Water, Households & Rural Livelihoods

Research promoting access of the poor to sustainable water supplies for domestic and productive uses in areas of water scarcity

WHiRL

Integration of drinking water supply-sanitation and watershed development

B. Kakade[1], H. Kulkarni[2], A. Marathe[1], K. Petare[1], G. Neelam[1], and P. Nagargoje[1]

[1]BAIF Development Research Foundation, Pune, India
[2]Advanced Centre for Water Resources Development and Management

WHIRL Project Working Paper 5
Preliminary results of research for discussion and comment

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PREFACE

This paper was prepared as a contribution to a joint Indian, South African and UK research project on Water, Households and Rural Livelihoods (WHiRL). Your comments would be welcomed. The lead author may be contacted at bharatkakade@onebox.com and the project coordinator at j.a.butterworth@gre.ac.uk.

Copies of the paper can be downloaded from the project website at http://www.nri.org/WSS-IWRM

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The study team recognizes the importance of active participation of the local communities in individual discussions and meetings during the field research.

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ACWADAM*: Advanced Centre for Water Resources Development and Management*
ANC*: Ante Natal Care*
ANM*: Assistant Nurse and Midwife*
APL*: Above Poverty Line*
ARWS*: Accelerated Water Supply Scheme*
BPL*: Below Poverty Line*
CCT*: Continues Contour Trenching*
CS: *Charagah Samiti (Silivipasture Committee)*
DFID: *Department for International Development (UK)*
DPAP*: Drought Prone Area Programme*
DRDA*: District Rural Development Agency*
EGS*: Employment Guarantee Scheme*
EPA: *Entry Point Activity*
EU: *European Union*
FD*: Forest Department*
GBFR*: Great Boundary Fault of Rajasthan*
GPB*: Giant Phenocryst Basalt*
GRISERV*: Gujarat Rural Institute for Socio-economic Reconstruction*
GSDA*: Groundwater Survey and Development Agency*
HP: *Hand Pump*
ICEF*: India Canada Environment Facility*
ICMR*: Indian Center for Medical Research*
IGWDP*: Indo German Wasteland Development Programme*
IMR*: Infant Mortality Rate*
JFM*: Joint Forest Management*
KAR: *Knowledge and Research*
LPCD*: Liters per Capita per Day*
LPG*: Liquefied Petroleum Gas*
MVS*: Manav Vikas Sangh*
NGO*: Non-Governmental Organization*
NH*: National Highway*
NRI: *Natural Resource Institute(UK)*
NWDPRA: *National Watershed Development Programme for Rainfed Areas*
NWDP*: National Wasteland Development Programme*
NWRS*: National Rural Water Supply Scheme*
OBC*: Other Backward Class*
PHC*: Public Health Center*
PTC*: Private Treatment Center*
SC*: Schedule Caste*
SCP*: Special Component Plan*
SFD*: Social Forestry Department*
SHG*: Self Help Group*
ST*: Schedule Tribes*
UG: *Users Group*
UP: *Uttar Pradesh*
VWC*: Village Watershed Committee*
WHO*: World Health Organisation*
WSS*: Water Supply and Sanitation*
WUG*: Water User Group*

EXECUTIVE SUMMARY

Watershed development, a legendary phrase among development community including government has proved its worth in rural development during last couple of decades. Yet, it is being looked only as a measure of water resources development for improved irrigation and crop production. On the other hand, rural India is increasingly facing problems of drinking water especially during summer. During scarcity days, government offers high investment and short-term relief measures such as supply of water through tankers. It is thus important to integrate the two programmes revolving around water, the Watershed Development (WD) and Water Supply and Sanitation (WSS). With a view to understand the linkage of WD and WSS, a research study was carried out in seven different locations of BAIF's watershed development project areas.

BAIF Development Research Foundation has been working in several parts of the India for upliftment of rural poor. Watershed development is one of its major programmes covering 6 states, 27 districts, 264 micro-watersheds and 128167 ha area. Seven micro-watersheds (500-1000 ha) were selected from among such programmes for the study **(Figure1).** During the study most of the selected watersheds were between 4^{th} to 5^{th} year of implementation and represent different agro-climatic conditions, problems pertaining to natural resources, social and economic factors and the mitigation mechanisms practiced through watershed models. The watersheds studied are from backward villages of Rajasthan, Karnataka, Uttar Pradesh, Maharashtra and Gujarat. Sixteen villages and their respective 10 hamlets have been covered in selected seven watersheds. The total geographical area of the watersheds studied is 7000 ha and about 2500 households with population of 14769 reside in the area.

The central objective of the study was to review the status of demand and supply of water for consumptive and productive uses with special emphasis on drinking water supplies and access to the rural poor within the selected watersheds. The linkage and effect of watershed development on WSS and also the impact of external environment including socio-economic, political, institutional and administrative environments at different levels have been studied.

The study involved integration of various data obtained from three sources namely from local community through participatory, questionnaire and transect methods (including villages from within and from outside the watershed), from BAIF offices (Pune, Cluster/Regional centers and Field centers) and Government sources. Fieldwork of the study was best optimized during March-April-May to experience the extreme situation during pre-monsoon summer and understand the changes due to the programme.

Drinking water, sanitation, ecosystem dimensions and socio-economic situation were the focus areas of study. Specific issues and indicators have been identified under each of the focus areas to assess the watershed system as a whole keeping WSS at centroid. After the study of seven cases with above methodology, the data gathered was synthesized through a simple matrix based analysis.

Findings of study watersheds actually represent their respective regions. The issues related to WSS not only reflect the local situation but also have very large-scale inferences. Findings are based on the relative analysis among different watersheds, pre-watershed development and post watershed development situations and between watershed project area and non-project area. Major findings are given below:

- Despite the location, all the study areas had problem of water scarcity during 3-4 months of summer (before the project).
- It was observed that at the baseline of the projects 60% water sources were defunct. Sustainability of water supply sources can be ensured only if the users are owners and have skills of repair and maintenance.
- Sanitation has been the low priority issue. Practice of open defecation prevails in all the watersheds studied. No linkage was considered while planning for the resource development for drinking water.
- Either through the project funding or organizing funds from other sources (15% projects), BAIF had ensured adequate water supply to watershed population.
- Watershed projects without provision of drinking water source development can only augment some existing sources but cannot solve the drinking water problem completely.
- The average ground water table has increased by about the range of 0.5 to 4 m. The dependent households per drinking water supply source have changed from 32 to 21. Out of earlier 32 households per source over 50% had to walk 1-2 kms to fetch water during summer. Combined effect of water source development and conservation measures made it possible to ensure safe drinking water throughout the year.
- Enhanced water availability has increased area under irrigation by 82% and doubled the over all crop production. The income of community has increased by about 1.5 to 4 times.
- There is neither social nor legal control over the use of water resource. However, the project communities have initiated the mechanisms for sharing of water resources by forming the Users Groups.
- Drought proofing is possible only through the comprehensive watershed development and not only through water harvesting structures like checkdams.

The recommendations to the policy makers and implementers for ensuring the sustained water supply in watersheds, include: a) Linkage of water supply, sanitation and watershed development, (b) Controlled utilization of water for irrigation needs to be incorporated in projects to avoid potential conflicts for the common resource, (c) Ensure the balanced use with the strong management and maintenance mechanisms developing the local user groups and (d) Application of comprehensive resource development package increasing the existing funding levels under National Level Watershed Development Programmes.

Research Team*: B K Kakade, G S Neelam, K J Petare, et. al.*

Figure 1. LOCATIONS OF STUDY WATERSHEDS

1. BACKGROUND

Repeated water scarcities resulting out of large-scale droughts have severely affected the livelihoods of the rural poor in India. Three types of reactions to such situations are broadly observed:

a) Short term, relief measures to mitigate water shortages by developing water sources that are often not sustainable. (tanking water to affected villages)

b) Highly expensive measures like development of regional piped water supply schemes that require high costs of operation and maintenance (O & M).

c) Local (longer-term) solutions through participatory approaches that have increasingly resorted to the integrated watershed management model to identify, assess and address the larger problem of rural systems management.

Watershed development and management is evolving as a useful mechanism to address two most common water resource problems in India. Firstly, it aims to address the problem of water availability resulting from an increased demand on a resource rendered fragile due to irregular and erratic rainfall. In addition to addressing water resource issues, the watershed development model also offers an effective medium to tackle larger natural resource management problems arising out of a competition for the limited resources that often results in conflicts at various levels.

1.1 The Study

"Water, Households and Rural Livelihoods (WHIRL)" is DFID-KAR programme that involves research in India and South Africa with the purpose of developing better institutional and operational solutions for integrated water resources management. This research aims at promoting mechanisms that will provide improved access for the rural poor to safe water supplies. In India, it is focused on the problems arising from competition between water uses at a local level, especially irrigation, comprising water sources for drinking and other household uses.

BAIF Development Research Foundation (referred to henceforth as BAIF) has been implementing Watershed Development programmes in six states of India. BAIF has been implementing watershed development projects for a period of nearly ten years. Watershed development is one of the major areas of BAIF's work in the rural development sector and the organization has implemented the 'watershed development model' in many parts of the country.

The variability in these frameworks is widely represented within the watershed development models of BAIF from within six states of India. These micro watersheds, which largely fall within a semi-arid tract, show a diverse set of physical and socio-economic conditions and were thought to represent typical scenarios in the context of water resources problems and attempts at improved water resources access.

Drinking water and sanitation should form important areas within the domain of a watershed development programme. A watershed development programme may or may not include a direct provision for drinking water and sanitation interventions. However, almost ubiquitously, watershed development programmes bring about some degree of change in the drinking water and sanitation sectors. This study attempted to highlight the mechanisms of interventions (direct or indirect) to drinking water and sanitation as well as the effects of other aspects of the watershed development model on the drinking water and sanitation regimes. The study was not aimed to be conclusive in any manner, since the time frame of the study was limited and the objective of the study was to conduct a broad review within the study watersheds. However, even within the rapid appraisal executed through this study, some significant observations were made regarding the status of drinking water and sanitation within the watershed development model executed through various programmes by BAIF. These observations are presented within this study.

2. OBJECTIVES AND SCOPE

The central objective of this study was to describe the impacts of a watershed development programme, that includes different models in different locations, on the water demand and supply scenarios for all types of uses, but with special emphasis on drinking water supplies and access and sanitation to the rural poor (backward communities).

In attempting to realize the study objective, through a case study approach, the research team synthesized, reviewed and documented based on the following specific objectives:

(a) Collect background information of selected watersheds, which mainly describes the type, scope and impact of activities undertaken, and the relevant geographic, demographic, agricultural, hydrological, social and economical status.

(b) Assess the key WSS issues in the watersheds and find out the mechanisms through which the issues are addressed.

(c) Study the effects of the WD projects on WSS.

(d) Assess linkages between watershed development activities and provision of drinking water in the covered watersheds.

(e) Study present socio-economic, political, institutional and administrative environments at different levels (Panchayat, State and Central) and their impact at the village/ watershed level. The study Focuses on the policies and programmes for watershed development, drinking water supply and sanitation.

3. METHODOLOGY

The methodology for the review phase conducted by the BAIF team centered on "domestic and productive uses of water in watershed development".

The study includes assessment of infrastructure in place, operation and maintenance arrangements, and institutional roles in development and management of infrastructure. Estimate the demand for domestic water and uses of the water for domestic (drinking water and other household uses) as well as productive uses (including livestock and other economic activities). Demand and supply of water and alternative arrangements during scarcity period are documented. The assessment of water quality related to key parameters was attempted wherever data for such water quality was available.

The present study was carried out in seven watersheds with different and varying agroclimatic environments. Study watersheds include about three to four villages in each of the areas covering about 500ha to 1500 ha of area. Sixteen villages and their respective 10 hamlets have been covered in these seven watersheds. The total geographical area is about 7000 ha and about 2500 households with population of 14769.

3.1 Watershed Selection

Seven watersheds were selected from among existing BAIF programmes for the present study (**Figure1**). The selection of watersheds for the study was based on the following factors:

- A time frame of four to five years from the initiation of the watershed development programme, as a minimum period for effects to be apparent.
- A fair representation of various agro-climatic conditions, problems pertaining to natural resources, social & economic factors and the mitigation mechanisms practiced through watershed models. This is based on the BAIF's experience in different areas.
- Availability of some baseline and background information as well as post-watershed data through monitoring mechanisms that have been set up.
- Projects covering the larger programmes supported by various donor agencies

The following watersheds have been selected and studied, based on the above factors:

(a) Govardhanpura-Gokulpura Watershed, Bundi District, Rajasthan.
(b) Adihalli-Mylanhalli Watershed, Hassan District, Karnataka.
(c) Karaondia-Sengur-Jamuna Watershed, Kanpur District, Uttar Pradesh.
(d) Kelghar-Ranjanpada Watershed, Thane District, Maharashtra.
(e) Titoi Watershed, Surat District, Gujarat.
(f) Manhere watershed Ahmednagar Dist. Maharashtra.
(g) Kharachiya and Kharachiya jam watersheds, Rajkot District Gujarat.

The above watersheds have certain common factors, which form the basis for their original selection in BAIF's watershed development programme. These factors are:

- Socio-economically backward communities form the majority population in these areas.

- Problems of natural resources, particularly because of shortage of water supplies during the dry periods of the year, prompted interventions by BAIF. Land degradation due to a combination of natural and anthropogenic factors was a significant problem other than water resources.

3.2 Study Period

The time frame for the project was five months, with the bulk of the time having been earmarked for collection of data, mainly through intensive field inventories including transects. It was critical that the fieldwork in all the areas be completed by May since most areas experience the first pre-monsoon showers by mid-May or end-May. Fieldwork time was best optimized during March-April-May in terms of two basic factors:

1. Water shortages are most apparent during the pre-monsoon summer (the time frame planned for the fieldwork), and
2. Farmers and farm labour (village communities) are relatively free during this period to discuss and spare their time to such an activity. Come the first rains, most of these people are busy in the ‘on farm pre-sowing activities’ either on their own farms or as labour on other farms, sometimes even outside the watershed.

Each visit (covering one microwatershed) was of nine to ten days and included the following:

- Participatory family surveys: 3 days
- Field transects including mapping and discussions with people, on site: 2 days
- Village meeting: 2 to 3 days
- Data collection from field offices and other allied sources: 2 days

3.3 Approach to Investigation

The study involved collection and analysis of various data obtained from three main sources, namely the watersheds themselves (including villages from within and from outside the watershed), from BAIF offices (Pune, Cluster/Regional centers and Field centers) and Government sources.

This study benefited from the monitoring systems put into place by BAIF, since interim data divulging information between the baseline and current time frames could be used for comparison from time to time.

Inputs to this study were generated from the following sources and methods:

(a) Background data (available with BAIF) and published literature. This also included data regarding the baseline situation available with BAIF and verified through people's feedback during the participatory surveys conducted during the current study.

(b) Field surveys that included transects across the watershed, covering all the villages in the watershed and at least one village each downstream and outside the watershed boundaries.

(c) Village mapping conducted through participatory approaches like meetings with people, informal chats with selected families and discussions with BAIF field staff as seen in *Photo 1*. This mapping was conducted for all villages within the watershed as well as villages outside, at least one each on the downstream and outside the watershed boundaries. Information obtained during these exercises is compiled into tables to attempt a comparative situation analysis for baseline versus current scenarios to gauge the impact of the programme as a whole, particularly on the drinking water and sanitation aspects. Participatory methods were preferred over the direct use of printed questionnaires in the field so as to avoid biased responses.

1. Research team in discussions with the families and field staff

(d) Meetings with Government officials to understand policies concerning watershed development and drinking water and their implementation through various programmes.

(e) Literature surveys on watershed development, water supply and sanitation and related topics.

(f) The questionnaires was developed and administrated in the watershed areas to acquire the household level information on changes in socio-economic factors. The details on the sample size are given below:

Sample data

A bulk of the information was generated through the intensive fieldwork that was undertaken in the seven watersheds mentioned above. This data was collected through surveys in each village, based upon a sample drawn from the village population; the sample was based on the community structure within each village. Considering the constraint of time and the overall areas to be covered, the sample surveys conducted in villages within the watershed and outside is as shown below.

Collection of sample data from each village of the programme area was of the order of:

- 25% for each village and hamlet within the watershed; covering both the main village and hamlet was important to get the stratified sample. In most of the selected areas, normally the main caste (upper caste, also they have more resources) stays in the main village and the backward classes (scheduled castes and scheduled tribes – SC & /STs: they are also low-income group people) stay in the smaller hamlets. So the data collected from main villages and hamlets represent all the sections of community. Total numbers of households in each of the identified watersheds are about 325 to 500. The data also considered representation from different land-holding groups.
- 10% for the downstream village up to the area of influence. This is for assessing the effect of watershed project on downstream side, and also to understand the area of influence of micro watersheds. Again, sampling principles were based on the stratification of the communities in the respective village.
- 10% outside the area of influence of the watershed. The identified areas may (or may not) have some interventions by the government through routine programmes or there may (or may not) be a general trend of development in the area. Study of the nearby village provided a basis for comparing the overall changes and the net effect of project interventions (**Figure 2**).

