
An Action Plan to Combat Salinity in

Hansot and Ankleshwar talukas, Bharuch District, Gujarat, INDIA.



PREPARED BY

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&

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Preface

Society has two basic resources - Human and Natural. The sustenance and development of humankind depends on how we use and develop our natural resources. The quality of our interaction with natural resources will determine the quality of life of our present as well as future generations. Hence we are not only the owners but also the trustees of our natural resources. They may satisfy our present needs but we also have to think about needs of our future generations.

It is with this enlightened public interest that, Mr. D. A. Anandpura, Chairman of Ankleshwar Environmental Preservation Society and former chairperson of Ankleshwar Industries Association (AIA) spearheaded the effort to address the issue of growing salinity in large portions of agriculture land and water resources of Ankleshwar and Hansot blocks of Bharuch district, Gujarat.

Ankleshwar and Hansot regions, like most of the regions covered by irrigation networks in the country, face the problems of water logging and salinity. The farmers in the region, though aware of the problem were silently suffering, some of them with the attitude of – *gain now worry later*, while some – *problem is too large for our resources and efforts*. Most of them expected Government to take the initiative and resolve the problem.

All this changed with Mr. Anandpura taking the lead in bringing farmers, Government officials and technocrats together and mobilise resources to initiate the process of preparing a long-term action plan for a long-standing problem. Gujarat Narmada valley Fertiliser Corporation, Gujarat State Fertiliser Corporation – Science Foundation, Notified Area Development Authority, Ankleshwar and Oxfam(U.K.) joined the effort by providing financial support for the project.

A private sector initiative for a public cause.

The project preparation followed participatory process combining traditional wisdom and knowledge base of the local farmers and expertise of research and development organisations, academic institutions of both Government and non-Government organisations. The planning process also tried to synthesis information from the field with modern technology of remote sensing.

Out of total the geographical area of 79,842 ha. and cultivable land of 59,761 ha., half i.e. 29,271 ha. is affected by water logging and salinity. The rate of deterioration doubled in last five years (1992-97) compared to the previous five years (1988-92) leading to greater loss of economic and asset base for the local farmers.

The Action Plan presents the extent, nature, and trends of the problem and analysis of the causes for the same. The plan proposes a systemic solution for a systemic problem by enlisting institutional and technical recommendations and solutions with financial resources for the same.

The spirit of the Action Plan is to promote regeneration and development of natural resources through participatory process in a sustainable manner.

The effective and successful implementation of the plan primarily depends on the leadership and participation of local farmers. The initial part of preparation of the Action Plan is over which will be followed by crucial phase of operationalisation of the same. Looking at the scale and nature of the problem in this endeavor, concerned people from both, public and private sectors will have to forge partnerships and multiply their strengths and resources.

It is hoped that successful implementation of the plan through public and private partnership will setup new trends in addressing the problem of water logging and salinity in general and natural resources in particular.

We are extremely thankful to Mr. N. K. Nawadia, Chairman Ankleshwar Industries Association, and Shri. Kamlesh Udani, Past President, Ankleshwar Industries Association, Shri. A. A. Panjawani, Honorary Secretary of Ankleshwar Environmental Preservation Society, and all the office bearers of the Association, leading industrialists, Trustees of AEPS, and local leaders of the area who provided valuable support to this study and also made significant contributions in the developing an appropriate Action Plan.

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Project Sponsored By:

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Gujarat State Fertilizer Corporation, Science Foundation, Vadodara.
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1.1 Water-logging and Salinity - a Cause for Concern

Rapid growth of population puts pressure on basic natural resources - land and water. These resources are scarce and hence with conventional modes of their utilization, it shall soon become difficult to sustain growing needs of the humankind.

Soil is the basic natural resource on which rests the edifice of agricultural productivity. With the increase in pressure on the existing arable land, the crop production demands greater use of inputs such as water and fertilizer. The irrigation projects with extensive canal networks are being implemented to augment agriculture productivity of arid and semi-arid regions. Along with increasing agriculture productivity, the overuse of irrigation waters leads to associated problems of water logging and salinity. According to study done for delineation of waterlogged areas by Water and Planning Consultancy Organisation (WAPCOS), India –

Estimates of waterlogged areas have ranged from 4.84-M ha by the Irrigation Commission (1972) to 6.0-M ha by the National Commission on Agriculture (1976) and 8.53-M ha by the Ministry of Agriculture (1984-85). These estimates cover waterlogged areas due to surface flooding and rise in water table both in and outside the canal commands. As per the Working Group Report (1991) of the Ministry of Water Resources (MoWR), the waterlogged and salt affected areas are estimated to be 2.46 and 3.30-M.ha respectively, in canal commands. Considering the fact that about 15% of the net canal irrigated area (about 17-M ha) is already affected by water logging, threat to the sustainability of the irrigated agriculture is quite obvious.

Gujarat state alone has 1.2 million ha. of saline and waterlogged soils which is either barren or is sparsely covered by native tree species, which have little economic or ecological value.

1.2 Ukai-Kakarapar Canal Command Area:

The irrigation project commissioned in the year 1957 was fully completed by 1998. The total planned GCA and CCA of the project are 6,08,799 ha. and 3,31,557 ha. respectively, Out of 3.3 lakh ha. CCA, about 1.0 lakh ha. Kakarapar and 1.18 lakh cover area ha. by Ukai canals. The total command is served by four main canal systems, which includes Ukai and Kakrapar Right Bank canal (UKRB).

According to one study by WAPCOS, the problem of waterlogging exists in about 1,19,000 ha. Of this, about 19,000 ha is critically waterlogged (water table depth of 0 to 1 m b.g.l.) and about 1,00,000 ha is waterlogged with water table depths in the range of 1 to 2 m b.g.l. About 30,000 ha. i.e. 26% of the total waterlogged area have brackish ground water. The estimated waterlogged area for UKRBC is 61,625 ha.

1.3 Ukai -Kakrapar Right Bank (UKRB) Canal Command Area:

In south Gujarat region, the Ukai- Kakrapar Right Bank main canal system irrigates the area located between the rivers Kim and Narmada. In this region the canal infrastructure became operational in the year 1974, initially as seasonal and after about 10 years period as perennial irrigation system.

After the introduction of canal irrigation, the people have switched over to water intensive crops like sugarcane, banana, paddy and wheat. Over a period of last 25 years it is observed that the water table in the region is rising at an alarming rate of 0.3 Mts. per year.

Approximately 46,000 ha. of land in the Ukai-kakrapar command area i.e. 64.32% of Gross Command Area (GCA) have a severe problem of water logging and 72.2% of GCA is affected by salinity. The hydro-isobath prepared in pre-irrigation survey indicates that the water table of 79.5% area of GCA was below 6 Mts. In 1988, the area with water tables below 6mts. in the pre-monsoon period was reduced to only 21.5 % of GCA. (Source: The Soil Survey Unit, Kakrapar Irrigation Project, Surat.)

1.4 Hansot and Kosamba branch canal command (Hansot and Ankleshwar talukas):

Hansot and Ankleshwar talukas, located on southwest corner of Bharuch district is also covered by the irrigation project (for Location refer Map). Though the region has benefited from the project, it also faces similar problems of waterlogging and salinity, experienced by other projects elsewhere in the state and the country.



MAP SHOWING LOCATION OF ANKLESHWAR AND HANSOT TALUKA

Salinity problem in the land and water resource system of the area has of late become acute and its intensity and spread are increasing at an accelerated rate, leading to decline in agriculture productivity and income and more importantly the erosion of asset-base of the farmers.

1.5 A Private sector Initiative for a Public Cause:

With the issue acquiring serious proportions, a need for a comprehensive action plan was felt more than ever before. In response to this, Ankleshwar Industries Association (AIA) decided to take the initiative to address the issue. Normally it is believed that such problems can and should only be addressed by the Government or research institutions. Contrary to this AIA, a private sector organisation took the initiative by organizing two meetings on the subject during the months of March and April 1999.

The meetings were attended by about 60 participants representing local farmers, voluntary organisations, industries, Government officials, semi - Government corporations, technical and academic institutions. During the discussions it was observed that though some understanding about the nature and extent of the problem and possible solutions exists, a comprehensive plan of action was required to effectively address the issue.

Salinity is a dynamic character of the land-water resources of the area. It is therefore essential that these natural resources are understood and the role of factors causing salinity identified. The human induced causes that have aggravated the hazard are to be studied in conjunction with the natural ones. The mitigation approach has to evolve out of the genetic nature of the causes and pattern of the problem.

With this broad understanding, the task of preparing the Action Plan was jointly entrusted to SAVE - Saline Area Vitalization Enterprise, Ahmedabad and AEPS - Ankleshwar Environment Preservation Society, Ankleshwar.

In order to ensure greater participation of all concerned a Consultative Committee comprising of representatives of various interest groups was constituted. (Names of the Committee members are enclosed in Annexure-1.)

This was followed by preparation of detailed Terms of Reference for the planning exercise and the actual project work began from 1st December 1999. (The detailed TOR is enclosed as Annexure-2.)

2

Conceptual Framework and The Expected Outputs:

2.1 Natural Resource Degrading as Process:

Degrading of natural resource is a process and not a product. It is a verb and not a noun. This process occurs over a period of time with a combination of natural and human activities. The type and intensity of interactions with natural resources i.e. land, water and bio-mass decides the impact created on surrounding places and people. This impact both irreversible and reversible is felt over a period of time and across generations.

The degeneration of natural resources is a complex and systemic problem and requires a systemic response.

Upgrading of natural resources is also a process and not a one-time activity. Moreover, in most situations the solutions to the problems go beyond the actual location and problem affected people and hence demands involvement and commitment from all concerned, for a sustained period of time.

However, the people whose survival & sustenance are linked with the natural resources in question are the first & primary stakeholders in the reversal & regeneration process. They should be and have to be the prime mover of the process of regeneration of natural resources. The role of the external agencies i.e. Government, technical research and academic institutions, industries and NGOs, should be one of promoting and strengthening the efforts of local people by creating enabling environment and technological, financial and organisational support system.

2.2 Need for Organisational, Technical and Financial Support System:

Though, to address the issues of degeneration of natural resources require technical solutions and financial resources, for effective resolution of the problem, appropriate and strong organisation and institutional structure is a precondition. The implementing organisation must have adequate representation and ownership of local people.

The technological aspects of the programme the effective solutions can only emerge with the synthesis of tradition knowledge based and skills of the local people and inputs from research and development organization and institutions.

Further, financial resources for such programme should be mobilized both internally and externally. The resources should be managed on a sustainable basis such that the programme activities support the organisational systems from internal revenues.

It is within this conceptual framework the problem of growing salinity in Hansot and Ankleshwar talukas was studied and solutions designed.

2.3 Expected out Puts:

- Ascertain the extent, nature and trend and impact of the problem of salinity.
- Identify the factors, both human and natural, responsible for the problem.
- Spell-out strategy to address the issue.
- Suggest technical, financial and organisational measures to reverse the process of salinity and regenerate the natural resources.
- Action plan with details of various activities to be carried out at various levels of operations, broad financial requirements, time - frame and organizational structure.

3.1 Participatory approach:

The effectiveness of such initiatives largely depends on genuine involvement and participation of all concerned. As observed earlier, the problem of salinity can not be addressed without the involvement of local people, Government organizations, technical and research institutions, local industrial community and Non-Government Organizations. They all must be involved in defining the problem as well as designing the solutions, as they all can contribute to the process through their immense experiences and knowledge base. This participatory and inclusive approach was followed through following phases of the planning project.

Further, the process of preparing the Action Plan was also utilized to lay foundation for implementation phase of the project.

3.2 Assessment of the Present Status:

An Assessment of the present status of the problem of salinity as well as its impact on the economy of the region was made. For this purpose, information was collected through secondary sources as well as consultations with local people, Government officials and research and academic institutions.

3.2.1 Collection of information from all 102 villages of the Study Area.

In the initial period of the planning project, the members of the project team organized visits to all the 102 villages of the study area. Basic information about the villages in terms of people, cropping pattern, the status of land and water resources, efforts made by the local people to address the problem of salinity was collected.

The exercise involved meeting the local Government functionaries, representatives of village panchayats and groups of progressive farmers. The observations of the visits and status of land resources in terms of degree and type of soil salinity were documented on village revenue maps.

3.2.2 Participatory Rural Appraisal exercises in select 20 villages.

Based on the initial visits to the villages and consultations with Government officials from Irrigation and Drainage Departments of Government of Gujarat and available socio-economic information of the region, PRA exercise was carried out in 20 selected villages. The exercise involved resource and social mapping, carrying out transact and documenting local people's knowledge about the problem and solutions. A brief report on the exercise is enclosed as Annexure-3.

3.2.3 Case study of progressive farmers, irrigation co-operative societies / Sugarcane processing unit / Cotton ginning units:

Detailed case studies of progressive farmers were carried out. Some of them even contributed in form of written papers on the subject of salinity - causes and solutions. Similarly, case studies of *Piyat Mandalies* - Water Cooperative Societies were carried out to understand the role and effectiveness of the organisation of local people in managing the irrigation infrastructure and water resources.

Further, the regional level organisations including sugarcane processing units and cotton ginning mill were studied as examples of farmers-owned, farmers-managed economic enterprises.

3.2.4 Group discussions with villagers:

Followed up by village studies and PRA exercises in 20 villages, two taluka level consultations were organised to revalidate emerging understanding on the problem of salinity and possible solutions for the same. About 60 farmers representing major villages of both the talukas, Government officials from irrigation and drainage department and representatives of AIA attended these meetings.

3.2.5 Formation of Clusters:

With number of studies, consultations and field visits a broad picture of the problem of salinity was developed. In order to study the issue in greater depth and evolve an implementation strategy the villages of both talukas were grouped in clusters of villages.

Cluster here, means a conglomeration of villages, which were formed on the basis of commonality in the type of problem, physical connectivity in terms of irrigation and drainage infrastructure and social composition. A total of 19 clusters comprising of 102 villages were identified. The lists of villages covered in each cluster are enclosed as Annexures.

Followed by this, a detailed exercise to ascertain the extent, degree and spatial distribution of salinity was carried out. Based on this typology of clusters in terms of level of salinity was worked out.

3.2.6 Detailed planning exercise with a cluster of six villages:

This was followed by an exercise to prepare a detailed plan of action for one cluster of villages. The representatives of farmers, Government officials and project team jointly carried out the exercise in the cluster which include Motvan, Rohid, Kalam, Kudadra, Kathodara & Valner. The exercise produced the extent and degree of degraded land, its causes, possible solutions and costs involved in improving the condition.

Based on the exercise broad estimates of technical and financial inputs for all the clusters of villages and the entire project were prepared. The exercise also helped in designing the system for preparation of detailed planning for other clusters in the region.

3.2.7 Use of Remote Sensing Data:

Simultaneously, in order to understand the history and trend of the degradation process, satellite data covering the period between 1988 and 1997 was studied. This involved preparing base map followed by detailed land use maps for the 3 time periods viz; 1988, 1992 and 1997. Apart from understanding the present status of the problem of salinity, the information collected would be useful in future to monitor the impact of proposed Action Plan.

3.3 Exploring alternative appropriate solutions:

Following assessing the extent, nature and type of salinity problem and its causes, efforts were made to explore solutions a) to stop and b) to reverse the process of salinity. This involved consultations with experts belonging to different disciplines, including, agriculture, irrigation, geo-hydrology and organisation & management.

3.4 Financing Plans and organisational setup:

An activity plan with time frame and costs estimates have been prepared for all the clusters requiring inputs to address the problem of salinity. The estimates of physical interventions are based on extrapolation of the work done in one cluster of villages and the study of information collected from different field exercises. In addition to this, the design of organisation structure and the costs for project management has been worked out for the entire duration of the project.

4 The Context:

4.1 Location

Geographically, the area is located between N 21⁰25' – 21⁰40' Latitudes & E 72⁰35' – 73⁰10' longitudes. It forms the southern part of the Mainland Alluvial Gujarat. The rivers Narmada and Kim provide natural physiographic as well as administrative boundaries in the North & South respectively. The Arabian Sea defines the western boundary whereas the rocky highlands make up the eastern boundary. Hence, the region forms a natural system that receives inputs from all sides.

The rivers that originate from the Eastern Highlands flow through this area and have deposited huge thickness of alluvium, laden with nutrients, which have made the land fertile. Nearer to the

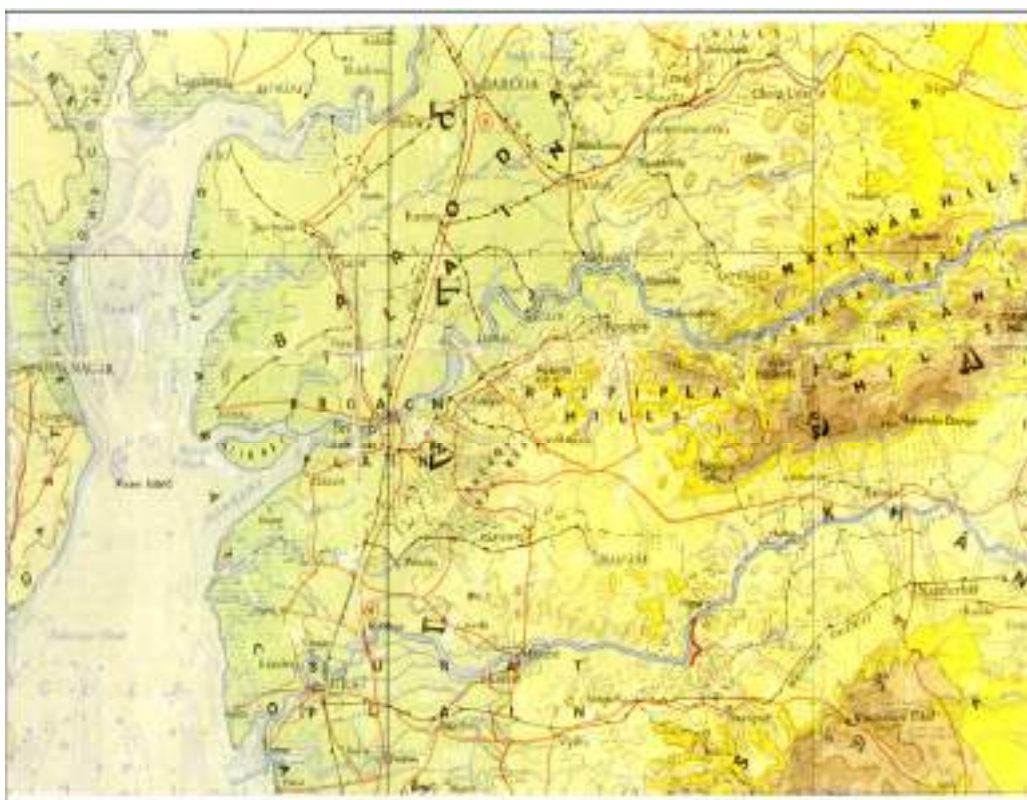


Fig. 2 Physiographic Map of the study area.

coast, the area experiences to and fro action of the sea. The seawater ingress through the creeks and estuarine zones during high tides and recedes during the ebb, thus allowing to and fro movement of the material and water leaving the inundated areas saline

4.2 Primary information:

The area under study has total population of 3,05,387 persons with Ankleshwar and Hansot taluka having 2,47,237 and 58,141 persons respectively. The total numbers of villages are 102 spread over a geographical area of 81,820 ha. Ankleshwar has 56 villages with geographical area of 41,940 ha. While Hansot has 46 villages with 39,880 ha.

