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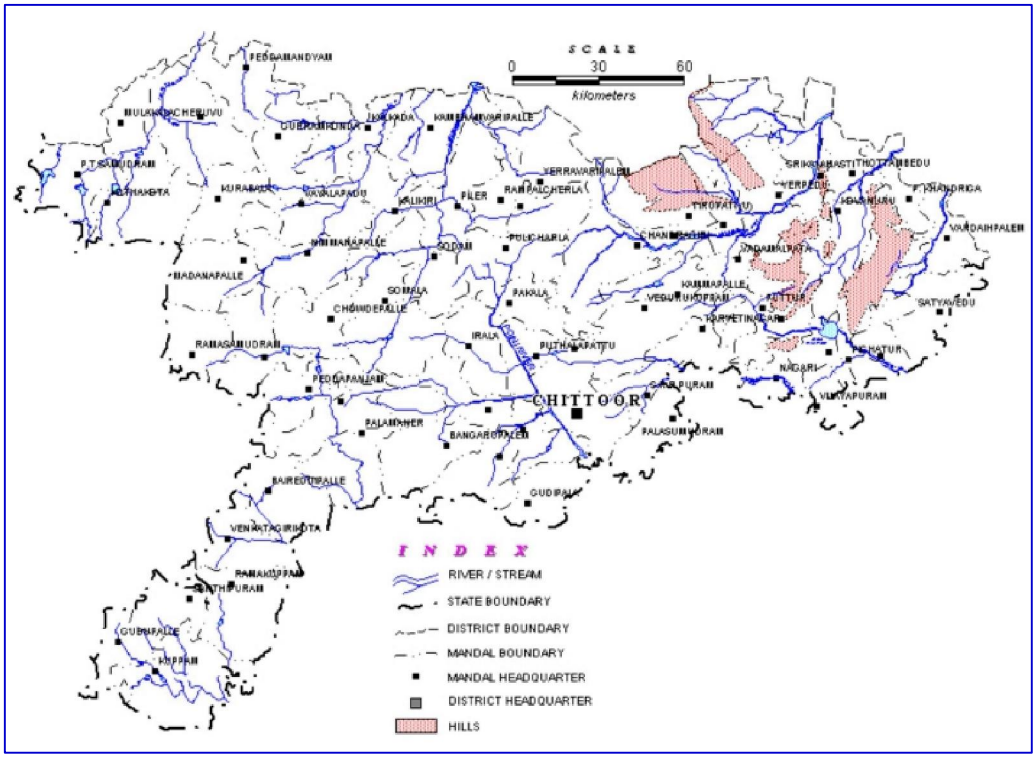
CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

GROUND WATER BROCHURE
CHITTOOR DISTRICT, ANDHRA PRADESH



SOUTHERN REGION
HYDERABAD
September 2013

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MINISTRY OF WATER RESOURCES
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GROUND WATER BROCHURE
CHITTOOR DISTRICT, ANDHRA PRADESH
(AAP-2012-13)

BY

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GROUND WATER BROCHURE
CHITTOOR DISTRICT, ANDHRA PRADESH

CONTENTS

DISTRICT AT A GLANCE

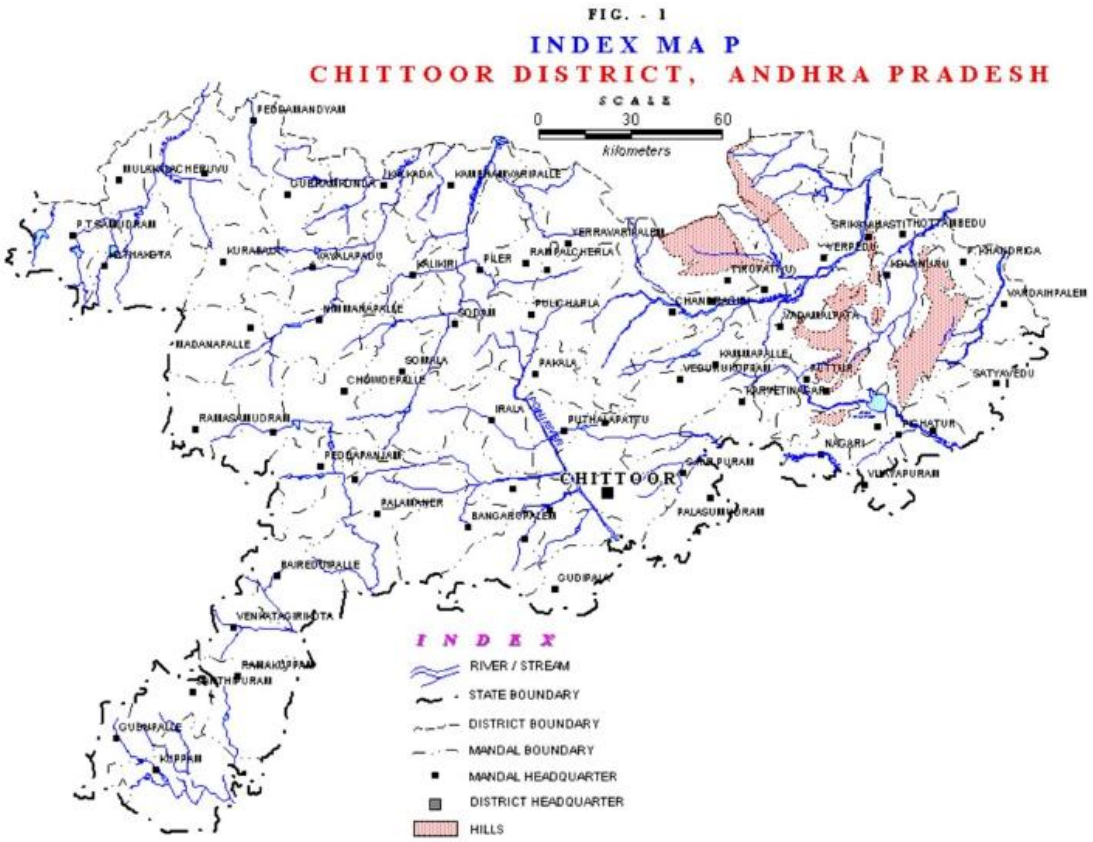
	Details	
1.GENERAL	Location North Latitude East Longitude Geographical Area Headquarters No. of revenue mandals No. of revenue villages Population (2011) Rural Total	12° 37' and 14° 00' 78° 03' and 79° 55' 15152 Sq.Km. Chittoor 66 1540 Urban 1228887 2941581 41,70,468
	Population density Major rivers, Soils Red Sandy Agroclimatic Zone	275 per Sq.Km. Pincha, Bahuda Swanamukhi, Palar, Ponnai Red Loamy 57% 34% Southern Zone
2. RAINFALL	Normal annual rainfall Total Southwest monsoon Northeast monsoon Cumulative departure from Normal rainfall for the last 5 years	934 mm 438 mm 47% 396 mm 42% -61%
3. LAND USE (2012) (Area in ha.)	Forest Barren and uncultivated Cultivable waste Current fallows Net area sown	4,52,018 1,52,918 45,431 1,68,907 3,54,812
1. IRRIGATION (2012) (Area in ha.)	Source of irrigation Canals Tanks Dug wells Bore / Tube wells Others Net area irrigated Gross area irrigated Major irrigation projects (completed) Medium irrigation projects (completed)	 5685 16,531 16,690 1,07,185 106 1,46,197 1,92,797 Nil 8 Swarnamukhi, Kalangi, Mallimadugu, Araniyar, Krishna Puram, Bahuda, Pedderu, Siddala Gandi

