Ecosystem Services, Poverty and Global Change:
Understanding links in Gujarat desakota areas of India
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Contents

A. Introduction

Desakota, an Indonesian word, means village-town. Thus the rural area having a characteristic of urban area is categorized under it. The natural as well as human resources are stressed at its optimum level to support the changing economic structure, like water of the area have to support the households and agriculture along with industries. On the other hand, these industries not only use the resources but dispose. Apathy of these areas is these are still considered as rural areas and the development plans are structured accordingly.

Most of the available studies have explored human pressure on ecosystem services in urban setups but the dynamics of this relationship remains relatively unexplored in the desakota areas that are in process to urbanization. The dual influence of traditional rural norms and the novel urban factors on the social, economic and ecological systems triggers unique responses from the human system in terms of changing interaction, dependence and demand of vital ecosystem services. The current study takes an insight into the changing status and condition of ecosystem services in these areas. The objectives of the study are to:

- Conduct preliminary assessment of the impact of global environmental change and political economy factors on the water based ecosystem services in these areas undergoing a process of urbanization and, in turn the poverty
- Highlight the gaps that exist in the secondary literature and ground reality in these areas on the marked issues.

B. Methodology and Data Aspects

Information and data related to the subject and area was collected from various government and non-government organizations. Also, web-based literature was reviewed on macro level, like information on policies, rules, acts and schemes for natural resources especially water resource management in India as well as the state level. This preliminary review helped to frame strategy to select desakota areas.

Based on the Ramachandran's definition and classification of rural- urban fringe, the method for demarcation of desakota area was devised. A three level selection procedure was followed to select areas.

Level 1: Sabarmati Basin Area: The basin in Gujarat state with a rectangular corridor of 175 km by 75 kms, presents a unique combination of vulnerable environment and ecological variables, making it ideal location for the current study.

Level 2: Ahmedabad-Gandhinagar Districts: The selection was limited to desakota areas surrounding Ahmedabad city. A total of three talukas from these districts were selected based on demographic features, i.e. Sanand and Daskroi taluka from Ahmedabad district and Gandhinagar taluka from Gandhinagar district.

Level 3: Selection of villages from the selected districts: Based on the change in landuse pattern and male working population in last decade - 1991 to 2001, two villages from each of the selected talukas were selected.

The selected villages for detail investigation include:

i. Lapkaman and Chosar villages from Daskroi Taluka
ii. Matoda: and Navapura villages from Sanand Taluka
iii. Tarapur and Jakhora village from Gandhinagar Taluka

Both primary and secondary data was collected for accomplishing the objectives of the study. The primary data on the demographic, social and political economy factors selected during preliminary survey was collected through various focus group discussions and semi- structured interviews with community groups from selected villages. This primary data was complemented with secondary data collected from various government and non-government organizations. Secondary data was collected at different levels: research reports, working papers, statistical information and policy documents. Finally the data was analysed to highlight the knowledge gaps that exist between the published data and the ground realities in regard to the water based ecosystem services

C. Sabarmati River Basin: It's Present and Future Prospects

a. Physical Attributes of the Sabarmati River Basin

Located in northwestern India, Sabarmati basin comprises of area from Rajasthan and Gujarat state. In total, Gujarat accounts for 17550 km^2 of total catchment (81%) area of the basin. Before empting itself into the Gulf of Cambay in the Arabian Sea, the river passes through Gandhinagar and Ahmedabad city of Gujarat State. Average temperature of the basin ranges from 25° C to 27.5° C, with an average annual rainfall of 750 mm. High co-efficient of variation of rainfall in the basin results to droughts in the basin. The river is perennial in nature with three smaller sub-basins namely: Dharoi, Hathmati and Watrak. The average annual surface water resources of the basin in Gujarat have been estimated to be 3,256 million cubic meters (MCM), while the average recharge of the groundwater is estimated to be 2,570 MCM per year.

b. Demographic Attributes of the Sabarmati River Basin

In 2001, the basin's population was 11.75 million, of which 11.44 million in Gujarat. The per capita water availability in the basin is 324 m^3/person/year, which is the lowest in India. About 52 percent of the population in the basin is urban, all of which lives in Gujarat. Ahmedabad alone accounts for 74.2 percent of the basin's urban population and 35.7 percent of the basin's total population.

c. Economic Attributes of the Sabarmati River Basin

Agriculture accounts for 57 percent of the total geographic area of the basin. The cropping pattern shows a significant change over the years with commercial agriculture being predominantly practiced in areas close to the urban centres. Kharif and rabi season are the main cultivation seasons, summer crop depends on the

availability of irrigation facility in the area. About 19 percent of the land in the basin is not available for cultivation. This land is either naturally hostile to cultivation (barren, hilly, marshy, saline) or it has been developed (build up areas, roads, railways and other uses). Rest 24 percent is forest and pastures.

