Assessment of Groundwater Quality and its Suitability for Irrigation and Drinking Purposes

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Introduction

- Groundwater has emerged as the primary democratic water source and poverty reduction tool
- Due to its low capital cost, it is the most preferred source of water in India.

- Ground water has made significant contributions to the growth of India's Economy and has been an important catalyst for its socio economic development.

- Its importance as a precious natural resource in the Indian context can be gauged that more than85 % of India's rural domestic water requirements, 50% of its urban water requirements and more than 50% of its irrigation requirements are met from G.W resources.

- Coastal aquifers prove to be an important source of ground water resource.
- Seawater is the most common pollutant of fresh water in coastal aquifers
- Seawater intrusion in fresh water aquifers- Results from the activities of Man.
- Excessive ground water pumping
  - Deterioration of water quality
  - Dictating expensive remedies

- Stress on groundwater, both in terms of quality and quantity, are increasing rapidly to growing demands, significant changes in land use pattern, sea water intrusion, industrial effluents, domestic effluent etc.
- The need to assess the groundwater quality is becoming increasingly important as groundwater sources become more and more contaminated by seawater intrusion, industrial effluents and unsustainable agricultural practices.

- Goal of coastal aquifer management – Maximize fresh water extraction without causing invasion of salt water into the wells.
- Mathematical models provide a quantitative frame work for analyzing data from monitoring and assess quantitative responses of the groundwater systems subjected to external stresses

Study area – Chittoor District

- Chittoor district is one of the chronically drought affected. 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.

- The district receives moderate rainfall. Failure of monsoons during the last few years lead to failure of bore wells and failure of crops.

- The soils of the district on the basis of village records are 57% Red loamy soils, 34% red sandy soils. The remaining 9% is covered by black clay (3%), black loamy (2%), black sandy (1%) and red clayey (3%).

Rainfall

- The annual rainfall of the district is 943 mm, which ranges from 600 mm at Molakacheruvu mandal to 1280 mm at Sri Kalahasti mandal.
- In the district level, the cumulative departure of annual rainfall was scanty i.e., more than 60% below normal, in 35 mandals and deficit i.e., below normal by 20% and 59% in 11 mandals.
- In the remaining 20 mandals the rainfall was above normal.
- On an average, the district rainfall condition was deficient by 61% from normal.