5. GEOLOGY	Major rock types Granites,	Gneisss, Shales, quartzites, Laterites, Conglomerates
6. GROUND WATER	Exploration by CGWB No. of wells drilled Major aquifer zones Aquifer parameters Transmissivity (m².m/day) Hard rock Storage Co-efficient Hard rock Monitoring No. of observation wells Dug wells Range of water levels Pre-monsoon(May 2012,) Minimum (m bgl) Maximum (m bgl) Post-monsoon (Nov 2012) Minimum (m bgl) Maximum (m bgl)	 112 30 - 100 m. 20 – 300 1x 10 -2 to 1x 10 -4 41 1.35 19.00 0.03 18.75
7. GROUND WATER RESOURCES (MCM	Net annual ground water availability Net annual draft Balance resource Stage of ground water development	153857 116097 37760 75%
8. GROUND WATER DEVELOPMENT CATEGORY	No. of mandals categorised as Safe (<70 % of net available resource) Semi Critical (70 - 90 %) Critical (90 - 100 %) Over exploited (> 100 %)	 37 9 7 37
9. CHEMICAL QUALITY	Electrical Conductivity (micro Siemens / cm at 25 deg. C) Chloride (mg/l) Fluoride (mg/l) Nitrate (mg/l)	750 to 3000 micro Siemens/cm at 25 deg. C 43 - 600 0.12 - 1.50 0 - 160

GROUND WATER BROCHURE
CHITTOOR DISTRICT, ANDHRA PRADESH

1.0 INTRODUCTION

Chittoor district is one of the chronically drought affected Rayalasema districts of Andhra Pradesh. It covers a geographical area of 15,152 sq. km and situated between 12° 37' and 14°00' North latitudes and 78°03' and 79°55' Eastern longitudes. Administratively the district is divided into 3 Revenue divisions, which are further sub-divided into 66 Revenue mandals (Fig.1). Farmers are mostly dependent on ground water for their irrigation purposes. The district receives moderate rainfall. Failure of monsoons during the last few years lead to failure of bore wells and failure of crops.



Out of the total geographical area of 15,15,100 ha, the forests cover is 4,52,018 ha i.e., 30% of the total area. The barren and uncultivable land covers1,63,650 ha (11%) whereas the land put to non-agricultural use is 1,48,529 ha(9%). The current fallows and other fallow lands cover 1,34,536 ha. (8%) and1,14,920 ha (8%) respectively. The net area sown is 3,90,487 ha i.e., 27% of the total area. The area sown more than once is 40,899 ha (3%) making the total cropped area is 4,31,386 ha i.e., 30% of total. The details of land utilization are given Table-1.

Table-1 Details of land utilization are given

Sl.No.	Category	2004-05	2005-06	2011-12
1.	Forests	4,52,018	4,52,01	4,52,018
2.	Barren and Uncultivable Land	164265	164220	1,63,650
3.	Land put to Non-Agricultural Use	142254	142254	1,48,529
4.	Cultivable Waste	39512	43537	41,691
5.	Permanent Pastures and Other Grazing Lands	36527	36502	33,769,
6.	Land Under Miscellaneous Tree Crops and Groves not Included in the Net Area Sown	25173	25165	35,496
7.	Current Fallows	161759	114254	1,34,536
8.	Other Fallow Lands	126276	117707	1,14,920
9.	Net Area Sown	351674	403774	3,90,487
10.	Total Geographical Area	15,15,100	15,15,10	15,15,100
11.	Total Cropped Area	390336	443005	4,31,386
12.	Area Sown more than once	36283	39229	40,899

2.0 DRAINAGE AND SOILS

There are no major rivers in the district. Most of the rivers are ephemeral in nature carrying large quantities of water immediately after precipitation. The drainage is generally sub-articulate to sub-parallel following straight courses. The important drainage basins are Bahuda, Pincha, Swarnamukhi, Palar, Ponnaiand Araniyar. The Bahuda and Pincha are north flowing rivers, Swarnamikhi is east flowing, Palar is southeast flowing, Ponnai towards south and Araniyar is southeast flowing. According to the assessment made on the basis of village records, 57% of the area is covered by Red loamy soils, 34% by red sandy soils. The remaining 9% is covered by black clay (3%), black loamy (2%), black sandy (1%) and red clayey (3%).

3.0 PHYSIOGRAPHY

The district forms a part of the Mysore plateau. The western and southwestern parts comprising Kuppam, Palamaneru, Punganur, Thamballapalle and Madanapalle areas have an altitude between 600 m and 900 m amsl. The altitude of central region comprising Bangarupalem, Chittoor, Piler, Vayalpad, Chandragiri areas have 300 m to 600 m amsl. The eastern/southern parts covering parts of Puttur, Karvetinagar, Satyavedu, Tottambedu and Srikalahasty areas have an altitude of less than 300 m amsl. This indicates that the elevation in the district is highly variable and having steep slopes.

4.0 GEOLOGY

The district is underlain by formations of Archaean, Proterozoic, Jurassic Cretaceous Tertiary and Quaternary ages. The oldest rocks in the area belong to Migmatite Complex, represented by migmatised quartzo-felspathic gneiss and are exposed in the northeastern part of the district. Older metamorphics comprise amphibolites, hornblende-talc-mica-schist, fuchsite quartzite, calc-sillicate rock, marble and banded ferruginous quartzite. These older metamorphics occur

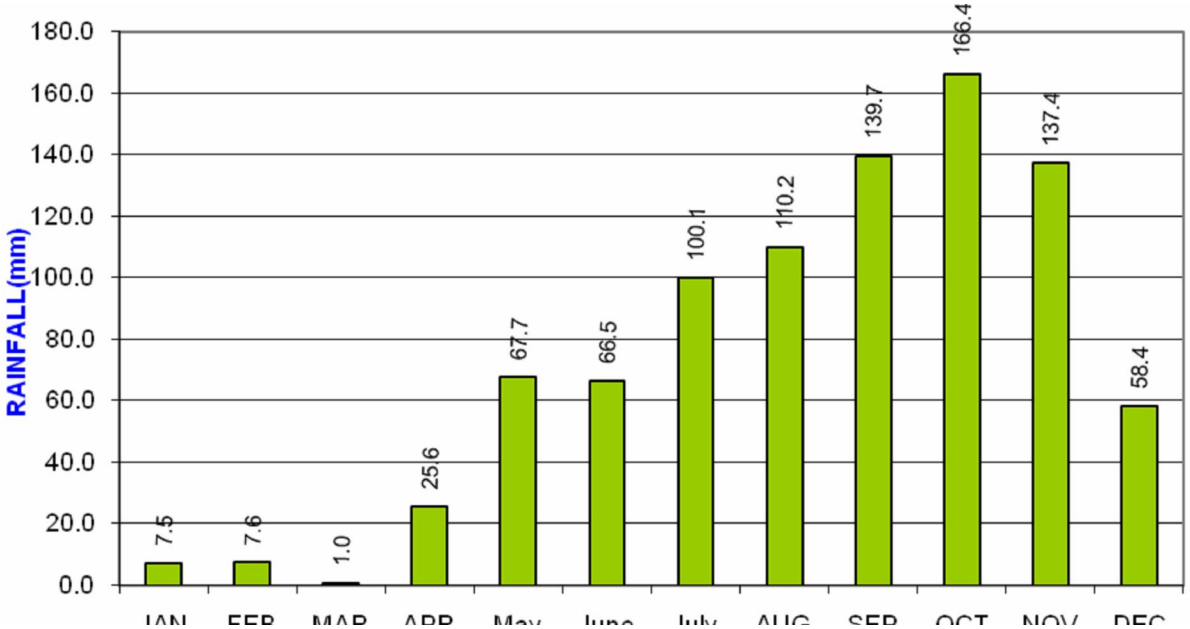
as enclaves within Peninsular Gneissic Complex (PGC). The PGC comprises a complex assemblage of gneissic variants and granitic rocks, which occupy almost major part of the district. PGC in the area is represented by biottte-homblende gneiss, biotite granite and migmatite. The Dharwar Supergroup of rocks represented by quartz-mica schist, amphibolite schist, quartzo-flespathic mica schist (Champion gneiss, metabasalt, matadacite and banded ferruginous quartzite, belonging to various schist belts and occur as long linear N-S trending belts and overlie PGC non-conformably. Acid intrusives of Proterozoic Age comprises granite and quartz veins. The granite plutons are exposed as patches and linear bodies in southwestern and northwestern parts of the district respectively. The basic dykes include dolerites. Three sets of dolerite dykes trends E-W, N-S, and NW-SE, traverse

The southern tip of the well-known Cuddapah Basin falls in the northeastern part of the district. Shale and quartzite of Bairenkonda Formation, shales/phyllite and limestone of Cumbum Formation are exposed in the district. The rocks of Gondwana Super group occur non-conformably over the PGC in southeastern part of the district, represented by Satyavedu Formation (Under Gondwana) and comprise motled, ferruginous quartzite and conglomerate with plant fossils. Laterite cappings occur over Gondwana formations. Large tracts of Alluvium occur along the major streams, which belong to Recent Age.