Within the Gujarat portion of the basin, there are 11 major and medium irrigation projects, five diversion projects, and many minor projects. In addition to the irrigation projects, the basin characterizes significant inter-basin transfer through network of canals and reservoirs, which import water from the Narmada River and the Mahi River.

The region is witnessing industrial boom with water intensive industrial units coming up at rapid pace irrespective of the limited surface water supply. The basin supports a large diversity of industries comprising of both large and small scale textile industries followed by chemical industries, dairy and alcohol being other industries. In addition to these industries industrial estates developed by Gujarat Industrial Development Cooperation (GIDC) have come in all urban centres in past two decades.

d. Basins' Water and its Uses

In general, 85 percent of rural drinking water comes from groundwater; rest is supplied from basin's surface water. In the Sabarmati river basin's urban centers, the majority of current water demands are met through a combination of groundwater wells and surface water imports. About 85 percent of the basins' groundwater is used for irrigation, while 15 percent is used for industry and domestic purposes. Of 921 villages affected by poor groundwater quality in the basin, 58 percent are affected by fluoride, 23 percent by salinity, and 19 percent by nitrates.

D. Existing and Emerging Ecosystems Trends in the selected Region (Sabarmati Basin)

a. Groundwater Status: Trends in Groundwater Development

The basin have a high yielding aquifers, despite this the ground water resource of the region is fast declining because of extraction of the ground water at a rate which far exceeds the recharge. Depleting state of groundwater in the region is evident from the fact that out of 6 districts falling in the basin, 3 namely Banaskantha, Gandhinagar and Sabarkantha are "over exploited" (draft >100% of recharge). At the taluka level out of 29 talukas, 8 are "over exploited" (draft >100% of recharge), 3 are in dark category (draft >85% recharge) and 5 in grey category (draft between 65- 85% of recharge). Declining water table is not the only issue related to ground water in the region, scarcity of water is further aggravated due to deteriorating water quality. The groundwater in the region is affected by multiple quality issues and suffers from high salinity and high fluoride and nitrate content making it unfit for domestic use.

b. Trends in Ecosystems Change

Various central and state government programmes are initiated towards ecological regeneration of natural resources, like Joint Forest Management (JFM), Integrated Watershed Development Programme (IWDP), and Participatory Irrigation Programme (PIM). Also, the Gujarat Ecological Commission (GEC) has formulated SEAP (State Environmental Action Plan), through which it has assessed the major environmental problems in the state and accordingly initiated an action plan. All these programmes has not only helped to restore the ecological balance in an area but also created immediate employment for the local people. Also, the assets generated through these programme have stabilized the employment and livelihood of people. Increased production of fuel wood and fodder through JFM programmes, and promotion of local water harvesting structures has enhanced the availability of fodder, fuel wood and water to a large section of people in villages. Easy accessibility of basic necessities has created positive impact on health and literacy of people in some cases.

c. Implications of Climate Change

The Global climate models (GCMs) and Regional climate models (RCMs) predict rising temperature and changing monsoon pattern for India. The climate change vulnerable regions of India include drought- prone areas including the States of Gujarat and Rajasthan and the flood- prone areas comprising of the north- eastern part.

In last 10 years (1997-2006), Gujarat has experienced cyclone (1999), droughts (2000, 2002), earthquake (2001) and floods (2000, 2006). A statistical analysis of the last couples of decades shows that the intensity and return period of major drought events has increased substantially, showing correlation with climate change impacts. The drought of 2001-2002 has affected 39.23 percent of the total population and 38.48 of the livestock of the State.

Contrasting to this observation of increasing intensity of the drought, the state currently is witnessing an increased occurrence of flood. In synchronization with the RCM predications of increased rainfall in the western region of India; the state has witnessed plenty of rainfall and five consecutive years of flood.

It can be predicted that similar trends would be witnessed in the Sabarmati basin although the uncertainty attached with climate change can result in contrasting scenarios. A study on climate change impacts on the hydrology of India reveals that the rainfall in Sabarmati basin will show an approximately 39% decrease from normal scenario to GHG scenario. A similar decline of about 57% and 33% is seen in river runoff and evapo-transpiration, respectively. Thus, this changing pattern of occurrence of extreme climatic events in the basin has serious implications on the social, ecological, economic and political scenario in the basin, as each of these aspect tries to reorient in a manner to cope with the changing climatic scenario.

