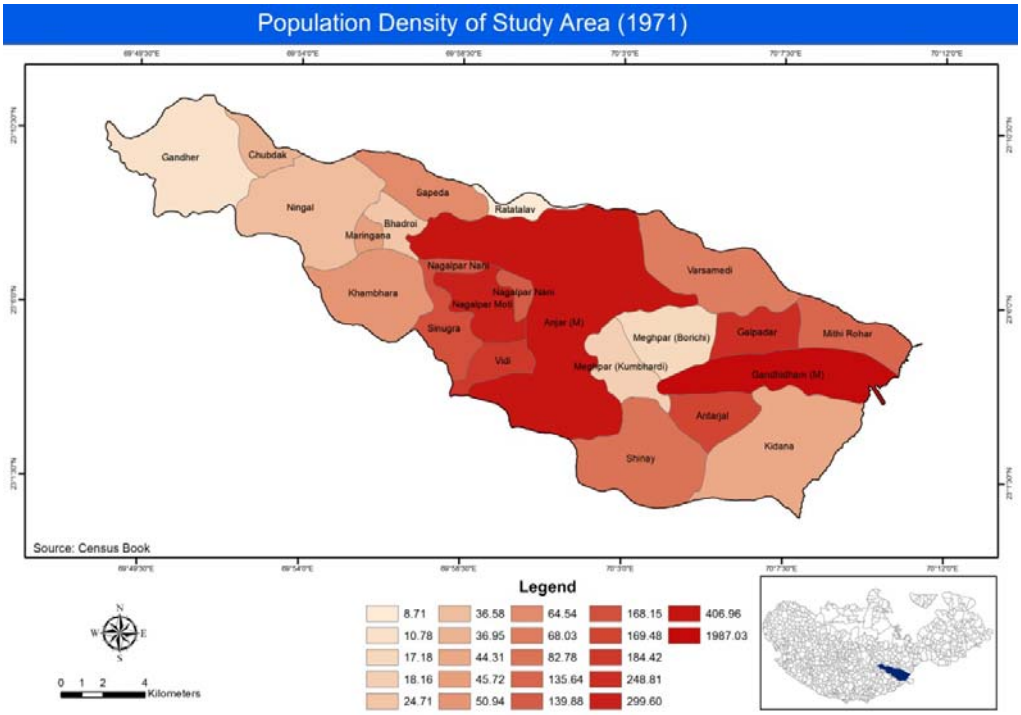


Fig. 2.12 (a) Population Density of Study Area (1971)

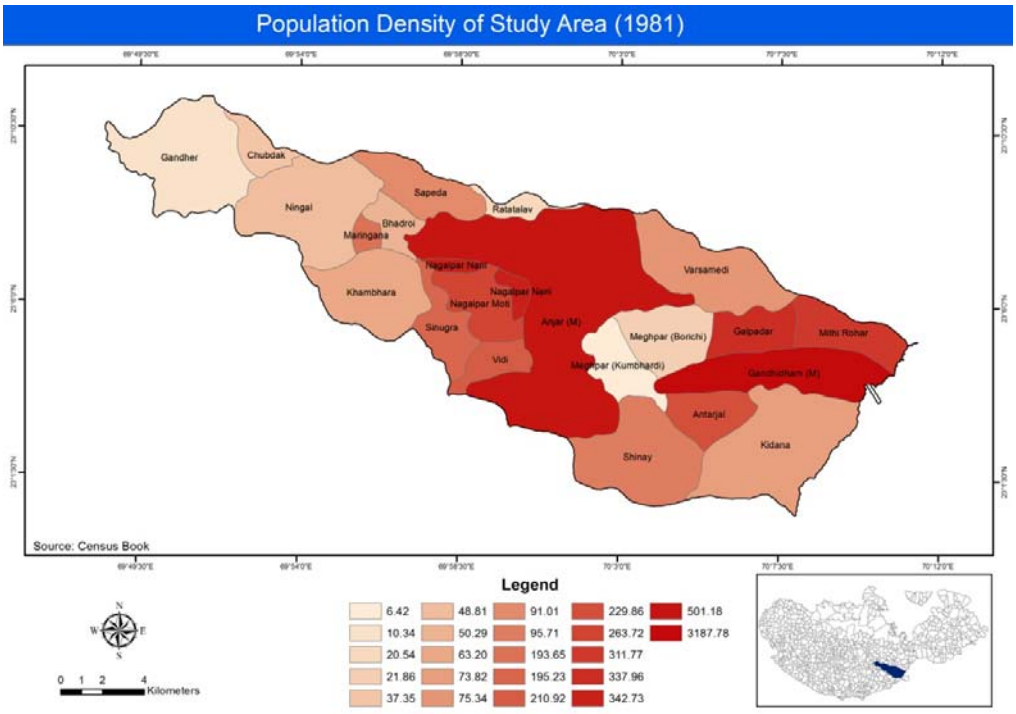


Fig. 2.12 (b) Population Density of Study Area (1981)

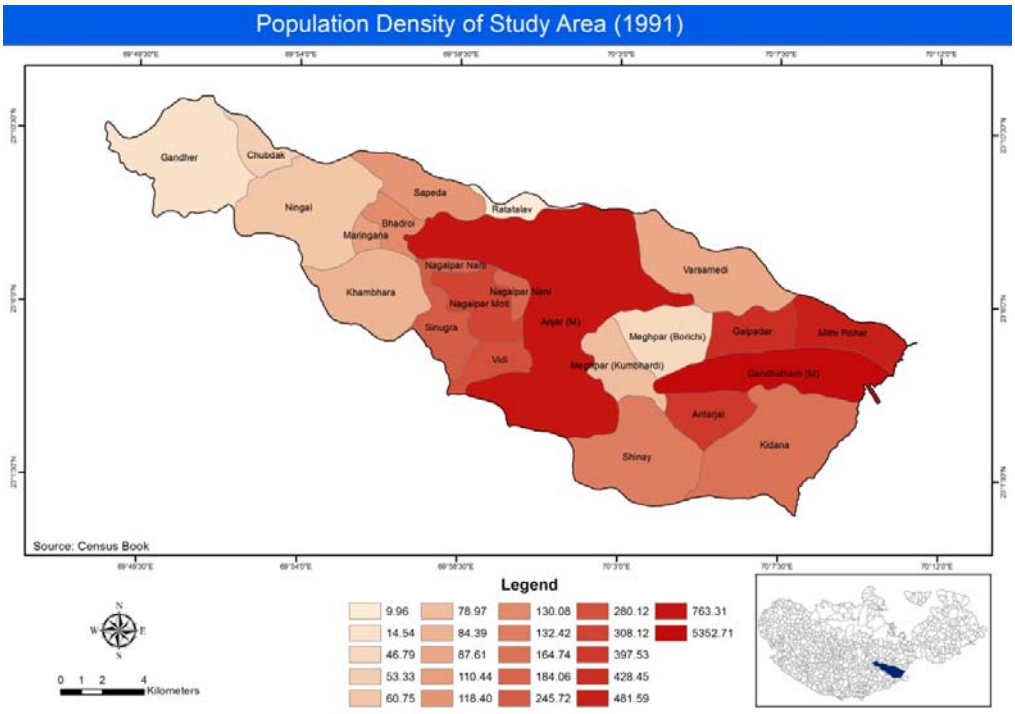


Fig. 2.12 (c) Population Density of Study Area (1991)

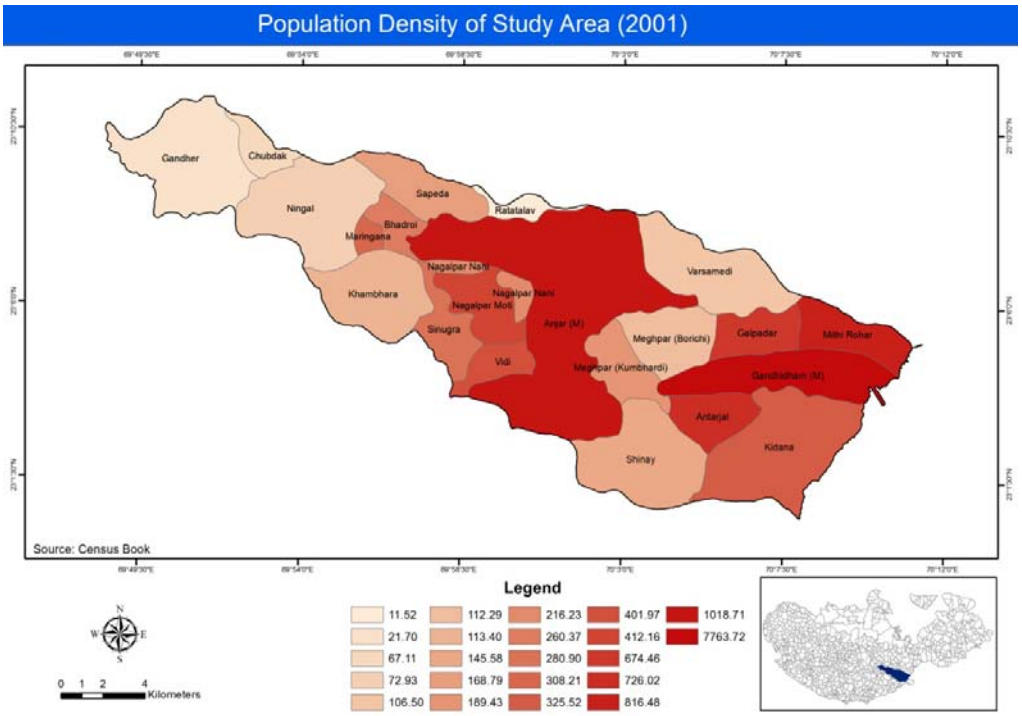


Fig. 2.12 (d) Population Density of Study Area (2001)

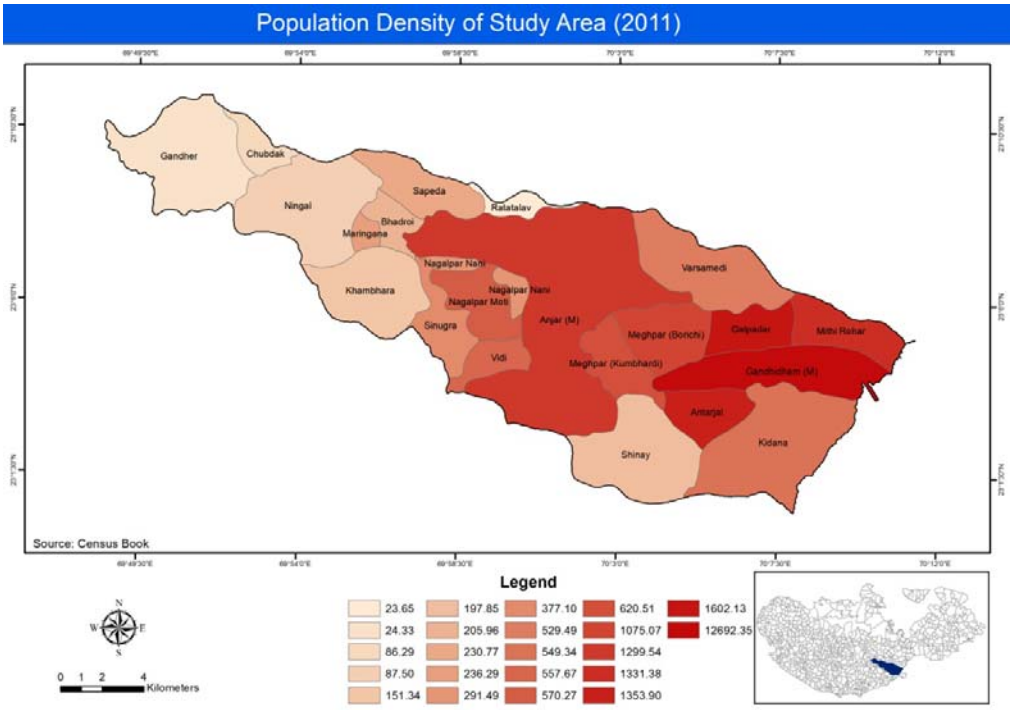


Fig. 2.12 (e) Population Density of Study Area (2011)

2.2.5 Category Wise Changes in population for the year 1991, 2001 to 2011

The primary goal of this study is to understand the growth pattern of the different classes of the population within the study area by analyzing the data of the census book along with the taluka wise growth pattern of the agricultural area based on the agriculture census which is available online.

Graphs that are generated based on the Census book are as below

Table 2.8 Village Code of Study Area

Village Code	TNAME	VILLAGE NAME
1	ANJAR	Anjar (M)
2	GANDHIDHAM	Antarjal
3	ANJAR	Bhadroi
4	BHUJ	Chubdak
5	GANDHIDHAM	Galpadar
6	BHUJ	Gandher
7	GANDHIDHAM	Gandhidham (M)
8	ANJAR	Khambhara
9	GANDHIDHAM	Kidana
10	ANJAR	Maringana
11	ANJAR	Meghpar (Borichi)
12	ANJAR	Meghpar (Kumbhardi)
13	GANDHIDHAM	Mithi Rohar
14	ANJAR	Nagalpar Moti
15	ANJAR	Nagalpar Nani
16	ANJAR	Ningal
17	ANJAR	Ratatalav
18	BHUJ	Saiyedpar
19	ANJAR	Sapeda
20	GANDHIDHAM	Shinay
21	ANJAR	Sinugra
22	ANJAR	Varsamedi
23	ANJAR	Vidi

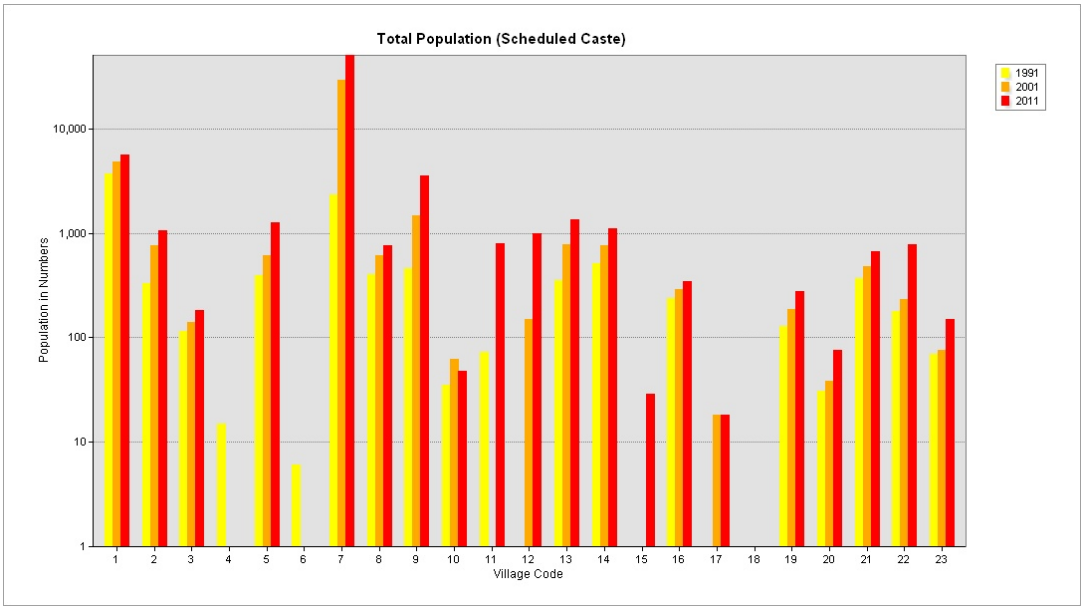


Fig. 2.13 Total Population (SC)

As seen from the graph it can be seen that there is an increase in the population of SC population in most of the villages except (4, 6, 18) Gandher, Chubdak and saiyedpar of Bhuj villages.

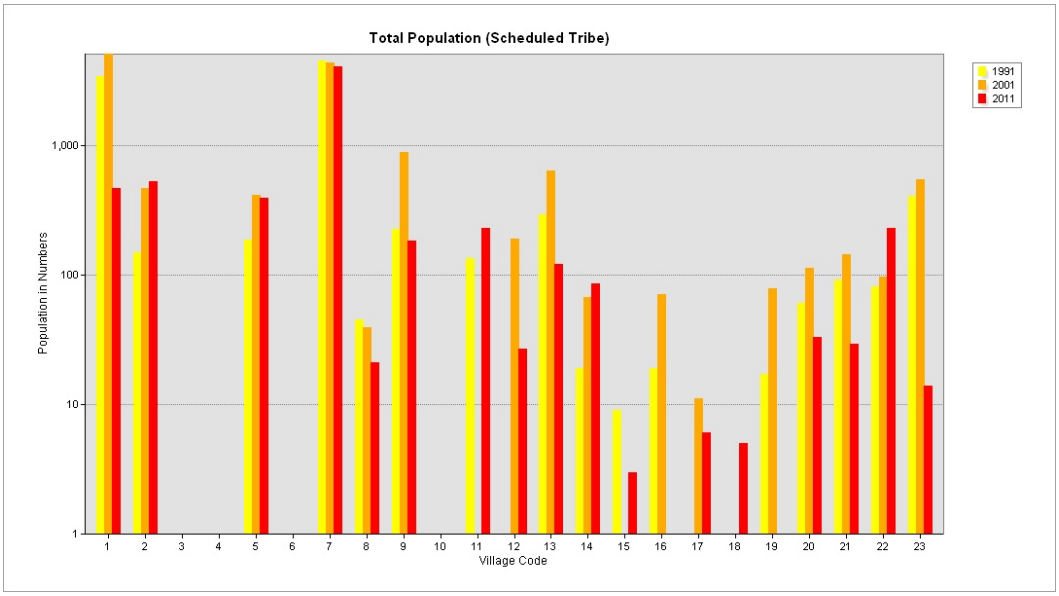


Fig. 2.14 Total Population (ST)

As seen from the graph it can be seen that there is decrease in the population of ST populations in most of the villages except (2, 11, 14, 22) Meghpar (Borichi), Nagalpar Moti, Varsamedi of Anjar and Anterjal of Gandhidham.

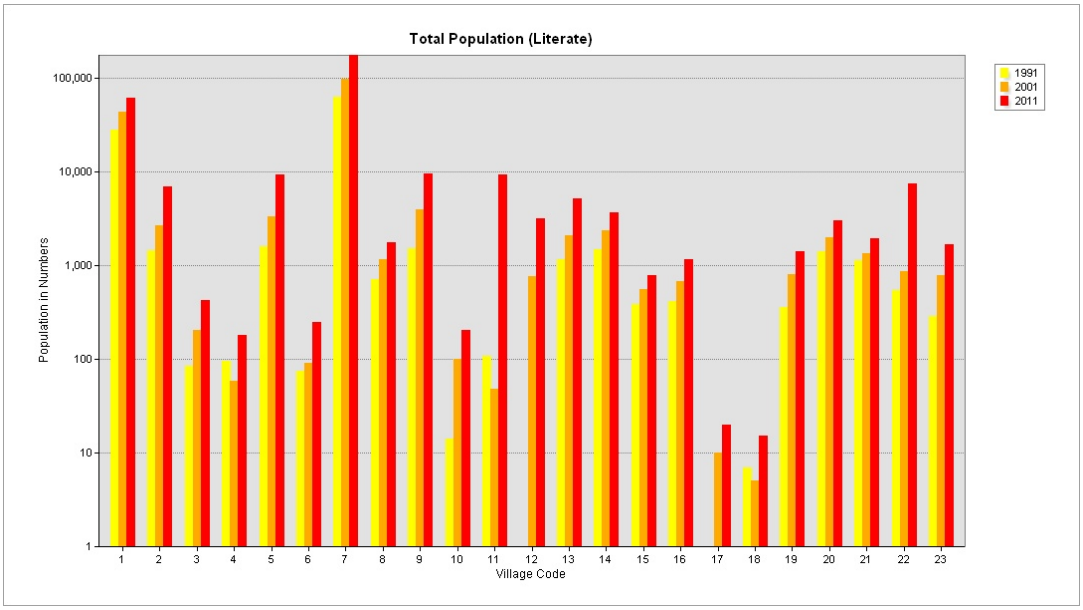


Fig. 2.15 Total Population (Literate)

As seen from the graph it can be seen that there is increase in population of Literate population over the period of time from 1991 to 2011 in almost all the villages within the study area.

