भारत सरकार

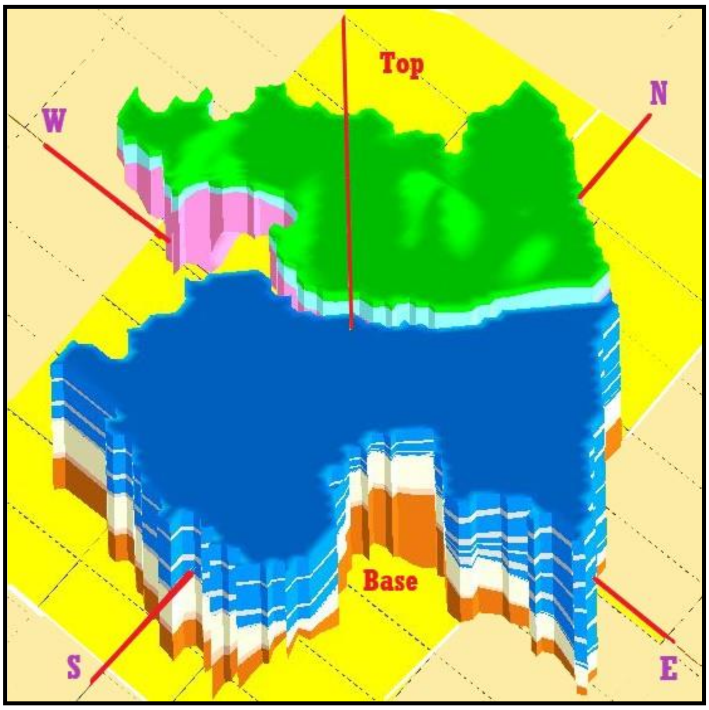
जल शक्ति मंत्रालय

जल संसाधन नदी विकास एवम् गंगा संरक्षण विभाग

केंद्रीय भूमि जल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RD & GR
CENTRAL GROUND WATER BOARD

# REPORT ON
# AQUIFER MAPPING AND MANAGEMENT OF GUNTUR DISTRICT ANDHRA PRADESH STATE
# (AAP-2023-24)




**CENTRAL GROUND WATER BOARD**
**SOUTHERN REGION**
**HYDERABAD**
**February 2025**

**REPORT ON**
**AQUIFER MAPPING AND MANAGEMENT OF**
**GUNTUR DISTRICT, ANDHRA PRADESH STATE**
**(AAP-2023-24)**

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# AQUIFER MAPPING AND MANAGEMENT OF
# GUNTUR DISTRICT, ANDHRA PRADESH STATE

Executive summary

Contents

**REPORT ON**
**AQUIFER MAPPING AND MANAGEMENT OF**
**GUNTUR DISTRICT , ANDHRA PRADESH STATE**
**(AAP-2022-2023)**

At a glance

| S.No. | Item | | Particulars |
|---|---|---|---|
| 1 | Districts | : | Guntur District |
| 2 | Revenue Divisions/ Mandals | : | 2/18 |
| 3 | Villages | : | 222 |
| 4 | Geographical Area | : | 2447 $km^2$ |
| 5 | Population (2011 Census) | : | 20.91 lakhs |
| 6 | Density of population (2011 Census) | : | 856 persons/$km^2$ |
| 7 | Locations | : | $16^{O}$-17’-57.18” Northern Latitude and $80^{O}$-25’-55.06” of the Eastern Longitude. |
| 8 | Rainfall (Normal) | : | The average normal annual rainfall of the district is 846.9 mm. This normal varies between 781 mm (Phirangipuram) to 997 mm (Mangalagiri). |
| 9 | Geomorphology | : | Deltaic plain & Pediplain |
| 10 | Major River | : | Krishna |
| 11 | Land Utilization (Ha) | : | Net area sown is 155973 ha (64%), land put to non-agricultural uses is 62834 ha (26%), the fallow is 16492 sq kms (7%), barren and uncultivable land is 5227 ha (2%) and others (1%). |
| 12 | Soils | : | Black Cotton soil covering 74% of the area and Red Loamy soil covering the remaining 26%. |
| 13 | Cropping Pattern | : | The total cropped area in the district is 219548 ha, out of which net area sown is 155973 ha and area sown more than once is 63575 ha |
| 14 | Irrigation | : | Out of total Net area sown of 155973 ha, the net area irrigated is 112752 ha (72%). The Irrigation through surface water sources like Canals is 95670 ha (85%), Tanks is 302 ha (0.2%), LIS is 2219 ha (2%) and other sources is 2171 ha (2%) accounts for 89% of total irrigation in the district while the net irrigation through Ground Water is 12390 ha (11%). The gross area irrigated is 159801 hectares where 47049 hectares under area irrigated more than once. |

| | | | |
|---|---|---|---|
| 16 | Prevailing Water Conservation/Recharge Practices | : | ~16657 ground water abstraction structures (Dug wells: 1248, Shallow Tubewells : 13025, Medium Tube wells: 2163, Deep Tube wells: 221) and 54 surface water schemes (54 functioning and 3 abandoned) in the district. Also, ~36 Check dams, 3 percolation tanks and 3846 farm ponds. In 2023-24, ~ 1300ha area is brought under micro-irrigation practices (Drip and Sprinklers) |
| 17 | Geology | : | The Guntur district area is underlain by various geological formations of different age groups ranging from Archean to Recent. The Archean basement complex comprising the Charnockites granite-gneisses, Schists, and basic dykes of dolerites form the predominant rock types in northern part. The southern area is mainly underlain by the recent to sub-recent alluvium comprising Sand, Gravel, Clay and Silt. |
| 19 | Hydrogeological data points | | |
| | Exploratory drilling data points | : | CGWB Exploration: 41 |
| | Water Level data points | | 52 wells (CGWB:35, SGWD:17) |
| | Hydrochemical Points | | Total 24 |
| | Geophysical | | VES: 90 (CGWB) |
| 20 | **DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING** | | |
| 20.1 | **Ground water Level Scenario** | | |
| | Water Levels<br>Depth to water level<br>(m bgl) | :<br>: | • Majority of the water levels during pre-monsoon are in the range of 2 to 5 m covering 85 % of the area, followed by 5 to 10m bgl (11 %) and <2 m (4%).<br>• Majority of the water levels during post-monsoon season are in the range of 2 to5 m (62%) of the area, followed by <2 m bgl (37%) and > 5 m (1%) of area. |
| | | : | During pre-monsoon season 11 wells shows falling trend ranging from 0.02 m to 0.33 m/year (Avg: 0.13 m/yr) and 10 wells shows rising trends ranging 0.02 to 0.31 m/yr (Avg: 0.038 m/yrs).<br>During post-monsoon season 7 wells shows falling trend ranging 0.01to to 0.10 m/yr (Avg: 0.04 m/yr) and 15 wells shows rising trend ranging 0.01 to 0.4 m/yrs (Avg: 0.09 m/yrs) |
| 20.2 | **Ground Water Quality** | | |
| | Electrical Conductivity (µ Siemens/cm) | : | Electrical conductivity varies from 650-8320 (avg: 2777) µ Siemens/cm. In 10 % of area, EC is within 2000 µ Siemens/cm, in 63 % area, it is between2000-3000µ Siemens and in 26% of area it is beyond permissible limit. Average concentration of |

| | | | |
|---|---|---|---|
| | | | TDS is 1748 mg/L. |
| | Nitrate mg/l | : | NO3 ranges from <1-1535 mg/L. Nitrate concentration in 50% of samples is beyond permissible limits of 45 mg/L. Fluoride concentration varies from 0.04-1.48 and all the samples are within the permissible limit. |
| | | | |
| 20 | **Aquifer Mapping** | | The principal aquifer in the area is Archean eastern ghat mobile belt mainly comprising of Charnockites, Migmatites, Khondalites and Granite Gneisses etc overlain by Recent Alluvium. The occurrence and movement of ground water in these rocks is controlled by the degree of interconnection of secondary pores/voids developed by fracturing and weathering of hard and crystalline formation and presence of sand and clay layers in alluvium formation of deltaic areas of Guntur district. |
| | | | |
| 21 | | | |
| | Ground water Resources (2023) MCM | : | |
| | Net Dynamic groundwater availability | : | 550. MCM |
| | Gross GW Draft | : | 106.52 MCM |
| | Annual GW Allocation for for Domestic Use as on 2025 (Ham) | : | 27.88 MCM |
| | Average Stage of Ground water development (%) | | 19.34% |
| | Net GW Availability for future irrigation | : | 441.8 MCM |
| | Categorization of mandals | | The stage of ground water development in Guntur district varies from 3.5 (Kakumanu) % to 34.75% (Ponnur) and |
| 22 | Major Ground Water Issues Identified | : | • All assessment (mandals) units have been categorized as Safe and Pedanandipadu and Vatticherukuru mandals are |

| | | | |
|---|---|---|---|
| | | | saline<br>• Water Logging<br>• Ground Water Salinity<br>• Impact of Aqua Culture on Ground Water Reservoir in respect of salinity and contamination due to Aqua feed and Medicinal chemicals<br>• Inferior ground water Quality<br>• Hard Areas with Ground Water Sustainability Issues |
| 23 | Management Strategies | : | **Supply side measures**<br>**To be taken up (Artificial Recharge Structures in the Study Area)**<br>66 artificial recharge structures (30 CD's and 36mini PT'in 9 villages)<br>**Demand side measure**<br>• **Micro irrigation:** An about 5500 ha of land can be brought under micro-irrigation (@50 ha/village in 110 villages, considering 1 unit/ha @0.6 lakh/ha). With adoption of micro irrigation practices, the total water requirement for irrigation can be reduced upto 60% to 70%. With this ~9.9MCM of ground water can be conserved over the traditional irrigation practices, considering @ 0.006 MCM/ha for ID crops with traditional irrigation methods).<br>**Other Recommendations**<br>• To avoid the interference of cone of depression between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism.<br>• The western part of the studty area is known for its rich lime stone deposts. As mandated by Central Ground Water Authority, the mine dewatered seepage can effectively be utilized by filling the tanks and supply to agriculture fields.<br>• As a mandatory measure, every groundwater user should recharge rainwater through artificial recharge |

| | | | |
|---|---|---|---|
| | | | structures in proportionate to the extraction<br>• Declaration of Minimum Support Price in advance (before start of season) and improved facilities at procurement centres.<br>• Capacity building in power supply regulation (4 hour each in morning and evening) will increase the sustainability of wells<br>• A participatory groundwater management (PGWM) approach in sharing of groundwater and monitoring resources on a constant basis along with effective implementation of the existing 'Water, Land and Trees Act' of 2002 (WALTA-2002).<br>• Laser levelling of irrigated land. Subsidy/incentives on cost involved in sharing of groundwater may be given to the concerned farmers. |
| 24 | Expected Results and Out come | : | With the above interventions, the likely benefit would be the net saving of 11.9 MCM of ground water either through water conservation measures like adoption of drip and sprinkle irrigation and artificial recharge to ground water. |

## ABBREVATIONS

| | | |
|---|---|---|
| 2D | : | 2 Dimensional |
| 3D | : | 3 Dimensional |
| ARS | : | Artificial Recharge Structures |
| Avg | : | Average |
| BDL | : | Below Detection Level |
| BW | : | Bore Well |
| CD | : | Check dam |
| CGWB | : | Central Ground Water Board |
| Cr | : | Crore |
| DTW | : | Depth to water |
| DW | : | Dug well |
| EC | : | Electrical conductivity |
| EL | : | East Longitude |
| F | : | Fluoride |
| FP | : | Farm Pond |
| GEC | : | Ground Water Estimation committee |
| GW | : | Ground Water |
| Ha | : | Hector |
| Ha.m | : | Hector meter |
| ID | : | Irrigated dry |
| IMD | : | Indian Meteorological Department |
| $Km^2$ | : | square kilometre |
| LPS | : | Litres per second |
| M | : | meter |
| $M^3$ | : | Cubic meter |
| m bgl | : | Metres below ground level |
| MCM | : | Million cubic meter |
| Mg/l | : | Milligram per litre |
| MI | : | Micro irrigation |
| Min | : | Minimum |
| max | : | Maximum |
| MPT | : | Mini percolation tank |
| MSP | : | Minimum Support price |
| NL | : | North Latitude |
| $NO_3$ | : | Nitrate |
| OE | : | Over Exploited |
| PGWM | : | Participatory ground water management |
| PT | : | Percolation tank |
| SGWD | : | State Ground Water Department |
| S | : | Storativity |
| Sy | : | Specific Yield |
| T | : | Transmissivity |
| WCM | : | Water conservation measures |

# EXECUTIVE SUMMARY

The Guntur district, Andhra Pradesh having geographical area of 2447 sq.km, lies between $16^{O}$-17’-57.18” Northern Latitude and $80^{O}$-25’-55.06” of the Eastern Longitude.. Administratively, the district is governed by 02 Revenue Divisions viz., Guntur and Tenali divisions, 18 revenue mandals including 222 villages. The total population of the district as per 2011 population census is ~20.91 lakhs. The normal rainfall of the district is 846.9 mm. The main River that drains the Guntur district is Krishna River.

Geomorphologically the district can be broadly divided into 2 distinct units, viz., deltaic plains & pediplain. Agriculture is the main stay of the people in the district. The total cropped area of the district is 2.19 Lakh hectares during the year 2021-2022. Main crops grown during Kharif are Paddy 69174 ha (47%), cotton 38475 ha (27%), Chillies 22721 ha (15%),Fodder Crops 2865 ha (2%) ,Turmeric 2269 ha (2%),Total pulses 793 ha (1%) and other crops while during Rabi season major crops are Jowar 24271 ha (33%),Total Pulses 20509 (28%),Maize 20164 ha (28%), Paddy 1196 ha (2%), Fodder Crops 1517 ha (2%), Tobacco 843 ha (1%) and Other crops. The net area sown is 155973 ha and area irrigated more than once is 63575 ha .In which, 89% of the irrigation is through surface irrigation and 11% of the area is irrigated through ground water irrigation.

Two major irrigation projects, 1 medium irrigation projects and 44 minor irrigation tanks are present in the district. Nagarjuna Sagar Jawahar Canal (75556 ha ayacut), Krishna Western Delta (61838 ha ayacut) & Guntur channel ( cover a significant portion of irrigated land, complemented by minor sources and tube wells. There are 44 Minor Irrigation sources in the district with a total registered ayacutis 1545 Ha but actual area irrigated is 527 Ha.

The Guntur district area is underlain by various geological formations of different age groups ranging from Archean to Recent. The Archean basement complex comprising the Charnockites granite-gneisses, Schists, and basic dykes of dolerites form the predominant rock types in northern part. The southern area is mainly underlain by the recent to sub-recent alluvium comprising Sand, Gravel, Clay and Silt. In hard rock areas, mega lineaments and micro lineaments are present. Charnokite rocks are present with vertical foliation and horizontal.

As on 31/12/2022, CGWB drilled 41 bore wells (exploratory, observation and piezometers) in the district. Data analyzed from CGWB wells indicates, 08 wells are of 30 to 100 m, 24 nos are of 100 to 200 m, 4 nos are of 200 to 300 m and 5 nos are of 300 to 600 m depth. The ground water well inventory details of 48 wells (BW:28, DW:16,TW:4) have been also utilized for analysis of aquifer characteristics in the district. Depth of exploratory wells in hard rocks such as charnockite from 35-200m and the deepest fractured encountered at 123 m at Atmakur in Mangalagiri in charnockite. In alluvium depth of tube wells ranges from 32-600m and zones tapped from 10-408 m.

The water levels are being monitored through 52 number of monitoring wells by both CGWB (35) and GWD & WA (17). Majority of the water levels during premonsoon are in the range of 2 to 5 m covering 85 % of the area, followed by 5 to 10m bgl (11 %) and <2 m (4%). Depth to water level more than 10 m is not observed in decadal analysis. During post-monsoon, majority of the water levels during this season are in the range of 2 to5 m (62%) of the area, followed by <2 m bgl (37%) and > 5 m (1%) of area. The water table elevation ranges from 2 (Ponnur) to 221 (Thullur) m.amsl during pre-monsoon period. The regional ground water flow is mainly towards coastal deltaic areas of Ponnur and Tenali mandals.