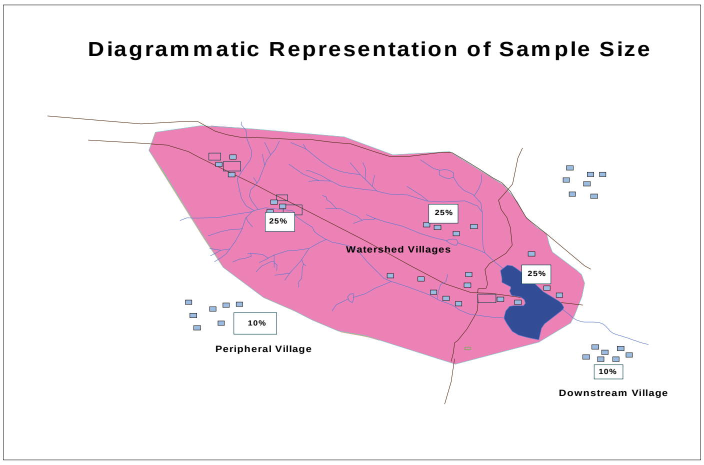

Figure 2: Diagrammatic Representation of the Sample Data.

3.4 Key Issues

In order to understand the effects of watershed development programme implemented by BAIF, key issues were selected to study various aspects of the programme. Information was collected to ascertain the impact of the watershed development programme around the key issues. The issues were studied for all villages within the watershed and for selected villages outside the watershed, at least one of these being downstream. Below is the list of key issues:

a) Drinking Water plus other domestic uses

- Source (surface water / groundwater)
- Access and distribution system
- Quantity and Quality
- Changes representing the impact of watershed development in the backdrop of larger policies and programs /Legislation
  (At village level /State level/National level/NGO perspectives)

b) Sanitation

- Access to toilet facilities (upstream/downstream)
- Water source for latrines/toilets
- Mode of disposal of waste
- Changes representing the impact of watershed development in the backdrop of larger policies and programs /Legislation
  (At village level /State level/National level/NGO perspectives)

c) Ecosystem

- Land: physical and cadastral characters
- Water: Geohydrological and administrative criteria (demand and supply for productive uses)
- Livestock
- Vegetation
- Energy
- Linkages between the above, indicating overall resource use and changes therein, if any.

d) Social and Economic factors

- Health and hygiene
- Wealth
- Equity
- Community
- Knowledge

4. CASE STUDIES

A study of seven watershed projects implemented by BAIF under various programmes based on key issues of change within the watersheds is documented as separate case studies. **Annexure 1** gives the summary of physical characteristics of seven watersheds. The objectives and activities of each of the cases are provided in **Annexure 2**. The data gathered during these case studies was analyzed through a simple matrix based analysis. It is on the basis of the fact that the activities and outputs of the project have direct and/or indirect effects on the key issues of drinking water, sanitation, ecosystem and socio-economic status. Activities and outputs are listed in a column and its outcomes around each key issues are described in the tables for the respective watersheds. The outcome results are described with the help of representative indicators. This matrix-based analysis is presented in **Annexure 3**.

The case studies also revealed some interesting facts and data on the similarities and differences in the implementation of the watershed model by a single agency (BAIF) under various programmes, each with its own objectives, approach, time frame and budget. Although the resulting data is not complete and projects are at different stages of the implementation period (two projects were completed 2 years ago), a broad picture regarding certain emerging trends was obvious. A conceptual model for the watershed programme by BAIF has been evolved here, indicating the scenario of watershed works in India by dedicated organizations engaged in watershed development.

Water appears to be the pivot around which watershed development programmes revolve. Groundwater in watershed development programmes is a critical component of the water resources regime since community access to water is almost inevitably linked to groundwater resources. Despite some inputs to the recharge mechanisms and improved situations for groundwater resources development, the studies through the seven cases highlighted certain issues, trends and concerns pertaining to water resources in general and Groundwater in particular. These factors ought to be addressed in the wake of all watershed development programmes but certainly in case of programmes that include water supply and sanitation components.

4.1 Govardhanpura – Gokulpura Watershed

This project on “Water Resource Development and Energy Conservation for Sustainable Management of the Environment.” is being implemented with watershed approach and financially supported by India Canada Environment Facility (ICEF). An integrated development programme was initiated in 1996 in the villages of Govardhanpura and Gokulpura in Bundi district of Rajasthan.

Traditionally the main source of water supply for both domestic and productive purposes in the project villages has been groundwater tapped mainly through the dug wells that tap the phyllitic aquifer.

In past (before 1985-90) the villages were totally dependent on the dug wells, which use to go dry during summer months. In the recent past (during 1990s) government had installed the hand pumps on bore wells in a very limited way. During summer, people used to walk long distances (average 500 m) to fetch water from the irrigation wells and also to the limited hand pumps (six numbers) in the villages.

After the project interventions the number of sources of drinking water supply has gone up from 34 to 47, an increase by 28% (**Figure 3**). These sources have been developed by the project with the contribution from the villagers, monitory as well as the labour. Due to the participation of villagers for the source development, formation of user groups and adoption of skills of hand pump repairs all the hand pumps have been found operational and well maintained. All the sources are now perennial due to improved groundwater and the time required for fetching water is just an hour as against more than two hours minimum in the past (**Table 4.1**). Improved Groundwater also increased the area under irrigation by 66% while the average Groundwater table has increased by 1 m (*Photo 2 shows the BAIF-ICEF tag on the well which is being regularly monitored by the project staff*). The rainfall however during 1998, 1999 and 2000 was 245.17mm, 439.3mm and 398.87mm respectively, which is below the average rainfall of 492mm in the area. High contents of E-coli have been found in the community wells (2400 MPN /100 ml) and the low contents of about 150 to 240 in the water of the hand pumps. This higher contamination is observed even after the regular chlorination of the open wells by the nature club of the school children and the VWC's. However, the improved accessibility to hand pumps to all the people, the consumption of water from open wells is negligible. This has also resulted in reduction of water borne diseases.

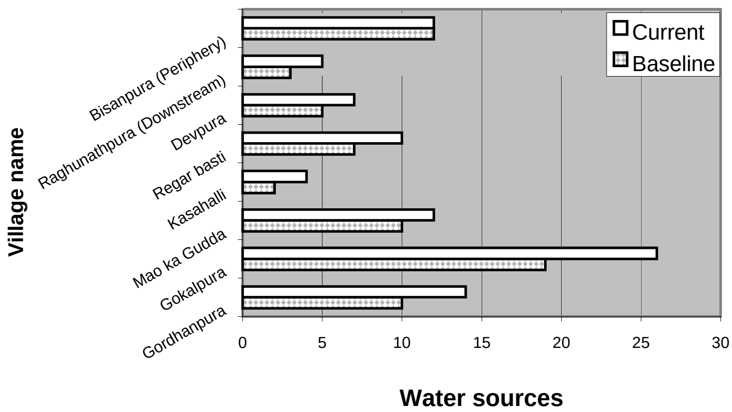

Figure 3: Village wise Change in Drinking Water Sources

Table 4.1 Changes in Access to Drinking Water Sources

Indicator	Baseline	Current
Distance to source	500 m	50 m
Mode of access	Pulley / Hand pump	Hand pump (one well has a diesel powered pump)
Time required to fetch daily water stock for each family	10 person hours (one person requires 30 minutes to fetch 15 litres of water from a distance of 500 m)	About 3.5 person hours (one person fan fetch 15 litres of water from a distance of 50m in 10 minutes)

There are no toilet facilities in the village either public or private. Open defecation is practiced everywhere. People go for defecation for about a kilometer away from the village and usually use the near by sources. The kitchen gardening, Vermicomposting (105 families) and Accelerated Pit Composting (137 families) is followed for agro and domestic waste recycling.

The downstream village has also been benefited by the watershed treatments in their upstream. The number of drinking water sources has increased from 3 to 5 in this village and they do not suffer from the water scarcity in summer. The survey in peripheral villages indicates that it is severely suffering from drinking water problems as all its sources have run dry and to fetch water they have to travel for about a distance of 2km. Both the downstream and peripheral villages are not practicing waste recycling methods.

2. Dug well in watershed being regularly monitored

4.2 Adihalli-Mylanhalli Watershed

This project on “Water Resource Development and Energy Conservation for Sustainable Management of the Environment.” Project is being implemented with watershed approach and financially supported by ICEF. An integrated development programme was initiated in 1996 in the villages of Adihalli and Mylanhalli in Arsikere taluka, Hassan district, Karnataka.

Drinking water need is satisfied by the sources that are totally dependent on the Groundwater. The groundwater is tapped through the dug wells and bore wells in the metamorphic aquifer for both the consumptive and productive uses. Dugwells and the hand pumps form the only sources of drinking water. The water availability from these sources use to drastically decline in the summer season, before the project. So the community had to fetch water from only a couple of sources, which were perennial, but had low yields. Since the *Gokattes*[1] also use to remain dry during summer season the

[1] A traditional water storage structure in Karnataka state, mainly for the use of cattle.

pressure of livestock was also on the same sources or otherwise they had to be taken to long distances upto 2-3 kms. This used to happen every year before the project.

The farm pond based water resource development model significantly increased the Groundwater table to the extent that some of the bore wells and open wells started over flowing and all the sources are now perennial. Average increase in Groundwater level is 3.79m (**Figure 4**). With the project initiative the defunct piped water supply scheme have been operationalised by drilling a bore well as a supply source in the Hunsekatte village. In addition similar mini piped water supply scheme is being developed in Adihalli village with the joint efforts by BAIF, Zilla Parishad and Gram Panchayat. These schemes and the surface storages, which are also perennial, have completely solved the problem of water supply for drinking water to community, livestock and irrigation. The total number of sources in the watershed used for drinking water has increased from 46 to 48. Both the new sources are bore wells, one by the Government and other by BAIF.

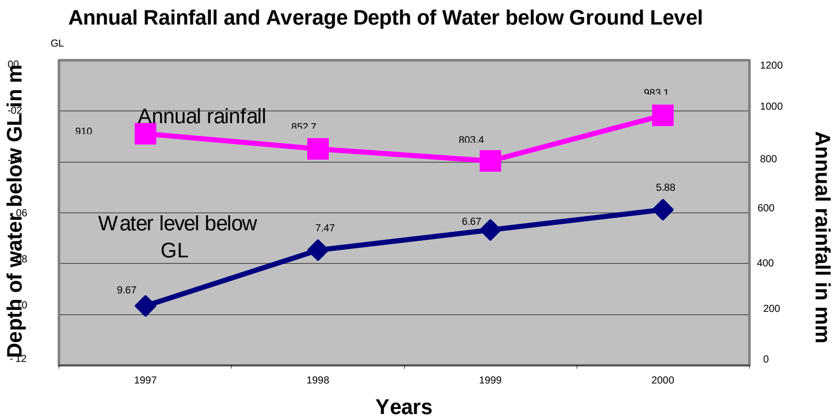

Figure 4: Rainfall and Groundwater Level in Adihalli Watershed

The provision of mini piped water supply scheme in Adihalli and Hunsekatte villages is a unique example of the cooperation among the Community, Gram Panchayat, Zilla Parishad and the NGO (BAIF). All the drinking water sources are maintained in good condition by the community. Regular chlorination is also practiced to ensure the potability of water. Drinking water problem has been completely solved. The area under irrigation has been increased to 173.4 ha from earlier 44.4 ha. The annual rainfall for each year during entire project period is in the range of 803 to 983, which is above the average annual rainfall of area of about 660.7mm by 34%.

There are 21 private latrines in the watershed. The other families have to go out in open. The project has created awareness of cleanliness and hygiene among the villagers. Bathing is normally performed in the bathing platforms inside the house, the water source is the same that used for drinking. An increase in the water availability in the surface water bodies has reduced the water use from the dug wells and hand pumps for latrines/toilets and washing clothes.

By practicing vermicomposting (409 units) and NADEP composting (207 units) all the organic waste is recycled and used as manure. Community Biogas, a method of using cow dung to produce electricity has been installed in one of the project villages and is working successfully. 311 families have been practicing kitchen gardening and 124 old kitchen gardens have been revived.

4.3 Karondiya-Sengur Watershed

The project on "Water Resource Development and Energy Conservation for Sustainable Management of the Environment." is being initiated under the aegis of ICEF since last 5 years in Chaparghata area of Kanpur Dehat district of Uttar Pradesh.

The area is mostly the ravine land located at the confluence of Jamuna and Sengur river. Being thick alluvium deposits in the area, which has been hardened at places to calcretes, the major source of water supply is the shallow and deep alluvial groundwater aquifers tapped through dug wells and tube wells.

At the baseline (year 1996), most villagers had to depend upon the community-dug wells for drinking water, although sometimes people fetched water from sources like irrigation tube wells and the rivers. The depth of the wells being about 23m the pulling out exercise for water from the sources was a hard task especially for women and children. Although there was no water scarcity problem as such but the accessibility due to distant and deep sources was the major concern. Project identified this priority need and provided the hand pumps on existing dug wells and newly developed tube wells (*Photo 3 shows the hand pump installed on the dug well through the project*). Decrease in number of dependant families on the sources from 35 to12 provided easy access and relieved women from the difficult task of fetching water. The supply sources have been created with contribution and active participation of locals. The maintenance has been taken care by the locals.

3. Hand pump installed on the dug well, which reduces the strain on women to pull water

The increase in number of sources (20 to 35) is almost entirely due to an increased number of obviously more sustainable and easy-to-maintain systems, i.e. hand pumps. The community has always been sensitive towards the maintenance of the sources and now after training people in the repairing of hand pumps the repairs are done rather immediately. The withdrawal time for obtaining drinking water supplies for a family has reduced to less than 50% of that at the baseline (Change in access to drinking water source is given in **Table 4.2**). Drinking water quality tests are done regularly and the test reports indicates that the water is potable. However during monsoon there is a problem of water quality due to rivers floods but the community chlorinates the wells at regular intervals.

Table 4.2: Change in Access to Drinking Water in Project Villages

Indicator	Baseline	Current
Number of dependant families per source	35	12
Distance to source	100 m to 200 m	50 to 100 m
Mode of access	Pulley	Hand pump
Withdrawal time for 10 litres of water	2 minutes	< 1 minute
Considering an average family size of 5 persons and assuming a daily drinking water requirement of 50 litres per family, the computed withdrawal times are:	10 minutes	< 5 minutes

Tradition of open defecation has been followed in the villages. Community has understood the importance of personal health and hygiene. In the village Nayapurva the internal roads have been paved with the help of joint efforts by community, BAIF and Gram Panchayat. Except for a few bathing places / bathrooms privately developed in Musaria, bathing is also performed in the Jamuna and Sengur rivers.

The families are motivated to use various techniques of waste recycling to be used as organic manure, which will improve fertility of the soil. About 35 families follow Vermicomposting and the number is going up day by day due to the increased awareness among the community.

4.4 Kelghar – Ranjanpada Watershed

This watershed development project is a part of the Jana Utthan approach for sustainable development of Below Poverty Line (BPL) families through "Transfer of Technologies for Sustainable Development". The funding for the project is from European Union (EU) and is being initiated since 1998 in Kelghar-Ranjanpada villages of Thane district in Maharashtra.

The watershed area has medium to steep slopes and thus the rainwater is lost due to surface runoff. The surface water is thus not stored in required amount to satisfy the needs for drinking water. The main source of water has always been the Groundwater. This Groundwater is tapped through the dug wells. Springs, which are both, fracture springs (emergence of water at the contact of the fracture and the slope cutting) and contact springs (emergence of water at the contact of two rock types), are also the source of drinking when the farmers are in the field. The change from the baseline to current situation includes an increased period of stream flow in the watershed area. Water availability in the main stream has increased from six months to eight months. The sources being limited and of shallow depth, used to yield very less water during summer. Few sources used to run dry in summer. Nearly all the sources are in the streambed as people have experienced that they get the required water at that location. The watershed development program has improved the perenniality of water in these sources and the required quantity of water is made available to the participants.

The access to the source has not improved much, the main reason being absence of sources within the village premises and hence even today they have to travel a distance of upto 500m one way for fetching water for drinking and domestic uses and traverse the rugged topography with undulating grounds. The vertical distance of climbing up and down the hills has always been a problem for the villagers. The average time required per trip to fetch water is around 45 minutes (**Table 4.3** gives average distance and time required to fetch water). The project has not tested the water for quality.

Table 4.3: Average Distance and Time Required for Fetching Drinking Water

Indicator	**Baseline**	**Current**
Distance to source	1 km.	1 km.
Mode of access	Pulley	Pulley
Time required to fetch water for each family	On an average 45 minutes for one visit.	On an average 45 minutes for one visit.
Period of water scarcity	2 months -April and May (summer season)	No water scarcity. Sources are perennial
Mode of satisfaction of demand during the scarcity period	During scarcity, they travel a distance of around 2 kms. to fetch drinking water on head load.	

Traditionally all the families in watershed go out in open for defecation, sometimes as far as half a kilometer away. The water source used for latrines mainly depends on the season. Usually people go to downstream side only when there is water availability in the streams. The rugged terrain adds to the difficulty in going for defecation. At present there is baseflow in the streams even in summer season as a result of the watershed measures. Hence stream water is now used throughout the year. As far as bathrooms are concerned fifteen families in Kelghar were benefited through the **"Gharkul Yojana"** by the Government. In Ranjanpada BAIF is constructing two community bathrooms near the community wells for the bathing purpose of women. The water source used for bathing purpose is the groundwater, taken from the wells and used for bathing and other domestic purposes.

