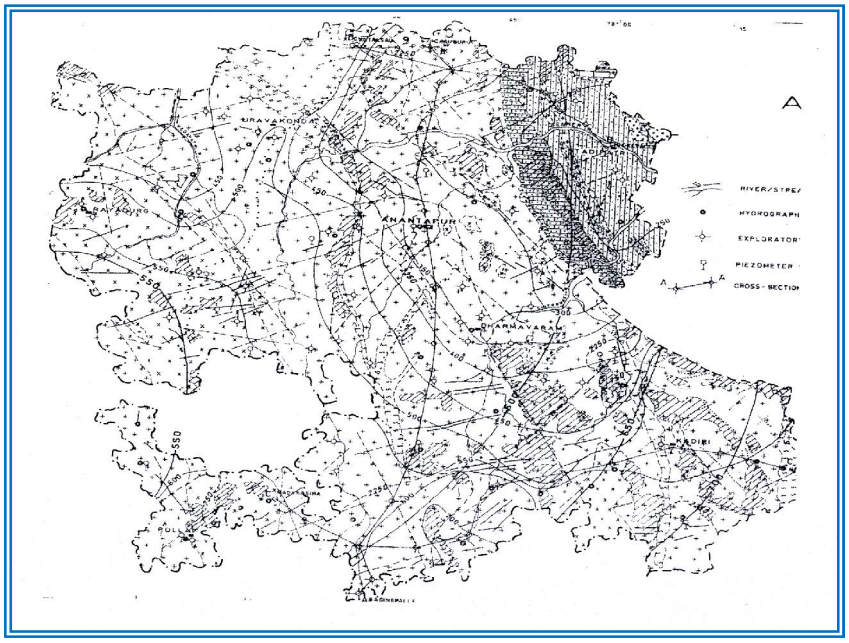
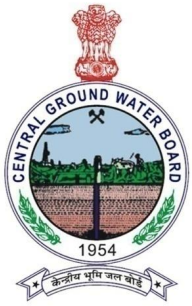
For Official Use Only

CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

GROUND WATER BROCHURE
ANANTAPUR DISTRICT, ANDHRA PRADESH



SOUTHERN REGION
HYDERABAD
September 2013



CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

GROUND WATER BROCHURE
ANANTAPUR DISTRICT, ANDHRA PRADESH
(AAP- 2012-13)

By

V.VINAY VIDYADHAR,
ASSISTANT HYDROGEOLOGIST

SOUTHERN REGION
GSI Post, Bandlaguda
Hyderabad-500068
Andhra Pradesh
Tel: 040-24225201
Gram: Antarjal

BHUJAL BHAWAN,
NH.IV, FARIDABAD -121001
HARYANA, INDIA
Tel: 0129-2418518
Gram: Bhumijal

GROUND WATER BROCHURE

ANANTAPUR DISTRICT, ANDHRA PRADESH

CONTENTS

DISTRICT AT A GLANCE

1. GENERAL	North Latitude:	13° 40’	16°15’
Location	East Longitude	70° 50’	78°38’
Geographical area (sq.km)		19,197	
Headquarters		Anantapur	
No. of revenue mandals		65	
No. of revenue villages		964	
Population (2011)			
Total		4083315	
Population density (persons/sq.km)		213	
Work force			
Cultivators		4,85,056	
Agricultural labour		4,62,292	
Major rivers		Pennar, Papagni Maddileru, Tadikaluru Naravanka	
Soils		Red sandy soil, Mixed red and black soil	
Agroclimatic zone		Scarce Rainfall zone and	
2. RAINFALL			
Normal annual rainfall	Total	535 mm	
	Southwest monsoon	316 mm	
	Northeast monsoon	146 mm	
	Summer	72 mm	
Cumulative departure from	- 31%		

3. LAND USE (2012) (Area in ha)

Forest	196978
Barren and uncultivated	167469
Cultivable waste	48856
Current fallows	85754
Net area sown	1049255

4. IRRIGATION 2012 (area in ha)

Canals	22,836
Tanks	898
Dug wells	5579

Bore/Tube wells	11525 + 111525
Others	1,548
Net area irrigated	1,42,386
Gross area irrigated	1,71,932
Major irrigation projects	Tungabhadra High level canal
Medium irrigation projects	1. Upper Pennar 2. Bhairavathippa 3.Chinnarayaswamy 4.Pennar Kumbdavati 5. Yogi Vemana

5. GEOLOGY

Major rock types	Granites, gneisses Quartzites, shales & limestones

6. GROUND WATER

Exploration by CGWB	
No. of wells drilled	108
Major aquifer zones (m bgl)	8-132
Depth to Water level	
Pre-monsoon (min –max)	0.65 – 11.97 m bgl
Post monsoon (min –max)	0.37 – 15.26 m bgl
Aquifer parameters	
Transmissivity (sq.m/day)/Hard rock	0.5 to 316 sq.m/day
Storage Co-efficient Hard rock	7.4x10-4 to 9.4x10-3

7. GROUND WATER RESOURCES (MCM)

Net ground water availability	120856 ham
Gross annual draft	411.85 ham
Balance resource	709.73 ham
Stage of ground water development	34%

8. CHEMICAL QUALITY(May2012)

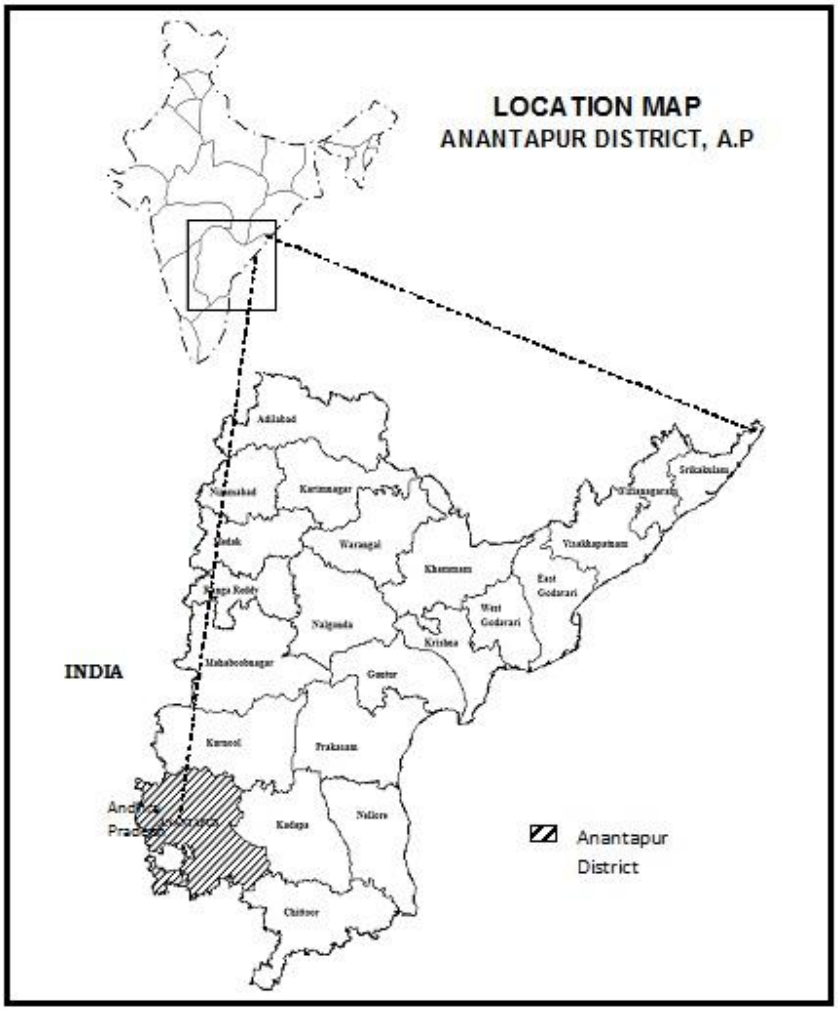
Electrical Conductivity (micro Siemens/cm at 25°C)	569-9990
Chloride (mg/l)	43-1560
Fluoride (mg/l)	0.03-45
Nitrate (mg/l)	2.0-600

GROUND WATER BROCHURE
ANANTAPUR DISTRICT, ANDHRA PRADESH

1. INTRODUCTION

Anantapur district is one of the four districts of Rayalaseema Region and the largest among the 23 districts of Andhra Pradesh. The district is economically backward and chronically drought affected. The district has three revenue districts, 63 mandals and 932 revenue villages and 7 municipalities. The district lies between North latitudes 13° 40' and 16° 15' and between East longitudes 70° 50' and 78° 38'. The district occupies the southern part of the State and is bounded on the north by Bellary district of Karnataka State and Kurnool district of Andhra Pradesh, on the East by Cuddapah and Chittoor districts of Andhra Pradesh and on the South and West by Karana state (**Fig.1**). The geographical area of the district is 19,197 sq.km with a population of 40.83 lakhs. The population density, which was 54 persons per sq.km during 1901, has risen to 213 persons per sq.km as per 2011 census.