5.0 RAINFALL

The average annual rainfall of the district is 976 mm, which ranges from 1 mm rainfall in March to 166.4 mm in October. October is the wettest months of the year. The mean seasonal rainfall distribution is 466.5 mm in southwest monsoon (June-September), 392.2 mm in northeast monsoon (Oct-Dec), 15.1 mm rainfall in winter (Jan-Feb) and 94.3 mm in summer (March – May). The percentage distribution of rainfall, season-wise, is 46.9% in southwest monsoon, 40.8 % in northeast monsoon, 1.7 percentage in winter and 10.6 % in summer. The mean monthly rainfall distribution is given in Fig.2.

Fig.2 Mean monthly rainfall distribution



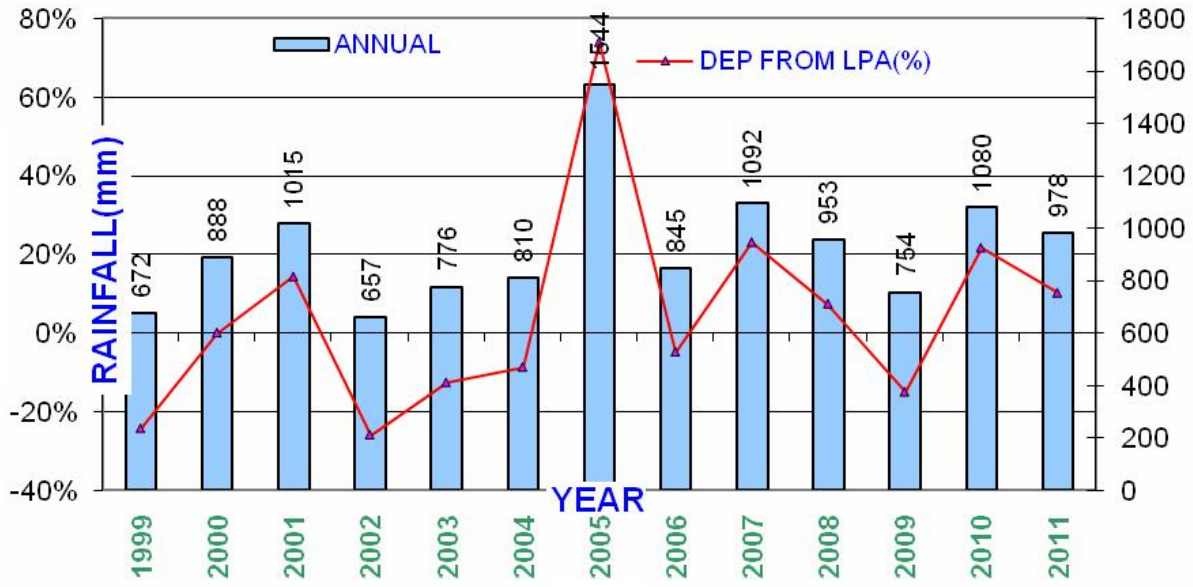
The annual and seasonal rainfall distribution with its departure from mean along with year-wise percentage distribution is furnished in Table-2. The annual rainfall ranges from 657.2 mm in 2003 to 1544 mm in 2005. The annual rainfall departure ranges from -26 % in 2002 to 74 % in 2005. The southwest monsoon rainfall contributes about 47 % of annual rainfall. It ranges from 259 mm in 1999 to 573.2 mm in 2005. The year 2002 experienced drought conditions in the district, as the annual rainfall recorded is 26 % less than the long period average (LPA) respectively. The cumulative departure of annual rainfall from LPA is presented in Fig.3. It indicates that, the rainfall departure, as on 2011 is positive i.e. 59%, showing rainfall excess.

Table – 2 Rainfall distribution and departure from mean

Sl No	YEAR	ANNUAL	SWM	NEM	WINTER	SUMMER	SWM(%)	NEM(%)	WINTER(%)	SUMMER(%)	DEP FROM LPA(%)
1	1999	672.0	259.0	307.0	1.0	105.0	38.54%	45.68%	0.15%	15.63%	-24%
2	2000	888.0	447.0	288.0	51.0	102.0	50.34%	32.43%	5.74%	11.49%	0%
3	2001	1014.7	400.0	484.7	5.0	125.0	39.42%	47.77%	0.49%	12.32%	14%
4	2002	657.2	301.1	275.1	17.0	64.0	45.82%	41.86%	2.59%	9.74%	-26%
5	2003	775.5	540.1	191.0	0.0	44.4	69.65%	24.63%	0.00%	5.73%	-13%
6	2004	810.2	352.8	230.3	6.3	220.8	43.54%	28.43%	0.78%	27.25%	-9%
7	2005	1543.9	573.2	792.4	27.1	151.2	37.13%	51.32%	1.76%	9.79%	74%
8	2006	844.6	378.7	315.2	1.5	149.2	44.84%	37.32%	0.18%	17.67%	-5%
9	2007	1092.2	559.1	437.3	2.9	92.9	51.19%	40.04%	0.27%	8.51%	23%
10	2008	953.3	366.5	434.2	19.3	133.3	38.45%	45.55%	2.02%	13.98%	7%
11	2009	754.4	398.1	294.8	1.3	60.2	52.77%	39.08%	0.17%	7.98%	-15%
12	2010	1079.5	530.1	421.6	2.1	125.7	49.11%	39.06%	0.19%	11.64%	22%
13	2011	978.1	507.1	354.4	23.1	93.5	51.85%	36.23%	2.36%	9.56%	10%
		888.0	416.5	362.2	15.1	94.3	46.90%	40.78%	1.70%	10.61%	

source: Inidia Meteorological Department And Directorate Of Economics And Statistics

Fig-3 Cumulative **departure of annual rainfall from LPA**



6.0 GROUND WATER SCENARIO

6.1 Hydrogeology

More than 90% of the district is underlain by crystalline formations and the remaining area by semi-consolidated formations. The degree and depth of weathering varies from place to place in crystalline formations and hence the potentiality of shallow aquifers also varies. Ground water occurs under unconfined conditions in weathered portion and semi-confined to confined condition occurs in fractures, joints at deeper depths. Ground water in weathered formations is developed by dug wells. For irrigation purposes, the dug wells are circular or rectangular in shape with 30 to 60 sq.m. The domestic wells are mostly circular in shape and smaller in size. The depth of the wells is upto 10m. The average discharge of energized wells ranges from 18 to 30 cu.m/day. However, during monsoon period, the discharge varies from 80 to 200 cu.m/day and during summer 10 to 50 cu.m/day.

To increase the yield of the dug wells inclined/horizontal bores of 25 mm dia were drilled to a length of around 10m. The deeper aquifers are developed through construction of shallow/deep bore wells. The bore wells are drilled down to 120 m depth with 162 m dia in. However, the encountering of fractures beyond 70 m is very less and at few places, the potential aquifers were encountered beyond 130 at Mogili and Malreddikandriga. This was noticed under the exploration programme by CGWB. The bore well yields generally vary from 0.1 to 5.0 lps. Analysis of fracture pattern and yield of exploratory wells are given in the Table-3.

The Nagari Quartzites are mostly confined to uplands and hilly areas, which are covered by forest. These formations are massive and compact and possess meagre ground water potential. The ground water development is very less and there is not much habitation in these formations. The alluvium is confined to mostly riverbanks and stream courses with varying width and depth. Ground water development in this formation is mostly by filter points and dug wells. The well yields vary from 3 to 10 lps. with drawdown of 2 to 6 m. They can sustain pumping for 6 to 8 hours/day with fast recovery of water levels. The Hydrogeology of Chittoor district is shown in Fig.4.

