Augmenting Groundwater Resources by Artificial Recharge AGRAR

Inception Report

For the research site at

Kodangipalayam village, Coimbatore District,

Tamil Nadu

Prepared by

WATER TECHNOLOGY CENTRE

TAMIL NADU AGRICULTURAL UNIVERSITY

COIMBATORE-641003

TAMIL NADU

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SUMMARY

Coimbatore is basically an agrarian district has an area of 7469 sq.km falling in the western part of Tamil Nadu. Cauvery and Ponnani river basins are partly covered and is drained by the Bhavani, Noyyal, Amaravathi and the tributaries. The Parambikulam – Aliyar multipurpose project meets out the irrigation and power requirement for agriculture and domestic purposes of this district.

During the past three decades rapid progress has been made in the development of groundwater resources in the district to meet the increasing demands of domestic, irrigation and industrial needs. The district is found with high-grade metamorphic rocks of charnockite, granites and migmatite. These rocks are highly weathered and overlain by recent valley fill and alluvial materials. The availability and the occurrence of groundwater in the crystalline rocks are very limited to the fractured, weathered and jointed zones. In the weathered mantle of the various metamorphic crystalline rocks and in the porous formations the groundwater will occur under water table conditions. It occurs under semi-confined to confined conditions in the deeper fractured aquifers. The aquifers have very limited recharge potential and the yields of the bore wells drilled down to a depth of 300 m below ground level. Groundwater occurs in almost all the geological formations and is developed by means of dug wells, dug cum bore wells and deep bore wells. Study of long term water levels reveals a declining trend, and the appreciable fall in water levels are seen in the taluks of Palladam, Avinashi, Coimbatore, Tiruppur and in the northern part of Pollachi. Over exploitation of groundwater caused serious damage to the phreatic aquifer. This may be attributed to the spurt in groundwater activity during the past three decades from increasing the number of groundwater abstraction structures coupled with erratic and poor rainfall.

In the southern parts of the district, Pollachi and Udumalpet taluks showing the rising trend in water levels which offer some scope for further development of groundwater. Major parts of the district have highly mineralised water that is unsuitable for drinking purpose. In canal irrigated areas groundwater is good and it can be used for domestic purposes. The fluoride content in groundwater exceeding permissible limits occurs in some areas of the district and it causing dental and skeletal fluorosis diseases. High nitrate content in groundwater is observed in Noyyal and Amaravathi river basins. Nitrate content is high in some domestic wells. Groundwater from the deeper aquifer is uniformly good and found suitable for all purposes. The groundwater of the district in

general is moderately hard to very hard to be softened for all purposes. The groundwater quality in the industries at Tiruppur is highly polluted and unsuitable for drinking purposes.

The district falls under the rain shadow region and the normal annual rainfall is 711.3 mm of which 50% is contributed by the northeast monsoon. The total dynamics and the utilisable groundwater resources of the district for irrigation are 941.5 and 825 MCM/yr. The net annual groundwater draft is 710 MCM/yr and the balance available for further development is 105 MCM/yr. Out of 21 blocks, 4 fall under over exploited (>100%) category, 2 blocks are under critical (90 to 100%) category, 8 blocks are fall under semi-critical (70 to 90%) category and the remaining 7 blocks are under safe (<70%) category prescribed by the revised norm of Groundwater Resource Estimation Committee (GREC). The situation needs regular monitoring, study, documentation and research into ameliorative measures. The problem should be tackled on both the demand side and the supply side.

Historically, the concern has been concentrated on the demand side by devising efficient methods of irrigation to conserve water and reduce the demand for water. Much research work had been, and continues to be done on these aspects at the experimental stations and farmers fields and extension work also has kept pace. This has yielded considerable dividends, with farmers widely adopting efficient irrigation methods ranging from controlled flooding for rice to micro-irrigation techniques for many crops.

The problem can also be tackled on the supply side by augmenting groundwater recharge. Soil and water conservation works like compartmental bunds, percolation ponds, farm ponds, that have been carried out by the Dept. of Agricultural. Engineering of the Government of Tamil Nadu under various watershed development programmes. Except for this, the aspect of recharge has remained largely unattended in research, monitoring, evaluation and documentation. This is a lacuna that currently needs priority attention.

INTRODUCTION

Augmenting Groundwater Resources by Artificial Recharge – AGRAR, is funded by the United Kingdom Department for International Development under the Knowledge and Research Programme. This Inception Report draws together the results of the detailed planning undertaken by Water Technology Centre, TNAU, Coimbatore, and Tamil Nadu through field site visits and selection of research site. The study period is from July 2003 to July 2005.

OVERVIEW OF THE STUDY

Groundwater is the main source for rural water supplies in many semi-arid developing countries. Over recent years, increasing abstraction to meet rising demand for domestic supplies and irrigation has raised concerns for the sustainability of the resource and the livelihoods it supports. Additionally, changing land use as well as hydrological interventions and climate change will have impacts on natural recharge and groundwater storage. Consequences of over-exploitation include declining water levels and increasing competition for scarce water resources between domestic and agricultural users and rural and urban communities.

To address these concerns, considerable emphasis is being given to the augmentation of natural recharge by both traditional and modern techniques. Some of these techniques have been employed for centuries, ranging from simple check bunds in gullies to complex diversion and infiltration structures as well as injection wells. Recently there has been considerable investment and renewed effort to restore and maintain such traditional facilities as well as building new structures. Much of the current effort is, however, empirical in choice of sites, structures and aquifers. Performance monitoring is rudimentary and benefits often anecdotal. Because there has been no systematic evaluation of their technical and economic performance, or their impacts on livelihoods, the overall benefits of recharge augmentation schemes may currently be over-emphasised. If the management of the demand side of the water balance (groundwater abstraction) is not also addressed, the benefits of recharge augmentation may not be significant and groundwater resources may continue to be over-exploited. In addition to the technical aspects, the societal, economic and environmental impacts of these schemes are seldom evaluated in detail and thus their effectiveness is often difficult to quantify.

The aim of this project is to produce and disseminate guidelines on the application and operation of schemes that aim to augment groundwater resources by artificial recharge. The main focus will be on the experience with low technology methods in rural India, where there are many hundreds of thousands of schemes. This will be built on by undertaking detailed studies at selected research sites in different hydro geological and societal settings. The data gathered will provide a sound basis on which the base recommendations for future application of aquifer recharge schemes.

This inception report details the scope of the research, i.e. the project objectives and the activities that will be undertaken to achieve those objectives and the roles of the WTC, TNAU, Coimbatore. The report also sets out a dissemination strategy for informing the wide range of target groups and organisations and for receiving feedback throughout the life of the project.

The outputs from the project are:

- improved knowledge of the impacts of AR in different physical and socio-economic settings;
- guidance on scope and effectiveness of AR for implementers, sponsors and policy makers;
- dissemination of knowledge throughout project life.

Activities will be carried out at the research sites in order to assess the effectiveness of using artificial recharge to augment groundwater resources in differing hydro geological environments and differing institutional and socio-economic settings. Activities at each research site will vary depending on preceding levels of knowledge and infrastructure but will all be approached in the following generic manner:

- produce a report of a **conceptual model** of the research site on which to base data collection during the life of the project;
- undertake **hydrological assessment and monitoring** of the research sites;
- study and compare the **operational and institutional issues** at research site;
- assess the impacts of artificial recharge interventions on **livelihoods,** both positive and negative;
- improved knowledge of the impacts of Artificial Recharge in different physical and socio-economic settings;

- **report the results** of the research site studies.

Coimbatore District is located in the west of Tamil Nadu State and includes the city of Coimbatore. The District is bordered to the west by the mountains of the Western Ghats but is dominated by the plains to the east. Although still important, the role of agriculture in the rural economy is diminishing. Migration to the textile industry in the urban centres is a significant income as are the many weaving sheds that have been established in the villages. In the District averages 650 mm and has a bimodal distribution related to the southwest monsoon and the northeast monsoon. The District is underlain by crystalline basement rocks, typical of much of peninsular India. The main recharge structure under investigation is located in Kodangipalayam village in Palladam block of Palladam taluk of the Coimbatore district. It has been selected for the AGRAR study because it is typical of the recharge structures found in this region of Tamil Nadu. The satellite sites to be monitored are located within the same micro-watershed, within a radius of 5 km.

ORGANISATIONS INVOLVED AND THE EXPERTISE OF THEIR STAFF

The Water Technology Centre (WTC), Tamil Nadu Agricultural University(TNAU), Coimbatore, Tamil Nadu state was established in 1982 with financial assistance from Swedish International Development Cooperation Agency (SIDA) to play a lead role in developing appropriate technology, knowledge base of the available water resources for maximising agricultural production and to evolve suitable water management prescriptions for different crops in different agro-climatic zones and to pursue excellence in water management research and training.

DEVELOPMENT ACTIVITIES

This centre has done extensive work on tank irrigation management (rehabilitation) policies. This centre has involved in developmental activities of 15 Drought Prone Area watersheds of Coimbatore district with people's participation at a cost of Rs. 300 lakhs. The accomplished measures include construction of water harvesting and erosion control structures numbering 800 (such as check dams, percolation and farm ponds) bunding, land levelling and plantation of avenue/horticultural trees including crop demonstrations. Involved in research activities in 84 watersheds covering 84 blocks in Tamil Nadu under National Watershed Development Program for Rainfed Areas (NWDPRA) with a total budget of about Rs 84 lakhs.

TECHNOLOGY DISSEMINATION

The Centre has a strong extension linkage. It houses an Advanced Training Centre (now called as Centre of Excellence for Training), exclusively to look after technology transfer which is widely recognized as one of the best centres. Technology developed, as few listed below, is transmitted to farmers, officials of development departments, NGO's, private agencies, corporate bodies and others through seminars, training programs, consultancies, workshops, mass media, bulletins etc.

So far 82 National, 10 Regional and 2 International training programmes were completed at this centre.

POLICY RESEARCH

This Centre has also committed for policy oriented research in key issues. Dr. K. Palanisami is the Co-opted Consultant Economist and member of the Water Service Charges Committee of the Govt. of Tamil Nadu to provide simplified water charges in irrigation and non-irrigation sectors. The Centre has already prepared several policy documents to the State Planning Commission on productivity per unit of water in different soil and water mixes, strategic planning paper on 'Agriculture and Irrigation' and 'Micro Irrigation – An Evaluation'. The Centre has also acted as member of the Inter-departmental Coordination Committee - organised by the Govt. of Tamil Nadu, and also prepared the document on Maximising the Productivity of water under SLUB. A document on Economics of Irrigation Technology transfer to African Countries was also prepared to FAO by Dr. K. Palanisami.

PUBLICATIONS

More than 105 scientific papers, 100 popular articles, 20 books and bulletins, 4 folders and 50 training manuals were published at this centre.

The major areas include:

1. Water requirements of field and horticultural crops.
2. Water scarcity management for crops.
3. Drip irrigation systems for field, horticultural and plantation crops.
4. Watershed development and management.
5. Problem-water management and water quality.
6. Managing salt encrustation in irrigation pipes.
7. Drainage needs and irrigation methods.
8. Water trading and conjunctive use of water.
9. Recycling of waste water for crops.
10. Participatory rural appraisal in water management.

NATIONAL AND INTERNATIONAL LINKAGES

The faculty members have visited several countries such as USA, UK, Japan, Thailand, Philippines, Netherlands, Sweden, China, Israel, Sri Lanka, Tanzania, Zimbabwe, Zambia, Malawi under different programmes related to water management.

This centre has signed MOU with leading international institutions which include FAO, NIES Japan, University of Newcastle UK, and KTH Sweden. Future linkages will be developed with ICRISAT, IWMI and other leading institutions working on water issues. WTC, TNAU is a member of the consortium for Sustainable Water Use and the other members include CWR Anna University, MIDS Chennai, and DHAN Madurai. Several students from Sweden have done their thesis work under Minor Field Studies programme at this centre.

THRUST AREAS

* Intersectoral water supply demand projections.
* Wasteland development.
* Integration of aquaculture within irrigation systems.
* Water pricing and efficient water use.
* Enhanced water use efficiency for commercial and plantation crops.
* Industrial and urban waste water and problem water.

* Agronomic management of improved irrigation methods and drainage.
* Micro irrigation and fertigation.
* Conjunctive use of ground and surface water.
* Integrated watershed development and management.
* Water rights and water markets.
* Sharing of common water.
* Water stress management.
* Technology transfer and upkeep.
* Economic evaluation of low cost and affordable irrigation systems and future policies.

This case study will be led by the Water Technology Centre (WTC), a department within the Tamil Nadu Agricultural University. The WTC has been at the forefront of research on groundwater problems and their management in South India. The WTC has been responsible for the implementation of 15 micro-watershed projects in Coimbatore District in recent years, acting as a partner organisation for the Government of India and rural communities. WTC is an interdisciplinary department, which includes hydro geologists, hydrologist, soil scientists, agricultural economists and crop-physiologists. It also has access to expertise within other departments in the university. Expertise from other organisations will be brought as necessary. The team leader for this project case study will be Dr. K. Palanisami, Director of the WTC.

ROLE PLAYED BY LOCAL COMMUNITIES

The institutional dimensions of Artificial Recharge in India need to be located within the wider context of watershed programmes. This is because activities aimed at enhancing recharge typically form part of a broader set of activities aimed at developing, or rehabilitating, watersheds. This is certainly the case for government-funded schemes (the majority) that combine a range of land development/ protection, soil moisture conservation, afforestation, pasture development and horticultural activities, as well as explicit water resource conservation/augmentation measures. Institutional approaches to watershed development, therefore Artificial Recharge have changed markedly over the last decade. In particular, there has been a major shift towards more participatory, bottom-up approaches involving the involvement of local communities in both the planning and implementation of interventions.

STRUCTURE OF THE REPORT

The reports on the research sites, written at the beginning of the monitoring phase of the project, will be built on by subsequent progress reports and meetings. This report will include the results of the physical measurements made relating to the technical effectiveness of recharge structures and the data collected relating to institutional and livelihoods issues. A summary report will be compiled for the study site detailing the site characteristics like geology, soil, climatic data etc, the work undertaken, the conclusions drawn and the lessons learnt.