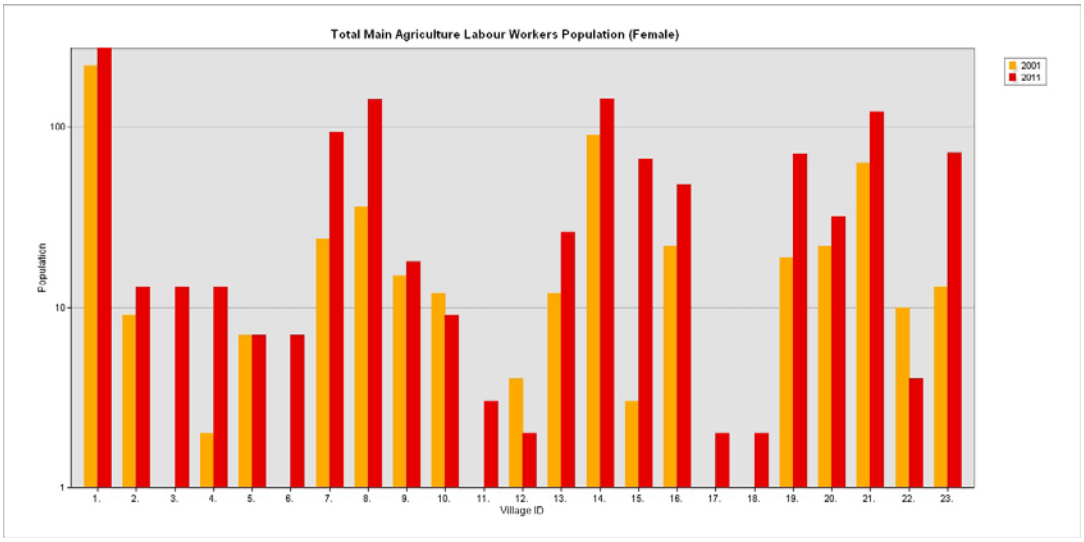


Fig. 2.16 Main Agriculture Labour Worker Population (Female)

As seen from the graph it can be seen that there is an increase in population of Main agriculture Labour worker population (Female) in most of the villages except (10, 12, 22) Malingna, Meghpar Khumberdi and varsamedi of Anjar.

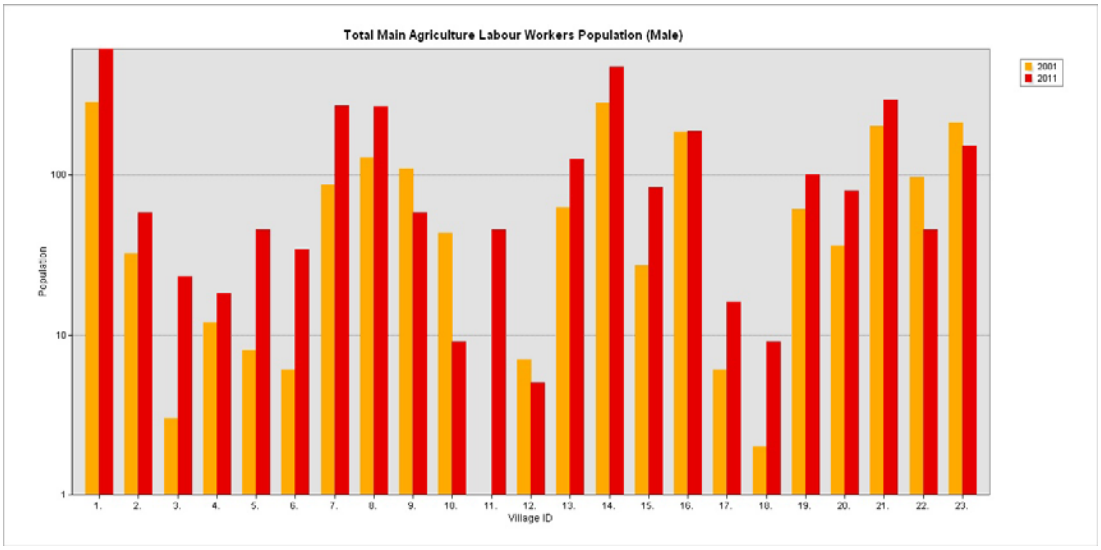


Fig. 2.17 Main Agriculture Labour Worker Population (Male)

As seen from the graph it is interpretative that there is an increase in population of Main Agriculture population (Male) in most of the villages within the study area except (9, 10, 12, 22, 23) i.e. Malingna, Meghpar khumberdi, varsamedi, Vidi of Anjar and Kidana of Gandhidham.

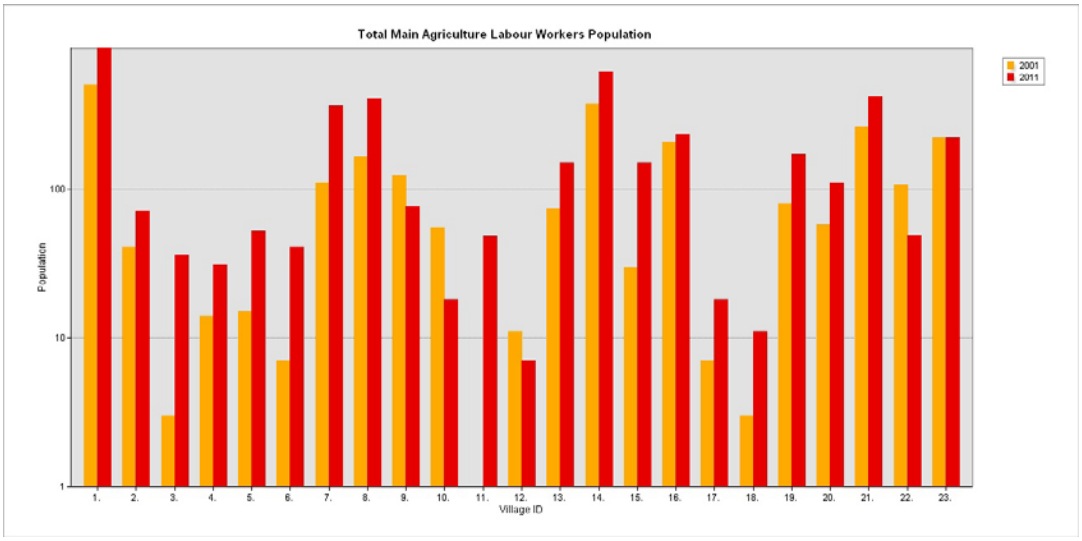


Fig. 2.18Main Agriculture Labour Worker Population

As seen from the graph it can be said that there is an increase in population of Main Agriculture Labour worker population (Total) in most of the villages within the study area except (9, 10, 12, 22) Malingna, Meghpar khumberdi, varsamedi of Anjar and Kidana of Gandhidham.

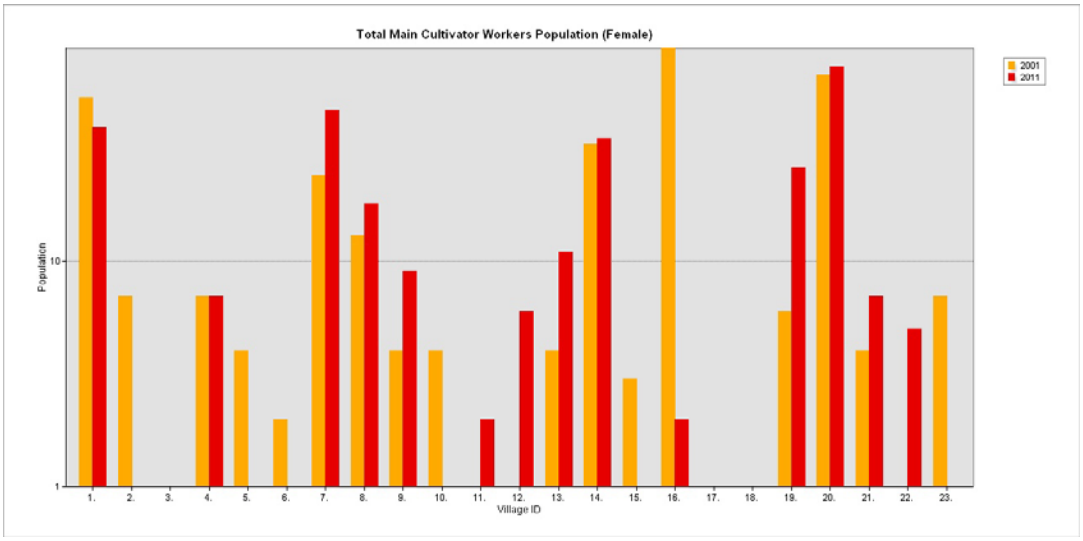


Fig. 2.19 Main Cultivator Workers (Female)

As seen from the graph it can be said that there is an increase in population of main cultivator workers (Female) in most of the villages except (2, 5, 6, 10, 15, 16, 23) Antarjal, Galpadar of Gandhidham, Gandher of Bhuj and Malingna, Nagalpar Nani, Ningal and Vidi of Anjar taluka.

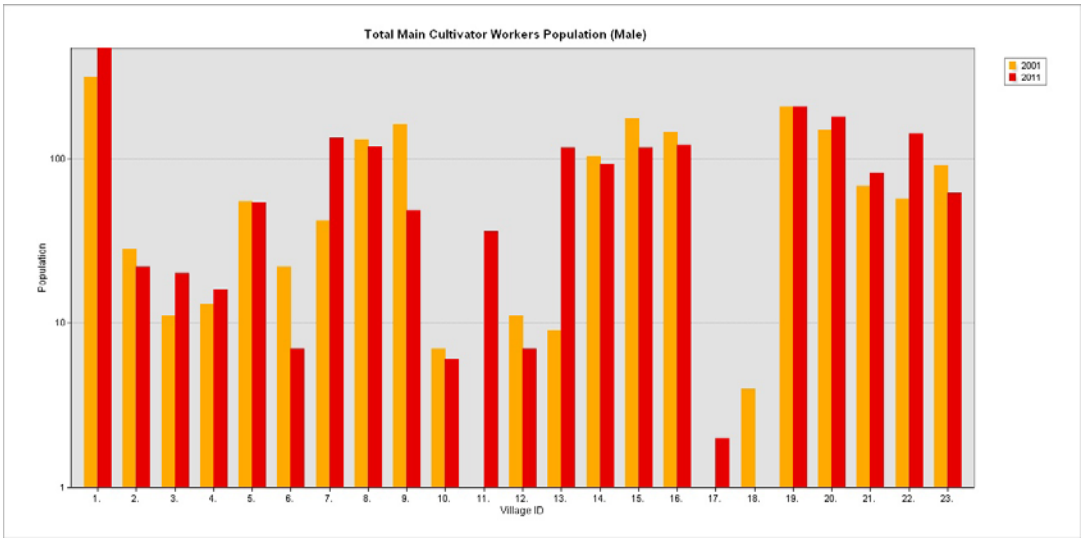


Fig. 2.20 Main Cultivator Workers (Male)

As seen from the graph it can be said that there is an increase in population of main cultivator workers (Male) in more than half of the villages except (2, 6, 8, 9, 10, 12, 14, 15, 16, 18, 23) Antarjal, Galpadar, Kidana of Gandhidham, Gandher, saiyedpar of Bhuj and khambra, Malingna, Meghpar khumbardi, Nagalpar Moti, Nagalpar Nani, Ningal and Vidi of Anjar taluka.

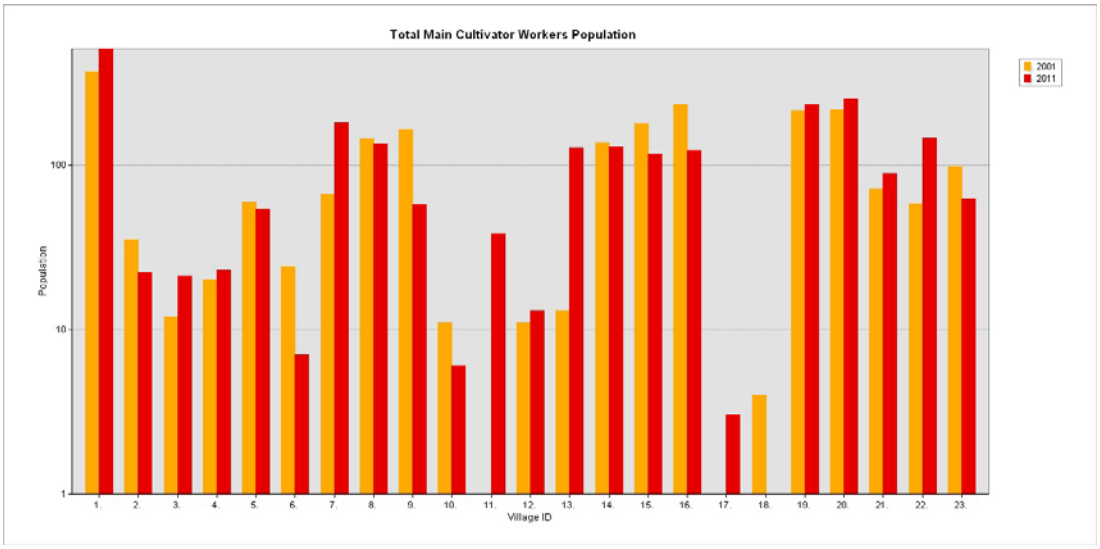


Fig. 2.21 Total Main Cultivator Workers Population

As seen from the graph it can be said that there is an increase in population of main cultivator workers (Total) in more than half of the villages except (2, 5, 6, 8, 9, 10, 14, 15, 16, 18, 23) Antarjal, Galpadar, Kidana of Gandhidham, Gandher, saiyedpar of Bhuj and khambra, Malingna, Nagalpar Moti, Nagalpar Nani, Ningal and Vidi of Anjar taluka.

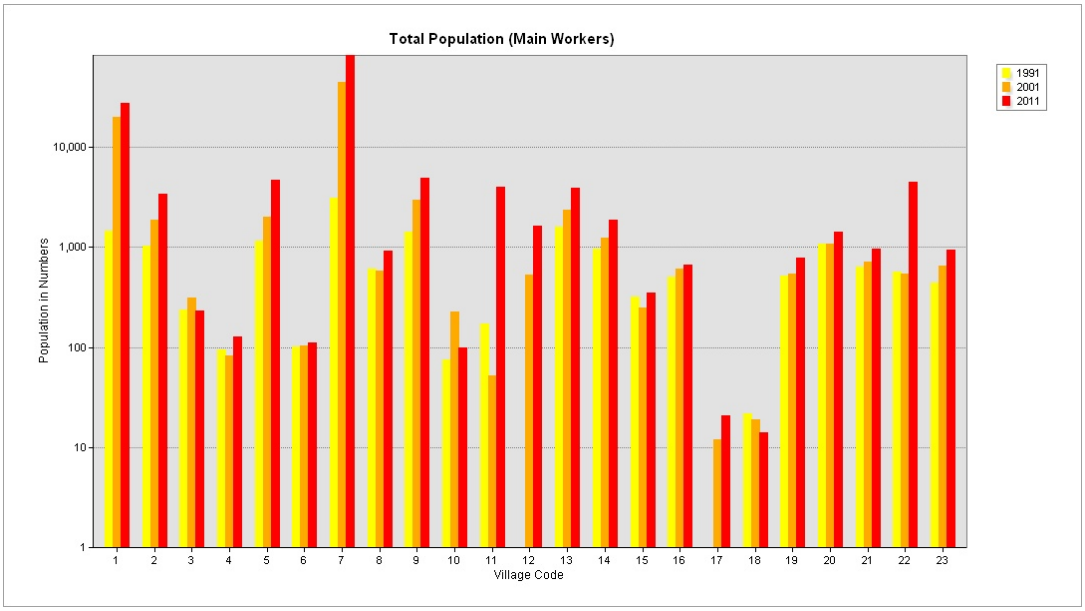


Fig. 2.22 Total Population of Main Workers

As seen from the graph it can be said that there is an increase in the total population of main workers within the study area in most of the villages except (3, 10, 18) i.e. Bhadroi and Malingna of Anjar and saiyedpar of Bhuj.

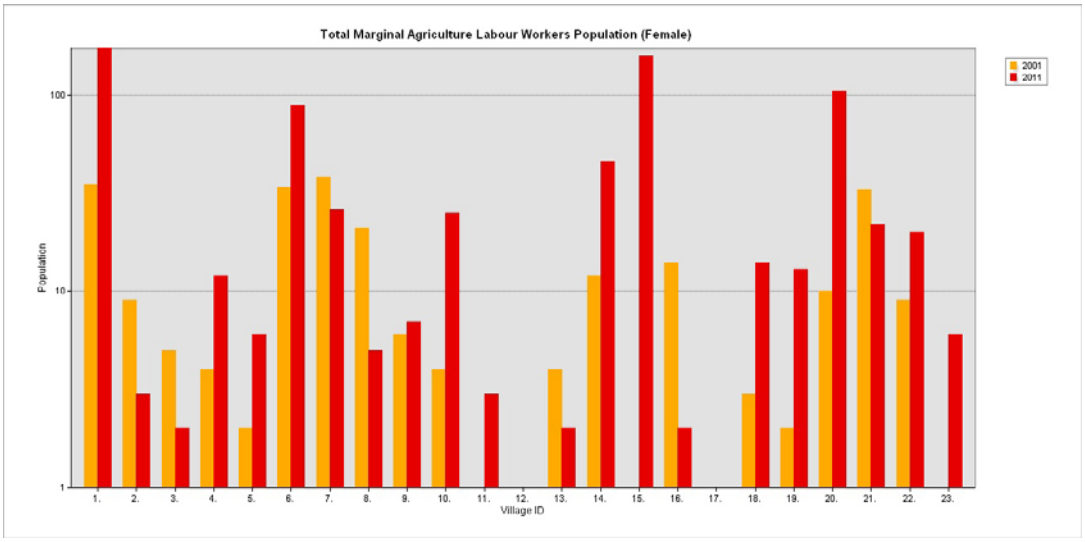


Fig. 2.23 Marginal Agriculture Labour workers (Female)

As seen from the graph it can be seen that there is an increase in the population of Marginal Agriculture workers (Female) in most of the villages except (2, 3, 7, 8, 13, 21) i.e. Antarjal, Mithi rohar, Gandhidham (M) of Gandhidham, bharoi, khambra, Sinugra of Anjar.

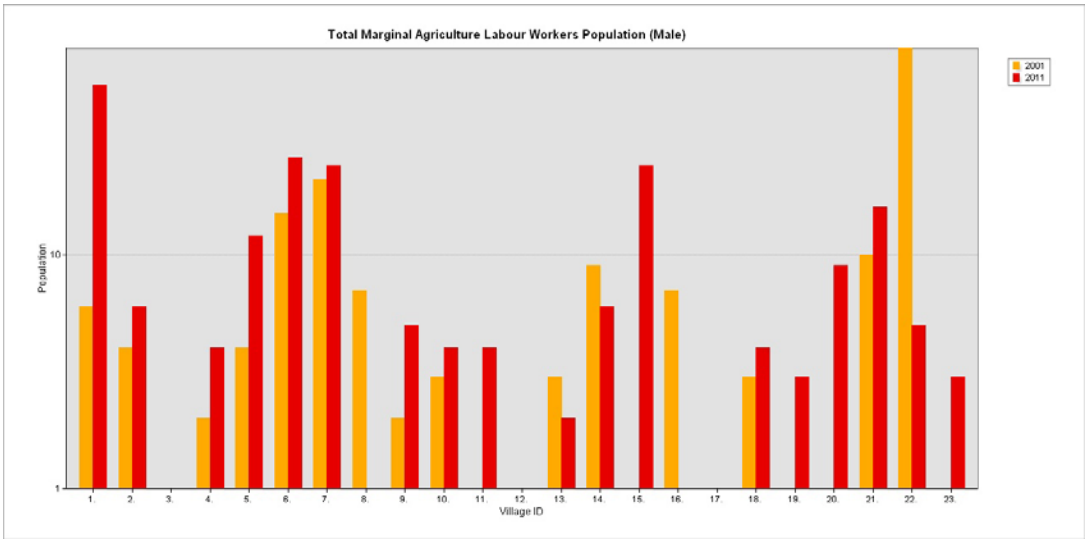


Fig. 2.24 Marginal Agriculture labour Workers Population (Male)

As seen from the graph it can be said that there is an increase in population of Marginal Agriculture labour (Male) in most of the villages except (8, 13, 16, 22) khambra, Ningal, varsamedi of Anjar and mithi rohar of Gandhidham.