E. Characteristics of Selected Districts – Ahmedabad and Gandhinagar

a. Introduction to the Study Area

Ahmedabad district, located in North Gujarat, encompasses a total area of 8087 km2. The district has 11 sub- districts. Ahmedabad city is the major urban centre of the district and is witnessing rapid expansion. The district is bestowed with Sabarmati River and other seasonal rivers like Meshwo, Sukhbhadar and Bhogavo.
Gandhinagar is an administrative capital of Gujarat, situated at the western bank of Sabarmati River. The district encompasses an area of 2163 km2. Gandhinagar is bestowed with Sabarmati, Meshwo and Khari rivers.

b. Demographic Details

The total population of Ahmedabad district as per the Census of 2001 was about 58.16 lakhs[1]. The district has been showing a growing trend towards urbanization as the urban population has risen from 78% during 1991 census to 80% during 2001. The sex ratio of the district is 892. The literacy rate in the district is 69.5 as per the 2001 census. However, the literacy among male population is as high as 76.4 percent, whereas only 62.7 percent of total female population is literates. Occupation attributes of the district follows the population composition, as 87.3 percent of the population is with non-agricultural sector (Census 2001). It was 75.9 percent in 1991. There are 3166 primary schools and 736 secondary schools in Ahmedabad district (2000-01).
According to the 2001 Census the total population of Gandhinagar district is 13.34 lakh. The urban population has risen from 29% in 1991 to 35% in 2001. This occupation feature of the district is also changing as the percentage male main working population 59 percent in 2001. The sex ratio of the district is 912 and the literacy rate is 76.6 as per 2001 census. There are 976 primary schools and 175 secondary schools in the district.

c. Performance of Agriculture

The share of employment at agricultural sector has declined rapidly from 22.29 percent in 1991 to 18.18 percent in 2001. In 1995-96, about 44.86 percent operational landholdings are of small and marginal farmers (less than 2 hectares) who operate only 13.1 percent of the cultivable area of the district. The net area sown is 62.5 percent of the total area of Ahmedabad district, of that only 26.2 percent is irrigated. Irrigation intensity of the district is 123.04 percent. The major sources of irrigation are tubewells & other wells (80.8 percent of net irrigated area), followed by canals (18.65%) and tanks (0.53%). About 48115 tonnes of fertilizer is used in Ahmedabad district. In total there are 9896 tractors in the district, 12076 oil engines with pumping sets and 6837 electric pumps in the district (as per the livestock census, 2003). There are 14002 dugwells in the district (2001-02), which irrigates 59200 hectares of gross irrigated area. The district has 2381 tubewells, which irrigates about 77500 hectares of gross irrigated area.

Agriculture sector in Gandhinagar uses 19521 tonnes of fertilizer. The district has 3762 tractors, 287 oil engines with pumping set, 5501 electric pump sets (2003). The district has 2171 dugwells and 5446 tubewells for irrigation purpose. Dugwells irrigate 4500 hectares and tubewells irrigates 123900 hectares of gross irrigated area in the district

[1] 1 lakh = 0.1 million

(2001-02). The net area sown in the district is 73.8 percent of the total area of Gandhinagar district, of which 56.04 percent is irrigated. Irrigation intensity2 of the district is 143.46 percent. The only source of irrigation in the district is tubewells and other wells, which irrigates 89500 hectares of the net cropped area. Agriculture sector employs more than half of the total working population of Gandhinagar district, which is 51.24 percent. The share of agricultural labourers in the agricultural workforce has decreased from 22.94 percent in 1991 to 21.65 percent in 2001. In 1995-96, about 71.35 percent of operational landholdings were of small and marginal farmers accounting for just 36.9 percent of the total cultivable area of the district.

d. Industries

As per the CMIE data, there are 314 working factories in Ahmedabad district, which employs 18219 persons (2000-01). Number of registered SSI units in the district is 6591 (2202-03). Similarly, Gandhinagar district have 203 working factories employing 12914 persons (2000-01). Number of registered SSI units in the district is 61185.

e. Migration

About 83.4% of the migrants in Ahmedabad district are engaged with secondary and tertiary sector (other than HH industry). About 12.6 percent of the migrants in the district are agricultural labourers, followed by 3.27 percent of the cultivators.

Similarly, 80.7 percent of the migrants in Gandhinagar district are engaged in secondary or tertiary sector. About 14.06 percent are agricultural labourers, 4.25 percent cultivators and rest workers in household industry. Its shows that mobility is high among the people engaged with secondary and tertiary sector.

f. Infrastructure

The road density of the Ahmedabad district is 0.42 per sq.km and of Gandhinagar district is 0.91. All the villages in Ahmedabad district and about 97 percent of the villages in Gandhinagar are electrified by 2001-02.

g. Water Resources: Demand, Supply and Distribution

The water supply within Ahmedabad city limits is catered by Ahmedabad Municipal Corporation (AMC), which is dependent on both surface water and groundwater sources. The rural water requirements are mostly catered through a total of 404 regional water supply schemes, reaching to 4675 villages. Irrigation water for agriculture is supplied to the rural areas of the district mainly through the Fatehwadi canal but this supply is always complemented with groundwater extraction from private and community bores present in the villages.