DISTRICT-SCALE

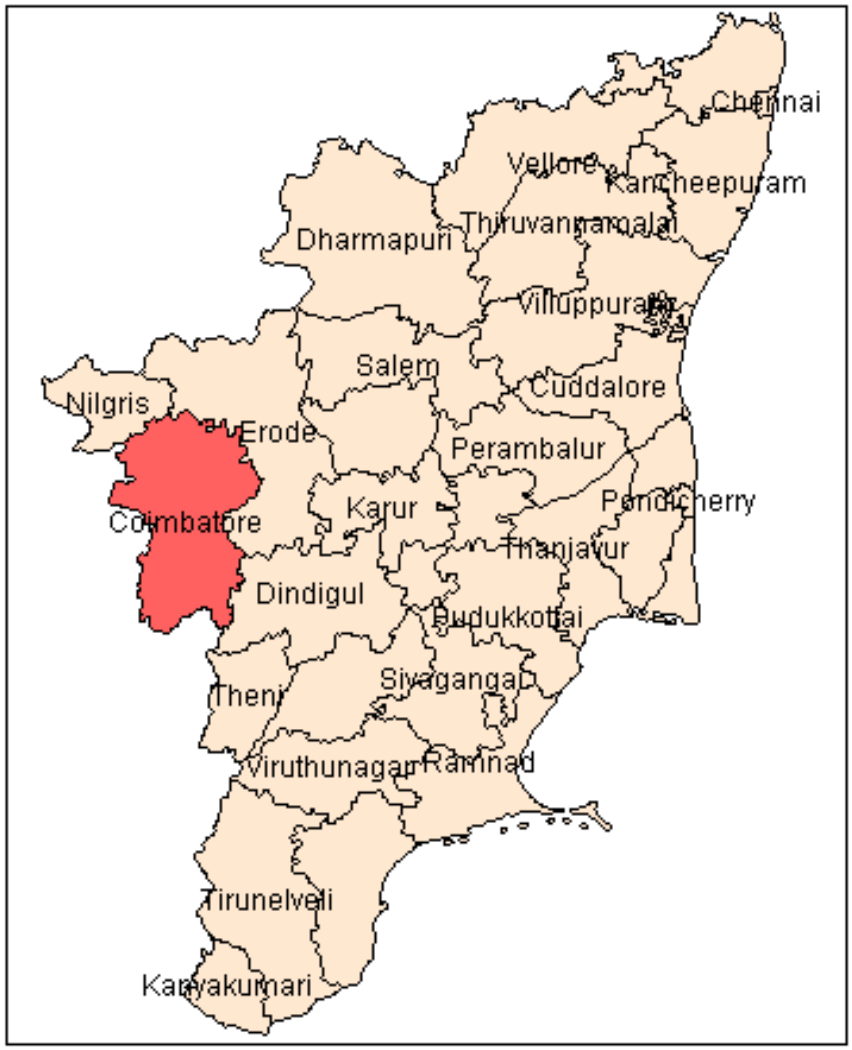


Fig. 1 Location of Coimbatore district

PHYSIOGRAPHY

Coimbatore district is bounded by the Western Ghats on the northwest and south by steeply raising mountains of Western Ghats. Of these, the Nilgiris on the northwest and Anamalais on the south are the important ranges, which attain a height of over 2500m above Mean Sea Level (MSL) and the highest elevation in the valleys adjoining the hills is 600 m above MSL. The rest of the district is an undulating plain sloping gradually from west (600 m) to east (150 m). In between the hill ranges, east west trending mountain ranges pass and it is known as Palghat gap. Besides these western ghat ranges, the other hill ranges of the district are Vellingiris and Boluvampatti hills. The Vellingiris are the spurs of the Nilgiris Mountain Lying in the west and northwest of

the district. Boluvampatti hills lies in the north eastern side of the district. Besides these hill ranges there are many isolated hillocks such as Janakal durg, Ratangiri, and Sirumugamalai etc., scattered over the entire district. The tributaries of the Cauvery namely the Noyyal and Amaravathi run through the district and are east flowing. There are smaller rivers like Aliyar, Solaiyar, Parambikulam and Palar originating in the Anamalai hills and flowing westwards.

The district consists of undulating plains sloping gradually from west to east, There are seven dams in chain in Coimbatore district, namely Parambikulam, Nirar dam, Solaiyar dam, Upper Aliyar dam, Thirumoorthy dam and Amaravathy dam constructed in Parambikulam Aliyar project for generating electricity and for irrigation. Out of total geographical extent of 7,46,799 Hectares, forestland accounts for 1,58,598 hectares representing 21.21% and the barren lands constitute 10,265 hectares representing 1.38%.

CLIMATE AND RAINFALL

Generally sub-tropical climatic condition prevails through out the district and there is no sharp variation in climate. The temperature slowly rises to its maximum in summer up to May and afterwards shows a gradual decline. The maximum temperature ranges from 36^{o}C to 41^{o}C and the minimum temperature varies from 14^{o}C to 31^{o}C. The mean daily temperature during summer (May) varies from 33^{o}C to 40^{o}C and the mean daily temperature during winter varies from 15^{o}C to 36^{o}C. This district receives rain both in south west and north east monsoon. The north east monsoon contributes more especially during October and November. The average annual rainfall of this district is 647.2 mm from four distinct seasons' viz., winter, hot weather period, south-west monsoon and north-east monsoon. The season-wise normal rainfall data are given in Table 2.1.

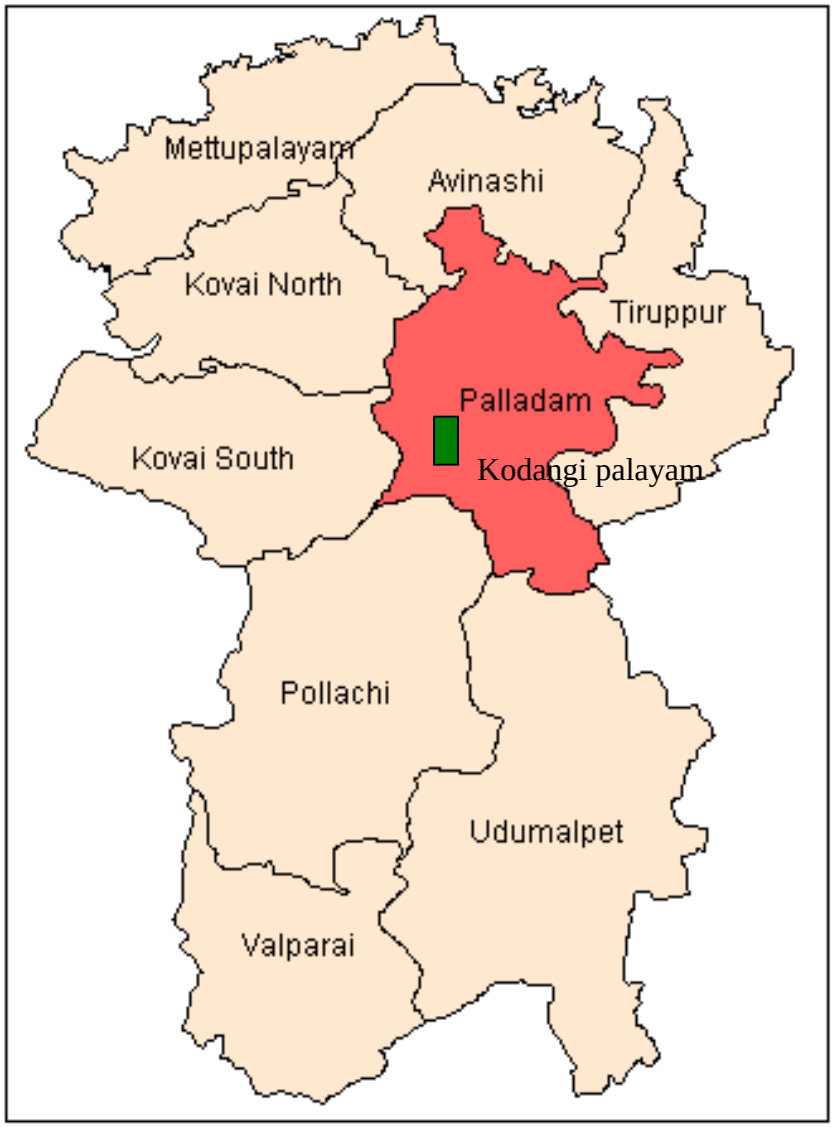


Fig. 2: Location of Kodangipalayam village in Coimbatore district

Table 2.1 Season wise normal rainfall of Coimbatore District

Seasons	Period	Rainfall (mm)	Percentage
Winter	January – February	25.6	3.96
Hot weather period	March – May	135.1	20.87
South - West monsoon	June- September	158.3	24.46
North - east monsoon	October – December	328.2	50.71

Source: Statistical department - Coimbatore

There are 36 rain gauge stations spread over the district and are maintained by different organisations. A general overview of rainfall pattern, as recorded in the rainfall stations indicates that the precipitation is mostly uncertain, uneven or unequally distributed. As per meteorological standards, deviation of plus 20% or more is excess rainfall, between minus 19.9% and plus 19.9% is normal rainfall, minus 20% to minus 59.9% is deficient rainfall and below minus 60% is scanty. The normal rainfall of Coimbatore district is given in Table 2.2.

Table 2.2 Rainfall of Coimbatore district – June – May

Sl. No	Taluk	Mean annual rainfall	SW monsoon (Jun - Sep)	NE monsoon (Oct - Dec)	Winter (Jan – Feb)	Summer (Mar – May)
		mm	%	%	%	%
1.	Coimbatore North and South	640	28.4	49.1	1.9	20.6
2.	Mettupalayam	797	18.3	51.1	6.8	23.8
3.	Avinashi	720	29.7	45.0	1.4	23.9
4.	**Palladam and Tiruppur**	**524**	**21.0**	**50.3**	**3.1**	**25.6**
5.	Pollachi and Valparai	842	47.2	33.6	1.4	17.8
6.	Udumalpet	573	22.7	50.6	3.5	23.2
	Mean	682.5	28.8	45.9	3.1	22.2

(Mean of data from 1971 to 1996)

SOILS

Natural soils are the product of physical and chemical weathering of rocks. The physical properties are formed during the course of formation and the subsequent existence is depending upon the topography, hydro meteorological condition and human interference. Soil characteristics of a terrain are more important aspects since they play a major role in ground water recharge and meet the basic needs of all agricultural production. Agricultural department indicates six different types of soil, as below:

1. Red calcareous soil
2. Black soil
3. Red non-calcareous soil
4. Alluvial and colluvial soil
5. Brown soil
6. Forest soil

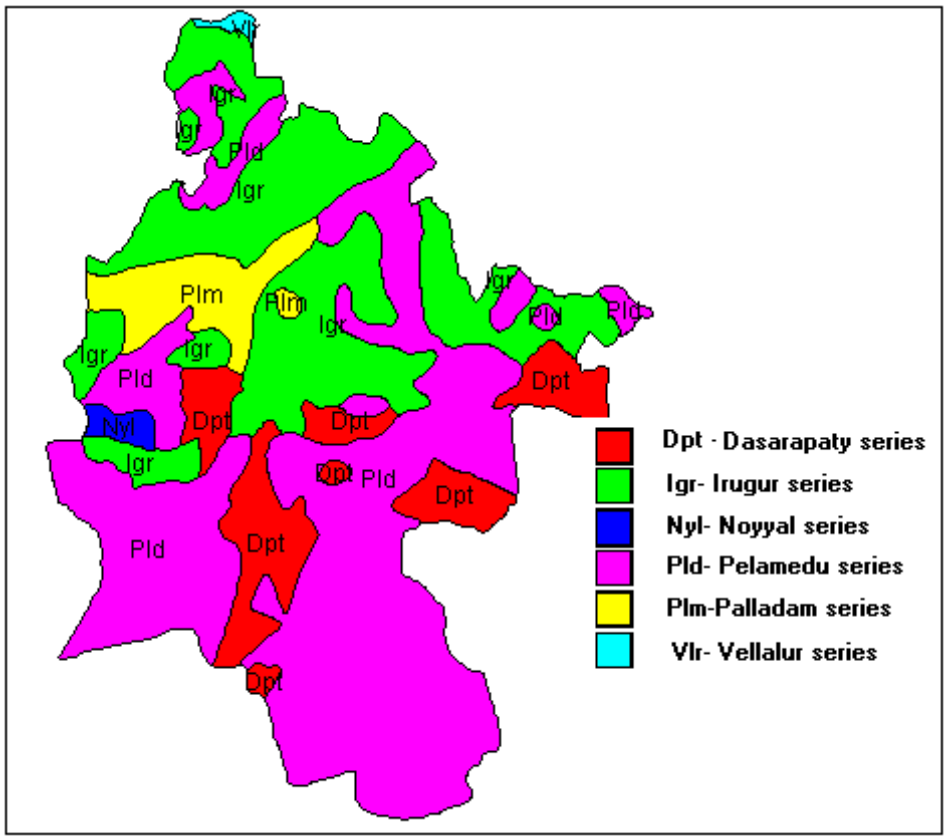


Fig.3 Soils of Palladam block in Coimbatore district

Various types of cropping pattern are practiced in different parts of Coimbatore district depending upon the soil characteristics (Table 2.3).

Table 2.3 Cropping pattern adopted in major soil types of Coimbatore District

Sl. No	Taluk	Percentage of major soil group	Major cropping pattern
1.	Coimbatore (north)	Red calcarious soil (60.39%)	Cotton, Ragi, Paddy, Groundnut, Sugarcane
		Black soil (12.54%)	Cumbu, Cotton, Groundnut
		Red non-calcarious soil (11.89%)	Cotton, Sugarcane, Tobacco
		Brown soil (5.61%)	Maize, Banana
		Alluvial & colluvial soil (9.57%)	Sugarcane, Banana, Pulses
2.	Coimbatore (south)	Red calcarious soil (67.26%)	Sorghum, Cumbu, Sugarcane, Turmeric
		Black soil (5.73%)	Cotton, Groundnut, Ragi
		Red non-calcarious soil (14.62%)	Banana, Sugarcane, Chillies, Coconut
		Brown soil (4.14%)	Sugarcane, Coconut
		Alluvial & colluvial soil (8.25%)	Sugarcane, Banana
3.	Mettupalayam	Red calcarious soil (39.57%)	Paddy, Sugarcane, Pulses, Banana
		Red non-calcarious soil (15.66%)	Banana, Tobacco, Chillies
		Forest soil (44.77%)	Banana, Sugarcane, Paddy
4.	Avinashi	Red calcarious soil (46.34%)	Sugarcane, Maize, Ragi, Sorghum, Onion
		Black soil (6.26%)	Cotton, Chillies, Maize
		Red non-calcarious soil (47.40%)	Sugarcane, Turmeric, Paddy, Onion
5.	Palladam	Red calcarious soil (49.88%)	Maize, Sorghum, Onion
		Black soil (15.38%)	Groundnut, Cotton, Sorghum
		Red non-calcarious soil (35.50%)	Maize, Sorghum, Ragi, Onion
		Brown soil(1.24%)	Ragi, Sorghum, Groundnut
6.	Tiruppur	Red calcarious soil (51.91%)	Onion, Tobacco, Maize
		Black soil (7.33%)	Sorghum, Cumbu, Cotton
		Red non-calcarious soil (40.94%)	Ragi
7.	Pollachi	Red calcarious soil (54.42%)	Paddy, Coconut, Groundnut, Chillies
		Black soil (8.23%)	Cotton, Tapioca, Groundnut
		Red non-calcarious soil (37.35%)	Maize, Tobacco, Sugarcane
8.	Udumalpet	Red calcarious soil (32.42%)	Paddy, Maize, Sugarcane, Chillies
		Black soil (36.26%)	Cotton, Coconut
		Red non-calcareous soil (31.32%)	Coconut, Paddy, Sorghum, Chillies
9.	Valparai	Forest soil (100.00%)	Coriander, Cardamom Banana, Vegetables And Tea

Source : Soil testing lab, Joint Director of Agriculture, Coimbatore

The infiltration rate of different types of soils in Coimbatore district is given in Table 2.4.