Fig: 1.Location and Administrative Map

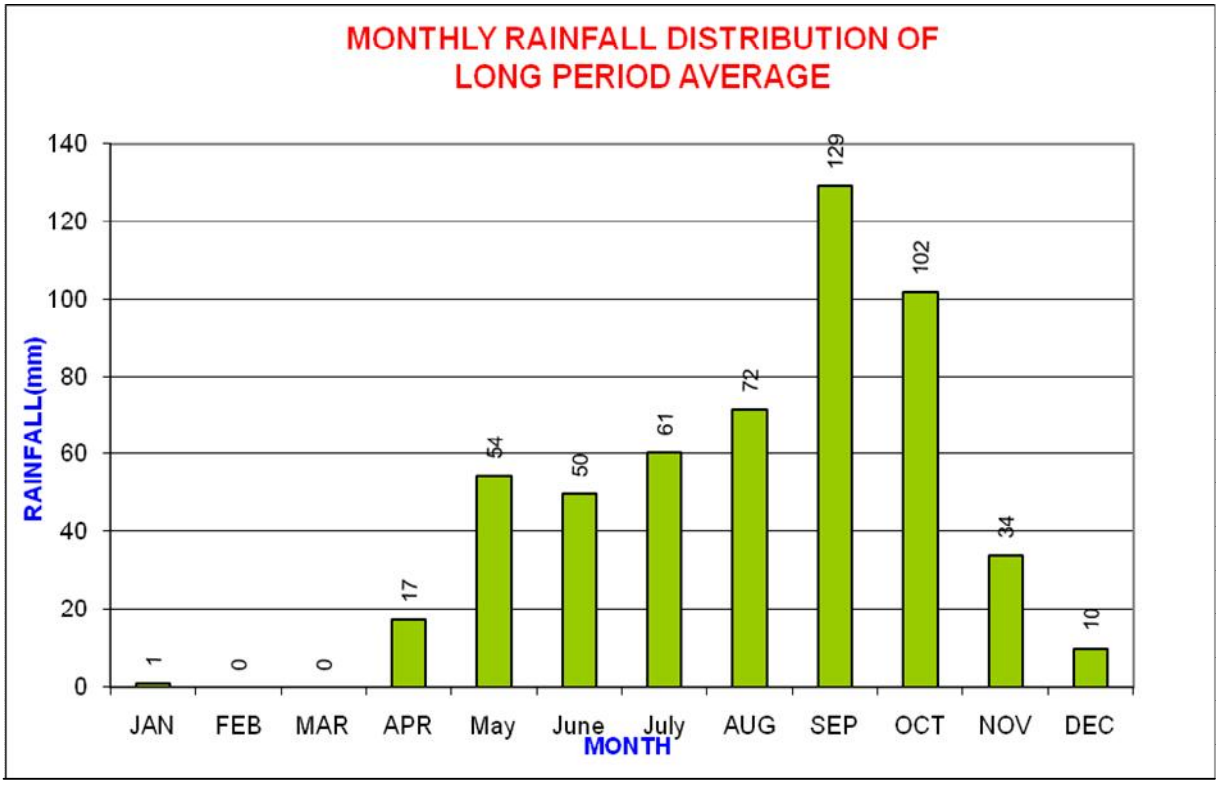


Out of the total geographical area of 19.197 sq. km, forests cover 10% of the area. Similarly, barren and uncultivable land is 9% and land put to non-agricultural use is 8%. The total net area sown is 824955 ha. The important crops harvested in the district are paddy, jowar, ragi, chillis, sugarcane, onions and groundnut. Paddy and ground nut are the most important crops accounting for gross hactarage of 65,550 and 36,500 respectively.

2. CLIMATE

The average annual rainfall of the district is 535 mm, which ranges from nil rainfall in February and March to 129 mm in September. September and October are the wettest months of the year. The mean seasonal rainfall distribution is 316 mm during southwest monsoon (June-September) 146 mm during northeast monsoon (Oct-Dec), 1 mm rainfall during winter (Jan-Feb) and 72 mm during summer (March-May). The percentage distribution of rainfall season wise is 58.7% in southwest monsoon, 27.6% in northeast monsoon, 0.21 percentages in winter and 13.5% in summer. The mean monthly rainfall distribution is given in **Fig. 2.**

Fig: 2. Mean monthly rainfall distribution



The annual and seasonal rainfall distribution with its departure from mean along with percentage distribution for the period 1999 – 2011 is given in **Table-1**.

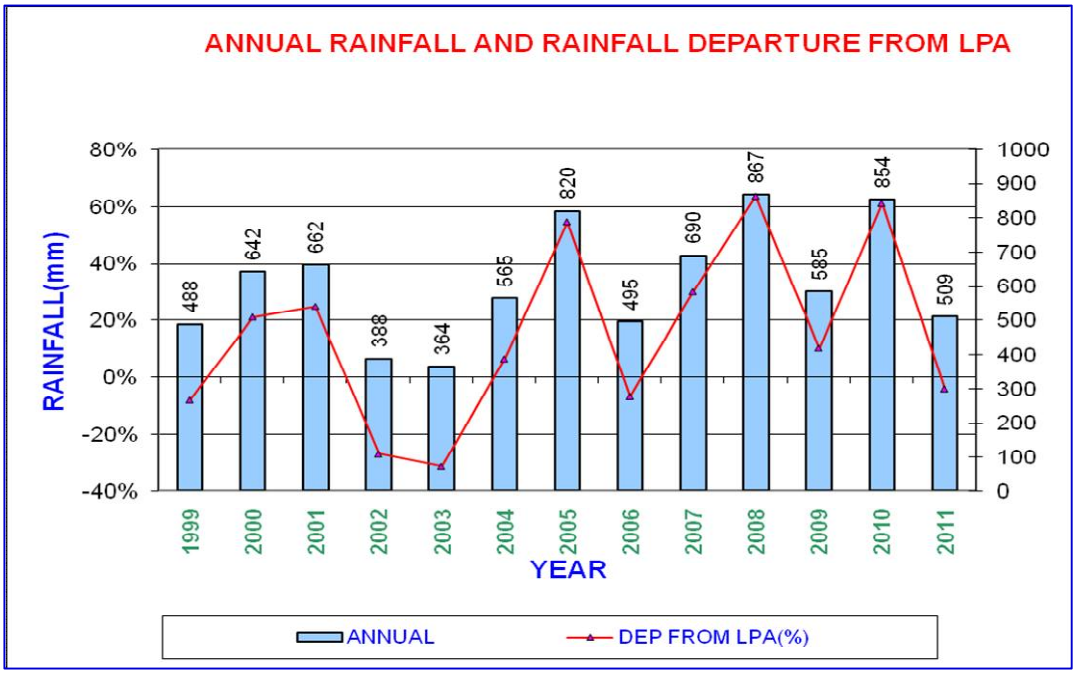
MONTHLY RAINFALL DISTRIBUTION (1999-2011)
SOURCE: INDIAN METEOROLOGICAL DEPARTMENT AND DIRECTORATE OF ECONOMICS AND STATISTICS

Sl No	District	YEAR	ANNUAL	SWM	NEM	WINTER	SUMMER	SWM (%)	NEM (%)	WINTER (%)	SUMMER (%)	DEP FROM LPA (%)
1	ANANTAPUR	1999	488.0	287.0	134.0	5.0	62.0	58.81%	27.46%	1.02%	12.70%	-8%
2		2000	642.0	372.0	170.0	29.0	71.0	57.94%	26.48%	4.52%	11.06%	21%
3		2001	661.7	353.0	238.7	0.0	70.0	53.35%	36.07%	0.00%	10.58%	25%
4		2002	387.6	157.0	120.0	8.6	102.0	40.50%	30.96%	2.22%	26.32%	-27%
5		2003	364.2	179.6	173.0	0.0	11.6	49.31%	47.50%	0.00%	3.19%	-31%
6		2004	564.5	297.9	90.7	10.8	165.1	52.77%	16.07%	1.91%	29.25%	7%
7		2005	819.7	465.2	228.9	10.4	115.2	56.75%	27.92%	1.27%	14.05%	55%
8		2006	494.6	200.2	160.9	0.0	133.5	40.48%	32.53%	0.00%	26.99%	-7%
9		2007	689.9	537.0	138.4	0.0	14.5	77.84%	20.06%	0.00%	2.10%	30%
10		2008	867.1	487.6	174.6	25.2	179.7	56.23%	20.14%	2.91%	20.72%	64%
11		2009	585.3	365.0	133.4	0.4	86.5	62.36%	22.79%	0.07%	14.78%	10%
12		2010	853.8	431.7	241.9	26.9	153.3	50.56%	28.33%	3.15%	17.96%	61%
13		2011	508.8	286.4	110.3	1.1	111.0	56.29%	21.68%	0.22%	21.82%	-4%
	Long Period Average		**530**	**311**	**146**	**1**	**72**	**58.74%**	**27.52%**	**0.19%**	**13.56%**	

Note : SWM = South west monsoon, NEM = North east monsoon, DEP = Departure and LPA = Long period average.