Groundwater

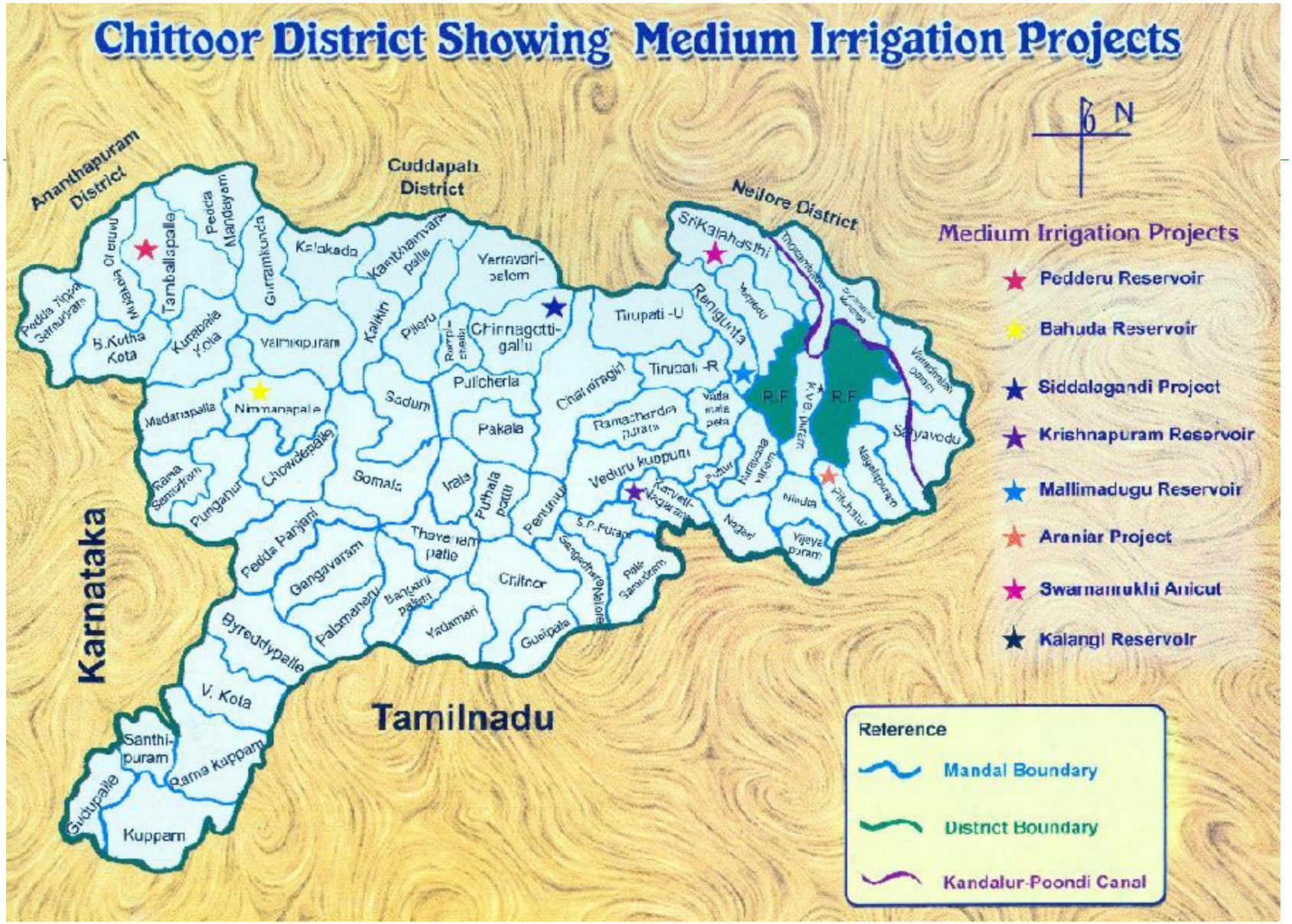
- Chittoor district is absolutely dependant on ground water for its irrigation and domestic needs.
- Out of the total irrigated land, 84.34% area is irrigated through 1,16,623 dug wells, 19,849 shallow bore wells and 28,933 deep bore wells.
- For irrigation purpose, there are 12,618 diesel engines and 99,402 electric pumps in the district.
- Drinking and domestic requirements of 10804 habitations are met through 6229 PWS & MPWS schemes and 20,368 bore wells.

Groundwater

- The overall stage of ground water development of the district is 72% and categorized as semi-critical.
- Out of the total 66 mandals, only 28 mandals are under safe category and 11 mandals are categorized as semi-critical category.
- There are as many as 781 villages declared as over-exploited villages out of 1540 revenue villages.

Irrigation

- As such, there are no existing major irrigation projects in the district.
- Though there are some ongoing irrigation projects, no irrigation through surface water except tank irrigation is being practiced.
- Only, 15% of area is irrigated through surface water under tanks.
- About, 84% of the irrigated area is through ground water, out of which 66% is by bore wells.


Chittoor District Showing Medium Irrigation Projects
Ananthapuram District
Cuddapah District
Nellore District
Karnataka
Tamilnadu
N
Medium Irrigation Projects
Pedderu Reservoir
Bahuda Reservoir
Siddalagandi Project
Krishnapuram Reservoir
Mallimadugu Reservoir
Araniar Project
Swarnamukhi Anicut
Kalangi Reservoir
Reference
Mandal Boundary
District Boundary
Kandalur-Poondi Canal
Tamballapalle
Pedda Mandyam
Gurramkonda
Kalakada
Kambhamvari palle
Yerravari-palem
Chinnagotti-gallu
Tirupati -U
Tirupati -R
Renigunta
Srikalahasthi
Pedda Tippa Samudram
B.Kothakota
Kurabala Kota
Valmikipuram
Kalikiri
Pileru
Pulicherla
Sadum
Nimmanapalle
Madanapalle
Pakala
Chandragiri
Ramachandrapuram
Vedurukuppam
Chowdepalle
Somala
Irala
Punganur
Ramasamudram
Pedda Panjani
Gangavaram
Palamaneru
Bangaru palem
Vadamali
Thavanam palle
Chittor
Gudipalle
Santhi-puram
Rama Kuppam
Kuppam
V. Kota
Byreddypalle
Guripala
Nindra
Nagari
Vijaya puram
Pitchatur
Nagalapuram
Satyavedu
Narayana vanam
K.V.Puram
R.F
R.F