Human waste disposal is "in-situ". Most common areas for disposal of waste are along the streams and in the fields. Cow dung is brought in use by the traditional methods of organic composting. The cow dung is also collected from the open areas and used in the fields as organic manure. Farm yard manure or organic composting on the farms has been a general practice even prior to the watershed development programme. Dung cakes are still used as cooking fuel in households. The agro waste, crop residue that remains after the harvesting, is used for preparing "*Rab*" a local term in which the grass is spread over the field along with cow dung and is burnt before ploughing, a traditional practice thought to maintain the fertility of soils. No new methods (vermicomposting and NADEP) of using the organic manure are practiced in the watershed.

4.5 Titoi Watershed

This watershed development project is a part of the Jana Utthan approach for sustainable development of Below Poverty Line (BPL) families through "Transfer of Technologies for Sustainable Development". The funding for the project is from European Union (EU) and is being initiated since 1998 in Titoi village of Surat district in Gujarat.

The community in Titoi always had drinking water scarcity during summer. The low and erratic rainfall and high surface runoff have been the main factors contributing the water scarcity problems. There are in all 6 dug wells and 15 hand pumps in the village. However during summer the hand pumps installed by the government use to yield very limited water to satisfy the needs of the entire village. Thus villagers had to travel a fairly long distance of about 1-2 km.

With the rigorous follow up and demand from the villagers with the government forest department, villagers received support from department for drinking water supply system on the ground of the participation in Joint Forest Management. The forest department provided support for drilling bore well, over head tank of 24 cum capacity and pipe line with 10 stand posts Villagers contributed for the diesel pump, and the labour work for laying the pipe line. In this way the problem of drinking water supply has been solved with the sole initiatives from the villagers. Villagers are managing and maintaining the drinking water source. They are also contributing for the maintenance. In addition a bore well with hand pump provided by the project in the remote area near the temple has been found very useful to the families residing around.

The eradication of problem of drinking water supply is due to the local initiatives and has no relation with the watershed development project. However the sustainability of the source will definitely be ensured with the improved recharge due to watershed measures. The improvement in Groundwater table is quiet apparent from the example of a bore well which struck water at a depth of 35 ft as against the usual depth of about 50 ft in the past.

In the absence of water tests the team is unable to comment on the quality of water.

People in the watershed follow the tradition of going out in open for defecation. Not a single family in the watershed has its own latrines. Cloth made bathrooms are used for bathing. The Sanitary water needs are also satisfied by the drinking water sources and the surface water sources during rainy season.

Being a part of a large Jana Utthan project the activities such as awareness camps on health and sanitation and integrated farming practices is about to be launched in this area.

4.6 ManhereWatershed

A project on “Integrated Watershed Development Project in Manhere area” in Akole taluka of Ahmednagar district, Maharashtra was implemented during 1993 to 1999 in the villages Manhere, Ambevangan, Titvi and Kodani. The project was supported under Indo-German Watershed Development Programme (IGWDP), which emphasize mainly on soil conservation through mechanical and vegetative measures.

In all the main villages community dug wells was the main supply source, which invariably use to dry up for 2- 3 months in summer. Hamlets have been dependant on the spring water or the irrigation dug wells, which are located normally in the deep valleys. During summer the *Zilla Parishad* (district Panchayat) tankers used to supply the water to main villages in a limited quantity however the hamlets had no option other than to collect the small seepage drops by wandering during the nights adding to the drudgery of women and also loosing the crucial wage earning days. Villagers had to walk a distance of more than 5 to 10 kms to fetch drinking water in summer.

Although the watershed project had no provision for drinking water supply the conservation measures helped augment the springs and dug wells, which particularly solved the problem of the hamlets. The period of scarcity was reduced in main villages also, which was evident from the tanker supply period being reduced from 2-3 months to 15-20 days in a year. Surface water storage structures such as check dams, roof water harvesting tanks and spring development from the non-project sources improved the access for the people *(The spring flowing nearly for the whole year is seen in Photo 4*).

4. Hamlets now have yearly water availability through the perennial springs.

In the year 1999-2000 the piped water supply scheme has been provided by the Government in Manhere village and is under progress in Ambevangan and Titvi. Looking at the past experience of the water supply schemes provided and maintained by the Government the sustained functioning of the new scheme is doubtful.

Traditionally, all the families in the watershed go out in open for defecation both on upstream and downstream sides of drinking water sources. The rugged terrain adds to the difficulty of going for latrine. However with the motivation from project, the individual latrines are slowly being adopted by the villagers. Bathing is normally performed in the platforms inside the house or some times the check dams are used.

4.7 Kharachiya and Kharachiya Jam Watersheds

In Saurashtra region of Gujarat watershed development project under National Watershed Development Programme for Rainfed Areas and National Wasteland Development Programme (NWDPRA & NWDP) was taken up in 1995-96 through District Rural Development Agency (DRDA). The projects were taken up in 5 districts of Saurashtra covering about 10 villages in each district. The project area studied by the team includes villages Kharachiya Jam and Kharachiya representing two different clusters of two talukas of Rajkot district. The projects have been implemented as per the common guidelines of watershed development by Hanumantha Rao committee.

The main drinking water source has been the Groundwater and the supply sources invariably run dry in the summer season. During this season the tanker water supply, which is very limited is the only source.

Looking at this persistent problem of drinking water BAIF initiated the project with the entry point activity of providing drinking water supply with bore well, pumps, overhead tank and stand posts. The total cost of the entry point measures is 5% of the project cost. The depth of the bore well drilled in Kharachiya Jam is 150m and that in Kharachiya is 335m. Near the sources the troughs have been provided for drinking water to the livestock, as there is no other surface water source for the livestock. Nearly 80% of the house holds own hand pumps of which only 5-10% hand pumps are functional only during rainy and winter season. Others are all defunct due to the depletion of Groundwater table.

After the completion of water conservation activities mainly the check dams and well recharging structures initially the water table improved and it appeared that drinking water problem has solved. The agriculture crop production was improved drastically during the initial two years. During last two years the area has faced severe droughts, which took the area back to the pre watershed development situation. The water supply sources went dry and the agriculture production has gone down upto 10% (**Figure 5**). The rainfall during 1999 and 2000 was 100 mm and 122mm respectively as against the average rainfall of 350mm. This indicates that the model of watershed implemented under NWDPRA is not sufficient enough to cope with the drought conditions (*Water problems are tried to be solved with the deployment of water tankers in the villages as seen in photo 5*).

5. Water tankers providing water to the villages in the period of drought

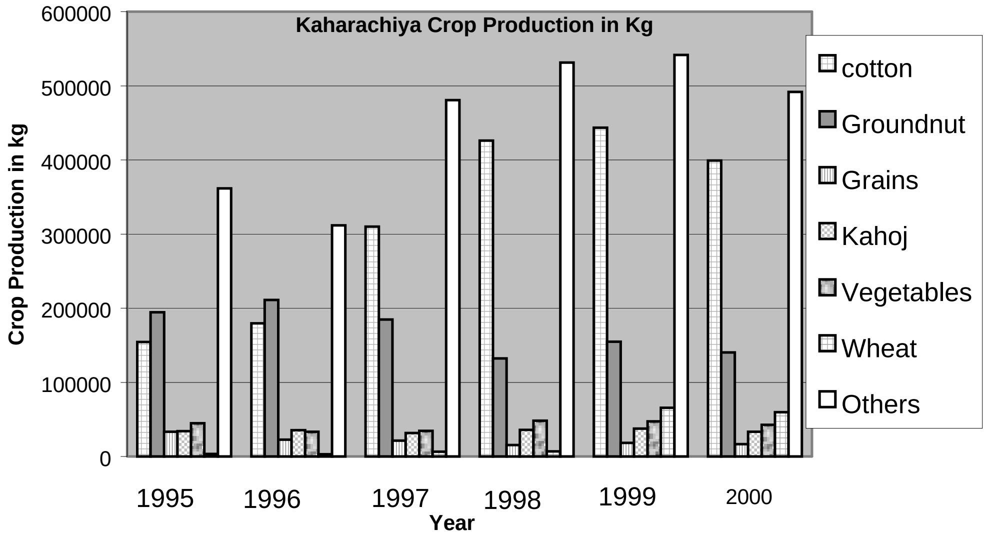

Figure 5: Change in Crop Production in Kharachiya Watershed

In the project area only 5% families have latrines. All other families practice open defecation. Most common areas of defecation are the dry open spaces in the lee of water storage structures along the drainage lines. The bathrooms are very common in the project villages and all the families have bathrooms.

The water source for toilet purpose is same as that used for drinking. Project provided the bore well and washing platform, which is being used by the women.

5. DISCUSSION

The discussion of the study is divided into three sections mainly WSS issues, WSS activities in Watershed Development Programme (WSD) and effects of WSD on WSS.

5.1 WSS Issues in Watershed Development Programme

The key issues, problems and its extent identified by the study team are on the basis of the baseline studies carried out by the project and discussions with the villagers during this research. The situations are considered to reflect the problems prevailing in the surrounding areas of the region. The identified issues still prevail in the surrounding villages even after 8-10 years of period from initiation of project studied. In this section the problems and issues prevailing in watersheds before the projects have been discussed in detail.

The **Tables 5.1 to 5.7** describe the problems pertaining to WSS in the study watersheds **before the watershed development programme**.

Table: 5.1 Govardhanpura – Gokulpura Watershed

Watershed	Key problems and issues of WSS (before project)	Extent of problem	Factors responsible for the problem	Remarks
Govardhanpura-Gokulpura	• Dependence on open wells. • Depletion of water sources during summer. • Limited number of reliable and potable water sources (HP), which have been introduced in recent past by Government. • During summer women have to walk long distance to fetch drinking water. • Due to high bacterial contamination water borne diseases are recurrent.	• Frequent droughts. • Problem of water scarcity for the 3-4 months during every summer season. • Limited water for irrigation	• Depletion of water in summer in the open wells is the direct effect of the extraction of water for irrigation to Kharif and Rabbi crops. • Common aquifer for both drinking and irrigation water supply source. • Non-maintenance of the drainage gutters. Absence of paved street roads in the villages. • No coping mechanisms through either temporary or permanent infrastructures and systems. • Open defecation system and dumping of animal dung in open contributing to water quality problems.	Drinking water in the hand pumps has less (150-240MPN/ 100ml) bacterial contamination as compared to the open wells (2400MPN/100 ml).

Table 5.2: Adihalli – Mylanhalli Watershed

Watershed	Key problems and issues of WSS (before project)	Extent of problem	Factors responsible for the problem	Remarks
Adihalli-Mylanhalli	• Water sources (dug wells mainly) go dry during summer and women then walk long distances, sometimes to the nearby village to fetch water. • Water contamination leading to water borne diseases.	• During summer season depletion of water table. • One hamlet had no reliable source at all.	• No proper infrastructure of maintenance of sources by the Government. • Low yielding hard rock aquifer. • Non-working of the mini piped water supply scheme due to drying up water supply bore well drilled by Government. • Open gutters, stagnant water and open defecation. • Dumping of garbage outside the house. • Pumping of available water for irrigation.	Due to adverse surface conditions, the natural recharge of ground water has been very poor.

Table 5.3: Karondiya – Sengur System

Watershed	Key problems and issues of WSS (before project)	Extent of problem	Factors responsible for the problems	Remarks
Karondiya-Sengur	• Ground water depletion during summer. • Dependence on the traditional dug wells. • About one hand pump per village provided by govt. most of the time are not functional. • Distant sources and difficult withdrawal from dug wells. • Water contamination leading health hazards especially during rainy season. • Open defecation	• Water level goes deeper during every year for 2-3 months in summer.	• Number of sources less than required. • Absence of local maintenance and management systems. • No regular chlorination of the sources. • No road pavements inside village and proper drainage systems. • Low yielding capacity of the shallow aquifers tapped through the dug wells. • Floods in river Jamuna and Sengur	Community had no awareness and sensitivity on health and hygiene, both the general in village and around the water sources.

Table 5.4: Kelghar – Ranjanpada Watershed

Watershed	Key problems and issues of WSS (before project)	Extent of problems	Factors responsible for the problems	Remarks
Kelghar - Ranjanpada	• In village Kelghar, only one dug well in valley, which is at a distance of about 500m and 200-300 m, lower altitude. While in Ranjanpada the sources are 2 shallow dug wells. Hilly terrain creates difficulty in access. All these sources dry up in summer forcing women to walk up to 2 km distance to get water from natural springs. • Health hazards due to consumption of non-potable water.	• Mainly during summer water is not available to the villagers.	• No Government scheme for drinking water supply. • Lack of awareness on health and hygiene. • Sources are dependent on low yielding shallow aquifers (top soil and weathered rocks). • Open defecation • No drainage system.	• Thick compact basalt at basement has very poor storativity. The Giant phenocryst basalt marks the main host of ground water. The aquifer thickness is good. Hence scope for ground water source development.

Table 5.5: Titoi Watershed

Watershed	Key problems and issues of WSS (before project)	Extent of problem	Factors responsible for the problem	Remarks
Titoi	• Very low yields in to hand pumps and dug wells dry up during summer. • Community fetch water from long distance (2 km) during scarcity period. • Open defecation and improper drainage system.	• Severe problem of drinking water availability during March to June every year.	• Erratic rainfall. • Impervious nature of the amygdaloidal basalts forming the limited sheet joints.	

Table 5.6: Manhere Watershed

Watershed	Key problems and issues of WSS (before project)	Extent of problems	Factors responsible for the problems	Remarks
Manhere	• Either only one or no community dug well for drinking water. These limited drinking water wells dry up in every summer. • Failure of Government water supply scheme in Manhere village. • Remote hamlets have to fetch water from deep valleys mainly through seepage points. Main village receive tanker water in scarcity period which is again very limited; only upto 30 liters per household. This creates chaos and fatal cases when the tanker is empted into the wells. • Recurrent water borne diseases due to source contamination. Certain permanent problems like skin diseases also prevail.	• Water scarcity during every summer season for 3 to 4 months. Usually, during this period water is collected from the seepage points located in valleys. • In the hamlets and village Titvi even during the winter women have to fetch water from valleys as deep as 300-400 metres and distances upto 1-2 km.	• Low recharge to the ground water and high surface runoff due to shallow soil cover and rugged terrain. • Carelessness towards the maintenance of the water supply scheme by the Government. • Lack of awareness for personal health and hygiene Poor drainage system, open defecation. • Common sources always get polluted during scarcity period, as being used by people as well as wild and domesticated animals	• The water problems are so severe that the people use to get water on head load or cart load from the Waki dam situated atleast 2-3 km away from the habitat. • Thick compact basalt at basement has very poor storativity due to absence of fractures, joints and secondary minerals. Hence scope for ground water source development is limited

Table 5.7: Kharachiya and Kharachiya Jam Watersheds

Watershed	Key problems and issues of WSS (before project)	Extent of problem	Factors responsible for the problem	Remarks
Kharachiya and Kharachiya Jam	• Water scarcity during summer • Drastic depletion of ground water due to naturaldroughts. • Absence of latrine facilities. • Poor drainage conditions leading to unhygienic environment in village. • Cattle needs to be taken to longdistances for satisfying their drinking needs.	Droughts are very frequent (years 1999-2000 the rainfall is only 50% of the average). Every year the sources dry up during summer.	• Low and erratic rainfall 384mm and 253mm respectively. All the requirements of human, cattle are satisfied by the limited sources. • Competition between drinking water supply and irrigation water supply is very high from the same aquifer. • No long-term sustainable solution to the problem by Government. • No infrastructure for proper drainage During scarcity period Government tankers supply less than 50% of the total requirement of family for domestic needs.	Because of the continues ground water depletion the locals are going deeper and deeper in the subsurface for finding the adequate water supply both for irrigation and drinking (about 500m deep). Looking at the current situation it seems that the process will go on continuing with the advancement of new mining technologies.

The WSS situation, before the initiation of projects, in all the watersheds studied was very pathetic especially during the scarcity period of summer. The tables above provide in brief the information on problems/issues, extent and severity of problems and the factors responsible for the situation. Certain commonalities and differences have been observed in the study of seven representative watersheds in six regions.

5.1.1 Common Issues at Baseline

The commonalities among 7 projects studied are as given below:

- All the seven watersheds have the ground water as the source of drinking water supply.
- Drying up of the dug wells tapping the shallow aquifer in summer.
- After drying up of the surface water sources, the supply source for drinking, other domestic purposes and livestock is common.
- Limited number of perennial sources particularly the recently introduced hand pumps by government authorities.
- Water scarcity period in the summer season from the end of February upto the end of June.
- Severe water scarcity in the upper catchment villages.
- Close link between water supply, sanitation and health and hygiene.
- Water contamination leading to water borne diseases.