The annual rainfall ranges from 364.2 mm to 867.1 mm. The annual rainfall departure ranges from -31% to 64%. The southwest monsoon rainfall contributes about 59% of annual rainfall. It ranges from 157 mm to 537 mm. The monthly rainfall distribution and the cumulative departure of annual rainfall from LPA are presented in **Fig.3**.

Fig: 3. The cumulative departure of annual rainfall from LPA



3. GEOMORPHOLOGY, DRAINAGE, IRRIGATION:

Geomorphologically, Anantapur district forms the northern extension of Mysore Plateau. The district has been classified into four major units based on relief, slope factor and soil i.e., (i) Denudation hills (ii) Dissected pediments (iii) Pediplains and (iv) Valley fills such as colluviums and alluvium.

i) Denudation Hills: The Geomorphic form of denudation hills occur as exfoliation domes, inselbergs, linear ridges, mesas and tors with partial scree or debris covered at the foot slopes. Most of the denudation hills are strong and barren of vegetation and forms about 30% of the total geographical area of the district.

ii) Dissected pediment: The term pediment has been defined as an eroded rock surface of considerable extent at the foot of the mountain slope. Formed in arid to semi-arid climate. Granites and migmatites as seen in Gooty, Kalyandurg, Anantapur and Penukonda Mandals underlie the dissected pediment area.

iii) Pediplains: Pediplains occupy maximum area of about 35% of the district is characterized by low line flat terrain with gentle slope of <5°. The pediplains are covered by red brown and black clayey soils extending upto 2 m.

iv) Valley Fills (Alluvium and Colluvium): River alluvium occurs along major river courses mostly derived from catchments, transported and deposited. Such alluvium is seen along the river Hageri, Chitravati, Pennar, Papagni and minor rivers and streams like Maddileru, Tadakaleru, Padameru, Kushavasti. Colluvium occurs in narrow valleys and minor nallas. The width is not much but more in shallow broad valleys. It is derived from the adjoining upland and deposited in the low lying shallow fluvial channels consisting of an admixture of unsorted material of various shapes and sizes.

Drainage:

Nearly 80% of the district is drained by the river Pennar and its tributaries like Chitravati, Papagni, Maddeleru, Tadakaleru & Maravanka. The joints and fractures structurally control majority of the streams. Radial drainage pattern is seen near Kalyandurg, Rayadurg and Urvakonda villages. All the streams are ephemeral in nature.

Irrigation:

The chief sources of irrigation in the district are tanks, wells and canals. The major and medium irrigation projects in the district are Tungabhadra High Level Canal project stage-I with registered Ayacut of 51771 ha, Bhairavani Tippa (BT) Project with a registered Ayacut of 4856 ha, Upper Pennar Project with an Ayacut of 4066 ha and Channarajaswamy Gudi Project with an Ayacut of 445 ha. The net area under Canal irrigation is 17234 ha (2009-10) which is 15% of net area irrigated.

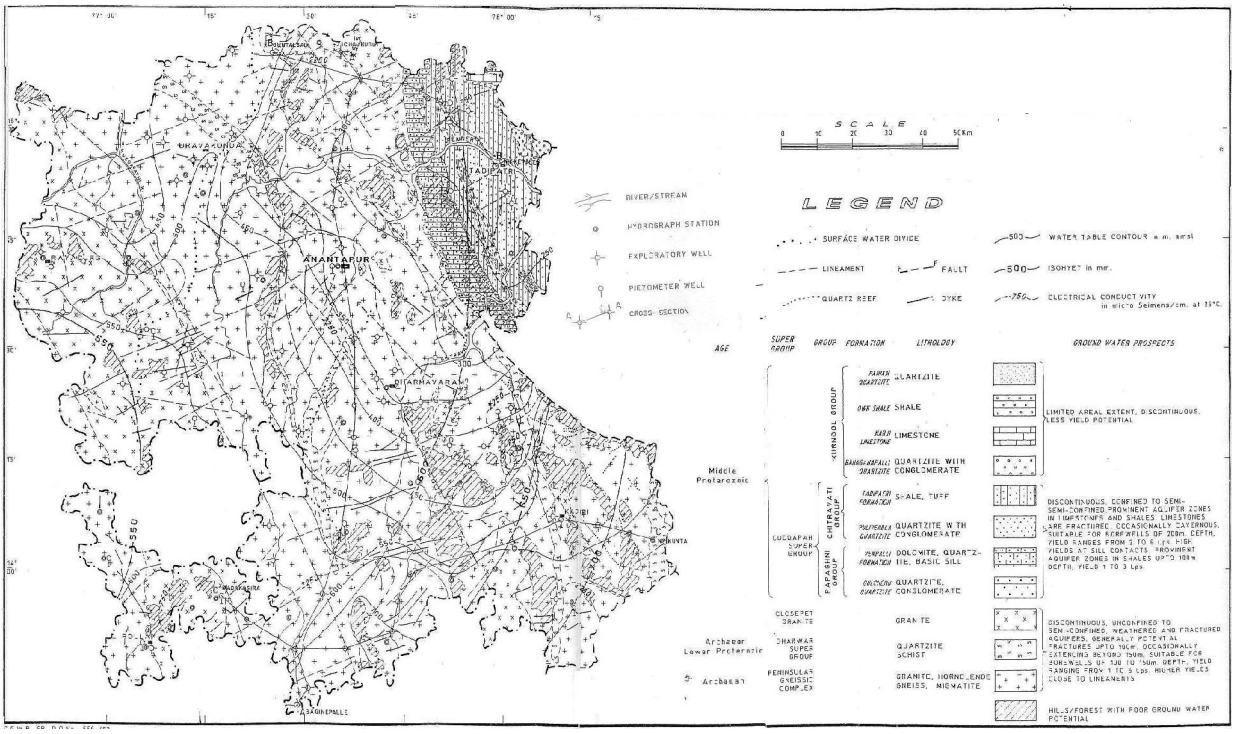
4. GEOLOGY

The district is underlain by various geological formations ranging in Age from Archaean to Recent. Major part of the district is underlain by the granites, gneisses and schists of Archaean and Dharwar Supergroup. Northeastern part of the district is occupied by the quartzites, limestones, shales of Cuddapah and Kurnool Group of rocks. Alluvium is restricted to Pennar, Vedavati and Papagni rivers.

5. HYDROGEOLOGY

The district is underlain by granite gneisses and schists of Archaean age and formation of Cuddapah Super Group belonging to upper Precambrian to lower Paleozoic Age. River alluvium occurs along the major river courses and to some extent along minor stream courses. The hydrogeololgical map of the district is presented in **Fig.4**.

Fig: 4. Hydrogeology map – Anantapur District



Ground water in Archaean Crystalline rocks

The Archaean crystalline rocks include granites, gneisses and Dharwarian schists. The ground water in these formations occurs in the weathered and fractured zones under water table and semi-confined conditions respectively. These rock types do not posses primary porosity. Due to fractured and weathering, they have developed secondary porosity often giving rise to potential aquifers at depth. The degree of weathering in the Archaean formation is less than 20 m. This weathered zone has been tapped extensively by the dug wells and dug-cum-bore wells,

which invariably tap the fractures occurring below the weathered zone. Ground water occurring in these formations is generally developed by dug-cum-bore wells and bore wells. The depth of open wells range from 6.0 to 25.0 m below ground level and depth to water level vary from 1.5 to 23 m bgl. The yield of dug wells varies from 10-200 cu.m/day for a pumping period of 3 to 6 hrs. a day.

Central Ground Water Board has carried out ground water exploration to a depth ranging from 38 to 305 m bgl. The drilling data reveals that fracture zones were encountered at various depths. Deep fractures were also encountered upto 200 m bgl. However, the potential fractures were encountered between 40 and 100 m depths. The cumulative yield of fracture zones vary from 0.4 to 15.7 lps. However, the yield of bore wells was found to be between 1 to 3 lps. The E-W, N-S and NNW-SSE fractures are tensile fractures and the bore wells drilled close to these fractures yielded 1 to 8 lps. The NE-SW, NNE-SSW fractures are shallow in nature and yield between 0.2 to 6.0 lps.

Ground Water in Cuddapah and Kurnool formations

The Cuddapah and Kurnool formations occurring in Northeastern part of the district comprises of quartzites, shales and limestones, over a limited area in erstwhile Tadipathri Taluk.

The Cuddapah sedimentaries have undergone compaction, metamorphism and post Cuddapah deformation. As a result, the rocks have developed fracturing, faulting and folding. Solution cavities also occur in limestone areas. Weathering in shales, limestones and basic intrusive rocks generally varies from 5.0 to 15.0 m bgl. The depth of dug wells varies from 8.0 to 18.0 m bgl. The depth to water level varies from 3 to 15 m bgl. The yield of dug wells varies from 50 to 250 cu.m/day for pumping period of 4 to 6 hrs. a day.

Bore wells drilled 10 years ago by APSIDC for irrigation, in the limestone tract indicates that yield of bore wells range from 6.0 lps to 12 lps. But generally, varies from 1 to 5 lps for varying pumping periods of 6 to 8 hrs daily. However, yields of these bore wells reduce during summer months and sustain pumping for 3-5 hours daily. Most of these wells are being used for Horticulture.