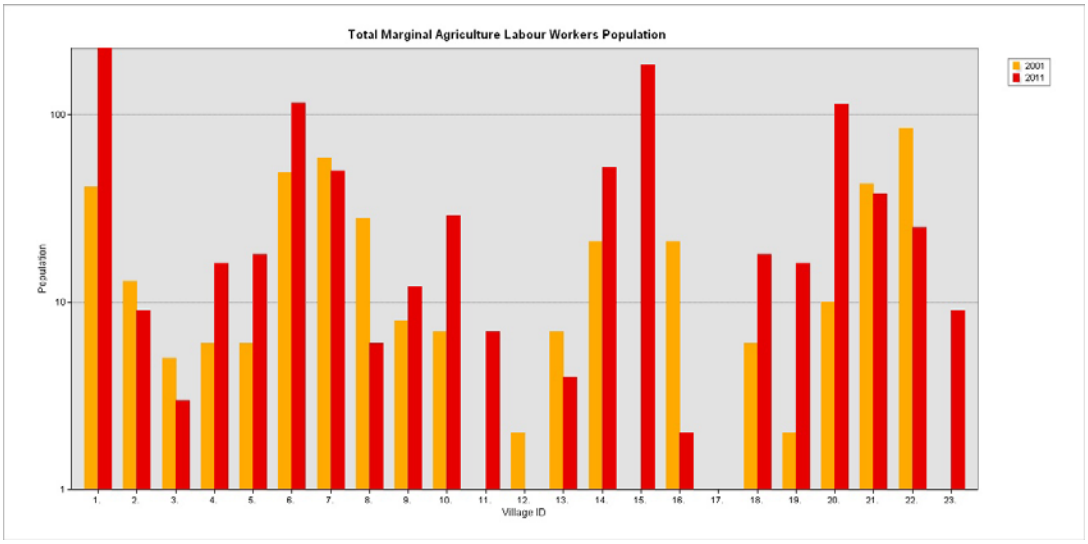


Fig. 2.25 Marginal Agriculture Labour Workers (Total)

As seen from the graph it can be said that there is an increase in the population of Marginal Agriculture Labours (Total) in most of the villages except (2, 3, 7, 8, 12, 13, 16, 21, 22) i.e.) khambhra, Ningal, Meghpar khumberdi, Ningal, Sinugra, Bhadroi, varsamedi of Anjar and Antarjal, Gandhidham (m), mithi rohar of Gandhidham.

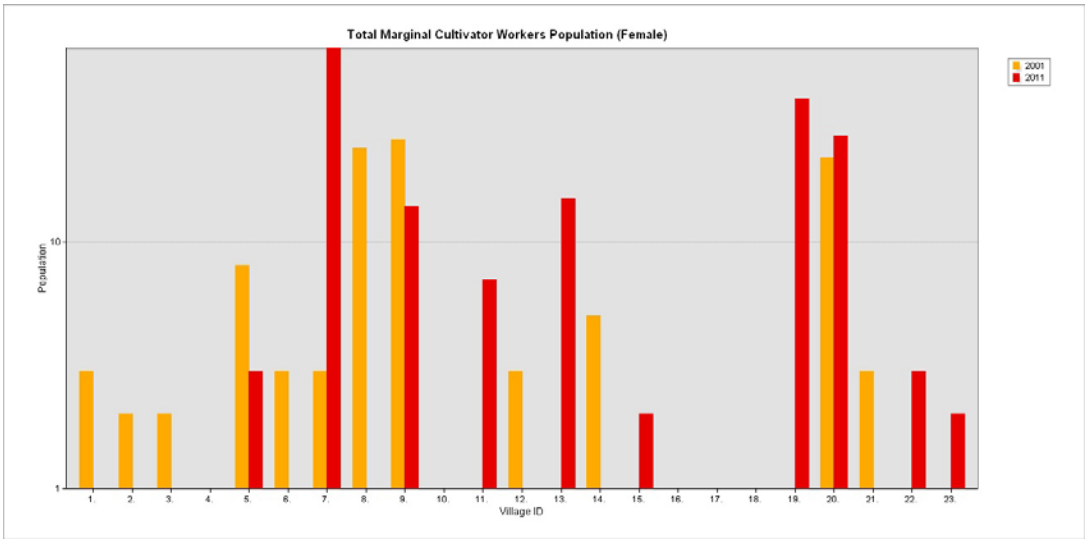


Fig. 2.26 Marginal Cultivator Population (Female)

As seen from the graph it can be said that there is an increase in the population of the Marginal cultivator population (Female) in two villages (7, 20) Gandhidham, Shinay of Gandhidham and where there were no female cultivator earlier, a new interest has been seen in the female of villages like (11, 13, 15, 19, 22, 23) Meghpar Borichi, Nagalpar Nani, Sapeda, varsamedi and Vidi of Anjar and mithi rohar of Gandhidham.

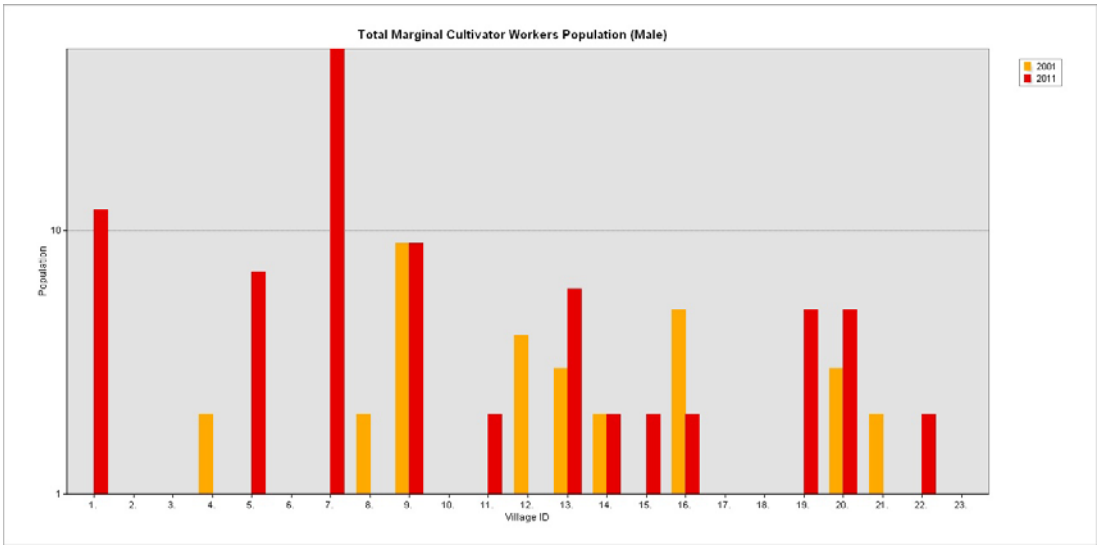


Fig. 2.27 Marginal Cultivator Workers (Male)

As seen from the graph it can be said that there is an increase in the population of the marginal cultivator workers (male) in villages (13, 20) mithi rohar and Shinay of Gandhidham and new interest has been developed in the male worker of villages in (1, 5, 11, 15, 19, 22) Anjar (m), Meghpar Borichi, Nagalpar Nani, Sapeda, varsamedi of Anjar and Galpadar of Gandhidham,

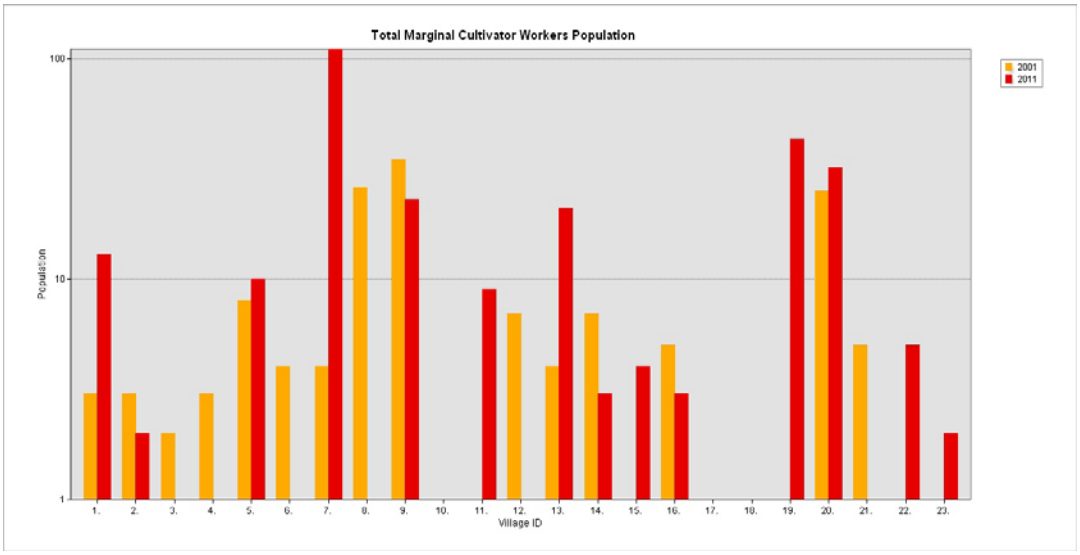


Fig. 2.28 Marginal Cultivator Workers Population

As seen from the graph it can be said that there is an increase in the population of marginal cultivator workers in villages (1, 5, 7, 13, 20) i.e. Anjar (m) of Anjar and Galpadar, Gandhidham (m), mithi rohar, Shinay of Gandhidham. New interest was developed in villages (11, 19, 22,23) Meghpar Borichi of Anjar, Sapeda, varsamedi and Vidi of Anjar.

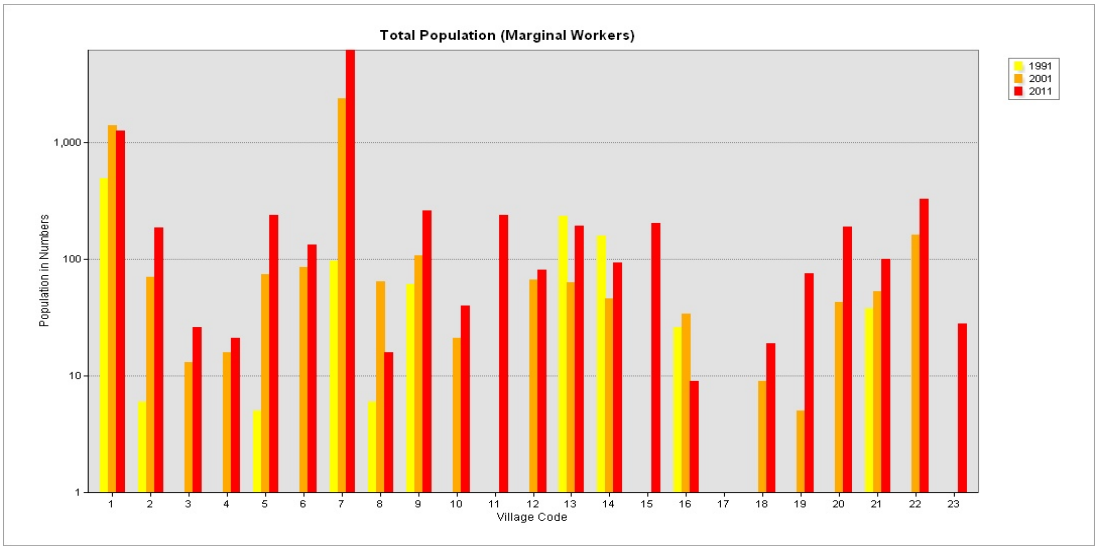


Fig. 2.29 Population of Marginal Workers

As seen from the graph it can be said that there is an increase in the total population of marginal workers in most of the villages except (8, 16) i.e. khambra and Ningal of Anjar taluka.

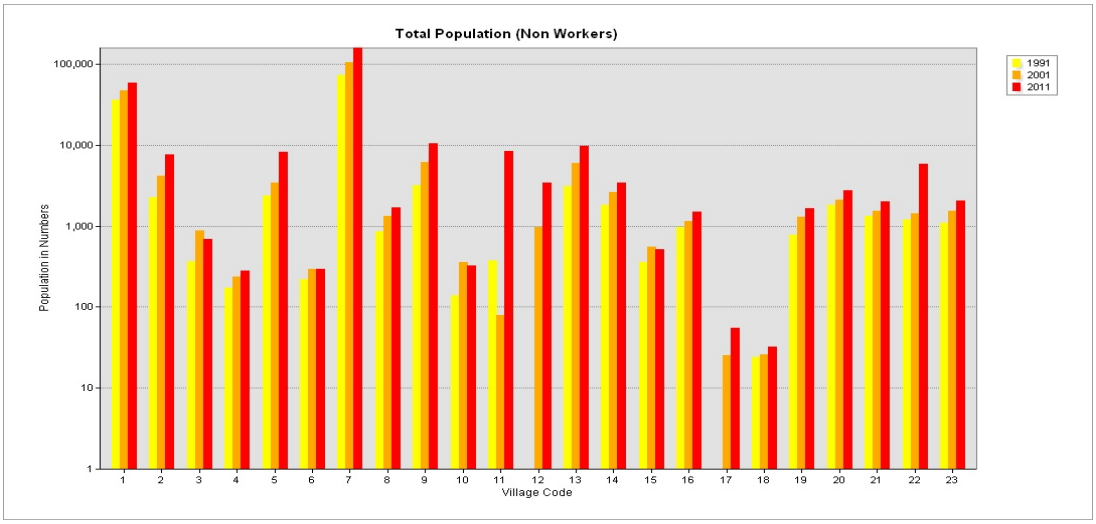


Fig. 2.30 Total Population of Non-Workers

As seen from the graph it can be said that there is an increase in the population of non-workers in most of the villages of study area except (3,6, 10, 15,) i.e. Bhadroi, Malingna, Nagalpar Nani of Anjar and Gandher of Bhuj.

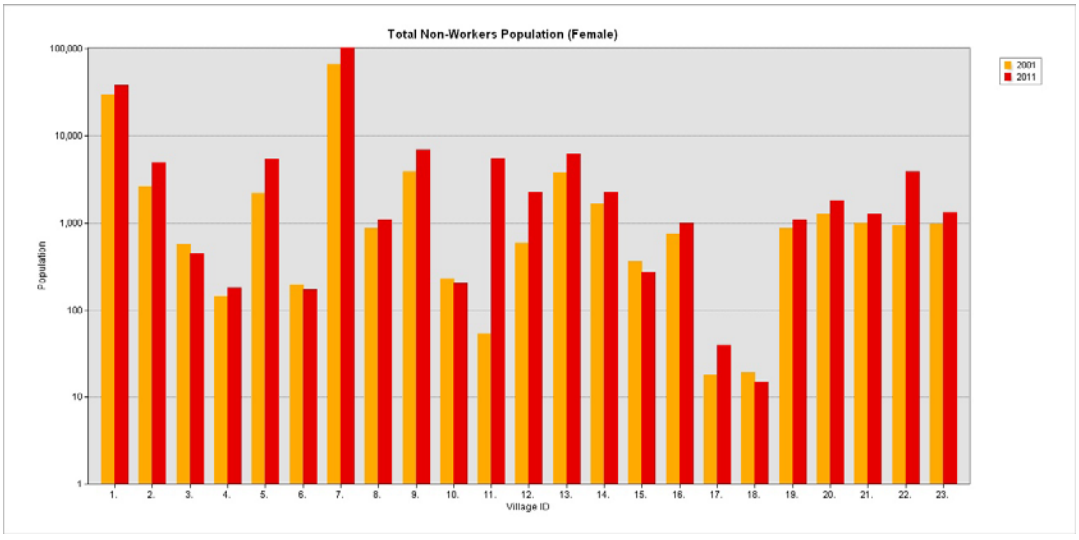


Fig. 2.31 Total Non-Worker Population (Female)

As seen from the graph it can be said that there is an increase in the population of total non-worker population (Female) except (3, 6, 10, 15, 18) i.e. Bhadroi, Malingna, Nagalpar Nani of Anjar and Gandher, saiyedpar of Bhuj

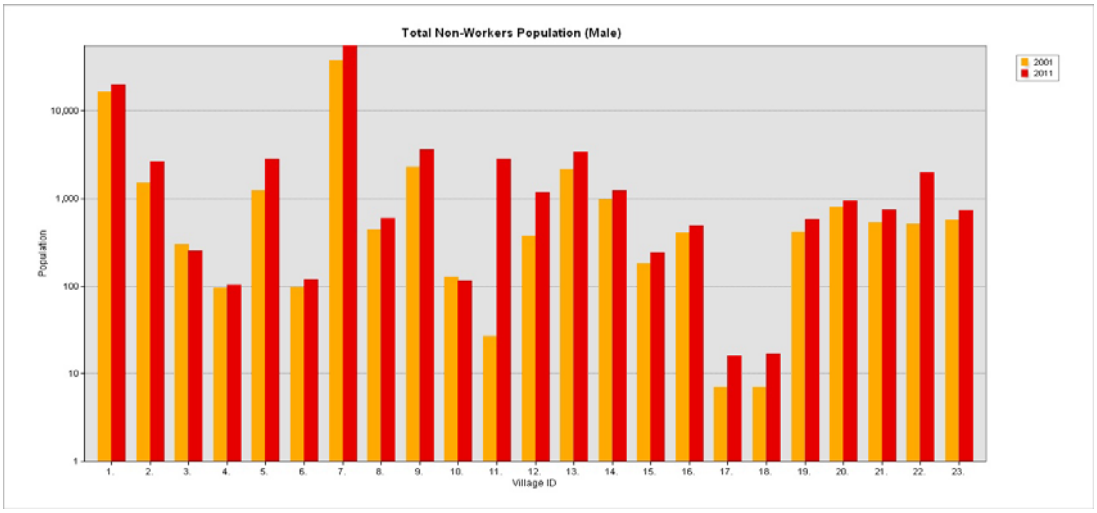


Fig. 2.32 Total Non-Worker Population (Male)

As seen from the graph it can be said that there is an increase in non-worker population (Male) in most of the villages of the study area except (3, 10) i.e. Bhadroi and Malingna of Anjar

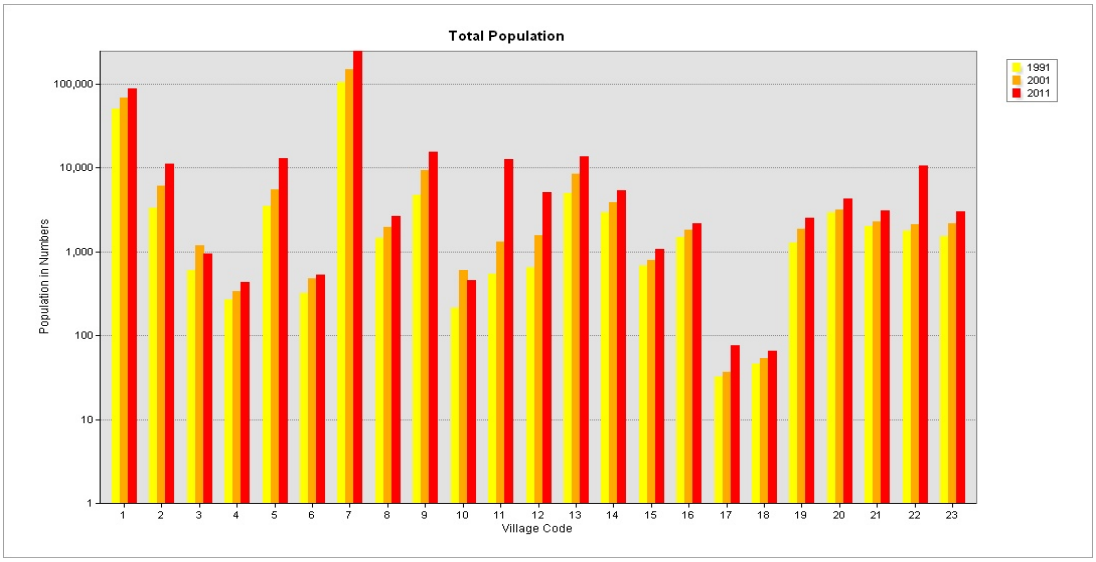


Fig. 2.33 Total Population

As seen from the graph it can be said that there is an increase in the total population within the study area in most of the villages except (3, 10) i.e. Bhadroi and Malingna of Anjar.