5.1.2 Different Consequences of WSS Problems (at baseline)

The above commonalities however have different consequences in the various regions as people find the local options for coping with the situation. The scarcity period is about 4 months of summer when the water table depletes creating tremendous stress on the local population and livestock. Scarcity leads to traveling long distances mainly by women (mostly all areas), standing in long queues waiting to get a pot of water from government tankers (Rajkot, Manhere), searching the seepage points in early morning hours and sometimes half a day (Manhere). The livestock have no choice than to remain thirsty or to go to the rivers located far away. Some areas like Saurashtra (Rajkot), livestock also depend on the same source used by human population, while in the area of Western Ghats (Manhere and Kelghar) not only domesticated but the wild life also use the same seepage water of the springs. The adverse situation forces the communities to drink non-potable water to quench their thirst leading to water borne diseases. This is also due to the lack of awareness about drinking the clean water.

Negligence on better sanitation has been unique feature all over. The open gutters, improper drainage, open defecation, haphazard disposal of domestic garbage, carelessness on health and hygiene is a common scenario in almost all the villages and their hamlets except Rajkot and Adihalli areas. Animal waste in the villages and human waste near by the streams and open fields affects the water quality. All this ultimately results in recurrent epidemics as well as the long lasting diseases.

5.1.3 Causes of Water Scarcity at Baseline

The severity of water related problems vary in different areas. The factors responsible for this severity are rainfall distribution in space and time, water exploitation for irrigation, geohydrological situations, inadequate infrastructural provisions and absence of local institutional arrangements. These causes are classified into two main categories viz Natural and Anthropogenic

a) Natural Causes

All the watersheds except two in Western Ghats (Manhere and Kelghar) fall under low rainfall zones. The annual rainfall in these areas ranges just between 350mm to 650mm that too is very erratic. In absence of surface storages, there has been very limited ground water recharge in monsoons. Natural recharge is very limited due to the fact that all the studied watersheds are located on the upper most parts of the region or valleys. Except UP area no other area has access to the river water coming from other regions. Although there is good rainfall in the watersheds at Western Ghats (Manhere and Kelghar) the topography and geology is not favourable for ground water storage and also the yield. Thick compact basalt at basement has very poor storativity due to absence of fractures, joints and secondary minerals. The steep slopes and shallow soil cover together with low infiltration rates of base rocks, the rainwater flushes down very quickly into the nallas and then to the river.

b) Anthropogenic Causes

Being a common aquifer for both domestic and irrigation use in Rajkot and Govardhanpura area, the irrigation use for kharif and rabi season depletes all the water sources. So overall depletion of the ground water leads to drinking water problem in the summer season in these areas. The water use for coconut throughout the year in Adihalli area dries up the drinking water dug wells in summer and reduces the yield of bore wells.

The presence of individual bore wells and dug wells for irrigation without proper management in Rajkot watersheds has led to over exploitation of groundwater. The exploitation rate is more than the available recharge rate. The dependence on the rabi crops has encouraged the individual to over use the only source both for drinking and irrigation. The absence of awareness among the community about harvesting of rainwater and proper utilization of both surface and ground water creates imbalance due to low recharge and high exploitation.

The coping mechanisms to drinking water problem in most of the watersheds were very short cited, as they had been limited to only following arrangement:

- Provision of limited HPs
- New HP if earlier one goes dry or becomes permanently defunct
- Water supply through water tankers (Gujarat & Maharashtra) in a very limited quantity

The government water supply departments have installed hand pumps in all areas except Kelghar (where dug wells form the only source). The hand pumps installed are very limited in number to meet the needs of the population. Many times locations are not appropriate for access to majority of the community. It has been observed that out of 60 HPs only 24 were functional at baseline. This problem is due to absence of local management and maintenance mechanisms and ignorance by the authorities to follow proper maintenance and management criterion. In Manhere and Adihalli watersheds mini piped water supply schemes were established by the Government with the entire infrastructure ready but the scheme never started off. The main reason for Manhere scheme failure was that after installation of the scheme it never got the electric supply and Govt did not turned back to see whether the system is working or not. While the locals also failed to take charge of the scheme to operationalise it. In case of the scheme at Adihalli watershed, the borewell, the supply source failed and then there was no further action on it. Regarding the failure of hand pumps, the reason is that the locals are not trained to take care of simple maintenance needs and hence they depend on authorities to come and repair the pump. In this process many times the scarcity season passes or HP goes out of order.

The main reason of improper sanitation is that the community in all the areas is not aware of personal as well as community level health and hygiene. In all watershed areas sanitation is neglected by the village authorities as well as the individuals. There is no infrastructure for the community toilets and bathrooms. Although there are private bathrooms and toilets (Rajkot) the number is very less.

In addition to the absence of local water management and water sharing mechanisms, concrete legislations for water management are also missing all over.

5.1.4 Water Extraction Trends in Rajkot and Govardhanpura

All the areas have different physical conditions and represent different geographic locations. The main difference seen is that even when there is water scarcity period only in summer in most of the areas this almost continues for about 8-10 months in Kharachiya, Kharchiya Jam and Govardhanpura-Gokulpura watersheds as these places have frequent droughts and the dependence on the irrigated crops is more as there are very limited Kharif crops due to the droughts. The physiographic differences are illustrated in the **Annexure 1.**

BOX-1

Rajkot district of Gujarat State receives annual average rainfall of about 350mm. In absence of water conservation measures this limited rainfall leads to high runoff. During past five years, villages in the district had to face great difficulty as the rains have decreased to nearly half of the average rainfall. The rains are very erratic and fall in short spell only. Kharachiya and Kharachiya Jam are the two villages located nearly 30 kms southwest of Rajkot city.

In the year 1995-96 BAIF-GRISERV initiated a watershed development project in these villages with the help of DPAP. The project period was for five years. The basic aim of it being conservation of soil and water with the participation of community. Along with this capacity building of the community especially the women for resource conservation was also looked upon. The holistic approach of development was adopted in the area.

The watershed project had good impact after two years of implementation. There was sufficient water for drinking during summer and the crop production was doubled. However due to successive low rains continued during 1999 & 2000, resulted into deepening of bore wells up to 400 m, drilling horizontal bores leading to severe scarcity of even drinking water in summer of 2000, which brought back the government water tankers to village.

6. *The villagers trying grab water after the tankers have been emptied in the community well*

The villagers have tried the integrated watershed development with great courage to the vagaries of nature in one way or another. However, nature has been so mighty, integrated watershed project also could not help people. This indicates that conventional approach of watershed development cannot cope with successive droughts (low rainfall) for 3-4 years. There has to be focused approach and technology to solve at least the problem of drinking water. See **figure 6** for change in water column.

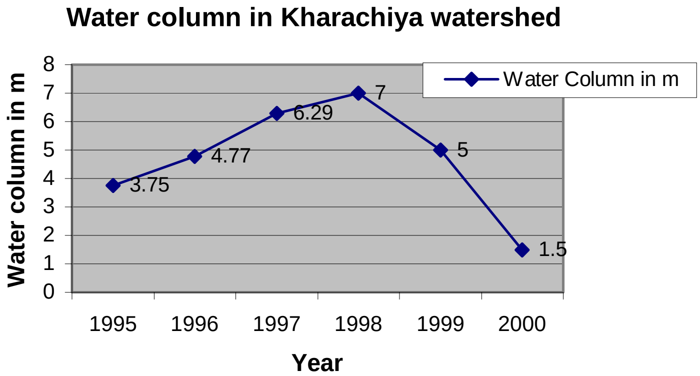

Figure 6: Change in Average Ground Water Column in Kharachiya Watershed

BOX-2

Rajasthan state is very often affected by droughts. The rainfall in the year 2000 was just 390mm as against average annual rainfall of 492mm. Out of the 32 districts of the state 26 were affected by droughts. Bundi district was one of them. BAIF has been implementing a watershed project in Gowardhanpura & Gokulpura villages of Bundi district with the financial assistance from India Canada Environmental Facility, New Delhi since 1997. The project is on 'Water Resource development and Energy for Sustainable Management of Environment' with the participation of the community.

The project has benefited the women folk the most as they had to walk long distances to fetch water, which is use to take excess time and also cause physical stress on them. Now the time required to fetch water is only 60 minutes as compared to the previous 120 minutes. The supply of smokeless chullas has also reduced their stress of going out to collect fuel wood.; The agriculture yield of the watershed has increased from 1008 kg/ha to 1841kg/ha for Kharif crop and from 2731 kg/ha to 5200 kg/ha for Rabi crop yield.

The watershed programme has been so fruitful that not only the villages in the watershed but also the downstream villages benefited with water availability during the scouring summer. All the nearby villages were declared as drought affected. It was a great constrain picture to see two villages side by side, the project village with green cover and sufficient water whereas the non-watershed project village with dried up wells and facing water scarcity. See **figure 7** for change in water column and annual rainfall.

This indicates that a holistic approach towards the watershed development can effectively combat the drought situation

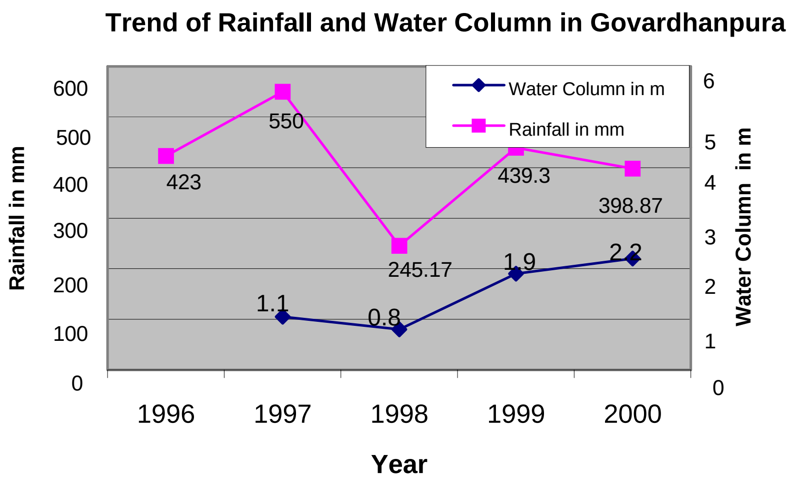

Figure 7: Change in Average Ground Water Column and Annual Rainfall in Govardhanpura Watershed

5.2 WSS Activities in Watershed Development

The study shows that although the projects were implemented by BAIF the project design has influence of the broad project objectives and the project-funding agency. Hence the WSS issues although found one of the top priority of locals in all the baseline reports, the solutions or the approach of tackling the problem vary from programme to programme.

The projects supported by EU and NWDPRA/NWDP, there has been a provision of Entry Point Activity (EPA) to help the project staff win the confidence of locals addressing their priority need before the mainstream activities initiated. The works of EPA taken up under DPAP projects are mostly related to solving Water Supply problems (Stand *post of the over head tank made at the entry point by the project as seen in Photo 7)*. The common EPA include:

- Drilling of bore wells and installation of electric pump on it.
- Construction of overhead tank and inflow and supply pipeline connected to a stand post with taps
- Common washing platform with a separate bore well.

7. Stand post with taps installed by the project as an entry point activity.

Under EU supported watersheds, the EPA related WSS were bore well with HP, repairs to HP and well deepening.

In Manhere project (Indo-German Watershed Development Programme) there was no activity for directly addressing the WSS issues; which was actually a priority of villagers. So BAIF actually addressed this issue finding the other sources of funds.

In case of Govardhanpura- Gokulpura, Karondiya – Sengur and Adihalli – Mylanhalli projects funded by ICEF (India Canada Environment Facility), there is no mention on EPA as such, but the projects have water resource development and local management as the mainstream activity. One of the project objectives is to provide the safe and easily accessible drinking water to reduce the drudgery of women.

It is also important to note that the above activities in isolation cannot solve the drinking water problem. The perenniality of the sources can be ensured only if the other water requirements are also taken into consideration. Then all the demands may be together addressed taking up an integrated approach of source development and management. In all the projects the User Groups have been developed to maintain, manage and share the water for both irrigation and drinking. Thus the main project activities for soil and water conservation indirectly benefited the drinking water supply situation in all the watersheds. The direct interventions for addressing WSS issues include:

- Drilling of new bore wells (Govardhanpura, Manhere, Kharachiya, Adihalli, Karondiya, Titoi)
- Installation of hand pumps on the dug wells and newly drilled bore wells. (Karondiya, Adihalli, Titoi, Govardhanpura). *Photo 8 shows the newly installed bore well with hand pump in Karondiya watershed.*
- Deepening of the existing dug wells. (Kelghar)
- Enhance recharge to groundwater (In all Watersheds)
- Development of springs (Manhere, Kelghar)
- Train locals in hand pump repairs. (Manhere, Govardhanpura, Karondiya, Adihalli)
- Create awareness among the community towards personal and community health and hygiene. (In all watersheds)
- Construction of bathing platforms in houses and at common places (Kelghar)

8. Bore well with hand pump installed through the project as seen in Nayapurva village.

The expenditure in each of the project on WSS is as given below in **Table 5.8** along with the sources of funding (project or non-project).

Table 5.8: Sources and Proportion of Funding for WSS

Project	% Investment for WSS	Source of funding
Govardhanpura – Gokulpura	1	Mainstream activity in project
Adihalli – Mylanhalli	1	Mainstream activity in project
Karondia – Sengur	2	Mainstream activity in project
Kelghar-Ranjanpada	1	EPA through project
Titoi	1	EPA through project
Manhere		Could not be calculated as the funds mobilized from three different non-project sources
Kharchiya and Kharachiya Jam	5	EPA through project

The percent investment ranges from 1 to 5%. However looking at money invested it is almost same in all the projects ranging from Rs 1 lakh to Rs 1.5 lakh (**Table 5.8**).

It is thus clear that whether or not the project has provision, the drinking water supply was identified as the priority issue and BAIF made efforts to tackle it. The issue of water supply is addressed through EPA or mainstream project activity or mobilizing non-project resources (as stated earlier in Manhere project funds were organized from integrated Tribal Development Programme). However, sanitation has been the non-priority item both from the community side and organizational side. Although few activities such as garbage recycling, internal road pavement (UP), soak pits (UP, Kar), community bath rooms (Kelghar), latrines (Manhere & Adihalli) these have been always treated as non priority matters.

Except the project under DPAP/NWDP the cost per hectare worked out was based on the integrated development needs of the watersheds. Since there is limitation for budget under DPAP, only limited measures like drainage line treatment could be executed (**Table 5.9**). The benefit of watershed activities limits only in the areas close to the drainage lines in case of the focused water conservation measures. In case of the holistic project design and implementation benefits are extended to most of the farmers in the watershed. The examples of decentralized measures and benefits to larger community are Adihalli, Govardhanpura and Manhere project.

Table 5.9 Sources and Level of Funding for Different Watersheds (per hectare cost)

Watershed	Cost per hectare
Govardhanpura (ICEF)	7500 – 10,000
Adihalli (ICEF)	7500 – 10,000
Karondiya (ICEF)	7500 – 10,000
Kelghar (CEC)	8000
Titoi (CEC)	8000
Manhere (IGWDP)	10,000
Kharachiya (DPAP/NWDP)	4500

5.3 Effects of Watershed Development on WSS

In the earlier section we saw the different initiatives and activities taken up under different watershed projects specifically for addressing the issues related to WSS. In this section the effects of these specific inputs for WSS and other activities under watershed projects are analyzed. Analysis of this breaks the boundaries of the focus area, as it becomes a complex system to synthesize and hence cuts across all the issues of a watershed system.

Firstly, in order to simplify the complex nature of the effects created, a matrix showing the relationship between different indicators is presented as **Annexures 3.1 to 3.7**. Each table shows the effect of activities and outputs of four focus areas on the specific issue within framework of the respective watershed development programmes. The focus areas (or issues) include drinking water, sanitation, ecosystem and socio-economics. Tables reveal certain commonalities across watersheds. These would be significant since they would tend to represent broad conditions representative of the watershed model in the country. Each outcome of the activity outputs is discussed below separately as to how it impacts the total regime as well as the manner in which it gets affected by other key areas/factors (represented by issues).

Comparison between case studies has been kept simple in terms of the major focus in the work carried out that was apparent during the studies as well as the overall impact on various factors ranging from eco-conservation to upliftment of the living conditions in the villages.

5.3.1 Drinking Water

The outcomes related to the WSS in the tables reveal that the water supply problem has been completely solved except in the two watersheds of Rajkot district. Rajkot area has been facing severe droughts during last two years resulting the drinking water problem even after watershed project implementation. While the Govardhanpura-Gokulpura project has overcome the drought situation due to watershed project implemented with more integrated approach.

Drinking water problem of most of the watershed areas has been solved due to the combined effect of the development of supply sources (HP, bore and dug wells, etc.) and improved ground water table as a result of recharge measures under watershed development projects (**Table 5.10 & 5.11 show change in water column and the number of drinking water sources**). In addition, the community initiatives in Titoi and Adihalli helped receive the support from forest department and government respectively. While in Manhere the piped water supply scheme by government has completely solved the problem in main villages and the watershed measures augmented the traditional sources in hamlets. So the tankered supply is no more required in Manhere.