Water resources

- The net ground water availability in the district is 1450.10 MCM.
- Ground water utilization is 1038.25 MCM and the ground water balance for future irrigation development is 411.85 MCM.
- The stage of ground water development arrived at 72% and hence the district falls under semi-critical category.

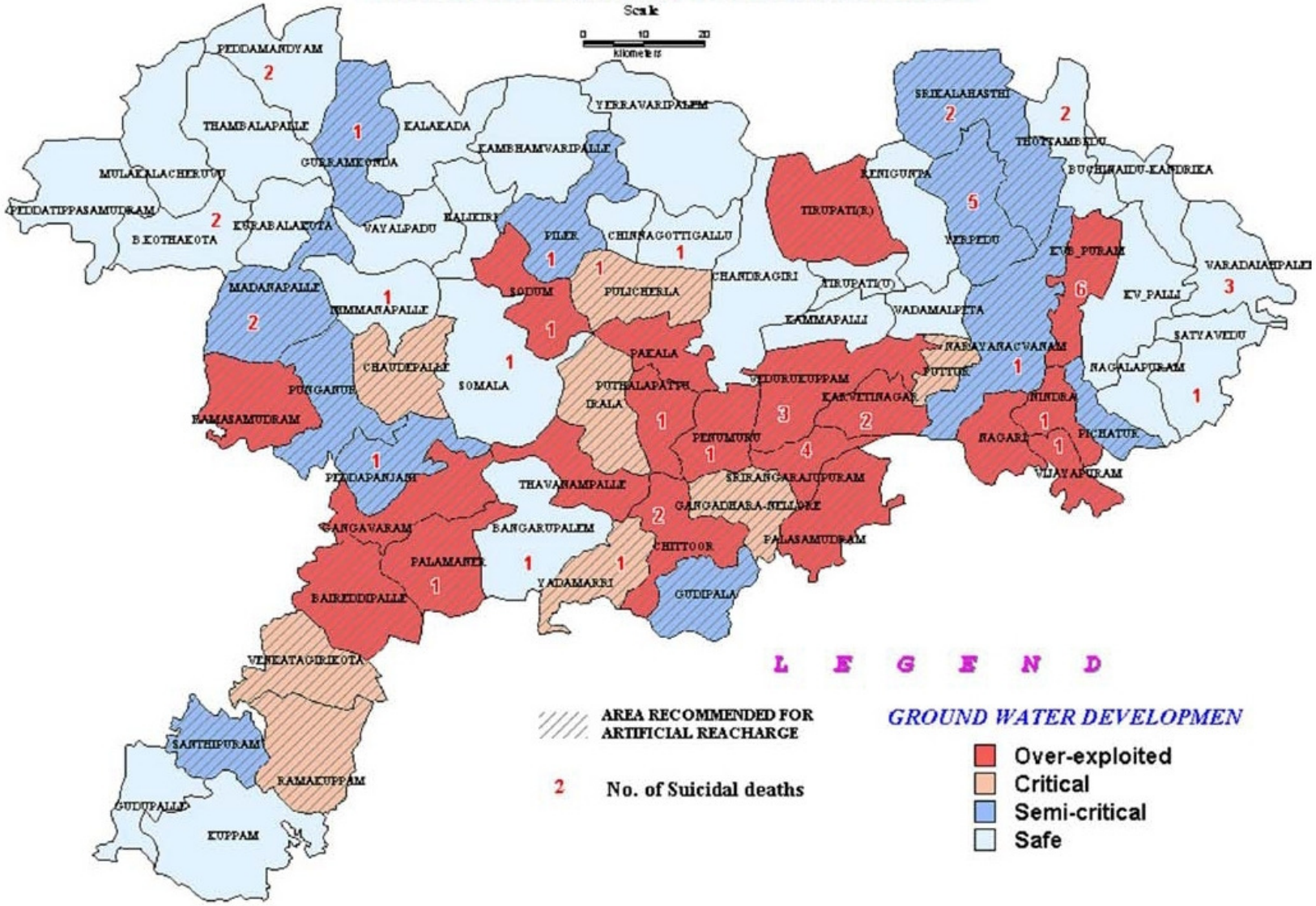
- Based on the stage of development, 28 mandals are categorized as safe, 11 as semi-critical, 9 as critical and 18 as over-exploited.