Table 2.4: Infiltration rate of the soils

Sl.No.	Type of major soil series	Infiltration rate (cm/hr)
1	Red calcarious salt (including deep, thin red and red lomy)	1.32 to 9.03
2	Cal carious brownish soil	1.41 to 10.4
3	Non-calcarious red soil (including reddish brown soil)	1.70 to 6.03
4	Black soil	0.40 to 4.83
5	Alluvial & colloid line	2.40 to 14.72

Source: PWD Ground water, Coimbatore

Table 2.5: Soil reaction of Coimbatore District

Neutral	**Mildly Alkaline**	**Moderately Alkaline**	**Strongly Alkaline**
pH 6.6 – 7.3	7.4 – 7.8	7.9 – 8.4	8.5 – 9.0
Irugur	Pichanur	**Palladam**	Okkilipalayam
Anamalai	Somayyanur	Manupatty	Peelamedu
Chavadiparai		Palathurai	Vellalur
		Periyanaickenpalayam	–
		Noyyal	–
		Dasarapatti	–
Area (ha) 2,19,236	38,127	2,42,190	69,098

GEOLOGY OF COIMBATORE DISTRICT

Coimbatore district is underlain by a wide range of high grade metamorphic rocks of the peninsular gneissic complex. These rocks are extensively weathered and overlain by recent valley fills and alluvium at places. The geological formations found in the district are Khondalite, Calc-granulite, complex gneiss mainly Hornblende-Biotite and crystalline limestone, Dolerite, Charnockite, Granite gneiss, Granite and Syenite, Pegmatite, and Quartzite veins. The mineral formations are Beryl, Feldspar, Gypsum, Limestone, Mica and Magnesite. The generalised stratigraphic succession of the geologic formations met within this district is as follows:

Recent to Sub recent: Solis, Alluvium, Laterites, Colluvium and Kankar.

Archaean : Syenite, granite, Hornblende biotite gneiss, garnet Sillimanite, gneiss, quartzites and charnockite.

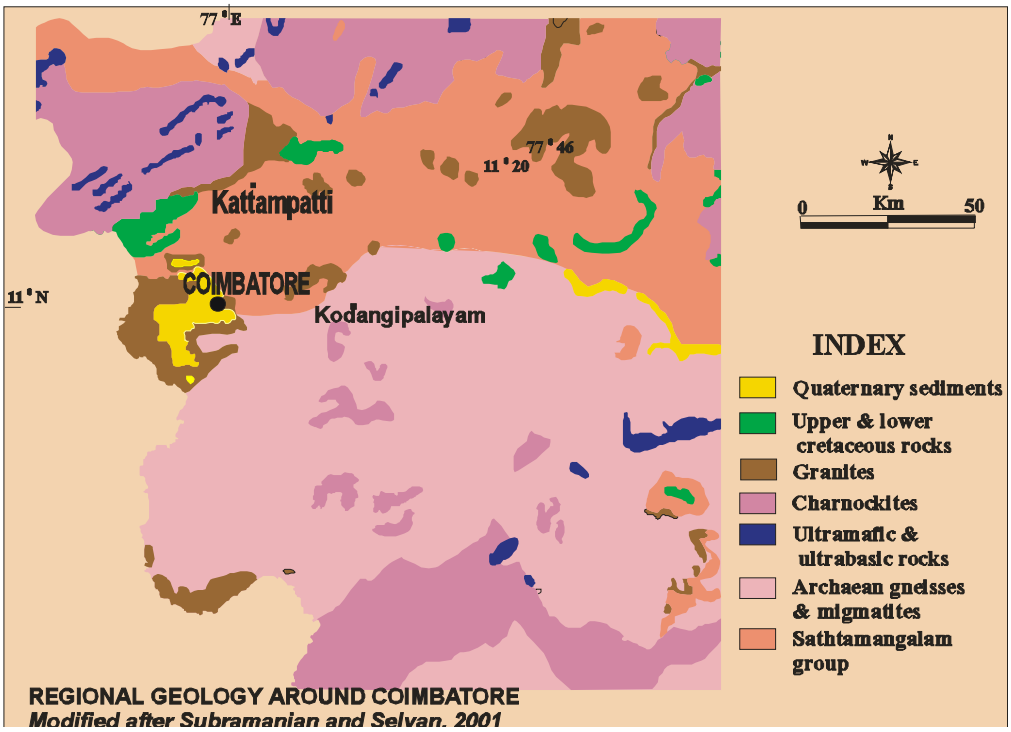


Fig. 4 Regional geology around Coimbatore

GEOMORPHOLOGY OF COIMBATORE DISTRICT

Geomorphological maps help to identify the various geomorphic units and ground water occurrence in each unit. Taluk-wise Geomorphological map is prepared with the help of satellite imageries and aerial photographs in the scale of 1:50,000 and subsequent checks are being carried out in the field for verification of the features identified in the laboratory.

A map showing the Geomorphological features in Coimbatore district prepared by the remote sensing lab, Tharamani reveals the various morphological features, fractures and lineaments. It is seen that structural and denudational processes predominate the fluvial processes. As a result the area is marked by plateau land forms, structural denudational and residual hills of charnockite and gneisses of linear ridge of basic dykes. The gneisses and ultra basic hills have invariably generated a wide bazada zone. The various geomorphic units as revealed from the studies are structural and

residual hills, linear ridges, bazada zones, buried pediments, active pediments, shallow pediments, erosional plains, valley fills, uplands etc.

Even though the hydro-geomorphological zones demarcated as ground water potential zone based on remote sensing techniques and the subsequent filed checks, the present extraction of ground water in each zone has to be taken into consideration before implementing further ground water schemes.

LAND USE PATTERN OF COIMBATORE DISTRICT

The land use pattern of Coimbatore district is presented in the table 3.1 for the past 50-year interval. The land used for the different purpose is categorized into nine divisions and measured in hectares. The forest area in Coimbatore district had reduced from 25.2 per cent to 21.1 per cent during 1960 – 61 to 2000 – 01. The water resources of Coimbatore district will worsen in the coming years due to declining trend in the forest area with the variation of monsoonal rainfall and ground water table. Following this the barren and uncultivable land area declined from 2.8 per cent to 1.37 per cent this is because of the urbanization, encroachment and development of the buildings and roads. The land put to non -agricultural uses had declined had increased from 4 per cent to 12.32 per cent over the same period this is one of the sign of the urbanization. The cultivable wastes declined from3.2 percent to 0.39 per cent because of the reduction in the total agricultural land. Hence the land, which is cultivable but kept as wasteland, has been utilised over the period into cultivable land and for other purposes.

Permanent pasture and other grazing lands decreased from 1.4 per cent to 0.15 per cent because of the reduction in the cattle population and land use for other purposes for the during past 50 years from 1960 – 61 to 2000 –01, the land used for growing miscellaneous tree crops and growers which were not included in the net sown area declined from 0.4 percent for the same period.

The fallow lands are the lands, which is left free without cultivation currently. For various reasons such as replenishment of nutrient, water scarcity, etc. The current fallow land over the period increased from 13.9 percent to 19.65 per cent and the other fallow lands decreased from 4.1 percent to 1.83 percent over the period.

The net area sown had declined from 45.7 per cent to 42.48 per cent over the period and the area sown more than once had declined drastically from 11.8 percent to

2.5 per cent over the same period. Likewise, the gross area sown also follows the same trend and decreased from 56.8 percent to 45.06 percent.

CROPPING PATTERN OF COIMBATORE DISTRICT

The cropping pattern followed in Coimbatore district is presented in the Table 4.2.over the period from 1960 - 61 to 2000 - 01 in ten years intervals. It implies that most of the crop area reduced over the years except few crops. The coconut cultivated area increased drastically from 4844 ha to 91799 ha during 1960 -61 to 2000 -01. This implies the reduction in cereal crops to perennial crops. The fodder crop also increased from 568ha to 1374 ha during the same period, due to less water requirement and more profit in comparison with other crop. The coffee being a plantation crop with more demand and remunerations, the area increased from 1322 ha to 2454 ha during 1960 – 61 to 2000 – 01.

The total food crop had reduced from 5,82,301 ha to 1,95,057 ha during 1960 – 61 to 2000 – 01. The total non-food crop reduced from 3,05,434 ha to 1,41,547 ha. The area cropped more than once declined from 1,83,582 ha to 19,229 ha for the same period. The net cropped area reduced from 7,04,153 ha to 3,17,375 ha which is almost 50 percent of the cropped area during 1960 – 61. The above factors contributes to the cropping index which reduced from 1.26 to 1.06 per cent during 1960 – 61 to 2000 – 01.

The study area Kodangipalayam village is in the Palladam block of Coimbatore district.

Project Area Location Details:

State: Tamil Nadu
District: Coimbatore
Name of the Village: Kodangipalayam
Village No.: 84
Block: Palladam
Taluk: Palladam
Longitude: $77^0$01’00” to $77^0$14’00” E
Latitude: $11^0$02’00” to $11^0$04’00” N
Distance from road: 3 Km

Irrigation Sources:

Wells:

Number of Drinking water Wells: 15

Government owned wells: 10

Private Wells: 5

No of Irrigation wells: 50

Number of energized wells: 40

Number of other wells not in use: 13

Dug cum bore wells and bore wells: 30

Hand pumps: 3

Check dams: 15

Percolation ponds: 10

Period in which water is available in lakes, tanks and ponds: 4 months

IRRIGATION BY SURFACE AND GROUNDWATER

The agriculture of the project area has to depend largely on irrigation projects of other sources such as wells, rainfed tanks etc., due to poor rainfall. The chief sources of irrigation in the project area are wells which play a significant role in the irrigation of the area followed by the surface water structure.

OCCURRENCE OF GROUNDWATER AND GROUNDWATER POTENTIAL

In the project area groundwater occur in all geological formations from the oldest Achaeans to recent alluvium. Groundwater potential and utilisation of groundwater resources for irrigation area is calculated. The groundwater recharge, net extraction and balance groundwater available have been estimated for the project area.

WATERSHED-SCALE

The selected recharge structure is in the Kodangipalayam micro watershed of Palladam block. This watershed development project was taken up under the Drought Prone Area Programme (DPAP) from 1995 – 1999 as part of the drought relief programme by the State Government. In this section, the basic details of the Kodangipalayam watershed are dealt with. The general characteristics of the study blocks are provided in Table.3.1. Palladam block has 21 revenue villages with a population of 98376. The population density in Palladam is 331 per sq.km. Percentage of literacy is worked out to 51.55 per cent in Palladam.

Table.3.1: General Characteristics of Palladam block

Particulars	**Palladam**
Total geographical area (ha.)	29759
Total population (no.)	98376
Total literates (no.)	50710
Average annual rainfall (mm)	400.1
No.of revenue villages	21
No.of town Panchayat	2
No. of primary school	72
No.of middle school	5
No.of Hr.Sec.school	4
No.of hospitals	2
No.of PHCs	2
No.of villages electrified	21
No.of villages having protected water supply	21
No.of post offices	20
No.of telegraphic offices	-
No.of veterinary hospitals	-
No.of veterinary dispensaries	2
No.of occupied residential houses	19257
No.of households	25759

Source: Block Statistical Handbook, 2002.Assistant Director of Statistics, Coimbatore.

The total population of Palladam block is 98376. Total work force constitutes 50.32 per cent of the total population, while the non-workers account for 49.68 per cent. Of the total population, agricultural labourers account for 45.42 per cent and cultivators constitute 29.85 per cent. Of the total work force, manufacturing, servicing, processing and repairing account for 6.31 per cent, trade and commerce 3.62 per cent, construction 1.70 per cent, transport, storage and communications 0.83 per cent and other services 5.46 per cent.

PHYSICAL

In this section, parameters like geology, rainfall pattern, soil type, cropping pattern etc for the Kodangipalayam watershed in Palladam block are given.

GEOLOGY

The Geology and soil types are given in Table 3.2. The Geological cross-section is given in figure below.