2.2.6 Village Wise Changes in different categories of population from 2001 to 2011

The Graphs showing Village wise changes in different categories of population based on the comparision of census data of 2001 and 2011 is as below:

Table 2.9 Population Category Code of Study Area

Number of households		1	Household workers	Persons	32
Total population (including institutional and houseless population)	Persons	2		Males	33
	Males	3		Females	34
	Females	4	Main Other workers	Persons	35
Population in the age-group 0-6	Persons	5		Males	36
	Males	6		Females	37
	Females	7	Marginal workers	Persons	38
Scheduled Castes population	Persons	8		Males	39
	Males	9		Females	40
	Females	10	Cultivators	Persons	41
Scheduled Tribes	Persons	11		Males	42

population	Males	12
	Females	13
Literates	Persons	14
	Males	15
	Females	16
Illiterates	Persons	17
	Males	18
	Females	19
Total workers	Persons	20
	Males	21
	Females	22
Main workers	Persons	23
	Males	24
	Females	25
Household industry Cultivators	Persons	26
	Males	27
	Females	28
Agricultural labourers	Persons	29
	Males	30
	Females	31
	Females	43
Agricultural labourers	Persons	44
	Males	45
	Females	46
Household industry workers	Persons	47
	Males	48
	Females	49
Marginal Other workers	Persons	50
	Males	51
	Females	52
Non-workers	Persons	53
	Males	54
	Females	55

Anjar Taluka:

Anjar (M)

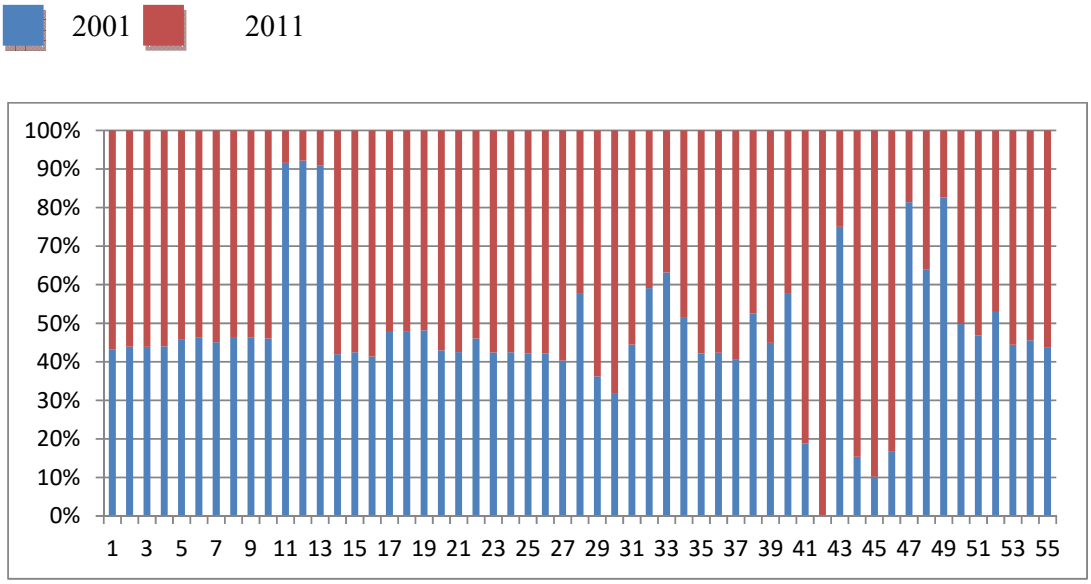


Fig 2.34 Changes in different categories of population from 2001 to 2011 (Anjar (M))

There has been a noticeable decrease in the population of ST including males and females, Females cultivator, household industry workers including male and females in 2011. While there has been marginal decrease in the population of females of householdindustry cultivators, household workers.

Ningal

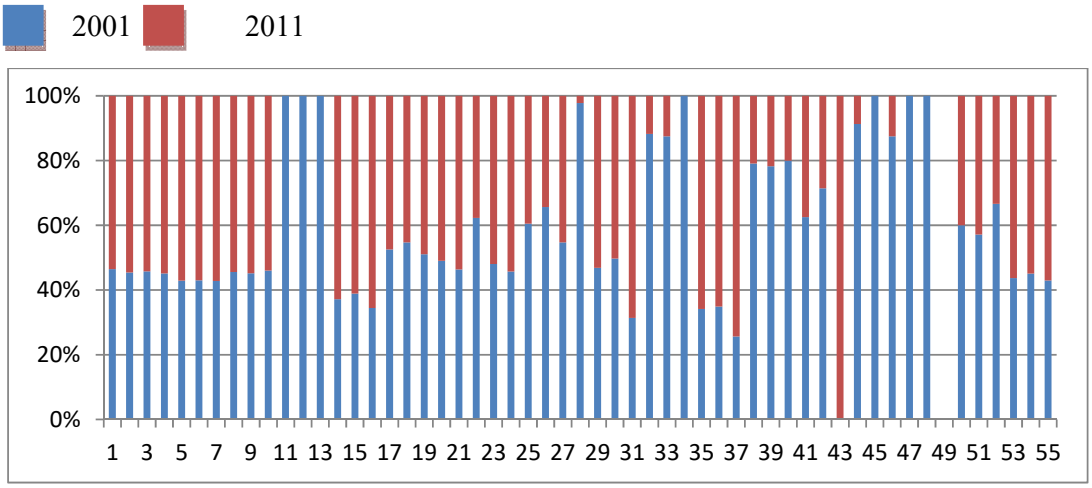


Fig 2.35 Changes in different categories of population from 2001 to 2011 (Ningal)

There has been a noticeable decrease in the population of ST including males and females, Females of household industry cultivators, household workers, marginal workers, agricultural labourers, household workers in 2011. While there has been marginal decrease in the population of total working females, females in main worker category, total household industry cultivators, females in other worker category.

Malingna

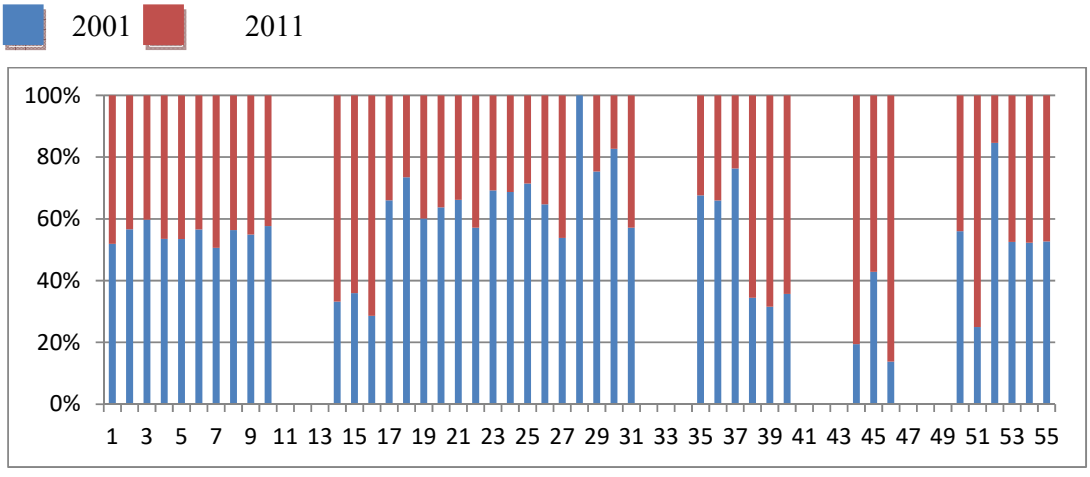


Fig 2.36 Changes in different categories of population from 2001 to 2011 (Malingna)

There has been a noticeable decrease in the males in illiterate category, females in main worker category, household industry cultivator females, total and male agricultural labourers, females in Main and Marginal other workers category, while there has been marginal decrease in total and female illiterate category, total workers, Main workers, Main other workers and Household industry cultivators.

Bhadroi

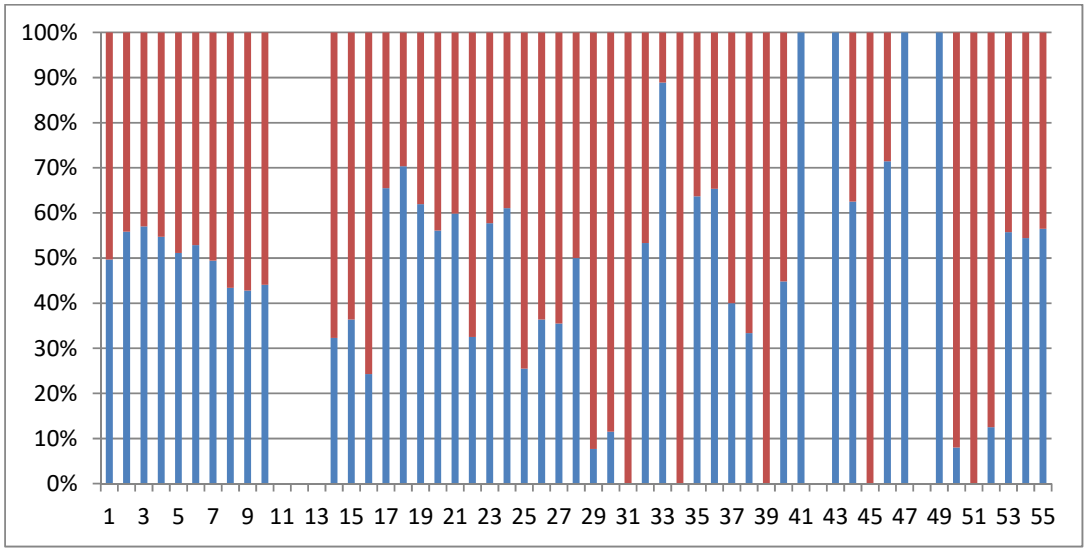


Fig 2.37 Changes in different categories of population from 2001 to 2011 (Bhadroi)

There has been a noticeable decrease in the population of Male household workers, total cultivators, female cultivators and agricultural labourers, total household industry workers, female household industry workers, while there is marginal decrease in total illiterates population, Main other workers, agricultural labourers.

Sapeda

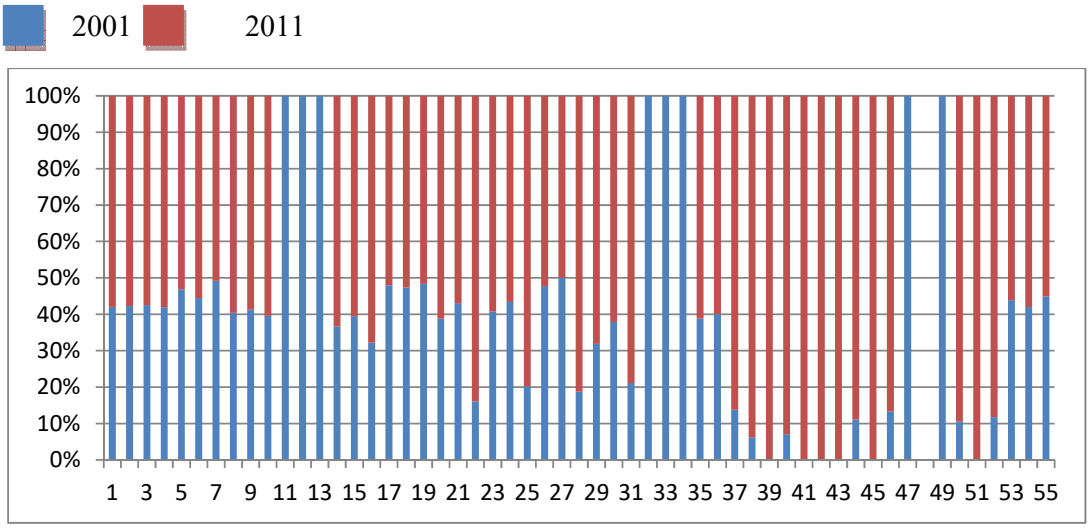


Fig 2.38 Changes in different categories of population from 2001 to 2011 (Sapeda)

There has been a noticeable decrease in male and females ST population, male and female household workers, total especially female household industry workers, while there has been a marginal or significant increase in almost all the remaining categories.

Ratatalav

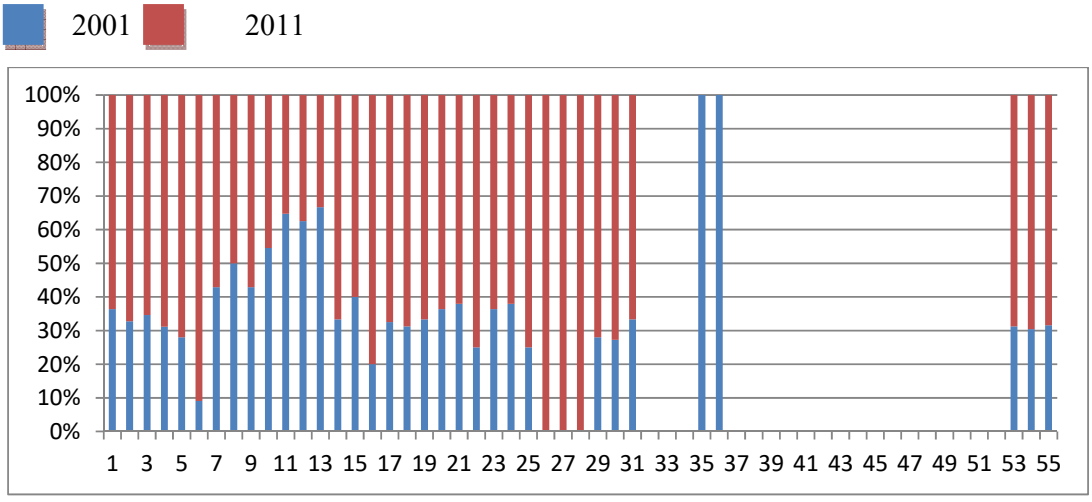


Fig 2.39 Changes in different categories of population from 2001 to 2011 (Ratatalav)

There has been a noticeable decrease in total especially male Main other workers, while there is marginal decrease in Male and Female ST population and female SC population.

Varsamedi

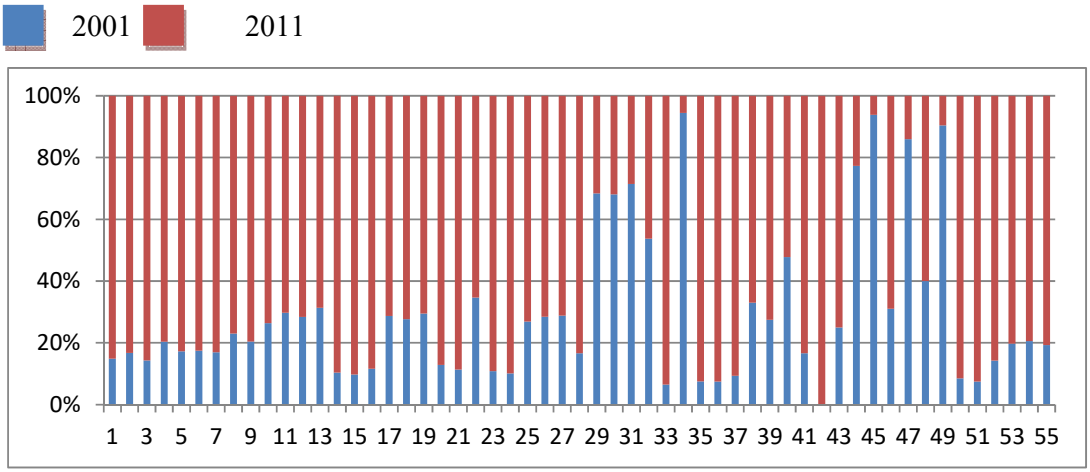


Fig 2.40 Changes in different categories of population from 2001 to 2011(Varsamedi)

There has been a significant decrease in the female household workers, total and male agricultural labourers, total and female household industry workers, while there is marginal decrease in male and female agricultural labourers.

Nagalpar Nani

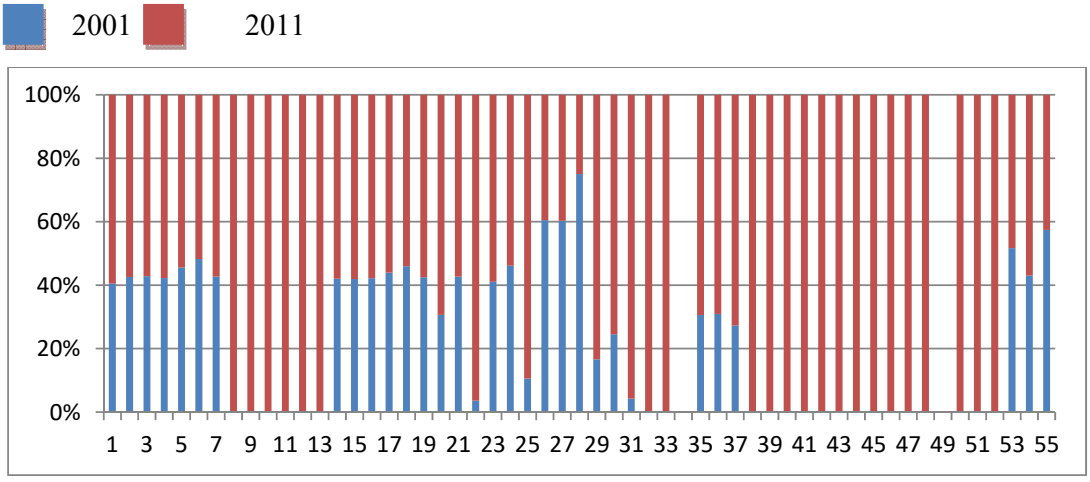


Fig 2.41 Changes in different categories of population from 2001 to 2011 (Nagalpar Nani)

There has been a noticeable decrease in female household industry workers, while there has been a marginal decrease in total and male household industry cultivators and female non-workers.

Nagalpar Moti

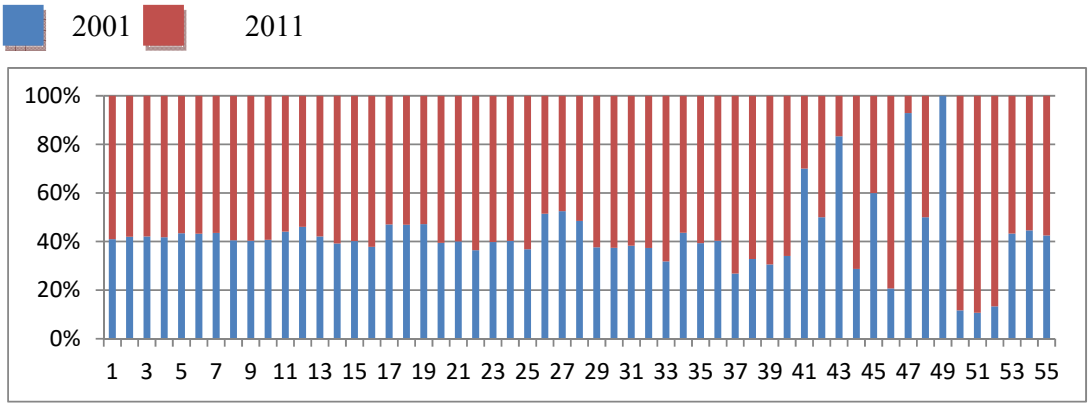


Fig 2.42 Changes in different categories of population from 2001 to 2011 (Nagalpar Moti)

There has been a noticeable decrease in female and total cultivators, total and especially female household industry workers, while there is marginal decrease in male agricultural labourers.

Khambhara

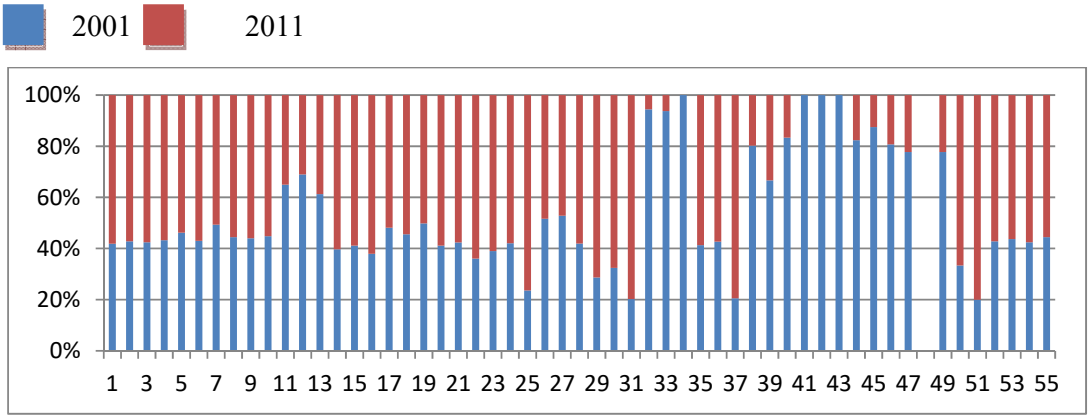


Fig 2.43 Changes in different categories of population from 2001 to 2011 (Khambhra)

There has been a noticeable decrease in male and female household workers, male and female marginal workers, male and female cultivators, male and female agricultural labourers, total especially female household industry workers, while there has been a marginal decrease in male and female ST population.