Table 5.10: Change in Average Ground Water Column

Watershed	**Water column (m)**	
	At Baseline	**Current**
Gowardhanpura-Gokulpura	1.1	2.2
Adihallli-Mylanhalli	5.88	9.67
Karondiya - Sengur	6.79	6.20
Kelghar-Ranjanpada	2.4	3.47
Titoi	0.5	1.00
Manhere	3 .0	6.0
Kharachiya	8.0	3.0

Table 5.11: Change in Drinking Water Sources and Access in the Watersheds

Watershed	Number of Sources		Average distance to the Source	
	At Baseline	Current	At Baseline (m)	Current (m)
Govardhanpura-Gokulpura(96-2000)	34	47	500	50
Adihalli-Mylanhalli(96-2000)	46	38	500	50
Karondiya-Sengur(97-2000)	20	35	100-200	50-100
Kelghar Ranjanpada(98-2000)	7	8	500	300
Titoi (97-2000)	21	22	300	10
Manhere(93-2000)	36	45	1000	300
Kharachiya (1995-99)	26	28	1000	500
Average	27	32	565	200

BOX-3

Community initiative in solving drinking water problem: Titoi village, Surat district, Gujarat

In the village the drinking water sources are unable to satisfy the needs of the community. Nearly all the dug wells used to go dry in the watershed and the hand pumps yielded very limited water. Facing the water scarcity for such a long duration a old lady in the village thought of taking an initiative and approached the Forest department for helping them by drilling a bore well, installing a overhead tank with stand post to solve their drinking water needs. At first the forest department did not listen to their suggestions but then the villagers started visiting the forest department office daily and use to sit there nearly for the whole day. The old lady who was the leader would not use to eat anything for the whole day and keep on demanding for a water supply system for the village.

After a long struggle, in the year 2000 the department approved the scheme. In this scheme there was a joint effort both by the community and the forest department. The forest department supplied with the drilling of bore well in the existing dug well and with the overhead tank and pipeline. The villagers contributed their labour work for laying down the pipeline and the cost of the pump. The dug wells and hand pumps are thus used as a supplementary source in case of electricity failure. This dug cum bore well has a pipeline from the source to the overhead tank of a capacity of 24 m^3. There is piped water supply from the tank to the 10-stand post in the village.

The community carries out the maintenance of the whole system. A committee has been formed for the maintenance and management of the system. A contribution of Rs. 10 per family/month is collected and is used to pay the installments of the money used by them in bringing the diesel pump. Part of the money is used for purchasing diesel and for the maintenance of the source. Extra money is collected if there is a major problem in the supply pipeline or the electric pump.

Watershed communities in all the seven areas enjoy the safe drinking water facility (**Table 5.12** gives the water quality test carried out by the project) (an increase in number of sources from 190 to 233). The improved quality is the outcome of improved hygienic conditions around sources, main source being the bore well tapping deeper aquifers, and regular chlorination to the open wells.

Table 5.12: Water Quality Data in the Study Watersheds (Year 2000)

Parameters	**Govardhanpura-Gokulpura**	**Karondiya-Sengur**	**Adihalli-Mylanhalli**	**WHO standards**
pH	7.6	7	7.5	6.5 - 8
Hardness (mg/l)	400	400	162	300
Turbidity NTU	0	7	1	5
Iron (mg/l)	0	0.3	0.02	0.3
Nitrate (mg/l)	-	45	10.6	50
Flouride (mg/l)	1.0	0.6	0.139	1.5
Chloride (mg/l)	95	354.4	125	250
Bacterial Count in Number	240	Nil	1	0/100ml

However, open defecation system is prevalent in all the areas, which in future is likely to contaminate the deep ground water sources as well. The open defecation is normally performed in the streams, particularly near the checkdams and other recharge measures in gullies. The treatment measures for water recharge thus are likely to take the contamination to shallow as well as deeper aquifers. So if the source chlorination is terminated the water in open wells is again likely to have quality problem.

Formation of user group for the utilization of ground water has been of great help in reducing pressure on the only source for drinking and agriculture i.e. the ground water. The sustainability of the sources will be ensured through proper management by the local user groups and the maintenance skills acquired by the village youths.

With example of Rajkot watersheds it is perceived by the study team that the increased use of water for irrigation from a common source such as one aquifer may create a stress on the drinking water stocks. Unless controlled, these effects could impact upon the drinking water regime in the watersheds. Foreseeing this threat in most of the watersheds water user groups have been formed to optimally use the water mainly for irrigation and maintain all the sources. However, only detailed research can reveal the time frame over which such effects will become obvious.

5.3.2 Sanitation

As seen from the **Annexures 3.1 to 3.7** sanitation in all the watersheds has been slow to take off as compared to drinking water resource development. The activities taken up for better sanitation have not been comprehensive; as against the various village sanitation issues. The main reason for this has been the lack of awareness among community towards the different sanitational aspects and their willingness to improve sanitation. Despite such situation the project activities have helped improve the community awareness towards sanitation issues.

Sanitation has progressed through bits and pieces since in some watersheds village sanitation has developed far better than home sanitation and vice-versa. The main problem in most villages is the dearth of toilets. People still prefer open defecation *(Project has tried to promote latrines to stop the practice of open defecation as can be seen in Photo 9)*. The project had offered the construction of community bathrooms (Govardhanpura) but the villagers did not come forward. However, the community in Adihalli-Mylanhalli watershed is slowly picking up the process of closed latrines, as now after the project there are 21 new latrines within the watershed.

9. *Latrines constructed through the project in Kelghar village*

The effect of improved water availability in streams facilitated the better access for water use for defecation.

Although the process of improvement in sanitation has been slow, trend shows that it is following a right direction. The initiatives such as village road pavements, soak pits, kitchen gardens have already shown good results on cleanliness.

5.3.3 Ecosystem

Ecosystem issues under watershed projects refer to land, water, vegetation and livestock. The part of water issue pertaining to drinking water supply has been discussed in section **5.3.1**. Watershed development programme revolves around the ecosystem mainly to improve the resource base for better livelihood of the community of which drinking water is one of the important factor.

It appears that at least during the initial stage due to the development of separate sources for drinking water, dependency on irrigation water supply sources has reduced. This has ensured the year-round water availability within the villages for the community as well as livestock.

The common effect of watershed development measures include reduced land degradation, improved green cover, increase in surface and ground water availability (Karnataka – area of surface water bodies has increased by 67.33 ha.m.) and improved livestock based production (**Table 5.13** gives the overall change in irrigation area). The watershed development measures carried out have improved the agriculture yield and overall production (except the Rajkot watersheds; the reason for no increase in yield in Rajkot being, the area has witnessed drought during last two years). The use of organic fertilizer methods viz. vermicomposting, NADEP, and improved pit composting are being increasingly adopted in all the watersheds except Kharachiya, Kelghar and Titoi. These organic manuring measures have also helped improving the crop production. In Govardhanpura-Gokulpura farmers have now started using diesel engine pump sets replacing traditional water extraction device called *chadas*. *Use of the diesel pumps has increased, one of which is seen in the Kelghar watershed in Photo 10*. In Adihalli-Mylanhalli, Govardhanpura and Manhere watersheds a considerable improvement in biodiversity has been noticed. Adihalli-Mylanhalli project has initiated making an eco-pond for awareness generation among the schools and other citizens.

10. The increase in water availability has provoked farmers to go for diesel pumps.

Table 5.13: Change in Irrigation Area

Watershed	Irrigation area in ha.		% Increase
	At Baseline	Year 2000	
Govardhanpura-Gokulpura	203	338	66
Adihali-Mylanhalli	44.4	173.4.	290
Karondiya-Sengur	33	77.	133
Kelghar-Ranjanpada			10
Manhere	167.35	198.94	18
Titoi	*	*	*
Kharachiya	112.50	235.25	109
Total	560.25	1022.59	82

*Too early to observe any change

Projects have promoted Water Users Group (WUGs), Village Watershed Committees (VWCs), to manage, maintain and share the resources. Although some good management mechanisms have been set in the watersheds, the real effect on sustainable resource conservation can be seen only after observations in future. Changing agriculture practices and irrigation patterns as a consequence of watershed development and particularly improved water availability, could be a threat to the system. In the absence of any limit the trend in increased irrigation might induce effects on the drinking water regime, although the time frame to reach this stage might be long.

Box 4

Water Resource Management Strategy

Resource Planning

As a component of watershed development and also to address the drinking water problem, the planning of the resource development (for drinking and for other uses) is done in a joint village meeting participated by all the project stakeholders. The main stakeholders include, the potential users, village watershed committees and BAIF. While planning for the resource development, the users are identified. The priority and need for the development is also assessed. Decisions are taken on the nature and extent of development, contribution to be paid by users and development strategy. BAIF comes forward to support for source development. While the community and especially the users have to take the lead in developing the source.

Source Development

First they have to collect the contribution amount and deposit it to the project. Which ranges from 10% to 30% of the total cost of the measures. While all the labour has to be volunteered by the users in case of Hand Pump. If it is checkdam or farm pond the contribution is about 30% of labour. This basically involves the users in development of source and they take the ownership of the assets. The people ensure the quality of work. The local youths have been trained in hand-pump maintenance and repair. A simple kit for the repair of HP is also given to the group.

User Groups (UG) for Irrigation Water

Karondiya watershed (UP): The UGs of 5-10 farmers are formed. The source of water is created by bore-well and diesel operated pump-set. The piece of land in which the source is created is formally transferred to the group. Rules, regulations for source development, management and maintenance and also crop planning and collection of maintenance charges are developed by the group along with the project staff. This ensures the complete control of the farmers/ users on the source and its use.

Govardhanpura watershed (Rajasthan): In case of Rajasthan the benefits of ground water are directly linked to the water harvesting structures. Hence the groups have been formed and linked to the development, management and maintenance of the checkdam. So the potential users come together and form a group, contribute for the construction of the structure up to 30% of cost of structure. This group of farmers then develop the rules and regulations for maintenance of structure, crop planning, and use of surface water e.g. auctioning it for fishery. The maintenance fund is created based on the area irrigated by a farmer. In this way the maintenance and management of the source is ensured.

Over and above the User Groups, village level watershed committees have been formed. Their initial purpose is programme implementation. Later, they have to carry on the development further. Overall resource management at watershed level, management, resolution of disputes and common interest activities. The maintenance fund created by these committees during project implementation is used for future financial sovereignty. These funds are also used for loaning to individual as well as to the group activities.

5.3.4 Socio-Economic Issues

Increased water availability has reduced the drudgery of women in fetching water from long distances. The combined effect of drinking water source development and increase in water table has addressed the equitable distribution of drinking water among various castes.

The construction of bathing platforms (Manhere, Kelghar and Rajkot) for women has provided close access as well as privacy. The common place for washing clothes has been of great help for women as seen in *Photo 11*, as they had to carry the clothes on their heads to places where water was available. This has reduced the distance to 500m as against earlier 1-2 km (Rajkot).

11. Provision of clothes washing facilities within village

The community has now become more aware of their health and hygiene issues, which was completely neglected in the past. With the motivation from the project staff, community actively participates in the national pulse polio campaign programme.

A watershed programme can be successful only with the participation of the community. Study carried out in the watersheds reveals that in all watersheds the communities participated actively. Through the projects, community acquired skills and knowledge related to natural resource development and management. In all watersheds communities have been organized in various groups such as VWC, WUG, SHG, CS (charagah samiti in Govardhanpura) to better manage the resources. The SHGs of Adihalli by forming *Stree-shakti Kendra (Women Empowerment Center) seen in Photo 12* have been involved in many micro-enterprises. This has helped increase their income and status in community

12. Stree shakti Kendra started by the women as a micro enterprise

There is overall increase of the income of the communities and have better livelihood support as a result of projects. The degree of the improvement varies from area to area due the several natural and human factors and limitations or flexibilities of different programmes.

6. TRENDS, ISSUES AND POTENTIAL CONFLICTS

6.1 Trends of Watershed Development

Having elaborately described the situations across diverse agro climatic and socio-economic regimes from five states in India, it was equally important to make comparisons and to matrix the study issues. These matrices have been presented and discussed earlier, with the objective of bringing out an overall picture of the watershed development programme in light of water supply and sanitation (WSS) scenarios.

Most of the watershed initiatives focus on integrated development of resources for increasing the overall productivity from the watershed unit, aiming thereby to improve the livelihood of the community. Very often, the overall impacts through watershed development are significant in terms of benefits to the community through improved social and economic status of the people brought about primarily through a boost in agricultural and allied activities. Such a boost often means increased water use, almost ubiquitously through development of groundwater resources. In Rajasthan there is an increase from 203ha to 338ha in irrigation area while in Karnataka it is increase from 44.4ha to 173.4ha. On the other hand, sometimes socio-economic advancement of the community is not commensurate with large-scale mobilization of natural resources systems through watershed development. Although it is too premature to put various study areas in either of the above perspectives, certain indications as to issues, trends and concerns pertaining to the watershed development model studied here are presented in this section. In many ways, these issues or trends act as "outcomes of outputs" and simply highlight concerns for the future.

Groundwater resources development in all the watershed development programmes studies has run concurrently to the watershed development activities. Development of groundwater resources has certain commonalities in all areas studied. These are:

1. Groundwater resources development proceeds almost inevitably through individual initiatives.
2. But surely as a consequence of increased recharge to the groundwater system (although the exact quantification of the augmented recharge is rarely examined).

There is little integration between recharge and potential/actual groundwater utilization leaving the utilization component in a "free-for-all" domain. Although, the community understands the importance of groundwater conservation (through conservation measures and protection of such measures), groundwater use still remains largely individualistic leaving an open-ended question regarding the sustainability of the resource.

Groundwater resources in all the watersheds (except perhaps in the Karaondia-Sengur-Jamuna system, U.P., where BAIF has initiated groundwater user groups for irrigation) continue to be used on individualistic basis. With loosely defined or non-existent policies on groundwater management, trends of groundwater over-use are likely to set in over various time frames. The variability in time frames would be a result of:

1. How quickly farmers/well owners are ready to invest in means of increased water use (higher rating pumps to abstract large quantities of water over shorter periods – dictated also by erratic power supply? deeper wells, bore wells/ tube wells as a consequence of direct or indirect evidence of increased recharge), In Kelghar there is a potential for groundwater utilization but as the community is not that well earning the sources are still left untouched. The case in Kharachiya is just opposite to that in Kelghar; where the community to cope with droughts itself have gone down to the depth of about 400m to irrigate their fields and thus one can understand what will be the over extraction when there is a normal rainfall and the aquifer is saturated. In case of Govardhanpura after watershed development the presence of diesel pumps as against the traditional '*chadas*' has increased nearly by 90%.

2. Trends in cropping pattern change (as a response to ecosystem interventions). Farmers are likely to bring in intensive cash crops or short-term return crops that require larger volumes of water, (Karnataka and Rajasthan). In Karnataka the area under cash crop has gone up from 44.4ha to 173.4ha as against baseline to current situation. Communities in all the watersheds have started using improved seeds.

Drinking water: Top priority but minimum proportion

The problem of potential groundwater over-use leaves one with another significant issue, the effect of the long-term impacts of groundwater use on drinking water (which significantly has been a common point of intervention in all the projects studied under the BAIF programme). Groundwater resources service both drinking water needs and irrigation requirements. In context of the utilization trends developing as a consequence of increased recharge, the effect of increased groundwater use for irrigation on drinking water will be complex and at times, even detrimental. Information on aquifers tapped (by irrigation sources and drinking water sources) is either lacking in enough details or is of poor quality to come up with the precise interrelationship between aquifers (shallow *vs* deep). It is too premature to say as to when and to what extent irrigation requirements and usage will impact upon drinking water stocks (time frames to this effect would vary from place to place) but detailed studies on this count could provide some estimates in this regard.

Box 5

PROPORTION OF DRINKING WATER USE TO IRRIGATION USE / NET GROUNDWATER DISCHARGE

Based on figures collected during this study, the relatively small proportion of drinking water requirements (and usage) to net groundwater discharges can be made.

With 40 litres per capita per day being an ideal figure in current situations, the annual domestic water use for the watershed works out to 3650 m^3. Even in Kelghar-Ranjanpada watershed, where groundwater abstraction for irrigation is limited and may be estimated to be about 10000 m^3 annually. Base flow has been estimated 200000 m^3 annually (based on field observations). Kelghar-Ranjanpada watershed encompasses an area of 300 hectares. Hence we have :

Domestic water	**=**	**1.21 mm**
Irrigation use	**=**	**3.33 mm**
Base flow	**=**	**667 mm**

(Total groundwater discharge from the watershed is 671 mm)

Therefore, domestic water (of which drinking water, which constitutes only about one fourth portion) is a mere 0.2% of the total groundwater discharge.

Kelghar-Ranjanpada has the least groundwater abstraction from among all the watersheds studied. In other watersheds though, groundwater abstraction is likely to use up some proportion of the base flow component, hence the broad relationship between groundwater discharge and domestic use would remain fairly consistent with the estimate above.