- The minimum stage of ground water development is in B.N. Kandriga (20%) and the highest development is in Tirupati (Rural) (98%).

- Penumuru mandal of Chittoor district has 38% of excess rainfall and has been categorized as over-exploited as per stage of ground water development

GROUND WATER DEVELOPMENT

CHITTOOR DISTRICT, ANDHRA PRADESH



Study Area

- Penumuru Mandal in Chittoor District of Andhra Pradesh State, India. belongs to Rayalaseema region and is located 24 KM towards North from District head quarters Chittoor, 530 KM from State capital Hyderabad towards North.

- Penumuru Mandal is bounded by by Puthalapattu Mandal towards west, Pakala Mandal towards North, Gangadhara Nellore Mandal towards South, Vedurukuppam Mandal towards East.

- Penumuru mandal consists of 169 Villages and 24 Panchayats. Thathireddipalle is the smallest Village and Penumuru is the biggest Village.

- The quality of groundwater has been studied by collecting water samples from five villages of Penumuru mandal namely Matampalli, Gangupalli, Nanjarpalli, Satambakam & Settipalli in the month of January, 2014.

- Twenty samples have been collected out which 19 have been collected from bore wells and 1 from Open dug well.

- These samples are analyzed for groundwater quality for the following parameters/ions, viz., pH, EC, TH, DO, Na, K and Alkalinity.

Objective

- The objectives of present work are as follows:
- To analyse groundwater quality for the following parameters/ions, viz., pH, EC, TH, DO, Na, K and Alkalinity.
- To assess groundwater quality and its suitability for irrigation and drinking purposes.