Name of the Taluka	Population			Area (ha.)	No of Villages	
	Total	Male	Female		Total	Coastal
Ankleshwar	2,47,237	1,28,563	61,710	41,940	56	10
Hansot	58,141	29,984	28,157	39,880	46	16
Total	3,05,378	158,547	89,867	81,820	102	26

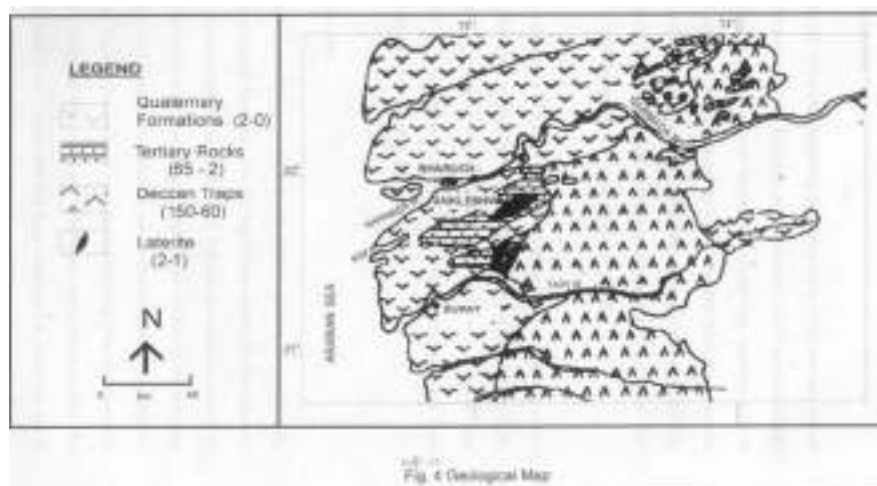
Source: District Census 1991

4.3 Climate

The study area experiences sub-tropical, sub-humid climate. The climatic characterizations of the area as observed at Bharuch IMD station for 1931-60 show that the maximum daily means temperature is 35⁰C and the minimum is 21⁰C. The percentage of humidity is 71 to 42. The average annual rainfall is about 1000 mm and the number of rainy days is 45. The maximum and minimum rain recorded was 1644mm and 425mm and intensity within 24 hours was 305 mm. The wind blows mainly from W, SW and NE at annual mean speed of 7.8 km/h.

4.4 Geology

The geology of Mainland Gujarat south of the river Narmada is predominantly made up of Deccan - Trap basalts of Cretaceo-Eocene age, i.e. about 60-150 MY B.P. (refer map), whereas nearer the coast, the formations are alluvium of Quaternary age (i.e. 0-2 MY BP). In between the two lies a patch of sedimentary rocks of Tertiary age (2-65 MY BP), a part of which is rich in hydrocarbon deposits. Structurally the area lies at the junction of Cambay graben and Narmada geofracture; and hence it is seismically sensitive.



4.5 Landforms

The major part of the area comprising the alluvial plains in fact has been formed by ancient deltaic deposition of the Narmada River that has gradually shifted towards north. The other features like coastal flats, estuarine parts of Narmada and Kim, ravines, channel bars, point bars and flood plains mark the landforms of this region. The internal drainage is sparse and controlled by the lineament features. The diversity of the terrain characters has played their due role in facilitating and controlling the movement of salts.

The sea tides mark a very broad and well-defined intertidal zone and the creeks of Amla Khadi and Wand Khadi are important terrain features leading to the salinity ingress conditions. The hydrological cycle for the area transports salts along with its movement course. Majority of the salt concentration is found closely linked with the water flow and accumulation.

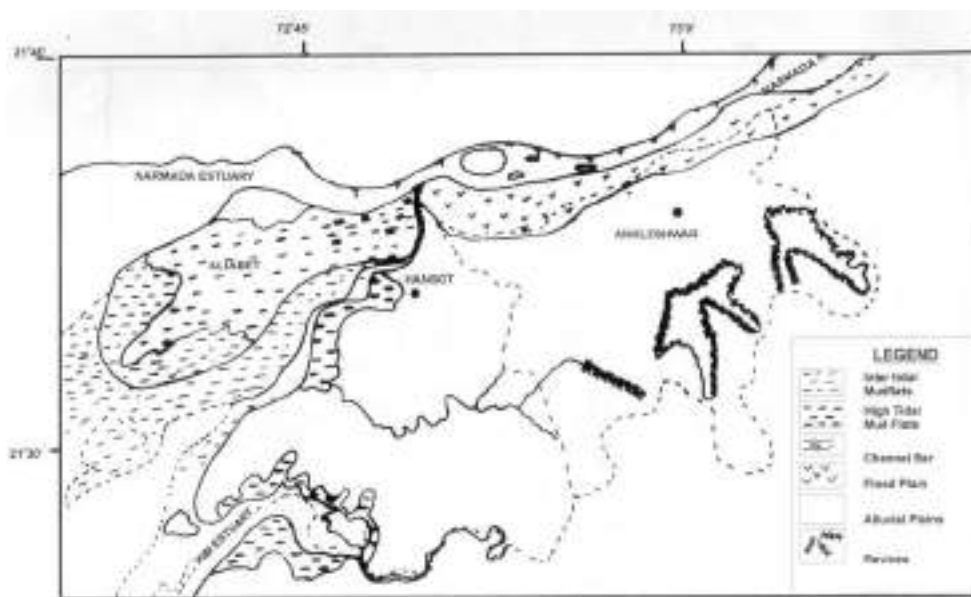
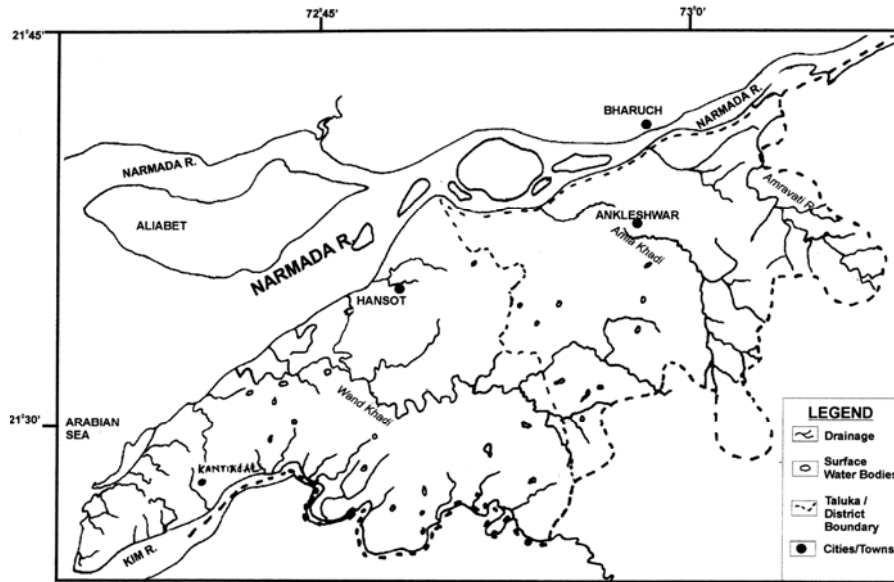


Fig. 5. Landform Map

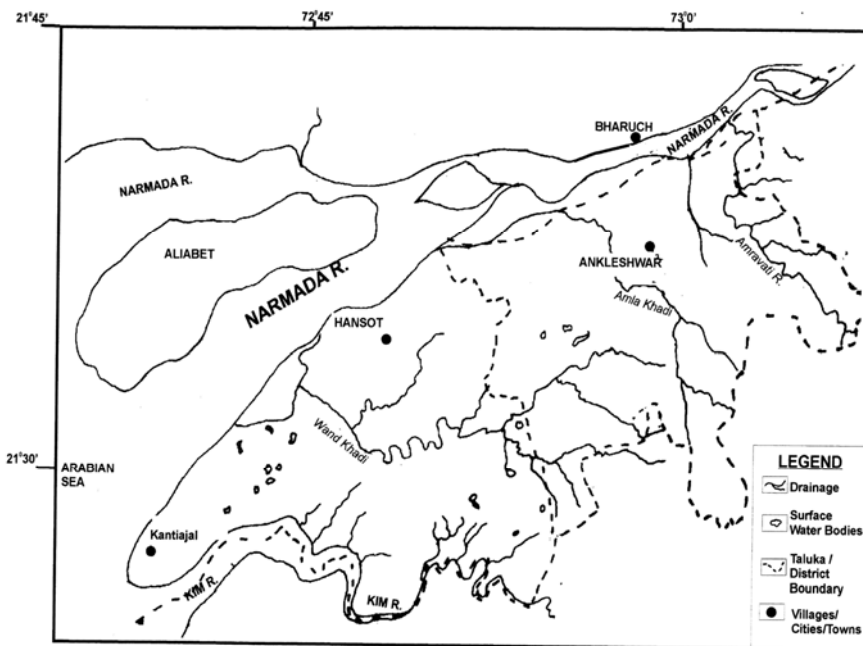
4.5.1 Drainage

Drainage has evolved as a result of the dynamic process of physiography, climate and tectonic framework. The two major rivers marking the boundaries of the study area are Narmada and Kim (refer map). The river Narmada originates in the hills of Amarkantak in Madhya Pradesh, 1150m amsl, cuts through the hill ranges of Satpura and Vindhya and debouches into the Gulf of Khambhat near Bharuch in Gujarat. The river flows along a major geo-fracture zone. The river Amravati is a tributary of the Narmada marks the northeastern limit of the study area. The river Kim rises in the Rajpipla hills and flows westward and meets the Gulf of Khambhat, defining the southern limit. Wand Khadi, Amla Khadi and Lim Khadi are the three other rivers, which drain the study area.

The drainage density is very low owing to a low gradient and the formation characters. Hence the natural draining in the area is very limited. Amla and Wand Khadi's bring act as natural channels for the backwaters of the Arabian Sea to enter the land during high tides.



Drainage Map (Survey Year 1863 – 1891)

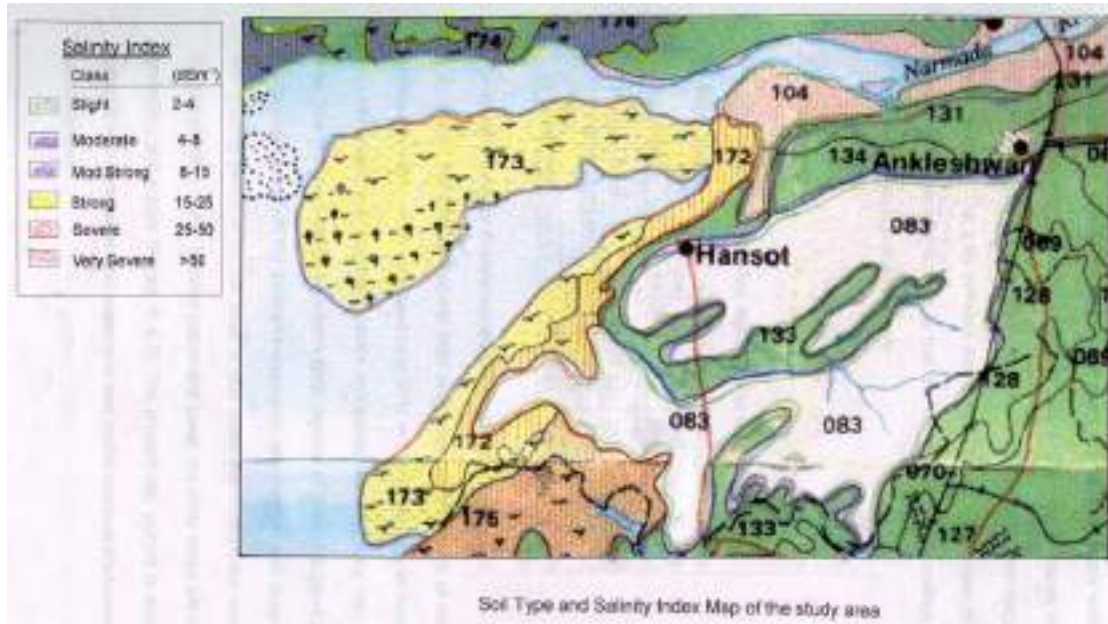


Drainage Map (Survey Year 1950 – 1952)

An interesting phenomenon has occurred at the river mouth of Narmada over the last 100 years. *Aliabet*, an island (refer map) has slowly joined the mainland due to heavy silting at the river mouth. Due to this, the natural freshwater flow of the river and flushing of the area along the estuarine zone has been obstructed and the river has changed its course and now flows in the northern part of its channel.

4.6 Soils

Based on landform analysis, field surveys, laboratory investigations and field reviews (NBSS-LUP, 1988), about 14 soil units can be identified in the study area (refer map). The characteristic taxonomy of each unit is given in Annexure 4. Almost all the units possess slight to moderate inherent salinity. The soils are of alluvial origin and are deep with high clay content and blackish in color. Since the soils are heavy textured with montmorillinitic clays, their draining capacity is low. Their infiltration rate is very low ranging from 2 to 3 mm/hr.



The soil temperature regime can be considered as isohyperthermic with mean summer soil temp 27.7⁰C and mean winter soil temp 25.6⁰C. The soil moisture regime is in general 'Ustic'. However, at many places due to continuous heavy irrigation, have altered to 'Udic'.

The soils are moderately to very deep, clayey, moderately well drained to poorly drained, high available water capacity (>150 mm/m), shows moderate to slight erosion, slight to moderate to strong salinity, non sodic, non calcareous and slightly alkaline. The soils possess adequate zinc and high copper contents. An interesting feature of this area is that the pH and electrical conductivity results show that the area is prone to salinity.

The Soil Survey Department carried out the pre-irrigation soil survey in the command area of the Ukai Right Bank Canal (UBRC) of the irrigation project. On the basis of the physical and chemical properties of soils, viz. soil texture, salt content, pH and sub surface water table the soils of the command areas of UBRC were grouped under following five classes.

Table - 1 Soil Classification

Sr.No.	Classification	Area in acres	% area
1	Class IA & IB	66,740	28.89
2	Class 11	12,050	5.22
3	Class 111	97,070	42.02
4	Class IV	27,090	11.73
5	Class V	28,050	12.14
	Total	2,31,000	100.00

Following are limitations of and recommendations for different classes of soils:

4.6.1 Class 1A & I B soils:

The soil of this class are clay loam to sandy loam with open structure and negligible. to low salt contents. The water table fluctuates between 6 Mt. and 9 Mt. The area falling in class IA is quite suitable for heavy perennial irrigation, while the area of class IB is suitable for light perennial irrigation.

4.6.2 Class II soils:

The soils of this class are fine in texture up to the depth of 1.8 Mt. or more and are followed by clay loam to sandy loam soil. The pH value varies from 7.5 to 8.5. This area is suitable for light perennial irrigation.

4.6.3 Class III Soils:

The Soil of this group is clay to clay loam up to the depth of 1.8 Mt. The water table fluctuates between 3.0 Mt. and 4.6 Mt. With proper drainage system the area can be brought under irrigation.

4.6.4 Class IV Soils:

The soils are clay loam to clay with impeded drainage condition and high salt contents. The water table fluctuates with 3.0 Mt. The area can be brought under irrigation only after artificial drainage system is provided.

4.6.5 Class V soils:

The soils are clay to clay loam on surface, followed by clay loam to sandy loam towards lower strata. The area has flat topography with very high salt content at lower depths, high pH value, water table and closer to sea. This also includes the Kharland. This kind of soils can be brought under irrigation only after providing systematic and planned drainage system.

Most of the land area under Hansot and Ankleshwar talukas falls under the soil classification groups III, IV and V where the canal water irrigation was suggested to be given with adequate drainage facilities.

4.7 Landuse

The landuse pattern of the two study talukas is as under

Landuse Type	Ankleshwar		Hansot		Total Study Area	
	(ha)	%	(ha)	%	(ha)	%
1. Total Area	44,024	100.00	39,879	100.00	83,903	100.00
2. Forest	91	0.02	984	2.5	1,075	1.29
3. Net Sown Area	29,710	67.62	23,259	58.32	52,969	63.13
4. Non-Agricultural Land	6,867	15.64	7,856	19.68	14,723	17.55
5. Others	7,356	16.72	7,780	19.50	15,136	18.03
6. Irrigated Area	7,855	26.43	12,863	55.30	20,718	39.11

(Source GEC, 1994)

The landuse data for Ankleshwar and Hansot taluka's are given in Annexures 5& 6. Out of the total agricultural area in Ankleshwar about 4% of the area was irrigated in 1981, which increased up to 27% in 1991.

Similarly in Hansot taluka, about 13% land was irrigated till 1981 and increased to 53% by 1991. The study area falls in zone 5 of the agro-ecological regions of India (NBSS –LUP, 1988), i.e. Gujarat plains with hot semi-arid ecoregion, with medium and deep black soils and growing period of 90-150 days. It falls under the cotton-millet crop region of Gujarat (CSSRI, 1995); besides cotton and jowar, the other crops are rice, wheat, groundnut and pulses (Annex.7 & 8) The present day picture is however, very different with sugarcane and paddy being cultivated as major crops.

5

Understanding Salinity: Extent, Type, Causes and Impact

The study area has been affected by salinity of soil and groundwater. The problem has several environmental aspects related to the resource productivity, eco-systems, public health, socio-economic conditions etc. The salinity is a complex problem with dynamic nature and hence its genetic aspects need to be understood in its appropriate perspective.

5.1 Extent of Salinity:

As part of the planning exercise the effort was made to estimate the extent, degree and type of salinity problem. As mentioned earlier the review of secondary literature, extensive fieldwork, community consultations, PRA exercises, soil tests interactions with the local people and analysis of remote sensing data were carried out.

5.1.1 Changing Landuse Pattern (1988-1997)

Based on the analysis of remote sensing data for the period between 1988 and 1997 a significant change is observed in the land use pattern. The data for three time intervals i.e. 1988,1992 and 1997 were analysed for the purpose. The major observations are:

1. A significant reduction is observed in the area under agriculture land. The total land under agriculture use has reduced from 60,202 ha. In 1988 to 52,574 ha. In 1997 i.e. total reduction of 7,628 ha. over a period of ten years. It is also important to note the rapid rate of reduction in land under agriculture use, with - 4.6% in first five years (1988-1992) and - 8.5% in last five years (1992-1997). (For details refer table)
2. Similarly the rise in salt affected land is noteworthy. The overall area affected by salt has grown from 12,547 ha. to 13,626 ha. i.e. reduction of 1,079 ha. over a period of 10 years.
3. Further, a huge increase in the land under degraded vegetation is observed for the same period. The area under degraded vegetation has increased from 3,398 ha. in 1988 to 9,341 ha. in 1997 i.e. total increase of 5,943 ha. over a period of ten years.