Sanitation: Partial development

Improved sanitation in all the watershed programmes has included both direct and indirect interventions. Soak pits, gutters, street pavements, bathing platforms are all direct interventions where as families building their own latrines/bathrooms, animal waste recycling for compost and awareness about personal and surrounding cleanliness are few indirect interventions of the project towards sanitation. Sanitation in watershed development programmes is handled through individual modules that essentially include components (UNICEF-Water Mission: Water and Environmental Sanitation Section,) defined by:

- Handling of drinking water
- Personal hygiene
- Disposal of waste water
- Disposal of garbage and cattle dung
- Village sanitation
- Home sanitation and food hygiene

Although inputs are provided to many of the above through the watershed development programme, one problem that largely remains unaffected through these inputs is that of open defecation in the villages. It was clearly observed that most communities seem to be sensitive to various issues like disposal of wastewater from homes and handling of drinking water. However, there is still a general (large-scale) apathy towards common/private latrines and toilets. This is bound to have serious impacts, especially on the drinking water regime in the long run. The exact mechanics of these impacts would be variable considering the variation in aquifer geometry, modalities of use and future trends in groundwater resources development across the country.

Water supply mechanisms in all watersheds studied have evolved either as an entry point activity or as a later part of watershed development programmes. However, unless complimented by a more ‘complete’ sanitation input, watershed development programmes will remain incomplete on the “water supply and sanitation (WSS)” front. A major issue is likely to emerge as the long-term impacts of leaching from human waste to shallow groundwater (part of which is used as drinking water) slowly contaminating the shallow aquifers that are still the most commonly accessed sources of water supply in many watersheds.

6.2 Groundwater Resources and Watershed Development

All the study areas include groundwater as the basic source of water supply, although surface water forms a reasonably large secondary or supplementary source. In order to study the relationship between watershed development and the history of groundwater resources development in an area, a conceptual graph showing the relationship between a rising demand and the responses to meet the demand through increased supply are illustrated in **Figure 8.** The figure shows the trends of the demand and supply within a typical groundwater regime. The salient features of the regime are as follows:

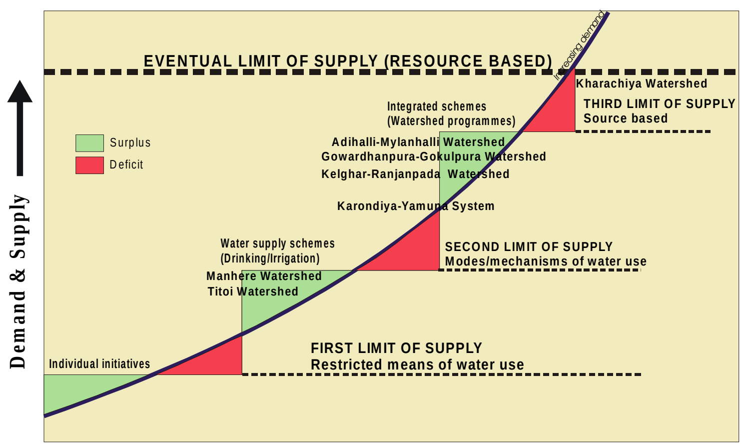

Figure 8: Representative Graph of Trends of Demand and Supply in Watershed

1. Demand rises progressively.
2. Supply initiatives are generally a consequence of the rising demand.
3. Increase in supply follows a step-wise pattern where the increase indicate the initiatives and the flat steps indicate limits of supply (temporary).
4. When demand reaches the limit of supply at any stage a new supply initiative emerges.
5. The eventual limit of supply (for an aquifer) would be its specific yield or simply the maximum amount of water it will yield at maximum rainfall and maximum recharge

to groundwater. Although largely hypothetical, this limit could actually be defined by the eventual limits imposed by natural and? Socio-economic systems on the supply potential.

The interplay between supply and demand trends creates alternate periods of deficit and surplus. One must bear in mind, however, that the deficits and surpluses initially are only temporary and are a result of the limitations in supply systems to cater to a growing demand. A careful study of the trends indicates how responses to cope with deficits have ranged from purely individual "technology" driven initiatives (like deepening of wells, higher rated & more? efficient pumping systems) to the more recent "resource development programmes". In between there are likely to be programmes taken up through some aid/loans (Government schemes), which again are purely supply based and simply address the growing demand.

Watershed programmes have a relatively recent history and would fall at the end of the hydrograph where the system is approaching the limits of supply. Although resource oriented, most watershed programmes are still supply oriented and therefore "source based" when they need to be water resources based (at least for groundwater resources). Unless special attention is given to groundwater management, many issues and conflicts are likely to reemerge as a consequence of various fallouts mentioned earlier, despite the integrated mechanism of watershed development initiatives.

Most of the areas studied are prone to vagaries of the monsoon. These vagaries can either be an erratic rainfall pattern or deficient rainfall years, both resulting in crop failure and droughts. It is therefore interesting to study the effects of a watershed development programme during a normal rainfall cycle as against a drought period. **Figure 9 (a)** shows how a watershed development programme during a normal rainfall year (cycle) can simply help in retrieving a deficit and converting it into a surplus through measures of increased recharge, conservation and integrated development of water resources.

The present study actually looked at the watershed development model during the phase illustrated in **Figure 9 (b)**. The drought period temporarily offsets the normal effects of a watershed development programme. It would be interesting to evaluate whether the drought period is only a temporary phase and watershed measures can revive the supply side to normalcy after a normal rainfall period or whether other trends emerge as a consequence of the drought itself and result in trends that would have been unlikely had the watershed development project come through a normal rainfall phase.

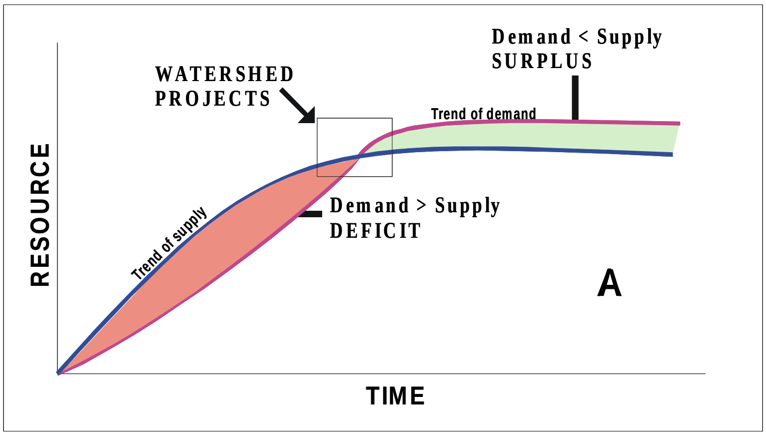

Figure 9A: Watershed Projects During Normal Rainfall Period

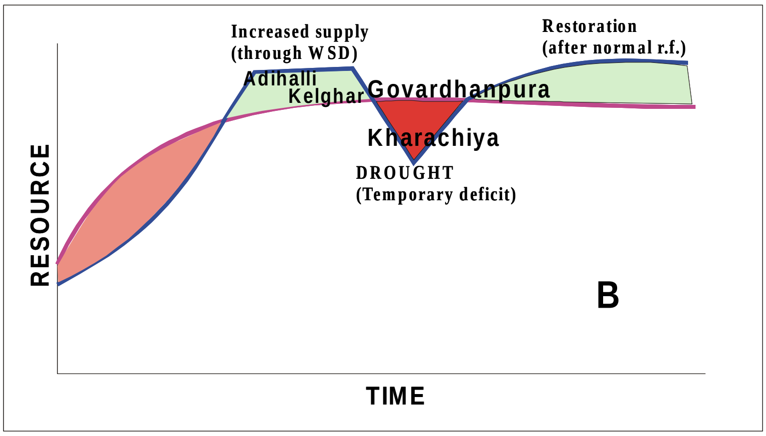

Figure 9B: Watershed Projects During Drought Period

6.3 Issues and Concerns

Watershed development focuses on the development of natural resources with the objective of improving livelihoods of communities. Some of the important factors in the improvement of community livelihoods are related to the supply and regularity of supply of certain natural resources like water. Similarly, maintaining improved livelihoods would depend upon the balance between the supply of natural resources and their demand by the local population. The watershed development model is a 'time-frame' intervention. Its efficacy depends as much upon the nature of implementation as its sustained carryover into the post watershed development phase. Hence the efficiency of a watershed development programme would tend to depend upon the stage at which watershed measures were implemented and the consequences of the programme as well as external effects, both natural and anthropogenic.

It would therefore be useful to examine the impacts of the watershed development model, especially the impacts on the water resources regime as well as on the other factors linked to water on the basis of three major aspects:

1) Efficiency
2) Equity
3) Sustainability

Although it would be early to draw conclusions regarding these factors purely on the basis of the present study that was a rather rapid appraisal of selected watersheds, some broad observations can be made on the basis of the issues of this study. These observations pertain to indicative changes that are part of each of the aspects given above. These trends indicating changes are listed below.

Efficiency

- *Increased water use through increased recharge.*
- *Improved efficiency of pumping in many areas due to shallow water levels in wells.*
- *Increased duration of water use during the annual cycle.*
- *Increase in irrigated cropping and resultant crop yields.*

Equity

- *Interventions regarding drinking water have helped the community at large and specific initiatives for underprivileged sections have reduced the inequities in drinking water access that existed before the watershed development programmes.*
- *Benefits (accruing out of increased recharge to groundwater) to 'endowed' water users (high yielding wells, wells in discharge areas, large land holders etc.) are likely to be equal or greater than benefits to relatively less endowed water users (low yielding wells, wells in recharge areas, small and marginal land holders etc.).*
- *In terms of 'resultant' benefits to peripheral communities/lands, downstream settlements benefit more than other peripheral settlements.*

Sustainability

- *Watershed development, without a follow-up natural resources management strategy, cannot resolve issues on sustainability, especially long-term sustainability of water resources.*
- *As long as demand side interventions are not a part of the follow-up programmes, especially in complex regimes such as the groundwater regimes described in many of the projects herein, watershed development will remain a largely temporary relief measure.*
- *Common property use through a joint management of resources is evolving in some of the cases studied. Water Users' Groups (WUGs), Joint Forestry Management (JFM) programmes, Village Watershed Committees (VWCs) may be considered examples of addressing the demand side problems of*

natural resources management. However, groundwater management will require more than the current efforts to address problems of sustainability.

6.4 Potential Conflicts

Conflicts over issues pertaining to water are common. Many watershed development programmes also include efforts towards resolving conflicts through improved efficiency and equity of water resources. As indicated in the above discussion, issues pertaining to efficiency of water use are directly addressed through many watershed programmes. Equity issues are either directly or tacitly resolved albeit only partially. Often inequities around water may actually result in the long run, as a consequence of watershed development activities. However, sustainability still remains a “grey” area since follow-up programmes to watershed development are still evolving, as concepts regarding demand and supply side management are fuzzy.

Post watershed development scenarios may witness various types of conflicts, not necessarily between individuals or communities but also between various components of the natural resources. Again, it would be premature to analyze conflicts resulting from trends developing through watershed development programmes or otherwise but it would be useful to list out some of these to gain a perspective regarding the potential areas of such conflicts.

Conflicts / Conflict areas

- Irrigation vs drinking water (Especially when both share the common source such as one aquifer, one tank, one well)
- Aquifer vs aquifer (when more than one aquifer is sharing the recharge to groundwater and when there are multiple users tapping both aquifers)
- Well owners (Dug well owners will compete by deepening wells, drilling horizontal or vertical bore holes in wells, installing higher rating pumping systems. Bore wells may compete with dug wells wherein deeper aquifers draw a part of the recharge to the shallow aquifer)
- Upstream communities vs downstream communities within a watershed (In areas where discharges downstream have increased in response to watershed measures upstream and where net benefits reaped are more by downstream communities)

7. FINDINGS AND RECOMMENDATIONS

Findings of the study are based on the representative watersheds selected from different working areas of BAIF. These represent the respective broader regions of the rural India. Below are the salient findings of the research study:

1) Despite the location of study areas in different topographic, geo-hydrological and climatic situations, all the rural areas had problem of water scarcity in summer. The scarcity problems were mainly due to:

- Natural causes like adverse topography, unfavorable geohydrology or common aquifer for both drinking water sources and irrigation sources.
- Anthropogenic causes such as overexploitation of ground water, absence of recharge measures, very limited reach or no government support for WSS, emphasis of government on relief measures than long term solutions (e.g. tanker water supply).
- Failure of government water supply schemes due to absence or very poorly established management and maintenance of water supply sources/ schemes in villages resulting into wastage of investment, dependency of locals on government authorities and lack feeling of ownership on the schemes provided by government.
- Water quality tests at baseline show contamination in most of the sources. Awareness on drinking potable water had been missing in most of the rural villages.

2) Sanitation has been the low priority issue and no linkage has been considered while planning for the resource development for drinking water. There had been no initiatives either from locals or from government for improving the sanitation in the villages. Practice of open defecation prevails in all the watersheds studied. It is either due to water scarcity or reluctance of villagers for closed latrines. If continues, in long term this practice may create serious contamination to shallow as well deep aquifers as the recharge measures under watershed projects help to take the contaminated water below the surface.

3) All the watershed projects implemented by BAIF tried to address the drinking water problem on priority. Even though some programmes had no funding, BAIF organized funds from other sources to ensure adequate water supply to watershed population. The investment on creation of water resources ranges from 1-5% of total project expenses. It brings out important observation that some watershed programmes provide support only for soil and water conservation leaving drinking water issue untouched. Such watershed project can only augment some existing sources but cannot solve the drinking water problem completely.

4) Availability of drinking water throughout the year has been ensured in all the watersheds. This was possible only due to the combined effect of development of drinking water supply sources within the village and hamlet and improvement of ground

water table (0.5 – 4m) or the yield of the sources due to water conservation measures. This has been also validated with the prevalence of scarcity situation during the survey in the peripheral villages.

5) All the water supply sources (mainly Hand Pumps and village level piped water supply systems) developed through the project were found in working condition (as against only 40 % sources were functional at baseline). This was possible due to the presence of local Water User Groups developed by project, local contribution for source development and development of local skills for repair and maintenance.

6) Due to improved availability of irrigation water, agriculture practices are drastically being changed. Cropping intensity has increased between the range of 100 to 130 % and the area under irrigation has increased by 82%. This has resulted into increased crop production up to double than the earlier. More sustainable agricultural practices are also seen (e.g. tree based farming, horticulture).

7) In all the projects, Water User Groups (WUG) and Village Watershed Committees (VWC) have been developed for management, maintenance and sharing the benefits of resources. However, their understanding of responsibility and capacity to manage (mainly irrigation sources) appears to be very limited. Thrust of watershed projects has been more on development of sources and less on proper utilization.

8) There is no state legislation (being enforced) for regulating water use for irrigation. There is no control on use of water and it is still a "free for all" source.

9) The study reveals that at least one downstream village has been benefited due to watershed development mainly due to improved ground water. A detailed study will be required to find out precise extent of the effects on downstream.

10) Comparison between two drought affected areas (Rajkot, Gujarat and Govardhanpura, Rajasthan) reveals that Govardhanpura had sufficient water for drinking during the summer of drought year while Rajkot area had to face scarcity problem, in fact, villagers received tanker-water during the summer. This has happened due to the fact that Govardhanpura project is more integrated and includes comprehensive activities for watershed development. On the other hand the project under NWDPRA/DPAP had focused only on water harvesting structures in drainage lines due to the limitation of funds. Secondly, although there were successive droughts in Rajkot area, the water withdrawal for irrigation remained same during these years. *This indicates that drought proofing is possible only through the comprehensive watershed development and judicious utilization of available resource and not only through water harvesting structures like check dams.* (See **Annexure 2** for objectives and activities under different projects)

Study revealed some tangible as well as intangible trends of development. Such trends imply quite obvious learnings. Based on learnings below are few recommendations:

- Water supply, sanitation and watershed development should be linked together to solve the problems of drinking water supply, sanitation and irrigation.

- Controlled utilization of water for irrigation needs to be incorporated in prospects to avoid potential conflicts in the areas such as irrigation vs. drinking water, aquifer vs. aquifer or among well owners.

- The responsible local management of sources can certainly ensure the balance of ground water system. So it is very important to develop strong local user groups who can regulate the water utilization. These groups should actually initiate the water management during project implementation. Responsibilities of the group should be:

  - ✓ *Look after maintenance of sources, collection of water use charges.*
  - ✓ *Ensure equitable sharing of water among the farmers in command areas (there is need to redefine the command area as well. The area, which is on upstream side, should also get benefit of surface as well as ground water reserve).*
  - ✓ *Assess the stock and utilize the portion of water quantity for irrigation during rabi season leaving sufficient stock for summer. It will also require appropriate crop planning during every season.*
  - ✓ *Mechanism to solve conflicts.*

- Drought proofing is possible only through a comprehensive natural resource programme. For such a holistic development the funds required should be at least about Rs.7500 to 10,000/- per ha in drought prone areas.

- Unless the balanced water utilization is ensured, any positive impacts of watershed project will be short term. So the watershed development plan or design itself should have sustainable water utilization as mainstream project objective.