Fig.4 Hydrogeology of Chittoor district

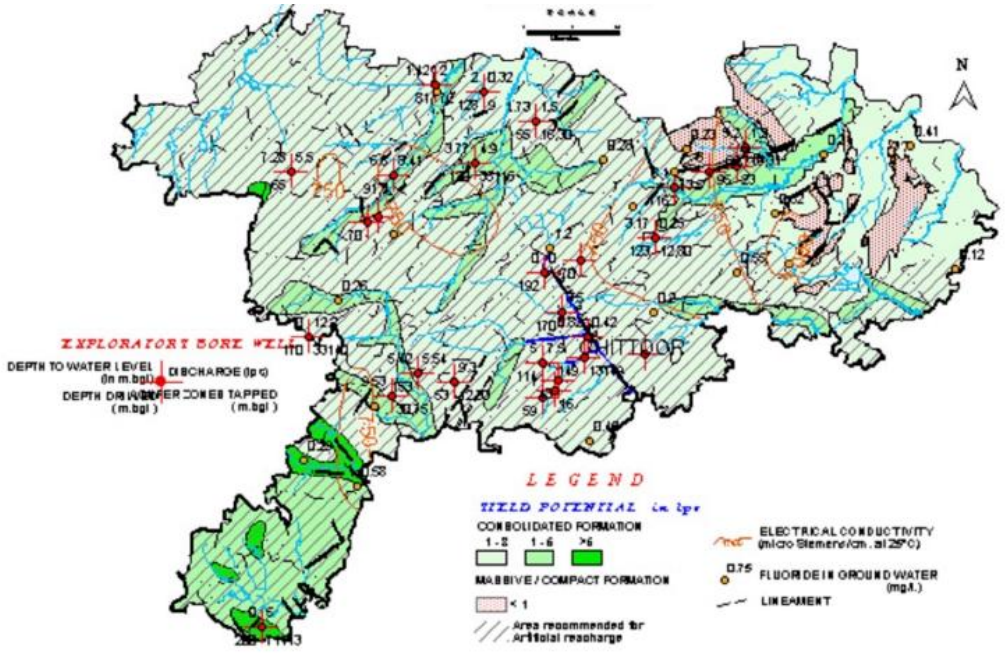


Table-3. Fracture Pattern & Yield of wells Constructed by CGWB

S. No.	Mandal	Depth drilled (m bgl)	Fracture zones encountered (m bgl)		Discharge Range (lps)
1	Nagari 13° 39' 30" 78° 53' 10"	120	Shallow	16	Traces
			Deeper	115-116	4.9
2	Srikalahasti	200	Shallow	16 35-36 41-42 64-65 81-82	Traces 1.3 2.2
			Deeper	----	--
			Deeper	----	--

6.2 Aquifer parameters

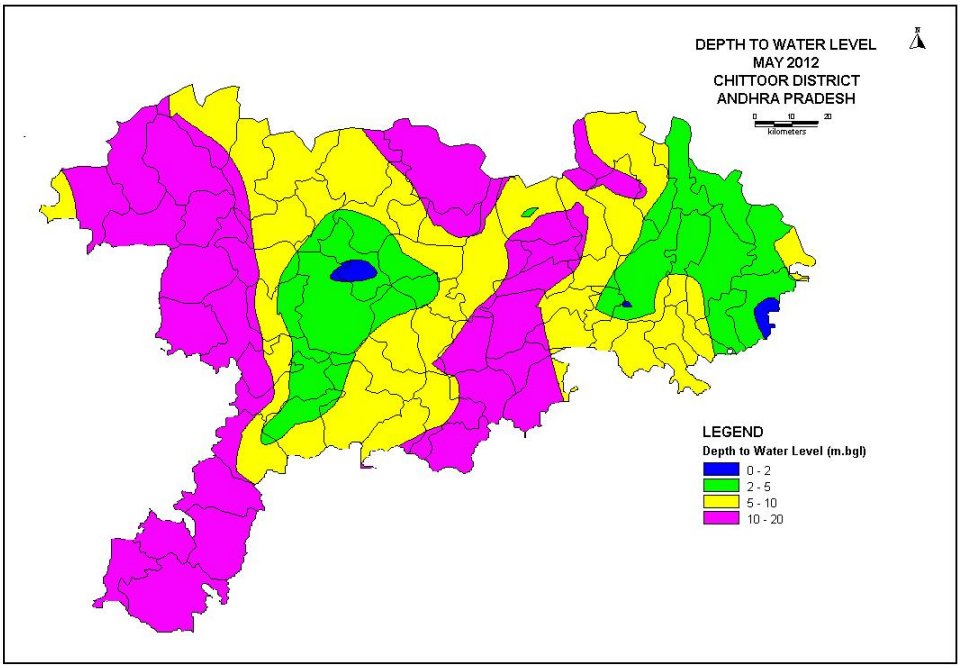
In hard rocks, the specific capacity of the bore wells is in the range of 0.13 to 11.38 cu.m/hr/m drawdown. The transmissivity is in the range of 30 to 150 sq.m/d with a maximum value of 824 sq.m/day. The specific capacity of wells in alluvium varies from 0.14 to 1.0 lpm/mdd.

7.0 WATER LEVELS

7.1 Pre-monsoon, (May 2012)

Depth to water level data of monitoring wells of CGWB and piezometers of APSGWD has been considered for analysis purpose. Depth to water levels during pre-monsoon season (2012) is presented in Fig.5. Water levels of 2-5mbgl is observed in the central and eastern parts of the district. 5-10mbgl range of water levels zone is noticed in central part. More than 10m depth to water levels has been seen in western and as isolated patches in northern and south central regions.

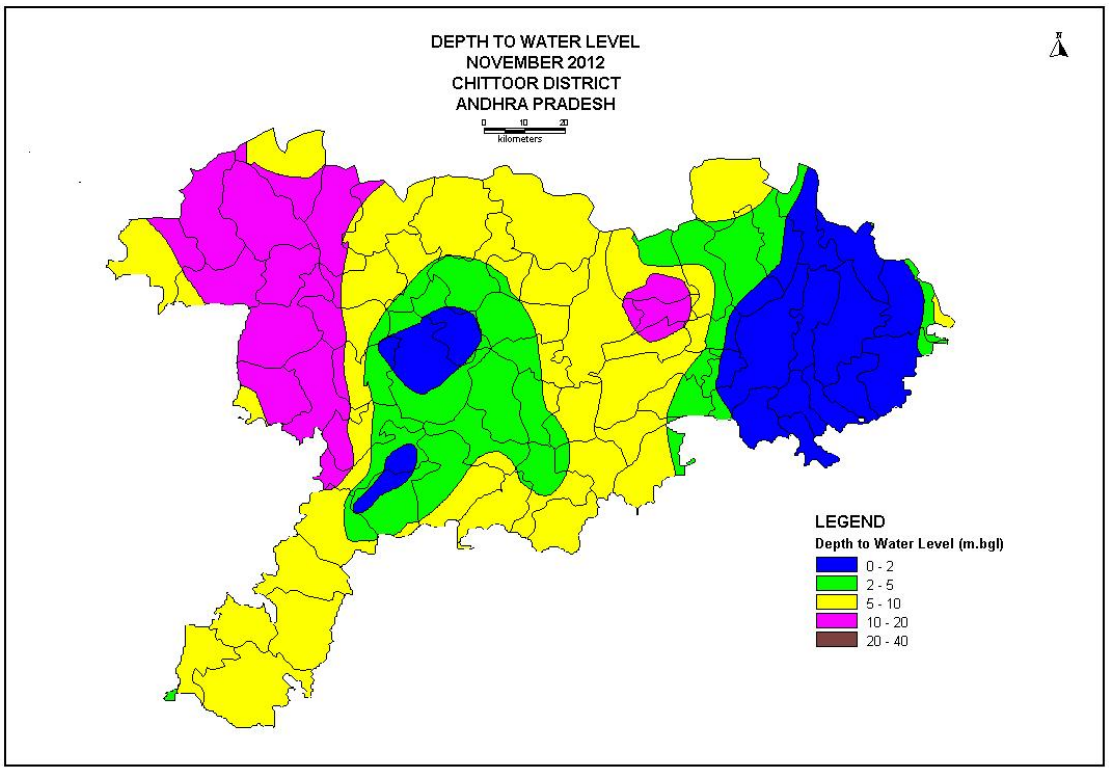
Fig.5



7.2 Post monsoon (November, 2012)

Most of the area in the district has water levels between 5-10 m bgl. However, water levels between 10 and 20mbgl were observed in the extreme western part of the district in and around Madanapalle, Peddamanyam, Ramasamudrum, Pedda Thippasamudrum and Gudipala areas(Fig.6). Shallow Water levels less than 2mbgl were observed in the eastern part.