Change in Land Use Pattern

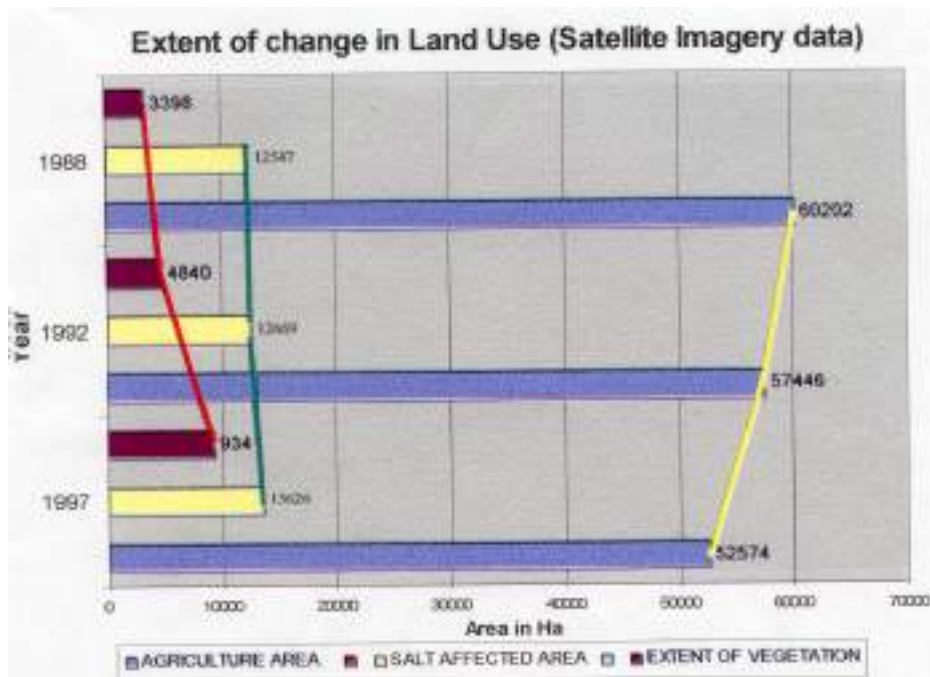
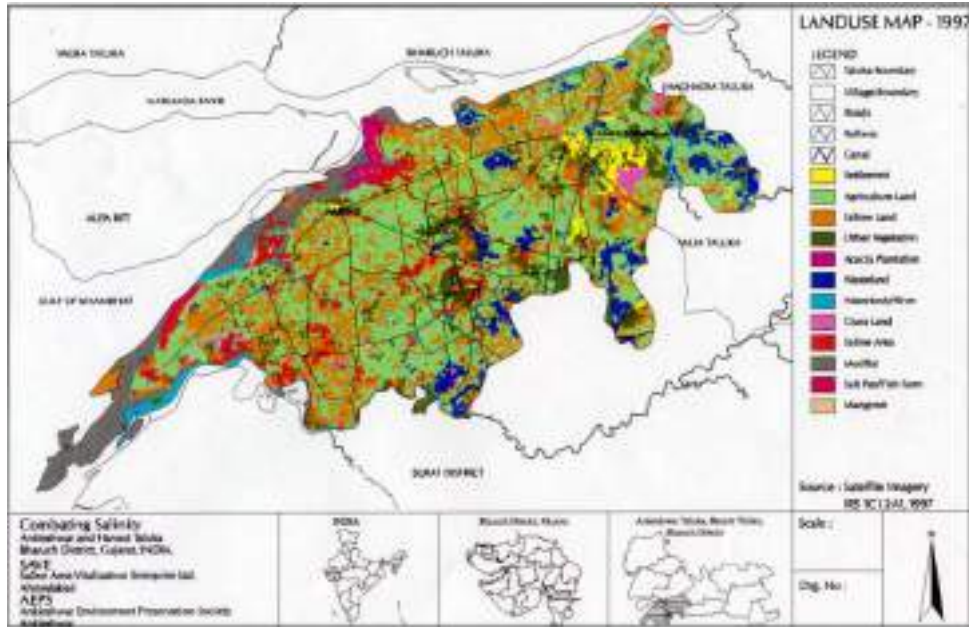
(Figures in bracket indicate percentage Rate of growth)

Land Use	Area in Hectors		
	1988 - 92	1992-97	1988-97
Agriculture Area	60,202 (-4.6)	57,446 (-8.5)	52,574 (-12.7)
Salt Affected Area	12,547 (+0.97)	12,669 (+7.6)	13,626 (+8.6)
Extent of degraded vegetation	3,398 (+42.4)	4,840 (+93.0)	9,341 (+174.9)

(Source: Remote Sensing Data IRS- IC)

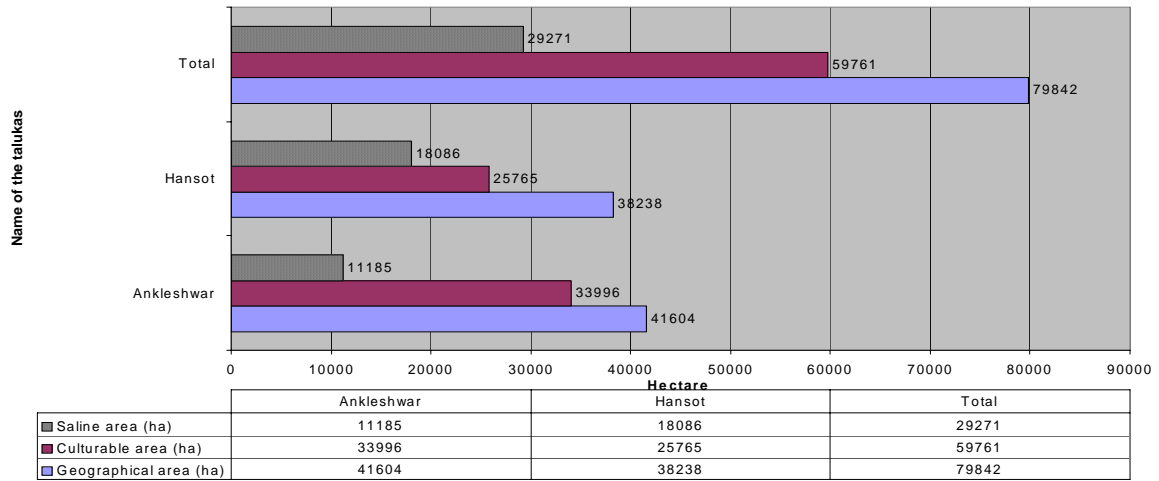
This is visually depicted in following land-use map and chart.

SATELLITE IMAGERY LAND USE PATTERN - 1997



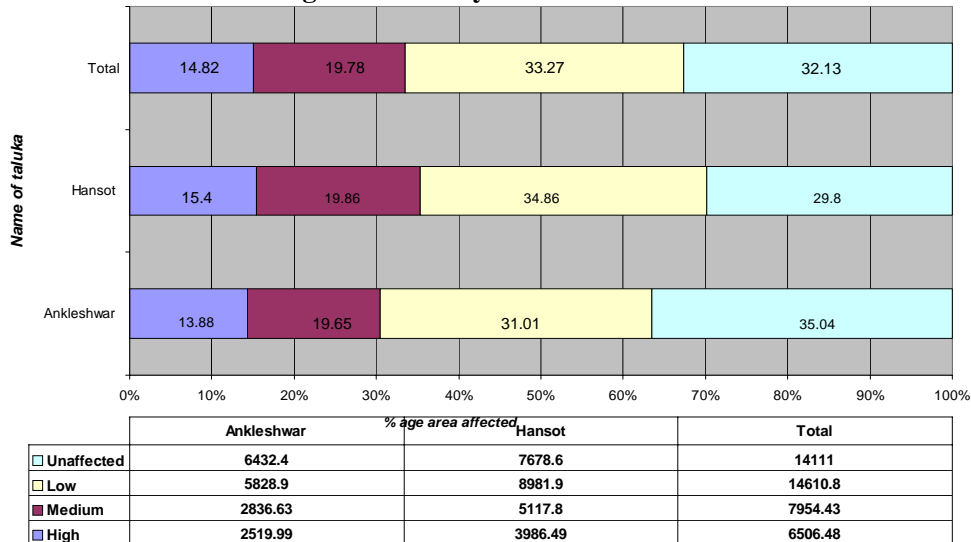
Further based on detailed analysis of information gathered through village visits, analysis of soil tests, secondary source of information following broad picture emerges:

Extent of Saline Area (ha)



As shown in the above chart out of the total geographical area of 79,884 ha of the region, 59,761 ha are culturable land of which 29,802 ha is affected by varying degree of salinity. In Hansot taluka out of 38,238 ha. of total area 18,086 ha. (47.29%) is affected by salinity while in Ankleshwar taluka out of 41,604 ha of total area 11,715 ha. (28.16%) is affected by salinity.

Degree of Salinity in Culturable land

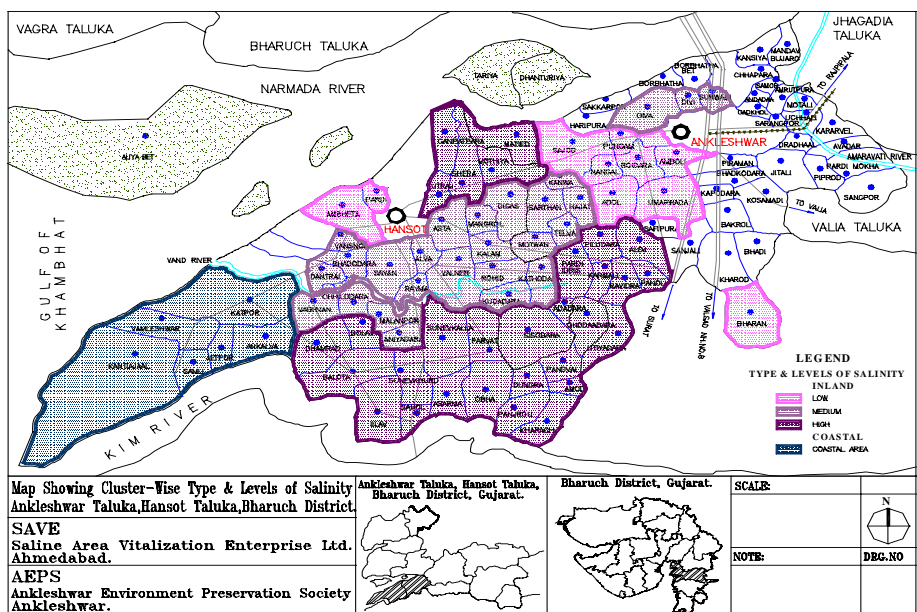


Further, investigations were carried out to estimate the degree of salinity in affected land. As the above chart shows out of the total land studied about 14.82% i.e. 6506.48 ha falls into high degree of salinity while 19.78% i.e. 8684.36 ha. & 33.27% i.e. 14,610.8 ha falls in medium and low degree of salinity respectively.

Based on the above, a detailed exercise was carried out to understand the geographical distribution of the extent and degree of salinity for the entire area under study. As mentioned earlier all 102 villages of the region were grouped in 23 clusters of villages. Of this 19 were taken up for further studies. Since the remaining four clusters from Ankleshwar taluka were not affected by the problem of salinity, they were not taken up for further work. The formation of clusters was done on the basis of commonality in the type of problem, physical connectivity in terms of irrigation and drainage infrastructure and social composition.

Once the clusters of villages were formed the data collected through PRA exercises, soil tests and village visits were analysed on spatial basis. Based on this village-wise and then cluster-wise, extent and degree of salinity was estimated. For details on results of soil tests, and village & cluster-wise distribution of saline land refer Annexure 14 & 15.

Once the extent and degree of salinity were estimated for clusters, the proportion of land affected by salinity in relation to the total culturable land was worked out. Followed by this clusters depending on the % affected land to the culturable land were grouped in two major types i.e. inland and coastal. All the inland clusters were further grouped in three major Levels i.e. Low (31-50%), Medium (51-70%) and High (71-100%). Following map and table show the geographical spread of the extent and degree of salinity.



Sr.	Clusters	EXTENT OF SALINITY IN CULTURABLE LAND							(2+3+4) Tot. Saline	% age of Cult. land
		Total Land	Total Vill.	Culturable Land	1 Unaffected	2 Less	3 Medium	4 High		
	Coastal									
1	Cluster - I	10945	6	3803	926	1276	1068	532	2877	76
		10945	6	3803	926	1276	1068	532	2877	
	Low									
1	Cluster - IV	1587	2	664	350	207	77	30	314	47
2	Cluster - XIII	2012	2	1735	1121	160	248	206	614	35
3	Cluster - XIV	3958	5	3501	1792	800	253	656	1709	49
4	Cluster XIX	1584	1	1204	635	270	239	60	569	47
		9141	10	7104	3898	1437	817	952	3206	
	Medium									
1	Cluster - II	1692	3	1359	634	465	192	68	725	53
2	Cluster - III	742	2	508	177	199	22	110	331	65
3	Cluster - VII	3011	5	2448	903	684	418	442	1545	63
4	Cluster - VIII	2015	3	1844	884	350	204	406	960	52
5	Cluster - XI	3634	6	3293	1168	1203	492	430	2125	65
6	Cluster - XII	1876	4	1577	547	399	235	397	1031	65
7	Cluster XVIII	2117	3	1900	912	615	254	120	988	52
		15087	26	12929	5225	3915	1817	1973	7705	
	High									
1	Cluster - V	4502	4	3461	930	1403	752	376	2531	73
2	Cluster - VI	2780	3	2029	405	886	402	336	1624	80
3	Cluster - IX	2685	3	2307	555	1068	459	225	1752	76
4	Cluster - X	3509	4	3140	729	1211	531	670	2411	77
5	Cluster - XV	4241	6	3826	992	1653	640	541	2834	74
6	Cluster - XVI	3493	4	3165	626	1194	609	736	2539	80
7	Cluster - XVII	2420	5	2148	355	668	930	195	1793	83
		23630	29	20076	4592	8083	4323	3079	15484	
	Total	58803	71	43912	14641	14711	8025	6536	29272	

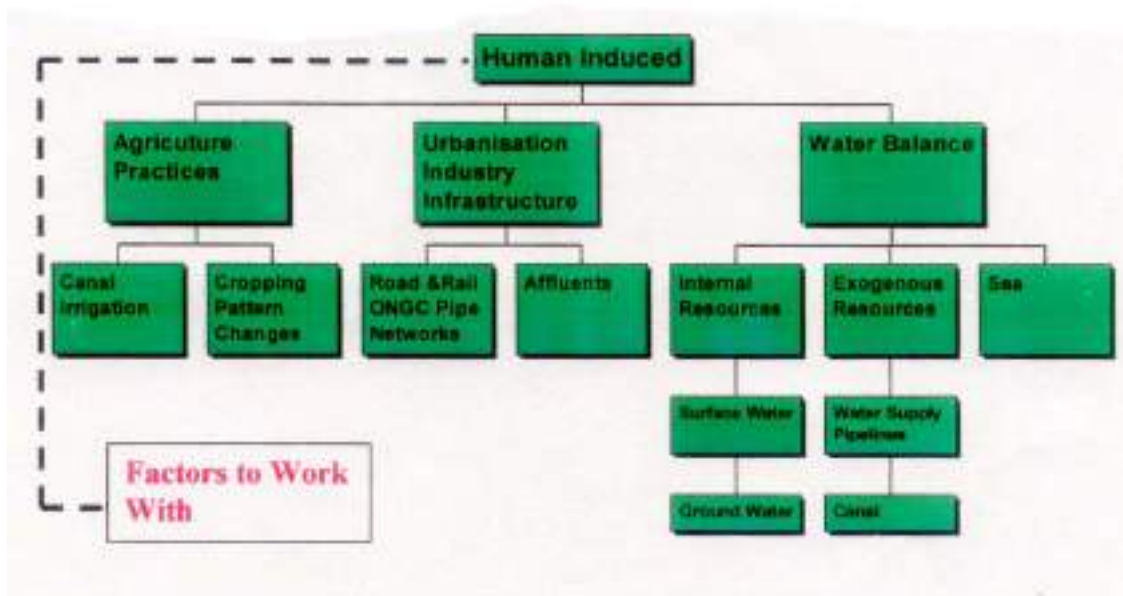
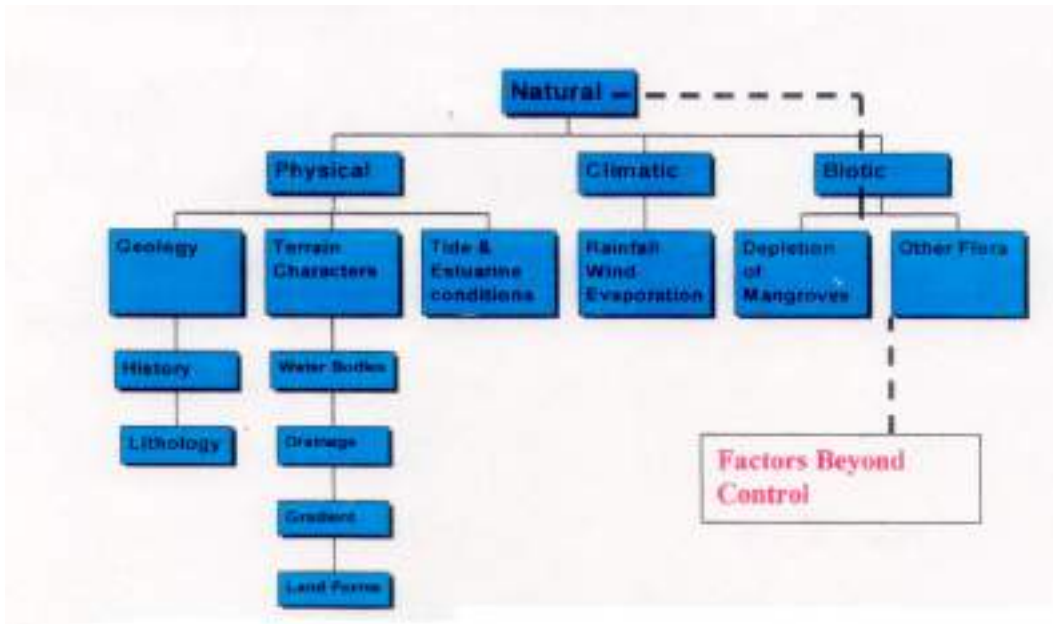
Following table gives summary of Typology of clusters based on nature and degree of salinity in relation to the total culturable land.

No	Type & Level of Salinity	Levels salinity in-terms of % of land affected	Number of Clusters	Number of Villages	Area Affected (ha.)
	COASTAL				
1	High	70-90	1	6	2,877
	INLAND				
2	Low	Below 50	4	10	3,206
3	Medium	50-60	7	26	7,705
4	High	Above-90	7	29	15,484
	Total		19	71	29,272

As shown above salinity of the region could be broadly divided in following two types:

- (1) Inland Salinity
- (2) Coastal Salinity

Factors and parameters causing the problem are outlined in following chart.



5.2 Salinity - Cause and Character

5.2.1 Inland Salinity

- **Natural Causes**

The subsurface and surface drainage plays an important role in the problem. The subsurface drainage is related to the geological evolutionary history of the subsoil formations. The land of the area has evolved during the last 2 million years of the earth's history. During this period the sediments were brought in by the then prevailing drainage system of the ancient Narmada from its upper catchment draining the older rock formations (Deccan lava and Tertiaries).

It is interesting to note here that during this period the interplay between land - sea has been of the order of 150m below and 50m above the present sea level. The sediment deposition has been therefore under cyclic order of marine and fluvial environments of estuarine deltaic conditions. A differential distribution of the sea salts in the various depositional land layers has taken place. The successions of the alluvial material mainly sandy and clayey layers have been periodically disturbed by frequently visiting seismic shocks. Such geological nature of the sediment succession does not permit easy under draining of subsoil water and hence the inherent salts do not get flushed out.

The surface drainage density in the study area is very sparse and the overall gradient of the area is also very gentle. Hence, the natural draining capacity of the area is very poor. The channel courses also progressively get silted and the overall drainage is not so efficient. Further, the topsoil being of black cotton nature have least percolation and land gets inundated for longer period. More of the surface water is lost by evaporation than drainage. The situation does not permit salt leaching and flushing; instead it helps in further concentration in the soil zone.

- **Human Induced Causes**

Agricultural Practices

Irrigated cropping has played an important role in aggravating the salinity in the land (Annexures 9 & 10). Prior to canal irrigation the salinity pattern remained almost in a balanced state. Introduction of canal system of initially seasonal and subsequently perennial has been the prime factor in intensifying and spreading the salinity of soil and groundwater. The bringing in of exogenous water has changed markedly the cropping pattern from Kharif to Rabi and water intensive.

Concomitant to this, water logging has also spread extensively with the result that the salt transfer from the deeper level to surface took place. Evaporation of soil moisture progressively resulted in concentration of salts in the upper soil layers. A majority of the study area suffers from salinity induced by excessive irrigation and improper drainage.

Ankleshwar and Hansot talukas are a part of the command area of Ukai Right Bank Canal (URBC), Project, distributed via the Hansot and Kosamba Branch Canals. The area is being irrigated by canal water seasonally since 1973 and perennially from 1984. The area under irrigation has also progressively increased in the last 40 years. Due to excessive irrigation and adverse terrain conditions as already mentioned, the groundwater level has risen and reached upto the root zone and over a period of time resulted into water logging.