Ground water in Alluvium

Unconsolidated alluvium occurs along major river courses like Pennar, Chitravathi, Kushavati, Tadakaleru, Maravanka. Filter point wells and infiltration wells have been constructed to tap the alluvium aquifers in addition to dug wells. The depth varies from 3.5 to 12.0 m bgl with yield varying from 8 to 135 cu.m/hr. These wells generally dry up during summer months.

Shallow aquifers

The shallow aquifers are being tapped by dug wells, shallow bore wells, dug-cum-bore wells for irrigation and domestic use. These aquifers occur to a depth of 30 to 40 m, depending upon location, topography etc., the saturated thickness of shallow aquifers varies from place to

place, depending upon the topography, etc. The saturated thickness of shallow aquifers varies from 15 to 20 m bgl with an average thickness being 10 m bgl. As per the yield tests conducted on open wells, specific capacity is varying from 1.4 to 10.6 lpm per metre drawdown.

Deeper Aquifers

Deeper aquifers have been tapped by borewells drilled by Central Ground Water Board, Southern Region below 100 m to 150 m bgl depth.

Aquifer parameters

The Central Ground Water Board has drilled 108 Exploratory Wells. Long duration aquifer performance tests were conducted on these wells. The result of the tests indicates that transmissivity of the fractured aquifer varied from 0.5-316 sq.m/day and storativity values varied from 7.4×10^{-5} to 9.5×10^{-3}. The specific yield of unconfined aquifers varies from 0.01 to 0.058. Central Ground Water Board has constructed 35 piezometers covering entire district to study ground water regime. The depth of Piezometers varies from 27-56 m bgl. The aquifer zones encountered between 8-43 m bgl. The yield of these peizometer wells varies from 0.07 to 1.08 lps. The transmissivity values vary from 0.71 to 21.8 sq.m/day.

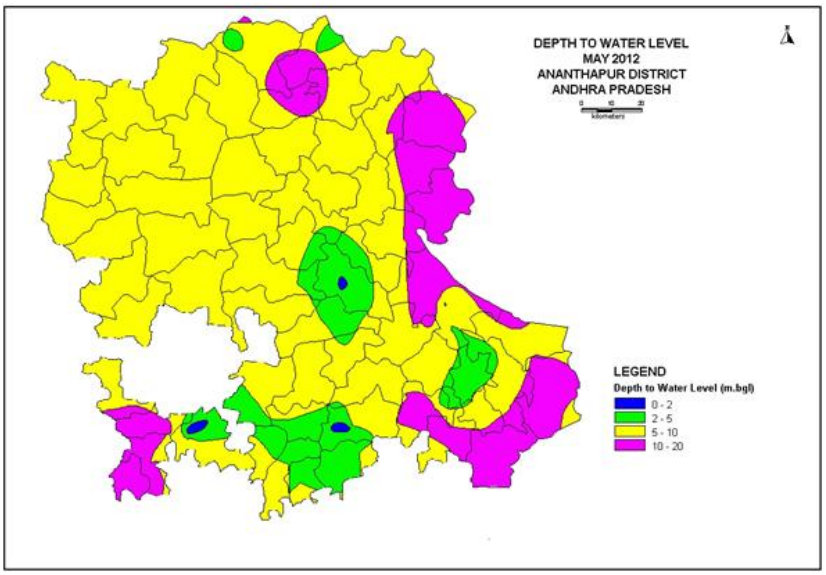
Depth to water level

Ground water levels are monitored from a network of 36 observation wells four times in a year. These observation wells, tapping the phreatic aquifer, include dug wells and shallow bore wells. The State Ground Water Department has also established 144 observation wells and 70 piezometers.

Pre-monsoon water levels

The depth to water level during pre-monsoon (2012) ranges from 0.65-11.97mbgl. The shallow water levels of 2 m are observed in southern part of the area at three locations. The depth to water levels between 5-10 m is observed in majority of the area. Deeper water levels of >10 m bgl are observed in the North Eastern and South Eastern parts of the area. (Fig.5).

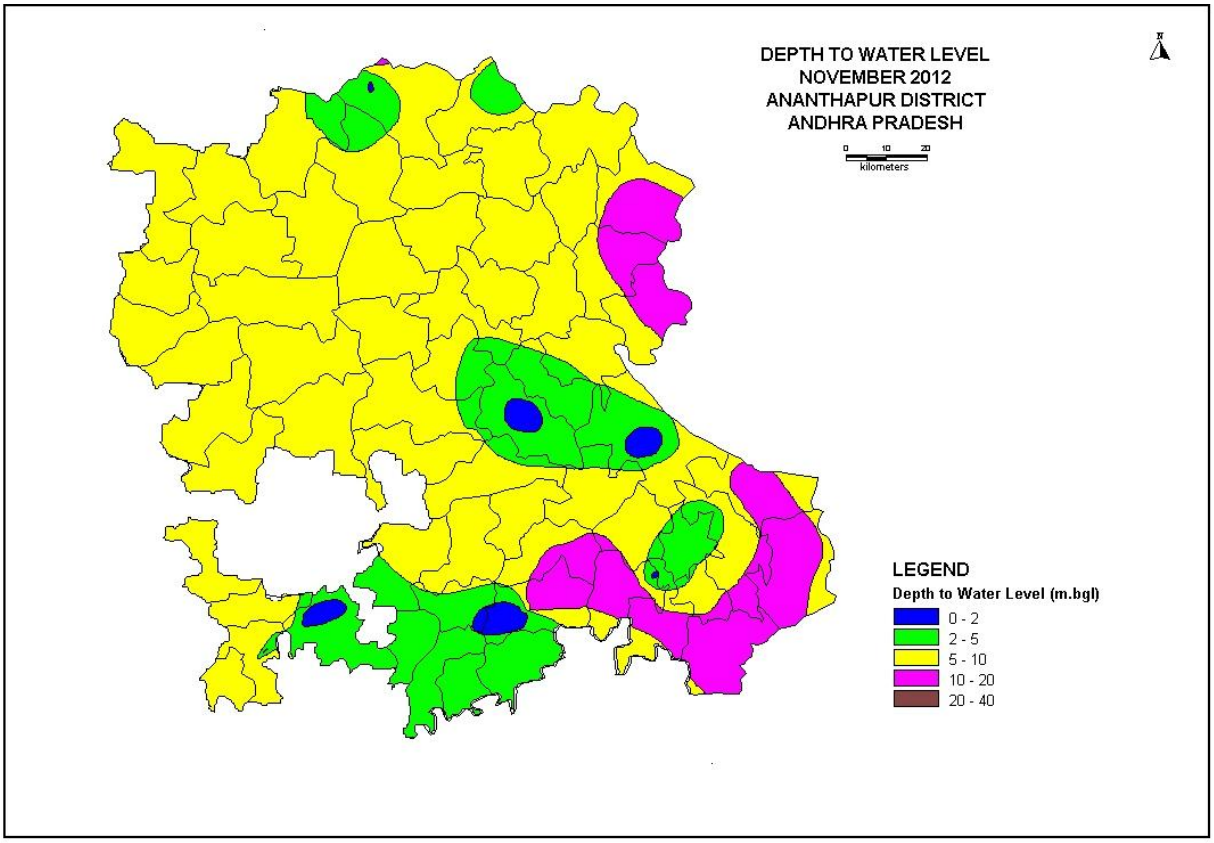
Fig.5



Post-monsoon

The depth to Water level ranges from 0.37 to 15.26mbgl during the post monsoon period (2012). The areas having water levels of <5 m during pre monsoon have come upto 2-5 m bgl with minimum recharge and the area having water level of more than 10 m bgl have come upto 5-10 m bgl in southwestern and northern eastern part of the district.