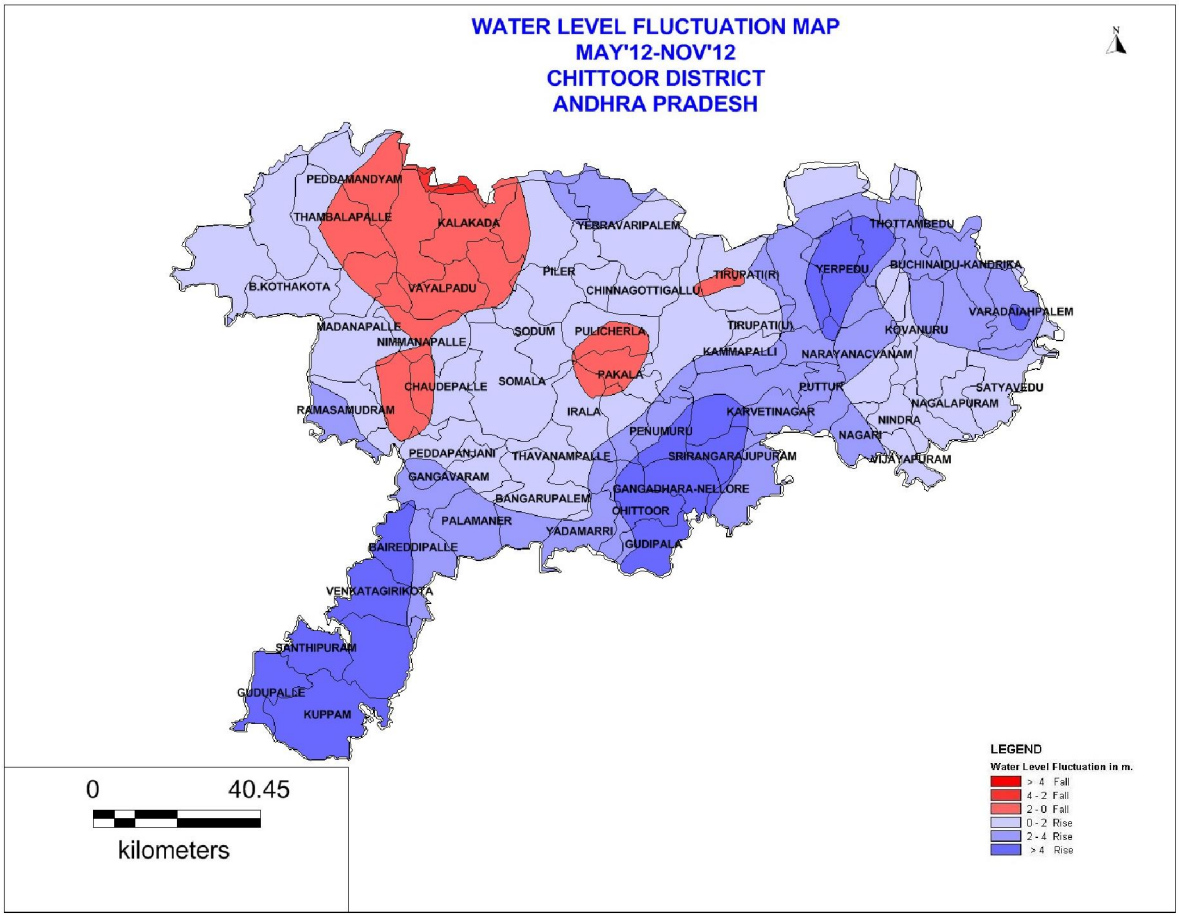
Fig.6



7.3 Water level Fluctuations

Map depicting water level fluctuation is presented in Fig.7. Fluctuation of + 0 to 4 m in water levels has been observed in most of the district. Fall in water levels in the range of 0 to 4 m has been noticed in the extreme western parts of the district around Madanapalle, Peddamanyam, Ramasamudrum and Pedda Thippasamudrum areas.

Fig.7

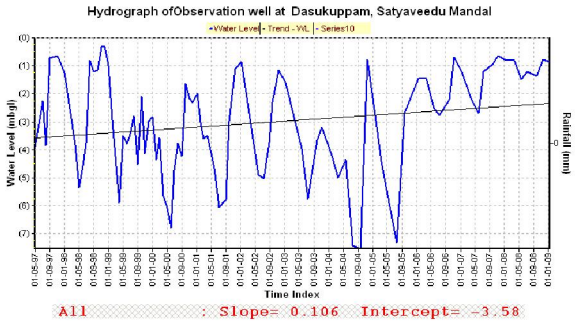


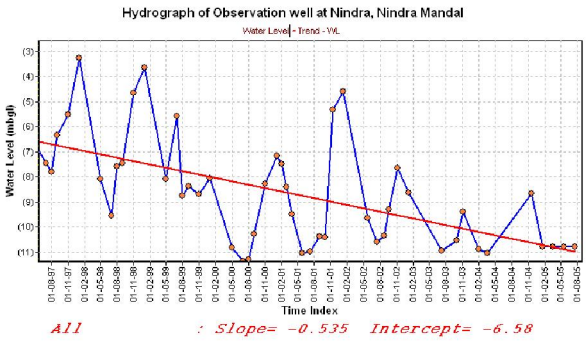
7.4 Long Term Water level Trends

The analysis carried out using historical water level data for the period 1997-2012 indicate that ground water levels are showing a long-term (annual) falling and rising trend. The falling trend is observed in mostly over exploited and critical mandals confined to be attributed to overdraft for irrigation. Representative Hydrographs with annual trend lines are shown in Fig.8. The rise in water levels in safe mandals of is an indicative of the effect of the good monsoons on the ground water regime.

The trend analysis indicates decline of ground water levels during pre-monsoon period ranged from 0.08 to 0.80 m/yr in 28 stations out of 38 stations with general declining trend of 0.10 to 0.40 m/yr. The rise of water levels is found to be ranging between 0.01 to 0.10 m/yr. During post monsoon period also, the water levels are found in some of the observation stations. It is ranged from 0.03 to 1.80 m/year with general range of 0.10 m to 0.70 m/yr. The rise of water levels is found to be 0.01 to 0.10 m/year.

Fig.8 Hydrographs with annual trend





8.0 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-4. The net annual Ground water resource available is 153857 ha.m.(Fig.9). There is no command and poor quality area in the district. The gross annual ground water draft for all the uses is 116097 ha.m and net annual ground water availability for future use is 37478 ha.m. The stage of development is 75%.

Based on the present stage of ground water development, out of 66 mandals, 13 mandals fall under *over exploited* category, 7 mandals fall under *critical* category, 9 mandals fall under *semi-critical* category and 37 mandals fall under *safe* category

Table-4

Assessment of Dynamic Groundwater Resources of Chittoor District, Andhra Pradesh
Administrative (Mandal) unit wise Categorisation [2008-2009]

Sl.No.	Mandal name	C/ NC / T	Stage of ground water develop ment [%]	Pre-monsoon		Post monsoon		Category [safe/ semicritical/ 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	B N Kandriga	NC	39	-20	No	-56	No	Safe
2	B.Kothakota	NC	70	-201	No	-162	No	Safe
3	Baireddypalli	NC	96	55	Yes	47	Yes	Critical
4	Bangarupalem	NC	53	-118	No	-43	No	Safe
5	Cggallu	NC	87	-140	No	-111	No	Safe
6	Chandragiri	NC	40	-214	No	-220	No	Safe
7	Chittoor	NC	66	-57	No	-306	No	Safe
8	Chowdepalli	NC	76	-58	No	31	Yes	Semi-Critical
9	G.D.Nellore	NC	91	72	Yes	137	Yes	Critical
10	Gangavaram	NC	94	-58	No	31	Yes	Semi-Critical
11	Gudipala	NC	68	-302	No	-365	No	Safe
12	Gudupalli	NC	86	-58	No	31	Yes	Semi-Critical
13	Gurramkonda	NC	64	-72	No	-49	No	Safe
14	Irala	NC	82	-186	No	-176	No	Safe
15	Kalakada	NC	60	-18	No	-49	No	Safe
16	Kalikiri	NC	70	-174	No	-141	No	Safe
17	Karvetinagaram	NC	90	-130	No	-117	No	Safe
18	Kuppam	NC	49	-42	No	-50	No	Safe
19	Kurabalakota	NC	61	-113	No	-100	No	Safe