The process progressively spread over larger areas. According to a report by WAPCOS (2000) about 12,810 ha (65%) of area in the Hansot Branch Command Area and 14,900 ha. (35%) of area in the Kosamba Branch is waterlogged. The initial cropping pattern of the area has changed from cotton and pulses to Sugarcane and Paddy. Since simultaneous drainage network was not properly and efficiently introduced and lay, the problem got enhanced and reached its present state. The farmers draw more water since they are not sure of receiving the next round as per demand. The contribution by the seepage from unlined section of the canals is also quite significant.

Industry, Urbanization and Infrastructure

These have changed the land use pattern, geomorphic configuration and disruption of original natural drainage system. The industrial affluent and urban sewage find their perennial disposal in the natural drainage courses has significantly contributed towards concentration of salts in the specific areas. The road and rail embankments, ONGC pipe network have adversely affected the surface and subsurface drainage, thereby aggravating the water logging. The neglect of local water sources like ponds and wells has distributed the long prevailing water balance in the area. With the advent of exogenous water the resource system collapsed resulting into the rise of the water table, quality deterioration and salinisation of soils.

5.2.2 Coastal Salinity

- **Natural Causes**

Coastal flats are the wide expanse of mud deposited by the tides rising in the sea. Thus these soils and water contain sea salts and are extremely saline. The marshy strip used to support a thick mangrove forest.

The mangrove girdle used to regulate the salinity ingress. However, since the last couple of decades, due to over cutting this natural biotic barrier has disappeared. This facilitates the movement of seawater, which enters further inland ward and renders more land saline. In the coastal areas, especially along Kanthiajal and Motimor Bet, there is severe soil erosion and vast areas of land are lost every year. Due to the loss of this land, the sea further encroaches the inland areas. The configuration of the seacoast is constantly being modified.

The Narmada and Kim estuaries allow mixing of seawater with freshwater quite further inland into their channels. The Amla and Wand khadi's also function similarly and thus the area surrounding these estuaries and creeks were under the salinity influence. The joining up of *Aliabet*, a mouthbar of Narmada, to mainland has also induced salinity in the villages fringing the coastline viz. Matied, Shera, Pungam, Diva etc. The reason being that the natural flow of freshwater in the channel of Narmada, which used to deposit silt in the monsoon as flood plains and was flushing away the inherent salinity of the soils has been obstructed due to siltation (refer map). Since the natural flushing system has been disrupted, the degree of salinity has shown a marked increase. The salt laden winds blowing from the sea spray over the agricultural land hence contribute to increasing the salinity.

- **Human Induced Causes**

The Government constructed Kharland Bunds as early as 1960 to counter the seawater spreading over the agricultural coastal lowlands. The bunds subsequently did not receive maintenance and seawater started entering with greater force from the breached sections. This water did not return back to the sea but spread over the land causing salinisation of the soil in vast expense.

Salt works and fish farms along the coastal belt, especially near Kantiajal and Motimor Bet, have spread over larger areas in recent years. This has caused the increase of salinity in neighboring areas.

5.3 Water Resources Development and Salinity Problem

The history of water resources development, especially for irrigation has direct linkage with the occurrence, spread and intensity of salinity of the land and groundwater. The local water resources, surface and underground availability and development in the context of the salinity problem has been briefly discussed here. It would provide a proper base for the evolution of the mitigation strategy.

5.3.1 Groundwater Resource

Hydrogeologically, both the talukas form a part of the coastal alluvial aquifer system where groundwater occurs under unconfined to semi-confined conditions. The aquifer system is composed of alternate layers of sandy and clayey material. The sandy layers forms the aquifer zones while the clay layers form the aquitard zones.

Depth to water table generally rests within 10m to less than 5m. Water quality is by and large brackish (>2000ppm) and it is not suitable for either drinking or for irrigation purposes. However, some wells located on the banks of local village ponds yield fresh water, being under the influence of the induced recharge of the pond storage. Such wells used to serve the purpose of domestic, industrial and other supply need. Occasional irrigation was also being done but it was highly localized and to a very limited extent.

Groundwater potential and utilization data as maintained by GWRDC at an interval of every five years since 1977 to 1997 (four sets) are given in Annexure 8 and 9. The salient features about the groundwater recharge and draft for the area are given below.

Recharge and Draft details for the Study Area

Details	Ankleshwar Taluka	Hansot Taluka	Total Study Area
1. Recharge Suitable area	60 %	25 %	49 %
2. Not Suitable for Recharge (Saline)	40 %	75 %	51 %
3. Recharge Potential			
(i) as % of Rainfall	20 %	17 %	19 %
(ii) as water depth	203 mm	160 mm	180 mm
(iii) as Vol. Per unit area	2030 m ³ /ha	1600 m ³ /ha	1800 m ³ /ha
4. Gross Recharge	44 Mm ³ /y	12 Mm ³ /y	56 Mm ³ /y
5. Gross Draft	40 Mm ³ /y	5 Mm ³ /y	45 Mm ³ /y
6. Development % (1979-97)	10 – 114 %	16 – 57 %	12 – 86 %

(Source GWRDC)

It has been observed that the groundwater recharge potential is quite high (19 % of rainfall) however, the area suitable for recharge is only 49 %. Thus the overall potential is low (56 Mm³/y). Of this water, there is hardly any use in irrigation, but there is quite some lift for non-irrigation purposes up to 86% of the average annual recharge. i.e., the area falls under the category of 'dark' from groundwater development point of view.

In spite of the quite high draft, the groundwater table keeps on rising up and causes the problem of water logging and salinity. It is predominantly due to the exogenous canal water being used for irrigation. It adds to the recharge and hence the water table keeps on rising up. GWRDC has 3 observation wells in Hansot and 2 in Ankleshwar taluka for water table and quality monitoring. Data for the period of about 30 years (1970-99) was collected and comparative statements and graphic plots are given in Annexures-10 & 11.

It could be observed that the well located in urban areas of Ankleshwar town where there is greater draft for domestic and industrial purposes records the water table to have progressively fallen down by about 6m (3 to 9m bgl) within 15 years (83-98). This is indicative of higher draft in urban and industrial areas. GWRDC data for the last five years (1991-1996) have shown over-exploitation of aquifers in the taluka to an extent of 114%. This is quite significant in view of the rising train of the water table in the area.

The monitoring well at Sajod indicates rise of water table from 5m bgl to almost to ground level within a short period of five years (1985-89). After '89 it has fluctuated from ground level to 2m below ground. This is clearly indicative of the intensive canal irrigation related induced recharge that has led to water logging and salinity. Almost similar behavior has been observed in the observation well at Hansot. The observations at Kantiajal, a coastal village, where there is neither canal irrigation nor major ground water draft, the water table has fluctuated within a depth range of 3 to 6m and has directly followed the annual rainfall pattern. The soil survey organization of the government in the irrigation command has got a regular programme of closely monitoring the water table and quality. This being a special study, related to irrigation practice, it has been dealt under separate section of irrigation practices.

5.3.2 Surface Water Resource

Considering the Tahal Consulting Engineers (TCE, 1996), the average surface runoff generation for the Kim river basin is about 50% of mean annual rainfall, i.e. about 600mm. This at 40%, 60% and 75% rainfall dependability works at 700mm, 500mm and 400mm respectively. At this factor, the total surface potential for 839 sq. km area works out as 503 Mm³. This quantity is quite high as against 56 Mm³ (180mm) groundwater potential. Thus the surface to groundwater ration is about 10: 1.

At unit area, the total water resource works out as $500 + 180 = 680\text{mm}$.

Considering the general flatness of the terrain, it is not possible to hold 500mm surface potential for surface storage. It generally gets drained out, but the drainage rate being poor, this water gets stagnated for quite some time in the monsoon and the area remains inundated. Even at some local pockets where drainage is very poor, it remains land locked. Such conditions of surface water potential also contribute to the water logging and salinity. However, there are quite a large number of local village ponds, which hold substantial portions of the surface runoff. If the storage capacity of these ponds is increased, the inundation intensity to some extent gets reduced. This surface water potential through a proper local harnessing system can form a good source of dependable water supply. The surface water has got a paradoxical situation, where it has a chronic problem of drainage congestion on one hand and is a dependable resource on the other.

5.4 The Problem statement in brief:

Based on above exercises following can be summarized as problem statement:

5.4.1 Extent of the Problem:

- Based on Remote Sensing data of last 10 years (1988-1997), major changes are observed in the land use pattern of Hansot and Ankleshwar talukas. The agriculture land has reduced from 60,202 ha to 52,574 ha. The rate of reduction in agriculture area is faster in second half of the decade than the first half. Similarly, land affected by salinity and area covered by degraded vegetation has grown substantially during the period.
- Out of the total geographical area of 78,884 ha. Hansot and Ankleshwar talukas, 59,761 ha. is cultivable. Of this 29,0802 ha. is affected by the problem of water logging and salinity in varying degree.
- The area affected under salinity can be broadly divided under two types i.e. a) Coastal (2877 ha.) and b) Inland (26,395 ha.).
- The total land affected by salinity is further grouped in three levels of salinity. Low (14,711 ha.), Medium (8,025 ha.) And High (6,538 ha.).
- Further, in order to understand the spatial character of the salinity problem villages were grouped in clusters. Villages-wise proportion of land affected by salinity over total cultivable land (in terms of %) was computed. Clusters of villages were further classified in three levels of salinity i.e. Low (No of clusters 4, No of Villages 10, Area 3,206 ha.), Medium (No of clusters 7 , No of Villages 26, Area 7,705 ha.), High (No of clusters 7, No of Villages 29, Area 15,484 ha.) and Coastal (No of clusters 1, No of Villages 6, Area 2,877).

5.4.2 Causes of Salinity:

For Inland Salinity

Rising water table:

- The conversion of seasonal irrigation system (after first ten years operations) into perennial irrigation system leading to over supply of water.
- Change of cropping pattern from rainfed to water-intensive crops.
- Uncontrolled use of irrigation water due to inappropriate water pricing policy.
- Lack of local people's involvement, both financial and managerial, in managing the irrigation and drainage infrastructure.
- Increased supply and overuse of irrigation water, along with poor sub-surface and surface drainage system, both natural and artificial.
- Inadequate repair and maintenance of irrigation and drainage infrastructure and seepage from the unlined canal system.
- Blockage of existing drainage system by activities related to infrastructure development for irrigation system, urban and industrial development and oil exploration and transportation.

- **All these lead to rise in water table and with it the salts inherent in the soils mainly due to geological history of the region, also moves upward. Due to inefficient draining system surplus water and undesired salts are retained leading to water logging and salinity.**

For Inland Salinity

- The reduction of mangrove forest cover and breaking down of earthen bund built by Kharland Development Board along the coastal regions of Hansot taluka, lead to deep intrusion of sea water on agriculture land and excessive soil erosion.
- Unchecked activities of salt and fish farming along the coast of Hansot taluka.
- Filling up of area between Aliabet and Hansot region leading to non-flushing of the region.

All these lead to aggravating the problem of salinity in the coastal areas of the region.

6

Mitigation Strategy

Once the problem causing character is understood, it helps in evolving the mitigation approach. In view of the discussions in the earlier sections and that of the prevailing canal irrigation practice, the issue can be briefly understood. The balance of the natural and introduced waters for the area has got the present status of being in much higher surplus.

6.1 Conceptual Framework:

Conceptually providing proportionate unit allocations to different inputs, the water balance is as under:

Inputs

Natural Groundwater	=	1 Unit
Internal Surface Water	=	3 Units
Exogenous Canal Irrigation	=	8 Units
Total	=	12 Units

b) Outputs and Consumption

Groundwater (Subsurface Drainage)	=	Nil
Surface water drainage	=	3 Units
Canal Water drainage	=	2 Units
Irrigation crop consumption	=	2 Units
Irrigation drainage	=	2 Units
Total	=	9 Units

System Retention:	a – b =	12 – 9 = 3 Units
		Drain = 7 Units
		Consumption = 2 Units

Internal system is progressively getting water rich
Out fall should be =1 unit

To maintain the system free of water logging, the retention units should not exceed 1. Thus the two extra units are required to be managed.

6.2 Managing Water table:

The other factor to be considered for evolving the strategy is to keep the groundwater table under safe limit. The water table 3mts. below the surface is considered as critical for water logging and is followed by salinisation. Therefore, a safe condition can be regarded as 5mts.; and that between 3mts. and 5mts. as gray condition that calls for warning. In short, all the efforts should be made in permanently maintaining the water table at around FIVE METERS below ground level. Any measures that achieve this should form the guideline for mitigation strategy.

6.3 Strategy Options

The present irrigation management requires a change. The prevailing system is one side straight supply; i.e. there is direct connection from dam reservoir to the farmer's field where supply arrangement is with the government setup of irrigation department. It has its own in-built system limitations. On the other side, the farmer is not always sure of regular supply on demand. On supply side there is more than enough, but the distribution is not regular.

Further, the excess disposal system especially of the drainage is inefficient. The head reach farmer flood the fields with over irrigation, whereas the tail enders have to wait long for their turn and they make it good by lifting water from the drainage. Thus the management needs a structural change.

Possibly a system is required to be evolved and introduced where input side provides just the bare minimum and the on-farm distribution is efficient. The surplus produced is least. This is possible by breaking the direct link of storage to site. The farmers will have to respond to the new system in their long-term interest. This means creating appropriate changes in the institutional arrangements in managing irrigation and drainage infrastructure and water supply system.

6.3.1 Institutional Arrangement:

The suggested institutional arrangement will have two levels of organisations. The first level of organisation has representation of local people as well as outsiders while the second comprising of local people.

The Second level of organisation is proposed to have three tiers structure. They are:

- Tier - 1: Individual (Farmer- Shareholder/Member)
- Tier - 2: Organisation of local people around sub-minors, minor level Pani - Panchayat (Members from Tier 1)
- Tier - 3: Cluster level institutions like Federation of Pani- Panchayats (Members from Tier 2)

Regional Level Organisation: Level-1

The First level of organisation at regional level will provide co-ordination support with the Government and other similar groups. The organisation may play a major role, facilitating between the institution and government, till it gets established. There will be several technical, social, financial, administrative and environmental aspects, which will be involved.

Cluster Level Organisations: Level-2

The Second level of organisation will be responsible for planning, managing and implementing various development activities related to the project. The organisation will mobilise both financial and human resources for the purpose.

6.3.2 Technical Options:

The other partner in this system, the irrigation department will have also to change the present mode of one-sided supply. An intermediary NGO like institutional link may possibly balance the role of Government on one side and the farmer on the other side. Keeping this broad frame in view several technical options have been thought of for consideration and are listed below.

6.3.3 For Inland Salinity:

- **The problem of over irrigation**

This needs a new management system as under:

Irrigation Department may supply on volumetric basis at system inputs and total internal distribution system on the branch to be maintained by a new institutional arrangement (Users - Participatory Irrigation Management Programme). This could be a water user's co-operative where each village group is a member, i.e. TOTAL COMMAND AREA DEVELOPMENT; a new approach.

Several technical options, which are to be considered looking to their local viability and acceptability, are as under:

- (i) Conjunctive use
- (ii) Rotation of crops
- (iii) Surface drainage
- (iv) Controlled use of Irrigation Water like sprinkler and drip
i.e. to provide water as per requirement of plant, to keep soil moist and not saturated, redefine the 'X' limit of canal Irrigation.
- (v) User education programme to be introduced (technical aspects)
- (vi) Interaction and visits to similar success areas

- **Drainage**

Proper drainage system has not been concurrently introduced with the canal system. The existing drainage system has several limitations like:

- (i) ONGC pipeline obstructions
- (ii) Under design
- (iii) Weed growth
- (iv) Silting
- (v) Lack of slope
- (vi) Cross drain structures
- (vii) Out falls

- Because of the above factors, the system of drainage is not functioning. However, the Revised Master Plan has been taken up by Irrigation Department for implementation and needs to be completed urgently.

- Once the proper drainage system is introduced, its operation and maintenance will also be put under the total charge of the above-suggested institutional arrangement.
- The industrial affluent discharged into the drain system also adversely affects the overall drainage efficiency by way of local silting, choking and over-spilling.
- It is suggested that the drains be exclusively used for storm water and irrigation excess discharge.

Conjunctive use of Groundwater and Canal Water

- In dealing with canal input and drainage output, the factor of groundwater plays an important role. In fact, water logging and salinity are related to this factor.
- Maximum input of groundwater use will have to be incorporated in the overall irrigation practice. This needs a detailed study of aquifer parameters so as to define the role of groundwater in the overall irrigation management. The study may include groundwater, hydrology, exploitation and quality aspects.
- It seems that the aquifer system holds the key to the problem

Use of Rainwater and Local Ponds

- Natural and artificial drainage has also to accommodate the storm water discharge during monsoon, taking care of the problem like silting and erosion. There is good scope to integrate the local village ponds in the system of drainage. The ponds will have to be renovated and inter linked by drainage, and could also be used for recharge.

6.3.4 For Coastal Salinity:

- Construction and renovation of Kharland Bandhara's that are to be designed appropriate with the pattern of tide and inundation
- Bandhara embankment to be protected with appropriate vegetation cover.
- The perennially wet zones to be developed by reintroduction and protection of mangrove vegetation zones
- Tidal regulators to be put across the creeks. The design of gate and discharge has to be made in accordance with the tide levels and storm discharge.
- Restrict and protect the salt works
- Regularly maintain the depth of drains
- Introduce regular canal flows and add the necessary requisite drainage
- Renovate and introduce the system of local ponds, wells and drains
- Canal water is bound to remain uncertain and hence a well-protected lift irrigation system through the ponds, wells and drains be designed and introduced.

With the above framework following measures are recommended:

6.5 Measures:

6.5.1 Curative Measures:

The present study provides a broad indicative assessment of the problem of water logging and concomitant soil salinity. For undertaking curative measures: cluster specific measures have to be developed.

Curative measures will include the following:

- **Drainage:**

- Construction of adequate surface drains to dispense with surface water accumulation. Undertaking drainage improvement works to make the existing drainage network functional by way of removing artificial or natural barriers that obstruct the flow of water in drainage channels.
- Construction of vertical drains wherever good quality of ground water exists.
- Provision of bio-drainage on the periphery of depressions and in areas where crop production is not feasible or not- profitable.
- Alternate cropping strategy along with suitable adjustment and adoption of new technologies in water logged saline lands.
- Use of appropriate soil amendments along with crops and its management for saline soil reclamation.
- Blending of drainage water in canals where feasible and safe.
- Reduction in irrigation water allowance.
- Routine monitoring and evaluation of the functioning and effectiveness of curative measures.

- **Maintenance Activities:**

The following maintenance activities are broadly identified as essential works to be carried out on the canal system:

- Removal of siltation in the canal
- Removal of aquatic and vegetative growth
- Restoration of bank levels
- Repairs to local lining
- Repairs to structures in main and branch canal
- Restoration of outlets and other structures in distributaries and minors
- Repairs to escape structures

- **The social issues of maintenance system:**

It was observed that in some areas farmers under fear of not getting adequate irrigation water often resort to following actions which cause problem for maintenance of the system:

- Obstructing flow by various means;
- Cutting banks or even removing outlets
- “Tunneling”; making outlet bypasses
- Tampering heads of channels or escapes
- Crossing through channels
- Encroaching canal banks
- Unauthorized use of service roads

The above social phenomenon needs to be tackled by institutional means.

6.5.2 Preventive Measures:

Improving efficiency of both the off farm and on farm along with activating conjunctive use of canal and ground water resources can be effective preventive measure.

Following specific measures needs to be implemented:

- **For Irrigation System:**

- Selective lining of irrigation system by identifying vulnerable segments to minimize seepage losses.
- Construction of interceptor drains to prevent water inflow from the adjoining high areas.
- Maintenance of the irrigation system to prevent wastage of water incidental to breaches and reduction in carrying capacity of channels.
- Provision of adequate head and cross regulators as well as sluice gates for proper system operation and regulation.
- Provision of safe disposal of surplus tail water from minors and sub-minors to natural nallahs.
- Developing ground water to enable conjunctive use of canal and ground water.
- Adoption of On Farm Distribution (OFD) work including “Warabandhi” to achieve better on-farm water management.
- Reduction in water allowance for potentially sensitive and critical areas and stopping water in waterlogged areas.
- Planting suitable vegetation in potentially sensitive areas.
- Adoption of policy measures (incentives/disincentives) to induce farmers to use water efficiently and to avoid excess water application as also to select cropping patterns which require less application of water.