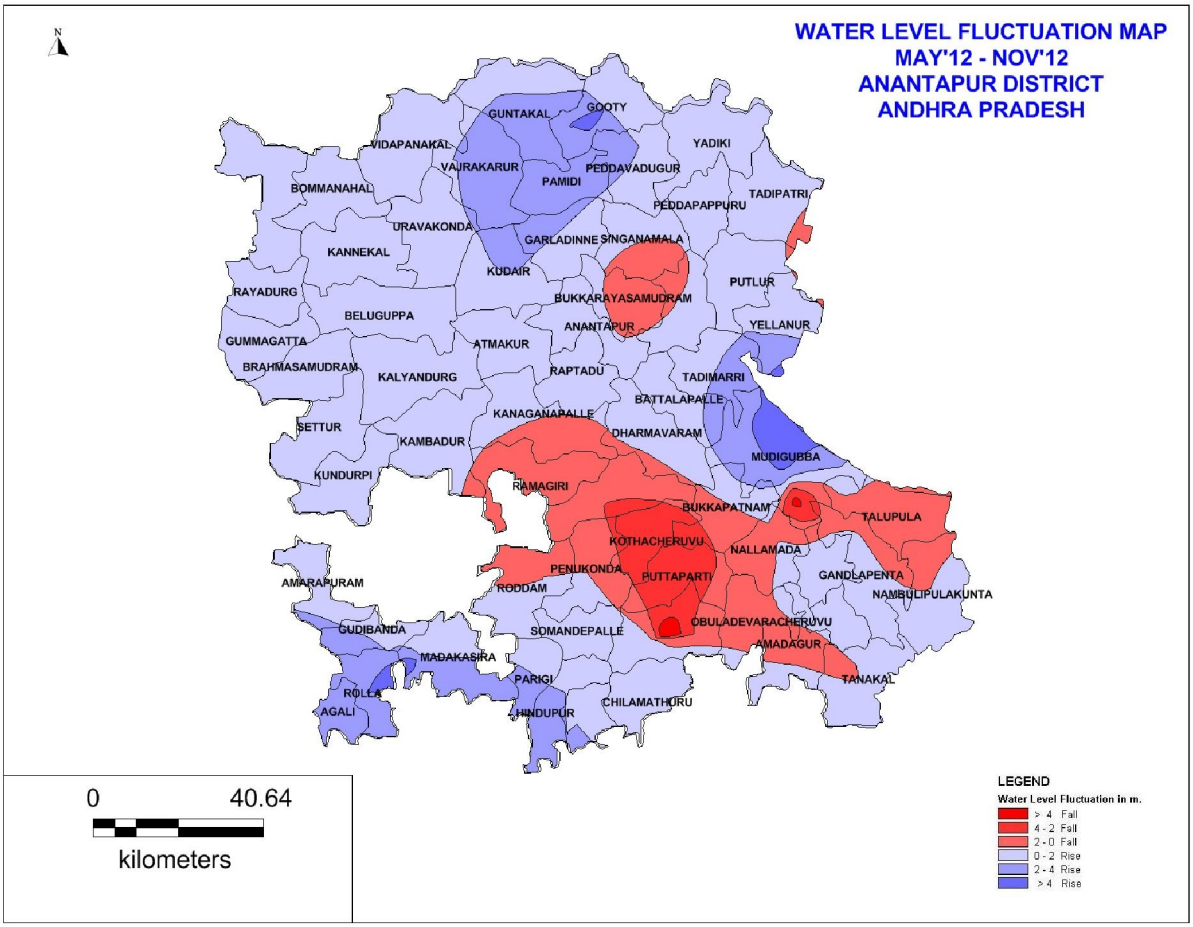
Fig.6



Water level fluctuation

Majority of the district shows 0-2m rise in water level between pre and post monsoon period of 2012. Rise of water level of 2-4 m is observed in North Eastern and northern part of the district as isolated pockets. Fall of Water levels have been observed in southeastern part of the district. Less fluctuation is observed in the areas where the water levels were comparatively shallow during pre-monsoon. (Fig.7).

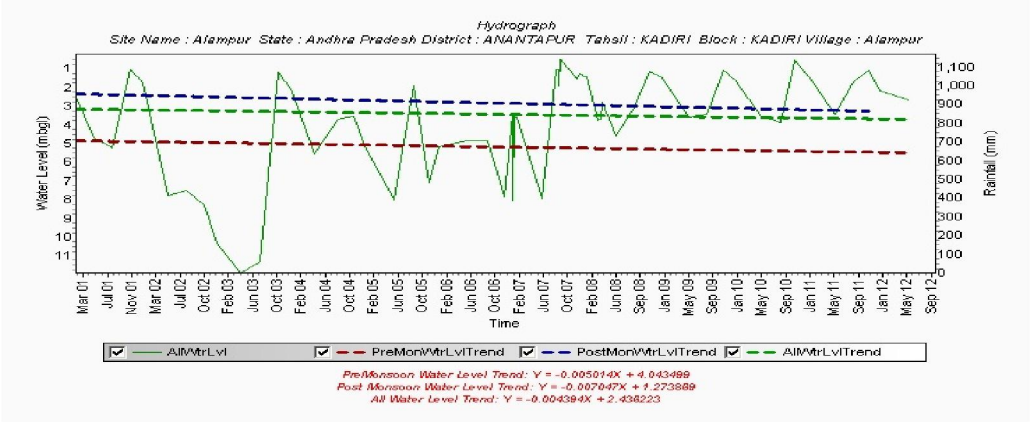
Fig.7

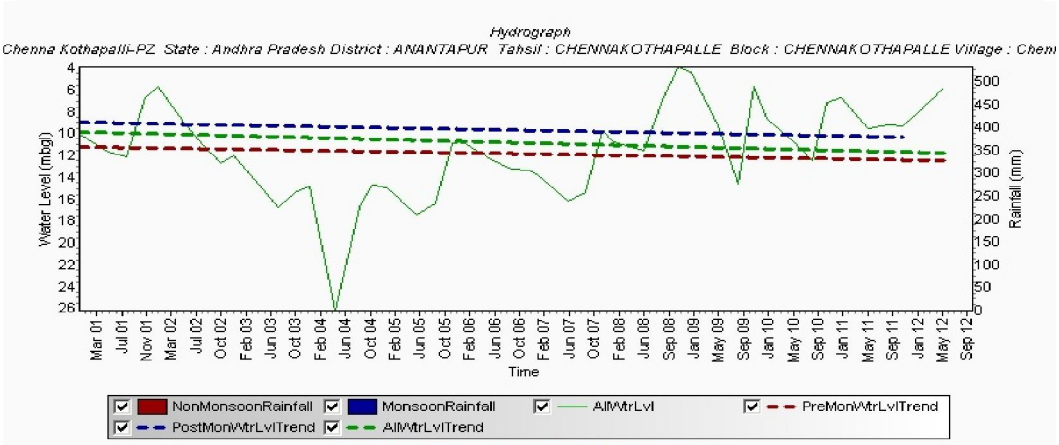


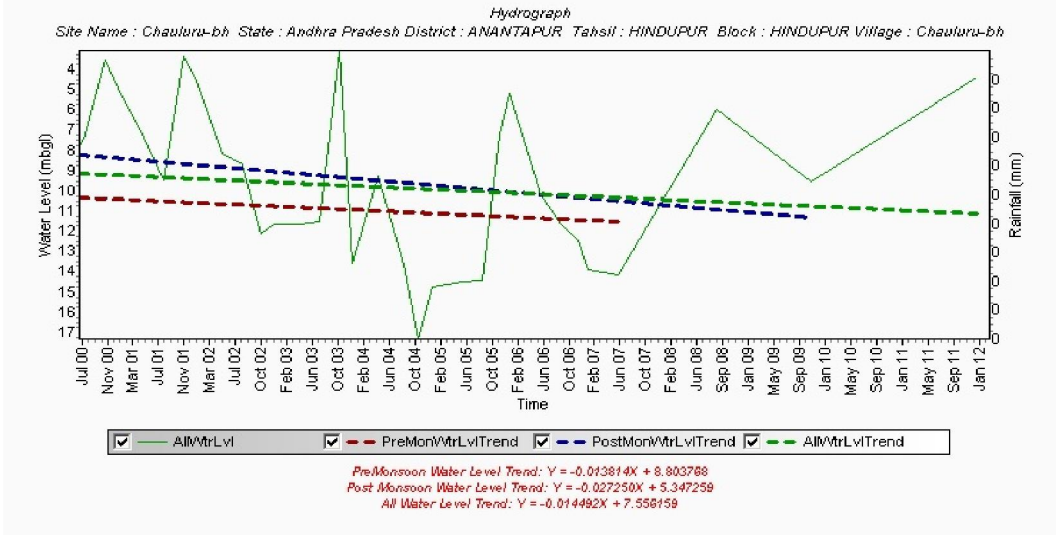
Long term water levels

The analysis of observation well data of Central Ground Water Board and State Ground Water Department for the period (2000-12) reveals that 45% of the wells show a general rising trend of 0.014 to 0.65 m/yr and the rest 55% of the wells show falling trend varying from 0.15 to 0.65 m/year. Hydrographs are presented in Fig.8. Pre-monsoon trend analysis indicates that 13% of the wells are showing rising trend ranging from 0.0521 to 0.7832 m/yr and 87% of the wells show falling trend ranging from 0.0172 m and 1.5877 m/yr. Post monsoon trend analysis indicates that 10% of the wells having rising trend ranging from 0.0015 to 0.5410 m/yr and the rest of the 90% of wells having rising trend ranging from 0.0015 to 0.5410 m/yr.