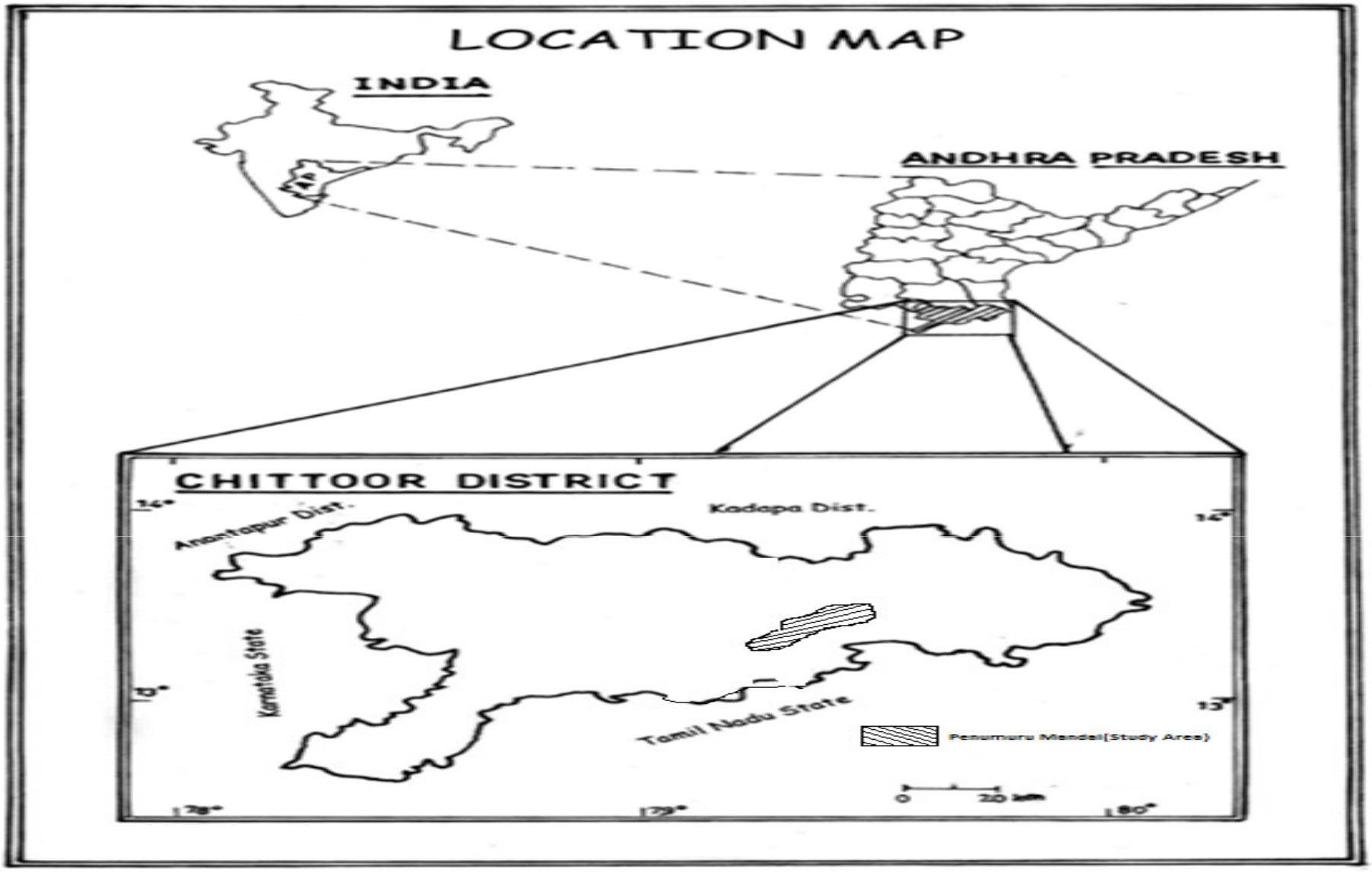


Fig. Study Area

Methodology

- The rainfall data was collected from the groundwater department and the water samples have been collected from the bore wells of the fields. The samples were analyzed for different ion concentration. The methodology includes

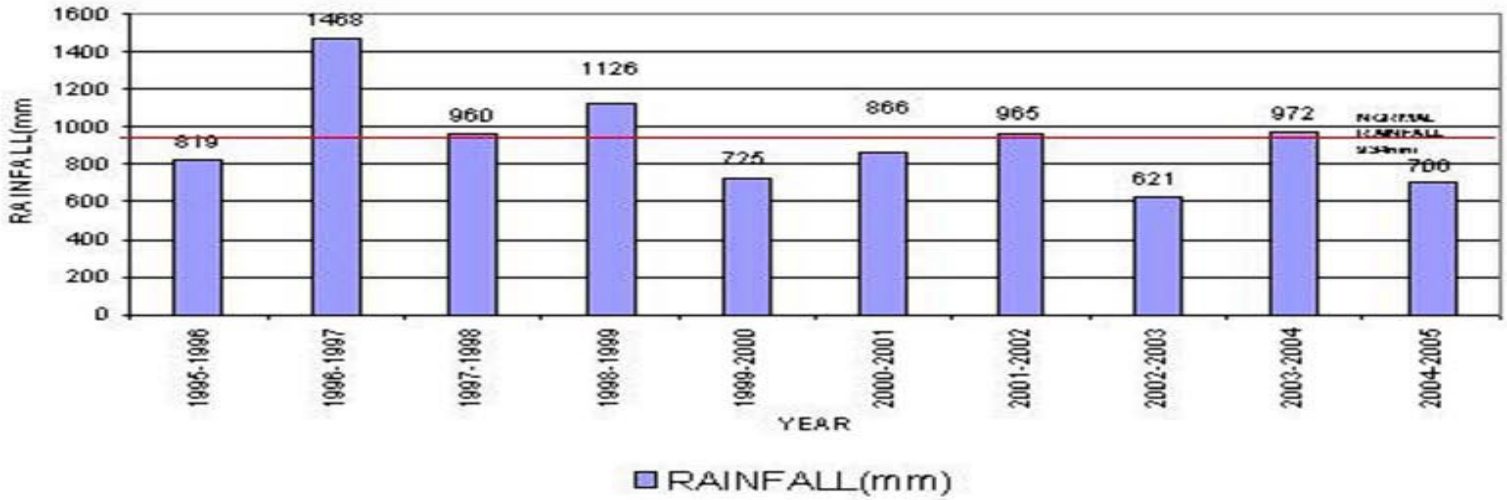
- Collection of hydrology particulars of wells
- Collection of rainfall data
- Collection of water samples
- Analysis of collected water samples.