- **For Drainage System:**

Besides adequacy and reliability of water supply, the success of an irrigation project depends upon the provision of drainage. Presently the significance of drainage is undervalued. There is a need for creating mass awareness among field functionaries and farmers regarding the utility of drainage for improving irrigation efficiency of the system and the farm for resources prevention and efficient resource utilization. Equally strong is the need to set up Participatory Irrigation Management (PIM) units at distributory level to handle irrigation and drainage improvement works.

In order to achieve the projected level of Kharif irrigation, the concept of reserve storage for sowing of crops during April to June will have to be developed. Moreover ground water has to be adequately developed for coordinated use of surface water.

- **For routine as well as long term monitoring of the problem.**

- **Post Drainage Package Of Practices:**

Drainage in itself may not be able to reclaim the lands although it is most essential pre-requisite for reclamation. Post drainage management of saline soils is as important for reclamation as is the design and installation of a cost-effective and efficient drainage system.

A technology package of the following nature is proposed:

- Land grading and construction of bunds (dykes) and surface drainage.
- Leaching
- Selection of crops and cropping sequence
- Improved cultural practices
- Nutrient Management
- Irrigation Water Management
- Fallowing
- Management of Drainage effluent
- Operational scheduling for shallow water table management
- Conjunctive use
- Use of blended drainage water for irrigation
- Cyclic or rotational use of drainage water.

- **Vegetation Measures:**

Waterlogged soil help thrive abundant plant species, which are as follows:

- *Ageratum conyzoides*
- *Ammania baccifera*
- *Caesulia axillaris*
- *chenopodium album*
- *Heliotropium supinum*
- *Herremia gangetica*
- *Commelina bengalensis*
- *Commelina compressus*
- *Fimbristylis*
- *Typha angustata*.

Salt tolerant plants also produce economically important extracts like gums, resins, flavours, fragrances, pharmaceutical base materials, fibers etc. *Pandanus fascicularis* is the natural source of kewada water, perfume and flavouring ingredient. Fibre is obtained from plants like *Hibiscus cannabinus*, *Agave americana*, *Sesbania bispinosa* etc. which grow on saline soils. Seeds of *Sesbania bispinosa*, which is also an important legume and fodder crop, form good source of galactomannan gum use for sizing and stabilizing applications.

Seeds of *salvadora persica*, a highly tolerant plant yield oil, which is rich in lauric and myriatic acids and is used in detergent industry. Seed oil from *Derris indica* (*Pongamia*) is used for leather treatment and soap making. The active ingredient of seed *Karanj*, possesses antibacterial and insecticidal properties.

- **Fodder crops:**

Forage trees and shrubs are valuable component of grazing lands and they could also be complementary nutrient sources to grasses in such kinds of regions. Following species form good source of fodder on saline soil.

- *Acacia nilotica* (Babool)
- *Albizia lebbek* (Siris)
- *Azadirachta indica* (Neem)
- *Leucaena leucocephala*. (Subabool)
- *Pithacellobium dulce*
- *Prosopis juliflora* (Vilayati Babool)
- *Prosopis cineraria* (Khejri)
- *Salvadora persica* (Piludi)

- **Fuel wood species**

Marginal or degraded lands can be better utilized for growing salt tolerant fuel wood trees. Fuel plantations established on saline soils or irrigated with saline water would allow more fertile lands and fresh water to be reserved for forage production or even food production. Plantation of following tree species will help rehabilitation of lands by establishing ecosystem and also will help supplement the fuel wood needs.

- *Acacia nilotica* - Desi Baval
- *Albizia lebbek* - Siris
- *Cassia siamea* -
- *Casuarina equisetifolia* - Saru
- *Prosopis juliflora* - Ganda Baval
- *Azadirachta indica* - Neem
- *Holoptelia integrifolia* - Cassa
- *Tamarix ericoides* -
- *Pithacellobium dulce* and
- *Cassia auriculata*

6.5.3 Techniques of reclamation

The methods to be adopted for reclamation must necessarily be based upon a proper understanding of the causative factors responsible for development of saline condition. For reclamation techniques to be permanent, the following three essential requirements have to be met with:

1. Salt must be completely removed from the root zone;
2. The land must be prevented from reverting to the original conditions; and
3. The repair of the damage, already done to the soil should be substantial.

Harmful salts being water soluble can be removed by leaching with water, but in many cases the exchangeable sodium in the soil has to be replaced by calcium, for which a calcareous amendment (Gypsum) may be necessary before the leaching process can be made effective. The drainage capacity of such lands must be restored to permit free percolation of water in the soil profile. Thus, depending upon the local conditions a combination of soil amendment can help achieve permanent solution. During the process of reclamation, the soil passes through a number of stages, which can be utilized to monitor the effectiveness of the reclamation methods under operation. These effects of ameliorative steps are reflected in increased crop growth vis-à-vis the physical and chemical changes in the soil characters.

The amount of soluble salts can be reduced to safe limits for agricultural crops for leaching for which availability of good water is an essential component. Use of saline water for initial leaching will reduce the requirement for non-saline water for achieving similar desalinization of soils. This should be practiced if salinity of water is sufficiently lower than the salinity of the soils to be leached. The quantity of water required for de-salinisation depends upon the initial salinity, the soil depth to be reclaimed and water application techniques. For removal of 80 percent of initial salts, approximately 0.5-cm water per cm. soil depth is required for sandy loam soils. De-sodification accompanies the desalinization process, through at a slower pace. Fine textured soils (black clay soils) require more water for similar amount of salt removal than coarser soils.

Under limited availability of fresh water a better practice will be to use saline water for initial leaching followed by leaching with fresh waters. Through this method even though the total quantity of water required for achieving similar desalinization can increase the need for fresh water is reduced. Generally a period of five years or more is required depending on the nature of problem to revert the soils to their natural productivity. The economics and duration of time involved are additional factors that need to be considered in any scheme of reclamation of such soils. The reclamation of problematic soils requires a systematic approach. It is therefore, desired that the areas be selected on the basis of intensity of problem.

- It is always desirable to have crop production in low intensity problem area (low salinity area) (EC_e 4 – $6dS/m^{-1}/ESP$ up to 30),
- Horticulture plantation in medium intensity problem area (Medium Salinity area) (EC_e 6-10 dSm^{-1}/ESP between 30-40) and
- Fuel wood / timber production in high intensity problem area ($EC_e > 10 dSm^{-1}/ESP > 40$)

The techniques to be adopted for crop production, horticulture plantation and fuel-wood plantation are as below: Techniques of Crop/ Horticulture/ fuel-wood Production The reclamation of saline soils for crop production requires provisions of chemical amendment, irrigation facilities and on farm drainage. The management tips required in handling such soils are:

- **Reclamation steps:**

1. Leveling, bunding of lands dividing in small segments of 0.4 ha
2. Collection of soil samples and getting them analysed
3. Provision of irrigation water-get analysis of well waters.

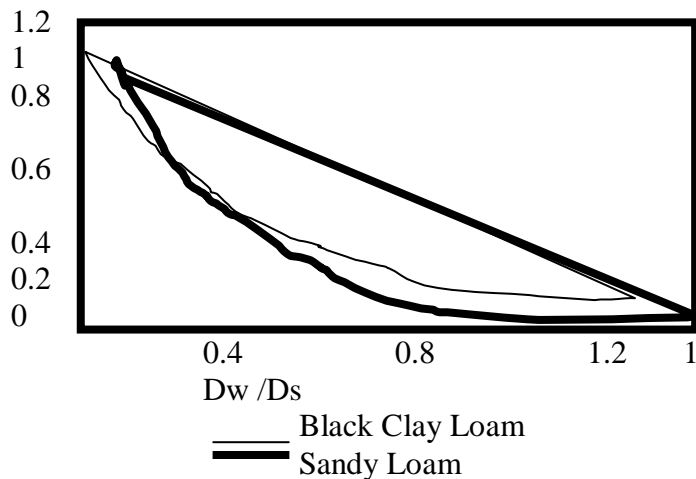
4. Adopting reclamation practices as per the soils type chemically
5. Not permitting the run-off water from the upland to enter into fields where soil reclamation is in progress.

- **When to start reclamation?**

It is desirable to start reclamation of salt affected soils before planting a kharif crop. The summer months (April, May and June) provides an appropriate time for such operation. Since, beneficial effects of rainwater in leaching soluble salts can be availed and the paddy crop can be raised if water is available and thereby hasten reclamation.

- **Reclamation of saline soils:**

Leaching with water is the only practical way to remove excess salts from soils. Leaching with rainwater is slower than ponding water in the fields. Leaching can be effective only if drainage facilities are adequate. The water carrying the salts must pass through and below the root zone and be discharged through seepage or flow in nallahs or artificially through a man-made drainage system. The quantity of water required will be dependent on the amount of salts to be reduced in a particular soil type. This can be calculated from the following figure.



Depth of Leaching water per unit depth of soil required to reclaim saline soils (A) Sandy-loam soils and (B) Black –clay loam soils.

6.5.4 Support Services

Application of science and technology is necessary to increase factor productivity in irrigated agriculture. Intervention on the policy front so as to develop institutions to make the improved technologies `accessible to the farmers should be encouraged. This requires support in the areas of credit, prices, marketing, input supply and extension to help the irrigated agriculture move forward.

Credit Services

Capital being a scarce resource, a strong credit support is essential for them to adopt improved technologies involving cash investment. The rate of interest charged by the non-institutional sources such as moneylenders is ranging from 24 to 60 percent per annum in the area. Farmers find it un-remunerative to borrow credit at such high rate of interest and invest it in risky crop production enterprise. Regional Rural Banks (RRBs) are better suited to the job.

Efforts should be made to strengthen the RRBs set-up. Since technological intervention is dependent upon many factors, repayment will have to be scheduled with an in-built flexibility linking to the performance of crops in the area. Interest subsidy for selected crops and specific situations involving greater risk should be encouraged. Where ever possible, credit should be linked with input supply and recovery with the marketing of the produce.

Marketing Services

Present marketing services are under-developed to handle higher production or new products. The density of regulated market is very low in the area. The major aspects of marketing that need immediate attention are storage and processing facilities. Traditional methods of storage require less capital, but are inefficient in checking the storage loss. Storage loss is quite high in some of crops, particularly in the pulses. Lack of storage facilities affects the bargaining capacity of the farmers and they are forced to sell their produce immediately after the harvest, irrespective of the price prevailing on hire basis, they can wait till the market prices recover. If this facility is further coupled with credit against hypothecation of stocks, their bargaining capacity will receive support. Unless marketing services are developed, it is difficult to generate enthusiasm in the area to digress from the present to produce more.

Input Supply

Adoption of new technologies requires the use of new inputs such as improved seeds, fertilizers, plant protection chemicals and improved machinery. Infrastructure, which could ensure the supply of critical inputs like seeds, fertilizer and organic manure, is needed in the area. Seed production geared to meet the vast requirement of the saline tract of land will have to be taken up.

The national network of research centers for different crops have evolved species for meeting aberrant weather and hydrological conditions. These will have to be backed up by a chain of seed banks, stocking quality seeds of various crops and varieties so as to meet the demand. Custom hiring facilities should be made available to the farmers either directly or through a network of depots manned by persons with proper training. A system of providing service subsidy to the vulnerable sections should be incorporated into these custom hiring units. Marketing should be linked up with the Custom Hiring Services for timely operations and input supply.

Extension

It is necessary to develop the skills of farmers so that they can reap full benefits of new technologies. Considering the magnitude of the problem, the training facilities and manpower will have to be increased manifold so as to give full coverage.

The organization of agricultural research and extension is poor in the area. The shortcomings are as follows:

- Lack of flexibility and willingness of research and extension staff to identify and respond to clients needs.
- Lack of problem area focus.
- Lack of on-farm participatory research.
- Poor linkage of research and extension.
- Lack of proper incentives to research and extension staff.

These should be strengthened by suitable linkage and networking mechanism.

6.5.5 Summary of Recommendation

The recommendations made in this section can be broadly summarized as follows:

Institutional

Establish techno - finance organization dedicated to Natural Resource Management with

- Fund to promote revitalization and development of Natural Resources.
- Technical service delivery system which links knowledge base of local people with research development institutions and Government organizations involved in the field.
- Community mobilization unit which ensures active participation of local people.

Technical

For Inland Salinity

- Increase efficiency of Irrigation & Drainage by
 - Providing adequate and appropriate canal and drainage infrastructure.
 - Setting up People's institutions to manage and maintain irrigation & drainage systems.
 - Developing village water- bodies as an integral part of irrigation & drainage system.
- Promote efficient water management agriculture practices by
 - Encouraging use of organic inputs.
 - Imparting training / awareness / motivation.
- Undertaking public / private salt tolerant energy plantations.

For Coastal Salinity

- Construct Check Dams/ Tidal regulators and Bandharas along the seacoast.
- Establish natural barriers along the sea coast by Plantation and conservation of Mangroves.

6.5.6 Strategic Shift

In order to achieve desired results following strategic shift is proposed:

PRESENT

PROPOSED

A. Lack of people's participation In Planning implementation And management of irrigation & Drainage infrastructure.	Creating Village Level Institution.
B. Lack of integration between irrigation/ drainage/ agriculture departments at different levels	Proposed Organization integrates all three disciplines.
C. Inefficient Agriculture Extension Services.	Setting up Technical service Delivery system.
D. Un-Conjunctive use of canal And ground water.	Integration of Village Water bodies with canal & Drainage system.
E. Inappropriate water pricing System on area and crop basis.	Pricing on volumetric basis.

7

Organization Structure:

Considering the extent and nature of the problem and need for involvement of several interest groups in addressing the same, it is understood that the major emphasis should be on institutional aspects of the project implementation.

As mentioned earlier a Special Purpose Organisation (SPO) is proposed to be created which is dedicated to the issue of Natural Resource Development in general and salinity in particular.

The organisation is designed at two levels:

Level One : Regional Level

Level Two: Cluster of Village level – having three internal Tiers



7.1 Regional Level Organisation:

Regional Level Organisation is visualized as technical support organisation. The organisation should be registered under Companies Act of 1956. As mentioned in the chart above different interest groups will have stakeholding in the Company. This will include local farmers, industries, technical research and development organisations, financial institutions and non-government organisations. The organisation is proposed to be managed by Board of Directors. The organisation will have mainly three types of professionals as part of implementation team i.e. Agriculture engineering, Agriculture/forestry and Community mobilization.

7.2 Cluster Level Organisation:

It is visualized that farmers along with sub minors/distributories will be organised as a smallest unit of operation. They will form the major base on which the entire effort of natural resource development is proposed to be organised. Such organisations will form a cluster level organisations.

The clusters are formed as mentioned earlier on the basis of commonality of nature and extent of problem, the linkage due to irrigation and drainage infrastructure and social composition. It is proposed to have 19 such cluster level organisations.

These organisations are proposed to registered as societies, which can carry out the function of implementation of natural resource development activities. (On the lines of Participatory Irrigation Management and Watershed Development Associations).

These organisations in collaboration with Regional Level Organisation will plan the development activities for the cluster. The mobilisation of financial resources and implementation will be carried out by the cluster level organisations. The role of Regional Level organisation will be to assist the cluster level organisation in carrying out the planned activities in proper manner and provide technical and organisational support whenever necessary.

7.3 Organisational strength:

7.3.1 Regional Level:

The team will be headed by a Project Director. The other team members will include persons with technical and community development background. The number of professionals in each section i.e. technical, community mobilisation and finance are expected to start with two. With expansion of the work team should be expanded. The team will be located at Ankleshwar.

7.3.2 Cluster Level:

A team of two persons mainly with background in Agriculture and Community work will be stationed at the cluster village.

8

Financial Requirements and Time Frame:

The financial requirements for the project is worked out which includes financial needs for actual work to improve the land resources and project costs including both establishment and recurring costs for entire project period.

The proposed financial requirement for the project is broken up in three major portions:

A) Treatment Work, B) Establishment Costs and C) Operating Costs.

8.1 Treatment Work:

As mentioned earlier, the region has been divided in 19 clusters of villages. These clusters have been categorized in two major type of salinity namely, a) Coastal and b) Inland. The inland salinity areas have been further classified in Low, Medium and high levels of salinity. The classification of clusters in terms of degree of salinity is based on % of land affected by salinity over the total culturable land of the cluster.

The model cost estimates for each type of salinity level are worked out in details and are enclosed along with the total budget. The model cost for cluster affected by each level of salinity includes work to be carried out for irrigation and drainage infrastructure. The cost also includes deepening of water tanks, promotion of appropriate agriculture practices and other inputs.

To arrive at these costs, a cluster of six villages was taken up for detailed study. A detailed planning exercise was carried out with the local people, concerned Government officers from the irrigation and drainage departments and technical experts. Based on the exercise detailed costs for irrigation and drainage works were prepared. The details of the exercise are enclosed in Annexure 16. On the basis of this exercise projects were made for remaining 18 Clusters of villages. These estimates will undergo changes when detailed planning exercise is carried out for the each of the clusters.

8.1.1 Phasing of the treatment works:

The treatment cost has been phased out over a period of five years, wherein it is expected that in first year mobilization and organisation of farmers will take place. During this period organizations of farmers at cluster level will be formed on the basis of Participatory Irrigation Management (PIM) scheme of the Government (for details refer Annexure). In second and third year physical work will be carried out. Simultaneously appropriate agriculture practices will be promoted. This includes use of organic inputs, efficient water utilization etc. The consolidation of programme activities will take place in Fourth year and fifth year will mark the initiation of withdrawals of Programme team. For details kindly refer the detailed costs estimates for model costs for each level of salinity.

Further, based on the above cost estimates for each cluster has been worked out which is enclosed as annexure 15.

8.2 Establishment Costs:

The costs for this section is worked out on the basis of required infrastructure for both Regional Level Organizations (RLO) as well as 19 Cluster Level Organisations (CLOs). The estimates of funds for RLO include office premises, furniture, computers, and vehicles. The capital investment is phased out in first three years of the Project period. For CLOs, the rent for the office unit, furniture and vehicles (two wheelers).

8.3 Operating Costs:

Under this item the costs include remuneration to the project staff, travel and office costs for both RLO and CLOs. These costs are projected for the entire period of the project considering growth of the project and annual inflation.

8.4 Phasing of the Project:

The project is envisaged to be implemented in 10 years period. During first three years work will be initiated in all the 19 clusters. The withdrawal process is expected to start in the sixth year of the total project. As mentioned earlier the work in each cluster is phased out in five years duration. Along with regular planning and review of the project two detailed project reviews one mid term and second at the end of the project. The detailed phasing is mentioned in the total budget presented below.

8.5 Financial allocation

The project has two basic components of irrigation and drainage infrastructure works. Both of these aspects have been included as part of the master plan prepared by the respective departments. The drainage division Ankleshwar has taken cognisance of the status of main/Sub-drain, lateral drain, sub-lateral drain and Road side drain lying within the command area of UKRBM. Similarly the irrigation works involving distributory, minor and sub-minor has been included therein.