To understand chemical nature of groundwater, total 25 data points is utilized from ground water monitoring wells. During pre-monsoon season of 2022, NHS: 25 wells, (mostly tapping combined aquifers Aq-1 and Aq-2) were analyzed. The groundwater quality in the area is generally good. Groundwater is mildly alkaline with pH in the range of 7.09- 8.6 (Avg: 7.79). Electrical conductivity varies from 650-8320 (avg:2777) µ Siemens/cm. In 10 % of area, EC is within 2000 µ Siemens/cm, in 63 % area, it is between2000-3000µ Siemens and in 26% of area it is beyond permissible limit. Average concentration of TDS is 1748 mg/L and NO3 ranges from <1-1535 mg/L. Nitrate concentration in 50% of samples is beyond permissible limits of 45 mg/L. Fluoride concentration varies from 0.04-1.48 and all the samples are within the permissible limit.

The aquifers of Guntur district can be classified into two i.e., hard rock aquifers and soft rock aquifers. In hard rock areas, the aquifers are conceptualized in to Aquifer-**1,** the shallow aquifer consisting of upper saprolite (~15 m) and lower sap rock (15-25m.), where the weathered zone varies from 5 to 30 m.bgl in Charnockite and granitic/gneiss formation.

Ground water yield in weathered Charnockite/granite/gneiss aquifer is average of <1 lps and 1 to 2 in metasedimentary aquifers. The transmissivity varies from <1 to 70m$^2$/day in weathered Archean crystalline aquifers and varies from <100 m$^2$/day in metasedimentary aquifers. The aquifer-II is the deeper aquifer which tapped the fractured zone. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures up to the maximum depth of 123 m bgl (deepest fracture encountered). The depth of fracturing varies from 28 m to 123 m with yield of <1 to 3 lps.The specific capacity of the consolidated formation ranges between 5 and 700 lpm/mdd and transmissivity of consolidated formation varies from <1 to 100 sq.m/day. The storativity in Schists/Charnockite/Gneisses varies from 1x $10^{-6}$ to 0.001.

The deltaic part of the Guntur district is underlain by alluvium consisting of fine to medium sand, silt and gravel with intercalations of clay of recent age followed by sandstones of Mio Pliocene age followed by crystallines and at places alluvium directly underlain by crystallines/ basement. The sand stone formations occur as isolated linear out crops in the north western parts of the area around Chebrolu and also encountered at shallow to greater depths in other parts. The hydrogeological studies reveal that the shallow aquifer is in unconfined condition and the deeper aquifers are confined in nature and the quality of the ground water in general deteriorates from shallow to deeper aquifers. These aquifers have been broadly grouped into two principal aquifers viz., Alluvium aquifers and Sandstone aquifers. The study reveals a stratified aquifer system in the area. The unconfined aquifer (Aquifer I) extends to a maximum depth of 35 meters below ground level (bgl) with a hydraulic conductivity ranging from 9 to 31m/day and a specific yield between 0.04 to 0.20. Aquifer II, III, IV, V, and VI are confined aquifers, each at varying depths and thicknesses. Aquifer II to VI exhibit yields <2 to >10 lps & transmissivity >100 m2/day.

Groundwater is mildly alkaline with pH in the range of 7.09- 8.6 (Avg: 7.79). Electrical conductivity varies from 650-8320 (avg: 2777) µ Siemens/cm. In 10 % of area, EC is within 2000 µ Siemens/cm, in 63 % area, it is between 2000-3000µ Siemens and in 26% of area it is beyond permissible limit. Average concentration of TDS is 1748 mg/L and NO3 ranges from <1-1535 mg/L. Nitrate concentration in 50% of samples is beyond permissible limits of 45 mg/L and fluoride concentration varies from 0.04-1.48

The Gross Annual Ground Water Recharge in the district is 579.77 MCM. The net available recharge in the district is 550.78 MCM. The Gross Ground Water Draft for All uses in the district is 106.52 MCM. The stage of ground water extraction in Guntur district varies from 3.5 (Kakumanu) % to 34.75% (Ponnur) and all assessment (mandals) units have been categorized as Safe and Pedanandipadu and Vatticherukuru mandals are salineas per Ground Water Resources Assessment 2023. The overall stage of groundwater development of Guntur districtis 19.34 %.

In deltaic areas of Guntur district naturally problems like water logging, in situ ground water salinity and saline water intrusion etc., are of great concern. During the last two decades with the advent of prawn culture some of the paddy fields have been converted into tanks for growing the prawns and salt water fish. High Electrical Conductance (EC) (>3000 µ Siemens/cm) is noticed in 21% of the samples during pre-monsoon season (Thullur, Prathipadu, Guntur and Tadikonda mandals), which is unsuitable for irrigation and high nitrate contamination (>45 mg/l) due to anthropogenic activities is also observed in 50% of the samples during pre-monsoon season (Tadikonda, Prathipadu, Thullur, Guntur, Chebrolu, Phirangipuram, Kollipara and Ponnur mandals. Around 37% of the area has a low yield (<1 lps) and exhibits low ground water potential in hard rock areas.

The management strategies mainly include both supply side and demand side measures. Recommended for construction of total 66 AR structures (36 check dams and 30 percolation tanks) in the study area. In addition, roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing). Existing ARS like percolation tanks and check dams can be de-silted involving people’s participation. The sprinkler and drip irrigation system with suitable cropping pattern is recommended where the yield of bore well is <2.0 lps identified in 5500 ha of land. De siltation and cascading of existing MI tanks can result in increased ayacut, sustainability of bore wells and decrease the ground water irrigation. Participatory groundwater management (PGWM) approach is recommended. In urban and rural area, the sewerage line should be constructed to arrest leaching of nitrate.

# 1. INTRODUCTION

Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. In recent past, there has been a paradigm shift from "**groundwater development**" to "**groundwater management**". As large parts of India particularly hard rocks have become water stressed due to rapid growth in demand for water due to population growth, irrigation, urbanization and changing life style. Therefore, in order to have an accurate and comprehensive micro-level picture of groundwater in India, aquifer mapping in different hydrogeological settings at the appropriate scale is devised and implemented, to enable robust groundwater management plans. This will help in achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural and many parts of urban India. The aquifer mapping program is important for planning suitable adaptation strategies to meet climate change also. Thus the crux of National Aquifer Mapping (NAQUIM) is not merely mapping, but reaching the goal-that of ground water management through community participation.

An integrated hydrogeological study was taken up in the Guntur district covering parts of Hard rocks (Granites/Gneisses,Charnockites and Khondalites) and alluvial deltaic part of Guntur districts of Andhra Pradesh during AAP 2023-2024. Besides these quantitative aspects, ground water quality also represents a major challenge which is threatened by both geogenic and anthropogenic pollution.

**1.1 Objectives:** In view of the above challenges, an integrated hydrogeological study was taken up to develop a reliable and comprehensive aquifer map and to suggest suitable groundwater management plan on 1: 50,000 scale.

**1.2 Scope of study:** The main scope of study is summarized below.

1. Compilation of existing data (exploration, geophysical, groundwater level and groundwater quality with geo-referencing information and identification of principal aquifer units.
2. Periodic long-term monitoring of ground water regime (for water levels and water quality) for creation of time series data base and ground water resource estimation.
3. Quantification of groundwater availability and assessing its quality.
4. To delineate aquifer in 3-D along with their characterization on 1:50, 000 scale.
5. Capacity building in all aspects of ground water development and management through information, education and communication (IEC) activities, information dissemination, education, awareness and training.
6. Enhancement of coordination with concerned central/state govt. organizations and academic/research institutions for sustainable ground water management.

**1.3 Area details:** The Guntur district, Andhra Pradesh having geographical area of 2447 sq.km, lies between $16^{O}$-17'-57.18" Northern Latitude and $80^{O}$-25'-55.06" of the Eastern Longitude. (Fig.1.1). As of Gazette No. 939 dated January 26, 2022, Guntur District has undergone division into three separate districts: Guntur (18 Mandals), Narasaraopet/ Palnadu (28 Mandals), and Bapatla (25 Mandals). The restructuring involved the merger of 12 Mandals from Tenali Division and 13 Mandals from Prakasam District into the newly formed Bapatla District. The District is bounded on the North by Krishna District, on the West by Palnadu District, on the South by Bapatla District, on the East by Krishna River. Majority of the district is agricultural land. Administratively the district is governed by 18 revenue mandals (**Fig 1.1**). There are 222 villages with a population of ~20.91 lakhs (2011 census). The density of population is 856 persons/sq.km whereas it is 304 per Sq.km. for the State. Administratively, the district is governed by 2 Revenue Divisions viz., Guntur and Tenali, covering 18 mandals. The land utilization for agricultural purposes accounts for 65% of the total geographical area. Guntur district, India, reigns as Asia's premier red chilli hub, contributing 72.44% to horticulture. Its superior chillies and powder dominate global markets, driving significant growth in the state's agriculture sector.

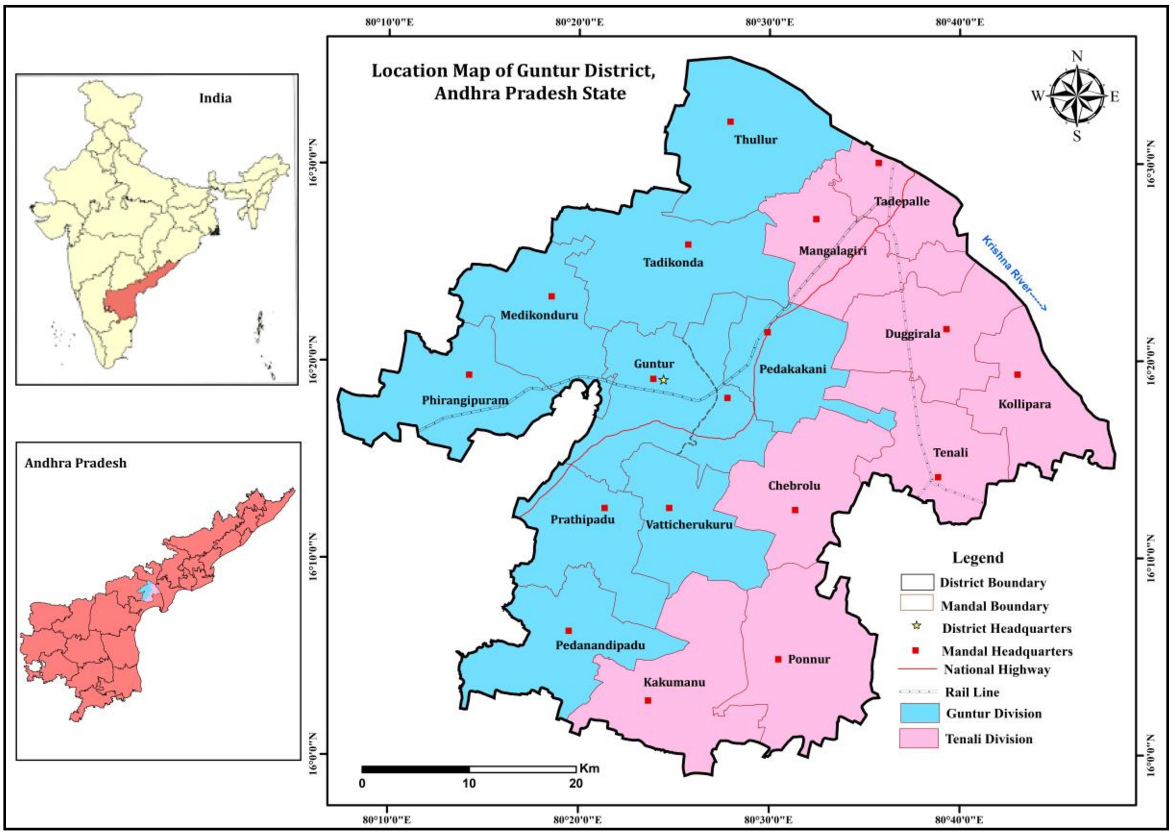



**Fig.1.1:** Location Map of Guntur district

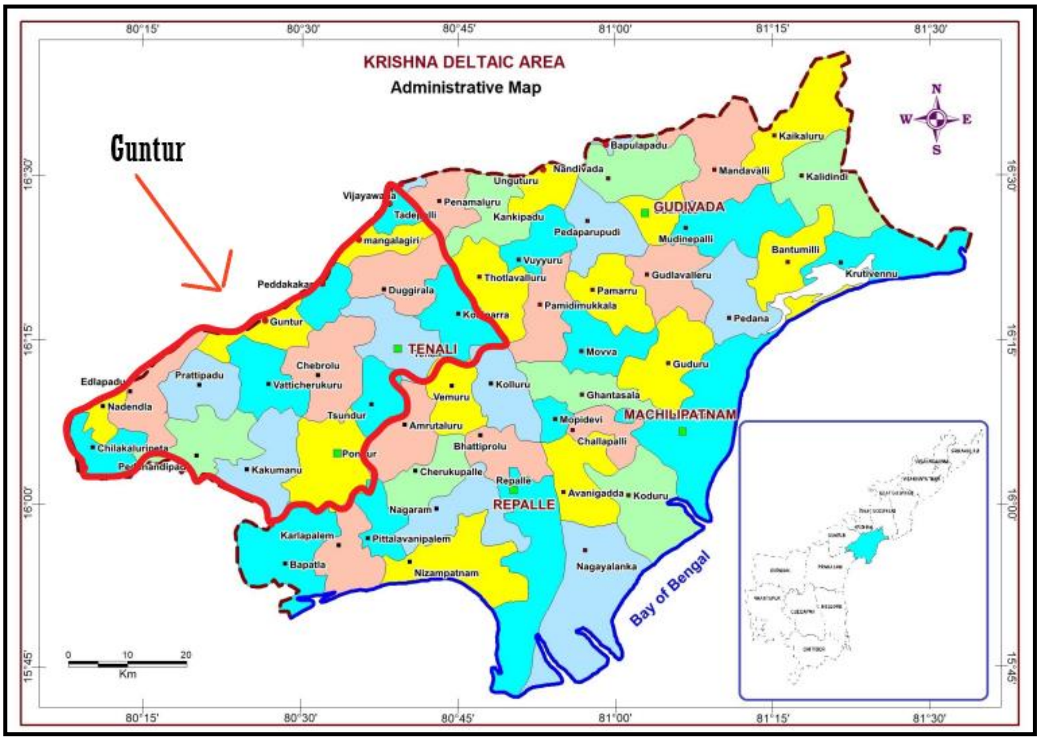



**Fig.1.2**: Location Map of Guntur District Delataic part of Krishna Delta

The Krishna Delta is one of the major delta systems along the east coast of India (**Fig 1.2**). The river Krishna is dividing the area into two units viz., Eastern Delta and Western Delta. Administratively the Eastern Delta is in Krishna District and the Western Delta is in Guntur and Baptla Districts of Andhra Pradesh. Only after construction of the anicut on river Krishna at Vijayawada i.e., Prakasam barrage (initially constructed in 1852 which was designed by Sir 2 Arthur Cotton and reconstructed in 1957), gradual and regulated development took place in terms of irrigation and agricultural production. The area is bounded by Baptla in the south which is having coast line with Bay of Bengal, where as in the east and north east it is bounded by West Godavari district and in the west by Prakasam district, and north by remaining mandals of Krishna and Guntur districts.

**1.4 Climate and Rainfall:** The climate of the district is characterized by hot summer and generally dry weather except during South-West monsoon season. The mean temperature of Guntur region is ~29° C. The district registers a mean daily maximum temperature of 42°C and a minimum temperature of 28°C in May. Conversely, January witnesses a mean daily minimum and maximum temperature of 18°C and 30°C, respectively. The highest temperatures are typically observed during April and May. The average normal annual rainfall of the district is 846.9 mm. This normal varies between 781 mm (Phirangipuram) to 997 mm (Mangalagiri). In the district, rainfall distribution is characterized by a significant contribution from the southwest monsoon, accounting for 71% of the precipitation. The northeast monsoon follows, contributing 27%, while the winter period contributes a minor 2% of the total rainfall in the region. During 2021-22, the district experienced a rainfall of 1173 mm, indicating a deviation of +37.5% from the normal rainfall of 853 mm. The presence of 86 rainy days underscores the higher frequency of rainfall events during this period. Overall, it signifies a wetter-than-usual climatic condition in the district. The Isohyetal mapof Guntur district is shown is **Fig-1.3**.