The water supply to Gandhinagar city is managed by the Gujarat State water Supply and Sewage Board (GSWSSB), Gandhinagar. The daily domestic water requirement of the city is 460 LPCD. This water requirement is jointly met by surface water and groundwater supplies but the dependence on groundwater in the area is very high, 76% of the water use is from borewells (1999). As regard agricultural, the cropping intensity is 116% with groundwater being the only source of irrigation in the district.

[2] Irrigation intensity = Gross Irrigated area/Net Irrigated area x 100

h. Groundwater condition of the area

With a groundwater development of 92.6% Ahmedabad district falls in the "dark" category as per the Central Groundwater Board (CGWB). The gross groundwater draft of the district is 701.7 MCM with gross annual withdrawal exceeding 90% of utilizable annual recharge (UNICEF/IRMA, 2000). Water quality is highly deteriorated. The groundwater drawn for domestic water supply to the urban residential area has high TDS level exceeding the permissible limit of 2000ppm in almost all areas (Moench et al 2003). Besides this out of 360 villages of the district, 359 are affected by fluoride, 34 with nitrate and 83 with salinity problem (WASMO, 2003)

Gandhinagar district falls in the over-exploited category as per the CGWB classification for groundwater development. The gross groundwater draft is 130.35 MCM/ year resulting in declining groundwater levels and it faces a water deficit of 41.09 MCM/year (CGWB 1997). The depleting water table also has an adverse effect on the water quality. Out of 168 villages in Gandhinagar district 132 villages are affected by fluoride, 32 with nitrate and 9 with the problem of salinity (WASMO, 2003)

i. Key stresses due to human interventions

The urban- rural mix that is evident in desakota areas result in unique stresses on ecosystem services. As the area has to support industries along with agriculture and domestic, the existent water resources of the area have to be shared with new user – industry. On the other hand, these industries are also contributing to large scale deterioration of the water quality in the area as they usually dispose their waste water in existing surface or ground water. Deterioration in water quality inflicts a chain of events adversely impacting the health of the entire ecosystem. A direct consequence of deterioration of water quality is land degradation, reducing its productivity.

Urban influence and accessibility to technology further add on to the stress on the water resource in the area. Technologies like borewells and pumps are making, even the otherwise inaccessible water resource accessible to people thus, resulting in water mining in the region.

This water resource use scenario in the area of interest, clearly presents the enormous pressure that exists over the resource. As water becomes scarce and technology is growing the access to the resource has become a function of capital power, resulting in inequitable use of water. This has an important implication on the social system and is a potential source of conflicts between various resource users.

Besides these, another aspect which remains mostly untouched is the requirement of water by nature, the natural flow of water required for the sustenance of the ecosystem is often compromised for meeting human water requirements. This practice has serious long term implications which might lead to total lapse of the ecosystem.

F. Sampled Villages from the Selected Desakota Area: A Micro Level evidence

Considering only the male main working population (as available in Census), it is evident from the table below that number of villages in Class III has increased in all the selected talukas. Also, the total villages in Class II and Class III have increased in last census decade. This shows that vicinity to urban centres has changed the occupational pattern in the village – a step forward to urbanization.

Table 1: Number of Desakota Villages in Selected Talukas

Name	1991		2001	
	Desakota I (25-50% Main Non Agri Male Workers)	Desakota II (50-75% Main Non Agri Male Workers)	Desakota I (25-50% Main Non Agri Male Workers)	Desakota II (50-75% Main Non Agri Male Workers)
Daskroi Taluka	29	13	26	19
Sanand Taluka	13	1	29	8
Gandhinagar taluka	44	8	39	17

Source: District Census Handbook, 1991 & 2001, Ahmedabad and Gandhinagar district

The following table gives the detailed information of the villages. Other than demographic and economic features, and available amenities in the villages, the last column presents the impact of urban influence in the villages.