FIG:8. HYDROGRAPHS







6. GROUND WATER RESOURCES

Based on the Ground Water Estimation Committee (GEC 97) norms, ground water assessment was done in 2008-09. The mandal-wise details are presented in **Table-2 and Figure-9.**

Table : 2:- ASSESSMENT OF DYNAMIC GROUNDWATER RESOURCES OF ANANTAPUR DISTRICT, ANDHRA PRADESH ASSESSMENT UNIT WISE CATEGORISATION [2008-2009]

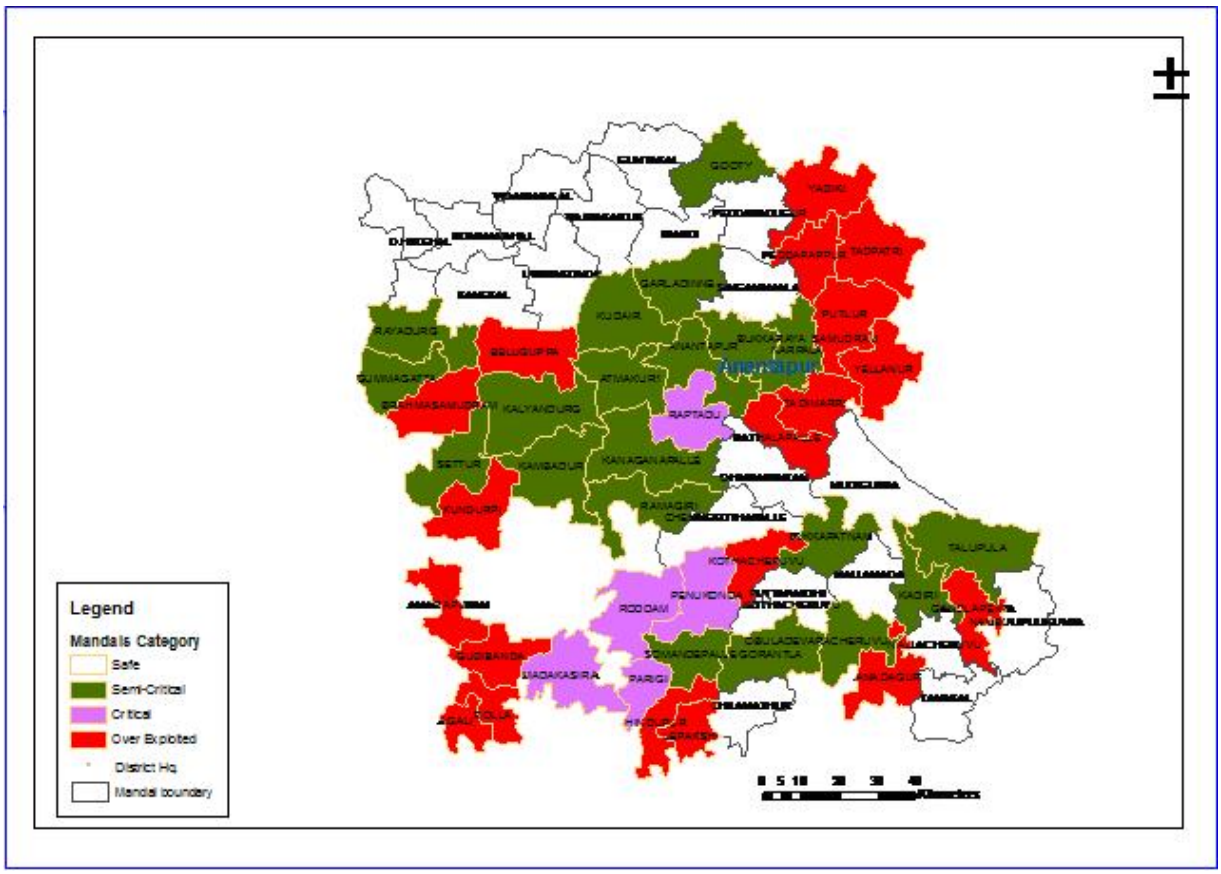
Sl.No.	Mandal name	C/ NC/ T	Stage of ground water develop ment [%]	Pre-monsoon		Post monsoon		Category [safe/ semi-critical/Critical/ Over exploited]
				Water level trend cm/yr	Is there a significant decline [YES/NO]	Water level trend cm/yr	Is there a significant decline [YES/NO]	
1	2	3	4	5	6	7	8	9
1	Agali	C	0					
		NC	161	700.9	Yes	826.0	Yes	O.E
		T	161	70	Yes	82	Yes	O.E
2	Amadaguru	C	0					
		NC	136	14.6	Yes	58.6	Yes	O.E
		T	136	14.6	Yes	59.6	Yes	O.E
3	Amarapuram	C	0					
		NC	120	11.9	Yes	22.2	Yes	O.E
		T	120	11.9	Yes	23.2	Yes	O.E
4	Anantapur	C	34	5	No	-74.87	No	Safe
		NC	80	156.3	Yes	0.0	No	S.C
		T	74	51	Yes	3	No	S.C
5	Atmakur	C	0					
		NC	77	156.3	Yes	0.0	No	S.C
		T	77	156.3	Yes	1.0	No	S.C
6	B.K.Samudram	C	73	1	No	49.50	Yes	S.C
		NC	116	84	Yes	62.36	Yes	O.E
		T	81	1	No	49.50	yes	S.C
7	Bathalapalli	C	0					
		NC	116	63.6	Yes	20.2	Yes	O.E
		T	116	63.6	Yes	21.2	Yes	O.E
8	Beluguppa	C	0					
		NC	109	25.1	Yes	10.6	Yes	O.E
		T	109	25.1	Yes	11.6	Yes	O.E
9	Bommanahal	C	41	-75	No	-60	No	Safe
		NC	32	-72	No	-81	No	Safe
		T	41	-75	NO	-60	No	Safe
10	Brahmasamudram	C	0					
		NC	108	104.9	Yes	128.1	Yes	O.E
		T	108	104.9	Yes	129.1	Yes	O.E
11	Bukkapatnam	C	0					
		NC	79	-4.1	No	25.5	Yes	S.C
		T	79	-4.1	No	26.5	Yes	S.C
12	C.K.palli	C	0					
		NC	67	2	No	-6.55	No	Safe
		T	67	2	No	-5.55	No	Safe
13	Chilamathur	C	0					
		NC	65	-10.0	No	6.7	No	Safe
		T	65	-10.0	No	7.7	No	Safe
14	D.Hirehal	C	24	-75	No	-60	No	Safe
		NC	103	81	Yes	93	Yes	O.E
		T	61	-75	NO	-60	No	Safe
15	Dharmavaram	C	0					
		NC	45	-16.2	No	-2.8	No	Safe
		T	45	-16.2	No	-1.8	No	Safe
16	Gandlapenta	C	0					
		NC	119	78.9	Yes	100.4	Yes	O.E
		T	119	78.9	Yes	101.4	Yes	O.E
17	Garladinne	C	68	-14	No	-19.51	No	Safe
		NC	134	80	Yes	66.68	Yes	O.E
		T	73	1	No	49.50	yes	S.C
18	Gooty	C	78	12	Yes	0.00	No	S.C
		NC	72	17.2	Yes	8.8	No	S.C
		T	74	12	Yes	0.00	No	S.C

1	2	3	4	5	6	7	8	9
19	Gorantla	C	0					
		NC	85	-4.1	No	25.5	Yes	S.C
		T	85	-4.1	No	26.5	Yes	S.C
20	Gudibanda	C	0					
		NC	118	88.8	Yes	69.4	Yes	O.E
		T	118	88.8	Yes	70.4	Yes	O.E
21	Gummagatta	C	68	-8	No	-30	No	Safe
		NC	100	21.4	Yes	18.2	Yes	O.E
		T	78	24.7	Yes	-15.4	No	S.C
22	Guntakal	C	34	-2	No	-5.42	No	Safe
		NC	74	12	Yes	0.00	No	S.C
		T	63	-2	No	-5.42	No	Safe
23	Hindupur	C	0					
		NC	106	141.1	Yes	24.2	Yes	O.E
		T	106	141.1	Yes	25.2	Yes	O.E
24	Kadiri	C	0					
		NC	76	-4.1	No	25.5	Yes	S.C
		T	76	-4.1	No	26.5	Yes	S.C
25	Kalyandurg	C	0					
		NC	84	-44.2	No	32.8	Yes	S.C
		T	84	-44.2	No	33.8	Yes	S.C
26	Kambadur	C	0					
		NC	84	156.3	Yes	0.0	No	S.C
		T	84	156.3	Yes	1.0	No	S.C
27	Kanaganapalli	C	0					
		NC	75	17.2	Yes	8.8	No	S.C
		T	75	17.2	Yes	9.8	No	S.C
28	Kanekal	C	48	2	No	0.66	No	Safe
		NC	60	-14	No	0.21	No	Safe
		T	53	-27	No	-34.59	No	Safe
29	Kothacheruvu	C	0					
		NC	110	52.0	Yes	-14.8	No	O.E
		T	110	52.0	Yes	-13.8	No	O.E
30	Kudair	C	0					
		NC	83	10.0	Yes	-59.9	No	S.C
		T	83	10.0	Yes	-58.9	No	S.C
31	Kundurpi	C	0					
		NC	104	104.9	Yes	128.1	Yes	O.E
		T	104	104.9	Yes	129.1	Yes	O.E
32	Lepakshi	C	0					
		NC	115	191.5	Yes	107.6	Yes	O.E
		T	115	191.5	Yes	108.6	Yes	O.E
33	Madakasira	C	0					
		NC	93	245.6	Yes	147.3	Yes	Critical
		T	93	245.6	Yes	148.3	Yes	Critical
34	Mudigubba	C	0					
		NC	54	-4.1	No	-30.3	No	Safe
		T	54	-4.1	No	-29.3	No	Safe
35	N.P.Kunta	C	0					
		NC	66	-22.3	No	-23.8	No	Safe
		T	66	-22.3	No	-22.8	No	Safe
36	Nallacheruvu	C	0					
		NC	60	-23.7	No	-23.8	No	Safe
		T	60	-23.7	No	-22.8	No	Safe
37	Nallamada	C	0					
		NC	37	-5.9	No	-7.0	No	Safe
		T	37	-5.9	No	-6.0	No	Safe
38	Narpala	C	65	5	No	-74.87	No	Safe
		NC	94	80	Yes	66.68	Yes	Critical
		T	84	51	Yes	3	No	S.C
39	O.D.Cheruvu	C	0					
		NC	84	52.0	Yes	-14.8	No	S.C
		T	84	52.0	Yes	-13.8	No	S.C
40	Pamidi	C	21	-22	No	-54.29	No	Safe
		NC	65	-10	No	-84.97	No	Safe
		T	31	-22	No	-54.29	No	Safe
41	Parigi	C	0					
		NC	91	129.7	Yes	113.2	Yes	Critical
		T	91	129.7	Yes	114.2	Yes	Critical
42	Peddapappur	C	0					
		NC	203	128.4	Yes	131.6	Yes	O.E
		T	203	128.4	Yes	132.6	Yes	O.E