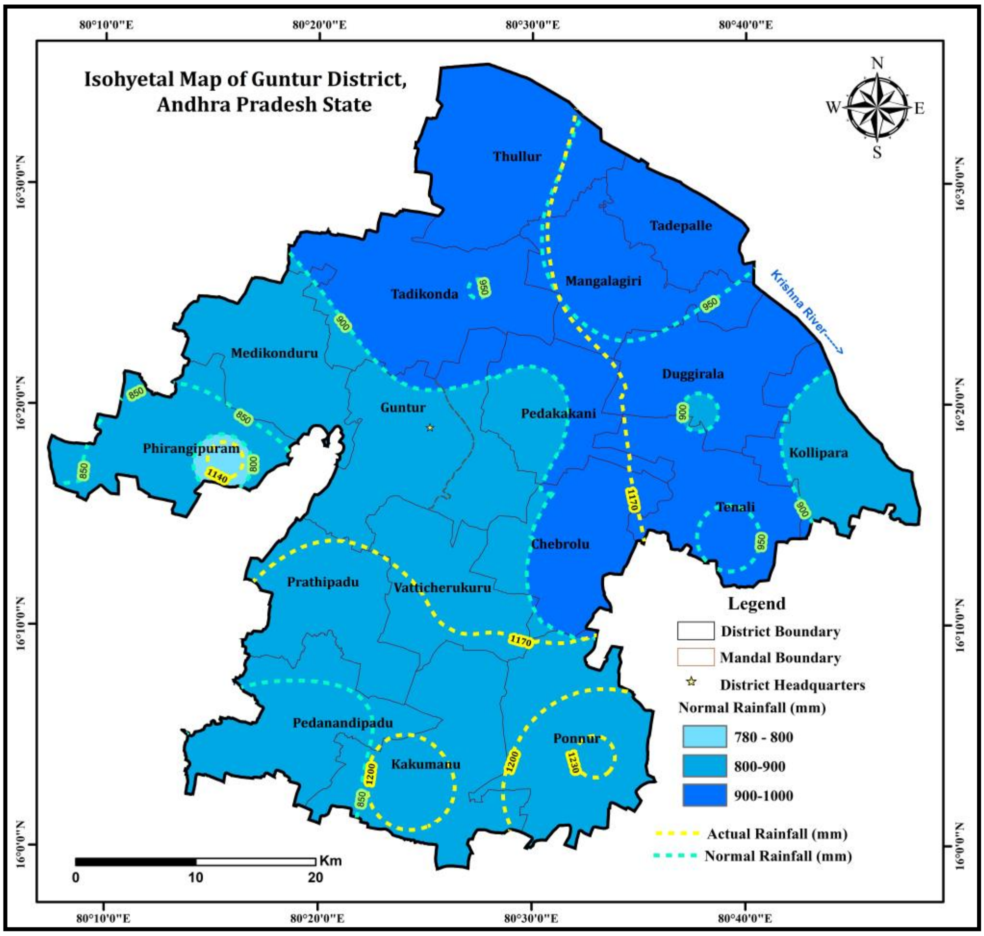



**Fig.1.3**: Isohyetal map of Guntur district.

**1.5 Geomorphological Set up:** Geomorphologically the district can be broadly divided into 2 distinct units, viz., deltaic plain & pediplain **(Fig.1.4) & (Table No-1.1)**. All deltaic area is covered under nearly level sloping and rest of the area predominantly covered under very gently sloping except hilly areas. The Pediplain area i.e., in the northern and western part of the district covering Phirangipuram, Medikonduru, Tadikonda, Guntur, Prathipadu, parts of Mangalagiri, Thullur, Pedakakani, Pedanandipadu and Vatticherukuru mandals. The general altitude of this physiographic unit varies from 4 to 256 m amsl with isolated hillocks. The master slope of the area towards the Bay of Bengal. The deltaic and coastal plain extends along the eastern margin of the district**..**

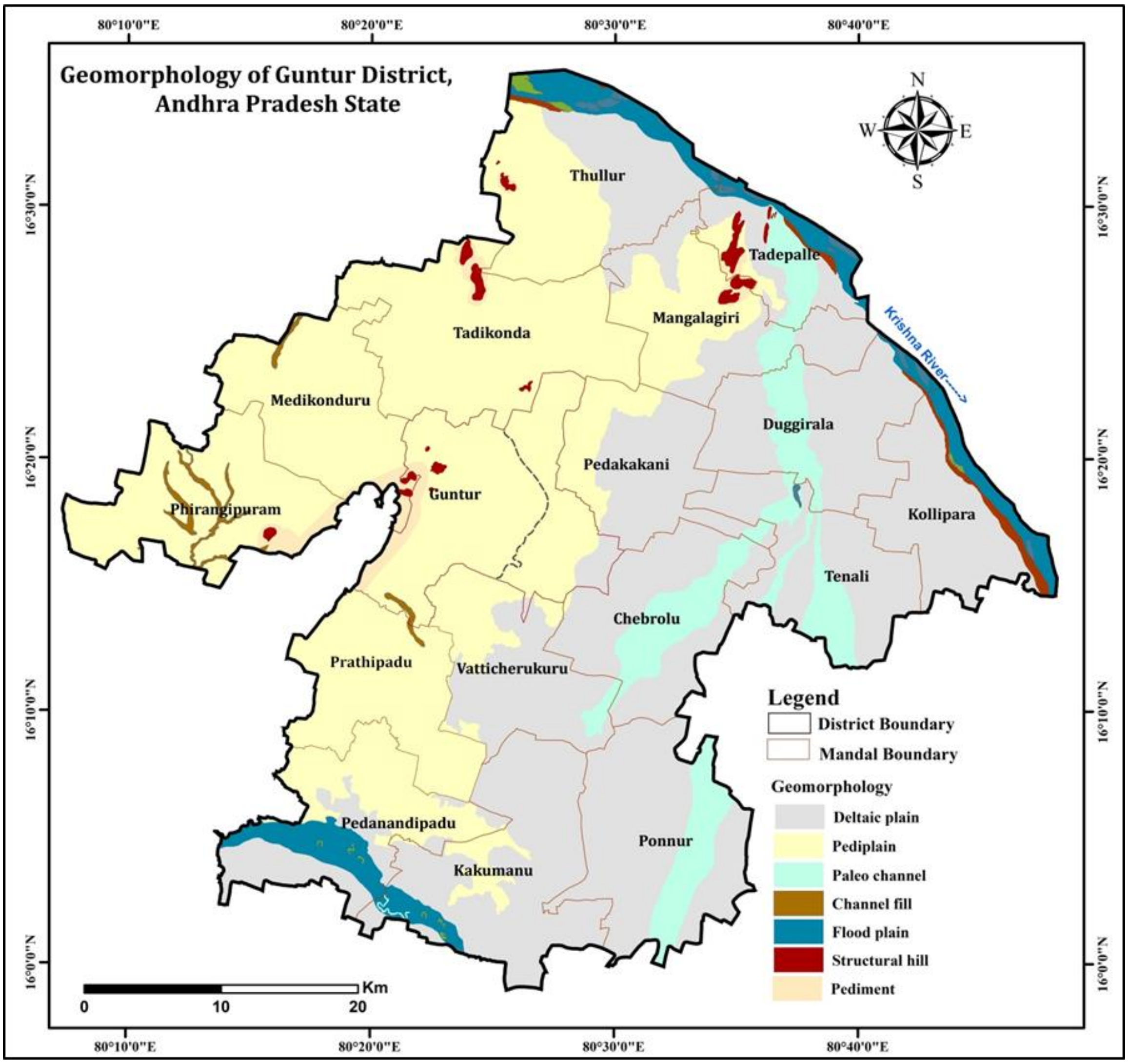



**Fig.1.4:** Geomorphology map of Guntur district

**Table No-1.1: Geomorphological features of Guntur District**

| Geomorphology | Area % |
|---|---|
| Pediplain | 41% |
| Deltaic plain | 42% |
| Paleo channel | 7% |
| Flood plain /Levee/channel island/bar | 5% |
| Pediment | 2% |
| Alluvial Plain | 1% |
| Structural Hill | 1% |
| Channel fill | 0.65% |
| others | 0.35% |

**1.6 Drainage and Structures:** The main River that drains the Guntur district is Krishna River,which is non-perennial, originates in Mahabaleshwar in Maharashtra and enters the district in Thullur mandal. Krishna River forms the northern boundry of the district and flows to south between Guntur and Krishna district. Krishna River flows for about 86 Kms in the district and serve as a boon to the Guntur and Tenali divisions. The Nallamada Vagu is a vital water channel spanning 100 kilometers, originating as an extension of the Ogeru Vagu near the Narasaraopet region. As it courses through Bapatla and merges with Nakka Vagu at Pedanandipadu, it transforms into the Nallamada Vagu. Due to the absence of a dedicated drainage system for Nagarjuna Sagar, this amalgamation becomes essential for effective water management in the region. The Nallamada Vagu plays a significant role in regulating water flow and drainage, underscoring its importance in the local hydrological system of Guntur district. The other streams are Pedda Vagu, Konda Vagu, Jalla Vagu,Rama Vagu, Tota Vagu, Kotella Vagu and Tummalapalem Vagu which are dry formajor part of the year and carry floods only during rainy season. Map depicting drainage and water bodies is presented in **Fig.1.5**.

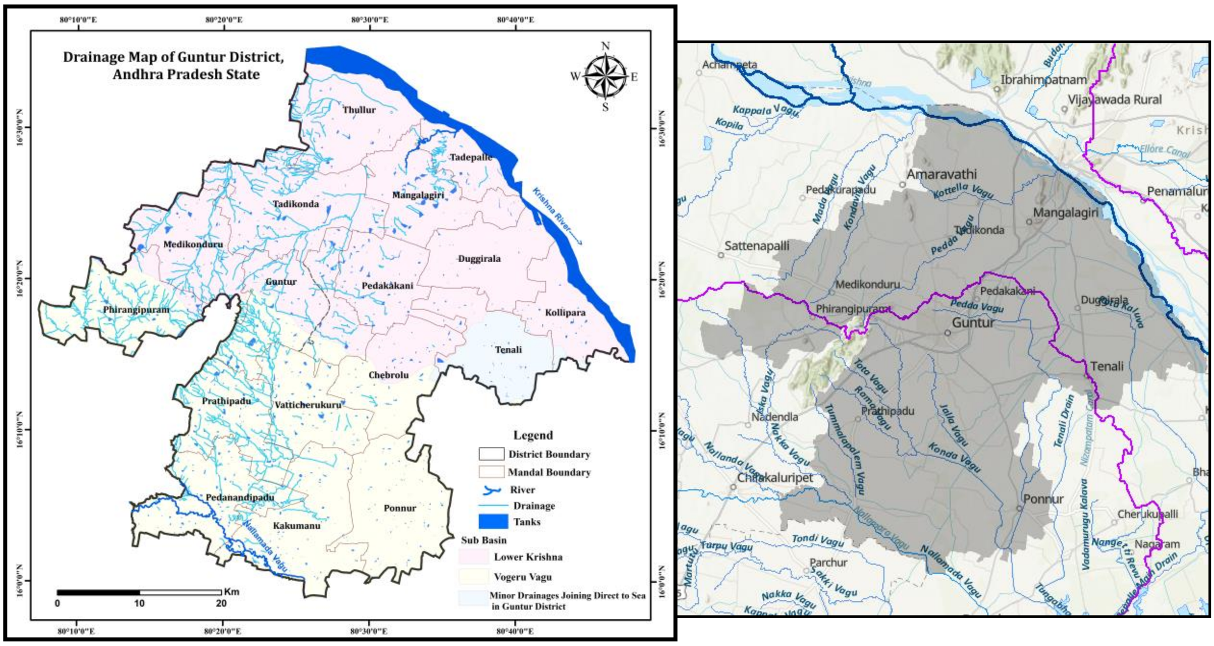



**Fig.1.5:** Drainage map of Guntur district

**1.7 Land use pattern (2022-2023**): Out of total geographical area of 2.4 lakh hectares , the net area sown is 155973 ha (64%), land put to non-agricultural uses is 62834 ha (26%), the fallow is 16492 sq kms (7%), barren and uncultivable land is 5227 ha (2%) and others (1%). The map and details depicting Land use and land cover of the district is provided in **Fig. 1.6 & 1.7.**

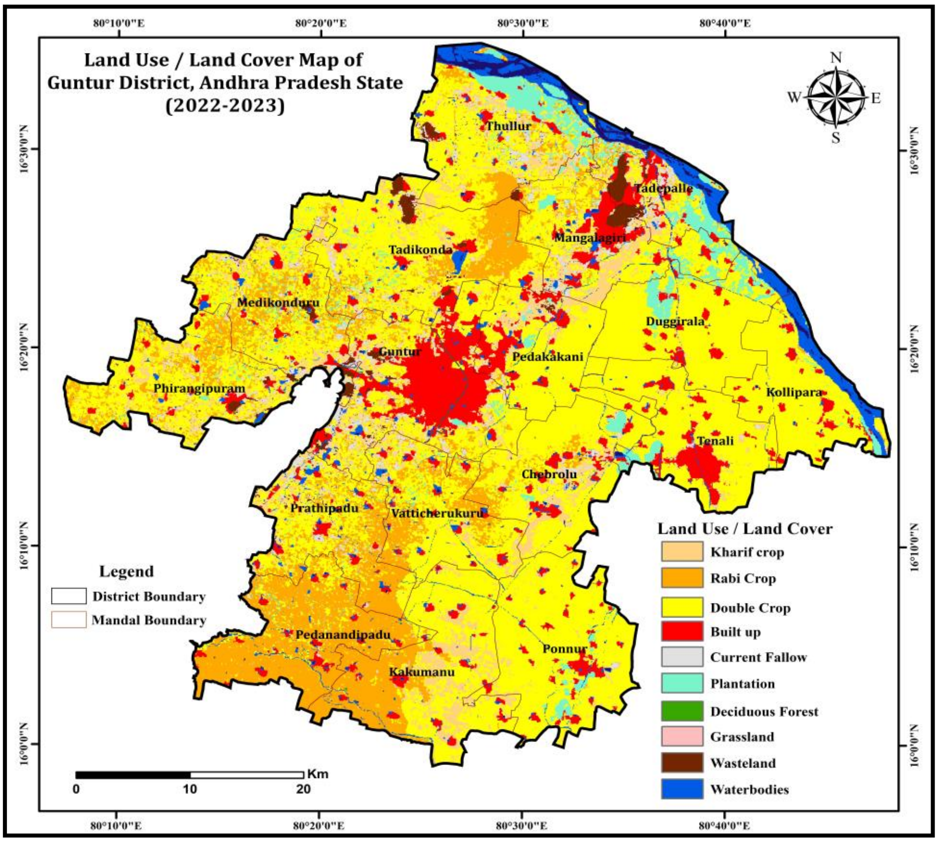



**Fig.1.6:** Land use and land cover map of Guntur district

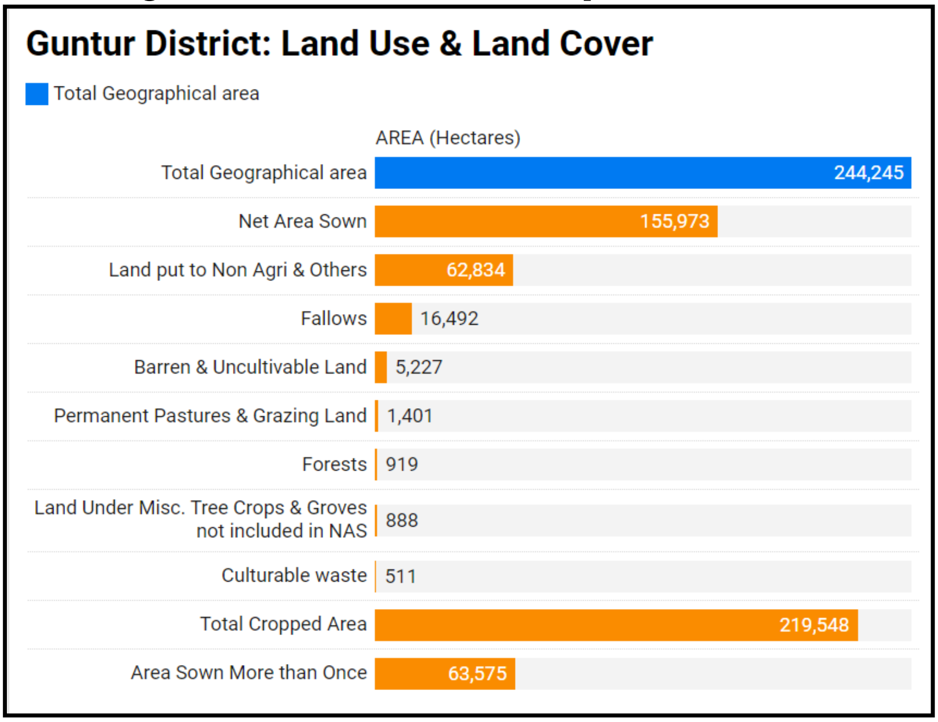



**Fig.1.7:** Land use and land cover particulars of Guntur district

**1.8 Soils**: The district's soils exhibit fertility, with a predominant classification into two main types: Black Cotton soil covering 74% of the area and Red Loamy soil covering the remaining 26%. The deltaic soils are considered to be the most fertile and are highly productive which keep the district in good stead in respect of agriculture. The important soil groups in the area are deltaic alluvial soils and coastal sands. The deltaic soils have high clay content and are less permeable and poorly drained and are highly fertile in nature and have high cation exchange capacity. In deltaic alluvium two crops are harvested every year. Paddy and sugarcane are extensively raised on these lands (**Fig.1.8**).