Village (1)	General features (2)	Demographic Attributes of the Area (3)	Economic Attributes of the Area (4)	Amenities in the village (5)	Impact of urban influence (6)
Lapkaman	A village in Daskroi taluka of Ahmedabad district 12km from Gota char-rasta	Total population: 1856 Total households: 400 150HHs Patel's and Thakore's, 20HHs Rawad's, 10HHs Vankar's, 10HHs Rabaris, 7HHs Kumbhar's and 45 HHs other castes Sex ratio: 719 Literacy Rate: 68.3% Current trends show emphasis on female education	Livelihood Basket Composition: 60% population in agriculture, 15% agricultural laborer, 25% in industrial labour Shift from agricultural to non agricultural sector although agriculture still principal occupation Occupational shift attributed to proximity to Vadsar Industraial area and Ahmedabad district. Youth prefer working in industries over working as agricultural labourer. Women also work in industries. Growing real estate market, thus massive sale of land only 10% is left under agriculture Agriculture mostly rainfed and mostly complemented with dairying and work in industries 25,000l/day milk supplied to cities, but decrease in agriculture also affecting this secondary source of income because of limited fodder supply Increase in neelgai population also working against agriculture.	Primary school, Higher secondary school, post office, PHC centre, Veterinary centre, para- medical college and district old- people house present A complete village water supply system exists. Water from the village over tank filled through borewell, is supplied to the houses through a network of pipeline and received through taps. MLA fund, village development fund used to maintain the water supply system as well as village ponds.	Diversifying livelihood basket with an occupational shift Enormous rise in land prices from 5-6 lakh/ *bigha*[3] to 1 crore/*bigha* in last 2 years due to growing real estate market thus, rapid sale of agricultural land to builders Money earned by sale of land invested in improving economic status, buying vehicles and reconstructing houses Rise in non-farm businesses, due to easier accessibility to city through cheap transport like jeeps, autorickshaws owned by village people Industrialization has adversely affected the natural habitat of stags who have shifted to agriculture land destroying the crops.

[3] I bigha = 0.22 hectares

					Advent of Narmada water canal has led to rise in water table although groundwater quality is under a potential threat because of illegal injection of industrial effluents in groundwater.
Chosar	A village in Daskroi taluka of Ahmedabad district Locate on the bank of Khari river at a distance of 18km from Ahmedabad city, 10 Km from Aslali village and 5km from GIDC, Vatva	Total Population: 1979 Total Households: 371 15years ago 60HHs were BPL while now only 8HHs Sex ratio: 867 Literacy rate: 70.7 Minimal education to children and then sent to industries for work	Occupational shift of male population to non agriculture sector from 36.62% to 74.93% in last decade. Role of women in agriculture is rising Livelihood Basket Composition: agriculture (25%), dairying (secondary activity), industrial workers 225hectare under agriculture, change in crop type pure paddy production currently, expansion of agricultural area with the advent of narmada water. Fertilizer and water intensive agriculture 3-4 cattle/ HH although with decline of agriculture decline in livestock has been initiated. Milk production: 1200l/day sold to buyers from ahmedabad at Rs.19/litre GIDC Vatva, Narol, Aslali and Isanpur major industrial centres generating employment for people of village undertaking daily movement to these industries Lack of agricultural labour attract tribal migrants from Dahod to village for working as agricultural labour	Primary school present in the village Water supply system: Narmada water supply for irrigation, drinking water supply from the village overtank filled through village borewell A waste water drainage system exists but it discharges water directly into Khari river All houses have motor bikes an each individual has cell phone. Bikes facilitate daily movement to industries 5 cars present in village	Diversifying livelihood basket. A negative landuse change could be attributed to eucalyptus plantation No land sale as such has been witnessed although people are looking forward to it Rise in water level with the advent of Narmada canal shift from 300ft to 150ft. But deteriorated water quality, high in fluoride and salinity. First water of the day is red in color Chosar presents a case of extreme water contamination due to unsafe disposal if industrial effluents into the groundwater
Tarapur	A village in Gandhinagar district Located next to Gandhinagar-Ahmedabad highway	Total population: 2274 Total Households: 650 150-200HHs- Patels and Thakores each, 50HHs	Shift of male workers to non- agiculture sector- rise from 25.1% to 56.4% in last one decade. growing women participation in agriculture Livelihood Basket Composition: 10% people involved in agriculture, 70% industrial labourers and 20% workers in brick	Village has a primary school and PHC centre while high school and post office are present 1km away in Adalaj village Residents receive tap- water in their compound/common	Diversifying livelihood basket and changing land use Rise in land prices from 2-3lakh/ bigha to 22-25 lakh/bigha 60% land sold to builders Money from land sale used