List of Annexures:

1. List of Consultative Committee
2. Terms of Reference for a study to prepare plan of action.
3. Participatory Rural Appraisal Exercise in select 20 villages
4. Soil Characteristics of Hansot and Ankleshwar Taluka
5. Changing Land use Profile – Hansot and Ankleshwar Taluka
6. Land Use Pattern – Hansot and Ankleshwar Taluka
7. Cropping Pattern (Food Crops) - Hansot and Ankleshwar Taluka
8. Cropping Pattern (Non- Food Crops) – Hansot and Ankleshwar Taluka
9. Number of Source of Irrigation (Medium & Minor Irrigation) – Ankleshwar & Hansot
10. Number of Source of irrigation (Major Irrigation Schemes) - Ankleshwar & Hansot
11. Geohydrological Data of Ankleshwar Taluka
12. Geohydrological Data of Hansot Taluka
13. Identification of Clusters
14. Sample analysis – Soil from 65 villages (123 samples)
15. Extent of Salinity in Culturable Land & Costs for Revitalisation
16. Proposal for Six Villages falling under Medium Salinity
 - 16a – Drainage status and required Work to be carried out
 - 16b – Village Wise Drainage Expenditure
 - 16c – Village Wise Drainage Expenditure (Sub-surface Drainage) & Costing for installation of Sub-surface drainage.
 - 16d - Canal Status and Required work to be carried out & Canal Work & Expenditure - Village Wise

17. An Analysis of Physical & Chemical Properties of Soil and Water Samples of Six village cluster
18. Agriculture programme in Six Village cluster
19. Rational for Afforestation programme in Six village Cluster
20. Participatory Irrigation Management – Programme at a glance.
21. Watershed Development Programme - Programme at a glance.
22. Conjunctive use of water – Perspective
23. Integrated Map of Six Villages Depicting different levels of Salinity
24. Integrated Map of the Infrastructure Existing and Proposed – Canal and Drainage
25. Socio- Economic aspects.

Annexure: 1
Consultative Committee

Na me and Address

Corporate

- | | |
|---|---|
| 1) Mr. D. A. Anandpura, PP (AIA) and Chairman - Rural Support Projects committ. Anand Texturisers P. Ltd. 5513/1, GIDC, Near Little Hut Restaurant Ankleshwar - 393 002 | 7) Dr. M. H. Mehta - Executive Director - Gujarat State Fertilizers Co. Ltd. PO. Fertilizer Nagar Dist : Baroda – 391 650 |
| 2) Mr. N. K. Navadia, President (AIA) Alvyn Rubber Products 1308, GIDC Ankleshwar - 393 002 | 8) Mr. H. G. Patel – Sr. Agro Services Officer Gujarat State Fertilizers Co. Ltd. PO. Fertilizer Nagar Dist : Baroda – 391 650 |
| 3) Mr. Kamlesh Udani, IPP (AIA) Unique Pharmaceuticals Lab. Ltd. 128, GIDC Ankleshwar – 393 002 | 9) Mr. Harishbhai Jani Chief Marketing Manage GNFC Ltd. PO – Narmadanagar, Dist : Bharuch |
| 4) Mr. N. H. Patel, VP (AIA) Norris Medicines Ltd. 901, GIDC Ankleshwar – 393 002 | 10) Dr. D. S. Yadav Sr. Marketing Manager (AS) GNFC Ltd. PO Narmadanagar, Dist : Bharuch |
| 5) Mr. Manshukbhai Vekaria, Member Rural Support Projects Committee - AIA, Colo Chem Industries, Plot No. C1/B/7002, GIDC Estate Ankleshwar – 393 002 | 11) Mr. J. K. Shah – Director Narmada Chematur Petrochemicals Ltd. (President - Bharuch Dist. Management Asso.) 601, Vailkunth Mega Township Opp. Polytechnic College, Bholav Bharuch |
| 6) Mr. Shantibhai Patel Tirupati Chemicals 712, GIDC Estate, Ankleshwar – 393 002 | 12) P N Parmeshwaran General Manager – Environment United Phosphorus Ltd. 117, GIDC Ankleshwar - 393 002 |

Resource Persons:

- 1) Mr. Jinabhai G. Patel
18, Narmada Nagar, Navi Divi Road,
Nr. Jalaram Temple, Bharuchi Naka
Ankleshwar - 393 001
Government
- 2) Dr. Anilbhai H. Bhatt
6, Niharika Bungalow,
Opp. Himmatlal Park,
Nr. Azad Society,
Ahmedabad - 380 075
- 3) Mr. Kanubhai Shah
4, Anhant Apartment
Opp. Tana Apartments
Subhabpura
Baroda – 390 007.

Farmers

- 1) Mr. Jayeshbhai Patel
Kalindi Apartment, Chiku Wadi
Opp. Railway Yard,
Ankleshwar - 393 001
- 2) Mr. Harishbhai Bhatt
At & Post - Rayma,
Taluka : Hansot
Dist : Bharuch
- 3) Mr. Suleman Patel
At - Piraman Gam,
Taluka : Ankleshwar
Dist : Bharuch
- 4) Mr. Jayantibhai Patel
Hon'ble M. L. A.
4, Virat Nagar Society, Nr, Overbridge,
Ankleshwar - 393 001
- 5) Mr. Ambubhai Patel
Shakti Nagar
Nr. Modi Nagar
Ankleshwar - 393 001
- 6) Mr. Laxmanbhai Patel
44, Jaldarshan Society,
GIDC, Valia Road,
Ankleshwar - 393 002.

NGOS

- 1) Mr. Ashokbhai Rathi
Manviya Technology Forum
25, Gokul Nagar Society,
Makarpura Road, Opp. ONGC
Baroda - 390 009.
- 2) Mr. Rajeshbhai Shah
Vikas Centre for Development
Shree Apartment
University Hostel Road,
Navrangpura
Ahmedabad - 380 009.

Government:

- 1) Taluka Development Officer
Taluka Panchayat
HANSOT
Dist : Bharuch
- 2) Mr. D. M. Shah - Executive Engineer
Ukai Irrigation Canal System
B/h. ITI, Station Road,
Ankleshwar - 393 001.
- 3) Mr. B. M. Makwana - Executive Engineer
Soil, Drainage and Reclamation
GERI Compound, Race Course
Baroda - 390 005.
- 4) Mr. P. C. Chelawat
Khar Land Development Board
Bharuch Sub Division
3rd Floor, Multi Storied Building
Nr. Gayatri Nagar, Kanabi Vaga, Bharuch
- 5) Dr. S. Raman - Research Scientist
Soil and Water Department
Gujarat Agriculture University
Navsari
- 6) Mr. B. V. Vaghela - Dy Forest Officer
Social Forestry Department
B/h. Mamlatdar Office
Opp. Gayatri Nagar
Bharuch

Annexure -2

Combating Salinity:

A collective effort of local people, Voluntary Organisations, Government and Industries to address the issue of increasing salinity in land & water in villages of Hansot taluka, Bharuch District, Gujarat, INDIA.

Terms of Reference for a study to prepare a Plan of Action

Prepared by:

SAVE - Saline Area Vitalisation Enterprise Limited, Ahmedabad

&

Ankleshwar Environment Protection Society, Ankleshwar

1.0 Background:

1.1 Coastal Belt of Gujarat:

With 1600 Km. long coastline, Gujarat has the distinction of having about one third of the total coastline of the country. This distinction also has its own disadvantages. Environmental degradation linked with poverty and under development is clearly evident in most part of the coastal region.

Large and ever expanding saline wastelands, strong sea winds, deep and advancing salinity ingress, uneven and uncertain rains leading to recurring draughts characterize the situation along the most part of the coastal region. The hostile natural conditions combined with inadequate development infrastructure in large parts of coastal belt have resulted into an overall economic stagnation and backwardness in one time economically vibrant region of Gujarat.

With the exception of few centers of economic prosperity, large portion of 8.0 million people living in about 550 villages & towns along the coastal belt are forced to subsist on low-investment low-return agriculture, animal husbandry and fisheries.

Some of the regions particularly in south Gujarat, endowed with reasonably good infrastructure and access to irrigation facilities have different sets of development concerns. Availability of development resources – water & land and infrastructure facilities including power and communication network has resulted into rapid industrial and agriculture development in the region. This has thrown new challenges to planners, policy makers and local people in terms of keeping delicate balance between economic development and quality of natural resources.

The local farmers and industries in region are confronting the problem of increasing salinity in agriculture land and water and the present initiative of preparing a comprehensive plan of action is born out of their on going struggle to address the issue.

1.2 Hansot, A coastal Taluka:

Hansot, one of the five coastal talukas of Bharuch District is facing similar problems of degeneration of natural resources in terms of increasing salinity in land and water. The local people particularly farmers, voluntary organisations, industries in Ankleshwar and Hansot regions, Government and policy makers are concerned about the issue.

As part of an on going effort, Ankleshwar Industries Association (AIA) organised two meetings of interested persons representing farmers, voluntary organisations, industries, Government officials, semi Government corporations, technical and academic groups at Ankleshwar, in March and April 1999.

Issues discussed during the meetings mainly focused on the nature and extent of the problem and its impact on local people. Broad direction and suggestions required resolving the issue was also discussed. It was observed at the end of the discussions that though some understanding about the nature and extent of the problem and possible solutions existed, a comprehensive plan of action was required to effectively address the issue.

This was felt necessary because of the scale and nature of the problem and need to,

- a) involve institutions and individuals from different disciplines and sectors
- b) link various levels of operations ranging from farmers at the village level to policy makers and planners at the state level
- c) mobilise necessary financial resources.

It was proposed to appoint SAVE - Saline Area Vitalization Enterprise limited, a technical service organisation and Ankleshwar Environment Protection Society to jointly carry out the planning exercise which would facilitate definite action on the issue. To ensure greater participation of all concerned, a consultative team of representatives of various interest groups was constituted.

Following is a Terms of Reference (TOR) for the planning exercise.

1.3 Conceptual Framework:

Environmental degrading is a process and not a product. It is a verb and not a noun. This process occurs over a period of time with a combination of natural and human activities. The nature and intensity of interactions with natural resources including land, water and bio-mass decides the impact created on surrounding people and places. The impact both irreversible and reversible, are felt over a period of time across generations. The acts of one generation are felt by many future generations. The controls and utilization of the given natural resources are essentially structural issues.

Hence degeneration of natural resources is a complex and systemic problem and requires a systemic response.

Environmental upgrading is also a process and not a one-time activity. Sometimes the solutions to problems go beyond the actual location and people affected by the problem and demands involvement and commitment from all concerned people and organisations for a sustained period of time.

The people whose survival & sustenance are linked with the eco-systems in question and suffer the consequences of its degradation are the first & primary stakeholders in the reversal & redevelopment process of their immediate environment. They should be the prime mover of the process suitably supported by external, organisational, technological and financial inputs.

Though to address the issues of degeneration of natural resources require technical solutions and financial resources, for effective resolution of the problem, sufficient attention must be given to initiation and strengthening of organisations of local people. It is hoped that the pioneering efforts made in the region by people concerned should provide useful experience to address the issue for other parts of the coastal belt of Gujarat.

2.0 Expected out Puts:

- Ascertain the nature and spatio temporal extent of the salinity problem.
- Estimates of adverse impacts of salinity on the population and their livelihood.
- Identification of factors, both natural and human, contributing to increasing salinity in the study areas.
- Articulation of a strategy to address the issue encompassing technical, financial, organisational and managerial issues at village, taluka, district and state level.
- Most suitable technological solutions for reversal of degradation process
- Affordable and sustainable financial plan.
- A detailed action plan with time frame & management system.
- An organisational setup to initiate a self sustaining process of upgradation of environment.

3.0 Methodology of the Study:

3.1 Assessment of the Present Status

An Assessment of the present status of the problem of increasing salinity in land and water bodies, as well as its effects on life style, agriculture and economy will be made.

a) Information from Secondary Sources:

For this purpose, information will be collected by field visits, as well as from several Government and non-government organisations (NGOs) which include GERI, M.S. University, WALMI, GSLDC, Departments of Fisheries, Irrigation and Agriculture, GPCB and others.

The data to be collected will include information on demography, agriculture, and expanse of salinity in land and water bodies, availability of water supply and general status of environment. However, data available from the above mentioned sources may not give a detailed account of the history of the degradation process. In view of this, appropriate use of remote sensing technique also will be made, whereby remotely sensed information of the previous years will be interpreted to have an idea of the rate and extent of degradation which has happened over the past.

Here, the efforts will be made to prepare thematic maps using remotely sensed data for different time period in order to evaluate the existing condition and changes over period of time to find out the factors affecting salinity.

The satellite images of the year 1988, 1992 and 1998 will be used for generating different maps. This includes the following:

- built-up land
- Transportation network
- Crop land
- Fallow land
- Plantation (agriculture)
- Forest land
- Degraded land
- Degraded forest land
- Mangroves
- Salt affected land
- Water logged land
- Wet lands
- Sandy area
- Rivers and water bodies

b) Primary information collection: Field visits:

As mentioned earlier the effectiveness of such an initiative largely depends on genuine involvement and participation of local people. People must be involved in defining the problem as they can contribute immensely through their traditional wisdom and knowledge base. The information collected through secondary sources will be shared and discussed with representatives of local people through series of field visits and meetings.

3.2 Analysis of Data to Identification of causes:

A rigorous analysis of observations and data will be made to identify causes of the ongoing process. Inputs of people will be obtained to this end also. At this juncture, during meetings with the people, their perceptions as regards the causes and possible solutions will also be discussed.

3.3 Presentation of Draft Report.

A Draft Report will be prepared upon completion of above activities, which will present the prevailing conditions and reasons thereof. The Draft Report will also present detailed programme for further studies. If any further field investigations/surveys are required to be carried out, the same will be indicated in the Draft Report.

3.4 Exploring alternative appropriate solutions:

Having ascertained the extent of the problem and its causes, available options will be explored i) to stop the damage; and ii) to reverse the process.

This will involve inputs from experts from various disciplines, including, land reclamation, agriculture, irrigation engineering & hydraulics and environmental engineering, organisation and management.

It is to be appreciated that in order to arrive at a solution, which can facilitate the beginning of a process of reversal of the environmental degradation, the technology will have to be combined with an understanding of the local people involved.

Essentially the effort will be to link age old traditional wisdom of local people and scientific knowledge base developed in research and development institutions and organisations. The options to be considered will attempt to adapt the local skills & materials with a view to ensure greater involvement of the community. This is of utmost importance to offer a sustainable reform process.

3.5 Financing Plans and Organisational setup:

For selected solutions, a detailed programme will be prepared for successful implementation of the project. This will also include periodic financial outlay during the project period and possible sources of funds.

The study will also propose an appropriate organisational structure for implementation of the project. As is mentioned earlier, the task of upgrading environment is a continuous process and hence the organisational structure will be proposed to ensure the participation of all concerned.

The organisational set up will also consider setting up core teams which will carry on the work of stopping the damage caused to the natural resources and that of improving the quality of environment beyond the formal completion of the project.

3.6 Cost-benefit analysis:

Finally, the report will present a summary of the strategy proposed, Its positive impacts and the cost-benefit analysis, including direct and indirect benefits. This will be addressed to motivate and generate interest of all concerned, directly or indirectly, including the people, the industry, the policy makers & the probable funding agencies and investors.

4.0 Time Frame for The Study

Entire study as per the TOR presented here will be completed within a period of 6 months. Indicative program schedule is presented here, which can be finalised after fine tuning the TOR.

ACTIVITY	WEEKS																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Data Collection	█	█	█																					
Desk Studies				█	█	█																		
Field Meetings				█																				
Draft Report																								
Exploring Solutions								█	█	█	█	█	█	█	█	█								
Field Meetings										█			█			█								
Financial Analysis																		█	█	█	█			
Organisational set up																					█	█	█	
Final report																								█

5.0 Human Resource:

In order to carry out the exercise, it is proposed to set up a project team of four persons supported by a group of subject specialist.

Project team:

1. Project coordinator
2. Project manager
3. Research Assistant (2)

Resource Persons:

1. Soil and irrigation
2. Agriculture & Forestry
3. Remote Sensing
4. Organisation and Management
5. Financial Planning

5.1 Expected work and time inputs:

Project Coordinator:

The project coordinator will provide overall leadership to the project. Though he will be fully responsible for the programme, his time input is estimated at two man months during the entire project period of six months.

Project Manager:

The person will have technical qualifications and work experience in soil and water conservation. The person appointed will be an Environment planner/engineer. He will be fully responsible for carrying out the exercise. His functions will involve carrying out information collection from local people and relevant technical organisations, analysis, and preparation of the draft reports and final document.

Research Assistants:

The project manager will be assisted by a team of two research assistants in the field to carry out the information collection. They will be involved in the project for two months period.

Resource Persons:

- **Soil and irrigation:**

The key issue is increasing salinity in soil and water. The primary reason seems to be over irrigation and flooding combined with sea ingress. The project team will benefit from the inputs from subject specialist. The time input estimated total of six weeks during the project period.

- **Agriculture and Forestry:**

Along with understanding the nature of the problem and designing physical solutions the issues of related to vegetation - agriculture, forestry and fodder will also have to be addressed. The subject specialist with relevant experience and expertise is proposed to provide four weeks of time during the project period.

- **Remote sensing:**

As mentioned earlier in order to understand the nature and scale of the problem of degradation of natural resources in general and salinity in particular along with collection of information from local people, satellite data will be collected and analyzed. This work will be carried out by the specialist with sufficient expertise and experience backed by necessary infrastructure facilities. The time input expected is four/six weeks.

- **Organization and Management:**

The expected output of the exercise also includes designing of an appropriate organisation and management structure for effective implementation of the programme. He would guide studies on social structure to have greater understanding of the people in terms of various aspects of caste and class structure prevailing in the region. This understanding shall contribute in designing the overall organisation structure. The resource person shall also design the human resource requirement and development plan to ultimately facilitate initiation of a local institution focused on the issue of salinity in particular and natural resources regeneration in general.

A senior management expert would devote three weeks of time during the project period.

Note:

- All the resource persons over and above carrying out their specific task will also participate in meetings with the project team for the planning purpose as well as with consultative committee for discussions and presentation as and when required.
- The financial planning inputs is considered to be provided by Ankleshwar Environment Protection Society (AEPS).

Annexures-3

Participatory Rural Appraisal Exercise in 20 selected villages

People's Knowledge

For the purpose of specificity it was considered essential to know people's perception into the cause and pattern of salinity. Local people those who have lived with the problem could contribute effectively in enriching knowledge on the problem of salinity. For the purpose an exercise wherein people themselves spoke about the issue was carried out in select villages to ascertain the extent and nature of salinity in the study area.

Objective of the exercise:

- To explore participation of local people in analyzing situation and taking decisions based on the ground situation. .
- To create an enabling environment in which innovations are encouraged from local people/ resources and foster long term resource management plans.
- To analyse possibilities of development of local level or federated support institutions for sustaining the development process.

Initially, The objectives of the exercise were clarified. It involved discussions with core group of people in the village, about the need of the exercise, nature of participation required, methods to be followed and the usefulness of the present exploratory exercise.

The key aspects of the approach were:

- Learning from each other
- People deciding their priorities and,
- Involvement of all sections of the community

The core group, in turn, sensitized others about participation in the exercise. Changes in the proposed methodology from the people were welcomed, like holding informal group discussion on the issues related to land during transect exercise etc.

Following exercises were carried out:

Natural Resource Mapping:

One of the villagers (a member of the core group) or one of the team member worked with a group of about 10 people to enable them to draw a base map either on the ground or on a sheet of paper. This map showed major natural resources in the village, landmarks, boundaries and divisions, drainage channels, inhabitation areas etc. This helped in developing participatory environment in the village. It also helped to understand the diversity of village resources. The initial group of 10 participants expanded to 20 and eventually more people joined the exercise.

This process of mapping was found to be a rapid way of overcoming inhibitions of the local people. The villagers showed lot of local diversity of resources. These maps represented Natural resources, State of these resources, Land use and soil classification, Rivers (nallas), Drainage points, Boundaries with other villages, Status of assets or common infrastructure (like ponds, drinking water source, tanks and even individual sources if any; functioning or dysfunctional) and the diversity of the village in terms of availability of resources, their utilization, status and access.

This base map was prepared by the villagers without any external support within half an hour to two hours period, depending on the size of the group and the level of participation. The map formed the basis for deciding the transect route, type of transects, and also transect groups in the village. At the time of transect discussions were held about issues like who are the owners and users of these resources and who is likely to have a stake in them.

Transect

The transect team involved 5 to 8 participants who own and use the resources and know the problems related with them. Depending on the local mapping, local soil classification proved to be most effective and representative of the diversity of the natural resources and people affected by them.