Results and Discussions

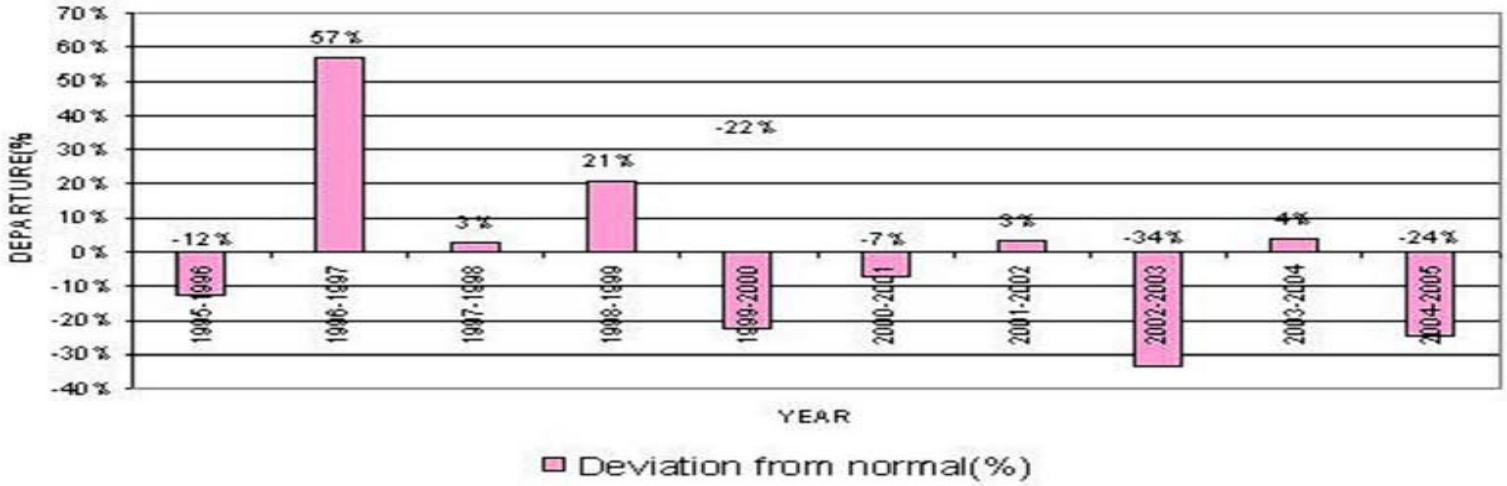
- Water samples were analyzed and the obtained values were compared with standard values.
- The drinking water standards of WHO (1971 and 2006) and Bureau of national standards (1983 and 1991) was the basis for the groundwater quality evaluation for drinking purpose.
- The chemical analysis of the samples for the following parameters/ions, viz., DO, pH, TH, EC, Na, K and Alkalinity are given in Table 1.