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ANNEXURES

Annexure 1: Summary of Physical Characteristics in Seven Watersheds

	Annual Rainfall	Temperature	Soil	Geology	Hydrogeology	Water resources
Gordhanpura-Gokulpura watershed	300 to 400 mm	Temp range Min 5-10^{o} C Max 35-45^{0}C	Sandy to silty	Metamorphic rocks, Phyllites	Unconfined aquifer extends to a depth of 30 m.	Mainly groundwater, tapped by 42 dug wells.
Adihali-Mylanhalli watershed	About 650 mm	Temp range Min10 – 20^{0} C Max 35 –40^{o}C	Clayey, mostly pale yellow to gray	Metamorphic rocks, Gneisses and Pegmatites	Two aquifer system, unconfined aquifer, Storage and transmissivity control by vertical and horizontal fracture	Mainly ground water, tapped by 24 dug wells and 17 bore wells with hand pumps
Karondiya-Sengur-Yamuna confluence System	600 to 800 mm	Temp range Min 5-10^{o} C Max 35-45^{0}C	Soil classified as “loam alluvial”. Loamy with high proportion of silty material.	Part of larger Gangetic basin. Predominatly constitute silty to clayey sediments.	Two aquifer system, Unconfined aquifer, shallow aquifer at 10-15 m depth and deeper at 60-70 m depth bgl.	Mainly ground water, tapped by 11 dug wells and 12 tube wells with hand pumps
Kelghar-Ranjanpada Watershed	1700 to 2500 mm	Temp range Min 5-10^{o} C Max 30-35^{o} C	Classified as “anthromorphic” as per soil classification.	Volcanic rocks, Giant Phenocryst Basalt	Unconfined aquifer system, Giant phenocryst basalt constitutes aquifer at a depth of 10 to 15 m bgl.	Mainly ground water, tapped by 5 dug wells.
Titoi Watershed	1000 to 1200 mm	Temp range Min 10-15^{o} C Max 35-40^{o} C	Red sandy/fragmentary soil	Volcanic rocks, vesicular amygdaloidal basalt and compact basalt	Two aquifer system, unconfined aquifer, shallow aquifer at 10-15 m depth and deeper at 30 - 35 m depth bgl.	Mainly ground water , tapped by 6 dug wells and 15 hand pumps on bore wells
Manhere Water shed	About 1500 mm	Temp range Min 5 –10$^{o\ C}$ Max 35–40^{o} C	“Sandy loams” and “silty loams”.	Volcanic rocks, compact basalt	Shallow aquifer system, unconfined aquifer	Mainly ground water, tapped by 46 dug wells
Rajkot and Jasdan Watershed	350mm	Temp range Min 5-10^{o} C Max 35-45^{0}C	Black cotton soil	Volcanic rocks, Basalt	Multilayered aquifer system.	Mainly ground water, tapped by 9 dug wells and 17 hand pumps on bore wells

Annexure 2: Project Objectives and Activities

Programme sponsor	Projects	Project Objectives / Goal	Activities				
			Entry	**Implementation**	**Withdrawal / Maturity**	**Sustenance**	**Remarks**
India Canada Environmental Facility (Project period including extension is 6.5 years. Study carried out in fifth year)	Govardhan pura – Gokulpura	Objectives 1) Identify and develop water resources. 2) Promote relevant technologies to enhance the living condition of the rural people especially water and energy availability with aimed at reducing physical drudgery of women in rural area. 3) Build capacity in the rural community, BAIF and other NGO's to manage environment conservation programme with the implementation of sustainable interventions.	No Activity identified in project proposal. Exposure visits of selected farmers help to win the trust of people.	**AT:** SP with CCT, AF with CCT, FB **DLT:** GP, SB, GS, ENB, CD, UGB, **EC:** VC, AC, HESD **PP:** VWC, SHG, NC, CS	Project Activities completed. Project outcome is better than expected. Common maintenance funds raised. SHGs involved in micro enterprise. Silvipasture committee developed but still to function independently.	Will depend on how smoothly the VWC takes over the project maintenance. How effectively VWC uses maintenance funds. Relationship between silvipasture committee and grampanchayat. Cohesiveness of VWCs Effective control over water uses. Project has shown high replicability value.	Needs lots of inputs build the capacity of local organisation.

	Karondia - Sengur – Yamuna Confluence System			**AT:** FB, AF, GIS, **DLT:** TCB, GP, CD **EC: VC, HESD** **DWS:** HP**,** CL **PP:** VWC, SHG	Most of the project activities have been completed expect GIS. Common maintenance funds raised. Absence of cohesiveness in VWCs. User groups developed for GIS.	Unless the project through Group Irrigation Schemes directly benefits the farmers it will be difficult to bring people together. Unless people at least the user group act unitedly project activity maintenance seems to be difficult at this juncture.	Needs an assortment of efforts to strengthen the local people's organizations.
	Adihalli – Mylanhalli			**AT:** AF with CCT, HC, FB, FP **DLT:** GP, GS, ENB, CD **EC:** VC, NC, HESD **DWS:** CL **PP:** VWC, SHG, NC	Project activities completed. Project outcome better than expected. VWCs are in initial phase of take over the management. Common maintenance funds raised. SHGs involved in micro enterprise.	Strong people's organizations exist in the project area. The awareness about the maintenance of activities is very good. The benefits of the project has been reached to almost all the sections of the society. Hence the project activities and out comes will be sustainable. The trend shows that there will be continuous upgradation of project management by people. Replicable model being developed.	

Programme Sponsor	Projects	Project Objectives/Goals	Activities				
			Entry	**Implementation**	**Withdrawal/Maturity**	**Sustenance**	**Remarks**
Commission of European Communities (project period 8 years)	Kelghar – Ranjanpada (Study carried out 3rd year)	1) To achieve development for small and marginal farmers and landless in selected project areas. 2) Implementation of environmentally beneficial income generating activities for men and women. 3) Formation of producers group, cooperatives and women self help groups. 4) Provision of adequate extension and training services and facilities for men and women. 5) Provision of adequate health programme and facilities. 6) Increased participation of women in development process.	Conduct child health camp, Nursery raising, Exposure visits.	**AT:** AF With CCT HC **DLT:** GP, SB, GS, CD, **EC:** VC **DWS:** DW, CL **PP:** VWC, SHG	Project activities yet to be competed. VWCs, SHGs, are developed. Horticulture and afforestation survival is good.	Village watershed committee developed. Individuals also aware on the use of natural resources.	The project has picked up very fast, the individuals have understood the needs of natural resources management.
	Titoi (Study carried out in third year)		Hand pump repair, Repair of the roof of school buildings, Cattle camp	**AT:** FB **DLT:** GP, SB, GS, CD, FP **EC:** VC, AC **DWS:** HP	Land treatment activity is over in the area.	Janan utthan program incorporated to improve the livelihood of the people, which will help to achieving the sustenance.	The village people will build a strong organization. Presently the people, maintaining the drinking water scheme developed with the help of Forest department.

Programme Sponsor	Projects	Project Objectives/Goals	Activities				
			Entry	**Implementation**	**Withdrawal**	**Sustenance**	**Remarks**
NWDPRA (DPAP) (Project period is 5 years. Study carried out after completion of project)	Kharachiya	1) Water resource development. 2) Soil and water conservation. 3) Agricultural/horticultural resource development. 4) Livestock and fodder resource development.	Drinking water source development, ground level water tank.	**AT:** FB, AF, HC **DLT:** GP, SB, GS, CD **DWS:** HP **PP:** VWC, SHG,	Project activities completed. Project has been handed over to VWCs.	The structures developed through the program. The VWCs in the villages are working well and look after the maintenance of the structures	It is difficult to comment on sustenance, due to the continuous drought for last two years.
KFW (NABARD) (Project period including extension is 6 years. Study carried out in 8th year)	Manhere	1) To undertake sustainable development of natural resources through restoration of ecological balance in the watershed and to improve the quality of life of the rural community. 2) Conservation of soil and water. 3) Avoiding gully formation and putting checks at suitable intervals to control soil erosion and recharge groundwater. 4) Harvesting rain water and using the harvested water for increase in agricultural production. 5) Improving land productivity. Increased cropping intensity through multiple cropping and intercropping. 6) Maximizing the overall income of the local community through development of natural resources.	Earlier, BAIF was working in the area through its wadi project so that was advantage, due to which BAIF didn't require to take up any entry point activity.	**AT:** SP with CCT AF with CCT, FB, **DLT:** GP, SB, GS, CD, ENB, UGB **DWS:** CL EC: **VC, AC, HESD** **PP:** VWC, SHG,	Project activities completed. Project out come is better than expected. Common maintenance funds raised. Project has been handed to VWCs	Project now with VWCs. No much clarity to VWCs to take the development further. Project activities are maintained but overall progress appear to be static.	

Full Forms of the Activities Carried out in Different Projects

AT – Area Treatment
SP – Silvipasture
CCT – Continuous Contour Trenching
AF – Afforestation
FB – Field Bunding
FP – Farm Pond

DLT – Drainage line Treatment
GP – Gully Plugs
SB – Stone Bunds
ENB - Earthen Nala Bund
CD – Check dam
UGB – Underground bund

EC – Energy Conservation & Recycling
VC – Vermicomposting
NC – Nadep Composting
AC – Accelerated composting
HESD – Household Energy Saving Devices (Promotion of pressure cookers, Improved cook stoves, etc)

DWS – Drinking water supply
HP – Hand Pump installation
DW – Dug well
CL – Chlorination of drinking water supply

PP- People's participation
VWC – Village working committee
SHG – Self Help Group
NC – Nature Club
CS – Charagaha samittee
GIS – Group irrigation scheme

Annexure 3: Outcomes of Watershed Development

Annexure 3.1: Govardhanpura - Gokulpura

Activity/Output	**Outcomes**			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic factors**
rinking water Activities- • Installation of hand pumps (13 hand pumps). • Chlorinating of wells Outputs • Distance reduced to fetch water from 500m to 50m. • Water availability increased. • Improvement in water quality.	• Availability of drinking water throughout the year and even during summer of the drought year.	Hand pumps provided for drinking water also mean better access to water for keeping better sanitary conditions in the villages. • *Availability of water for bathing and toilet purposes*	• Water use now is systematic since drinking water, water for livestock and irrigation water seldom overlap with respect to sources and access. • The Community going for cash crops like Sugarcane and improved variety of rice may in the near future harm the ground water system, which is the only drinking water source.	• Time and efforts (especially of women) for fetching drinking water has reduced due to reliable sources and better access. • Hand pumps provided in all the hamlets including a relatively more backward community insured equitable share of water resource for drinking.
Sanitation Activities • Awareness on personal health & hygiene • Trainings given in new methods of organic fertilizers. Waste reusing • Providing soak pits Outputs • Improved personal health, hygiene and cleanliness • Hygienic conditions around water sources	• Absence of latrine/toilet facilities imply open defecation on a large scale; likely to affect the irrigation sources more than the sources in village (some of these irrigation wells are used to supplement drinking water needs). • Recent water quality test show that the bacterial count still exist may be it is due to a) Fecal contamination b) Bathing near sources	• No development in defecation are likely to harm the other parts of sanitation, these are the personal health and hygiene and the village cleanliness. • Environment clubs of school children's helped improved overall cleanliness in village.	• Increased uses of organic fertilizers have reduced the use of chemical fertilizers, which in the long run had a threat to reduce the fertility of the soils. • Vermicompost (105 families) and accelerated composting practices (120 families) have provided significant inputs to agriculture, at the same time ensuring some system of waste re-use. • The tradition of open defecation may affect the ecosystem by contaminating the water resource and polluting the environment • Improved soil fertility from organic fertilizers	• Awareness on health and hygiene has improved on personal hygiene, household sanitation and food hygiene. • Enhanced relationship of community with nature. • Due to pre conditions of locals contribution for hand pump and development of user group internal dynamics created in the community.

Annex 3.1 (continued)

Activity/Output	**Outcomes**			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic factors**
Ecosystem Activities • Water & soil conservation structures • Afforestation, Silvipasture, Horticulture, Improved agriculture (700 ha) • Cattle development Outputs • Increased vegetation • Reduction in soil erosion • Increase period of water availability (12 months). • Improved livestock quality (292 families with at least 2 cross breeds)	• Conservation measures improved perenniality and sustainability of WS sources • On the other hand, trends in irrigation patterns and changes therein as a consequence of watershed development resulted an increased water use from the groundwater system. In the absence of any limit to water use (direct/indirect), any degree of over-abstraction (that might result in the future as an order of increase in number of wells, deepened wells, higher rating pumps) is likely to affect drinking water sources (since both tap the same aquifer).	• Increase in period base flow and water availability in the surface water bodies has improved the access for open defecation.	• Increase in agricultural production from 4649kg/ha to 12113kg/ha. • Increase in area of green cover (45 ha in silvipasture). • Improved biodiversity • Improved carrying capacity of ecosystem. • The trend of increased groundwater abstraction may lead to over abstraction and hence imbalance in ecosystem.	Improved economic status of villagers due to increased productivity of land and livestock (including that of marginal landholders).
Socio-economic factors Activities • Awareness generation among community on watershed activities and environment. • Trainings for participants in various activities. • Formation of VWC • Formation of SHG • Development of water user group. Outputs • Participation from the community in the watershed activities. • Community becoming aware to protect environment. • Improved skills of community in conservation measures.	• Improved awareness towards conservation of natural resources as well as certain improvement in the lifestyle of the population has created a greater sensitivity towards drinking water. This will ensure protection and maintenance of drinking water infrastructure. • User groups maintaining the water sources. However, limitations in realizing the protection of the aquifer as a step towards protecting drinking water might pose problems in the future (require more strong groups for sustainable water use).	• Better understanding and skills at community and local institutional levels will help continue the better sanitary condition in village.	• Improved awareness of agriculture, natural resources management, etc, through the watershed programme has brought about improved irrigation and agricultural management practices. • Improved capacity of locals through people institutions resulted in a) Degraded resource brought under productive use (silvipasture) b) Resource management by locals. c) Better chance of sustainable resource development and use.	• Better livelihood support to community. • Improved access to resources to all sections of community. • SHGs help women participate in development. *Awareness generated through the program on various aspects has brought about a change in the living of the community.* *Increase in income from agriculture and other activities can bring about a rapid change in the economic status of the village This may create discrimination among the community*

Annexure 3.2: Adihalli-Mylanhalli Watershed

Activity/Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Drinking water Activities • Regular Chlorination of wells • Installation of two bore wells-hand pumps • Re-establishment of govt. water supply system Outputs • Increase in water levels • Reduced time and distance to fetch water (from 500m to 200m). • Better water quality	• Improved quality and quantity.	• The increase in the quantity of water in the project area has meant an opportunity for improved sanitation.	• Drinking water problems for livestock have been solved through the increase in surface water quantity. • Increased in level of the groundwater has been a step towards the balance of the ecosystem.	• Less time and efforts required extracting drinking water for the women as the sources have become perennial and the efforts for accessing water reduced.
Sanitation Activities • Awareness generation activities on personal health & hygiene • Provision of soak pits for drainage pit. • Organic waster recycling. Outputs • Improved personal health & hygiene. • Better utilization of the cattle & agro wastes.	• The participants to some extent have an awareness towards cleanliness but the tradition of open defecation can in the near future cause contamination to the groundwater, especially through the fracture zones.	• The open drainages in villages and the process of open defecation are likely to enhance the chances of health problems (if the present trend continues). • Increased acceptance of personal latrines.	• All the waste of kitchen, agriculture, cattle is recycled by most of participants through vermi and NADEP composting leading to better use of waste and improved crop production, reduced chemical fertilizers. (409 units of vermicomposting of which 28435 kgs of compost is produced & 270 families are involved in NADEP and have produced 155 tones of compost, 311 families involved in kitchen gardening).	• The community is very sensitive of home cleanliness and surroundings. The training and awareness through the project has improved the personal health and hygiene. There is increase in number of latrines (21) the project intervention.

Annex 3.2 (continued)

Activity/Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Ecosystem Activities Afforestation and silvipasture (118 ha) • Farm pond based decentralized water management programme. • Water & soil conservation structures. • Cattle development Outputs • Improved livestock breeds (316 improved breeds). • Increase in vegetation (349 ha in horticulture & 118 ha under Afforestation) • Increase in area of surface water bodies from 0.028091sqkm to 0.280160 sqkm. • Decentralised surface water availability.	• The measures carried out for the natural resources conservation has increased the water quantity considerably increasing the total volume of ground water including drinking water.	• The conservation measure has ensured water availability through out the year. This has offered better water availability for sanitation in project villages.	• The water & soil conservation structures and the vegetation in the area has improved microenvironment of the area. Water in the surface bodies present for the whole year is inviting the various species of birds in the area. The Ecopond is also a place for attracting tourists in the area. This all has resulted in the great benefit to the ecosystem. • Overall improvement in biodiversity of the area.	• Improved crop production and diverse cropping pattern providing better livelihood options and better QOL.
Socio-economic Activities • Formation of VWC • Formation of SHG • Formation of Stree Shakti Kendra • Create awareness among the children and the elders on environmental aspects Outputs • Women coming together and investing the money in the groups. • VWC coming together for their monthly meeting to discuss about the further plans. • Stree Shakti Kendra manufacturing different products to be sold in the market to increase their income. • School children involved in conservation activities and cleanliness in village.	• People are very sensitive towards drinking water source protection. The awareness towards the natural resources has brought a great sensitiveness towards ground water the main drinking water source.	• Increase in the number of latrines has contributed to the improved village sanitation. Cleanliness at household and personal levels have improved. • Better drainage in the village.	• The skills, knowledge and conscious efforts of community and PI resulted in protection maintenance and improvement in ecosystem. The trend show that the ecosystem will enrich to a great extent in near future.	• Improved livelihood in the villages. • Increase income has helped in improving the assets of the families. • Siddhi samadhi yoga has changed the attitude of the villagers towards the different aspects. • People are much more attached in various community level activities and environmental conservation. • Increased income of women groups and status of women in community.