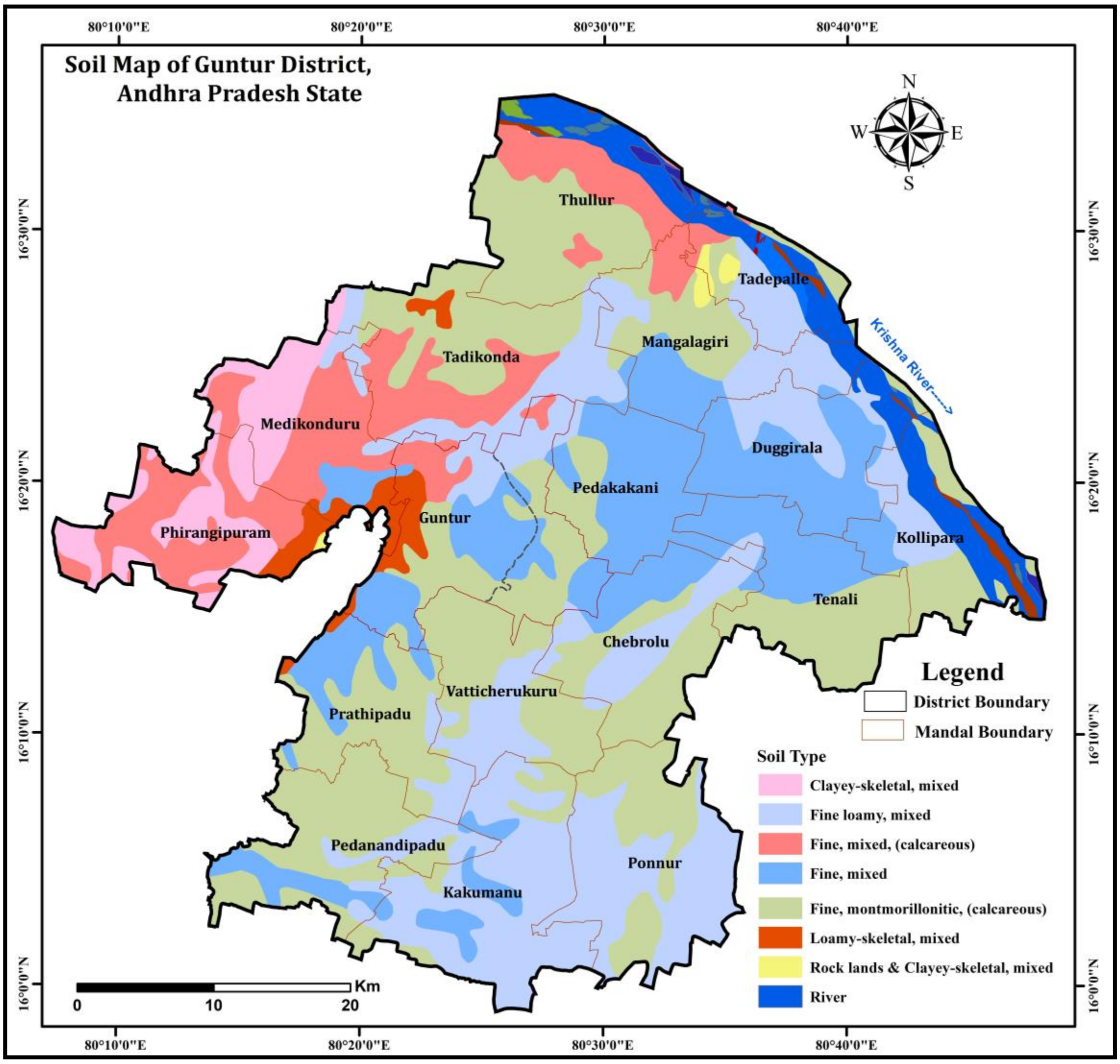



**Fig.1.8:** Soil map of Guntur district

**1.9 Agriculture and Irrigation:** The total cropped area in the district is 219548 ha, out of which net area sown is 155973 ha and area sown more than once is 63575 ha. The details of cropped area are provided in **Table-1.2**. Main crops grown during Kharif are Paddy 69174 ha (47%), cotton 38475 ha (27%), Chillies 22721 ha (15%),Fodder Crops 2865 ha (2%) ,Turmeric 2269 ha (2%),Total pulses 793 ha (1%) and other crops (6%). During rabi season major crops are Jowar 24271 ha (33%),Total Pulses 20509 (28%),Maize 20164 ha (28%), Paddy 1196 ha (3%), Fodder Crops 1517 ha (2%), Tobacco 843 ha (1%) and Other crops (5%). Sugarcane is also grown in Mangalagiri, Tadepalle, Duggirala and Ponnur mandals. Season wise cropping pattern is given in **Fig.1.8a** and **Fig.1.8b**.

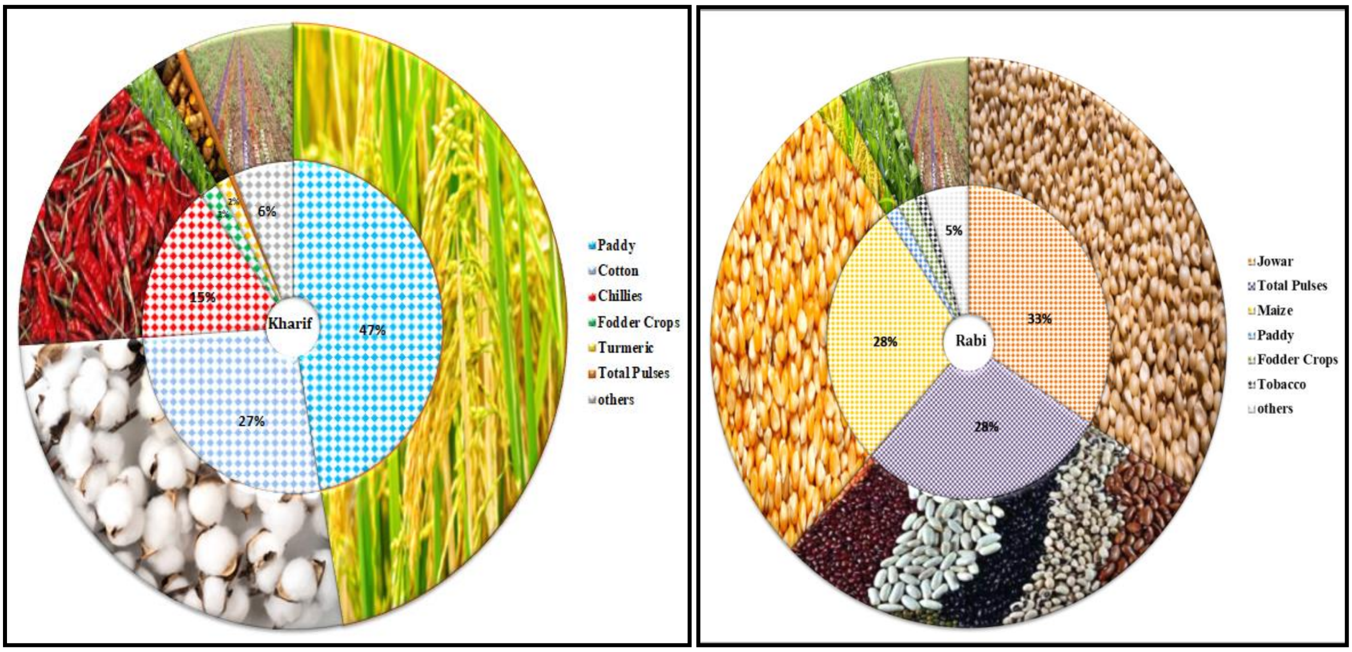


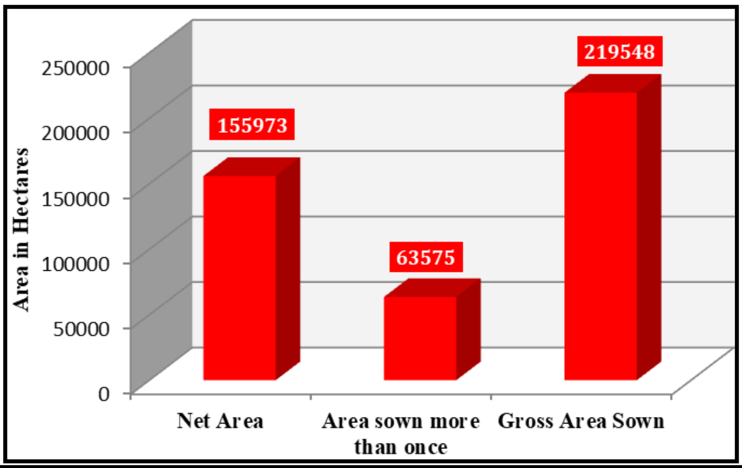

**Fig 1.8a & 1.8b** Crop wise irrigation Status in the Guntur District

| Mandals | Gross Area Sown (ha) | Net Area Sown (ha) | Net Area Sown (ha) | Net Area Sown (ha) |
|---|---|---|---|---|
| | | | Kharif | Rabi |
| Chebrolu | 14,530 | 7,896 | 7,328 | 568 |
| Duggirala | 19,696 | 10,774 | 10,403 | 371 |
| Guntur | 6,305 | 6,059 | 5,546 | 513 |
| Kakumanu | 20,439 | 13,613 | 11,480 | 2,133 |
| Kollipara | 16,979 | 9,113 | 9,113 | 0 |
| Mangalagiri | 6,542 | 5,251 | 4,632 | 619 |
| Medikonduru | 10,107 | 10,090 | 9,934 | 156 |
| Pedakakani | 12,044 | 6,997 | 6,814 | 183 |
| Pedanandipadu | 10,775 | 10,562 | 7,556 | 3,006 |
| Phirangipuram | 11,911 | 11,409 | 11,409 | 0 |
| Ponnur | 26,768 | 13,963 | 13,963 | 0 |
| Prathipadu | 10,193 | 10,017 | 9,597 | 420 |
| Tadepalle | 3,164 | 2,290 | 2,290 | 0 |
| Tadikonda | 14,762 | 14,705 | 13,224 | 1,481 |
| Tenali | 18,385 | 9,343 | 9,343 | 0 |
| Thullur | 3,842 | 3,761 | 2,804 | 957 |
| Vatticherukuru | 13,111 | 10,130 | 10,130 | 0 |
| **Total** | **219,548** | **155,973** | **145,566** | **10,407** |

**Table-1.2:** Details of cropped area in Guntur District

In the district there are 214774 marginal farmers (Below 1.00 Hectares of land), 33751 small farmers (1.0-2.0 Hectares of land), 10822 semi-medium farmers (2.0-4.0 Hectares of land), 2038 medium farmers (4.0-10.0 Hectares of land) and 90 large farmers (10 & above Hectaresof land).

**1.10 Irrigation**: The district is mainly irrigated by both surface and ground water. Out of total Net area sown of 155973 ha, the net area irrigated is 112752 ha (72%). The Irrigation through surface water sources like Canals is 95670 ha (85%), Tanks is 302 ha (0.2%), LIS is 2219 ha (2%) and other sources is 2171 ha (2%) accounts for 89% of total irrigation in the district while the net irrigation through Ground Water is 12390 ha (11%). The gross area irrigated is 159801 hectares where 47049 hectares under area irrigated more than once. There are total ~16657 ground water abstraction structures (Dug wells: 1248, Shallow Tubewells : 13025, Medium Tube wells: 2163, Deep Tube wells: 221) and 54 surface water schemes (54 functioning and 3 abandoned) in the district. The salient features of irrigation are given in **Table-1.3 & Fig 1.9.**



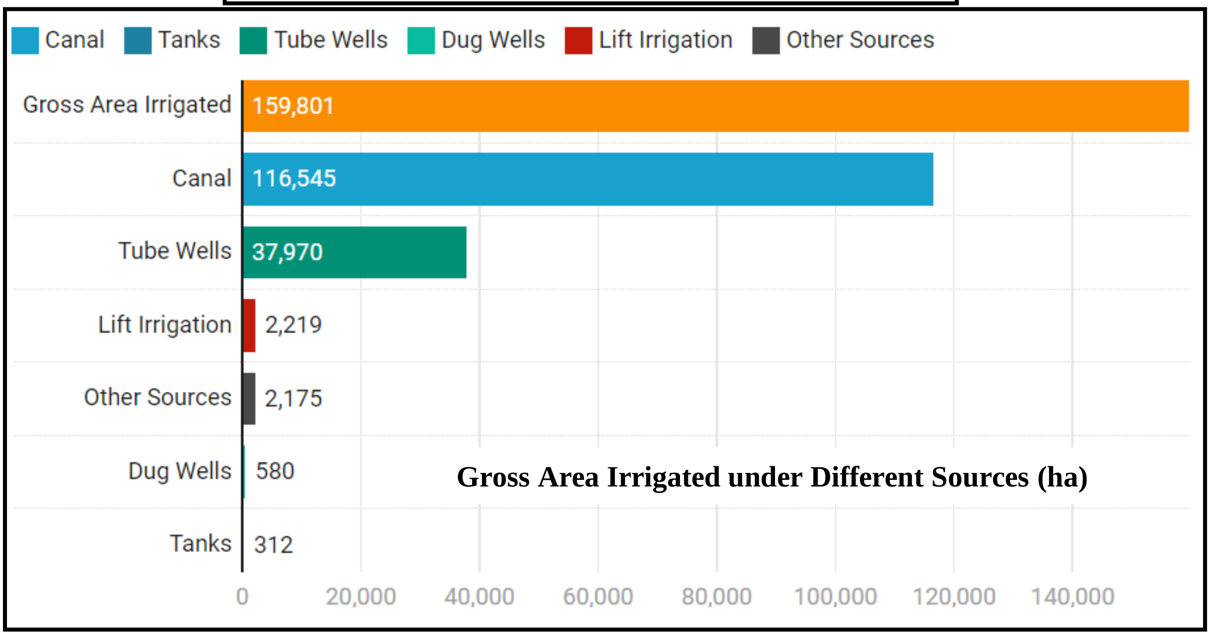




**Fig – 1.9**.: Cropping Area & Gross Area Irrigated under different sources

**1.10 Irrigation Projects:** Irrigation is essential in modern agriculture, particularly with the adoption of advanced technologies. It addresses challenges like inadequate rainfall, enabling shifts to more advantageous cropping patterns.In Guntur district, primary irrigation sources include canals, tube wells/dug wells, tanks, and lift irrigation. Major irrigation projects like Nagauna Sagar Jawahar Canal (75556 ha ayacut), Krishna Western Delta (61838 ha ayacut) & Guntur channel cover a significant portion of irrigated land, complemented by minor sources and tube wells . These initiatives are crucial for enhancing agricultural production and ensuring a stable and productive cropping pattern. A medium Irrigation channel - Guntur Branch Canal (GBC) and it takes off from Right bank of river Krishna upstream side of Prakasam barrage with a length of 47 km and the total ayacut of this channel is 10926 ha (**Table 1.4**). Tadepalli, Mangalagiri, Pedakakani, Guntur, Chebrolu, Vatticherukuru and Prathipadu mandals are benefitted from Guntur channel. There are 44 Minor Irrigation sources in the district with a total registered ayacutis 1545 Ha but actual area irrigated is 527 Ha and is given in **(Fig 1.10), (Fig 1.11) & (Fg 1.12)**