S. No.	Sample No.	Village	DO (mg/l)	pH	TH (mg/l)	EC (µS/cm)	Na (mg/l)	K (mg/l)	Alkalinity (ppm)
1	PM1	Matampalle	2.8	7.3	360	1200	318	3.0	765
2	PM2	Matampalle	1.8	7.2	350	1260	320	1.5	1155
3	PM3	Matampalle	5.0	7.2	425	1260	320	2.2	725
4	PM4	Matampalle	4.2	7.1	430	540	314	1.4	760
5	PM5	Matampalle	6.0	7.1	760	1740	309	1.6	340
6	PN1	Nanjarpalle	8.0	7.3	405	960	390	6.0	380
7	PN2	Nanjarpalle	9.0	7.2	465	880	386	5.2	540
8	PG1	Gangupalle	5.4	7.1	325	660	284	4.1	670
9	PG2	Gangupalle	5.4	7.2	355	780	300	4.5	745
10	PG3	Gangupalle	8.0	7.4	455	680	300	4.4	710
11	PS1	Satambakam	8.0	7.5	265	600	190	0.5	855
12	PS2	Satambakam	8.4	7.5	300	620	188	0.8	895
13	PS3	Satambakam	9.2	7.4	330	580	175	1.2	710
14	PS4	Satambakam	5.4	7.2	310	580	178	1.0	660
15	PS5	Satambakam	7.4	7.1	275	640	194	1.1	690
16	PS6	Satambakam	7.6	7.2	740	620	194	1.6	520
17	PSC1	Settipalle	9.8	7.1	230	200	74	1.0	460
18	PSC2	Settipalle	8.2	7.2	325	540	102	1.5	835
19	PSC3	Settipalle	9.0	7.4	530	200	84	1.1	520
20	PSC4	Settipalle	8.2	7.2	340	360	82	2.3	675

RAINFALL DISTRIBUTION, CHITTOOR DISTRICT, ANDHRA PRADESH



RAINFALL DEPARTURE FROM NORMAL, CHITTOOR DISTRICT
ANDHRA PRADESH



- **Dissolved Oxygen:**

  DO value in the majority of study area is between 4-8mg/l, and is within permissible limit. Matampalle village is having DO value less than 4mg/l, it will not suit for aquatic life.

- **pH:** pH value represents the concentration of hydrogen ions in water and is measure of acidity and alkalinity of water. pH value below 7.0 indicate acidic character while pH greater than 7.0 is indicative of alkaline character of water.

The average value for the study area is 7.2, the water is slightly alkaline. However pH values is within permissible limit.

- **Total Hardness:** Hardness is attributed principally to Ca and Mg. Hardness is also considered as total hardness is expressed in mg/l of equivalent $CaCO_3$.

Most of the study area is having hard water as hardness is more than 300 ppm. Settipalle village has been reported of hardness more than 500 ppm.

- **Electrical Conductivity:**

  The EC value in the area of study ranges between 500-1000 µS/cm. The average value of EC is 745 µS/cm.

- **Sodium:**

  The average value of sodium obtained in the study area is 235mg/l which is more than the permissible value.

- **Potassium:**

  The average value for potassium in the study area is 3.4.

- **Alkalinity:**

  Normal range of alkalinity in the area of study is 500-1000mg/l and the average value is 680mg/l. Alkalinity is quite high and it shows higher resistance towards changes in pH.

Conclusions

- The quality of groundwater plays a significant role in the crop productivity and human as well as cattle health.
- Chemistry of groundwater in the area is studied with respect to the major cation, sodium and potassium.
- Chemically related properties such as pH, TDS, TH are also discussed.

Conclusions....

- Dissolved oxygen content is within the permissible limit except in Matampalli village and its range in study area is in between 4-8mg/l.
- pH value in the study area is slightly higher.
- Total Hardness and Alkalinity are more than the permissible limit, water is not good for industrial purposes as it is hard, it can be used for domestic purposes as there is no considerable health effect due to hardness.

Conclusions.....

- Alkalinity is just a measure of acid neutralizing capacity of water so even its higher value is not harmful for its use in drinking and irrigation purpose.
- Normal range of alkalinity in the area of study is 500-1000mg/l and the average value is 680mg/l.
- Alkalinity is quite high and it shows higher resistance towards changes in pH.
- Sodium is slightly more than the permissible limit.
- The average value of sodium obtained is 235mg/l which is more than the permissible value.

Conclusions....

- Normal range of alkalinity in the area of study is 500-1000mg/l and the average value is 680mg/l.
- Alkalinity is quite high and it shows higher resistance towards changes in pH.
- Sodium is slightly more than the permissible limit.
- The average value of sodium obtained is 235mg/l which is more than the permissible value.

Conclusions....

- 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 in many of the mandals and also in reduction of yields of bore wells.

- This necessitates construction of additional 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.

Conclusions....

- 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.

Conclusions....

- 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 imparted on the scientific techniques in selection of site, design of structure, etc. for construction of artificial recharge structure.

Thank you!!!