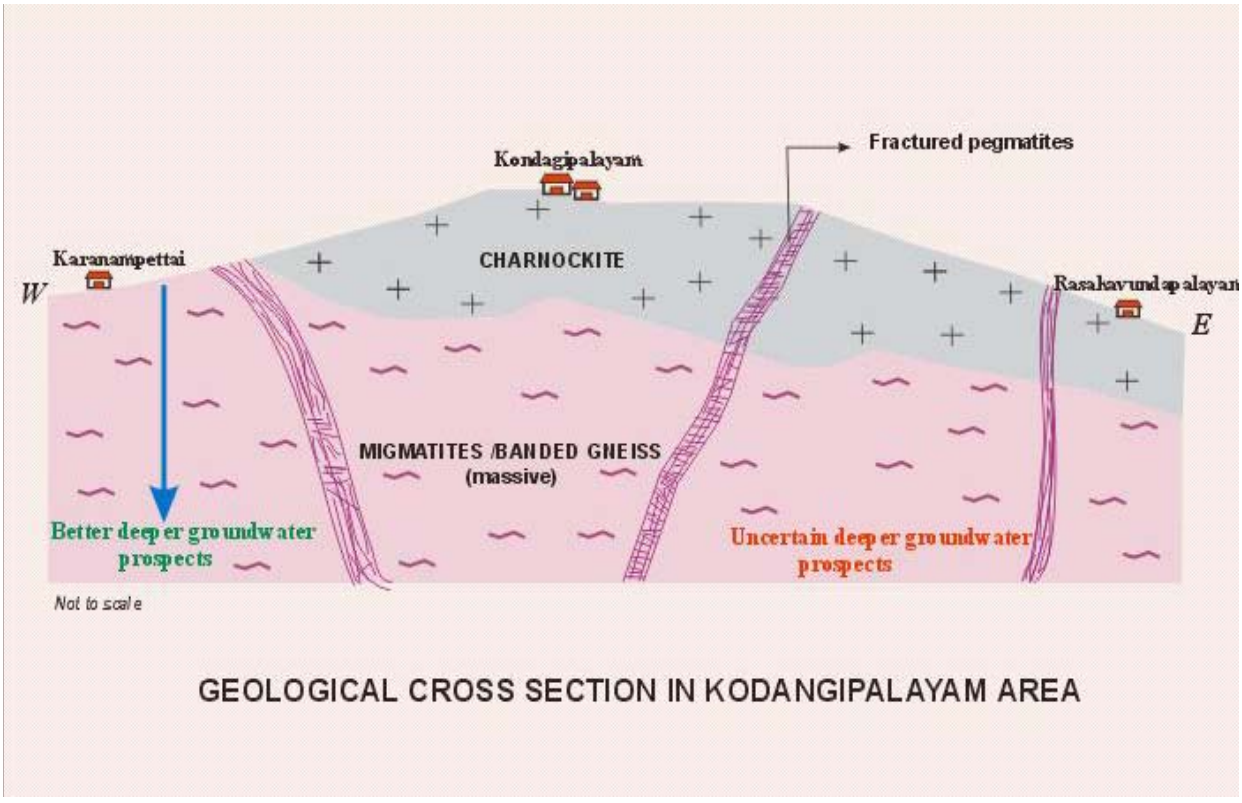
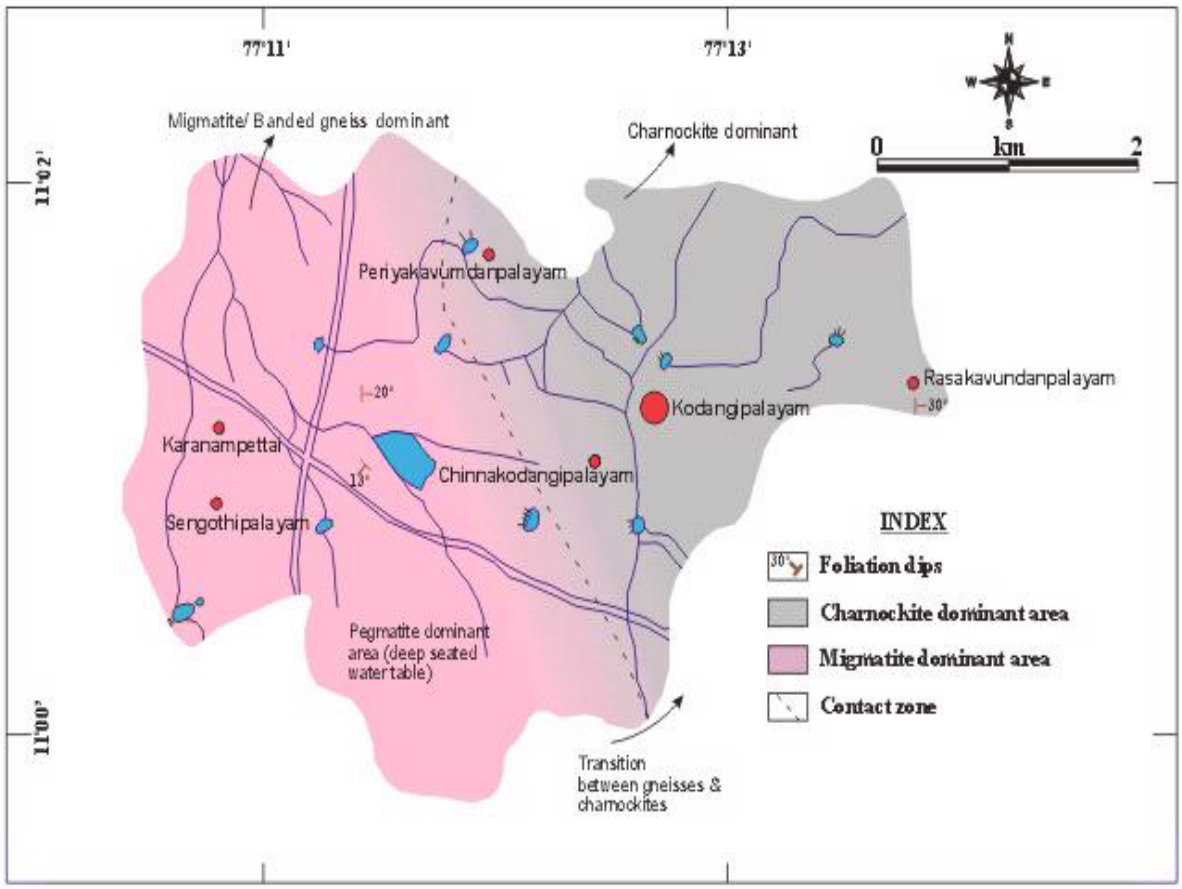


Fig.5 Geological cross-section of Kodangipalayam watershed

Table 3.2 Geology and Soil Types

Age	Rock formation
Recent to sub-recent	Soil, Alluvium
Archaean	Granite, hornblende, biotite gneiss, garnet sillimanite gneiss, quartzite and charnockite.

Watershed particulars related to Drainage, Soil conservation problems, remedies are given in Table 3.3. The geological setting of the Kodangipalayam watershed is shown in figure below.



MAP SHOWING GEOLOGICAL SETTING OF KODANGIPALAYAM AREA

Fig.6 Geological setting of Kodangipalayam watershed

Table 3.3 Kodangipalayam Watershed particulars

Location	Physiography	Geology	Drainage	Problems	Initiatives
Kodangipalayam village/ Palladam block/Palladam taluk/Coimbatore	Gently undulating to flat topography. Hard rock Mostly	Charnockite , granite, branded gneiss and	Dendritic to sub-dendritic and	Soil erosion, falling water	Soil and water conservation mechanisms

district/Tamil Nadu	cultivable lands. Low to moderate rainfall. Domains. Groundwater major sources of rural water supply.	migmatite surrounded by calc-granulite rocks and quartzite rocks.	controlled by structural features in underlying rocks.	levels have prompted recharge measures. Water shortage. Crop failure.	. Recharge through percolation ponds, check dams. Well deepening as response to water shortage.

LAND UTILISATION

Particulars of land utilisation of the Palladam block is given in Table 3.4. The total geographical area is 29759 hectares in Palladam. In Palladam, of the total geographical area of 29597 hectares, the area under current fallows account for 47.04 per cent followed by net area sown (39.23 per cent). Kodangipalayam watershed encompasses a total area of about 1767.05 Ha in which dryland constitutes to 1644.97 Ha, Uncultivable lands to 122.08 Ha, Government Poromboke lands to122.08 Ha. From the statistics it is seen that there is no wetlands in the watershed.

Table.3.4. Land use pattern in the Palladam block, 2001 (Hectares)

Particulars	Palladam	Percent
Total geographical area	29759	100.00
Forests	-	0.00
Barren and uncultivable land	49	0.16
Land put to non-agrl. Uses	3045	10.23
Cultivable waste	21	0.07
Permanent pastures and other grazing land	21	0.07
Land under miscellaneous tree crops and grooves not included in net area sown	17	0.05
Current fallows	13998	47.04
Other fallows	932	3.13
Net area sown	11676	39.23
Total cropped area	11837	39.77

Source: Block Statistical Handbook, 2002. AD, Statistics, Coimbatore.

CLIMATE AND RAINFALL

Sub- tropical climate prevails throughout the area. The Maximum temperature ranges from 36^0 C to 41^0 C, the minimum temperature ranges from 14^0 C to 31^0 C. The rainfall is an important factor which influences agricultural production in any region. The

distribution of rainfall becomes critical in deciding the groundwater extraction and cropping pattern. The average rainfall is 650 mm from four distinct seasons viz. southwest monsoon, northeast monsoon, winter season and hot weather periods. Fig. 7 shows the trend in rainfall in the Palladam block from the year 1991 to 2003. An Automatic weather station with five sensors viz., Rainfall, Relative humidity, Solar radiation, Air Temperature and Evaporation is installed near to the recharge structure for recording the parameters. In addition to the above, two automatic rain gauges are installed one near to the Kodangipalayam East pond and another one near to the Kodangipalayam West pond.

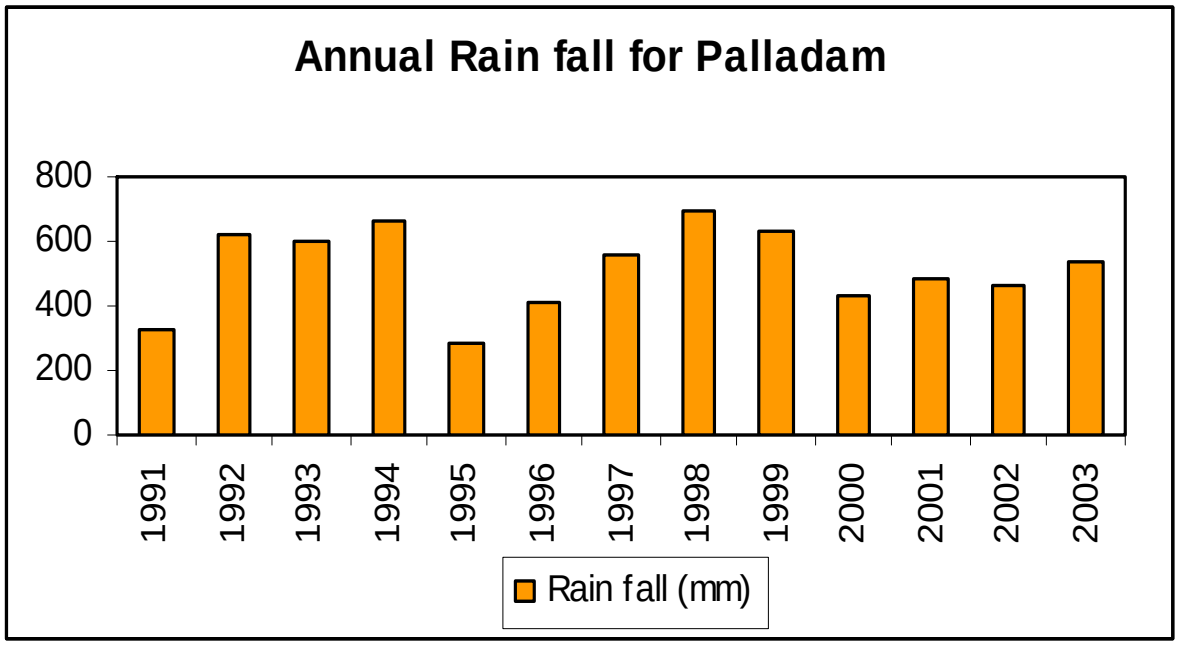


Fig.7 Rain fall pattern in Kodangipalayam area

IRRIGATION

The area irrigated by different sources of irrigation is furnished in Table 3.5. It is observed that the groundwater sources through private tube wells and dug wells are the major sources of irrigation. The irrigation intensity worked out to 100 per cent in Palladam. The dependence on groundwater for irrigation implies that the importance of watershed development programmes through the development of water resources in these regions.

Table.3.5 Area irrigated by different sources, 2001(Hectares)

Particulars	Palladam		
	No.s	Net(ha)	Gross(ha)
Surface water Tanks			
Large	-	-	-
Small	1	-	-
Groundwater Private tube wells	1245	124	124
Dug wells	6446	4772	4805
Total		4896	4929
Irrigation intensity (%)		100.67	

Source: Block Statistical Handbook, 2002.Assistant Director of Statistics, Coimbatore.

* Net area irrigated (actual area irrigated): Represent the area irrigated under first crop/season during the falsi year.

* Gross area irrigated: represent the total area irrigated including the area irrigated more than once during the falsi year.

$$\text{* Irrigation intensity} = \frac{\text{Gross area irrigated}}{\text{Net area irrigated}} \times 100$$

STAGES OF GROUNDWATER DEVELOPMENT

The importance and need of water, particularly, for the agriculture and its role in augmenting food production need no emphasis since water is the basic input. Prudential planning for systematic and scientific development of groundwater resources by means of various types of groundwater abstraction structures requires balanced estimation of groundwater potential. The groundwater potential, net draft, balance potential available and stages of groundwater development are furnished in Table.3.6.

Table.3.6.Groundwater potential in Palladam block as on 1998

(hectare meters)

Name of the blocks	Annual groundwater recharge	Net groundwater recharge available	Net groundwater recharge available for irrigation	Gross Groundwater draft	Balance groundwater available	Stages of groundwater development (%)
Palladam	4615	4154	3987	2422	1565	61

Source: Groundwater Perspectives: A Profile of Coimbatore District of Tamil Nadu,

SOCIO-ECONOMICS

- **Villages within the watershed**

The villages covered in the Kodangipalayam watershed are Sangothipalayam, Karanampettai, Perumagovundampalayam, Rasagovundampalayam, Chinnakodangipalayam and Periyakodangipalayam.

- **Population/households**

Total Population: 5696

Male: 2725

Female: 2971

Number of Household: 500

- **Types and distribution of castes**

  Castes (No.): 10

  Dominating caste: Gounder

- **Local institution**

  Government Primary and Middle school,

  Village Panchayat,

  Watershed Association,

  Farmer's Association,

  NGO's field workers and,

  DRDA watershed development team members etc

- **Infrastructure**

  Check dams, Percolation ponds, Cattle ponds and other gully control and water harvesting structures.

- **Sources of drinking water**

The access to drinking water is concerned, most of study villages are enjoying the Tamil Nadu Water supply And Drainage Board (TWAD) water systems (Pillur) through taps system. For the purpose of understanding the drinking water access, the details of different sources of drinking water supply is presented.

Table 3.7 Source-wise details of Domestic water supply in Kodangipalayam village.

Source	1990-91			2000-01		
	% of HHs used	Purpose	Quality of water	% of HHs used	Purpose	Quality of water
Open well	25	Cleaning, Washing, Drinking	F	-	-	-
Street Pipes Bore water	80	Drinking, cooking	F	80	Drinking, Cooking	F
Athikadavu water	-	-		80	Drinking, cooking	G
Hand pumps	10	Washing and Cleaning	F	4	Washing and Cleaning	F
Paraikulli **	20	Washing only	F	40	Washing only	F
Own well *	40	Livestock drinking, Washing and Cleaning	F	80	Livestock drinking, Washing, Cleaning and Drinking	F

G-Good, F- Fair, HHs-Household

Drinking water supplied from Athikadavu Dam through the Rajiv Gandhi Drinking Water Mission Scheme.

- **Livelihood Trends**

With the declining scope for agricultural production due to growing groundwater scarcity, farm households diversified their economic activities through involving non-farm income generation activities. The major non-farm income activities include setting up of power looms, quarrying and other non-agricultural businesses. Mostly the medium and large farmers are afforded to make investment on this type business ventures. Few small and marginal farmers are also involved in these type economic activities.

It is evidenced from the survey that there is a major shift in economic activities towards non-agricultural activities and this is more pronounced among medium and large farm households.

Table 3.8 Changes in Livelihood in Kodangipalayam (Percent of farmers)

Size group	1990-91					2000-01				
	Off Farm	Non Farm				Off Farm	Non Farm			
		Power loom	Quarry	Shop	Others		Power loom	Quarry	Shop	Others
Marginal	42	25	16	4	13	22	40	20	6	12
Small	25	35	20	2	18	12	50	28	4	6
Med.& Large	0	50	25	5	20	0	65	25	2	3

In both the villages the non-farm activities have increased among all size groups with the reduction in off-farm activities.

Table 3.9 Income from alternative resources of selected farms in Kodangipalayam village. (Rs/year)

Size Group	Farm alone	Farm +Animal	Farm +Power loom	Farm +Power loom +Animal	Power loom alone
Marginal	9900	17500	..	..	..
Small	19800	38900	127800	146900	108000
Medium & Large	62000	124000	216000	278000	254000

Being bottom of the rural income scale next to landless agricultural labour households, the resource poor farm households show more inclination towards maintaining livestock particularly milch animals, sheep and goats in order to derive additional income.