20	Kv Palli	NC	62	-192	No	-65	No	Safe
21	Kvb Puram	NC	49	-20	No	-56	No	Safe
22	Madanapalli	NC	87	-58	No	31	Yes	Semi-Critical
23	Molakala Cheruvu	NC	76	-9	No	10	No	Safe
24	Nagalapuram	NC	68	-20	No	-56	No	Safe
25	Nagari	NC	81	-83	No	-74	No	Safe
26	Narayanavanam	NC	88	-130	No	-106	No	Safe
27	Nimmanapalli	NC	78	1	No	44	Yes	S.C
28	Nindra	NC	141	1	No	44	Yes	Over Exploited
29	Pakala	NC	129	79	Yes	132	Yes	Over Exploited
30	Palamaneru	NC	80	-58	No	31	Yes	Semi-Critical
31	Palasamudram	NC	127	-76	No	31	Yes	Over Exploited
32	Pedda Thippa Samudram	NC	81	-56	No	-50	No	Safe
33	Peddamandyam	NC	46	-473	No	-99	No	Safe
34	Peddapanjani	NC	84	-58	No	31	Yes	Semi-Critical
35	Penumuru	NC	115	72	Yes	137	Yes	Over Exploited
36	Piler	NC	91	13	Yes	19	Yes	Critical
37	Pitchaturu	NC	65	-20	No	-56	No	Safe
38	Pulicherla	NC	96	13	Yes	19	Yes	Critical
39	Punganur	NC	90	140	Yes	127	Yes	Critical
40	Puthalapattu	NC	125	120	Yes	-24	No	Over Exploited
41	Puttur	NC	90	-130	No	-106	No	Safe
42	R.C.Puram	NC	150	79	Yes	132	Yes	Over Exploited
43	Ramakuppam	NC	107	55	Yes	47	Yes	Over Exploited
44	Ramasamudram	NC	176	65	Yes	107	Yes	Over Exploited
45	Renigunta	NC	62	-71	No	-73	No	Safe
46	Rompicherla	NC	41	-140	No	-111	No	Safe
47	S R Puram	NC	149	72	Yes	137	Yes	Over Exploited
48	Santhipuram	NC	116	55	Yes	47	Yes	Over Exploited
49	Satyavedu	NC	36	-8	No	2	No	Safe
50	Sodam	NC	70	-61	No	-119	No	Safe
51	Somala	NC	53	-119	No	-115	No	Safe
52	Sri Kalahasti	NC	68	-71	No	-41	No	Safe
53	Thamballapalle	NC	39	-270	No	-97	No	Safe
54	Thavanampalli	NC	99	72	yes	137	yes	Critical
55	Thottambedu	NC	72	11	Yes	-3	No	Semi-Critical
56	Tirupathi(U)	NC	4	-214	No	-220	No	Safe
57	Tirupathi®	NC	180	79	Yes	132	Yes	Over Exploited
58	V.Kota	NC	89	-11	No	-24	No	Safe
59	Vadamalapeta	NC	87	1	No	44	Yes	Semi-Critical
60	Valmiki Puram	NC	49	-82	No	-90	No	Safe
61	Varadaiahpalem	NC	51	-77	No	-70	No	Safe
62	Vedurukuppam	NC	62	-2	No	-7	No	Safe
63	Vijayapuram	NC	116	11	Yes	-3	No	Over Exploited
64	Y.V.Palem	NC	58	-150	No	-137	No	Safe
65	Yadamarri	NC	92	72	Yes	137	Yes	Critical
66	Yerpedu	NC	106	11	Yes	-3	No	Over Exploited

Fig.9 Ground Water Resources in Chittoor district

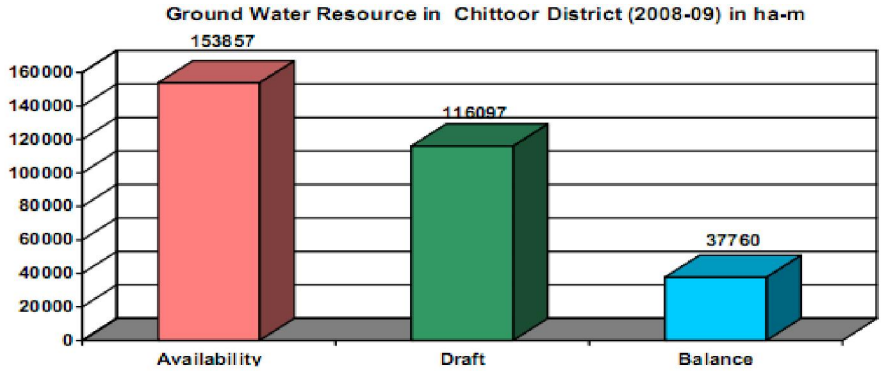
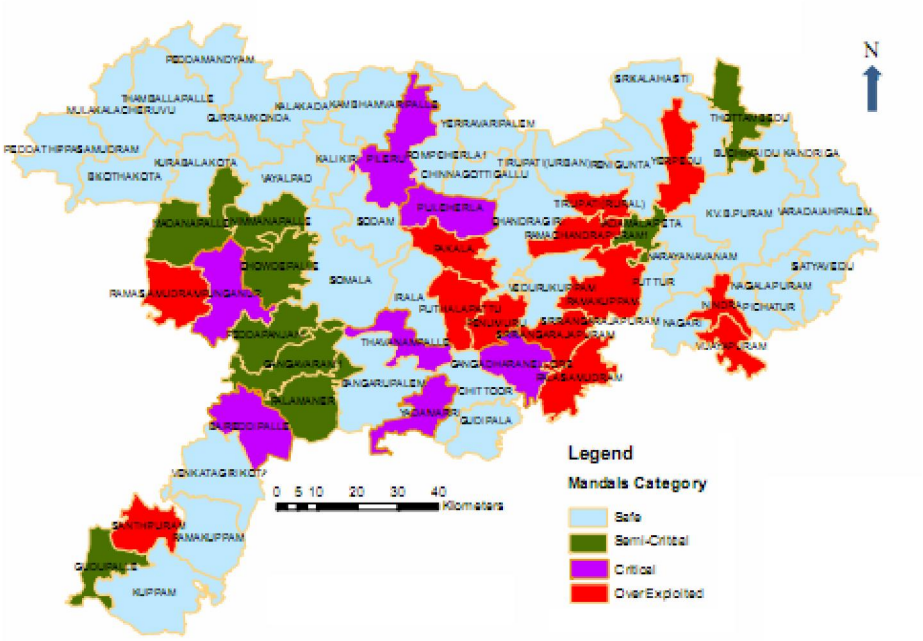