1	2	3	4	5	6	7	8	9
43	Peddavaduguru	C	11	-49	No	-60.74	No	Safe
		NC	88	11	Yes	1.99	No	S.C
		T	36	-49	No	-60.74	No	Safe
44	Penukonda	C	0					
		NC	93	83.9	Yes	26.5	Yes	Critical
		T	93	83.9	Yes	27.5	Yes	Critical
45	Putlur	C	83	51	Yes	3.13	No	S.C
		NC	232	113.5	Yes	89.1	Yes	O.E
		T	173	30	Yes	38	Yes	O.E
46	Puttaparthi	C	0					
		NC	53	2.0	No	-6.5	No	Safe
		T	53	2.0	No	-5.5	No	Safe
47	Ramagiri	C	0					
		NC	74	10.0	Yes	-59.9	No	S.C
		T	74	10.0	Yes	-58.9	No	S.C
48	Raptadu	C	0					
		NC	90	45.4	Yes	49.0	Yes	Critical
		T	90	45.4	Yes	50.0	Yes	Critical
49	Rayadurg	C	40	-44	No	-133.57	No	Safe
		NC	82	55.3	Yes	3.8	No	S.C
		T	77	52.0	Yes	-14.8	No	S.C
50	Roddam	C	0					
		NC	94	98.3	Yes	90.5	Yes	Critical
		T	94	98.3	Yes	91.5	Yes	Critical
51	Rolla	C	0					
		NC	162	88.8	Yes	69.4	Yes	O.E
		T	162	88.8	Yes	70.4	Yes	O.E
52	Settur	C	0					
		NC	81	55.3	Yes	3.8	No	S.C
		T	81	55.3	Yes	4.8	No	S.C
53	Singanamala	C	32	-7	No	-14.59	No	Safe
		NC	67	-2	No	-33.80	No	Safe
		T	45	-7	No	-15	No	Safe
54	Somandepalli	C	0					
		NC	83	30.0	Yes	-10.4	No	S.C
		T	83	30.0	Yes	-9.4	No	S.C
55	Tadimarri	C	0					
		NC	166	63.6	Yes	20.2	Yes	O.E
		T	166	63.6	Yes	21.2	Yes	O.E
56	Tadipatri	C	0					
		NC	123	84.8	Yes	32.4	Yes	O.E
		T	123	84.8	Yes	33.4	Yes	O.E
57	Talupula	C	0					
		NC	77	24.7	Yes	-15.4	No	S.C
		T	77	24.7	Yes	-14.4	No	S.C
58	Tanakallu	C	0					
		NC	61	-23.7	No	-23.8	No	Safe
		T	61	-23.7	No	-22.8	No	Safe
59	Uravakonda	C	5	-17	No	-13.54	No	Safe
		NC	29	-12	No	-16.14	No	Safe
		T	27	-17	No	-13.54	No	Safe
60	Vajrakaruru	C	15	-27	No	-41.36	No	Safe
		NC	50	-9	No	0.00	No	Safe
		T	44	-27	No	-41.36	No	Safe
61	Vidapanakal	C	18	-27	No	-24.82	No	Safe
		NC	40	-9	No	-16.55	No	Safe
		T	19	-27	No	-24.82	No	Safe
62	Yadiki	C	0					
		NC	148	128.2	Yes	108.1	Yes	O.E
		T	148	128.2	Yes	109.1	Yes	O.E
63	Yellanur	C	84	51	Yes	3.13	No	S.C
		NC	242	186.2	Yes	160.7	Yes	O.E
		T	170	-38	No	47.92	Yes	O.E

C = Command, NC = Non-command and T = Total

Fig:9. Mandal-wise Categorisation of Anantapur district.

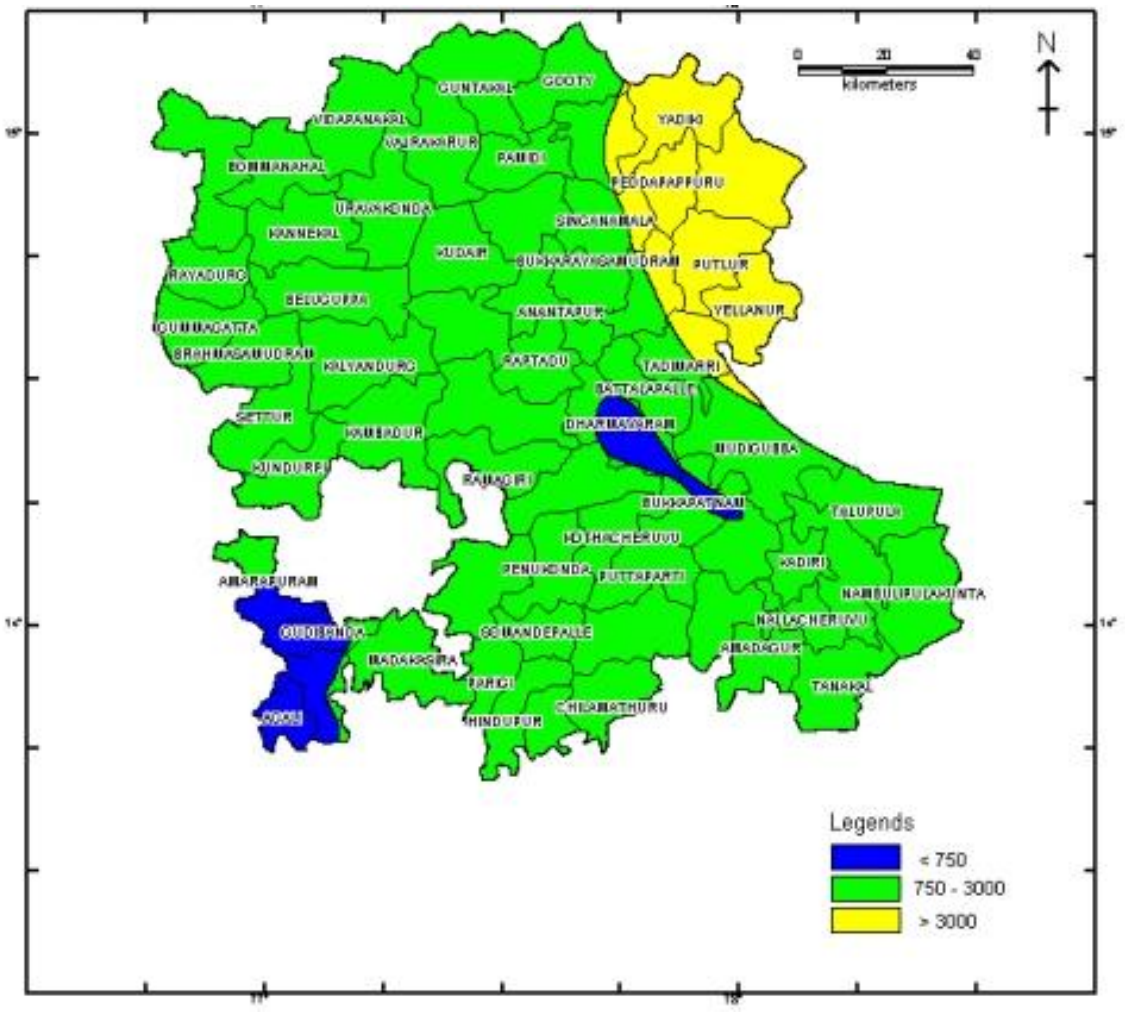


Ground water resource available is 60578 ha.m in command area 60278 MCM in non-command area while the total ground water resources available are 120856 MCM. The net ground water availability is 53024 MCM and 33849 MCM in command and non-command areas respectively. The stage of ground water development in command area is 33%, while in non command area, it is 35%. 34 mandals of the district falls under Safe category and15 mandals fall under Over-Exploited (OE) category.