The process of transect involved following steps:

1. Observation of physical characteristics - water- logging, soil depth, soil type and people's perceptions on these issues. It involved drawing flows of run off, ground water, drainage and showing how various phenomena viz.: development of salinity, are affecting productivity and management of resources owned and used by the participants.
2. Observation of crops or any other bio-mass. It was useful to ask people about the relationship between productivity and the characteristics of land and other resources. Asking people to make a sketch map of their own field on the ground to show the problems and constraints faced by them was found the best way to encourage discussion of the problem and the constraints faced. This exercise helped further discussion and also encouraged other members to contribute ideas and facilitate interviews with focus groups.
3. Thematic maps were drawn at this stage on paper, which included water resource map, local land use, classification map, resource utilization map, cropping pattern map, aquifer map. They were generally an extension of the base map but were very useful to understand the resources and the problems related with productive management and utilization of these resources. It was not uncommon to find a source of local expertise on a thematic issue like a water diviner or a local soil expert who would be able to contribute towards areas requiring intervention. However, it was difficult for illiterate people to participate unless they were encouraged to draw symbols to illustrate various solutions. They could draw well and most of them were creative in drawing diagrams.
4. These led to questions about problems faced / constraints in effective utilization of resources. Most of the people had some solutions in mind when they were talking about the problem. In fact they tended to indicate them along with the problems. During transect walk observations were made leading to identification of problems. Mapping was done to facilitate analysis of the problems and helped in focussing on the problems and the solutions during the subsequent discussions (both local solutions as well as suggested based on the experience).

5. This led to a transect diagram which was prepared by the local people in the form of opportunity identification matrices. This matrices showed all natural resources, local land use classifications, existing state of resources, constraints / problems in productive development of these resources, local solutions tried out by the people and options identified by the people for solving the problems and development of each resources.

Social mapping

Another exercise undertaken at this stage was social mapping. This involved mapping different social groups within a village. This was particularly important since almost all villages had heterogeneous village communities. In number of cases social mapping and wealth groupings were combined to understand the relationship between social groupings and the wealth status. In some cases social maps were extrapolated to find out the correlation between resource ownership, resource management the social groups in the village. It was possible to identify resources that need interaction between various social groups for managing or developing them. For example; grazing land, revenue land and also common wastelands.

Participatory Technology Generation:

1. Farmers were asked to carry out observation exercise for various technologies being tried out by the farmers in different zones of the village and also enumerate innovations.
2. Once these experiences were shared, people prepared inventory of all local techniques and examined its impact on solving all problems associated with a particular land or soil type. At this stage discussions were held with the help of diagram to suggest modifications.
3. Discussions were now held with the farmers facing the problem in the field. Farmers suggested specific changes and contributed to the technology evolution process and then the adaptation process.

The above exercise involved intensive dialogue with different members of the community in around 20 villages of taluka. In addition to the above exercise informal group discussion with the local people of all the villages falling within the taluka was also carried out. This helped to delineate areas having different levels of salinity and falling within a single cluster. On an analysis of local perspectives the following statement of problem emerged:

Annexure 4 – Soil Characteristics Of Hansot-Ankleshwar Talukas

UNIT	SOIL CHARACTERISTICS	TAXONOMY
069	Very deep, moderately well drained, fine soils on very gently sloping basaltic interfluvies with slight erosion and with fine calcareous soils with slight erosion	Fine montmorillonitic hyperthermic Typic Chromusterts
070	Very deep, moderately well drained, fine soils on very gently sloping basaltic interfluvies with moderate erosion and with fine calcareous soils with moderate erosion	Fine montmorillonitic hyperthermic Vertic Ustochrepts
083	Very deep, moderately well drained, fine soils on nearly level alluvial plain with slight erosion and slight salinity and associated with fine calcareous soils.	Fine montmorillonitic isohyperthermic Vertic Ustochrepts
104	Deep, well drained, calcareous fine soils on very gently sloping alluvial plains with slight erosion and with slight salinity	Coarse, loamy, mixed hyperthermic Typic Ustochrepts
127	Deep, well drained, calcareous, fine soils on very gently sloping alluvial plains with slight erosion and slight salinity and also associated with very deep imperfectly drained fine loamy soils	Fine (mixed) Hyperthermic Fluventic Ustochrepts and Udic Ustochrepts
129	Very deep, moderately well drained, fine soils on nearly level alluvial plain with slight erosion and associated with fine calcareous soils on gently sloping lands with severe erosion	Fine montmorillonitic hyperthermic Typic Chromusterts
131	Very deep, moderately well drained, fine soils on very gently sloping alluvial plain with moderate erosion and moderate salinity and associated with very deep, moderately well drained calcareous fine soils	Fine montmorillonitic hyperthermic Typic Chromusterts and Udic Chromusterts
133	Moderately deep, moderately well drained, fine soils on nearly level alluvial plain with slight erosion and moderate salinity and associated with fine calcareous soils	Fine montmorillonitic Isohyperthermic Typic Chromusterts and Udic Chromusterts
134	Very deep, moderately well drained, fine soils on very level alluvial plain with slight erosion and moderate salinity and associated with very deep, imperfectly drained calcareous fine soils	Fine montmorillonitic Isohyperthermic Typic Chromusterts and Udic Chromusterts
172	Very deep, imperfectly drained, fine calcareous soils on nearly level coastal plain with slight erosion and very strong salinity and associated with very deep, moderately well drained fine calcareous soils with slight erosion and moderate salinity	Very fine montmorillonitic Isohyperthermic Typic Chromusterts and Vertic Ustochrepts
173	Deep, poorly drained, fine calcareous soils on nearly level coastal plain with slight erosion and very strong salinity and associated with very deep, poorly drained fine calcareous soils with slight erosion and moderate salinity	Fine mixed Isohyperthermic Typic Halaquepts and fine Montmorillonitic typic Chromusterts
175	Very deep, moderately well drained, calcareous fine soils on nearly level coastal plain with slight erosion and very strong salinity	Fine loamy (mixed) Hyperthermic Acid Halaquepts and Fine Mixed hyperthermic Typic Halaquepts

Annexure- 5**CHANGING LANDUSE PROFILE OF ANKLESHWAR AND HANSOT TALUKA**

Name Of Taluka	ANKLESHWAR		HANSOT	
	1981	1991	1981	1991
Year	1981	1991	1981	1991
Total Area (Ha)	42370	42370	38251	38251
Total Population	84944	111943	42670	48552
Area Irrigated By Source (Ha)	1135	8794	3370	12702
Unirrigated (Ha)	30035	23259	21705	11210
Culturable Waste (Ha)	1737	1943	2688	1852
Area Unavailable For Cultivation (Ha)	7039	7516	9818	11490

(SOURCE : DISTRICT CENSUS)

Annexure - 6.**Landuse Pattern of Hansot - Ankleshwar Talukas (in ha)**

	Detail	Hansot	Ankleshwar
1	Geographical Area	39879	44024
2	Forest	984	91
3	Barren & Uncultivated Land	693	708
4	Non-Agricultural Land	7856	6867
5	Permanent Pasture Land	7821	1486
6	Land Under Misc. Tree Crops, Grove	0	0
7	Culturable Waste	4779	1779
8	Current Fallows	461	3383
9	Other Fallows	26	0
10	Net Sown Area	23259	29710
11	Area sown more than once	237	203
12	Gross Cropped Area	23496	29913

Annexure -7.**CROPPING PATTERN : FOOD CROPS AREA (ha)**

	Detail	Hansot	Ankleshwar
1.	Paddy	1048	630
2.	Wheat	1391	1637
3.	Jowar	1381	5606
4.	Bajari	143	1
5.	Maize	1	3
6.	Total Cereals	3694	8252
7.	Gram	34	137
8.	Green Gram	123	26
9.	Tur	12341	13216
10.	Black Gram	0	1
11.	Total Pulses	12589	13677
12.	Sugarcane	487	910
13.	Total Condi. & Spices	19	14
14.	Total Fruits	40	1554
15.	Total Vegetables	336	789
16.	Other Misc. Crops	0	0
	Total Food Crops	17347	25196

Annexure -8**CROPPING PATTERN : NON-FOOD CROPS AREA (ha)**

	Detail	Hansot	Ankleshwar
1.	Cotton	3110	739
2.	Groundnut	130	175
3.	Seasum	203	96
4.	Rapeseed	0	0
5.	Mustard	1	7
6.	Sunflower	0	0
7.	Total edit. Oilseeds	371	280
8.	Castor	2	93
9.	Total non-edi oilseeds	2	93
10.	Total oilseeds	373	373
11.	Tobacco	1	6
12.	Total Fodder crops	2567	3583
13.	Other Misc. crops	0	0
	Total Non-Food Crops	6059	4717

(Source GEC. 1994)

Annexure – 9

NUMBER OF SOURCES OF IRRIGATION

	Detail	Hansot	Ankleshwar
1.	Tank for irrigation	59	12
2.	Total tanks	224	95
3.	Reservoir excluding tanks	0	3
4.	Canals	1	1
5.	Medium Irrigation Projects	0	0
6.	Minor Irrigation Projects	0	0
7.	Lift Irrigation Projects	0	0
8.	Tube wells	0	0
9.	Dug wells	138	498
10.	Wells for domestic use	428	300
11.	Wells not in use	115	78
12.	Oil Engines	146	160
13.	Electric Motors	30	196

(Source GEC, 1994)

Annexure -10

NUMBER OF SOURCES OF IRRIGATION

	Detail	Hansot	Ankleshwar
1.	Large Tanks	170	42
2.	Small Tanks	0	0
3.	Maj. Pub flow Irrigation Projects	12693	4207
4.	Maj. Pvt. Flow Irrigation Projects	0	0
5.	Medium Pvt. Flow Irrigation Projects	0	0
6.	Minor Pub flow Irrigation Projects	0	0
7.	Minor. Pvt. Flow Irrigation Projects	0	0
8.	Major lift Irrigation Projects	0	0
9.	Medium lift Irrigation Projects	0	0
10.	Minor lift Irrigation Projects	0	0
11.	Other Lift Irrigation Projects	0	0
12.	Other Flow Irrigation Projects	0	0
13.	Public GW Tube wells	0	0
14.	Private GW Tube wells	0	0
15.	Dug wells	0	606
16.	Gross Irrigated Area	12863	7855

(Source GEC, 1994)

Annexure - 11

Geohydrological Data Of Ankleshwar Taluka

Sr.	Details	Unit	1978	1984	1991	1997
1.	Geographical Area	Sq km	414.90	414.90	414.90	414.90
2.	Recharge Suitable area	Sq. km	251.94	250.94	251.94	251.94
3.	Area not suitable for recharge (Saline)	Sq. km	162.96	163.76	162.96	162.96
4.	Av. Ann. Rainfall	Mm	1089.58	1084.58	878.27	NA
5.	Rise in SWL	M	-	2.04	0.76-1.9	NA
6.	Sp. Yield	%	-	9.0	9.5	NA
7.	Recharge from Rainfall	Mm ³ /yr	48.32	59.85	45.27	Na
8.	Recharge from Irrigation and other sources	Mm ³ /yr	-	0.04	0.04	NA
9.	Gross Ann. Recharge	Mm ³ /yr	48.51	59.89	45.31	44.18
10.	Utilisable Recharge	Mm ³ /yr	33.95	50.90	38.51	35.34
11.	Total Dug Wells	No's	-	-	337	NA
12.	Total Pump sets	No's	400	Nil	51	Na
13.	Total Pvt. Tube wells	No's	Nil	Nil	630	NA
14.	Total Govt. Tube wells	No's	Nil	Nil	Nil	Nil
15.	Total GWRDC Tube wells	No's	Nil	Nil	Nil	Nil
16.	Gross Draft	Mm ³ /yr	4.85	11.95	33.77	40.02
17.	Net Draft (70% of Gross Draft)	Mm ³ /yr	3.56	8.36	23.64	28.02
18.	Balance GW	Mm ³ /yr	30.39	42.54	14.87	-5.08
19.	Development Rating	%	10.48	16.42	61.38	114.36
20.	Category		White	White	White	Over Explo.

Annexure - 12

Geohydrological Data Of Hansot Taluka

Sr.	Details	Unit	1978	1984	1991	1997
1.	Geographical Area	Sq km	398.80	398.80	398.80	398.80
2.	Recharge Suitable area	Sq. km	99.70	99.70	99.70	99.70
3.	Area not suitable for recharge (Saline)	Sq. km	299.10	299.10	299.10	299.10
4.	Av. Ann. Rainfall	Mm	932.18	932.18	829.80	560
5.	Rise in SWL	M	NA	1.89	0.80	1.0
6.	Sp. Yield	%	NA	9.5	10	NA
7.	Recharge from Rainfall	Mm ³ /yr	17.35	21.79	8.39	NA
8.	Recharge from Irrigation and other sources	Mm ³ /yr	NA	0.04	0.04	NA
9.	Gross Ann. Recharge	Mm ³ /yr	17.39	21.83	8.43	11.78
10.	Utilisable Recharge	Mm ³ /yr	12.17	18.55	7.59	9.42
11.	Total Dug Wells	No's	137	NA	127	5.33
12.	Total Pump sets	No's	122	NA	21	NA
13.	Total Pvt, Tube wells	No's	Nil	Nil	46	NA
14.	Total Govt. Tube wells	No's	Nil	Nil	Nil	Nil
15.	Total GWRDC Tube wells	No's	Nil	Nil	Nil	Nil
16.	Gross Draft	Mm ³ /yr	2.7	3.20	5.42	5.33
17.	Net Draft (70% of Gross Draft)	Mm ³ /yr	1.90	2.24	3.79	3.73
18.	Balance GW	Mm ³ /yr	10.27	16.31	3.80	4.09
19.	GW Development	%	15.61	12.07	49.92	56.56
20.	Category		White	White	White	White

(Source GWRDC)

Annexure:13

Identification Of Clusters

Cluster here, means a conglomeration of select villages, which have homogenous kind of problem and have similar social composition. For the purpose, a total of 23 clusters were identified. It was worked out on the premise that the kind of problem to be tackled will remain the same falling within a particular cluster. Following broad criteria was adopted for the identification of clusters:

Severity of the problem.

Existence of common drainage point

Canal infrastructure - Point of water delivery. (outlet/Minor)

Social cohesiveness.

Clusters identified are:

Sr.	Cluster No.	Name of the Villages					
1	CLUSTER - I	Ankalva	Jetpor	Kantiyajal	Katpor *	Samli	Vamleshwar
2	CLUSTER II	Chhilodra	Dantrai	Vaghvan			
3	CLUSTER - III	Badodra	Vasnoli				
4	CLUSTER - IV	Pardi	Ambheta				
5	CLUSTER - V	Mothiya	Sera	Utraj *	Matied		
6	CLUSTER - VI	Balota	Bolav	Dhamrad			
7	CLUSTER - VII	Alva	Aniyadra	Malanpor	Rayma	Sayan	
8	CLUSTER - VIII	Astha	Digas	Mangrol			
9	CLUSTER - IX	Ilav	Sunev Khurd	Sahol			
10	CLUSTER - X	Aasarma	Obha	Parbat	Sunev Kalla		
11	CLUSTER XI	Kalam	Kathodra	Kudadra	Motvan	Rohid	Valner
12	CLUSTER XII	Hajat	Kanva	Sarthan	Telva		
13	CLUSTER XIII	Sajod	Pungam				
14	CLUSTER XIV	Nangal	Boidra	Amboli	Adol	Umarvada	
15	CLUSTER XV	Piludara	Alunj	Pardi	Karmali	Ravidra	Panoli
16	CLUSTER XVI	Sisodra	Adadara	Utiyadra	Ghodadra		
17	CLUSTER XVII	Dungra	Pandvai	Amod	Kharach	Panjroli	
18	Cluster XVIII	Diva	Divi	Survadi			
19	CLUSTER XIX	Bharan					

Annexure: 14

Sample Analysis - Soil from 65 villages (123 samples)

S.No	Levels of Salinity	pH		Ec		Exchangable Na Percentage	
		(0-15)*	(15 -30)*	(0-15)*	(15 -30)*	(0-15)*	(15 -30)*
		2	High	7.2	8.9	0.82	2
	8.8	8		0.82	1.25	1.55	1.3
	7.9	7.9		3.2	2.1	1.2	1
	7.5	7.7		7	3.7	1.16	2.6
	7.8	7.9		4	4	7	6.2
	Total	39.2	40.4	15.84	13.05	16.81	15.4
	Mean	7.8	8.1	3.2	2.6	3.4	3.1
3	Medium	7.5	8	0.22	0.4	1.2	2.9
		7.5	7.7	3.6	1	2.21	2.1
		8.3	8	0.5	0.15	4.1	2.4
		7.6	7.5	0.4	0.2	2.05	3
		7.4	7.8	1.2	1.1	5.4	2.4
	Total	38.3	39	5.92	2.85	14.96	12.8
	Mean	7.7	7.8	1.2	0.6	3.0	2.6
3	Low	7.2	7.2	0.5	1	1.2	1.9
		7.0	7.3	0.7	0.11	2.21	2.1
		7.2	7.1	1.2	0.12	2.1	2.5
		7.5	7.3	2	0.55	2.4	3
		7.8	7.1	1	0.88	5.4	2.4
	Total	36.7	36	5.4	2.66	13.31	11.9
	Mean	7.3	7.2	1.1	0.5	2.7	2.4
Note	Normal Limits	Up to 6.5		Up to 0.1		Up to 1	

Annexure - 17

An analysis of the physical and Chemical properties of the soil & water to understand different levels of salinity (high, medium and low) in the six village cluster:

I. Physical characteristics of the soil:

1. Soil Depth:

Most the area surveyed was found to have very deep soils having soil depth more than 90 cms. However at places the soil is 'deep' having soil depth between 45 to 90 cms. Following table gives the distribution of areas falling in different soil depth classes in the six village cluster.

Sr. No	Soil depth (cms)	Depth class	Area (in ha)	
			Area	%age
1	45.0 to 90.0	Deep	165	5.1
2	More than 90.0	Very Deep	3128	94.9
		Total	3293	100

It can be seen from the above tabulated data that dominantly large area ie; 3128 ha of culturable area (ie; 94.9% of the culturable land area) has very deep soils within the command area of UKRBMC.

2. Soil Texture:

The data on the dominant texture of the soil in the area under six village cluster for different depths viz; Surface soil (0-30cm) and sub-surface (30-90cms) are given in the following table:

(The Classification has been done only for the culturable land)

Sr.No.	Soil Textural Class	Area in hactares	
		Surface soil	Sub-surface
1	Sand, Loamy sand	330	275
2	Sandy Loam, Fine Sandy loam	153	235
3	Loam, silty loam, silt	565	773
4	Clay loam, sandy clay loam, Silty clay loam	765	354
5	Sandy clay, silty clay, clay	1480	1656
	Total	3293	3293

It can be seen from the above data that the soils of the major area surveyed are clayey in nature with clay content varying from 41 to 61 percent in the fine earth fraction. The dominant clay is montmorillonite.

3. Soil Permeability:

The permeability, measured on random soil survey basis ranged from 0 to 2.84cm/hr. On the basis of the morphological characteristics of the profiles, the data of texture, previous sub-surface strata etc. The soil permeability can generally be inferred to as very slow to moderately slow in most of the villages surveyed in the cluster.

4. Infiltration rate

During the course of survey water intake rate was measured. An average intake rate varied from 0.35 to 2.94 cm/hr. However at places particularly in light textured soil it was found maximum upto 4.20 cm/hr. For example infiltration rates were found to be 0.51 and 0.40 cm/hr at Kalam and Rohid villages respectively.

II. Chemical characteristics of soil:

1. Soil salinity / Alkalinity:

Soil Salinity was measured in term of Electrical Conductivity in mmhos/cm at 25 degree centigrade in 1:2 soil-water ratio.

The Following table gives the data on soil salinity and status of ground water in the six village cluster surveyed.