Annexure 3.3: Karaondia-Sengur-Jamuna System

Activities/ Outputs	**Outcomes**			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic factors**
Drinking water Activities • Installation of hand pump on dug well and bore wells (4 in number). • Regular chlorination of drinking water sources. Outputs • Reduced distance to fetch water from 200m to 100m. • Increased water availability	• Increased number of sources has reduced the stress on few sources available.	• Increased water availability in the first two three years created in-hygienic conditions around sources and in village. Later villages improved the situation.	• Increased number of sources and the increased supply has overcome over the demand phase. • Improved quality of groundwater.	• The source reliability and increase in number of drinking water sources has improved the access to ground water. The time required to fetch water has reduced the drudgery of women. • Villagers are now getting pure and clean water as the quality of water has improved by regular chlorination.
Sanitation Activities • Awareness on personal health & hygiene. • Provision of sock pits for wastewater disposal. • Kitchen garden on household wastewater. • Pavements to internal village roads. • Awareness on Immunization camps. • Promotion of organic composting by agro waste recycling. Outputs • Increase awareness on personal hygiene. Improved health status of children, cleanliness in village	• No latrine/toilet facilities, practice of open defecation. • Improved quality of drinking water.	• Improved sanitary condition in village.	• Increased awareness on use of organic manure will positively affect the soil health status. 35 families doing vermicomposting.	• Improved personal hygiene, home sanitation and food hygiene. • Improved consumption of vegetables, better nutritional consumption *(availability from kitchen/vegetable gardens).*

Annex 3.3 (continued)

Activities/ Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic factors**
Ecosystem Activities • Water & soil conservation structures. • Horticulture and forestry species • Cattle development • Group irrigation scheme • Improved agriculture Outputs • Improved groundwater availability • Improvement of ravine land productivity. • Increased area under irrigation from 33 ha to 77 ha. • Reduction in soil erosion	• Impacts of watershed development (recharge) likely to be small in proportion to the water resources base. increase in groundwater stock for drinking water is marginal. *Trends in increased irrigation use of water as a response to developed potential might induce effects on the drinking water regime, although the time frame to reach this stage might be long.*	The major rivers flowing have always been the source for the water use for defecation and bathing. Only during the rainy season the water from the hand pumps is used. The marginal improvement in the sources has helped marginally in the access for defecation.	• Increased in agricultural production is now more than 50% over the baseline. • Ravine wasteland brought under agriculture. • Marginal increased in green cover.	• Increase in crop yield has certainly made a change in the livelihood of the participants. • The trend of impact of activities likely to create remarkable improvement in livelihood of the people.
Socio-economic factors Activities • Village meetings • Formation of VWC • Formation of SHG • Formation of Water User Groups. • Introduction of Balwadis. Outputs • Couple of users groups actually took charge of water management. • Women started attending common meetings in villages. • The SHG are saving money and giving it on loan to the participants who are in need.	• Drinking water sources are kept clean and tidy • Limitations in realizing the protection of the aquifer as a step towards protecting drinking water might pose problems in the future. *Greater public sensitivity towards the protection of the drinking water sources indicates the betterment of the sources.*	• The improvement in health and hygiene on personal and community grounds has improved the way of living of the community. Although toilet and latrine facilities are largely lacking, sanitation incentives in household, personal and community fronts have meant a certain improvement in the health conditions in villages. • Pavement of the village roads by Shramadan has improved the access especially in the rainy season. • The well user groups formed will restrict the over exploitation of the ground water source which inturn will keep the ecosystem balance.	• The improvement in the ecosystem has resulted through participation from the community. • Water User groups will check over abstraction of ground water. • VWC/WUG together expected to manage the resources sustainably to protect ecosystem balance. • Household levels system improved considerably. • The inadequate capacity of PI may lead to imbalance of groundwater system.	• Participation of the villagers in the various programs in the watershed has brought them together and formed a better community. The formation of user groups for the extraction of groundwater clearly indicates the change in attitude of the villagers. • Better access to formal education to children • Improved skills and knowledge community for NRM.

Annexure 3.4: Kelghar-Ranjanpada Watershed

Activity/Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Drinking water Activities • Well deepening (2) • New dug wells (1) Outputs • Water availability has improved • Improved water quality		• The perenniality of the drinking water source has made water available for the sanitation purpose also. The drinking water sources are used as a supplementary source during the summer season.	• Fulfillment of drinking water requirement in the project villages has reduced the danger on ecosystem. • Chances of new bore well reduced and there will not be further deepening of open wells.	• Perennial sources have now reduced the drudgery on the women folks for fetching water during summer.
Sanitation Activities • Awareness on personal health and hygiene • Construction of bathrooms (2) Outputs • Improved personal health & hygiene • Improved nutritional diet especially for women & children.	• There is no facility of latrines/toilets in the area. People usually go near the streams for defecation and the water sources are also present in the streambed. Thus there is a greater chance of contamination to the ground water.	• No development on sanitation front have a fear of health related problems in the area. No proper place for defecation and waste disposal is causing problems from the flies & mosquitoes, which carry a lot of infections along with them.	• There is no much use of the wastes in the area. People are not going for the new methods of organic composting and follow only the traditional ones. This has not made a significant change in the agricultural yield in the watershed.	• The project has made the participants aware about the personal and village cleanliness. This has improved their thinking for personal and home hygiene. As far as defecation is concerned they do not want to have common latrines and prefer the tradition of going in open.

Annex 3.4 (continued)

Activity/Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Ecosystem Activities • Water & soil conservation structures • Horticulture & forestry. • Cattle development Outputs • Increase in vegetation (45 ha of fruit plants, 193 ha of forestry plants) • Increase in agricultural area & yield (10% increase in crop area & 112% increase in crop intensity). • Improved water availability	• The soil and water conservation measures have helped in the recharge to the ground water. This has improved the perenniality & sustainability of drinking water in the area	• The increase in no of days of stream flow and increase in base flow has improved access for defecation.	• The increase in green cover has again brought a change in the natural system of the area which was almost barren before. • Improved carrying capacity of ecosystem	• The concept of earning returns from the horticulture plants has motivated a lot to the community. • Improved resource base has created better option of livelihood of local tribals.
Socio-economic Activities • Formation of Manav Vikas Sangh. • Community health activities. • Formation of SHG • Opening of bank accounts with a participant from each group. Outputs • VWC coming forward to work with the watershed team.	• Increased demand for the development of drinking water sources from the community has improved in the availability and access (to some extent) of drinking water.	• The awareness on personal hygiene, health and home cleanliness has been taken up and improved the health condition in the area. The participants take no measures with regards to open defecation.	• The horticulture species have started fruiting and about to become a source of income to the families. They are now getting a better income from the crops. • Janautthan approach coupled with watershed development will create a sustainable base for eco-restoration.	• The work done has improved the livelihood of the participants and has brought a change in the income which ultimately will take them above poverty line from below poverty line.

Annexure 3.5: Titoi Watershed

Activity/Outputs	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Drinking water Activities • Installation of a hand pump near the temple Output • Improved access for few families who are staying near temple. (300m to 100m)		• The presence of stand post with taps for drinking water and the small tanks made for storing the water from the piped water supply scheme has improved in the access for water required for the Sanitation.	• The main supply for drinking water is from only one bore well source and the other handpumps and dug wells are used supplementary. This has reduced stress on the ground water.	• Drinking water first priority of locals. The improvement in the sources and creation of a new source have relived villagers from drinking water problem.
Sanitation Activities • No activity on sanitational fronts.	• The open defecation at the periphery of the village. Drinking water sources are protected but there being no latrine facility has a fair chance of contamination to the groundwater.	• Improper drainage system, no latrines/toilets in turn can cause problem to personal health & hygiene.	• Use of cattle dung in fields as organic manure has been a tradition. There has been no improvement in the ecosystem with regards the sanitation. The waste re use is very limited in the fields.	• Sanitation with respect to health and hygiene is only looked upon marginally.

Annex 3.5 (continued)

Activity/Outputs	**Outcomes**			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Ecosystem Activities • Area treatment for soil & water conservation Outputs • Increase in water level in the ground water. • Marginal increase in greenness.	• The water levels in the drinking water sources have improved. • The structures constructed on the drainage lines and in the farms will contribute to the recharge to the ground water.		• The provision of horticulture & forestry plants will in the near future increase in the green cover in the area. Community forest protected by people. (327 horticulture plants)	• The water and soil conservation measures have improved the ground water recharge and the soil fertility. This has improved in the income of the farmers to some extent. The livestock has always been a source of income. **?**
Socio-economic Activities • Formation of VWC	• The villagers have been on strike for the provision of drinking water from the Forest department. This itself indicates the people's sensitiveness towards drinking water.	• The villagers have an understanding towards personal health and hygiene but with village sanitation there is no awareness and thus no much improvement in the sanitation status.	• The villagers have been very active as seen that they have got the drinking water source from the forest department by going on to their offices daily. They have also been ahead in making the watershed structures for water & soil conservation.	• The fight of the villagers for the drinking water supply is a indicator towards the community unity. • The joint management of the villagers with the forestry department has also been a significant issue in terms of community participation. • The community has always been well behaving.

Annex 3.6: Manhere Watershed

Activity/Outputs	**Outcomes**			
	Drinking Water	**Sanitation**	**Ecosystem**	**Socio-economy**
Drinking Water Activities • Development of springs (2) • Roof top water harvesting • Well deepening *(not as a part of watershed development activities)* Outputs • Quality water available • Increase in water availability.	• The installation of the overhead tank and the piped water supply has in turn reduced the pressure on the only dug wells within the village *(Government intervention).*	• Improved household cleanliness due to water availability.	• The spring development and water availability for year round has reduced the pressure on the limited sources available in the past.	• Scarcity problems of drinking water, which now after the development of the sources are reduced considerably. • Reduced drudgery of women in fetching drinking water. • Dependence on Government (Z.P.) water supply tankers in summer has eliminated.
Sanitation Activities Outputs • Improved health • Improved nutritional diet.	• Improper sanitation within the village and open defecation are harmful to the drinking water sources.	• No improvement on sanitation has caused a problem of village cleanliness. No proper roads cause problems for walking during the rainy season. Children sitting for defecation in the village vicinity in turn give way for the flies, which is harmful.	• The waste recycling of cow dung is carried out in the fields to improve the agricultural production. The places for open defecation are mostly near the streams and in the fields. This in future may contaminate the resources, which in turn will imbalance the ecosystem.	• There is awareness on the participants on family health and hygiene, this in turn has improved the health of people.

Annex.6(continued)

Activity/Outputs	Outcomes			
	Drinking Water	**Sanitation**	**Ecosystem**	**Socio-economy**
Ecosystem Activities • Water & Soil conservation structures • Horticulture and forestry plantation Output • Increase ground water recharge • Increased green cover area • Increase surface water flow in streams. • Increased spring water yields.	• The measures carried out have benefited the ground water, this in turn has increased the water level in the wells and also the drinking water availability.	• Improved access for defecation by the increase in base flow of the nalas. • Water availability has improved upon the personal cleanliness measures within the area.	• The forest cover in the area was very scattered as the villagers sometimes use to cut it for fuel wood and burning in the fields (Rab). • Forest cover has been increased. (1,20,802 plants) • Soil loss and runoff reduced. • Agricultural production gone up. (18.88% increase) • Improved livestock quality due to fodder availability. (75 cross bred)	• The fruiting of horticulture plants has increased in the income source. • The increased agricultural yield has also contributed towards income increment. • The presence of the cross breed cows and buffaloes have in turn increased the milk yield, which now is sold in the market.
Socio-economic Activities • Formation of VWC • Formation of SHG • Income generation trainings to the participants Output • Improved skill in various technical aspects. • Knowledge in different small scale income activities increased.	• Improved knowledge towards the protection of natural resources has created a great attention towards drinking water by the community. • *There is still need to make proper mechanism for source maintenance.*		• All the participants are aware of better cropping pattern and benefits of horticulture plants. They are so much aware that now to water a plant they get water from a distance of about a km if the source is not near to the individuals wadi. • This has helped improving resource base in the area.	• The improved skill have resulted in increased labour wages and increased income. This has helped in increasing the assets within the watershed. • The increase in income source of few people in the community, may in the near future have conflicts with respect to money matters. (*there needs to be proper planning for the use of maintenance funds created by project).*

Annex 3.7: Kharachiya (Rajkot) and Kharachiya Jam (Jasdan) Watersheds

Activity/Output	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Drinking water Activity • Entry point activity of installation of borewell, overhead tank and stand posts. Outputs • Reduced distance to fetch drinking water. • Improved access and distribution system.	• Due to the droughts for the last 3 years ground water level has gone down. • Drilling of bore wells at a depth of 400m has caused a great threat to the ground water, which is the only source of drinking water.	• Increase in the number of drinking water sources and water availability has improved the access for defecation. Surface water and ground water both form the source for sanitary use.	• A threat to the groundwater reservoir due to high competition between use of drinking and irrigation from the same aquifer.	• Tapped water supply drastically reduced the drudgery of women.
Sanitation Activities • Awareness on family & surrounding cleanliness. Outputs • Improved health • Cleanliness in village.	• Open access to sanitation and going for defecation in the canals that have been deepened for recharging the ground water can cause contamination to the ground water.	• Personal health and the household cleanliness has always shown good progress in the area. The only problem is open defecation, which may affect personal health and hygiene of the villagers.	• Organic manure use in fields has been a common practice.	• Provision of clothes washing place for women has improved access to washing of clothes. Awareness among the community on proper sanitation has also made a change in attitude of the locals.

Annex 3.7 (continued)

Activity/Output	Outcomes			
	Drinking water	**Sanitation**	**Ecosystem**	**Socio-economic**
Ecosystem Activities • Water & soil conservation structures. Outputs • No change observed mainly due to successive drought during last three years.	• There was no much provision for plantation of trees in the area. The structures made for water conservation has helped in the recharge of ground water to some extent.	• The construction of water conservation structures has increased the months of water availability, which can be used for sanitation purpose	• The ecosystem in the area has been completely disturbed due to the continous drought for 3 years. The agricultural yield has been reduced to half of the past. Drilling of well nearly upto 600m has been of great threat to the ground water in the area.	• Difficult to comment on the impact of watershed activities on people due to droughts. However the successive droughts demand a good/innovative crises management system related to water in such situation.
Socio-economic Activities • Formation of VWC • Formation of SHG Outputs • Involvement of women in social activities • Women coming together and running the different income generating institute eg Milk Dairy.	• Drinking water needs was the first priority of the community. Their demand for drinking water facility has been brought in at the entry point activity	• Keeping the surroundings clean has always been a plus point in the community. Open defecation is still practiced in the area. Awareness among the families on sanitation has resulted in a positive manner.	• Awareness on improved agriculture has made a change in the cropping pattern to some extent. Participants going for improved seeds have also been an effective measure towards improved agricultural production.	• Improved capacity of people for management of scares resources.

LIST OF TECHNICAL TERMS

Aa: A Hawaiian term for a lava flow that has a rough, jagged surface.

Agro horticulture: Area with fruit trees and inter-cultivation.

Alluvium: Material, which is transported by a river and deposited at points along the flood plains of river.

Artesian well: A well in which the water in the aquifer is under pressure that raises the water above the point that the well first encounters it.

Aquifer: A body of permeable rock, which is capable of storing significant quantities of water, is underlain by impermeable material and through which groundwater moves.

Checkdam: Structure constructed across a stream to check runoff velocity and soil erosion, recharge water and store water.

Contour bunding: Earthen bunds built along the contours on gently sloping land to reduce surface runoff and erosion.

Drainage line/Nalla: Natural water carrier.

Drainage basin: The area from which a stream and its tributaries receive its water.

Dyke: A sheet like body, which is discordant to the host rock, i.e. cuts across the bedding.

Farm pond: A dugout pond for water storage, as an alternative to checkdam where the topography does not permit the storage of water by constructing embankments.

Gabion structure: Dry stone bund bounded by galvanized chainlink.

Gully plugging: A bund constructed out of stones across the stream to conserve soil and water.

Horticulture: The science and art of cultivating fruit plants.

Hortiforestry: The science and art of cultivating horticulture and forestry plants.

Mesa: An isolated tableland area with steep sides.

Pahoehoe: A Hawaiian term for a basaltic lava flow with a smooth, or ropy surface.

Percolation/Infiltration: Portion of the precipitation that makes its way into the ground.

Permeability: The capacity of material to transmit water or other fluids.

Porosity: The percentage of material occupied by pore space.

Rainfall Intensity: Amount of rainfall that an area receives during a specific period.

Runoff: Portion of the precipitation that makes its way towards rivers, nallas, etc.

Silvipasture: Area with grasses and trees.

Spring: Point from where the ground water oozes out.

Storativity: Volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change of head normal to that surface.

Transmissivity: The rate at which water prevailing kinematic viscosity is transmitted through a unit width of aquifer under a unit hydraulic gradient.