		Rabaris, 70HHs Dantanis, 10HHs Nais, 40HHs Prajapatis and 80 HHs other Castes Sex ratio: 934 Literacy rate: 73.3% male-female gap in literacy: 14% Higher education of girls is limited	manufacturing unit Small landholdings, rising cost of agriculture and increasing work opportunities in neighboring cities have led to occupational shift The village and surrounding area is a brick manufacturing zone with 25 units around Tarapur. These units attract seasonal migrant labourers from MP and Rajasthan. Agricultural lands are also rented to these units Private salons and rearing goats are other income generating activities in village	point in each community from a village overtank of 40,000litre capacity, 3 hours a day. Drinking water mixed with narmada water. Tanker water supply has been used for last 3 years to meet the village water demand in summers	to initiate non- farm business, intercity transport thus, facilitating daily migration Infocity development has led to habitat loss of stags which has adversely affected agriculture Critical state of groundwater due to high fluoride content and future threat of scarcity due to use by brick making units Illegal water use from village sewer for cultivation
Jakhora	A village in Gandhinagar district 12-13km away from Chiloda char rasta A regular supplier of vegetables to Ahmedabad city	Total population: 2205 Total households: 400 150- 170HHs each Patels and Thakores 50- 60HHs other castes including nais, rabaris and ST 30-40HHs are BPL HHs Sex ratio: 994 Literacy rate: 78.9%	The male working population has shown a shift to secondary and tertiary sector; 13.77% in 1991 to 47.7% in 2001, shift is attributed to proximity to urban centre and naroda industrial area Livelihood basket: Agriculture principal occupation, dairying, agriculture labour, Industrial labour 70% of total agriculture land is irrigated during rabi season and 20% in summer while kharif crop totally rainfed Vegetables are primary agriculture produce. Agriculture is fertilizer intensive, use of chemical fertilizers being doubled in last decade Total livestock has increased in last few years due to increase in irrigation facilities and thus, land under fodder. Milk production 6000litre/day 100-125 youth go to nearby industrial areas for work Lack of agriculture labour in village have inflicted seasonal immigration of laborers from Rajasthan, Panchmal and Godhra	Primary school, PHC Centre and milk cooperative present in the village. Secondary school 2-3km away. Tapped water supply to all houses from village overtank of 1 lakh/ litre capacity filled by means of a village borewell 80 tubewells in the village Autorickshaws, jeeps and GSRTC bus are cheap mode of transport Motorbikes present in each house 600-700 mobile phones and 100 landline connection 40 tractors, threshers and trailors	Greater connectivity with the urban centre has increased area under vegetable production. 2 vans engaged for regular supply of vegetables from the village to Ahmedabad market Middlemen play a key role between contactor and villagers for employment in industries. Cell phone is use for contacting contractor and villager as and when labour is needed 60% village land sold to builders, land prices have risen from 5-6lakh/bigha to 1 crore/bigha and even higher right next to the highway Groundwater level has improved due to Hathmati water canal from 600ft to

			districts.		45ft. Salinity of water has risen and land productivity has decreased as a consequence of usage of this water 500-600 immigrants/ season to this village
Matoda	A village in Sanand taluka of Ahmedabad district Located at a distance of 25 km from Ahmedabad city	Total population: 1856 Total households: 341 250HHs Patels, 20-25HHs Parwa, 100HHs Vagri, 15 to Bhangi, 5 HHs to Nayak, 10 Nais and 1HH chamar BPL: 10- 15 yrs ago 45HHs and now only 5 HHs Sex ratio: 915 Literacy Rate: 53.8	Occupational shift for male working population to non agriculture sector from 12% to 27% in last decade Livelihood basket: Agriculture, livestock rearing, agriculture labourers (especially women) and industrial jobs. Total irrigated area 150- 200hectare. Declining agriculture due to high cost and degraded water quality Livestock rearing and dairying a major source of income generation. Village has a Mahila Sanchalit Matoda Doodh Utpadan Dairy. Cow dung cakes mostly used as fuel Growth of chemical and pharma industries in and around the village, Cadila, Nirma, Modern, Disham etc.	Primary school uptil 7th standard and a village community hall present and village milk cooperative Water supply: pipeline supply network not used, village well used for drinking water and village pond is the place for washing, bathing and and cattle drinking water Fatehwadi canal water used for irrigation along with pond water 100 water pumping machines There are 250 bikes, 5 jeeps and 65 tractors in the village	Livelihood diversification. Landuse change of 13.87% 30% of village land sold to GIDC Sanand Increased connectivity through autorickshaws, MTS bus Water level not a concern but quality deteriorated due to discharge of acidic water from the industries Air pollution due to emissions from chemical industries Mechanized agriculture Rise in land prices from 30000/ bigha to 3-4 lakh/bigha
Navapura	A village in Sanand taluka of Ahmedabad Located at a distance of about 17 km from Ahmedabad city	Total population: 3005 Total Households: 587 259HHs Thakores, 115HHs Patels, 30HHs each Rawad, Bhoi, Darbar and SC/ST BPL: 90HHs in 1991 and 70 HHs now	Occupational shift for male working population to non- agriculture sector from 29% in 1991 to 59.4% in 2001 Livelihood basket: Agricluture (25- 35%), Agriculture labour, industrial workers and small scale business in city A shift from vegetable cultivation (Navapura known for brinjal 20yrs ago) to Paddy, wheat and fodder cultivation, due to deteriorating land and water quality ,higher occurrence of disease and thus,	Village primary school till 7th standard and village common hall present Water supply: People receive water in houses in taps from the over tank of the village filled by village borewell at the cost of Rs.50/ year Narmada water supply not taken by the village	Diversifying livelihood basket. Landuse change of 14.03% Enormous sale of agriculture land Money from sale of land used for buy cars and building bunglows (thakores), Patels invest their money in buying land at cheaper price in near by