Sinugra

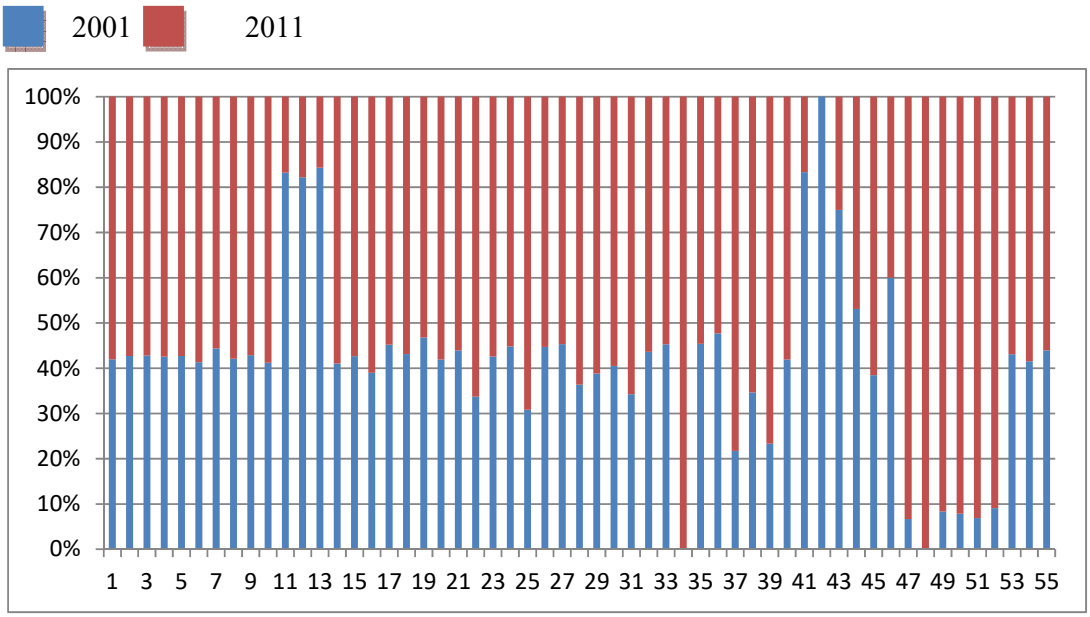


Fig 2.44 Changes in different categories of population from 2001 to 2011 (Sinugra)

There has been a noticeable decrease in male and female ST population, male and female cultivators, while there is marginal decrease in female and total agricultural labourers.

Vidi

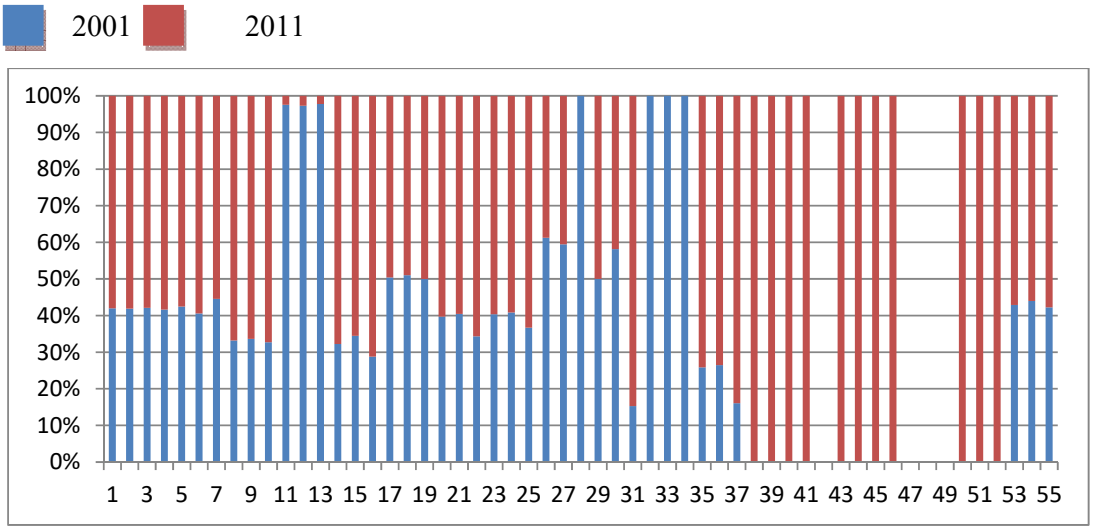


Fig 2.45 Changes in different categories of population from 2001 to 2011 (Vidi)

There has been a noticeable decrease in ST population, female household industry cultivators, male and female household workers, while there has been a marginal decrease in total and especially male household industry cultivators.

Meghpar Borichi

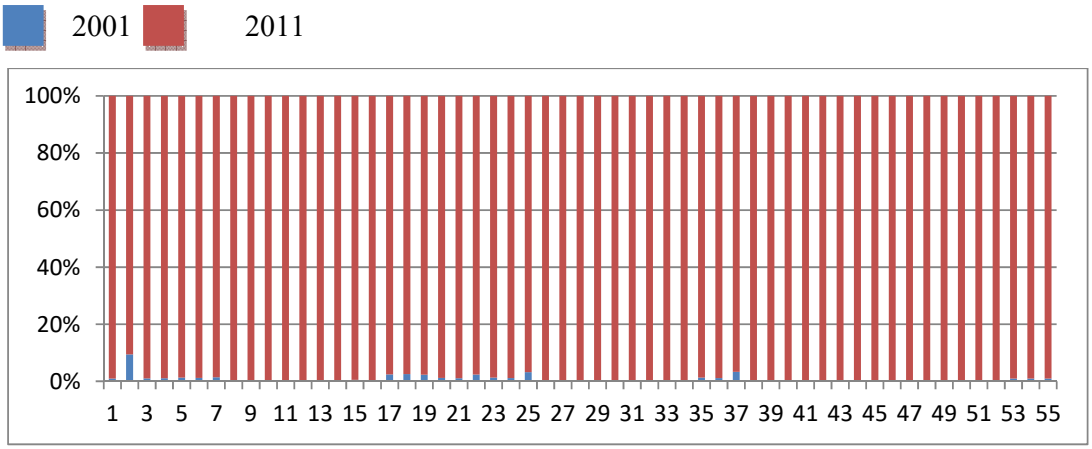


Fig 2.46 Changes in different categories of population from 2001 to 2011 (Meghpar Borichi)

There has been a noticeable increase in all the 55 categories of population.

Meghpar Khumbhardi

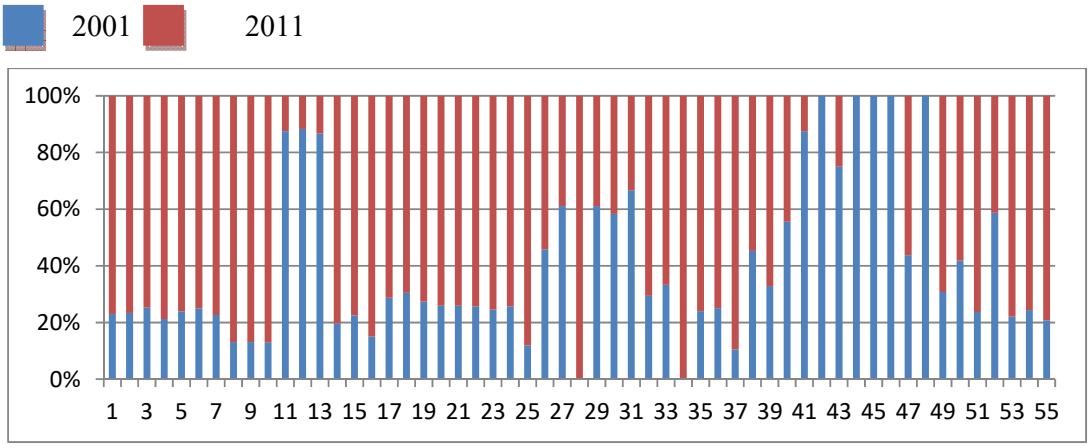


Fig 2.47 Changes in different categories of population from 2001 to 2011 (Meghpar Khumbhardi)

There has been a noticeable decrease in male and female ST population, male and female cultivators, male and female agricultural labourers and male household industry workers, while there has been a marginal decrease in male household industry cultivators, male and female agricultural labourers.

Bhuj Taluka

Chubdak

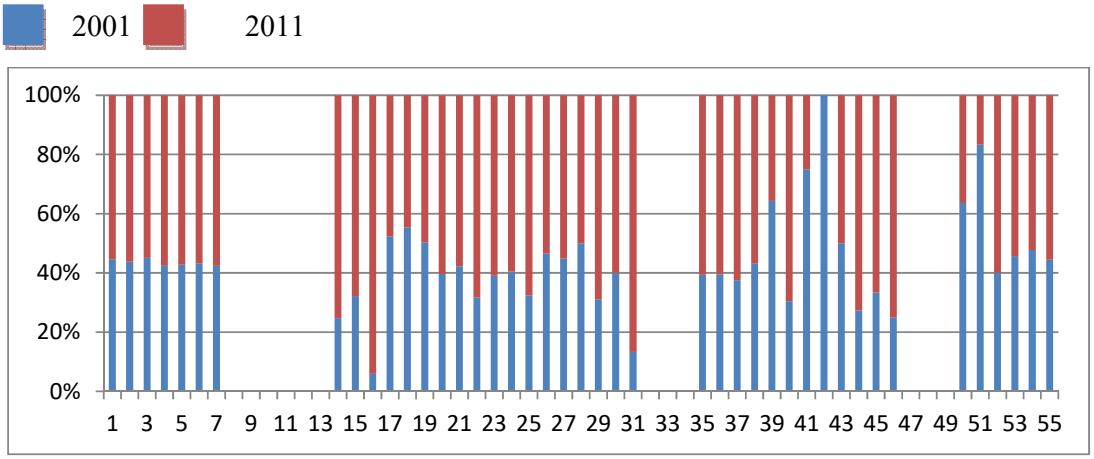


Fig 2.48 Changes in different categories of population from 2001 to 2011 (Chubdak)

There has been a noticeable decrease in total and especially male cultivators and male marginal other workers, while there has been a marginal decrease in male marginal workers and total marginal other workers

Gandher

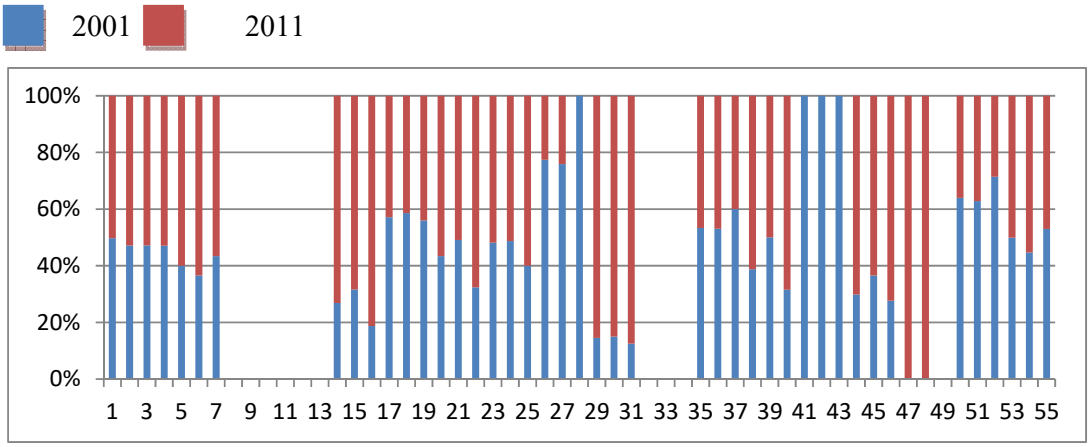


Fig 2.49 Changes in different categories of population from 2001 to 2011 (Gandher)

There has been a noticeable decrease in male and female household industry cultivators, male and female cultivators and marginal other workers while there is marginal decrease in male and female illiterates.

Gandhidham Taluka / Gandhidham (Urban)

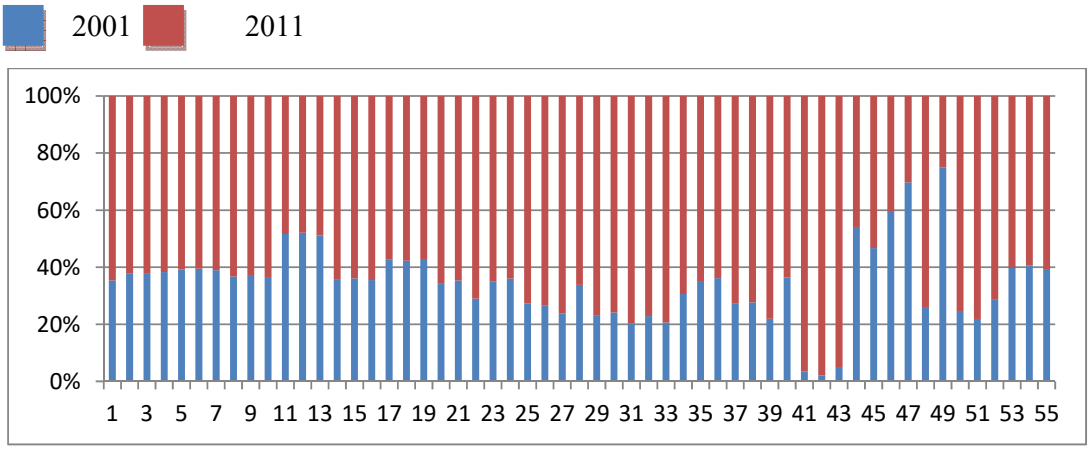


Fig 2.50 Changes in different categories of population from 2001 to 2011 (Gandhidham (Urban))

There has been a noticeable decrease in total especially female household industry workers, while there is very marginal decrease in ST population.

Mithi Rohar

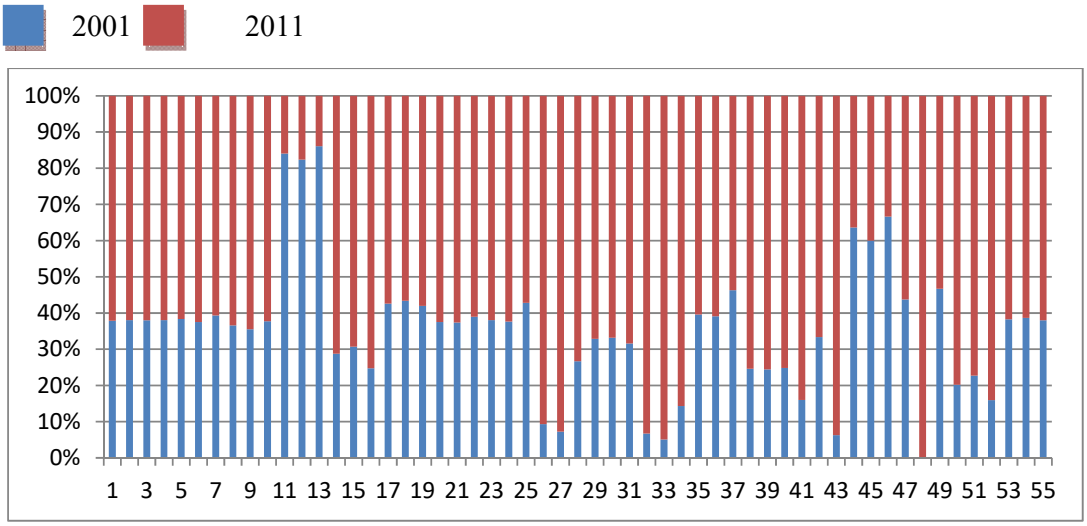


Fig 2.51 Changes in different categories of population from 2001 to 2011 (Mithi Rohar)

There has been a noticeable decrease in male and female ST population, while there is marginal decrease in male and female agricultural labourers.

Shinay

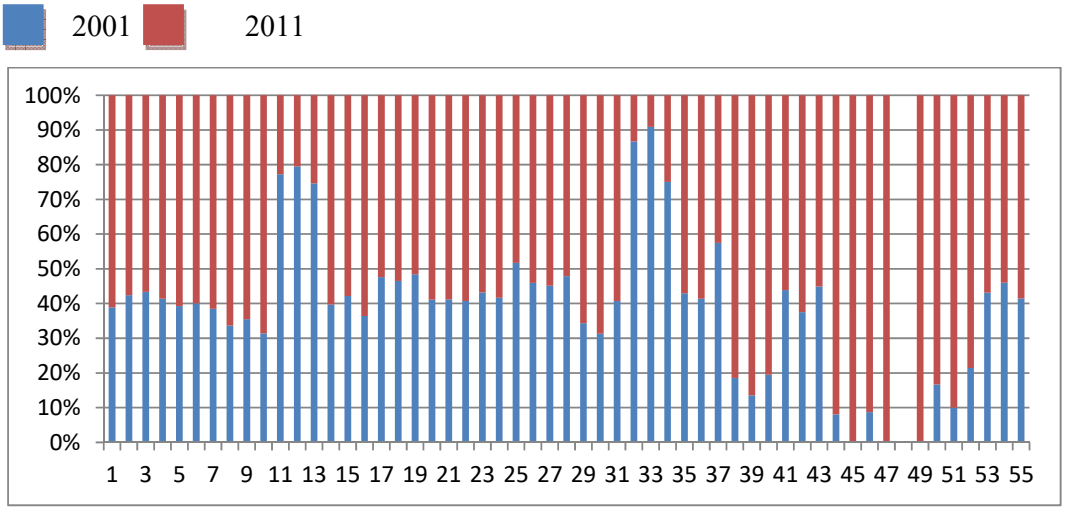


Fig 2.52 Changes in different categories of population from 2001 to 2011 (Shinay)

There has been a noticeable decrease in male and female ST population and male and female household workers, while there is marginal decrease in female Main other workers.

Kidana

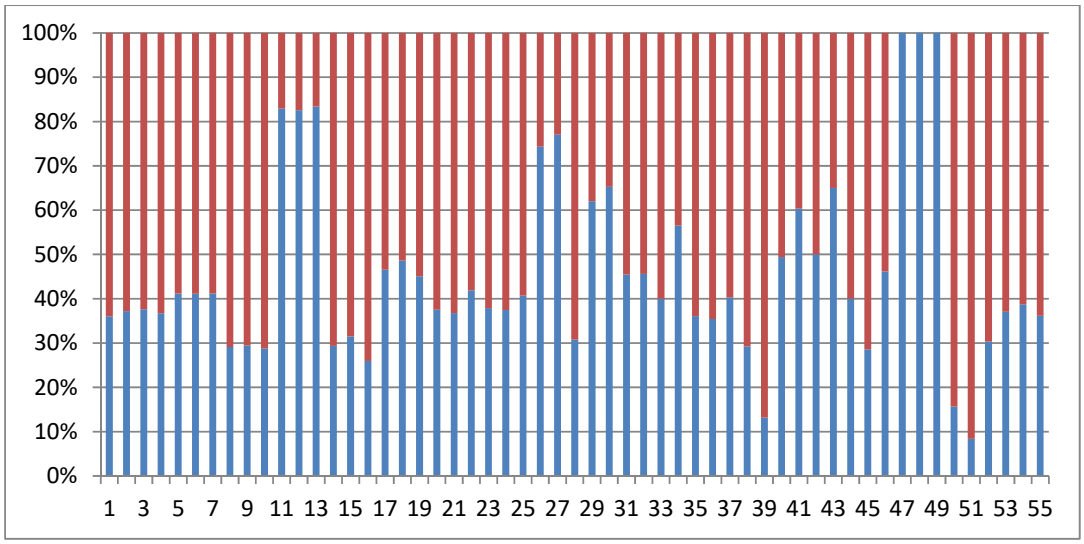


Fig 2.53 Changes in different categories of population from 2001 to 2011 (Kidana)

There has been a noticeable decrease in male and female ST population, male household industry cultivators and household industry workers, while there is marginal decrease in total especially male household industry cultivators, total and male agricultural labourers, total and female cultivators.

Galpadar

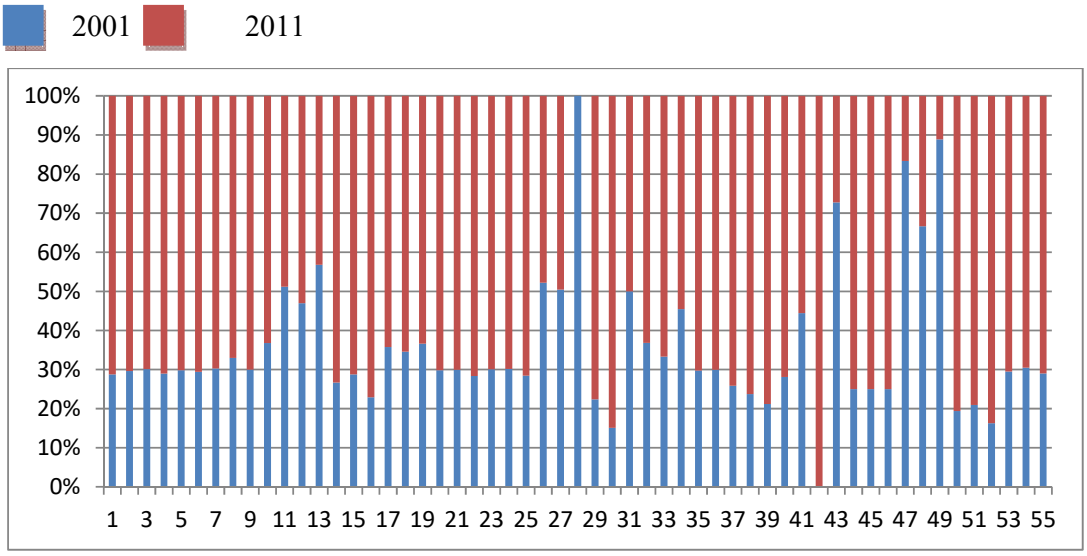


Fig 2.54 Changes in different categories of population from 2001 to 2011 (Galpadar)

There has been a noticeable decrease in female household industry cultivators, female cultivators, male and female household industry workers, while there is marginal decrease in total and female ST population.