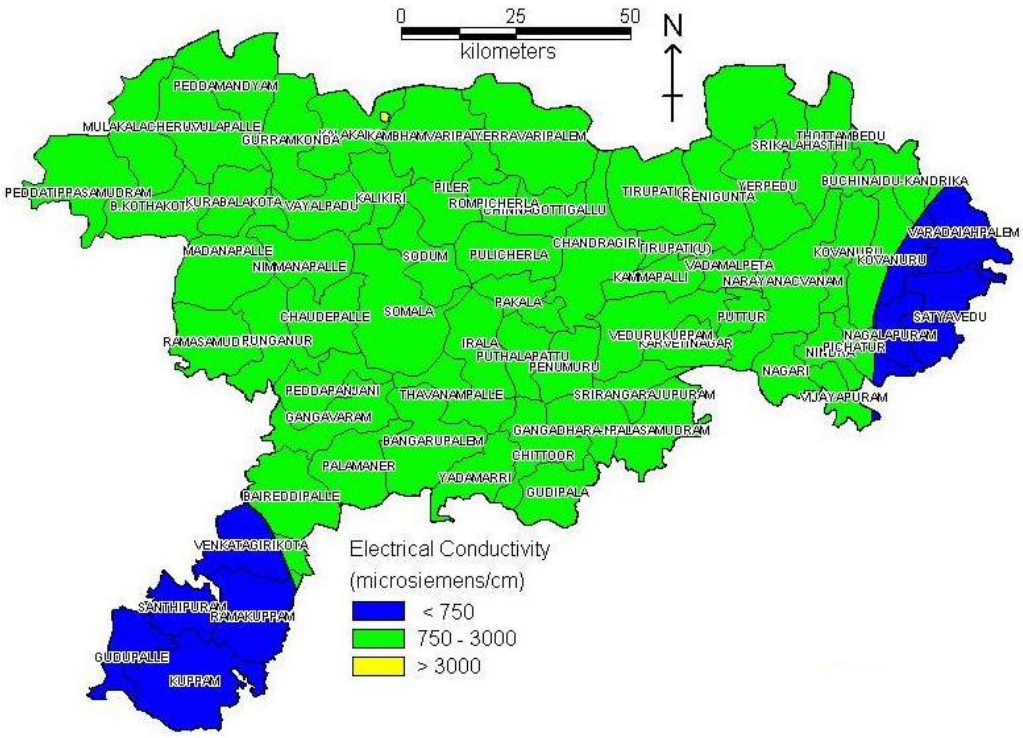
Fig.10 Mandal wise Categorisation in Chittoor District



9.0 Ground Water Quality

The ground water in the district is in general suitable for both domestic and irrigation purposes. The Electrical Conductivity ranges from 750 to 3000 micro Siemens/cm at 25 deg. C. Distribution of EC is shown in Fig.11. Fluoride concentration in ground water is within the permissible limit. The assessment of deep ground water is done based on water samples collected from the bore wells during the exploratory drilling programme. The deep ground water is generally alkaline. The deep waters are generally suitable for agricultural and irrigation purposes

Fig.11 Distribution of Electrical Conductivity in Ground Water in Chittoor District



10.0. Ground Water Development and Management

Ground water development is through deep bore wells, dug cum bore wells crystalline formations and filter points in alluvial aquifers. 15% area is irrigated by surface water under tanks. 84% of the irrigated area is by ground water, out which 70% is through bore wells and demand for ground water is constantly increasing and leads to over exploitation and depletion of water levels. This problem has been compounded by the availability of cheap/subsidized or even free supply of power to the farmers. Power subsidy has undoubtedly encouraged the greater use of ground water. It is imperative that an effective ground water management strategy shall be evolved in such a way that there is an optimal utilization of ground water on the basis of more crops per drop of water.

The ground water development in the safe mandals should be through bore wells of 70 to 100 m depth. The occurrence of potential fracture zones beyond this depth is rare and its success rate is one in ten or fifteen. The places where the depth of weathering is more than 10m, dug-cum-bore wells are feasible to a depth of 10 to 15m. Sites for bore wells should be selected scientifically by conducting hydrogeological and geophysical studies. Ground water development can be taken up only in safe mandals. Well space norms should be followed strictly as shown in the Table-5.

Table-5 Well spacing norms

Situation	Spacing between two wells (m)		
Situation	Dug wells	Filter point	Bore wells
Non-ayacut area	160	260	200-500
Ayacut area	100	160	200-300
Near perennial source within 200 m	100	160	200-300
Near perennial steams within 100 m	150	180	300-500

Further ground water development should be stopped in over-exploited mandals through administrative and legal measures where provision already exists in WALTA Act. Areas should be prioritized for rainwater harvesting and artificial recharge in critical and over exploited mandals as an immediate measure on scientific lines.

There are three major ongoing irrigation projects in the district. They are

I)Telugu Ganga Project
2) Galeru-Nagari Sujala Sravanthi Project and
3) Handri-Neeva Sujala Sravanti Scheme

with a total ayacut of 2,92,329 acres. The mandals covered are Renigunta, Yerpedu, Srikalahasthi, K.V.B. Puram, Pichatoor, Nindra,Mulakalacheruvu, Madanapalli, Punganur, Palamaner, Kuppam, etc. Hence, the proposed ayacut under these irrigation projects are likely to get water in future. This will increase the ground water recharge. Hence, there will be much scope for further ground water development in these proposed ayacut area in future.

11.0. Water conservation and artificial recharge

In view of the increasing thrust on development of ground water resources, there is an urgent need to augment these depleting resources in the active recharge zone. This can be augmented through natural or artificial recharge. Rainfall is the main source of both types of recharge. The rainfall occurrence in different parts of India is limited to a period ranging from about10 to 100 days. The natural recharge to groundwater reservoir is restricted to this period only and is not enough to keep pace with the excessive continued exploitation. Since large volumes of rain fall flows out into the sea or get evaporated, artificial recharge has been advocated to supplement the natural recharge.

Under Neeru-Meeru (Water and You) programme, rainwater conservation and artificial recharge to ground water works have been taken up on large scale in the district under DPAP, EAS, NWDP and other programmes. Various structures like check dams, percolation tanks, continuous contour trenches, contour bunding, dug out ponds, farm ponds, and other structures were constructed by various Departments like District Water Management Agency (DWMA), Forest Department and Panchayati Raj Departments. The district is drained by large number of rivers and the elevation difference between maximum and minimum is around 800 m and the area is with steep slopes. Hence, artificial recharge structures should be taken up at appropriate places after studying the availability of surface run-off in the area. All the works should be taken up on watershed basis and all stakeholders be involved in the programme. Each watershed

should be developed by gully plugs and check dams in upper reaches and percolation tanks and contour bunds etc. in the plains. However, all structures should be constructed for 50% of available run off potential, leaving the requirement of existing structures in a watershed.

12. Ground Water Problems & Special Studies

12.1 Vulnerable Area

The stage of ground water development as computed in the year 2004 is >100 percent in seven mandals and classified as overexploited category. Industrial units generating toxic effluents polluting the ground water are existing in Nagari mandal and vulnerable to ground water pollution when compared with other areas in the state. As the pre-monsoon water levels in all the observation wells in the area of investigation are >2.0 m bgl, the problems likely to arise from water-logging are also practically non-existent.

As serious problems related to depletion of ground water resources are felt, suitable measures are to be implemented to regulate the withdrawal of ground water and for replenishment of ground water resources in the shallow zone. With regard to the ground water pollution, higher values of Nitrate have been identified in ground water as isolated patches due to intensive agricultural activities, use of fertilizers and urban & municipal sewerage.

12.2 Scope for Conjunctive use of surface and Ground water

Ground water is the major source of irrigation, supplemented by tanks, canals and other sources. No detailed studies have been taken up so far to explore the possibilities of using surface water in conjunction with ground water for irrigation. However, in view of the increasing dependence on ground water as the main source for irrigation, it is imperative that plans for conjunctive use of surface and ground water be drawn up for the ayacut areas of major tanks and reservoirs. In view of the prevalent pattern of water use, conjunctive use seems to be the best option for the study area in which ground water will be used as the major source only during summer months.

12.3 Artificial Recharge

The stress on ground water is many folds due to increasing populace, agricultural needs and urbanization. Development and management of water resources become a challenging task for the agencies in developing countries.

The water table aquifer in the weathered residuum is desaturated and the dug wells became dry even in post monsoon season in most of the locations in Karvetinagar, Nagari, Nindra, Palasamudram, S.R.Puram, Vedurukuppam, and Vijayapuram mandals.

Ground Water recharge through existing dug wells will facilitate improvement in ground water quality, quantity and overall scenario of ground water resources. Many of the Artificial Recharge schemes fails to deliver the objectives due to non holistic and scientific approach and the lack of basic inputs like evaluation of drainage characteristics, catchment analysis and capacities and hydrogeological aspects ect. Detailed studies are necessary for formulating a comprehensive scheme for artificial recharge of ground water in view of the variability in topographic set-up and the complex hydrogeological conditions.

Implementation of Central sector artificial recharge scheme (by Ministry of Water Resources, Government of India) has been taken up by the State Government agencies during 2009-10 for ground water management and regulation. The total cost of the project is Rs.1,30.02,00. The scheme was proposed to construct 28 Check Dams, 1 Percolation Tank and 29 Piezometers in 7 over exploited Mandals of Chittoor District. I & CAD Govt. of Andhra Pradesh is the implementing agency. Location details of AR structures proposed in the area of investigation are furnished in the Table –6.