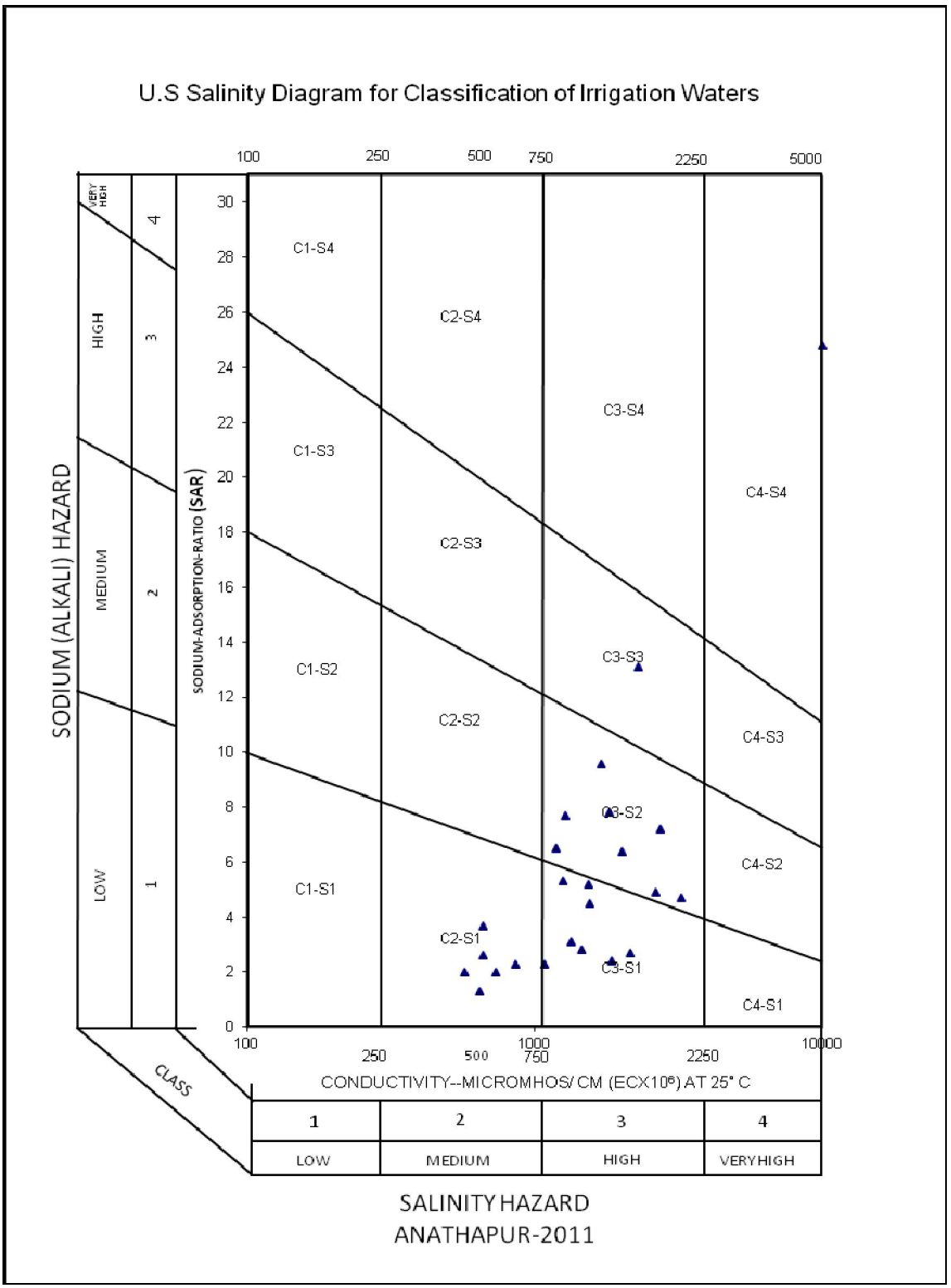
7. GROUND WATER QUALITY

The ground water in the district is in general suitable for both domestic and irrigation purposes. The Electrical Conductivity ranges from 569 to 9980 micro Siemens/cm at 25^0C. (**Fig. 10)**. Fluoride concentration in some locations of the district is more than permissible limit. In some places, it is not suitable for drinking due to the presence of Nitrates. A total of 993 Fluoride affected villages exist in the district.

Fig: 10. Electrical Conductivity Map



The assessment of deep ground water is done based on 78 water samples collected from the bore wells during the exploratory drilling programme. The deep ground water is generally alkaline, but about 70% of the samples have fluoride content of more than permissible limit of 1.5 mg/l. As far as for the irrigation use is concerned, all the samples fall in 'excellent' category. The deep waters are generally suitable for irrigation purpose. (**Fig11)**.


U.S Salinity Diagram for Classification of Irrigation Waters
SODIUM (ALKALI) HAZARD
SODIUM-ADSORPTION-RATIO (SAR)
CONDUCTIVITY--MICROMHOS/CM (ECX10⁶) AT 25° C
CLASS
VERY HIGH
HIGH
MEDIUM
LOW
C1-S4
C2-S4
C3-S4
C4-S4
C1-S3
C2-S3
C3-S3
C4-S3
C1-S2
C2-S2
C3-S2
C4-S2
C1-S1
C2-S1
C3-S1
C4-S1
1 LOW
2 MEDIUM
3 HIGH
4 VERY HIGH
SALINITY HAZARD
ANATHAPUR-2011

8. GROUND WATER DEVELOPMENT

The district is mainly dependent on ground water for its irrigation and domestic needs. About 52937 dug wells, 33964 bore wells and 561 deep tube wells exist in the district.

Ground water development is through deep bore wells in the non-command areas and through dug wells and shallow borewells in command areas. Alluvial aquifers are developed through filter point wells. In command area, the stage of ground water development is 33 per cent and in non-command area, it is 35 per cent.

Large diameter dug wells piercing the weathered rock exist in the area for irrigation purpose. They are mostly rectangular with dimension ranging from 4x6 m to 10x11 m. The depth of the dug wells varies from 8 to 25 m bgl. The dug wells are fitted with 3 to 5 HP electrical motors and yield of dug wells varies from 10 to 220 cu.m/day for a pumping period of 3 to 5 hrs. a day.

The depth of bore wells range from 60-200 m bgl with 6" dia and yields range from 1 to 45 cu.m/hr. Most of the bore well yields go down in summer months. The bore wells are fitted with 5 HP motors and generally and run for 4 hrs. to 8 hrs. The depth of filter point wells along the river and stream courses varies from 3.5 to 12 m bgl with yields varying from 8 to 135 cu.m/hr. These wells yield low during summer months.

9. GROUND WATER RELATED ISSUES AND PROBLEMS

Water Depleted Areas

Out of the total 65 mandals, 15 mandals fall in over exploited areas where the ground water development is more than 100%. Caution is to be exercised in these mandals for future ground water development. Rain water harvesting structures like contour bunding, check dams, percolation tanks, farm ponds etc., are already in vogue. The construction of artificial recharge structures should be taken up on watershed basis after ascertaining the quantum of runoff potential. The number and type of structures should be designed for 50% of non-committed runoff so as not to deprive the down stream watersheds.

10. CONCLUSIONS

1.0 It is seen from the exploration data that most of the potential zones were encountered within the depth range of 50-150 m and beyond this depth, potential fractures through occur, but rarely.

2.0 Conjunctive use practices has to be adopted in the command area by utilizing both surface and ground water resources. Ground water potential zones in the command area are to be identified and developed. Ground water development through bore wells can be restricted to 40-120 m.

3.0 Large-scale artificial recharge structures need to be constructed in the non-command areas and over-exploited mandals and corpus fund has to be created to maintain those structures.

4.0 There is need to explore the possibilities of diversion of surface water through canals/pipes for filling up of existing dried up tanks in over-exploited mandals.

5.0 Rainwater harvesting structures like contour bunding, check dams, percolation tanks, farm ponds are already in vogue. The construction of the artificial recharge structures should be taken up on the watershed basis and designed for 50% of non-committed run-off so as to not to deprive the down stream watersheds.

6.0 It is important to take up artificial recharge structures based on topography, soil, slope, surface run-off of available and hydrogeological conditions rather than target oriented in achieving the numbers. A technical team consisting of Scientists, Engineers, Bureaucrats should monitor the structures on regular basis.

7.0 In Safe category mandals, the artificial recharge to ground water should go hand-in-hand with ground water development. Further development of ground water should be restricted upto a depth of 100 m to avoid failures of bore wells.

8.0 Further ground water development through bore wells has to be avoided strictly by implementing APWALTA Act in the villages that are categorized as OE villages. However, ground water development in villages/mandals falling in safe to semi-critical/critical category can be developed on scientific lines.

9.0 Since the district is water scarce, land use system should place emphasis on cultivation of high value and low water requiring crops such as pulses, oilseeds. The suggestions of Agriculture Department has to be followed, according to seasons. Modern irrigation systems using drip and sprinkler irrigation equipment have to be used for reducing the stress on ground water system and help in enhancing the availability of resource.

10.0 Roof Top harvesting both in urban and rural areas should be made mandatory to enhance the ground water resources.