Sr.No	Name of village	Water level	Ec	pH
1	Motwan	0.80	2.3	8.4
		1.25	7.8	8.1
2	Kathodara	1.25	4.8	8.0
		1.35	3.4	7.7
3	Rohid	1.05	0.72	8.1
		1.10	1.2	7.4
		2.30	2.6	7.8
4	Kalam	1.85	3.4	7.6
5	Valner	2.65	5.8	8.0
6	Kudadara	1.89	1.2	8.2

The following international norm has been used for quality assessment of ground water:

	No Problem	Increasing Problem	Severe Problem
Ec	up to 0.75	0.75- 3.0	More than 3.0

The soil alkalinity data given in the table reveal that maximum 64.4 percent (2120 ha) area having soil depth within 90 cms and 55 percent (1811 ha) of the culturable area, having soil depth below 90 cms are moderately alkaline (pH 7.4 to 8.4). Such alkali affected area is located in the entire command of six villages in isolated patches.

2. Cation Exchange Capacity and Exchangeable cations:

The cation Exchange Capacity of the soils of open profiles observed is found to vary between 17.0 to 62.0 meq/100 gms soils. The exchangeable sodium percentage of these soils, except in very few localised patches is found to vary between 0.65 to 20.89.

The preventive measures including restricted irrigation, altered cropping pattern, artificial drainage system etc are required to be adopted in the areas indicating high Exchangeable sodium percentage.

III. Land Features

1. Slope and Erosion

The average slope gradient of Hansot Branch Canal command is 1:860. This shows that the area has plain to very gently sloping lands. The Soil erosion for the major part of the area can be considered as slightly eroded phase or even less except in the area adjacent to the bank of Wand Khadi, where moderate erosion is observed.

2. Drainage

The command area of Hansot Branch Canal command is situated at an average elevation of 3.5 to 24.0 m from the sea level having drainage density, 0.726 km/sq.km. However in the area in the six village cluster of Hansot Branch canal, the lands area is just levelled to very gently sloping having average slope gradient 1:735 and hence does take some what care of surface drainage to the excess waters through Wand Khadi.

3. Land Use and Vegetation

Cultivated in Kharif, Rabi & hot seasons. Common crops cultivated in Valner and Kalam are wheat, Tuvar, Sugarcane, Banana, Paddy, Juwar, Cotton, Arenda, Vegetable fruits etc; The other vegetation are Babool, Samadi, Gundo, Neem, Nilgiri, Sharu, Amali, Banian tree, Bordi etc

Where as in other four villages the crops grown are Tuvar, Banana, Wheat, Cotton, Sugarcane, Paddy, Jowar, Aran etc. The other vegetation are Babool, Samadi, Tad, Umaro, Aml, Pipal, Neem, Nilgiri, Bordi, Gundo, Vad, Sharu etc.

The land falling in the above village fall under 2,3 & 4 category of Land irrigability class.

Class - 2 Lands those have moderate limitations for sustained use under irrigation.

Class -3 Lands those have severe limitations for sustained use under irrigation.

Class -4 Lands those are marginal for sustained use under irrigation because of severe limitations.

Here, suitability for sustained use under irrigation means a reasonable expectancy of permanent profitable production under irrigation, measured in terms of anticipated relative net farm income by consideration of potential productive capacity of soils and the cost of production. The term sustained use under irrigation does not mean perennial irrigation but some irrigation year after year in the same type/kind of soils.

Table showing distribution of different kinds of soils in six village cluster:

Sr.No	Land Irrigability Class	Area		Major Constraints	Area	
		ha	%		(ha)	(%)
1	2	580	29.31	Soil	165	8.3
				Soil&Drainage	195	9.8
				Drainage	220	11.1
				Total	580	29.2
2	3	850	42.95	Soil	125	6.3
				Soil & drainage	255	12.8
				Drainage	470	23.8
				Total	850	42.9
3	4	549	27.74	Soil	145	7.32
				Soil & drainage	145	7.32
				Drainage	259	13.0
				Total	549	27.7
	Total	1979	100		1979	100.00

The above table depicts factors responsible for varying degrees of salinity under different land irrigability class.

Annexure - 18

Agriculture Programme:

Based on the above technicalities found in the cluster Agriculture extension, training and demonstration will involve investigations of soil characteristics, drainage layout, inundation and leaching etc. It will be undertaken in the following three phases:

Phase - I :

- (a) Carrying out detailed soil surveys.
- (b) Topographic survey indicating close contours in the area for determining drainage and outfall conditions.
- (c) Measurements of subsoil hydraulic conductivity, movements of water table and quality of water.
- (d) Meteorological observations (available from nearby hydremet stations).
- (e) Measurements of flow irrigation through distributaries, minors and water channels (including inundations in the field for leaching).
- (f) Engineering surveys for designing and spacing of field drains, intercepting drains, main and tail cutfall drains.
- (g) Design of necessary hydraulic structures including outlets and regulating works.

Phase - II

- (a) Layout of irrigation channels, drainage system and farm roads etc.
- (b) Installing measuring devices for irrigation waters such as standing wave flumes, Parshall flumes, 'V' notches etc.
- (c) Inundation and leaching including periodical check over the moisture balance and depletion in salinity.
- (d) Appropriate operations for reclamation, which include application of organic manures, soil amendments like gypsum etc.

Phase - III :

Agronomic aspects of reclamation:

These techniques include the following stages:

- i Using salt tolerant crops at various stages of reclamation.
- ii Applying green manuring, organic manures etc.
- iii Intensification of agriculture after reclamation.
- iv Soil and water management practices to keep the soil reclaimed.

Once the layout for water channels and drains has been fixed and constructed in the field, the good quality water of the irrigation scheme or supplemental irrigation from the village ponds can be let into the field watercourses and the fields can be inundated.

The water is allowed to be kept over the soil till it dissolves the salts in the field. Raking is done in the case of heavy soils to accelerate dissolution. Normally six inundations of 15 cm (six inches) each would leach out salts from the surface layers in the case of coarse to medium (Loamy and sandy loam) soils, whereas twelve inundations will be required for heavy soils.

Periodical checking of soil salinity in the surface and sub-surface layers would indicate the stage of leaching. As soon as the soil salinity in the surface layers reaches a level of 0.8 to 1.0 percent, there is likelihood of excessive sodium going to exchange complex and convert the soils into 'alkali' soils. At this stage it is advisable to add organic manures alongwith gypsum to avoid sodiumisation.

Agronomy:

During the process of leaching and reclamation, the selection of crops at various stages of desalinisation plays a very important role. These procedures involve adoption of suitable varieties of crops depending upon their salt tolerance. The crop of paddy has been found to be one of the most suitable crops during early stages of reclamation. This is because it grows in the standing water of 10 to 15 cm depth. The salt tolerant varieties of paddy like Chinsura - 1327, Local varieties like Kada, Kala Rata and Bhura Rata can withstand salinity even upto 1 (One) percent. Such varieties are grown till the salinity levels are reduced to near about 0.8 percent. This not only helps in reduction of soil salinity but at the same time produces adequate yield from such varieties. The crop rotation should necessarily include green manuring of Ikkad / Dhaincha (*Sesbania aculeata*) and also application of gypsum to avoid problem of alkali development. The salt tolerance of normal paddy varieties being about 0.8 percent or less, such varieties can be introduced at this stage. The next in order of salt tolerance are the crops like safflower, barley, wheat and cotton. As the process of reclamation advances and the soils are desalinised further, the above mentioned crops can be grown with success. On complete reclamation normal crops can very well be introduced. It is also equally essential to see that the drains and water courses are maintained properly to avoid excessive irrigation. The soil and water management aspect needs careful attention throughout the leaching and reclamation.

Annexure - 19

Afforestation - Its Rationale as a Proposed measure:

The various ways in which vegetation improves the soil are as under :

(a) Formation of root channels :

The root system of a tree when it decays leaves behind a network of channels which act as pathways for movement of water into the subsurface layers of the ground.

The leaves which fall on the ground through the process of decomposition form a sponge like humus layer which can absorb the rain water and give it time to percolate into sub-soil.

(b) Increase in retention of rain water :

It has been established that if water can be made to move slowly on the ground the percolation of water into the sub-soil is greatly increased. Trees help to reduce the impact of the rain drops and reduce the velocity of the rain drops and reduce the velocity of the rain water by not acting as an obstruction in the path of the flowing water but also retaining the surface of the leaves, branches etc., which fall on the ground gradually after the rainfall has stopped, thus giving more time for the water to seep into the ground. A study carried out by the Central Soil Research Centre, Octacamundi has indicated that rate of infiltration of water under natural forest cover was 5 to 6 cm per hour whereas on terraced cultivation it was only about 1.4 cm per hour.

(c) Reduction in evaporation from land:

It is an established fact that higher the speed of the wind more is the evaporation of water from the surface, thus in open terrain the wind increases in velocity and in the process accelerates the evaporation of moisture from the surface of the soil. Trees in the form of shelter belts in locks or singly help to reduce the velocity of the wind and thus decrease its capacity to pick up moisture from the soil. Trees by casting their shadows on the ground also help to reduce evaporation of soil moisture percentage due to the heat of the sun.

Annexure -20

PARTICIPATORY IRRIGATION MANAGEMENT

The Government of Gujarat has declared Participatory Irrigation Management Policy vide **resolution No: PGT - 1093/8/k3 dated 1st June 1995**. The basic objective of the policy is to involve farmers in the operation and management of irrigation system to achieve higher water use efficiency and higher productivity. Under the policy, the water users association is expected to adopt appropriate water economizing measures and crop pattern.

Following are the underlying principles of PIM:

1. Irrigation schemes or a part of it is taken up under the project, should necessarily have the willingness of 50% of the farmers in the command area, to be associated with the project & carry out administrative functions (vide GR dated 1st June 1995)
2. Farmers are required to form a local level membership based organization and get it registered. However for speedy implementation of the scheme an approval of the concerned Superintending Engineer can be obtained by applying for any kind of the work to be undertaken in the name of Mandali.
3. The project has to handed over to local organization only once the repair and maintenance works have been carried out successfully. In order to ascertain the quantum of work it is necessary that a joint inspection of the canal site is done with the involvement of Farmer's organization and the personnel from the department. Joint exercise once undertaken, will then lead to formulation of plan, design and estimate of the work to be carried out. The estimate once prepared will be subject to final approval of farmer's organization. The farmer's organization has the complete authority to add to delete any portion of the proposed estimate.
4. As per GR dated 24th November 1995, Govt. has also recognized farmer's organization to carry out the repair and maintenance work in the canal command area. In case the local organization is not in a position to do so the same can be taken up by participating NGO. Refusal or unavailability of an NGO, the responsibility automatically gets transferred to the department. If not then to the designated contractor for the work.
5. Water rates have to be decided by the Irrigation Co-operative Society on a crop area basis for an initial period of 3 years. Later the rates will have to be fixed on a volumetric basis. However, the rates as decided by the Mandali should not exceed to that of the government rates.
6. Government bears 90% of the expenses towards the salary of the community organizer up to a period the project is being supported by the Voluntary organization. However, once the MOU is signed between the Mandali and the government department the salary of the community organizer gets terminated.

7. The committees formed within PIM should incorporate 33% women members.
8. It is envisaged that Rs 50 per acre share has to be taken up by the participating families. However the Rs 10 per acre nominal membership can be taken up by women member those not owning land on their name.
9. NGOs which are non-profit and carry out non-contractual and developmental activities are only eligible to apply.
10. Regarding the cost to be borne towards the repair and maintenance work, 85% cost will be met by the department, 5% of the estimated cost will have to be contributed by the Government while the participating NGO will dole out 10% of the project cost.
11. An advance of 1/3rd of the estimated will be released as first installment towards the project.
12. Following committees have to be constituted compulsorily.
Construction Committee
Accounts Committee
Water Distribution Committee
13. Irrigation Co-operative Society is represented at two levels:
 - a. Project co-ordination committee. Suptd Eng - President, Ex Engg - member NGO representative - member, Representative of Irrigation Co-operative society - Member
 - b. State Co-ordination committee - Ex. Eng - President, Deputy Eng - Member, Section Officer (Concerned Project) - Member, NGO representative - Member, Irrigation co-operative society representative - Member.

The coordination committees are required to meet once in every three months preferably once before the start of rainy season.

Reviving defunct irrigation water user's association under state policy of PIM:

The issue of reviving defunct societies was discussed in the PIM operation group on 5th July, 1996 and based on the above facts, the operation group decided that the superintending Engineer concerned should be authorized to examine the possibility of reviving such societies.

In view of the above narrated facts, the question regarding the reviving of defunct irrigation WUA's under state policy of PIM is under consideration by the Government:

Resolution:

After careful consideration, department has decided to revive the defunct irrigation WUA's under state policy of PIM with the following conditions:

1. The Suptd. Eng. Concerned are authorized to revive co-operative societies with retrospective effect as per the following instructions:
 - a. Suptd. Eng. Should collect all the information about the defunct co-op. Soc., their history, how they functioned as society, how they carried out their financial obligations in terms of water collection and payment to the Government etc.
 - b. Assessment should also be conducted whether they will function well if their financial problems can be sorted out.
 - c. If the society is likely to be organizationally viable, then the Suptd. Eng, are empowered to bring such irrigation co-operative societies under the scope of PIM project subject to following conditions:
 - (i) The irrigation water bill for the co-operative society, the period for which it operated, should be calculated in terms of crop area basis and volumetric rate basis from the authentic records separately. Admissible rebates minus the total management subsidy paid to the irrigation cooperative society should be refunded to the cooperative society.
 - (ii) The superintending Engineer should approve for such PIM project to enable the concerned Executive Engineer to enter into an agreement with the Irrigation Co-operative society in terms of MOU approved vide GR Dtd. 22nd Nov. 1995.
 - (iii) The dues if any, due from the defunct irrigation WUA's will be adjusted against the admissible rebate, provided the dues are of water bill, due from WUA's only.

The above GR will largely apply to the defunct co-operative societies of the UKRBMC in Hansot and Ankleshwar region.

Watershed Development Programme at a glance:

Watershed Development Programme initiated by Government is a process of formulating and carrying out a course of action involving manipulation of natural, agricultural and human resources of a watershed to provide resources that are desired by and suitable to the watershed community, but under the condition that soil and water resources are not adversely affected. Watershed management must consider the social and economic and institutional factors within and outside the watershed. Watershed management is an integrated and interdisciplinary approach.

Definition:

It is a geo-hydrological unit draining at a common point by a system of streams. All land everywhere is part of some watershed. Essentially, a watershed is all the land and water area which contributes runoff to a common point. It is a land area that captures rainfall and conveys the overland flow and runoff to an outlet in the main flow channel. It is a topographically delineated area draining into a single channel.

The Programme:

Development of dryland agriculture on a watershed basis has been a national strategy for sustained productivity and rational utilisation of natural resources. Thus deterioration of natural resources in an area can be contained. The total resources can be properly developed only by adopting the watershed approach. In this approach, development is not confined just to agriculture lands alone, but covers all the areas, starting from the highest point of the area (ridge line) to the outlet of the natural stream. In terms of resource development, it covers development and management of resources like soil, water, vegetation and all associated components. By adopting watershed as a unit, different measures are adopted and executed carefully in each of the topo-sequences according to its capability. It essentially relates to soil and water conservation in the watershed which includes proper land use, protection of land against all forms of degradation, building and maintaining soil fertility, water conservation and harvesting, proper management of surface and groundwater, flood protection, sediment reduction, increasing productivity from all land uses, etc.

Selection of a watershed:

In each selected villages, a watershed of approximately 500 ha should be identified and selected by the watershed development team in consultation with the village community. However should it not be possible to find watersheds of this size, the area can be increased or decreased keeping in view this fact that the PIA (Programme Implementation agency) handles a total area of 5000 to 6000 ha.

The following criteria may be used in the selection of watershed:

1. Watershed has a large population of schedule caste/schedule tribe dependent on it.
2. Watershed has a preponderance of wastelands.
3. Watershed has a preponderance of common lands.

4. Watershed where actual wages are significantly lower than the minimum wages.
5. Watershed which is contiguous to another watershed which has already been developed/ is selected for development.
6. Watershed which had previously been taken up for comprehensive development /treatment works under any of the programmes like DPAP/ DDP/ IWDP shall not be taken up again.
7. Five hundred ha is a general norm and if on actual survey, a watershed is found to have slightly less or more areas, it may be taken up for development.
8. Though a watershed should normally fall within the village boundaries, if a small part of the watershed area falls outside the village boundary, it may still be taken up for development with the consent of the neighbouring village.

Components of watershed treatment plan:

1. Agronomic measures in agriculture land. (eg; strip cropping, crop canopy, residue management, land management)
2. Mechanical measures in agriculture land (eg; contour bund and graded bunds, bench terracing, contour cultivation etc)
3. Erosion control measure for non- agriculture land (eg; contour trenches, gully control measures, nalla-bunds etc.)
4. Water conservation and harvesting structures (eg; farm ponds, earthen embankments, weirs etc)
5. Ground water recharge and management (eg; percolation tank, sub-surface dykes etc)
6. Nursery raising and community plantation of fuel, fodder, fruit and small timber species)
7. Grassland development on recharge, transition and discharge zones.
8. Agroforestry.
9. Horticulture development.
10. Protection, conservation and enrichment of degraded forest land in watershed through JFM.

Steps in implementation of integrated watershed development programme:

1. Initiation of the watershed programme by selection of watersheds, selection of PIAs, community mobilization, various tiers of institution building, capacity building
2. PRA/ RRA exercises in watershed, use of remote sensing in watershed planning, preparation of action plan, entry point activity.
3. Treatment plan execution.
4. Integration of various government programmes.
5. Propagation of allied activities and non - farm sector interventions.
6. Systems and institutions for CPR management.
7. Schemes and campaigns for empowerment of women, landless and resource poor.
8. Setting up systems for sustainability of programmes.
9. Standardization of accounting procedures and audit systems..
10. Monitoring and evaluation.

Annexure - 22

Conjunctive use of water:

Since crops require irrigation differently during their different growth stages, scheduling of irrigation should be planned accordingly. In the early stages, the crops require usually lesser amount of water and any excess water applied is either wasted or propagated through more vegetative growth instead of deeper root penetration. It might also be manifested in the form of development of salinity as has been the case in the UKRBMC command area. Water needs are more in the stages of tillering, flower formation and fruiting. When the soil is alkaline or saline or if the water contains more soluble salts, water needs may be higher. Water needs differ according to different seasons also. They differ also in case of differing tillage practices, vegetative growth, crop systems and land shapes. This suggests that climatic conditions, genetic variation in plants, agronomic practices, reduction in evapo-transpiration and water stress, fertilizer application, plant protection measures, including weed control become the essential aspects in irrigation management. Since all these aspects determine yield productivity, a proper synthesis of amount of water and the above factors may be necessary for an efficient system. Viewing the status of ground water availability and also at the same time the amount of surface water available (average rainfall in the region being 860 mm) in the command area it is essential that a strategy well suited to region is planned.

Annexure - 25

Socio-Economic aspects about the area:

There a total of 106 villages in Ankleshwar & Hansot taluka with 29721 households and a population of 160495 which consists of 7988 households of schedule tribe population. Major caste in the taluka is predominantly Patels & Brahmins. Among the others include carpenter, washermen and harijans. The schedule tribe population are largely Vasavas. The Vasavas are generally landless. Some of them do own 1 to 1.5 acres of land. They migrate to nearby factories as casual labourers earning Rs 30-40 per day. At times they also lease in a small patch of land from the land owning family. Having blessed with villages adjacent to the water bodies, fishing is also an important occupation for the families. However the fisheries market is quite unorganized. Most of the time they have to indulge into distress selling in order to feed their families. The land ownership is skewed. Patels and Brahmins own on an average 32 acres of land however the others in the village the average land holding is around 7-8 acres. The main occupation of the area is largely agriculture with some of the families engaged in small enterprises like sale of agriculture inputs, trading of cloth etc.