AGRICULTURE

LAND-USE

This section presents the field experience on livelihood aspects. The overall changes due to changes in groundwater scenario are grouped into three aspects viz., agricultural production, socio-economic and coping mechanism adopted by the rural households. To study the relationship between water resources and household economy, it is important to understand the farming systems followed in the study area. There is no single type of farming; instead there is a large variety of farming systems, as

a result of differences in the physical, biological and socio-economic environment. The farmers grow agricultural crops such as sugarcane, banana, maize and vegetables as main agricultural crops. Livestock provide manures to the agricultural crop production and trees. A further important characteristic of the prevailing farming system is the prevalence of supplementary off-farm and non-farm income activities.

CROPPING PATTERNS

The problems associated with the over exploitation of the groundwater such as long term decline in water table, well failure rates and fluctuation in water levels, eventually, affect the crop yields. The problems associated with the over exploitation of the groundwater such as long term decline in water table, well failure rates and fluctuation in water levels, eventually, affect the crop yields. To account this impact, changes in cropping pattern, productivity of crops and economics of crop production are presented and discussed here. The details of changes in cropping pattern are given in Table 3.10.

Table 3.10 Changes in cropping pattern of sample farms in Kodangipalayam village. (Area in hectares)

Crops	Marginal		Small		Medium &Large	
	1990-91	2000-01	1990-91	2000-01	1990-91	2000-01
Cotton	0.11	-	0.27	-	0.16	-
Vegetables	0.09	0.07	0.15	0.06	0.30	0.13
Banana	0.16	-	0.25	-	1.13	0.40
Maize	0.38	0.04	0.53	0.19	0.77	0.94
Sorghum	0.43	0.74	0.54	0.94	0.65	1.62
Tobacco	0.05	0.02	0.10	0.06	0.12	-
Turmeric	0.09	-	0.30	-	0.20	0.61
Coriander	-	-	0.02	0.14	-	0.20
Others	0.11	0.02	0.13	0.17	1.04	0.81
Current fallow	-	0.28	0.19	0.57	-	1.01
Total	1.42	1.17	2.48	2.13	4.37	5.72

The major cause of changes in cropping pattern was water scarcity. Cotton was replaced by rainfed sorghum in all the size groups. The area under banana in medium and large farms has been declining over the years. As banana is highly water consuming crop, the small and marginal farmers altered their cropping pattern so that

the rainfed crops are included in cropping system. It is interesting to note that the area under current fallows has increased marginally over the periods.

SOURCES OF IRRIGATION WATER AND USAGE

The area is irrigated by different sources of irrigation. It is observed that the groundwater sources through private tube wells and dug wells are the major sources of irrigation in the study blocks. The irrigation intensity worked out to 100 per cent in Palladam block respectively. The dependence on groundwater for irrigation implies that the importance of watershed development programmes through the development of water resources in these regions.

AREAS OF LAND IRRIGATED BY SEASON

Total Area: 1767.05 Ha

Dry Land: 1625.60 Ha

Crops in garden land area: Paddy, banana, cotton, tobacco, turmeric, tapioca

Extent: 141.45 Ha

Types of irrigation: Well irrigation

Crop nature: Ist. crop, 2nd crop

During the survey it was found that groundwater is the major source of irrigation in the study area. As the use of groundwater has direct implications on agricultural production and their livelihood, analysis of the share of well irrigation to the total cropped area is more important. The area irrigated by wells indicates that on an average the percentage of area irrigated has declined from 67.29 per cent to 41.16 per cent in Kodangipalayam over ten years period. It is interesting to note that though the area under irrigation has reduced, the large farmers go for rainfed perennial trees to cope up with the increasing water scarcity.

Table 3.11 Details of Irrigated area of Kodangipalayam village

Particulars	1990-91	2000-01
Total area (ha)	8.19	8.17
Area irrigated (ha)	5.51 (67.28%)	3.36 (41.13%)

Un irrigated area (ha)	2.49 (30.40%)	2.99 (36.60%)
Fallow area (ac)	0.48 (2.37%)	4.49 (22.24%)

LAND MANAGEMENT PRACTICES

Being a critical resource, the groundwater demand is a derived demand for achieving higher agricultural production. The uncontrolled extraction has resulted in decline in groundwater level. This section presents briefly the coping mechanisms adopted by farmers for growing groundwater scarcity due to over exploitation of groundwater.

WATER CONSERVATION METHODS

With the ever-increasing demand for and depletion of groundwater, there is a dire need for development of water harvesting structures. These factors force the farm households to construct water harvesting structures like farm ponds, livestock ponds, check dams, contour bunds and compartmental bunds, planting grasses like vetiver etc.,

One of the important such structures found in the study area is construction of farm surface storage tanks. Irregular and erratic power supply, very low water table push the farmers (particularly bore well farmers owning compressor type motors) develop farm surface storage tanks. The water is pumped from very deep bore well and stored in these tanks and the stored water is used for irrigating crops. As the cost of construction of surface storage tank is very low (Rs.500 for a tank with an area of 25 cents of 9'' depth), it is becoming popular among the farmers. It is found that on an average nearly 10 cm of water per day is lost due to percolation and evaporation under this type structures.

Table 3.12 Water conservation methods adopted by sample farms in Kodangipalayam village

Particulars	1990-91	2000-01
Surface Storage tank	7	15
Farm Pond	2	18
Modern Irrigation techniques	4	12
Others	3	7

ALTERING CROP PATTERN

Altering cropping pattern towards less water consuming crops is another coping strategy adopted by the farmers in the study area. Inadequate groundwater availability to grow annual crops, groundwater recharge, labour scarcity and the huge cost of well deepening forced the farmers to go for rainfed annual agricultural crops and perennial fruit trees. Trees not only help the farmers to manage groundwater scarcity also help them to increase farm income. These trees act as cushion to reduce the impact of crop failure especially during droughts.

Table 3.13. Changes in cropping pattern in Kodangipalayam Village (Percent)

Year	Crop area in %				Total area (ha)
	Cotton	Banana	Sorghum	Cur. fallow	
1990-91	7	18	19	2	8.19
2000-01	0	0.04	40	22	8.17

During the survey it was found that farmers shifted from water consuming crops to rainfed crops particularly sorghum. Farmers prefer sorghum because this is mainly used for fodder for animals.

FARM DIVERSIFICATION

To cope up with the growing groundwater scarcity, farmers in general go for farm diversification by inclusion of different enterprises in their farms. The diversification is done by inclusion of livestock enterprises and trees in the farming system.

The presence of trees as part of contemporary farming systems has its origins in two attributes of trees. One is their role in maintaining and restoring the physical environment needed in order to sustain crop agriculture; most notably through the restoration of soil nutrients and energy. The other is the role various tree products play in helping sustain the rural household economy. This includes products used directly by the households as food, fuel, construction materials; inputs to agriculture such as fodder, mulch and raw materials for making agricultural implements and storage structure; and products or activities that provide household members with employment and income. Trees also help to fill in seasonal shortfalls of income and help reduce risk and lessen the impact of droughts and other emergencies.

Fuel wood is frequently the main source of energy used for cooking. For those with limited resources, the resource poor farmers, tree products often provide one of the few

income earning options. Products from farm trees are most extensively used to supplement other resource and income flows during particular seasons in the year. Many tree based employment opportunities are seasonal. For example, the collection of neem seeds by the farm family labourers. The seasonality of such activities is dictated by the availability of the product or raw materials. In some cases, the activities may be linked to seasonally induced cash needs such as loan repayments or school fees. This way trees act as 'mortgage lifters'. The very important role of tree based activities is an economic and environmental buffer, fodder. Trees play these roles in the farming system.

Table. 3.14. Diversification of farm activities in Kodangipalayam Village

Size group	1990-91					2000-01				
	Crop (ha)			Lives tock (no)	Tree crop (ha)	Crop (ha)			Lives tock (no)	Tree crop (ha)
	Cash crop	Sub. crop	Dry crop			Cash crop	Sub. crop	Dry crop		
Marginal	0.41	0.47	0.43	1	0.02	0.03	0.26	0.74	2	0.04
Small	0.92	1.62	0.40	3	0.08	0.20	0.11	0.94	4	0.40
Medium & Large	1.62	1.07	0.65	10	0.76	1.21	1.35	1.62	6	0.94

Farm diversification helps the farm households to derive additional income to meet expenditure on production, consumption and other social obligations.

WATERSHED DVELOPMENT

WATERSHED DEVELOPMENT ACTIVITIES

Drought Prone Area Programme (DPAP) of Government of India funded jointly by Ministry of Rural Development, Government of India and Government of Tamil Nadu was taken up on watershed basis in Coimbatore. The major objectives of the programme include (i) promotion of economic development of the village community which is directly or indirectly dependent upon the watershed through optimum utilization of watershed's natural resources (land, water and vegetation) that will mitigate adverse effects of drought, (ii) employment generation and development of the human and economic resources of watershed and (iii) encourage restoration of ecological balance in watershed through sustained community action. The watershed development

activities were implemented in five blocks of Coimbatore viz., Annur, Avinashi, Sulur, Palladam and Tiruppur since 1995-96 under the DPAP.

The details of various activities and their coverage are given in Table.3.15. The watershed treatment activities were broadly classified into soil and moisture conservation measures, drainage line treatment measures, water resources development, crop demonstration, horticulture plantation and afforestation measures. The various treatment activities were basically carried out to improve agricultural productivity and biomass in the DPAP watersheds.

Table.3.15. Details of various activities in the Kodangipalayam watershed

Activities	Unit	Kodangipalayam
Contour bunding	Ha	52
Land levelling	Ha	10
Summer ploughing	Ha	150
Crop demonstration	Ha	100
Vettiver plantation	Ha	50
Minor check dams	No	20
Major check dams	No	7
Loose boulder check dams	No.	20
Retaining walls	Rmt	108
Percolation ponds	No.	3
Farm ponds	No.	1
Renovation of tanks	No.	2
Drip/sprinkler irrigation	No.	4
Avenue plantation	Km	2
Horticulture plantation	Ha	16
Palm nut plantation	Ha	3
Fodder plots	Ha	1
Mulberry	Ha	2
Fuel wood plantation	Ha	10
Entry point activities	No	3

The Entry Point Activities were taken up for rapport and confidence building. Most of the entry point activities are of common interest to the watershed community. The major entry point activities undertaken were renovation of school building including fencing, noon meal centre, road repair, temple repair, drinking water supply, burial ground improvement, improvement/providing of drainage works in the village area and sanitation. The other major activities were training for Watershed Development Team members, Watershed Committee members and exposure visits to model watershed projects.

INSTITUTIONS INVOLVED

In the case of Watershed Development, the various organizations/ institutions involved are District Rural Development Agency (DRDA), Tamil Nadu Agricultural University, Department of Agricultural Engineering, Agriculture, Horticulture, Forestry, Sericulture and Public Works Department(PWD), NGO's etc. DRDA is the Nodal agency for most of the Watershed Development Projects in the district, while other departments are acting as the Project Implementing Agencies for the development activities.

Watershed Association and Committees comprising the village panchayat members and other local people were formed and registered under the Companies act of India. The development works are carried out with the help of User group members of the watershed and the Watershed Committee will be monitoring the works carried out. The recharge structure under study is being constructed by the Department of Agricultural Engineering as part of the Watershed Development works. Recently another check dam is being constructed just 200 metres downstream to the main recharge structure.

The normal elevation of water surfaces in this block ranged from approximately 328 to 334 metres. The data on rise and fall of water level from this normal elevation of water surface was noted from Public Works Department, Coimbatore district. To know the location specific water level fluctuations for this study purpose, the water level recorders were installed in two locations.

WATERSHED MANAGEMENT AND GROUNDWATER RECHARGE

During the survey / field inspection, almost all the major and minor check dams and percolation ponds and 70-80 per cent of other works were visited for observations, data collection / measurements and collecting necessary information as regards to condition of works. Construction of Percolation ponds, farm ponds, major and minor check dams and renovation of existing ponds have enhanced the available storage capacity in the watersheds to store runoff water for surface water use and ground water recharge.

Table 3.16 Increase in surface water storage capacity for Kodangipalayam watershed in Coimbatore District

Name of watershed	Surface water storage capacity (ha-cm)				Total storage (ha-cm)	Additional capacity increased (ha-cm)
	Reno. of tanks		New PP*	Min/Major, CD's		
	Before	After				
Kodangipalayam I	50.94	73.58	104.71	2.08	180.37	129.43
Kodangipalayam II	29.72	76.41	-	2.08	78.49	48.77

Table 3.17 Additional area brought under irrigation in Kodangipalayam watershed

Name of watershed	No. of wells influenced by groundwater recharge	Total irrigated area (ha)	Actual irrigated area (ha)	Additional irrigated area	
				(ha)	Increase (%)
Kodangipalayam	19	37	32.6	2.07	5.6

The recharge rate has now increased in the range of 25-31 per cent. It was also observed that recharge to wells decreased with distance of wells away from the percolation pond and influence could be generally observed up to a distance of about 500-600 m. On the basis of household survey it was observed that area under irrigation is increased by about 7 to 21 per cent and as a result of water availability, farmers have diversified crops also. Groundwater forms the main source of rural water supply in many regions of India. Whatever the causative factors, there has been a clear-cut decline in the availability and quality of groundwater resources in many regions. The discharge from aquifers depends upon the recharge to groundwater from rainfall. In a country like India, the groundwater system is sensitive to the vagaries of the monsoon. Wells tend to dry up in summers following abnormally low rainfall, inducing droughts in large tracts of the country. Short and long term problems pertaining to water resources have prompted several promising responses to the problem of water resources. Most of these responses have been in the form of integrated management of natural resources including surface and groundwater. Increasing recharge to groundwater is an important aspect of all these programs where in the groundwater development system is largely accepted and adopted as a mechanism for integrated management of natural resources.

The concept of groundwater systems is proposed the occurrence and movement of groundwater. A groundwater system should be considered as a unit for attempting groundwater management. Understanding the behavior of such a groundwater system as a response to actual and anthropogenic factors is the first step towards attempts in groundwater management. Similarly effective understanding of the recharge and discharge process operating within the groundwater system are important in planning groundwater management alternatives.

Community based interventions and legislation are two areas for attempting demand side groundwater management. Whereas community based groundwater management might be practically difficult, it could be a distinct possibility if backed by detailed scientific research in areas where some experience in natural resources management has already been gained. Groundwater legislation, are effective at times and already being developed in many States in India, has limitations in efficiency of practical implementation. Groundwater legislation will be an important tool, albeit in a different form as compared to its present status, in regulation, and control of groundwater utilization. Groundwater management must evolve within both physical and socio economic frameworks. Limited inputs were given in this study; issues of sustainability, equity and efficiency are the important for better groundwater management.