Table – 6 Details of AR structures proposed

Sl.No	Mandal	Location	Type of Structure	Topo-sheet No
1	Vijayapuram	Mittur	Check Dam -1 & PZ-1	57O/11
		Vijayapuram	Check Dam -1 & PZ-1	57O/11
		Kosalanagaram	Check Dam -1 & PZ-1	57O/12
2	Nagari	Mangadu	Check Dam -1 & PZ-1	57O/11
		Umity+D26 Illu	Check Dam -1 & PZ-1	
		Kakavedu	Check Dam -1 & PZ-1	
3	Karvetnagar	Padmasarasu ST colony, Kathukalava	Check Dam -1 & PZ-1	57O/7
		Karvetnagar Nagalagunta Vagu	Check Dam -1 & PZ-1	
		GollaKandriga Local Vagu	Check Dam -1 & PZ-1	
4	S R Puram	Pathapalem Marrimanu Vanka	Percolation tank & PZ-1	57O/7
		Kothapatti village Local Vagu	Check Dam -1 & PZ-1	
		SR Puram Local Vagu	Check Dam -1 & PZ-1	
		Settivanatham Eguva Vagu	Check Dam -1 & PZ-1	
5	Palasamudraum	SimharaJapuram Local vanka	Check Dam -1 & PZ-1	57O/8
		ThimmaraJapuram Valakalavagu	Percolation tank & PZ-1	57O/8
		Kaverirajapuram Valakalavagu	Check Dam -1 & PZ-1	
6	Vedurukuppam	Bommaiah Palli	Check Dam -1 & PZ-1	57O/7
		Santhabayalu	Check Dam -1 & PZ-1	
		Vedurukuppam	Check Dam -1 & PZ-1	
		Thariabayalu	Check Dam -1 & PZ-1	

12.4 Andhra Pradesh Community Based Tank Management Project

Government of Andhra Pradesh has taken up a project to restore and rehabilitate the minor irrigation tanks in all the districts to stabilize the ayacut areas and to minimize the gap ayacuts. The works include sluice repair, clearing of filled channels and bund strengthening with unit cost restoration of Rs.23,000 per hectare. The total cost of works depends on size of tank and work will be completed within 36 months. The technical guidance is provided by Civil Engineering Department, Ground Water Department, Animal Husbandry, Agriculture and Fisheries Department etc., The civil works are allotted to user farmer groups. Completed tanks are handed over to user association for operation and maintenance. The total available water can be used to maximum extent in time, through cleaning and desilting of field channels.

13.0 DEVELOPMENT PLAN

About 40 percent of the total geographical area is covered by hills and forests. Another 15 percent of the area has been put to non-agricultural uses. Hence, about 45 per cent of the total geographical area is available for planning of development of ground water resources.

The level of ground water development, balance irrigation potential to be harnessed and behaviour of ground water levels and net area irrigated by ground water sources and annual rainfall are the principal factors to be considered while planning for future development of ground water resources of any area. A tentative ground water development plan has been suggested in two ways by regulating the usage of available ground water and augmenting the resources by artificial recharge. The developmental plan will ensure perennial availability of adequate quantity of water for all the purposes. The development plan proposed is envisaged to be taken up for case of execution and to overcome financial constraints.

1. No further ground water development is envisaged in the study area as the level of ground water development has already reached >100% and declared as overexploited category and irrigation potential had been fully harnessed.

2. Development of ground water in the study area is permitted on scientific lines for drinking water purposes.

3. At present the net area irrigated by ground water by water intense crops like paddy, sugarcane and banana is 71,891 ha and it should not be increased in future, as the ground water requirement is very high.

4. Dry land forming may be take-up in large extent and drought resistant plants like mango, tamarind etc., may be cultivated.

5. Ground water in the study area should be used judiciously by adopting water saving techniques like sprinkler and drip irrigation system.

6. Large area should be brought under sprinkler and drip irrigation system. Institutional finance is available with attractive subsidy to the formers in overexploited areas to implementing this technology. Awareness should be created among the farmers about the ground water scenario of their villages and methods to be adapted to safeguard the precious resource for future generation.

7. Regulating legal measures should be enacted ensuring strict adherence of plan.

8. Construction of AR structures in the study area for augmentation of ground water resource is at scientifically suitable locations.

9. The ground water levels should be monitored regularly in a closed interval and if the ground water situation is improved, the need for additional wells may be considered on merit and constructed after detailed hydrogeological investigation.

10. To create awareness among farmers regarding Ground water management and Conservation of water, changing of cropping pattern for high yields and other artificial

recharge methods and suitable structures. CGWB has already conducted Mass Awareness Programmes at Somala and Kalikiri mandals, where the District Collector, State Govt. Officials, NGOs dealing water related activities participated in the programme. Such type of Programmes is to be conducted more frequently by the State government more particularly in OE mandals.

13.1 Design of Wells

The well design criteria and the types of lifting devices suitable for the designed discharge are given in Table-. For efficient functioning of pumping wells, it is necessary to reduce their mutual interference effects by ensuring that the wells are constructed sufficiently apart. Adequate spacing between wells has been made mandatory by Government of India in the case of institutional financing so as to ensure their economic viability. The spacing in various haydrogeological settings for each type of ground water abstraction structure should be worked out from the data of pump tests of 6-12 hour duration. In case of dug wells without pump sets, the spacing norms should be arrived at through short-duration pumping tests.

Economic viability of wells in an area implies that two structures should not exist within the command area of a single well so as to avoid over-capitalization of minor irrigation structures. These should be adopted for the wells to be economically viable in the non-ayacut area. In the ayacut areas of tanks and other surface water bodies where ground water is used only for supplementary irrigation during lean periods and for increasing the cropping intensity, 75 percent of the spacing recommended is considered adequate. The spacing norms for irrigation wells in different situations are presented in the Table-7.

Table-7 Spacing Norms for Irrigation wells in different situations

Situation	Spacing between any two wells (m)		
	Dugwells	Filter point wells	Borewells
Non-ayacut	160	260	300-500
Ayacut	100	160	200-300
Near perennial source like river or tank within 200 m	100	160	200-300
Non-perennial streams within 100m	150	180	300-500

14.0 Recommendations

1. Failure of the monsoon leads to less recharge to ground water and more draft from ground water reservoir. As a result, water levels are declined, which lead to drying up of dug wells and reduction of yield of bore wells. This necessitates construction of additional deep bore wells to provide water to the standing crop. More often, the new bore wells are likely to be a failure because of absence/de-saturation aquifers.. This can be addressed by strict implementation of APWALTA Act.

2. The Government has contemplated 47 tanks with an ayacut of 40,129 acres. These tanks should be taken up after completion of the ongoing projects

3. In the over exploited areas, large-scale artificial recharge to ground water has to be taken up at appropriate places on scientific lines, involving all stakeholders. Maintenance of these structures should be made mandatory by providing budget.

4. In safe mandals, bore wells are to be constructed observing the spacing norms upto a depth of 70-80 m based on the scientific selection of sites.

5. 'More crop per drop' methods i.e., sprinkler and drip irrigation methods shouldbe encouraged by giving higher subsidy to the farmers so that ground water for existing bore wells can be utilized to its optimum level.

6. Cultivation of water intensive crops like paddy, sugar cane, betel leaves etc. should be discouraged under ground water irrigation.

7. Storage facilities for the farm produce may be provided in cooperative sector to store the farm produce.

8. Adequate low interest institutional finance may be provided to the farmers.

9. Steps may be taken up for formation of bore well Insurance Corporation of India by Govt. of India in cooperation with State Governments. This facilitates reimbursement of drilling costs to the farmer, if the bore well is a failure.

10. Literature on crops eg. Vyavasaya Panchangam prepared by NG Ranga Agricultural University may be supplied to all the habitations at free of cost. It will increase the awareness of the farmers regarding various crops.

11. Mass awareness programmes should be conducted in rural areas to educate the farmers regarding the ground water management to update their knowledge. Training for local government functionaries, NGOs, Voluntary Organizations in watershed management activities needs to be imparte.