		Sex Ratio: 931 Literacy Rate: 67.5 Emphasis on education but only a few girls sent out of the village for higher education	rising cost of production Immigration of Dahod tribals for working agriculture labourers Declining livestock rearing due to declining agriculture. Fodder preferably saled in Bavla, Sanand or Daskroi APMC Industrial growth of chemical and pharma industries in the surrounding area generating employment for villagers and a major pull factor for migrants from UP, Bihar and MP	Around 500 borewells in the village for irrigation Village has 350 bikes and 100 cars There are also 6-10 computers in the village	areas Water quality deteriorated, high fluoride content Air pollution due to emissions from nearby villages MTS, autorickshaws and private vehicles facilitate daily migration of people to city centre Presence of bhajan mandals and women saving groups; saving used for religious donations Water for irrigation sold at Rs.25- 30/hour

G. Knowledge gaps and challenges

a. Conceptual

Rural population show direct dependence on natural ecosystems. All their livelihood options are linked directly to ecosystem and hence their well being is a direct function of the ecosystem health. Any macro- level change, be it social, political or economic will manifest at micro level in the form of changing human behavior which will inflict a subsequent change in the ecosystem. Poor people who are most closely associated with the ecosystems get directly impacted by this ecosystem change. Changing economic approach promoting rapid industrialization serve as a strong pull for the people and result in occupational change in the rural areas, but this growing industrialization hampers the sink capacity of the ecosystems leading to air, water and land pollution as evident from our case studies with a clear gap of assessing extent. This in turn indicates gaps in consequences of pollution on the marginalized classes who rely directly on nature for their subsistence and have limited access to modern technologies (water purifiers, filters) and health facilities.

Although this inter-linkage between human well being and ecosystem health has been well established but the policy as well as the development planning fail to take this vital interlinkage into account. The accountability of this interrelationship is an even bigger challenge in mixed economies i.e. the Desakota Areas. Thus, the developmental planning of these areas in the back drop of rural areas (as they are considered in census) is not justifiable. The diversified livelihood basket, changes the resource utilization as well, water resource which in rural areas is mostly used for domestic and agricultural purpose is to a large extent diverted to industrial use along with domestic and agricultural uses in desakota areas. Thus, there is need to identify desakota targeted planning and management for maintaining the ecological resources.

b. Institutional

There are host of policies and acts at national level which govern management of ecosystems desakota areas directly or indirectly. This include the National Water Policy (2002), National Agriculture Policy (2000), National Environmental Policy (2004), Tariff Policy (National Electricity Policy), Water (Prevention and Control) Act, 1974 and Groundwater Regulations. These policies are aimed at environment conservation, sustainable and economic development. At the same time there are various programs and policies at the state level which operate under overall framework of national policies. These include, for example for Gujarat, Regional water supply Schemes (RWSS), Accelerated Rural Water Supply Programme, Swajaldhara Programme, Sujalam Sufalam Yojana, Industrial Policy of Gujarat, (2000), and Agro- industrial Policy (2000). The policies aim to cover all the aspects of conservation and development. However, the challenge remains in horizontal and vertical integration of these policies and programmes for overall development in Desakota areas. There is need for assessing scope for synergies and integration of policies and programmes. In addition, there is need to understand the type of community and market based models that will work.

c. Natural and Social Scientific Knowledge Systems

Better planning and management of ecosystem demands collection of data as well as integration of data from various sources for knowledge creation useful for decision making, implementation and monitoring. The data on various aspects including natural science--Global environmental change and ecosystem health and status, political science and economics are present in a highly scattered form, ranging from crude government data to highly specific project and annual reports of work done by NGOs as well as government bodies. The gap is in matching data/ knowledge demand with scale of decision making.

d. Data Issues

Consistency and comparability of data are two major issues arising because of diverse sources of data on same parameters. For example, Census data being available at decadal interval fails to account for changes in landuse and population parameters at intermediate intervals. Besides this, census only cover primary occupation of a person and fails to capture the diverse occupations in which the rural people engage during the year. Migration tables do not take into account the daily migration and covers migration if it is more than six months. Thus, these are some of the data inaccessibility issues.