Natural and socio economic variability are characteristics in the two project areas. The factors controlling this variability need to be considered while developing the groundwater management. The foremost amongst these factors is the highly variable physical framework hosting groundwater systems, namely the topography, the geology, and soils. Most of the areas studied showed a well developed infrastructure for tapping the shallow groundwater systems. Groundwater abstraction is the single largest component of groundwater discharge in most areas. Priority in groundwater use, encouraging local level groundwater management groups and promoting innovative water allocation mechanisms could be three types of initiatives that could be implemented as a broad groundwater management mechanism. However, the exact implementation could only take place after detailed researches to gain a complete understanding of the groundwater systems are undertaken. Such researches ought to also include an important issues pertaining to these systems such as sustainability, equity and efficient management of the resources. Groundwater resources in an area are primarily governed by natural factors, mainly by the precipitation and the geology. Both these factors tend to vary considerably even over short distances and hence

attribute a certain complexity to the accumulation and flow of groundwater. These factors are also dictating the mechanisms of utilization of groundwater to a large extent. Primarily, geological variability of the resource; it also controls the quality of water to some extent; quality concerns are likely to be more natural. Rainfall provides the basic input to groundwater accumulation and rainfall patterns the availability of water over certain period of time. Many hard rock areas in India are also characterized by low and erratic rainfall patterns that attribute a degree of uncertainty to the groundwater resource. The efficiency of utilization, equity of the resource and its sustainability are going to be the core issues in groundwater planning and policies are implemented in time.

LIVELIHOOD AND OTHER IMPACTS ASSOCIATED WITH WATER-LEVEL DECLINES

This section presents the key results and findings from the field experience on livelihood aspects. The overall changes due to changes in groundwater scenario are grouped into three aspects viz., agricultural production, socio-economic and coping mechanism adopted by the rural households.

To study the relationship between water resources and household economy, it is important to understand the farming systems followed in the study area. There is no single type of farming; instead there is a large variety of farming systems, as a result of differences in the physical, biological and socio-economic environment. The farmers grow agricultural crops such as sugarcane, banana, maize and vegetables as main agricultural crops. Farmers grow trees on their lands. Trees provide the farm family with fuel wood, timber and fodder but also provide shade and reduce soil erosion and improve soil fertility. Further more, tree products are sold on the market for cash. In order to utilise the products from trees and to get supplemental income, the livestock are included in the farming system. Livestock provide manures to the agricultural crop production and trees. A further important characteristic of the prevailing farming system is the prevalence of supplementary off-farm and non-farm income activities.

For the present study, four production systems that can be distinguished within the farming system. They are the crop production system, the livestock production system, and the tree production system and off-farm and non-farm activities. To understand role of water resources in the farm household economy, the present study constructed a household model. The conceptual framework of the model is given in Fig.3.1. The figure depicts the organisation of the farm households. At a given moment in time, the stock of family labour, land, capital and knowledge are used for farm and

home production activities. The family labour is also used for off-farm and non-farm activities. The farm produced commodities generate a gross product. Part of the household production is consumed and partly sold in the market. This is consistent with the major part of world agriculture which is located intermediately on a continuum between a wholly commercial farm employing only hired labour and marketing all outputs and a pure subsistence farm using only family labour and producing no marketed surplus. The sale of commodities and wages from off-farm and non-farm activities and returns from investment, constitute the gross income. This income after deduction of the various costs involved in production generates a net income which permits the purchase of the means of consumption and production. Means of consumption and production are derived from the household as both a consumption and production unit. This is the way the farm households organise their household activities. This conceptual framework forms the basis of the analysis.

RECHARGE STRUCTURE-SCALE

RECHARGE SITE – KODANGIPALAYAM

The case study is being carried out in Kodangipalayam village. This village contained six hamlets namely, Sangothipalayam, Karanampettai, Perumagoundampalayam, Rasagoundampalayam, Chinnakodangipalayam, Periyakodangipalayam. In the first phase of the project, WTC identified the study area and collected socio-economic profile of the households in these 6 hamlets. The second phase of the project was started in July 2003 and will be completed in July 2005.

BASELINE INFORMATION

In order to characterise the site the following baseline information has been, or is being collected.

- The map of structure and the surrounding area to a radius of 0.5 km, including water features, drainage lines, field boundaries, wells/boreholes, habitations and positions of all monitoring equipment are under preparation along with the topographic survey.
- An assessment of geology in Coimbatore, thickness and nature of weathering of basement rocks etc is carried out in detail as part of project.
- Borehole drilled at five or six locations (Figure 7) and aquifer test is also conducted in both shallow and deep sites.
- Detailed topography map of the structure including catchment area is under progress.

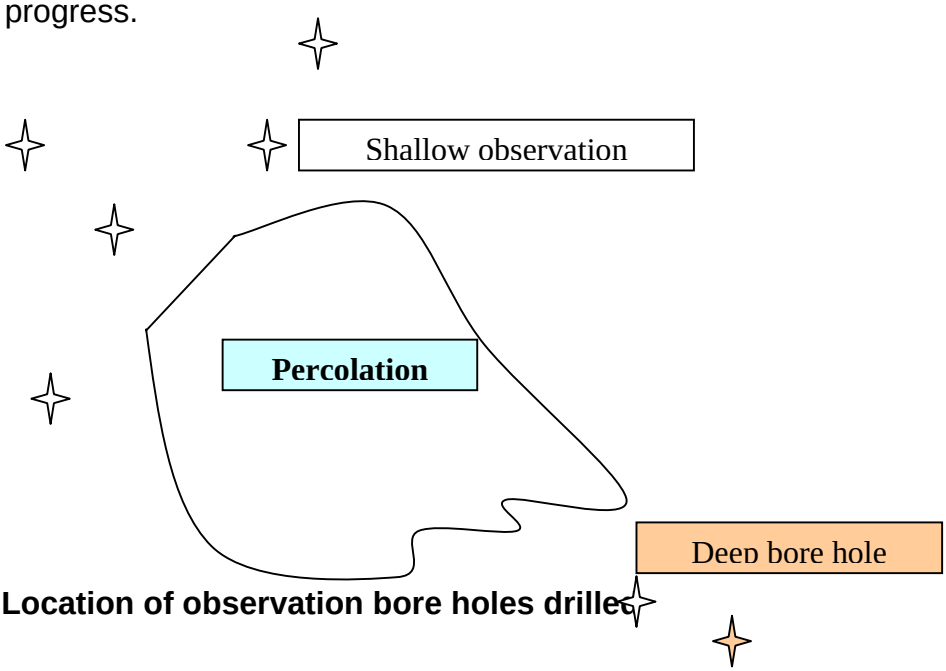


Fig. 8 Location of observation bore holes drilled

- Monitoring of groundwater levels in the open wells in Karanampettai and Kodangipalayam villages is carried out on a daily basis. In all, 28 well structures including three percolation ponds (dug wells, dug-cum-bore wells) are located within one kilometre are being monitored. These wells are identified taking into consideration the distance from the recharge structures and the probable zones of influence. All the wells are marked with benchmark identification codes.

The research activity on the AGRAR project at the Kodangipalayam village site commenced formally in March 2003, WTC staff have been visiting the site on a regular basis and looking at background data available with other institutions like PWD, TWAD Board etc. The geological mapping and preliminary hydrogeological surveys including well inventories have been completed. Base-maps were prepared, and developed into thematic maps as a result of these surveys.

DETAILS OF ALL INSTALLATIONS

- A water-level gauge post has been installed in the main recharge structure. Recently an automatic water level recorder is installed in the Karanampettai pond (KP PP) which enables automatic water level recording through a module fitted in the data logger. The water levels in the observation wells around the structure are measured with a water level dipper.

- An automatic weather station has been installed near the main structure at Karanampettai village. Data collected from the AWS is being processed and plotted graphically for analysis

- In addition to the Automatic Weather Station, two automatic rain gauges are installed near to the Kodangipalayam East and West ponds to check for the spatial variations in rainfall.

INITIAL FINDINGS AT THE RESEARCH SITE

TECHNICAL

Initially before installing the Automatic weather station, the rainfall for the project area is taken from Sulur station. From December 2003, all the meteorological parameters are measured in the Automatic Weather Station installed in the Karanampettai area.

The rainfall for the project area is shown in the figure 9 given below for the period 15th March, 2003 to 18th April, 2004. It has recorded a maximum of 120mm during 19th March, 2003. The evaporation from the open pan was recorded from 2nd December, 2003 to 21st April, 2004, the figure 10 shows the various daily evaporation rates, of which the minimum found to be on 10th December, 2003 about 1.13mm and maximum found to be 12.38mm on 17th January, 2004.

The water level in the Karanampettai was measured through the manual staff gauge and the figure 11 and 12 shows the decline in the water level for the various period of filling between 15th March, 2003 to 14th April, 2004 and the relative water level of the observation wells are shown in figure 13 and 14.