**Table 1.4: Details of Irrigation Projects**

| Name of the Project | | Assembly Name | Registered Ayacut in Acres |
|---|---|---|---|
| Major Irrigation Project | Nagauna Sagar Jawahar Canal | Pedanandipadu | ~111154 |
| | | Prathipadu | ~31100 |
| | | Tadikonda | ~44,451 |
| | | Total | **~186705** |
| | Krishna Western Delta | Mangalagiri | ~29114 |
| | | Ponnur | ~43163 |
| | | Prathipadu | ~35050 |
| | | Tenali | ~45479 |
| | | Total | **~152806** |
| Medium Irrigation Project | Guntur Channel | Guntur East | ~359 |
| | | Mangalagiri | ~6990 |
| | | Ponnur | ~12697 |
| | | Prathipadu | ~5061 |
| | | Tenali | ~1893 |
| | | Total | **~27000** |

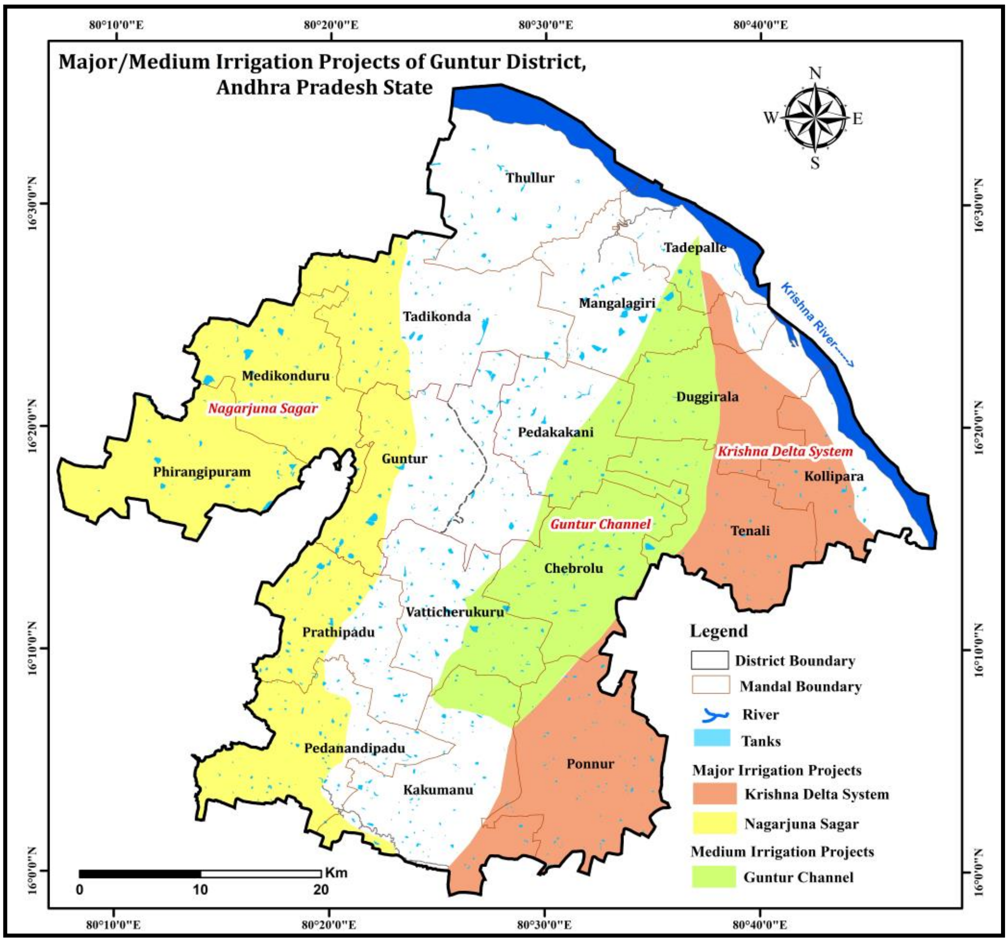



**Fig 1.10 Irrigation Projects**

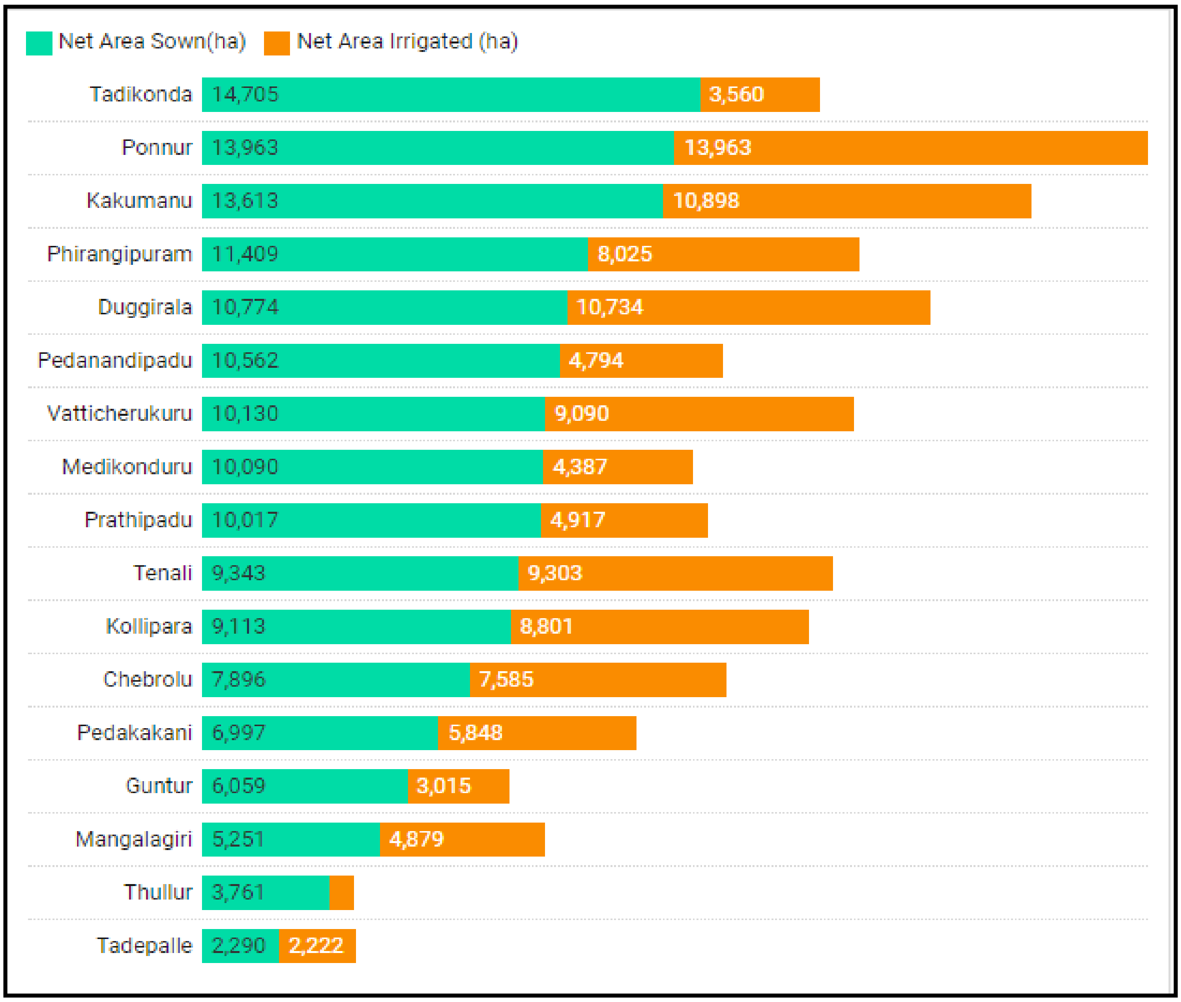



Fig – 1.11: Net Area Sown Vs Net Area Irrigated

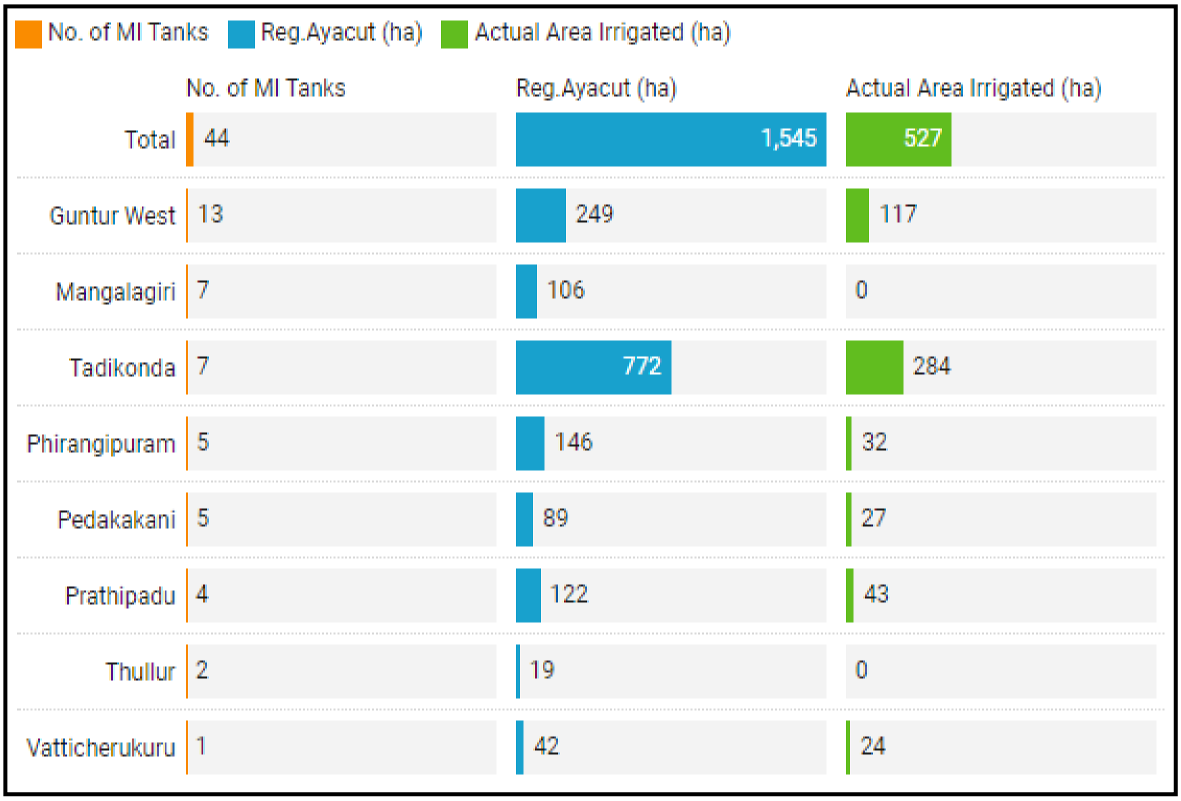



**Fig: - 1.12** Area Irrigated under Minor Irrigation.

**1.11 Prevailing water conservation/ Recharge practices:** In the district there are ~36 Check dams, 3 percolation tanks and 3846 farm ponds. In 2023-24, ~ 1300 ha area is brought under micro-irrigation practices (Drip and Sprinklers) **in Fig 1.13**

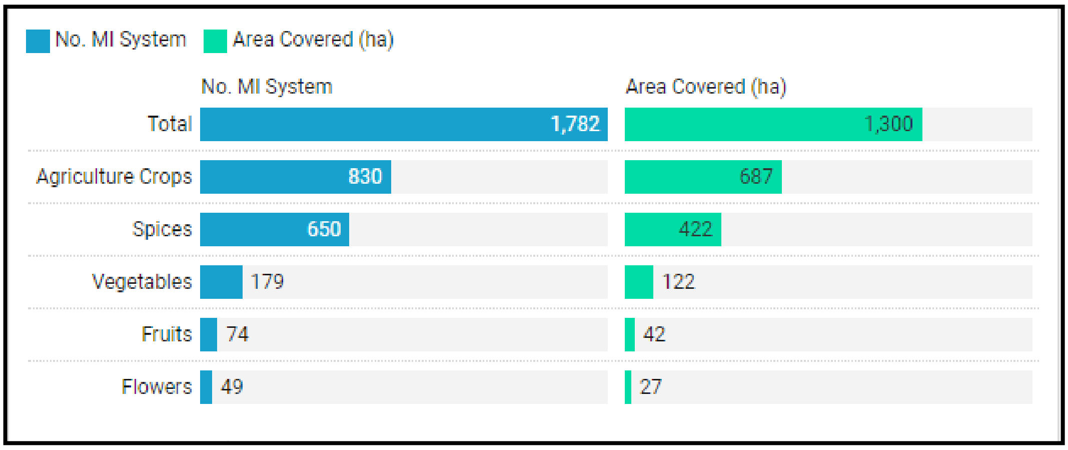


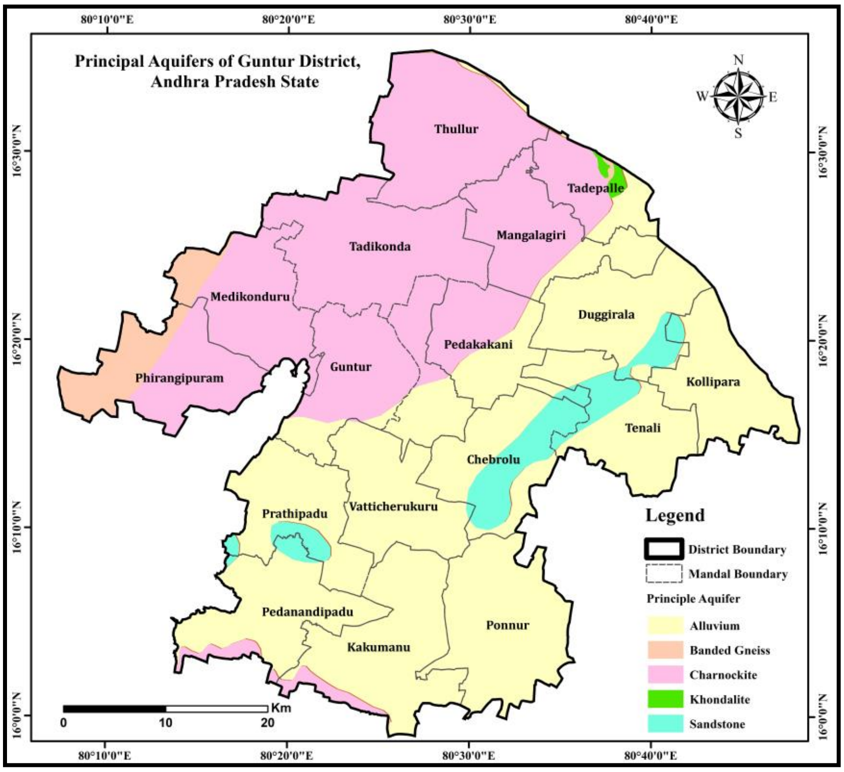

**Fig 1.13: Crop Wise Area covered under MI System**

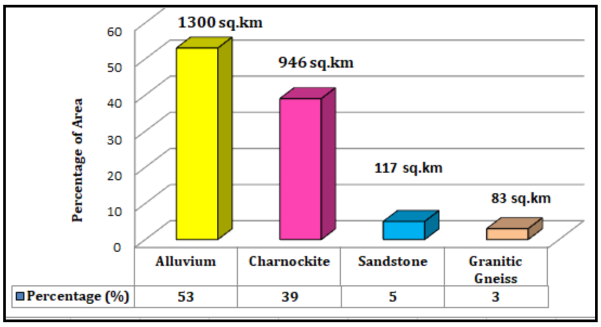
## 1.12 Geology

The Guntur district area is underlain by various geological formations of different age groups ranging from Archean to Recent. The Archean basement complex comprising the Charnockites granite-gneisses, Schists, and basic dykes of dolerites form the predominant rock types in northern part. The southern area is mainly underlain by the recent to sub-recent alluvium comprising Sand, Gravel, Clay and Silt. The Upper Gondwana formations (Gollapalli sand stones) are occur as isolated linear out crops trending NE – SW direction around Chebrolu- Tenali area. In the larger dimension i.e., Krishna deltaic area, the alluvium is underlined mainly by the Rajahmunry sandstones in eastern deltaic area and by the Gollapalle sandstones in western deltaic area and at places directly by crystallines. The sandstones formations and crystallines are encountered at different depth in the boreholes drilled by CGWB in the western and northern parts of the area at shallow depths, and towards coast and south eastern parts at greater depths. The Upper Gondwana group of sandstones and shales out crop are seen at places between Guntur and Tenali. The youngest rock types of the district appear to be of Mio-Pliocene age followed by the alluvial deposits of Recent to Sub-Recent age. Basic Charnokites are exposed in the applied area in the form of boulders. They are made up of Hypersthene, Quartz, Biotite and Grey Feldspar and other mafic minerals. These rocks belong to Granulite facies of metamorphism and they are expected to have been formed due to palingnetic fusion of and metamorphism. These rocks represent the Precambrian basement of Easternghat province. The aquifer map of the district ,stratigraphy and distribution of lithological units are depicted in Table 1.5 and Fig 1.14, respectively.