Antarjal

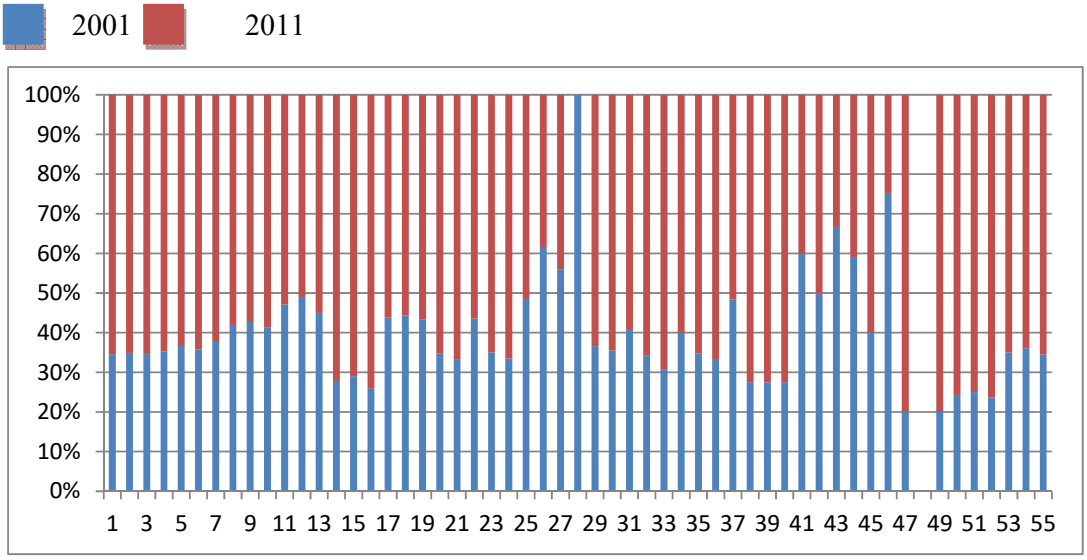


Fig 2.55 Changes in different categories of population from 2001 to 2011 (Antarjal)

There has been a noticeable decrease in female household industry cultivators and female agricultural labourers, while there has been a marginal decrease in total and male household industry cultivators, total and female cultivators,

2.3 AGRICULTURE STATUS OF STUDY AREA

Agriculture is very prominent in the study area. According to Agriculture census for the years 1995-96 to 2010-11, irrigation through Tube well has increased to significant levels compared to the earlier periods. While in 1995-96 contributed to only 3.36% of the total irrigated area while majority of the irrigation was done through wells which contributed to 78.24%. There has been significant change of practice in irrigation since then due to scanty of rainfall years and increase in depth of the water levels. During the period of 2000-01 irrigation through well reduced to 32 .34 % while there was a drastic increase in the irrigation practices through tube wells with an increase of 66.73 %. The tube well fed agriculture area covers major part of the irrigated area in the recent years i.e. 2010-11 (about 67.46 % of total agriculture land) while irrigation through well has been reduced to only 4.28%. Irrigation through canal is also been done which has increased to 6.54% from 0.18% in 2000-11. This can be attributed to the recent development of SSNL canal planned through various parts of kutch district. While alternate sources of water sources like tankers are also been used were no or negligible amount of water for irrigation is available.

Table 2.10 Source of Irrigation

Irrigated Area (Hectare) through various sources								
Year	Taluka	Total Holdings	Canals	Tanks	Wells	Tubewells	Other Sources	Total Net Irrigated
1995-96	Anjar	82550.0	91.0	171.0	5551.0	122.0	1606.0	7541.0
1995-96	Bhuj	93312.0	744.0	57.0	6820.0	410.0	240.0	8271.0

1995-96	Total	175862.0	835.0	228.0	12371.0	532.0	1846.0	15812.0
1995-96	Percentage	-	5.28%	1.44%	78.24%	3.36%	11.67%	100.00%
2000-11	Anjar	65370.0	15.0	6.0	1853.0	3157.0	0.0	5032.0
2000-11	Bhuj	91040.0	34.0	18.0	7050.0	15225.0	184.0	22510.0
2000-11	Gandhidham	5311.0	0.0	0.0	5.0	0.0	0.0	5.0
2000-11	Total	161721.0	49.0	24.0	8908.0	18382.0	184.0	27547.0
2000-11	Percentage	-	0.18%	0.09%	32.34%	66.73%	0.67%	100.00%
2005-06	Anjar	68885.0	13.0	0.0	2557.0	946.0	71.0	3587.0
2005-06	Bhuj	96266.0	104.0	150.0	1818.0	8276.0	899.0	11247.0
2005-06	Gandhidham	6449.0	0.0	0.0	367.0	382.0	0.0	749.0
2005-06	Total	171600.0	117.0	150.0	4742.0	9604.0	970.0	15583.0
2005-06	Percentage	-	0.75%	0.96%	30.43%	61.63%	6.22%	100.00%
2010-11	Anjar	73286.0	856.0	0.0	404.0	11614.0	1230.0	14104.0
2010-11	Bhuj	86419.0	1084.0	159.0	1136.0	13064.0	6556.0	21999.0
2010-11	Gandhidham	5209.0	452.0	0.0	25.0	0.0	0.0	477.0
2010-11	Total	164914.0	2392.0	159.0	1565.0	24678.0	7786.0	36580.0
2010-11	Percentage	-	6.54%	0.43%	4.28%	67.46%	21.28%	100.00%

Source: Agricultural Census 2011

2.3.1 Changes in Wells and Tubewells

Due to erratic rainfall seasons, scanty of surface water for agriculture purpose and unavailability of adequate amount of other sources of water like canal, the dependency of the tube well for agriculture purposes has increased to an exponential levels at most of the part of kutch district. This can be confirmed from the data available from the agriculture census. According to it there has been considerable rise in the number of tube wells in the year 2005-06 which is nearly 4 times than that of 2000-01. While for the year 2010-11, the dependence of tube well can still be considered significantly high than that of 2000-01.

Table 2.11 Changes in Wells and Tubewells from 1995 to 2011

Year	Taluka	Total Holdings Area (Hectare)	Number of Wells in Use	Number of Wells Not in Use	Number of Tubewells
1995-96	Anjar	82550	895	100	5
1995-96	Bhuj	93312	1667	116	8
1995-96	Total	175862	2562	216	13
2000-01	Anjar	65370	551	262	375
2000-01	Bhuj	91040	1194	45	376
2000-01	Gandhidham	5311	13	6	0
2000-01	Total	161721	1758	313	751
2005-06	Anjar	68885	719	4	475
2005-06	Bhuj	96266	777	0	2221
2005-06	Gandhidham	6449	81	0	273
2005-06	Total	171600	1577	4	2969
2010-11	Anjar	73286	37	154	927
2010-11	Bhuj	86419	503	0	243
2010-11	Gandhidham	5209	119	0	0
2010-11	Total	164914	659	154	1170

Source: Agricultural Census 2011

2.3.2 Total Persons of SC Group holding the agriculture land

While Bhuj and Gandhidham showed fall in the total Male and Female population holding the agriculture area, rise is seen in the total Male and female population holding the agriculture area in Anjar in last decade.

There is an increase in the total persons holding agriculture area in Anjar while there is a decrease in the total persons holding the agriculture in Bhuj and Gandhidham

Table 2.12 Total Persons of SC Group holding the agriculture land

Years	Taluka	Total Holdings No. Male	Total Holdings No. Female	Total Holdings No.
2000	Anjar	692	102	794
2000	Bhuj	1159	171	1330
2000	Gandhidham	18	6	24
2005	Anjar	626	129	755
2005	Bhuj	1090	179	1269
2005	Gandhidham	35	5	40
2010	Anjar	757	213	970
2010	Bhuj	914	155	1069
2010	Gandhidham	12	7	19

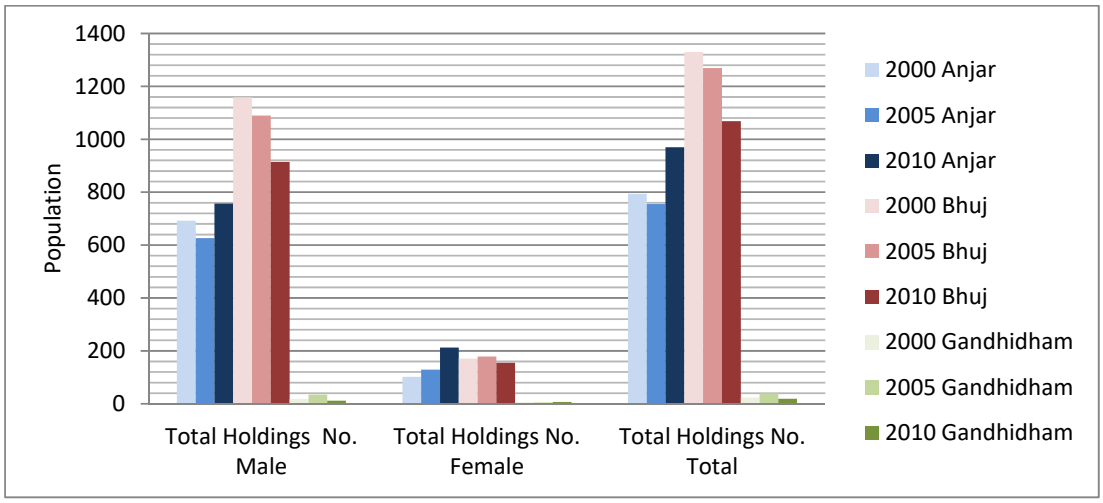


Fig 2.56 Total Persons of SC Group holding the Agriculture Land

2.3.3 Total Holding Areas of SC Group

From the graph it can be said that

There is a fall in the total agriculture area occupied by Male population in all three talukas i.e. Anjar, Bhuj and Gandhidham in last decade.

There is a rise in the the agriculture area occupied by female population in Anjar and Gandhidham while there is fall in Bhuj.

There is an increase in the total agriculture area in Anjar while there is a decrease in the total agriculture areas in Bhuj and Gandhidham

Table 2.13 Total Holding Areas of SC Group

Years	Taluka	Total Holdings Area Male	Total Holdings Area Female	Total Holdings Area
2000	Anjar	2549	342	2890
2000	Bhuj	3740	487	4228
2000	Gandhidham	47	15	62
2005	Anjar	2062	386	2448
2005	Bhuj	3716	611	4328
2005	Gandhidham	91	17	108
2010	Anjar	2489	689	3178
2010	Bhuj	2884	476	3360
2010	Gandhidham	30	20	50

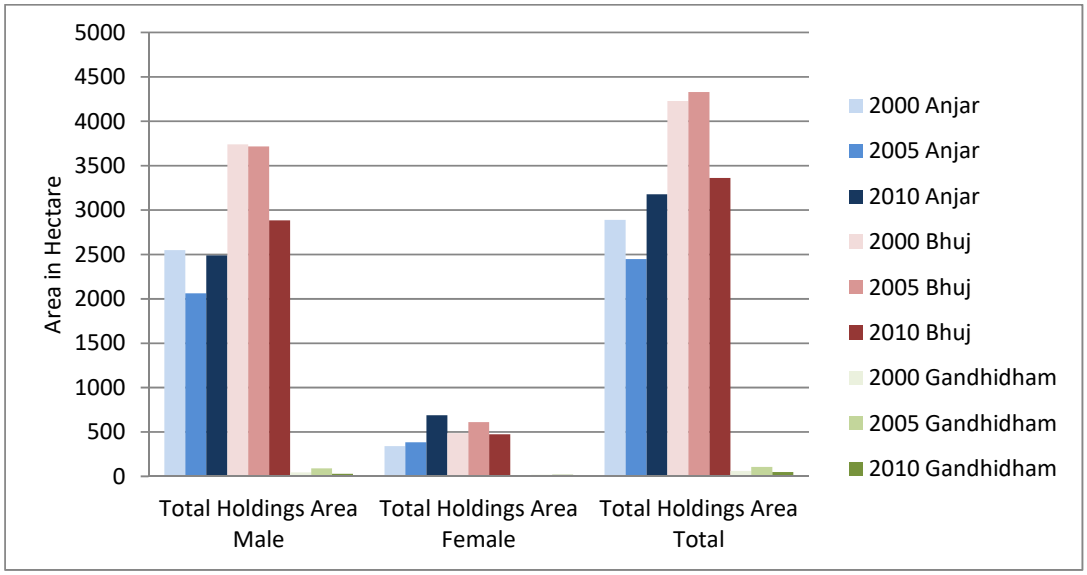


Fig. 2.57 Total Holding Areas of SC Group (in Hectare)

2.3.4 Total Persons of ST Group holding the agriculture land

From the graph it can be said that

There is a fall in the total Male & Female i.e. total population holding the agriculture area in Anjar, Bhuj and Gandhidham.

Table 2.14 Total Persons of ST Group holding the agriculture land

Years	Taluka	Total Holdings Persons (Male)	Total Holdings Persons (Female)	Total Holdings Persons
2000	Anjar	200	30	230
2000	Bhuj	433	51	484
2000	Gandhidham	7	1	8
2005	Anjar	31	4	35
2005	Bhuj	112	16	128
2005	Gandhidham	2	0	2
2010	Anjar	49	20	69
2010	Bhuj	83	8	91
2010	Gandhidham	3	0	3

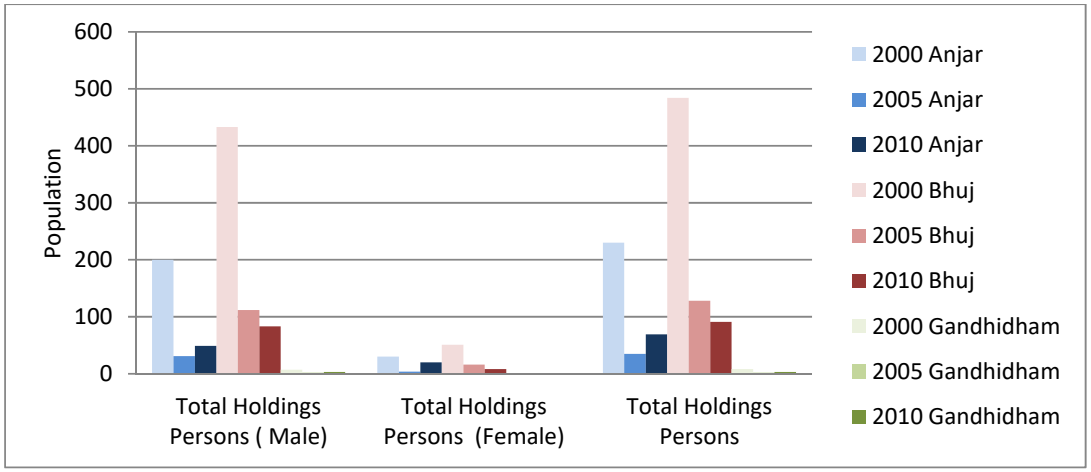


Fig. 2.58 Total Persons of ST Group Holding the Agriculture Land.

2.3.5 Total Holding Areas of ST Group

There is a fall in the total agriculture area occupied by Male & Female i.e. total population in all three talukas i.e. Anjar, Bhuj and Gandhidham in last decade.

Table 2.15 Total Holding Areas of ST Group

Years	Taluka	Total Holdings Area Male	Total Holdings Area Female	Total Holdings Area Total
2000	Anjar	832	101	934
2000	Bhuj	932	120	1051
2000	Gandhidham	13	2	15
2005	Anjar	102	14	116
2005	Bhuj	305	191	496
2005	Gandhidham	3	0	3
2010	Anjar	161	94	255
2010	Bhuj	204	23	227
2010	Gandhidham	9	0	9

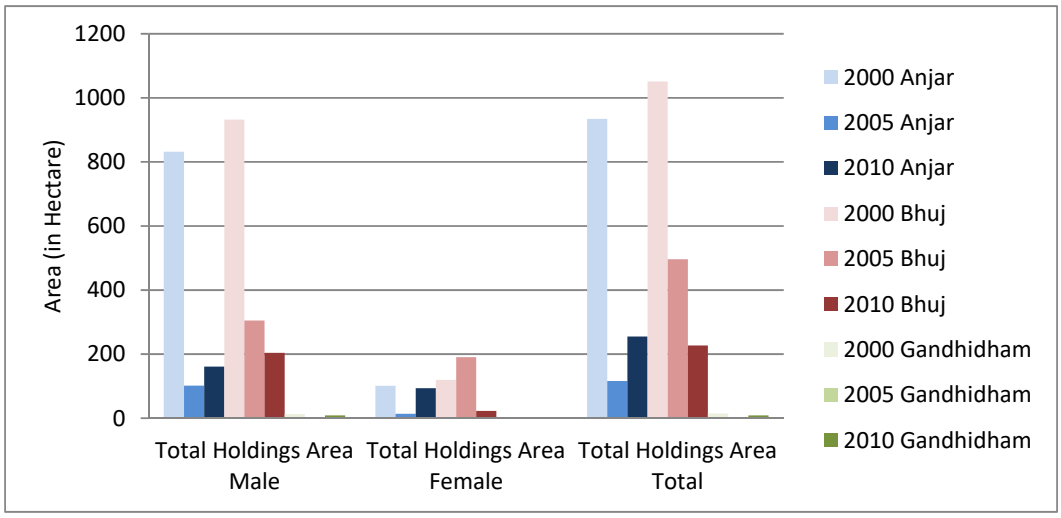


Fig 2.59 Total Holding Areas of ST Group (in Hectare)

2.3.6 Institutional Holdings

There is drastic reduction in the interests of the institutes in all the three talukas i.e. Anjar, Bhuj and Gandhidham and this is reflected in the agriculture area occupied by them.

Table 2.16 Institutional Holdings of Agriculture Area

Years	Taluka	Total Holdings (Institutes)	Total Holdings Area of Institutes
2000	Anjar	208	2001
2000	Bhuj	232	1610
2000	Gandhidham	29	320
2005	Anjar	1	1
2005	Bhuj	26	254
2005	Gandhidham	1	4
2010	Anjar	6	185
2010	Bhuj	7	108
2010	Gandhidham	1	4

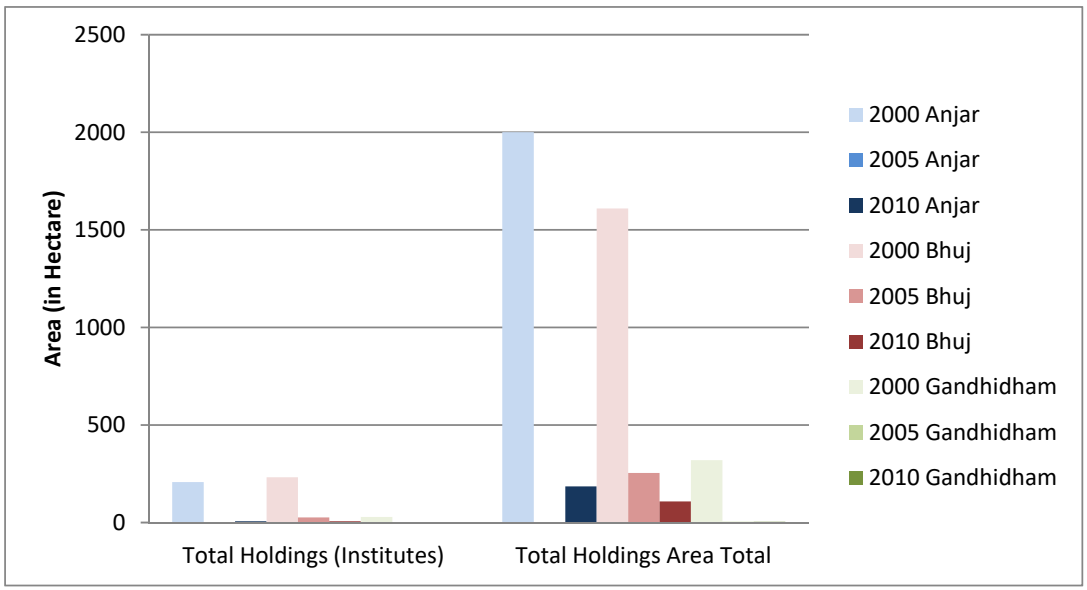


Fig. 2.60 Institutional Holdings of Agriculture Area (in Hectare)

2.3.7 Total Persons of Others Group Holding the Agriculture Land

There is an increase in both male and the female population holding the agriculture area in all the three talukas i.e. Anjar Bhuj and Gandhidham. So it can be said that there is an increase in the total population holding the agriculture area in all the three talukas.