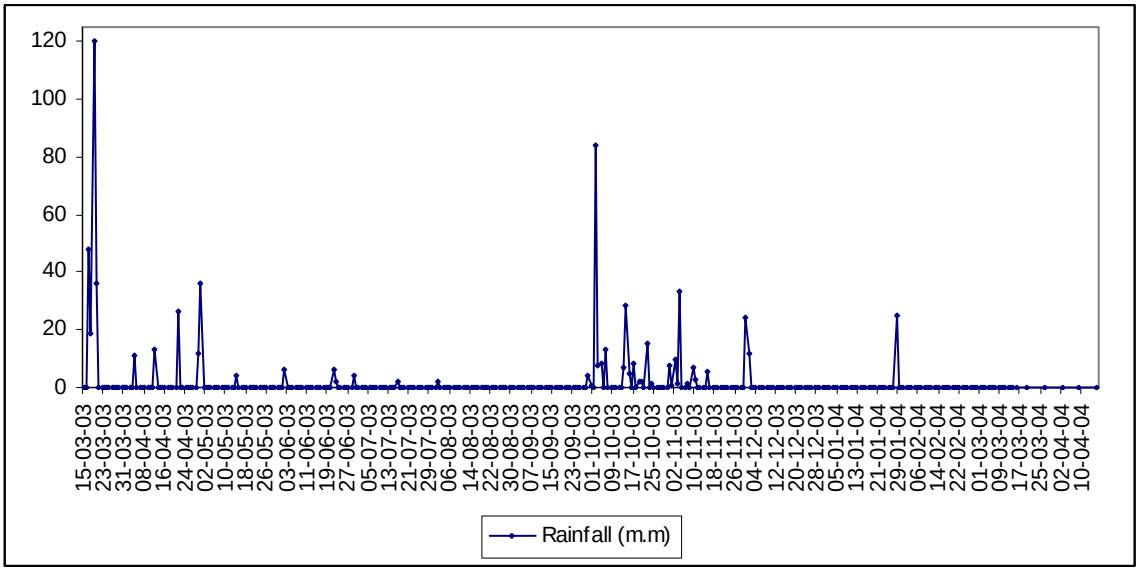


Fig 9. Rainfall pattern during project period

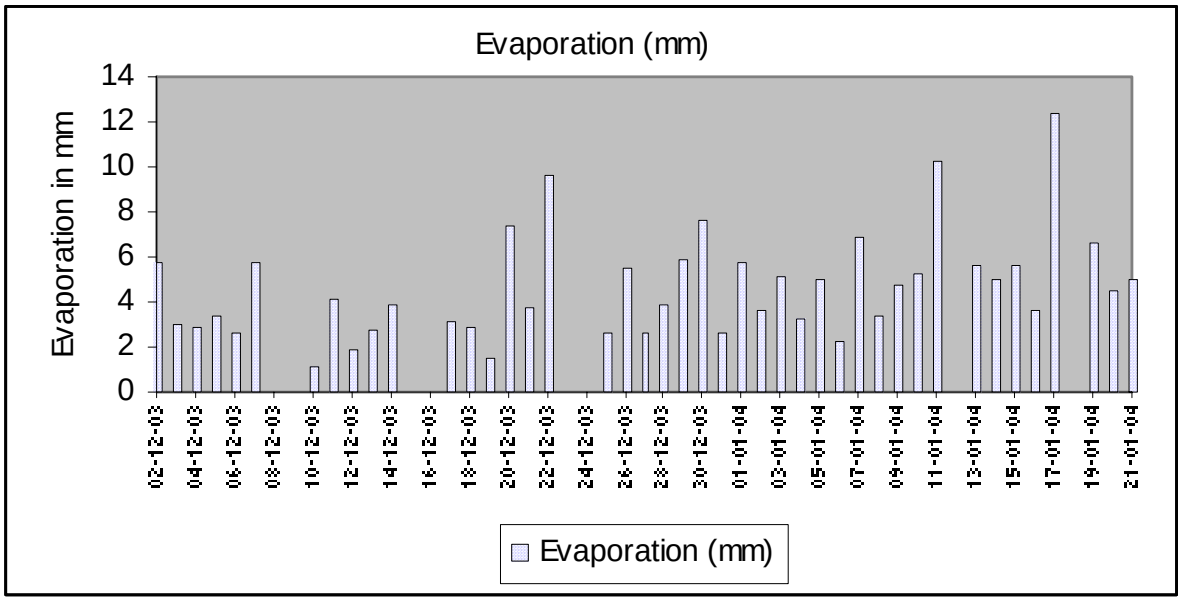


Fig 10. Pan evaporation in Karanampettai main pond

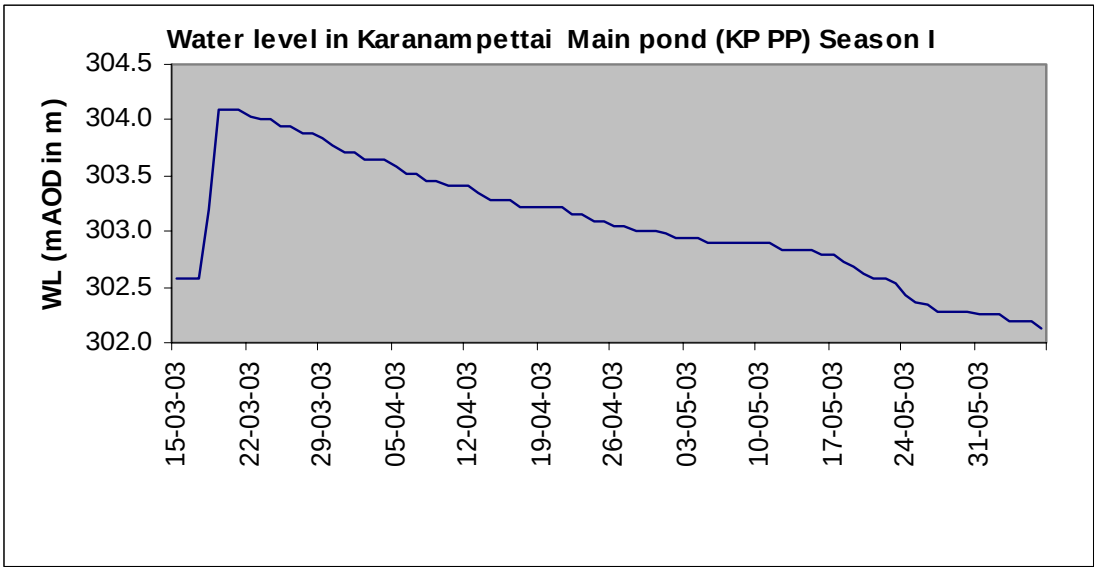


Fig 11. Water level in the Karanampettai structure during season I

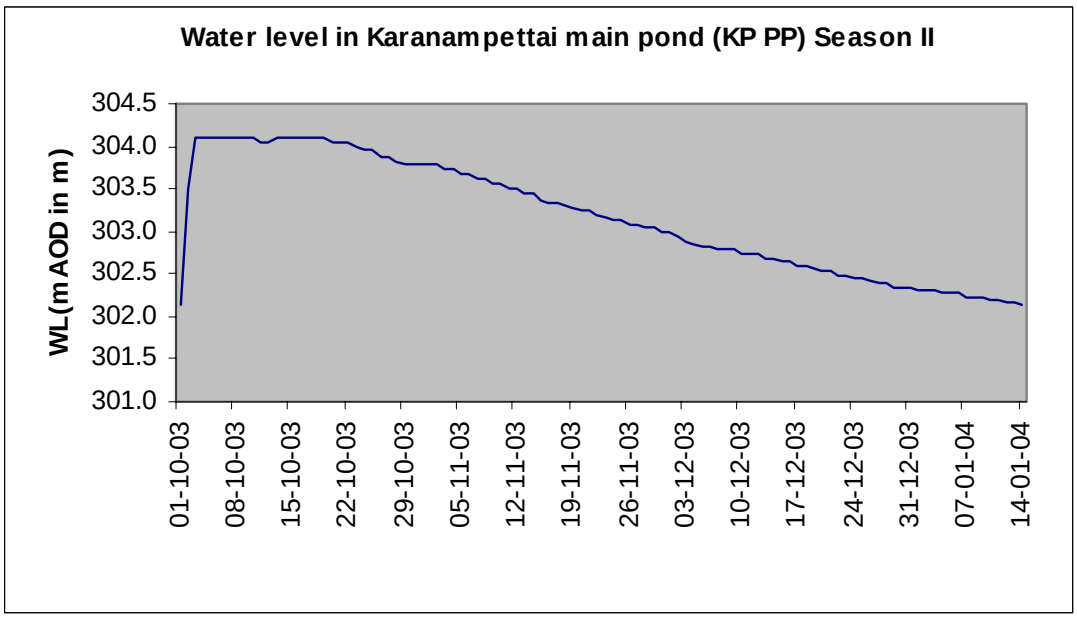


Fig 12. Water level in the Karanampettai structure during season II

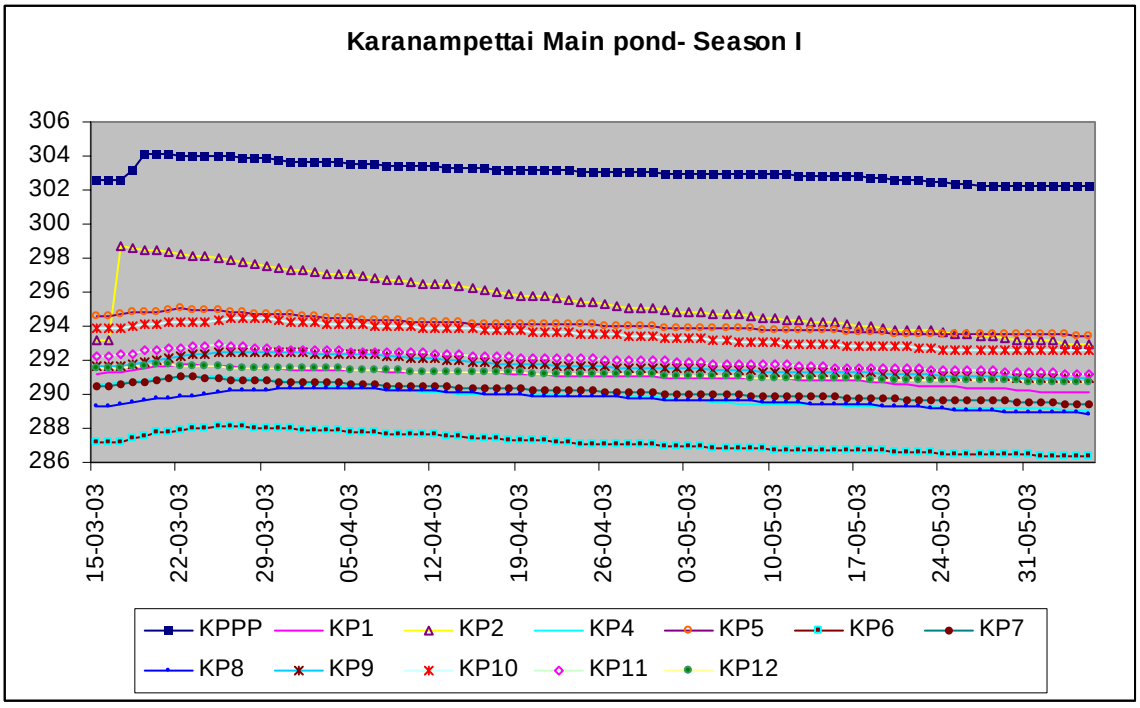


Fig 13. Relative water level in the structure to that in the surrounding boreholes and wells in the Karanampettai structure during season I

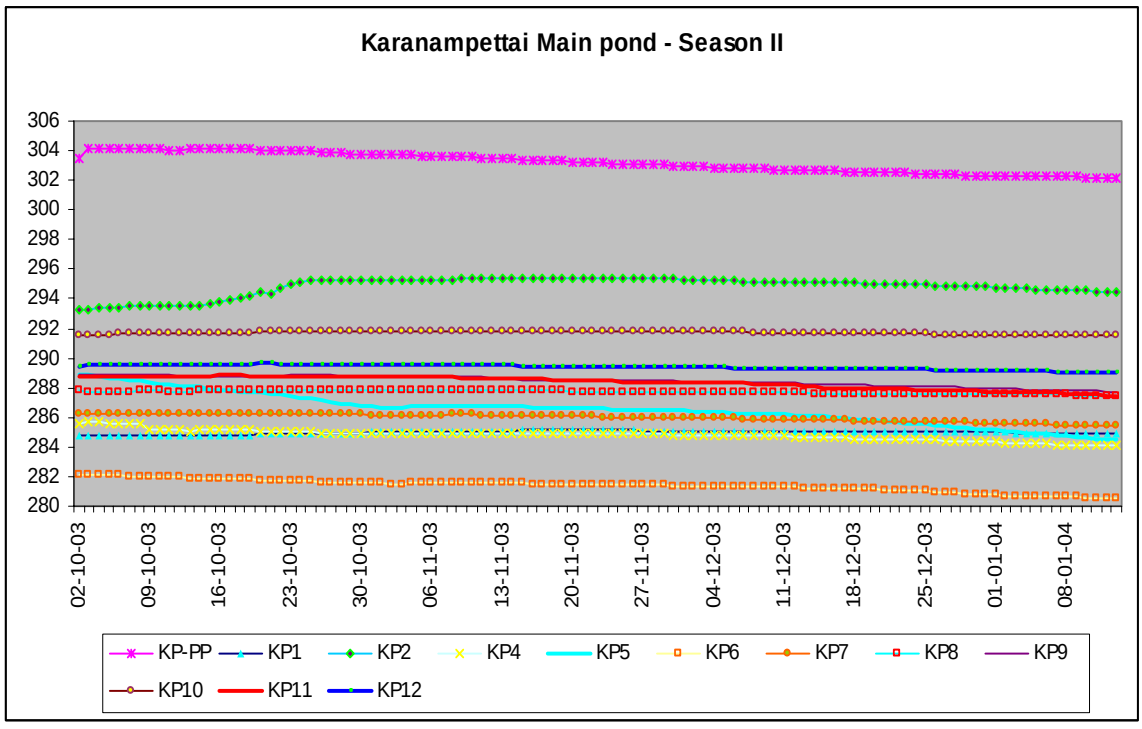


Fig 14. Relative water level in the structure to that in the surrounding boreholes and wells in the Karanampettai structure during season II

WATER CHEMISTRY RESULTS

Water samples collected from 23 wells, two bore wells and 3 structures were analyzed for water quality parameters. Samples showed medium to high salinity (ec between 0.25and 2.25 ds/m). Very high salinity was recorded (>2.25 ds/m) in four wells (nos. KPE2, KPE3, KPW 7, KPW 8) of Kodangipalayamand in three wells (nos. KP7, KP8 and KP9) of Karanampettai. Well no. KP 9 of Karanampettai had excessively high salinity (>5 ds/m). There was slight variation in salinity with stage of sampling showing continuous rise and fall in few locations. The concentration of chloride exceeding 10 me/1 in irrigation water is injurious to plants. In many of the wells, the chloride ion concentration was at injurious level. Many of wells in Karanampettai had more injurious chloride levels than Kodangipalayam with second stage of sampling chloride level generally increased slightly, and later decreased in the third stage of sampling.

RESULTS OF WATER CHEMISTRY OF WELLS, BORE WELLS AND POND IN KARANAMPETTAI AND KODANGIPALAYAM

Sl.No	Sample ID	pH				EC dS/m				CO3 (me /L)			
		25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03
		1	2	3	4	1	2	3	4	1	2	3	4
1	KPE 1	7.44	7.45	7.55	7.90	1.50	1.60	1.34	1.40	0.00	0.80	0.00	0.00
2	KPE 2	7.62	7.43	7.90	8.00	3.80	3.80	4.11	4.20	0.80	0.40	1.20	0.40
3	KPE 3	7.62	7.90	8.13	8.30	2.80	2.90	2.92	2.94	0.00	0.80	0.00	0.00
4	KPE 4	7.54	7.60	8.28	8.34	0.93	1.00	0.90	1.10	0.00	0.40	0.00	1.60
5	KPE BW	NA	8.16	8.69	8.70	NA	1.10	0.91	1.10	NA	2.00	2.40	0.80
6	KPW PP	7.62	7.61	7.97	8.15	0.40	0.60	0.41	0.45	0.00	0.80	0.00	0.00
7	KPW 1	7.87	7.85	8.14	8.30	1.40	1.20	1.13	0.90	0.00	0.80	0.00	1.60
8	KPW 2	8.08	7.72	8.22	8.35	1.00	1.00	1.00	0.90	0.00	0.80	0.00	0.80
9	KPW 3	7.85	7.62	NA	8.54	0.50	0.60	NA	0.50	0.00	0.80	NA	0.80
10	KPW 5	8.13	8.08	8.42	8.82	1.80	1.70	1.53	1.60	0.00	0.80	0.00	0.80
11	KPW 6	8.04	8.06	8.00	8.03	2.20	2.20	2.12	2.30	0.00	0.80	0.00	0.00
12	KPW 7	7.88	7.62	8.07	8.05	4.00	4.10	4.30	4.50	0.00	2.40	0.00	0.00
13	KPW 8	7.46	7.69	8.05	8.14	4.90	4.90	5.41	5.62	0.00	1.60	0.00	0.00
14	KPW 9	7.53	7.76	8.13	8.16	1.90	1.90	1.72	1.94	0.00	0.80	0.00	0.00
15	KP1	7.82	7.77	8.26	7.86	1.70	1.90	1.66	2.21	0.00	2.40	0.00	0.80
16	KP2	NA	NA	NA	7.98	NA	NA	NA	0.16	NA	NA	NA	0.00
17	KP3	7.44	NA	8.24	8.30	1.00	NA	0.90	1.20	0.00	NA	0.00	0.80
18	KP4	7.59	7.74	7.82	7.86	1.80	1.80	1.77	2.40	0.00	0.00	0.00	0.00
19	KP5	7.62	7.52	8.38	8.12	1.50	1.80	1.20	2.00	0.00	0.00	0.00	0.00
20	KP6	7.52	7.70	7.97	7.91	2.20	2.10	2.05	2.45	0.00	0.00	0.00	0.00

21	**KP7**	**7.59**	**7.67**	**8.01**	**8.08**	**2.20**	**2.30**	**2.16**	**2.90**	**0.80**	**0.00**	**0.00**	**0.00**
22	**KP8**	**7.30**	**7.66**	**7.86**	**8.13**	**3.80**	**3.30**	**3.10**	**3.20**	**0.00**	**0.00**	**0.00**	**0.00**
23	**KP9**	**7.32**	**6.91**	**7.61**	**7.96**	**6.80**	**6.80**	**6.10**	**6.90**	**0.00**	**0.00**	**0.00**	**0.00**
24	**KP10**	**8.30**	**8.04**	**8.45**	**8.50**	**1.50**	**1.50**	**1.34**	**1.60**	**1.60**	**0.80**	**0.00**	**1.60**
25	**KP11**	**8.36**	**7.92**	**7.98**	**8.16**	**1.90**	**2.10**	**1.81**	**1.90**	**1.60**	**0.00**	**0.00**	**0.00**
26	**KP12**	**7.80**	**8.07**	**8.20**	**7.85**	**1.20**	**1.00**	**1.10**	**1.50**	**0.00**	**0.00**	**0.00**	**0.00**
27	**KP BW**	**8.30**	**7.60**	**NA**	**8.46**	**0.90**	**0.60**	**NA**	**0.30**	**0.80**	**0.00**	**NA**	**0.80**
28	**KP PP**	**NA**	**NA**	**NA**	**8.00**	**NA**	**NA**	**NA**	**0.19**	**NA**	**NA**	**NA**	**0**

RESULTS OF WATER CHEMISTRY OF WELLS, BORE WELLS AND POND IN KARANAMPETTAI AND KODANGIPALAYAM (CONTD…)