**Table.1.5.** Stratigraphic succession in Guntur district

| Age | System | Formation | Lithology |
|---|---|---|---|
| **Recent to Sub Recent** | | Alluvium | Gravel,Sand,Silt and Clay |
| **Mio-Pliocene** | | Rajahmundry | Sandstone,Shale/ Clay |
| **Lower Cretaceous to Lower Triassic** | Upper Gondwana | Tirupathi | Sandstone,Shale/ Clay |
| | | Raghavapuram | Sandstone,Shale/ Clay |
| | | Gollapalli | Sandstone,Shale/ Clay |
| | Lower Gondwana | Chintalapudi | Sandstone,Shale/ Clay |
| **Upper Proteriozoic** | Kurnool | Narji Limestone | Limestone/ Owk Shale |
| **Middle to Lower Proteriozoic** | Cuddapah | Cumbum Shale | Shale & Quartzite |
| **………………………Unconformity…………………………………………..** | | | |
| **Archean** | | | Charnockite & Gneisses |




Alluvium covers 53% of the area followed by charnockites covering 39 %. Sandstone of Gondwana formation covers 5% and archean gneiss forms 3%.

**Fig1.14:** Principal Aquifers of Guntur district & its distribution

## 1.13 Structural Features of Guntur District:

The southern and eastern part of the Guntur District is covered with delta area and lineaments cannot be deciphered because this area is totally covered by alluvium. In hard rock areas, mega lineaments and micro lineaments are present. Charnokite rocks are present with vertical foliation and horizontal. From the analysis of structural patterns and other details,Micro lineaments - Very small (magnitude) linear features frequently observed and they correspond to minor faults, fractures, joints and bedding traces in the rock. Geomorphologically they are expressed as linear alignments of local depressions/ ponds and tonal changes in soil and vegetation. For quantification purpose, lineament length < 3 km is classified as micro lineaments which are seen in Tadikonda mandal.

# 2. Data Collection And Generation

The historically available data of Geology, Geophysics, Hydrogeology, and Hydrochemistry generated under various studies by the CGWB through Systematic Hydrogeological studies, Reappraisal Hydrogeological studies, Groundwater Management studies, Exploratory drilling, and special studies have been utilized for data gap analysis, along with the data collected from various State and Central government departments. **(Table-2.1)**.

**Table-2.1: Brief activities showing data compilation and generations.**

| **S.No.** | **Activity** | **Sub-activity** | **Task** |
|---|---|---|---|
| 1 | Compilation of existing data/ Identification of Principal Aquifer Units and Data Gap | Compilation of Existingdata on groundwater | Preparation of base map and various thematic layers, compilation of information on Hydrology, Geology, Geophysics, Hydrogeology, Geochemical etc. Creation of data base of Exploration Wells,delineation of Principal aquifers (vertical and lateral) and compilation of Aquifer wise water level and draft data etc. |
| 2. | Generation of Data | Generation of geological layers (1:50,000) | Preparation of sub-surface geology, geomorphologic analysis of land use pattern. |
| | | Surface and sub-surface geo-electrical and gravity data generation | Vertical Electrical Sounding (VES), bore-holelogging, 2-D imaging etc. |
| | | Hydrological Parameters on groundwater recharge | Soil infiltration studies, rainfall data analysis, canal flow and recharge structures. |
| | | Preparation of Hydrogeological map (1:50, 000 scale) | Water level monitoring, exploratory drilling, pumping tests, preparation of sub-surface hydrogeological sections. |
| | | Generation of additionalwater quality parameters | Analysis of groundwater for general parametersincluding fluoride. |
| 3. | Aquifer Map Preparation (1:50,000 scale) | Analysis of data and preparation of GIS layers and preparation of aquifer maps | Integration of Hydrogeological, Geophysical,Geological and Hydro-chemical data. |
| 4. | Aquifer Management Plan | Preparation of aquifer managementplan | Information on aquifer through training to administrators, NGO's, progressive farmers and stakeholders etc. and putting in public domain. |

**2.1 Exploratory Drilling:** As on 31/12/2022, CGWB drilled 41 bore wells (Table-2.2) (exploratory, observation and piezometers) in the district. Data analyzed from CGWB wells indicates, 08 wells are of 30 to 100 m, 24 nos are of 100 to 200 m, 4 nos are of 200 to 300 m and 5 nos are of 300 to 600 m depth. The ground water well inventory details of 48 wells (BW:28,DW:16,TW:4) have been also utilized for analysis of aquifer characteristics in the district.Depth of exploratory wells in hard rocks such as charnockite from 35-200m and the deepest fractured encountered at 123 m at Atmakur in Mangalagiri in charnockite. In alluvium depth of tube wells ranges from 32-600m and zones tapped from 10-408 m.

**2.2 Water Level:** Ground water regime monitoring is the basic component of groundwater management and it is carried out in Guntur district through National Hydrograph Network Stations (NHNS or NHS). NHSs are observation wells, comprising of dug wells and purpose built bore wells – known as piezometers. There are 52 wells (CGWB: 35, SGWD: 17 PZ)part of the NHS. CGWB wells are being monitored four times (January, May, August and November) in a year whereas; the monitoring wells of State Ground Water Department (SGWD) arebeing monitored every month. These 51 groundwater monitoring wells were used in order to understand the annual as well as decadal spatial-temporal behavior of the groundwater regime. 48 private wells were also utilized for monitoring of water level and ground water samples collected for chemical analysis.

**2.3 Hydro chemical Studies:** Water quality data of NHS monitoring wells of CGWB are utilized for understanding the spatial variation of quality in the district. A total of 24 Pre monsoon were utilized to understand the the chemical characteristics of groundwater. Parameters namely pH, EC (in µS/cm at 25 ° C), TH, Ca, Mg, Na, K, CO3, HCO3, Cl, SO4, NO3 and F were analyzed.

**2.4 Geophysical Studies:** Geophysical data on VES and profiling are used to extract informationon the weathered thickness, fracture depth, thickness of fracture etc in the study area. For the interpretation of the aquifer geometry geophysical data in conjunction with the available groundwater exploration data is utilized. A total of 85 VES studies have been carried out in the district as per data gap analysis. **(Fig 2.1) & (Fig 2.2)**

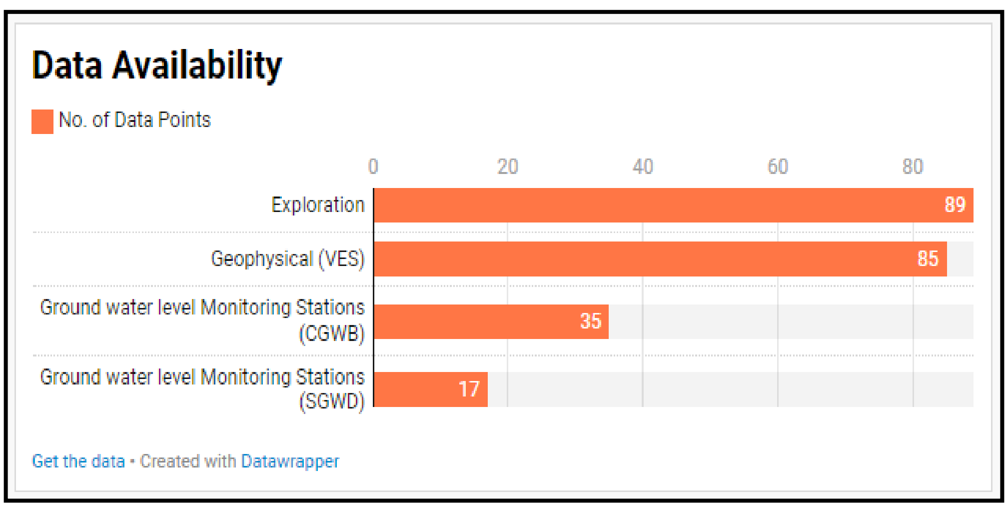



Fig 2.1 Available Data Points

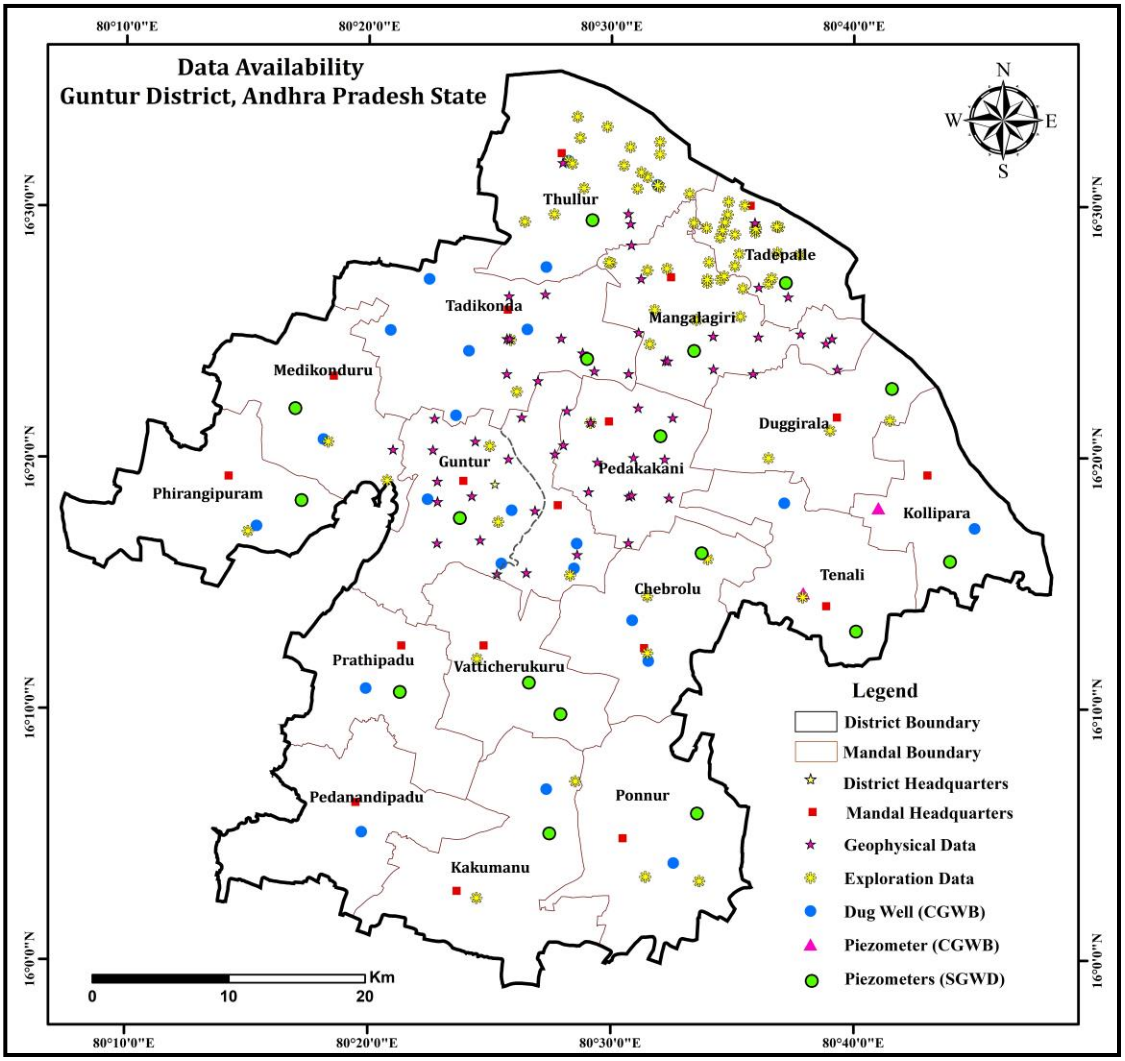



**Fig. 2.2: Map Showing Hydrogeological data availability in Guntur District**

## 3. Ground water Level Scenario

### 3.1 **Decadal Ground Water Scenario: (2014-2023)**

**3.1.1 Pre-monsoon season:** Majority of the water levels during this season are in the range of 2 to 5 m covering 85 % of the area, followed by 5 to 10m bgl (11 %) and <2 m (4%). Depth to water level more than 10 m is not observed in decadal analysis (**Fig:3.1**).

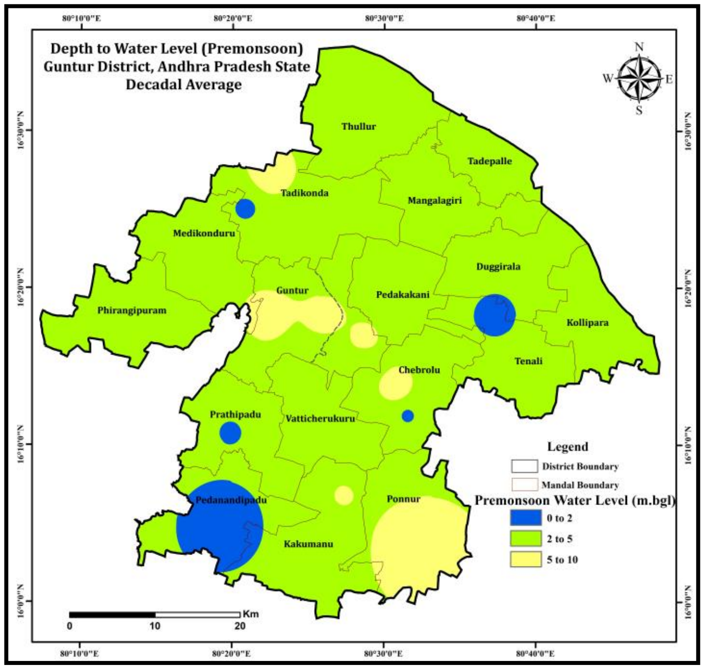



**Fig. 3.1**: Depth to Water Level 2014-2023 (Pre monsoon)- Decadal Average

**3.1.2 Post-monsoon season:** Majority of the water levels during this season are in the range of 2 to5 m (62%) of the area, followed by <2 m bgl (37%) and > 5 m (1%) of area. Depth to water level >5m is not observed in post monsoon decadal analysis (**Fig:3.2**).