Table 2.17 Total Persons of Others Group Holding the Agriculture Land

Years	Taluka	Total Holdings No. Male	Total Holdings No. Female	Total Holdings No. Total
2000	Anjar	12163	1857	14020
2000	Bhuj	18300	2569	20869
2000	Gandhidham	1299	253	1552
2005	Anjar	14653	2806	17459
2005	Bhuj	19628	2959	22587
2005	Gandhidham	1761	300	2061
2010	Anjar	16406	3630	20036
2010	Bhuj	21046	3380	24426
2010	Gandhidham	1520	324	1844

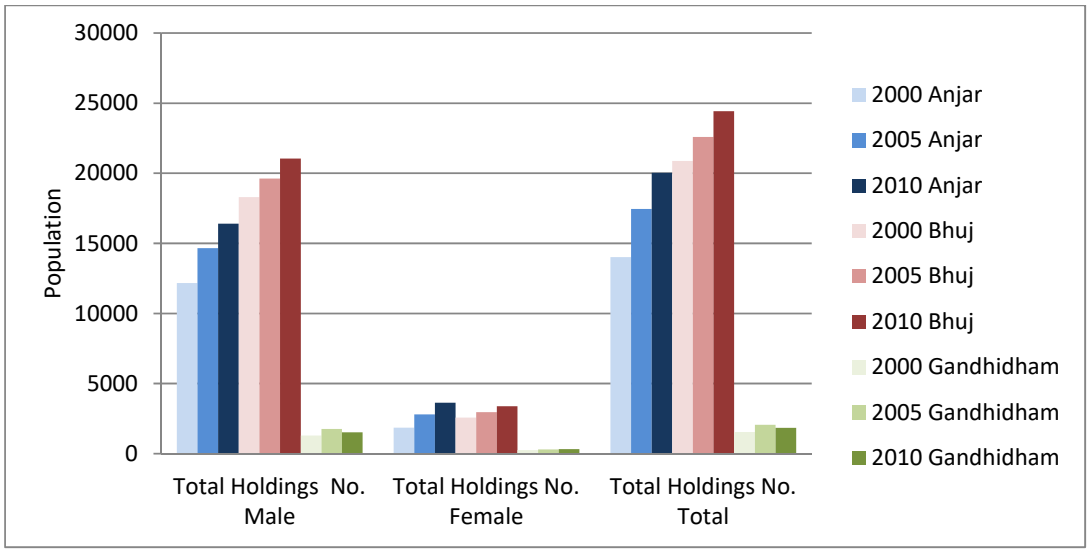


Fig. 2.61 Total Persons of Others Group Holding the Agriculture Land

2.3.8 Total Holding Areas of Other Group

From the graph it can be said that

There is a rise in the total agriculture area occupied by the male & female population in Anjar and Gandhidham while there is a fall in Bhuj.

There is a rise in the total agriculture area occupied by the female population in all the three talukas i.e. Anjar Bhuj and Gandhidham

Table 2.18 Total Holding Areas of Other Group

Years	Taluka	Total Holdings Area Male	Total Holdings Area Female	Total Holdings Area Total
2000	Anjar	51668	7877	59545
2000	Bhuj	74441	9710	84150
2000	Gandhidham	4138	776	4913
2005	Anjar	55042	11278	66320
2005	Bhuj	78559	12630	91188
2005	Gandhidham	5519	814	6333
2010	Anjar	56545	13123	69668
2010	Bhuj	72067	10657	82724
2010	Gandhidham	4278	867	5145

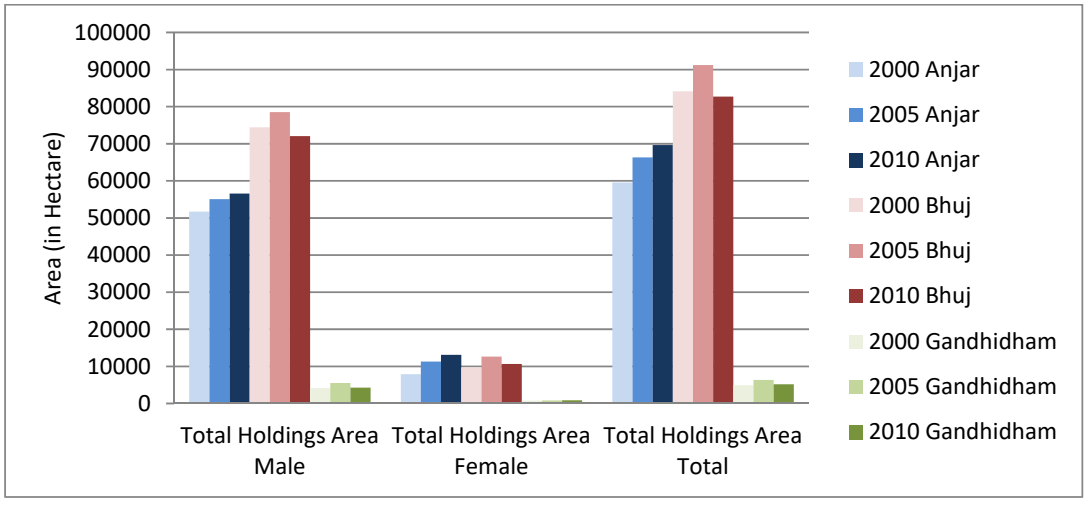


Fig. 2.62 Total Holding Areas of Other Group (in Hectare)

2.3.9 Total Holding Persons of All social Groups (Institutional+SC+ST+Others)

There is rise in total Male & Female population holding the agriculture land in Anjar Bhuj and Gandhidham.

There is a drastic fall in the institutes holding the agriculture land in Anjar Bhuj and Gandhidham.

There is a rise in overall population holding the agriculture lands in Anjar and Bhuj but there is a fall in Gandhidham.

Table 2.19 Total Holding Persons of All social Groups (Institutional+SC+ST+Others)

Years	Taluka	Total Holdings Persons(Male)	Total Holdings Persons(Female)	Institutional Holdings Numbers (Total)	Total Holdings Numbers
2000	Anjar	13055	1989	208	15252
2000	Bhuj	19892	2791	232	22915
2000	Gandhidham	1324	260	29	1613
2005	Anjar	15310	2939	1	18250
2005	Bhuj	20830	3154	26	24010
2005	Gandhidham	1798	305	1	2104
2010	Anjar	17212	3863	6	21081
2010	Bhuj	22043	3543	7	25593
2010	Gandhidham	1535	331	1	1867

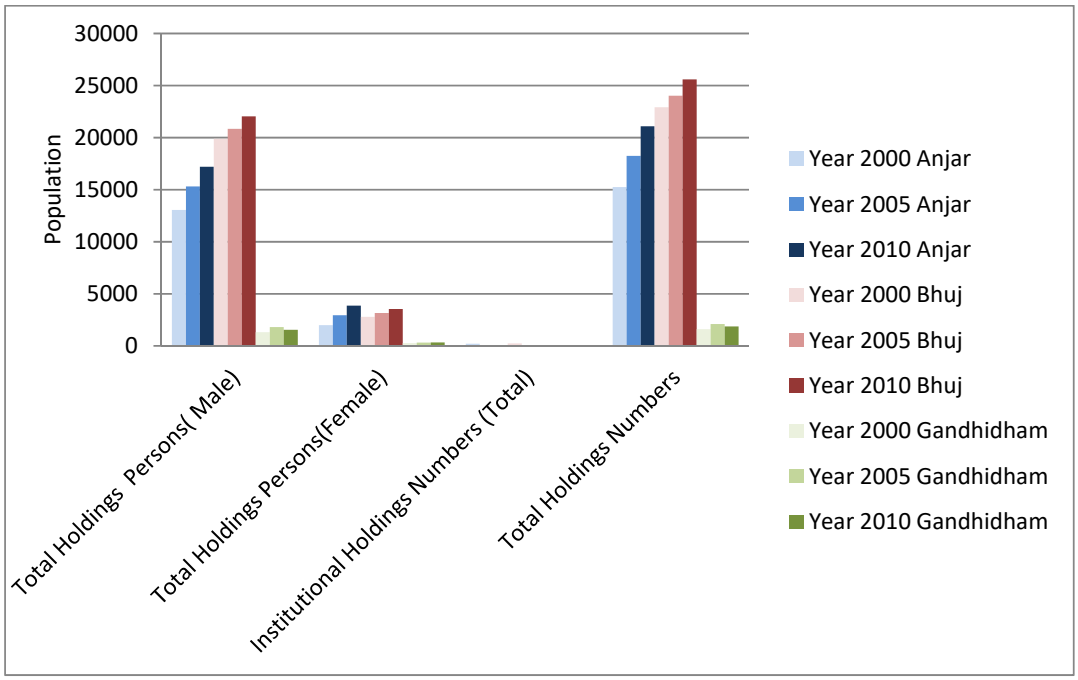


Fig. 2.63 Total Holding Persons of All social Groups (Institutional+SC+ST+Others)

2.3.10 Total Holding of Areas of all Social Groups (Institutional+SC+ST+Others)

There is a rise in total agriculture land occupied by male & female population in Anjar Bhuj and Gandhidham. There is a fall in total agriculture area occupied by institutes in Anjar Bhuj and Gandhidham

Table 2.20 Total Areas Holding of all Groups (Institutional+SC+ST+Others)

Years	Taluka	Total Holdings Area (Male)	Total Holdings Area (Female)	Institutional Holdings Area (Total)	Total Holdings Area (Male+ Female+ Inst)
2000	Anjar	55049	8320	2001	65370
2000	Bhuj	79113	10316	1610	91040
2000	Gandhidham	4198	792	320	5311
2005	Anjar	57206	11678	1	68885
2005	Bhuj	82580	13432	254	96266
2005	Gandhidham	5614	831	4	6449
2010	Anjar	59195	13906	185	73286
2010	Bhuj	75155	11156	108	86419
2010	Gandhidham	4318	887	4	5209

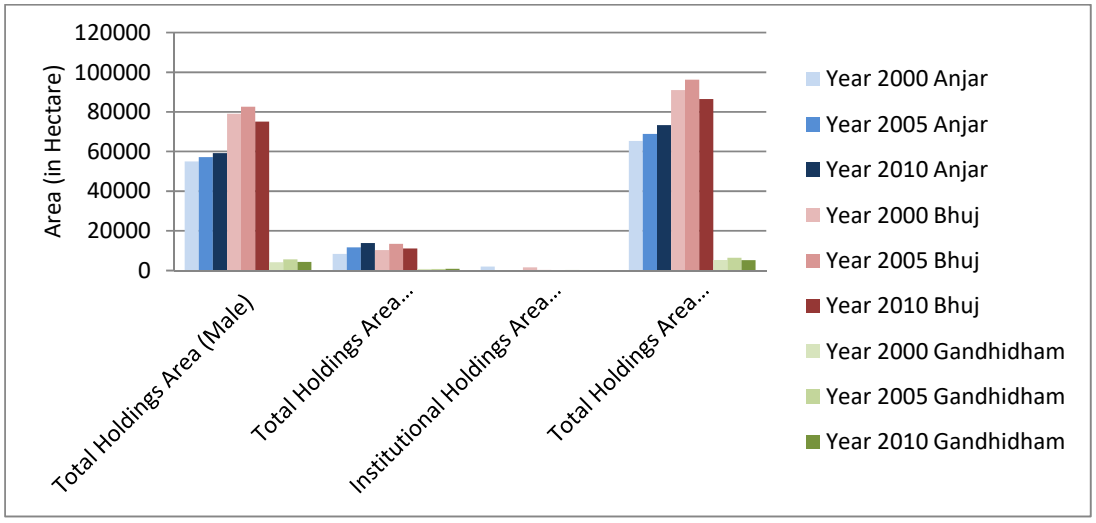


Fig. 2.64 Total Holding of Areas of all Social Groups (Institutional+SC+ST+Others)

2.4 QUESTIONNAIRE SURVEY

A questionnaire was designed in English and local language i.e. Gujarati for the survey regarding the issues related to groundwater prevailing in their area and existing RWH structures. The questionnaire is designed in three parts which asks about specific information related to groundwater.

Questionnaire Survey is conducted using Participatory Urban Appraisal tool with individual households over a period of one 3 months. 150 samples are collected (coastal watershed: 50 samples, urban watershed: 50 samples, rural/sub urban watershed: 50 samples).

This questionnaire was prepared prior to the field survey based on the inputs from various agencies and locals to understand the socio-economic aspects as well as the Village-wise problems prevailing in the study area. A group discussion where ever possible and/or individual opinion was taken.

It consisted of three parts;

The first part deals with the general information and personal background of the area.

The second part probes details about water resources like availability of water, their usage and quality in their areas.

The third part is about KAP of RWH systems within their area like type of RWH, its features and their opinion about it.

Table 2.21 Template of KAP of RWH in Study Area

Sr	Parameters	Codes	Remarks
Part 1			
1	Name		
2	Occupation		
3	position in family		
4	Total Family Members		
5	Building Type		
6	Town/Village		
Part 2			
1	Open well/Dugwell/Borewell		
2	Purpose of water well		
3	Satisfied with present water		
4	Total Water requirement		
5	water quality		
6	Water availability hours		
7	Agriculture/Crop type/ Industry type		
8	Agriculture season-rabi/karif		
9	Production – Better/moderate/poor		
Part 3			
1	Is village water supplied else ware/		
2	Recharge well availability		
3	Possibility of Recharge		
4	Type of Recharge well present		
5	Area and Depth of Recharge		
6	Cost of Recharge (Personal recharge		
7	Water well cement sealing		
8	Remarks		

2.4.1 Questionnaire Analysis

Codes were generated for specific features and tables and graphs were prepared based on the percentage of the available features in the study area. Based on this technique it became possible to display the information in a quantitative and measurable form.

2.4.2 KAP about RWH Structures among the public

The respondents were asked about the RWH system for improving groundwater recharge to check on their awareness about depleting groundwater levels. Most of the people in all three watersheds are aware of structures like sump, open /recharge well and Rooftop harvesting, but less 50 of respondents were aware of recharge/percolation pit and even lesser amount i.e. less than 20% were aware about recharge well with bore pit this was more so in urban areas.

2.4.3 Type of RWH structures, design details and costs

The respondents were asked about the cost, type of the RWH structures, its design details and the period of implementation. It was found that They require to invest around Rs.10,000 to 30,000 on an average to install a recharge structure at personal level. Most of the people are opting for roof top harvesting only.

The details of implemented RWH structures in all three i.e. Coastal, Urban and Rural watersheds are represented in Figure 2.65, Figure 2.66 and Figure 2.67 respectively.
In coastal watershed, 61% of respondents have implemented open well through filter, 25% recharge well and 14% percolation pit and only 1 % recharge well cum bore pit.

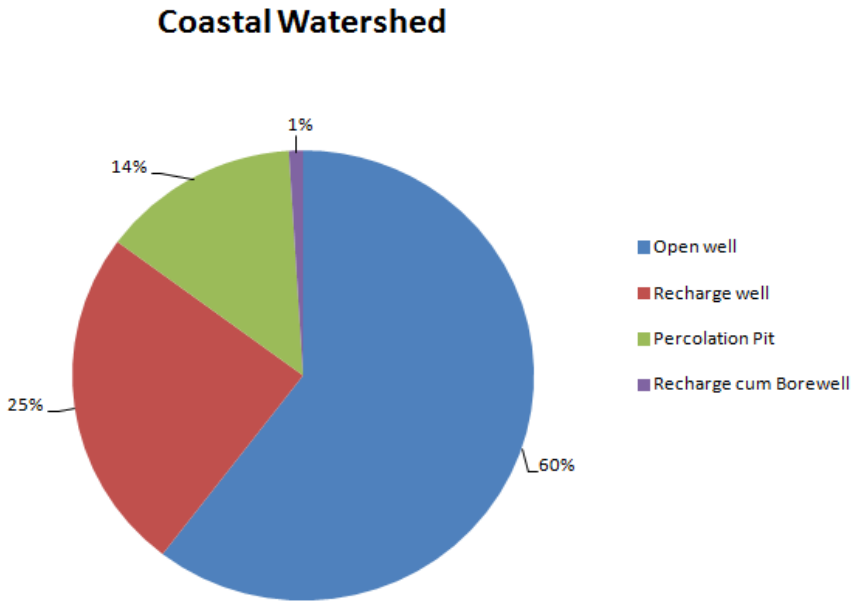


Fig. 2.65 Chart of Implemented RWH structures in Coastal Watershed

But, in urban watershed, 52 % of them have implemented open well, only 9 % recharge well and 38 % percolation pit and only 1% recharge well cum bore pit.

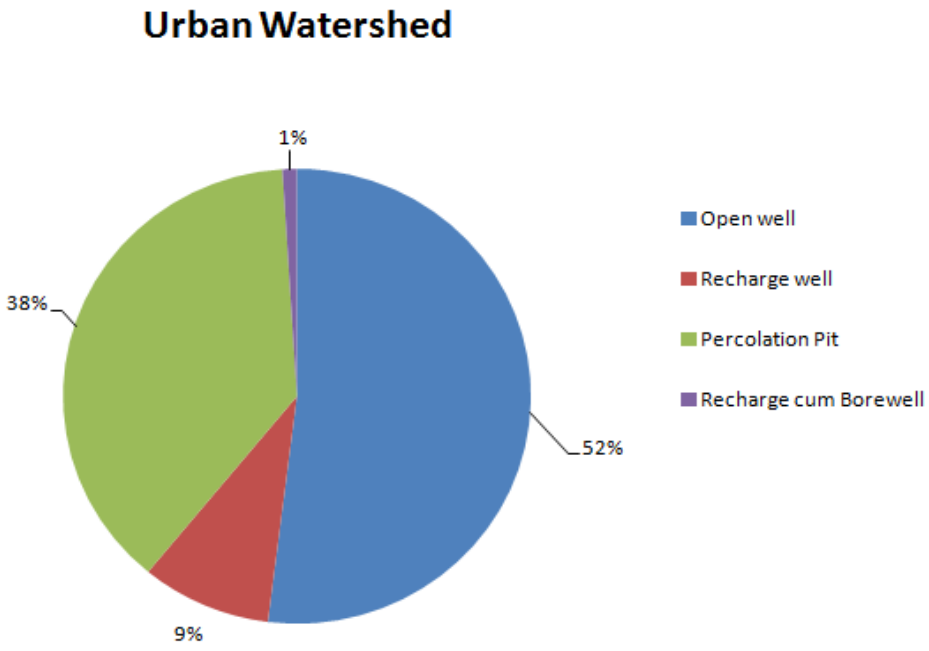


Fig. 2.66 Chart of Implemented RWH structures in Urban Watershed

In sub urban / Rural watershed, 74 % of respondents have implemented open well through filter, only 18 % recharge well and 6 % percolation pit but only 2 % recharge well cum bore pit.

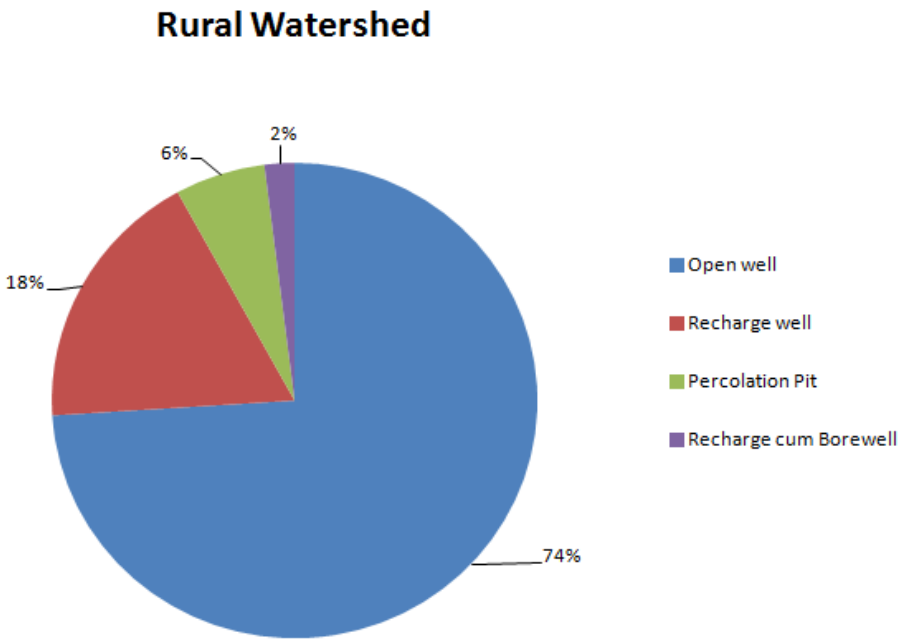


Fig. 2.67 Chart of Implemented RWH structures in Rural Watershed

Fig 2.68 Questionnaire Survey at Anjar

2.5 LAND USE / LAND COVER

Sikdar and Chakraborthy (2004) investigated on landuse / land coverage in Ranigang area (1972-1998) and also groundwater potential zoning for future development using remote sensing and GIS. The study indicated that land covered vegetation and settlement has decreased at the expense of mining activity. For delineating groundwater potential zone overlay analysis using multicriteria such as drainage, texture, geomorphology, lithology, land use and steepness of slope and were utilized to understand the potentiality of groundwater for future development.