Sl. No	Sample ID	HCO3(me /L)				Cl (me /L)				SO4 (me /L)				Ca (me /L)			
		25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	KPE 1	5.20	5.60	4.80	4.80	9.2	8.8	8.4	5.2	0.37	0.46	0.53	0.55	6.56	7.44	5.84	5.40
2	KPE 2	8.40	8.00	7.00	8.20	22.8	22.8	24.0	28.0	1.99	2.50	1.40	1.36	10.00	9.60	11.04	11.92
3	KPE 3	8.40	8.80	8.40	8.40	16.8	16.8	16.0	16.4	1.78	2.18	1.14	1.25	5.36	7.28	8.24	8.32
4	KPE 4	4.80	4.20	5.00	3.20	3.0	3.6	4.4	4.4	1.35	1.55	0.94	0.96	4.24	4.32	3.92	5.20
5	KPE BW	NA	4.20	3.20	4.40	NA	5.2	5.6	4.8	NA	0.49	0.38	0.41	NA	1.76	1.60	2.00
6	KPW PP	1.60	2.00	4.00	2.40	2.4	3.2	2.0	2.0	0.04	0.26	0.49	0.53	2.08	2.64	2.64	2.00
7	KPW 1	1.60	2.80	3.20	2.40	8.0	6.4	7.2	5.6	0.93	0.88	0.47	0.57	5.20	5.28	4.64	4.00
8	KPW 2	4.80	3.20	5.60	3.60	4.4	5.6	4.0	4.0	0.47	0.39	0.23	0.23	2.32	2.96	2.72	1.80
9	KPW 3	3.20	3.20	NA	4.00	1.6	1.6	NA	0.8	0.01	0.23	NA	0.00	0.88	2.56	NA	3.20
10	KPW 5	7.20	5.60	7.20	5.20	8.6	8.8	9.2	10.4	1.37	1.41	0.67	0.69	1.28	2.96	2.00	2.20
11	KPW 6	5.60	4.80	6.00	7.20	12.8	13.6	13.2	13.6	2.09	1.96	1.02	1.09	3.20	3.92	4.56	7.60
12	KPW 7	6.00	4.00	5.60	6.00	29.6	30.4	28.8	28.8	2.95	3.40	2.99	3.27	10.20	10.72	11.44	12.00
13	KPW 8	6.40	4.00	4.80	5.60	38.0	37.6	40.0	42.8	3.22	3.59	2.67	2.98	10.80	12.24	16.72	18.00
14	KPW 9	7.60	6.40	6.40	7.20	10.0	10.4	8.4	10.0	0.59	0.93	0.29	0.32	8.48	8.48	9.92	9.20
15	KP1	4.00	2.80	5.20	3.20	12.0	11.6	12.4	13.6	1.04	1.06	0.52	0.58	7.44	7.92	8.24	5.80
16	KP2	NA	NA	NA	2.00	NA	NA	NA	1.2	NA	NA	NA	0.36	NA	NA	NA	3.20
17	KP3	5.20	NA	6.80	5.60	4.4	NA	3.6	4.0	0.07	NA	0.18	0.19	4.00	NA	4.16	5.00
18	KP4	6.40	5.60	4.80	4.80	11.6	11.2	11.2	13.2	0.03	0.70	0.15	0.15	9.20	7.76	8.56	7.00
19	KP5	5.60	5.20	5.20	3.60	9.2	12.0	7.2	12.0	0.05	0.28	0.56	0.51	8.96	8.80	6.96	7.40
20	KP6	4.80	4.00	4.00	3.20	16.0	16.4	14.6	16.0	0.61	0.25	2.31	2.22	8.88	9.92	9.68	8.80
21	KP7	4.80	4.00	6.00	3.20	15.6	16.0	15.0	17.6	0.20	2.37	2.15	2.17	11.20	11.04	8.72	10.00
22	KP8	6.00	4.00	6.00	5.20	27.6	25.2	21.2	26.8	3.80	3.57	1.96	2.01	11.60	13.20	8.64	12.00
23	KP9	5.60	7.20	7.60	8.00	56.4	57.6	51.6	48.8	5.88	2.88	3.54	3.62	27.20	28.24	24.96	25.20
24	KP10	4.40	6.00	6.40	4.00	8.0	7.6	7.6	5.6	0.08	0.29	1.13	1.20	6.80	5.84	3.44	4.80
25	KP11	5.20	5.20	5.40	4.00	10.8	13.6	12.0	10.4	0.36	1.13	0.48	0.53	7.68	9.92	5.12	6.60
26	KP12	4.80	4.00	4.20	4.80	5.2	4.4	5.2	8.4	1.07	1.04	0.27	0.31	3.68	4.24	4.72	6.40
27	KP BW	4.40	3.20	NA	2.80	2.8	2.4	NA	0.4	0.26	0.21	NA	0.30	1.60	2.56	NA	2.20
28	KP PP	NA	NA	NA	2	NA	NA	NA	1.6	NA	NA	NA	0.203	NA	NA	NA	2.8

RESULTS OF WATER CHEMISTRY OF WELLS, BORE WELLS AND POND IN KARANAMPETTAI AND KODANGIPALAYAM (CONTD…)

Sl.No	Sample ID	Mg (me /L)				Na (me /L)				K (me /L)			
		25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03
		1	2	3	4	1	2	3	4	1	2	3	4
1	KPE 1	5.53	4.50	5.45	4.14	2.84	3.63	2.26	2.40	0.06	0.18	0.06	0.06
2	KPE 2	5.72	7.89	8.37	8.21	14.88	13.65	14.57	15.19	6.42	6.73	6.12	6.57
3	KPE 3	1.66	2.68	3.55	4.18	15.19	13.35	12.48	13.06	5.40	5.54	4.72	4.99
4	KPE 4	2.53	2.37	2.68	1.78	2.55	2.99	2.26	3.30	0.06	0.12	0.12	0.06
5	KPE BW	NA	3.08	2.53	1.58	NA	6.90	5.64	6.90	NA	0.24	0.18	0.18
6	KPW PP	1.50	1.97	1.26	2.57	0.46	1.38	0.55	0.84	0.12	0.24	0.18	0.18
7	KPW 1	3.79	2.29	2.13	2.76	4.32	3.97	3.63	2.55	0.57	0.18	0.12	0.12
8	KPW 2	3.36	3.47	2.53	2.96	3.97	3.63	4.32	3.97	0.12	0.18	0.12	0.18
9	KPW 3	3.39	2.92	NA	1.97	0.64	0.55	NA	0.38	0.01	0.01	NA	0.01
10	KPW 5	4.58	2.13	4.42	4.93	12.19	11.63	8.75	11.35	0.06	0.12	0.12	0.12
11	KPW 6	3.55	5.05	3.95	5.13	14.57	12.77	13.35	10.54	0.01	0.06	0.01	0.06
12	KPW 7	9.39	9.32	9.39	10.07	17.82	18.51	20.29	18.51	2.17	2.37	1.61	1.88
13	KPW 8	14.01	16.34	13.34	10.86	22.91	19.57	22.52	21.39	0.57	0.71	0.50	0.57
14	KPW 9	4.97	4.97	3.63	5.33	5.06	5.06	3.80	3.63	0.57	0.64	0.37	0.50
15	KP1	4.42	5.29	3.71	5.92	5.25	5.06	4.50	6.68	0.06	0.18	0.12	0.12
16	KP2	NA	NA	NA	1.18	NA	NA	NA	0.06	NA	NA	NA	0.01
17	KP3	3.55	NA	2.76	3.75	2.40	NA	1.99	3.46	0.06	NA	0.06	0.12
18	KP4	5.68	5.92	6.00	6.12	3.30	3.80	2.99	5.06	0.12	0.24	0.12	0.24
19	KP5	2.84	5.37	2.13	5.92	2.99	3.63	2.99	3.15	0.12	0.18	0.06	0.12
20	KP6	8.21	6.39	7.11	6.91	4.32	4.68	3.63	5.06	0.12	0.18	0.06	0.18
21	KP7	6.87	5.92	8.76	8.88	3.97	5.25	4.14	4.68	0.12	0.24	0.12	0.18
22	KP8	11.45	7.11	10.42	14.80	14.57	12.19	11.35	10.81	0.24	0.30	0.12	0.24
23	KP9	12.32	17.92	11.21	16.97	28.17	21.39	24.07	20.65	0.24	0.37	0.18	0.24
24	KP10	3.24	4.11	5.29	3.16	4.50	4.68	4.32	4.68	0.12	0.18	0.12	0.06
25	KP11	5.61	5.37	6.00	3.75	5.06	4.68	4.87	4.50	0.06	0.18	0.06	0.06
26	KP12	3.39	2.29	2.92	5.13	4.68	3.30	2.69	2.69	0.06	0.18	0.06	0.06
27	KP BW	3.16	1.50	NA	0.20	3.63	1.86	NA	2.13	0.18	0.01	NA	0.00
28	KP PP	NA	NA	NA	1.579	NA	NA	NA	0.551	NA	NA	0.00	KP PP

RESULTS OF WATER CHEMISTRY OF WELLS, BORE WELLS AND POND IN KARANAMPETTAI AND KODANGIPALAYAM (CONTD…)

Sl.No	Sample ID	TSS (ppm)				SAR				RSC			
		25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03	25.08.03	11.09.03	30.09.03	28.10.03
		1	2	3	4	1	2	3	4	1	2	3	4
1	KPE 1	961.5	1025.6	858.9	897.4	1.15	1.49	0.95	1.10	-6.89	-5.54	-6.49	-4.74
2	KPE 2	2435.8	2435.8	2634.5	2692.2	5.31	4.62	4.68	4.79	-6.52	-9.09	-11.21	-11.53
3	KPE 3	1794.8	1858.9	1871.7	1884.5	8.11	5.98	5.14	5.22	1.38	-0.36	-3.39	-4.10
4	KPE 4	596.1	641.0	576.9	705.1	1.38	1.64	1.25	1.77	-1.97	-2.09	-1.60	-2.18
5	KPE BW	NA	705.1	583.3	705.1	NA	4.44	3.93	5.16	NA	1.36	1.47	1.62
6	KPW PP	256.4	384.6	262.8	288.5	0.35	0.91	0.39	0.55	-1.98	-1.81	0.10	-2.17
7	KPW 1	897.4	769.2	724.3	576.9	2.04	2.04	1.97	1.38	-7.39	-3.97	-3.57	-2.76
8	KPW 2	641.0	641.0	641.0	576.9	2.35	2.02	2.67	2.57	-0.88	-2.43	0.35	-0.36
9	KPW 3	320.5	384.6	NA	320.5	0.44	0.33	NA	0.23	-1.07	-1.48	NA	-0.37
10	KPW 5	1153.8	1089.7	980.7	1025.6	7.12	7.29	4.88	6.01	1.34	1.31	0.78	-1.13
11	KPW 6	1410.2	1410.2	1358.9	1474.3	7.93	6.03	6.47	4.18	-1.15	-3.37	-2.51	-5.53
12	KPW 7	2564.0	2628.1	2756.3	2884.5	5.69	5.85	6.29	5.57	-13.59	-13.64	-15.23	-16.07
13	KPW 8	3140.9	3140.9	3467.8	3602.4	6.50	5.18	5.81	5.63	-18.41	-22.98	-25.26	-23.26
14	KPW 9	1217.9	1217.9	1102.5	1243.5	1.95	1.95	1.46	1.35	-5.85	-6.25	-7.15	-7.33
15	KP1	1089.7	1217.9	1064.1	1416.6	2.16	1.97	1.84	2.76	-7.86	-8.01	-6.75	-7.72
16	KP2	NA	NA	NA	102.6	NA	NA	NA	0.04	NA	NA	NA	-2.38
17	KP3	641.0	NA	576.9	769.2	1.24	NA	1.07	1.66	-2.35	NA	-0.12	-2.35
18	KP4	1153.8	1153.8	1134.6	1538.4	1.21	1.45	1.11	1.97	-8.48	-8.08	-9.76	-8.32
19	KP5	961.5	1153.8	769.2	1282.0	1.23	1.36	1.40	1.22	-6.20	-8.97	-3.89	-9.72
20	KP6	1410.2	1346.1	1314.1	1570.5	1.48	1.64	1.25	1.80	-12.29	-12.31	-12.79	-12.51
21	KP7	1410.2	1474.3	1384.6	1858.9	1.32	1.80	1.40	1.52	-12.47	-12.96	-11.48	-15.68
22	KP8	2435.8	2115.3	1987.1	2051.2	4.29	3.83	3.68	2.95	-17.05	-16.31	-13.06	-21.60
23	KP9	4358.8	4358.8	3910.1	4422.9	6.34	4.45	5.66	4.50	-33.92	-38.96	-28.57	-34.17
24	KP10	961.5	961.5	858.9	1025.6	2.01	2.10	2.07	2.35	-4.04	-3.15	-2.33	-2.36
25	KP11	1217.9	1346.1	1160.2	1217.9	1.96	1.69	2.06	1.98	-6.49	-10.09	-5.72	-6.35
26	KP12	769.2	641.0	705.1	961.5	2.49	1.83	1.38	1.12	-2.27	-2.53	-3.44	-6.73
27	KP BW	576.9	384.6	NA	192.3	2.35	1.31	NA	1.94	0.44	-0.86	NA	1.20
28	KP PP	NA	NA	NA	121.79	NA	NA	NA	0.373	NA	NNA	NA	-2.37895

Though the water samples are within the safer limit regarding sodicity, KPE 2, KPE 3, KPE BW, KPW 5, KPW 6, KPW 7, KPW 8, KP8 and KP9 are towards sodicity build up. Samples from KPE BW and KPW 5 are found have residual sodium carbonate.

SOCIO-ECONOMIC

IMPACT OF ARTIFICIAL RECHARGE ON LIVELIHOODS

The households in the artificial recharge zone had a steady improvement over the period due to the watershed activities. The main beneficiaries were the people in the downstream of the recharge structure. During the rainy season the artificial recharge zone has direct impact on ground water recharge. The non- artificial recharge zone has

to decide the cropping pattern by involving a factor of the water scarcity or the assurance of irrigation. The non-artificial recharge zone people mostly go for the crops with less water consumption which in turn affects the income.

Other activities carried out were livestock, cattle rearing etc, which recorded a stable growth in terms of income in artificial recharge areas. But in the non- artificial recharge zone, the income is uncertain and the cattle population reduced over the period due to the water scarcity. Naturally farmers forced to involve in other economic activities such as power looms etc.

Main concerns were the drinking water and food requirement for human and livestock to reseed in the area. This causes panic during the drought periods, where the drinking water itself is problem which leads to reduction in livestock population and migration etc.

There is clear evidence that due to the artificial recharge programmes the livelihood in the artificial recharge zones is stabilized and the farmers are getting more confidence in the agriculture and allied activities. There is some improvement in the livelihood standard and in the asset position. There is noticeable improvement in education, entertainment, food pattern etc.

This development helped the artificial recharge zone (downstream) people since the available water is used for the agriculture for at least a season. If the watershed activities continued and maintained properly then the people in the upstream also will benefit and the cropping activities can be carried out throughout the year. So this artificial recharge programme can be trusted and it can improve the standard of living in the village as a whole due to creation of new employment.

AGRICULTURE

Survey to be taken from the farmers and their land holdings with cropping in surrounding fields, including above and below average rainfall years, irrigation methods Structure management practices. Strategies adopted by farmers and their cost-benefit will also are highlighted.

Farmers don’t pump from the recharge structures, the water is allowed to percolate down to the under ground aquifers. Irrigation methods followed are flooding for vegetables, turmeric, tobacco etc. and drip irrigation for horticultural crops.

There is no agreed maintenance plan. However, given the DPAP mandate the stakeholder will be responsible for management of the structures. Government is making necessary intervention to do this by the beneficiaries.

Preliminary socio-economic surveys have been initiated in some of the villages. Background information has also been collected from various sources including primary and secondary sources.

CONCEPTUAL FLOW MODEL

Based on the available data and information's gathered through surveys to be undertaken as part of the study will be used for framing the conceptual model of water flow. The initial model that is being tested through data collection and monitoring. Shallow aquifer in Kodangipalayam village is based on both, geological and hydrogeological observations made so far, the conceptual model illustrates the geometry of the shallow unconfined aquifer. The aquifer is well-bound in the sense that it has a well-defined impermeable base in the form of the composite gneissic structures and that underlies the charnockite rocks. The shallow aquifer is likely to be within the horizontally jointed and massive charnockite based rock unit. Field observations in wells indicate that these fractured and jointed migmatite and composite gneisses are well developed towards the watershed boundaries.

There are not many deep bore wells in kodangipalayam village, some bore wells in the study area are about 200 m deep. In order to understand whether the head in these deeper aquifers is different from the shallow water table, two deep borehole is being drilled in the main structure in the up-stream side. Pumping test may be conducted in the main structure and satellite structure.