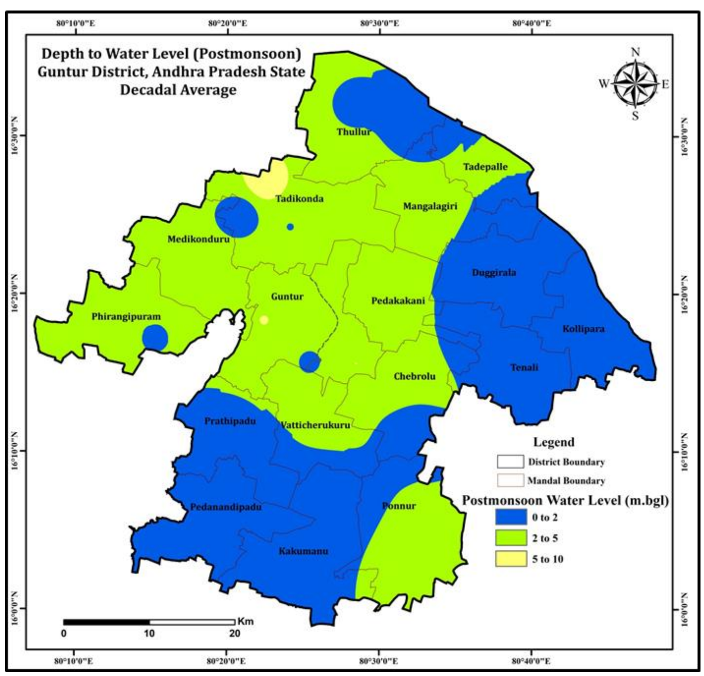



**Fig.3.2:** Depth to Water Level 2014-2023 (Post Monsoon)- Decadal Average

### 3.3 Long term water level trends:

Trend analysis for the last 10 years (2014-2023) is studied from 21 hydrograph stations for pre-monsoon and post-monsoon season respectively. It is observed that during pre-monsoon season 11 wells shows falling trend ranging from 0.02 m to 0.33 m/year (Avg: 0.13 m/yr) and 10 wells shows rising trends ranging 0.02 to 0.31 m/yr (Avg: 0.038 m/yrs) in **Fig.3.3**. During post-monsoon season 7 wells shows falling trend ranging 0.01to to 0.10 m/yr (Avg: 0.04 m/yr) and 15 wells shows rising trend ranging 0.01 to 0.4 m/yrs (Avg: 0.09 m/yrs) in **Fig.3.4** .

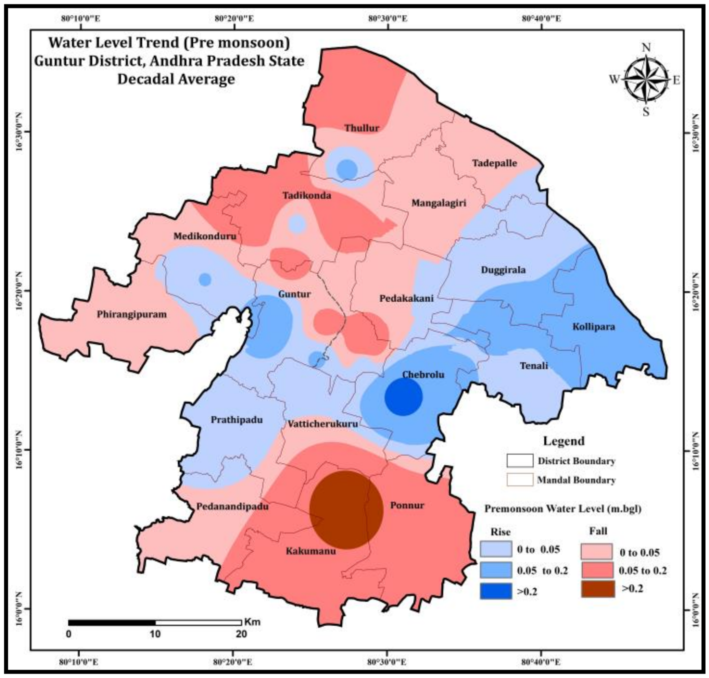



**Fig.3.3:** Pre monsoon Water Long Term Water Level Trend

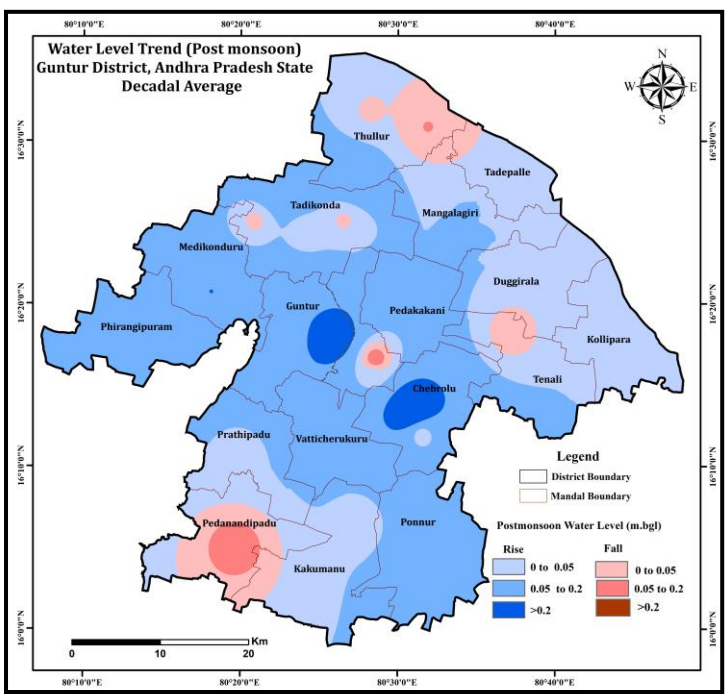



**Fig.3.4 :** Post monsoon Water Long Term Water Level Trend

## 3.4 **Water Table Elevation**

The water table elevation map was prepared to understand the ground water flow directions. The water table elevation ranges from 2 (Ponnur) to 221 (Thullur) m.amsl during pre-monsoon period. The regional ground water flow is mainly towards coastal deltaic areas of Ponnur and Tenali mandals. However, in northern part of district underlined by charnockites where there is localized water divide. Majority of the district is covered with nearly level to very gently sloping category. All deltaic area is covered under nearly level sloping and rest of the area predominantly covered under very gently sloping except hilly areas in Guntur district.

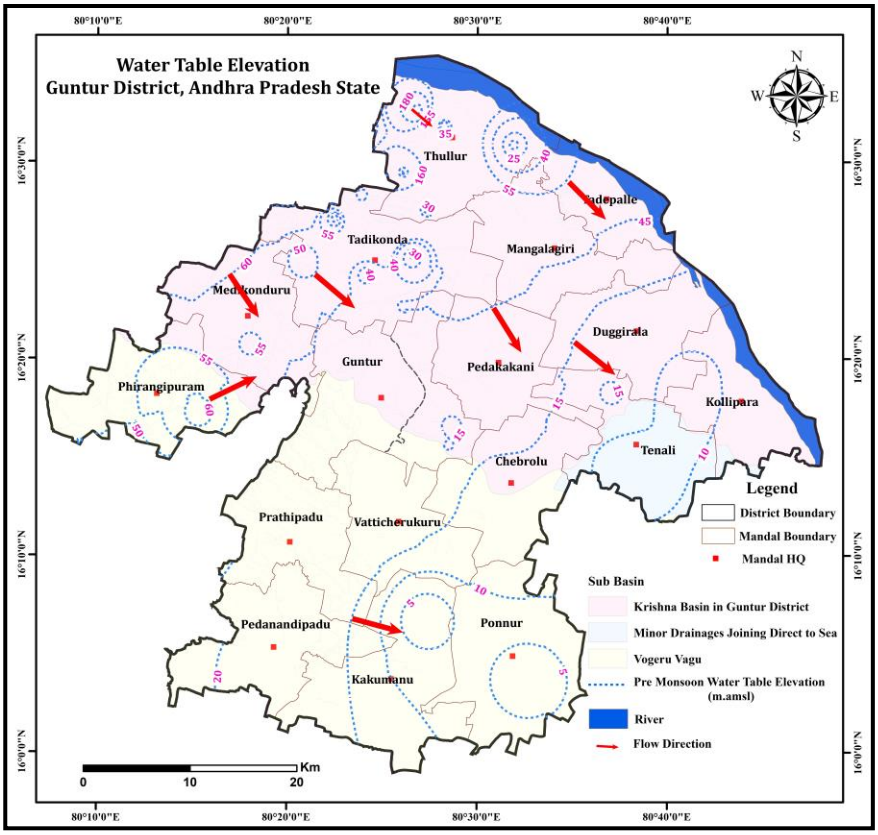



**Fig. 3.5:** Water table elevation map of Guntur District

## 3.5 Ground Water Level Scenario in 2023

**3.5.1 Depth to Water Level 2023:** The depth to water level scenario for pre-monsoon was generated by utilizing water level data of 52 wells (CGWB: 34, SGWD: 17 PZ). The pre-monsoon depth to water levels ranges between 0.73m bgl (Pedanandipadu) to 13.28 mbgl (Tenali).The depth to water levels of Guntur district can be divided into 4 zones; where the shallowest water level are towards the southern part in the alluvium formation in Pedanandipadu, Prathipadu and Chebrolu districts and deeper in Tenali, Ponnur and Tadikonda districts. 80% of the area recorded water level between 2 to 5 m.bgl. The post-monsoon depth to water levels ranged between 0.78m bgl (Pedanandipadu) to 7.4 m bgl (Chebrolu). More than ~86% of the district has water levels measured from 2 to 5 m in month of november. When compared the water levels of same stations in premonsoon and postmonsoon period, it was observed that there has been improvement in water levels in month of November as compared to May. Also 77% of the station has rise in water levels while 23% of the stations has falling water level as compared to premonsoon period to that of postmonsoon period in **Fig 3.6 & Fig 3.7.**

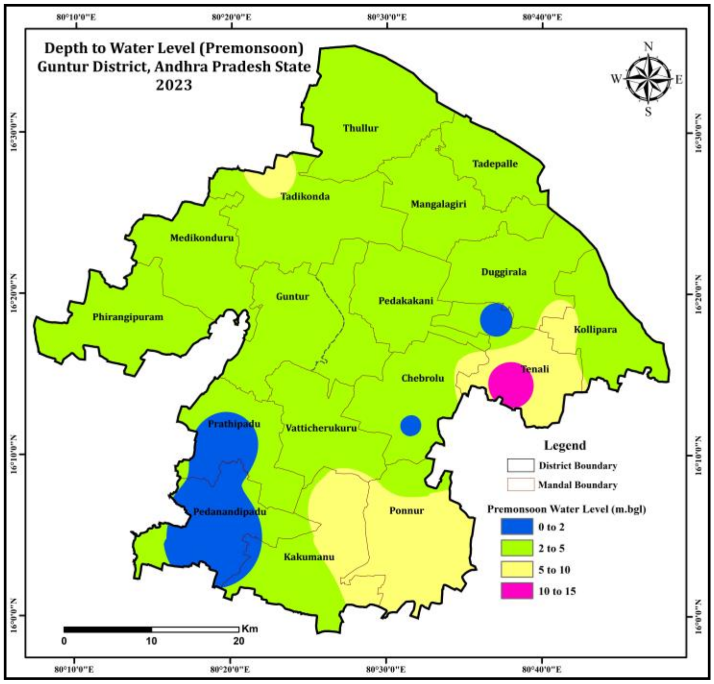



**Fig. 3.6:** Depth to water Level (Premonsoon-2023)

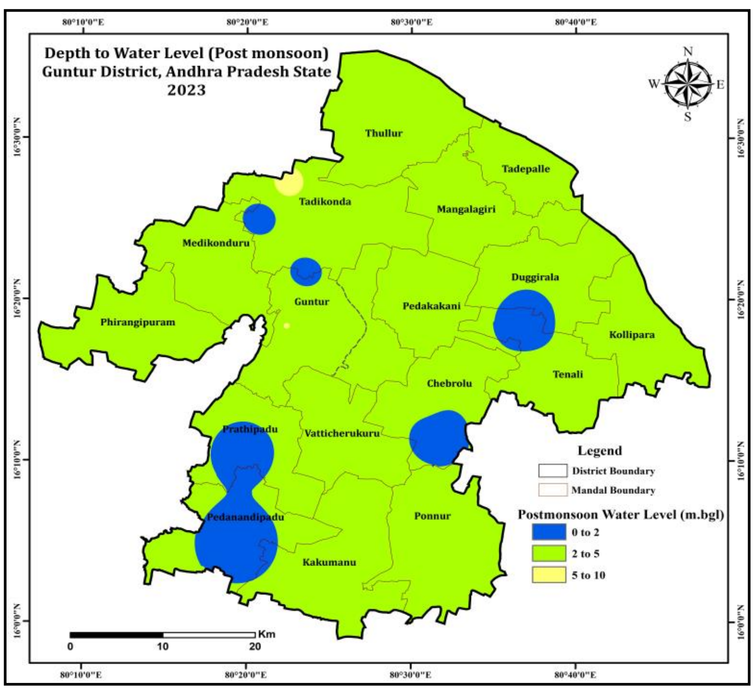


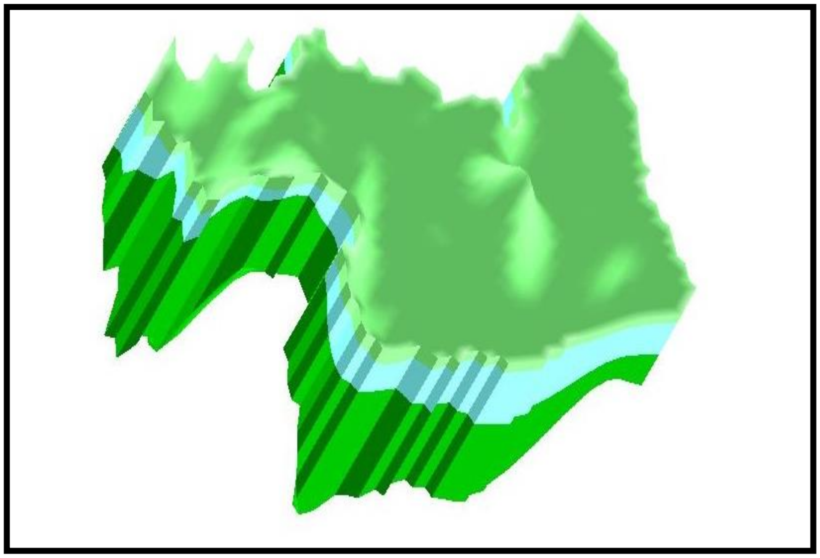

**Fig. 3.7:** Depth to water Level (Post monsoon-2023)

# 4. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

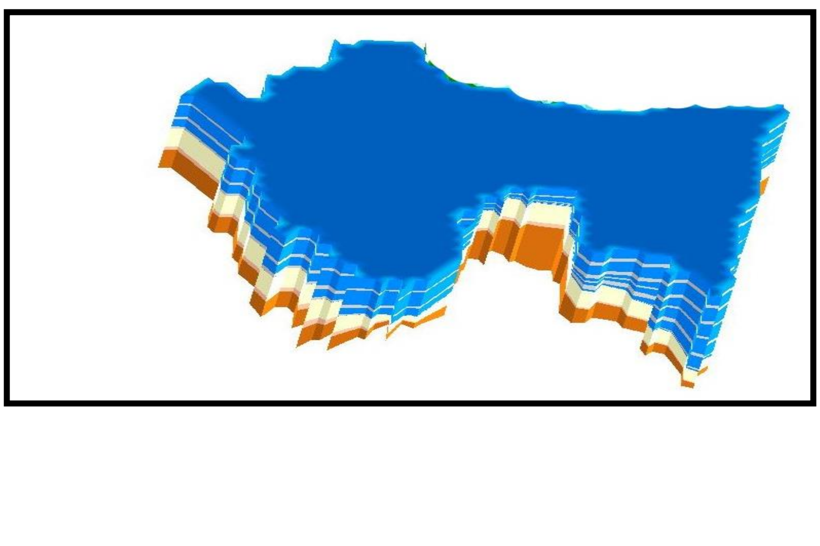
Conceptualization of 3-D hydrogeological model was carried out by integrating and interpreting data. A representative hydrogeological data collected from exploration, VES and well inventory carried out at different locations in the district down to the depth of 200 m bgl by CGWB and SGWD were utilized for preparation of 3D map, panel diagram and hydrogeological sections. The data is calibrated for elevations with SRTM data. The lithological information was generated by using the RockWorks-16 software and generated 3D map for district (Fig. 3.1) along with panel diagram (Fig. 3.2) and hydrogeological sections.

## 4.1 Conceptualization of aquifer system in 3D

Aquifers were characterized in terms of their potential and quality based on integrated hydrogeological data and various thematic maps. The depth of investigation carried out was up to 200m.bgl in hard rock and 600 m bgl in alluvium. In hard rock formation, weathered zone consisting Aquifer-I, varies from 5 to 30 m.bgl in Charnockite and granitic/gneiss formation. Alluvium aquifers and Sandstone aquifers are stratified aquifer system in the area. The unconfined aquifer (Aquifer I) extends to a maximum depth of 35 meters below ground level (bgl) and Aquifer II, III, IV, V, and VI are confined aquifers, each at varying depths and thicknesses ( **Fig: 4.1** & **Fig: 4.2**).