Adam Johnson, Dennis D. Truax, Charles G. O'Hara, John Cartwright (2001) applied the technology of Remote sensing, GIS for land use and land cover mapping along the i-10 corridor. For an environmentally sensitive area on the Mississippi Gulf Coast, ongoing research studies the changes in land cover for the area with particular emphasis on changes that have occurred related to completion of Interstate 10. Analyses of population and demographic information, existing land cover data, and non-spectral retrospective research illustrate that the area has changed dramatically in the past thirty years as evidence by a population increase of around 50%. These preliminary studies have detected the growth and change, but the lack of spectral analysis precludes the identification of spatial patterns of growth and change for the area. Spatial patterns of population growth and land cover change were identified through exploratory analyses, land cover classification, and change detection analyses conducted on multitemporal Landsat TM data. Exploratory analyses included creating tasseled-cap transformations and normalized difference vegetation index (NDVI) products of the Landsat TM image data. Tasseled cap transformation was used to enhance spectral information of Landsat TM data and to subdivide the landscape into

water and non-water areas. The tasseled cap transformation optimizes data viewing for vegetation studies, a task essential for ecosystem delineation as related transportation system impact analysis. In this study, three specific bands were used with reasonable success to correlate soil, wetness, and vegetation. Tasseled cap results and changes in values with time were used to assess changes in environment. These changes were compared and contrasted to changes in Normalized Difference Vegetation Indices and results were used to assist in subdiViding areas on the landscape prior to classification. Combinations of supervised and unsupervised classifications were conducted to define land cover and land use types for the area. The resulting products of the exploratory analyses and classification were then used to assess spatial patterns of land cover and land use change for the area.

Daniel ayalew mengistu, 2008. Investigated a Remote sensing and gis-based Land use and land cover change detection in the upper Dijo river catchment, Silte zone, southern Ethiopia. In this study changes in land use and land cover which occurred between 1972 and 2004 in the Upper Dijo River catchment, located in the middle Rift Valley system of Ethiopia, were monitored. The main objective of the study was to assess and evaluate the extent and direction of changes in LULC in the Upper Dijo River catchment, to explain the changes and identify some of their effects on both the livelihoods of the local people and the local environment, and also to explore some of the conservation measures designed to overcome problems associated with land use and land cover changes. Aerial photographs taken in 1972, an EROS-1 satellite image from late 2004 and also geographic information system (GIS) techniques were used to monitor the changes and to generate maps of the LULC of the area in these periods. Information on the socio-economic conditions of 120 selected households and the

results of tests on soil samples taken from a depth of 30 cm at four different land use sites were used to identify the underlying factors and explain the effects of LULC changes. Observations showed that in the 32-year period between 1972 and 2004 shrub-grassland and riverine trees covers had decreased at a rate of 21.5 and 16.3 ha per year respectively. Riverine trees suffered the greatest devastation and by 2004 had been reduced to only 16% of their cover in 1972. In contrast, eucalyptus tree plantations, annual crops and bare land/open grassland cover increased at a rate of 2.8, 12.5 and 24.8 ha per year, respectively. Correspondingly, bare land/open grassland increased by 344.5% at the expense of shrinking shrub grasslands, and have expanded in uninhabited areas.

Selçuk Reis, 2008. Analyzed Land Use/Land Cover Changes Using Remote Sensing and GIS in Rize, North-East Turkey. For this purpose, firstly supervised classification technique is applied to Landsat images acquired in 1976 and 2000. Image Classification of six reflective bands of two Landsat images is carried out by using maximum likelihood method with the aid of ground truth data obtained from aerial images dated 1973 and 2002. The second part focused on land use land cover changes by using change detection comparison (pixel by pixel). In third part of the study, the land cover changes are analyzed according to the topographic structure (slope and altitude) by using GIS functions. The results indicate that severe land cover changes have occurred in agricultural (36.2%) (especially in tea gardens), urban (117%), pasture (-72.8%) and forestry (-12.8%) areas has been experienced in the region between 1976 and 2000. It was seen that the LULC changes were mostly occurred in coastal areas and in areas having low slope values.

N. Nagarajan 1, S. Poongothai, 2011. Studied the trend in Land Use/Land Cover Change Detection by RS and GIS Application in Manimuktha sub-watershed of Vellar basin, Tamilnadu, India. The relationship between Land Use Changes and its trend were analysed using IRS IC LISS III and PAN merged data. Further, the preparation of LU/LC map using Survey of India (SOI) Toposheet for the year 1972 were used to know the past land use pattern. Similarly, the Land Use/Land Cover (LU/LC) map of various years, namely, 1996, 2003 and 2007, were digitized using Arc GIS software. It was concluded that about 52.89 per cent of land is devoted to agricultural practices under agriculture and cropland has a major impact over the hydrological processes of the basin. Hence, the information obtained from change detection of LU/LC aided in proViding optimal solutions for the selection, planning, implementation and monitoring of development schemes to meet the increasing demands of human needs has lead to land management.

Muthusamy.S, Rosario Arunkumar.X, 2010. Studied Land Use and Land Cover Changes Detection Using Multitemporal Satellite Data, Cuddalore Coastal zone , Se-Coast of India. The Coastal zone under study was suffered from many natural catastrophes such as storms, cyclones, floods, tsunami and erosion. The study area was seriously affected by 2004 Tsunami and during 2008 Nisha cyclone. Multitemporal Landsat satellite data (1977, 1991 and 2006) was used for the study. Based on the quantitative analysis on LULC , it was observed that a rapid growth in built-up land between 1977 and 2006 while the periods between 1977 and 2006 witnessed a reduction in this class. Landsat satellite data using remote sensing and GIS proved that the model can be employed under different climate changes as well as management scenarios for developing adaptation strategies for this study area.

Alaguraja .P, Yuvaraj.D , Sekar.M Muthuveerran.P, Manivel .M , Thirunavukkarasu. A , 2010. Studied Land Use and Land Cover Mapping of Madurai District, Tamilnadu, India Using Remote Sensing and GIS Techniques. Preparation of various thematic data such Land use and Land cover was done using Landsat data. Supervised classification was used for the generation of the LULC map and their areas were found. The satellite imagery was downloaded from GLCF (Global Land Cover Facility) web site. The land use and land cover map clearly showed that area of crop land is higher than others.

Saroj, M.P. Sharma, Ravindra Prawasi, 2015. Studied Land use /land cover change detection using remote sensing & GIS in Rohtak and Jhajjar districts of NCR, Haryana, India between 2005-06 to 2011-12 . The study involved the use of IRS-Resourcesat-2 (LISS-III) data through which they demonstrated the scope, methodology and outcomes of land use/land cover change mapping of Rohtak & Jhajjar district in Haryana. The data was interpretated using hybrid approach for the mapping of various land use/land cover categories on 1:50,000 scale. The land use/land cover classes in the study area were divided into seven categories. They concluded that the agriculture land decreased between 2005-06 and 2011-12 and through their study they managed to point out some Major changes from 2005-06 to 2011-12 for the built-up, agriculture land, water bodies and wasteland.

Ravindra Kumar Verma et al. 2013. Made use of remote sensing and GIS technique for efficient urban planning in india. This was an attempt to improve the performance ability of municipalities/urban local bodies, so that they would be able to discharge their duties efficiently in the planning and development of urban areas. However,

most studies undertaken to assess the functioning of municipalities in India, point out that the municipalities are confronted with a number of problems, such as non-availability of data, ineffective participation in the decision-making process despite adoption of the policy of reservation, delays in the transfer of funds to the municipalities despite constitution of State Finance Commissions, poor recovery from various tax and non-tax sources despite devolution of power etc. Remote sensing data allowed them to collect lot of physical data rather easily, with speed and on repetitive basis, and together with GIS helped them to analyze the data spatially, offering possibilities of generating various options (modeling), thereby optimizing the whole planning process. These information systems also offered interpretation of physical (spatial) data with other socio-economic data, and thereby provided an important linkage in the total planning process and making it more effective and meaningful.

G. Sreenivasulu et al. 2013. Had done an Analysis on Land Use/Land Cover Using Remote Sensing and GIS in and Around Vempalli, Kadapa District, Andhra Pradesh, India. covering an area of about 711 sq. km. to study and assess some of the natural resources and environmental potential of study area which was falling in the Survey of India toposheets No: 57 J 07 and 57 J 11. Three thematic maps such as location map, drainage map and land use / land cover maps were prepared. The land use and land cover analysis on the study area had been attempted based on thematic mapping of the area consisting of built-up land, cultivated land, water bodies, forest and uncultivated land using the satellite image. The research concluded that there is a rapid expansion of built-up area. Land use and land cover information, when used along with information on other natural resources, like water, soil, hydro-

geomorphology, etc. can help in the optimal land use planning at the macro and micro level.

2.5.1 Data Set

A Spatio-temporal analyisis of landuse landcover is carried out using satellite data for the period of 1990, 2000 and 2015.

Table 2.22 Satellite Data Sets

Sensor type	Resolution	Acquisition date / Path Row	Bands	Usefulness
LandSat 7 Landsat 8	30 mtr	2/11/1990 18/10/2000 22/10/2015 (Post Monsoon); 150 P 44 R	8 11	Delineating larger features like agricultures fields / cultivated and uncultivated lands, larger waterbodies and mudflat areas etc.
Google Earth (Free Online Source)	0.5 to 2.0 mtr	From 2000 to 2015	Colour Image	Identifying smaller features like roads, railways tracks, industries and settlement boundaries, small water bodies etc.

2.5.2 Spatio-Temporal Analysis of Landuse /Landcover in Study Area

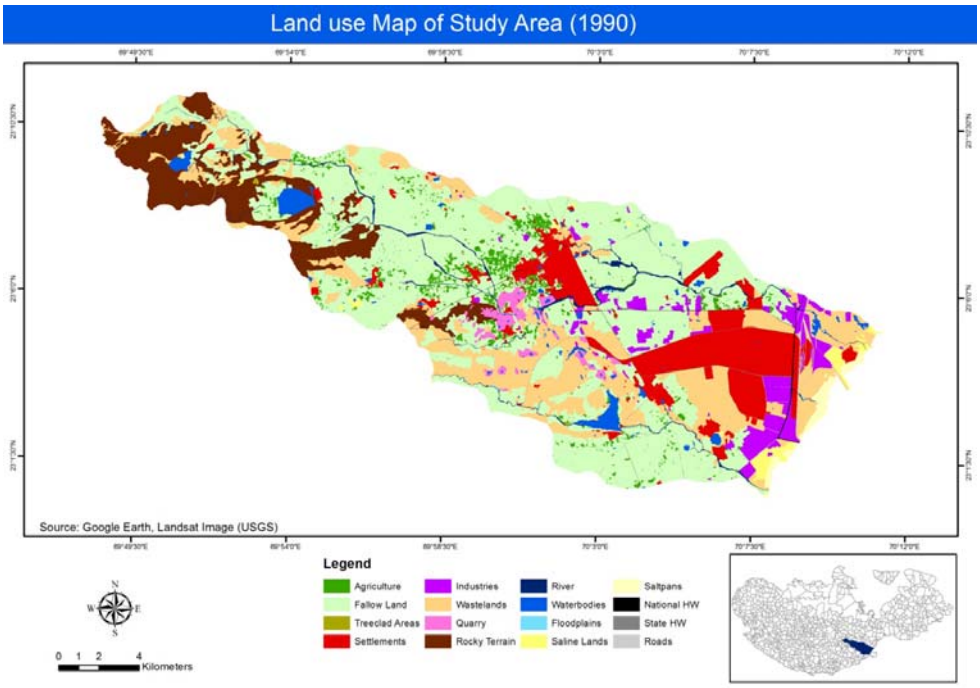


Fig. 2.69 Land use Map of Study Area (1990)

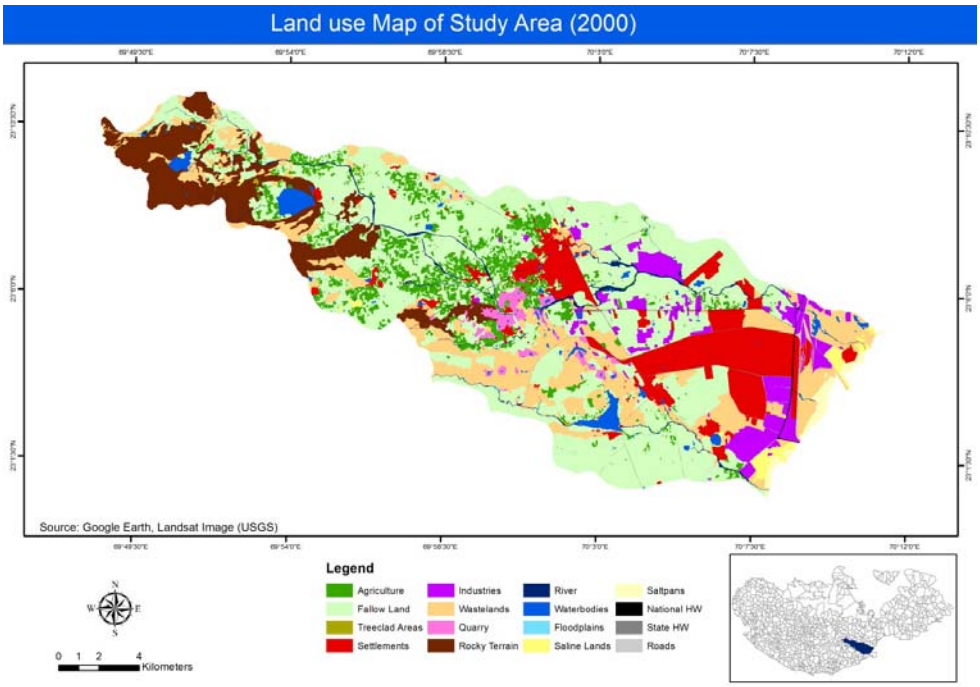


Fig. 2.70 Land use Map of Study Area (2000)

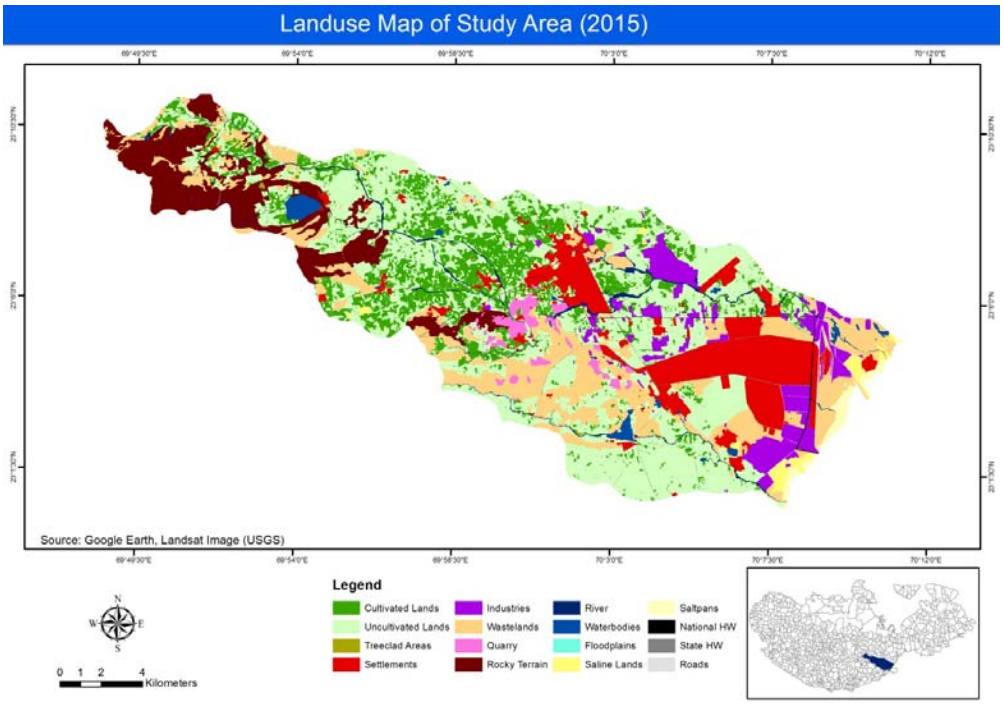


Fig. 2.71 Land use Map of Study Area (2015)

Table 2.23 Change in Landuse from 1990 to 2015

Legends	1990		2000		2015	
	Area (SqKm)	Percentage	Area (SqKm)	Percentage	Area (SqKm)	Percentage
Agriculture	10.32	3.18%	25.24	7.79%	43.43	13.40%
Fallow Land	143.40	44.25%	130.37	40.23%	112.77	34.80%
Floodplains	0.06	0.02%	0.06	0.02%	0.06	0.02%
Industries	14.87	4.59%	16.84	5.20%	18.01	5.56%
National HW	0.63	0.20%	0.63	0.20%	0.63	0.20%

Quarry	4.83	1.49%	4.47	1.38%	4.49	1.38%
River	5.12	1.58%	4.39	1.36%	4.39	1.36%
Roads	1.82	0.56%	1.82	0.56%	1.82	0.56%
Rocky Terrain	31.01	9.57%	31.02	9.57%	31.02	9.57%
Saline Lands	4.02	1.24%	3.38	1.04%	3.57	1.10%
Saltpans	2.80	0.86%	2.80	0.86%	2.80	0.86%
Settlements	35.65	11.00%	36.78	11.35%	37.43	11.55%
State HW	0.87	0.27%	0.87	0.27%	0.87	0.27%
Tree clad Areas	0.14	0.04%	0.14	0.04%	0.14	0.04%
Wastelands	61.41	18.95%	58.13	17.94%	55.33	17.07%
Waterbodies	7.12	2.20%	7.11	2.19%	7.30	2.25%
Grand Total	324.07	100.00%	324.07	100.00%	324.07	100.00%

2.5.3 Interpretation

It can be interpreted from the results that there is marginal increase in total agriculture land including fallow land from 1990 to 2015 i.e. 47.43 % in 1990 to 48.2 % in 2015. The land utilized for the expansion of the agriculture activities seems to be mostly coming from the wasteland as it is seen that there is a little decrease in the wasteland from 1990 to 2015 within the study area (i.e. from 18.95% in 1990 to 17.07% in

2015). There is also an increase seen in the total industrial area (i.e. 4.59% in 1990 to 5.56% in 2015) and total built-up area (i.e. 11.0 % in 1990 to 11.55 % in 2015) between these period. The other parameter like road, railway, floodplains, rocky terrain, tree clad areas, waterbodies, quarrying activities, river does not seem to have any major visible changes at this scale within these time frames. However there has been a little increase in the saline area over the period of 1990 to 2015. These may be attributed to the salt work activities, sea water ingression due to over exploitation of the water in some places within the study area.

Field Photographs:

Fig. 2.72 Exposed Rocky Terrain

Fig. 2.73 Agriculture Field

Fig 2.74 Fallow Land

Fig 2.75 Flood Plains

Fig 2.76 Industries

Fig 2.77 Settlements / Village Area

Fig 2.78 Village Lake / Water bodies

Fig 2.79 River

Fig. 2.80 Saline Lands

Fig. 2.81 Salt works / Saline area

Fig. 2.82 Tree Clad Area

Fig. 2.83 Wastelands

Fig. 2.84 Road Network

Fig. 2.85 Quarries

2.6 SUMMARY

Hence from the population and agriculture census analysis we can understand the impact of groundwater on the residents of the villages and its growth pattern. This will assist us to prioritize the work of implementing the RWH system for future developments.

Data collected through the questionnaire is not only important to analyze the behavior of already implemented RWH but also helps in design new RWH. This would give us a better understanding of type, size, depth and area of RWH that should be considered while considering new RWH system.

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