H. Linkages: Desakota characteristics, Ecosystem Services and Poverty

Desakota Criteria (sub-characteristics observed)	Water ecosystem service	Poverty
1. Greater Connectivity—physical, electronic and cultural. • Good road network • Public and private transport facilitates daily movement • Television and cell phones accessible to all	• Connectivity promotes diversification of livelihood basket as evident from all villages. A mix of agriculture and industrial activity increases the water demand. In villages Matoda and Navapura the groundwater resource is being used by both villagers for agriculture and industries for industrial processes. Thus, overall water demand increases. • Facilitates accessibility to alternative sources of water like water tankers as observed in Tarapur • Promotes commercialization of agriculture sector thus, making it more water intensive as evident in Jakhora famous for vegetable cultivation	• Greater connectivity provides employment opportunities, greater access to health and education facilities although education still not a primary concern. In Jakhora village cell phones serve as important mode of information dissemination regarding job opportunities in an industry. People from Navapura go to Ahmedabad city in case of serious health ailments and access to the city is facilitated by private vehicles as well as cheap transport like autorickshaws and jeeps • Alternatively, it facilitates in-migration into the villages and as evident from Navapura 5 families who have migrated to Navapura from Bihar, MP etc. are BPL HHs, thus connectivity facilitating in-migration might lead to increase in poverty
2. Greater penetration of cash economy, with remnants of exchange and reciprocity mechanisms on the decline. • Labor terms are mostly cash. • Traditional access to tubewells for irrigation water in exchange of agriculture produce weakening • Services are cash based	• Although electricity is priced but inefficient subsidies and flat rates are responsible for over- extraction and wasteful use of groundwater, thus decline in water table as evident in all villages. • On the other hand nominal cess rate of Rs. 14/ year for Naramada water supply has led to rise in water table in villages like Matoda and Chosar • Fodder is generally sold at nominal prices to landless people while fuel requirements are complemented by the cheap fuels like cow dung cakes.	• Penetration of cash economy is disadvantageous to the poor because earlier large farm owners used to allow them to cut fodder free of cost • Agriculture labour was given a share of foodgrains which helped them sustain their living while payment in cash is not sufficient to meet all needs • Lack of money also restricts them from access to irrigation water as water is also priced and thus, contributes to growing poverty. In Navapura, people who don't own tubewells are charged Rs25- 35/hr and it takes 3 hours to irrigate 1bigha so the overall irrigation becomes expensive

3. Mixed livelihoods drawing upon local as well as non-local service, and manufacturing sector opportunities. • Substantial remittances from migrant workers. • Household members engaged in a variety of non-farm livelihoods.	• Diversifying livelihood basket involving industrial as well as agricultural activity increase the overall demand of water. • In-migration (Navapura and Tarapur) leads to population rise thus, more food demand and higher water consumption for agriculture • Discharge of industrial effluents into groundwater seen in all villages lead to groundwater contamination • Direct discharge of domestic waste water in surface water bodies like ponds in Matoda and Navapura and river like Khari in Chosar lead to surface water pollution	• Provides better work opportunities in industries , higher income generation; Rs.10,000 to 15,000/ month income of a family with men working in industries and women engaged in agriculture in Chosar, thus help in alleviating poverty • Industrialization is generating income but also impacting human health through air and water pollution, flourosis, gallstones are common ailments. Chosar is a clear case of these health problems where each member suffers from joint pains. People here are compelled to drink contaminated water as they don't have access to any alternative. • Work pressure on women increases as they play a greater role in dairying as well as agriculture making them vulnerable to body ailments
4. Greater diffusion of modern production and resource extractive technologies. • Tubewells and Borewells main water extraction technologies. • Chemical fertilizers in use. • Tractors ubiquitous. • Use of crop harvestors	• Tubewells and borewells along with subsidized electricity are two technologies currently leading to groundwater mining • Cheap cost of chemical fertilizers, increased fertilizer input to agriculture land led to land degradation thus, demanding even higher water inputs • Crop harvesters reduce fodder yield thus separate cultivation of fodder leading to increased water use • Over- extraction of water adversely affected the water quality, high fluoride and nitrate content and salinity are common issues	• Penetration of modern technologies has widened the economic disparity • Poor farmers becoming landless subject to erosion of asset base • Modern technologies have provided access to even inaccessible groundwater resource, this groundwater mining has affected the water quality, poor people due to limited access to fuel as well modern technology (for water purification) are left with no option to use polluted water for domestic purpose. • Farm mechanization have increased the cost of production as was complained by poor farmers in Navapura village thus, threatening food security as well as making it an expensive activity for small landholders. Thus, reducing net income for family

5. Greater penetration of formal institutions existing in a transformational tension with traditional informal institutions • Village panchayats for water supply • Groundwater markets • Bhajan mandals Self Help groups, Saving groups	• Village panchayats have not been efficiently able to maintain quality and quantity of water supply as seen in Navapura where water is priced at Rs.50/year irrespective of water utilization by people leading to overuse of water. • Lack of irrigation water distribution systems between u/s and d/s fields leads to wastage of water as seen in Chosar where water to the downstream farm reaches only if upstream farmer allows	• Increased social cohesion • Water pricing effects the accessibility to water and leads to inequitable distribution of water. • Women saving groups, save money, in Navapura the saving is Rs. 4000/ month and this money is given to the distressed families when need arises, thus, it serves as a helping hand for the poor.

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