**Charnockite Disposition of Guntur District**



**Deltaic Alluvium and Sandstone disposition of Guntur District**

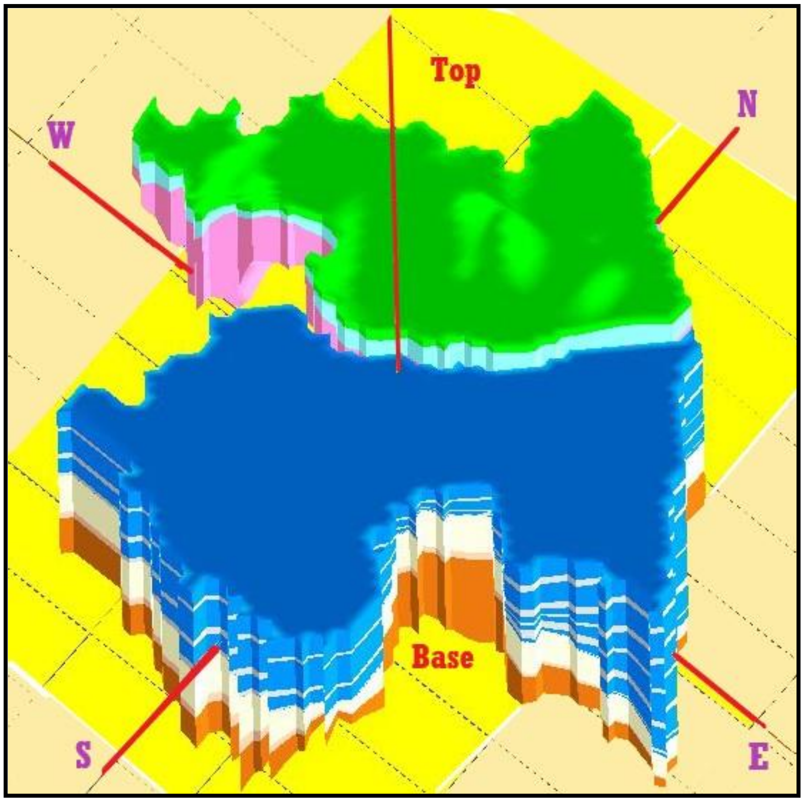
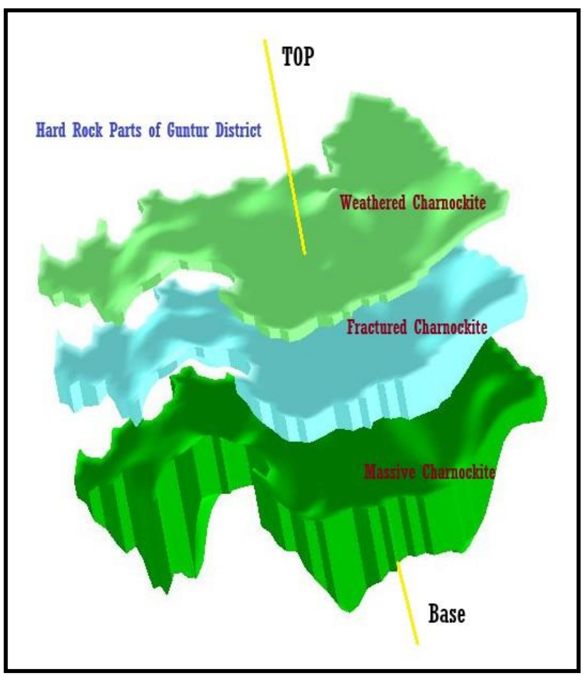


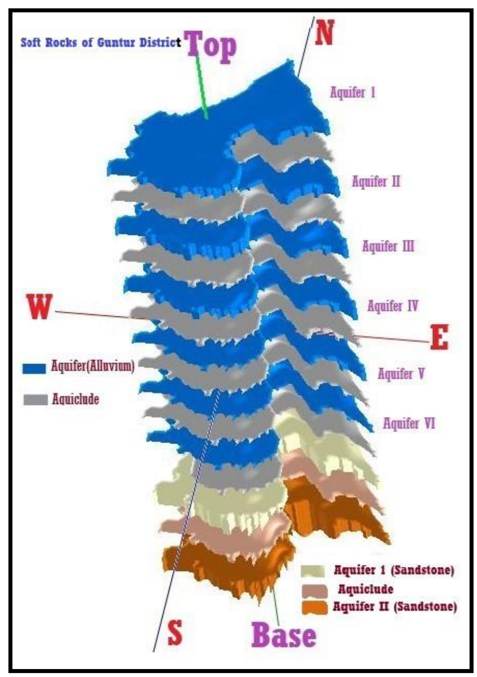


**Fig: 4.1: 3D of Guntur District**

**Legend Index**




**3D of Hard Rocks of Guntur**




**3D of Soft Rocks of Guntur**

**Fig : 4.2 :** 3D of Hard rock and Soft rock of the study area

### 4.2 Conceptualization of aquifer system in 3D

Hydrogeological Sections Two hydrogeological sections were prepared in hard rock along **(a) E-W (b) NNE-SSW and in soft rock along (c) NNE-SSE directions and (d) ENE-WSW** given in **Fig: 4.3.**

4.2.1 **E-W Section in hard rock** (a) The section drawn along the E-W direction, covering a distance of ~25 kms depicts un uniform weathered zone thickness all along the section. The fracture thickness is more in eastern part of the section and also noticed significant fracture thickness all along the profile towards eastern side (**Fig. 4.4 a**).

4.2.2 **NNE-SSW Section in hard rock** (b) Section drawn along NNE-SSW directions, covering a distance of ~30 kms, depicts thicker weathered zone and fractured zone in Thullur and Tadikonda areas. (**Fig. 4.4b**).

4.2.3 **NNE-SSW ection in Soft rock rock** (c) Section drawn along NNE-SSW directions, covering a distance of ~30 kms, depicts Alluvium layers with intervening clay layers. The alluvium layers is underlined by Sandstone. The sandstone outcrop is identified in chebrolu mandal. The thickness of alluvium aquifer is more towards southern and south- eastern part from chebrolu (**Fig. 4.4 c**).

4.2.4 **ENE-WSW Section in Soft rock rock** (c) Section drawn along ENE-SE directions, covering a distance of ~35 kms, depicts alluvium unconfined Aquifer –I occurs down to a maximum depth of 35 m bgl,followed by Aquifer II, III, IV, V, and VI are confined aquifers with intervening clay layers, each at varying depths and thicknesses. (**Fig. 4.5 d**).

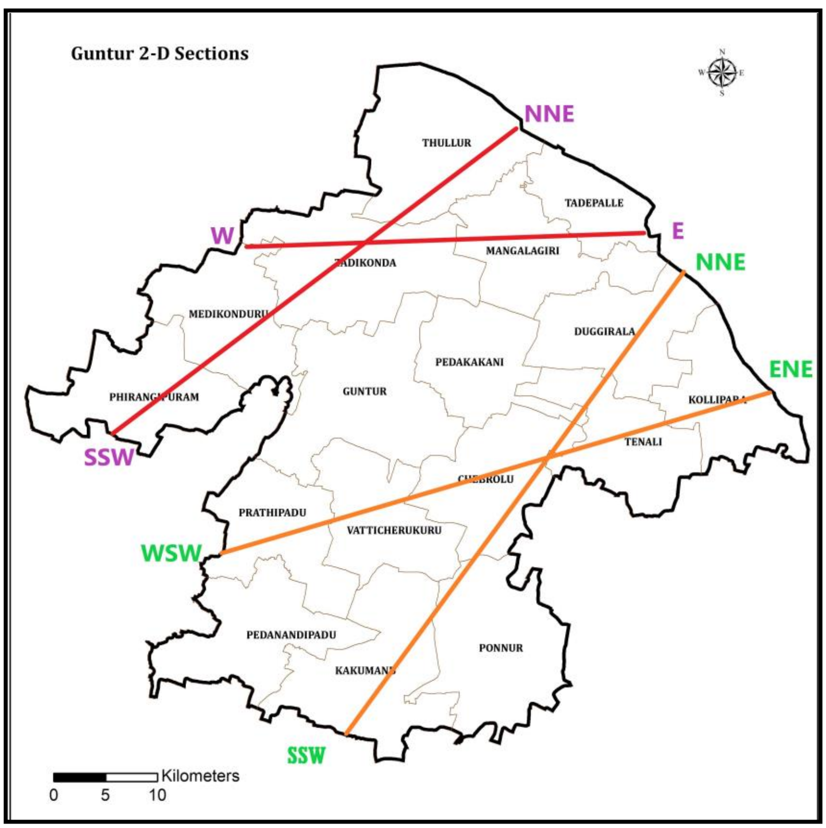



**Fig 4.3:** Map Showing Section Lines

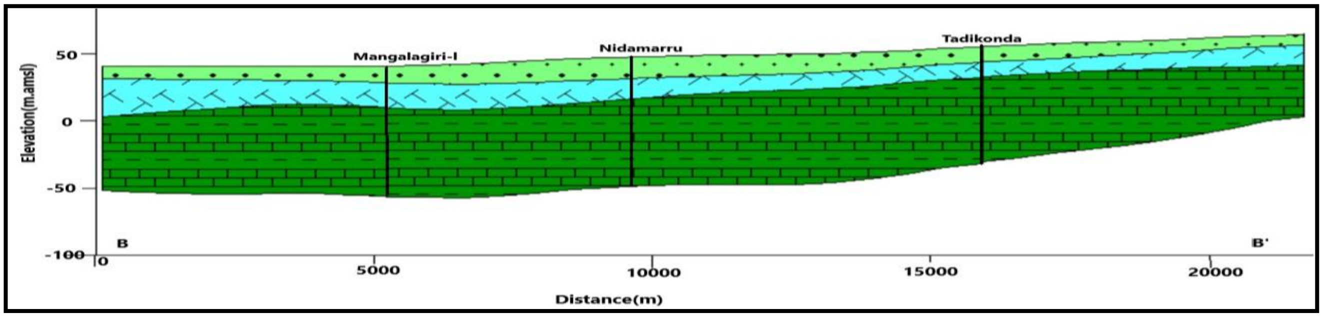



**Fig 4.4 a.: E-W Section in Hard Rock**

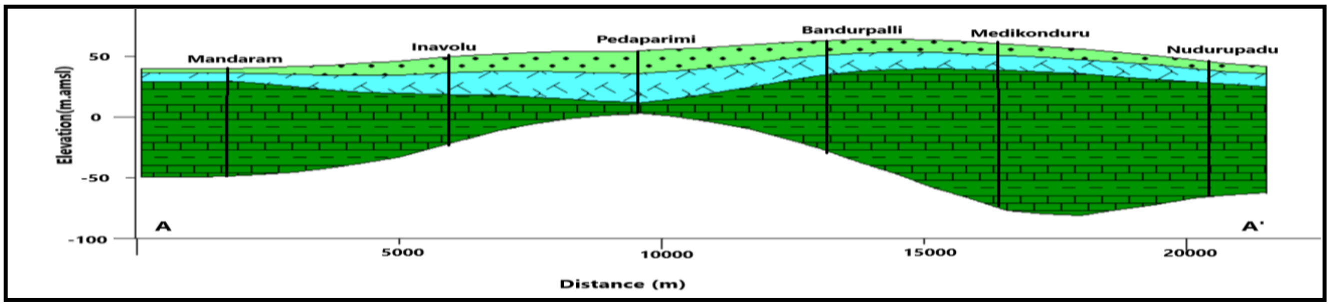



**Fig4.4 b: NNE-SSW Section in Hard Rock**

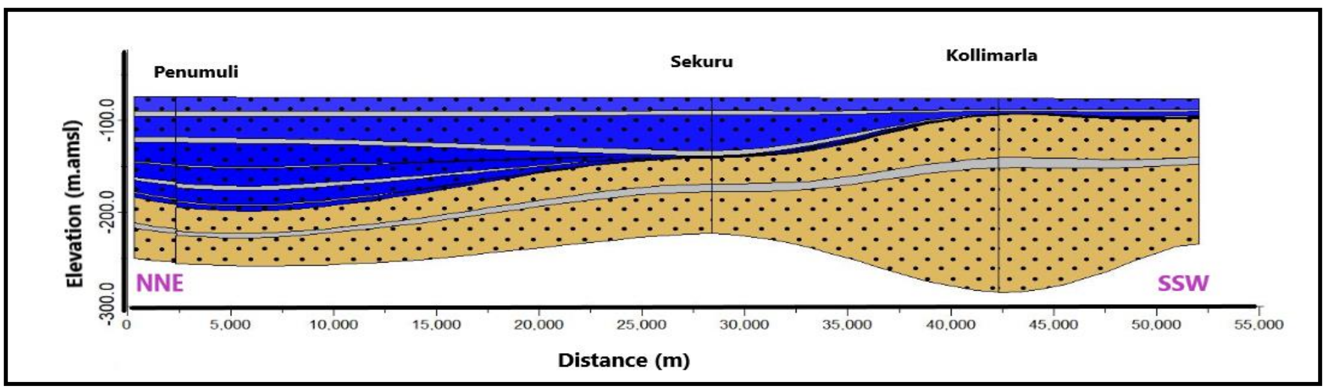



**Fig 4.4 c: NNE-SSW Section n Soft Rock**

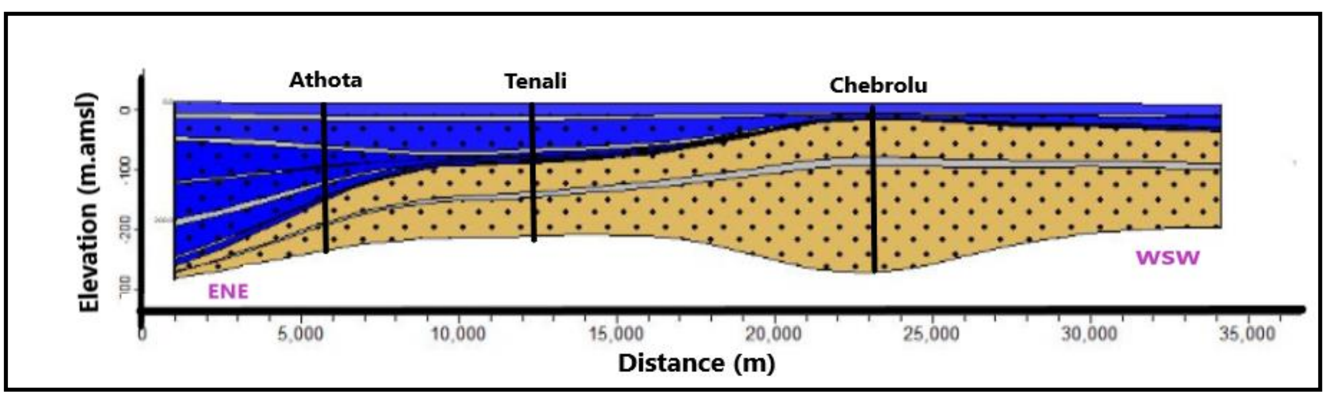



**Fig 4.4 d: ENE-WSW Section in Soft Rock**

# 5.0 Hydrogeology and Aquifer Characterization

Hydrogeology is concerned primarily with mode of occurrence, distribution, movement and chemistry of ground water occurring in the subsurface in relation to the geological environment. The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is Archean eastern ghat mobile belt mainly comprising of Charnockites, Migmatites, Khondalites and Granite Gneisses etc overlain by Recent Alluvium. The occurrence and movement of ground water in these rocks is controlled by the degree of interconnection of secondary pores/voids developed by fracturing and weathering of hard and crystalline formation and presence of sand and clay layers in alluvium formation of deltaic areas of Guntur district.

**5.1 Ground water Yield:** Ground water yield from weathered and fractured Charnockites Schist/gneiss aquifer varies from < 1 to 3 lps while in alluvium areas of deltaic part have yield >5lps. Based on exploratory data of CGWB, yield map is prepared and shownin **Fig.5.1**. In most of the area wells yields are in the range of 1-3 lps in ~40 % of the area and < 1 lps in ~37% of the area observed, followed by yield range 3 to 5 lps observed in ~10 % area and >5 lps observed in ~13% area. Wells located in the command area have higheryield (3-4 lps). and sustain for more hours of pumping as compared to non-command area where yields are relatively low with sustainability for 2-3 hrs **.**

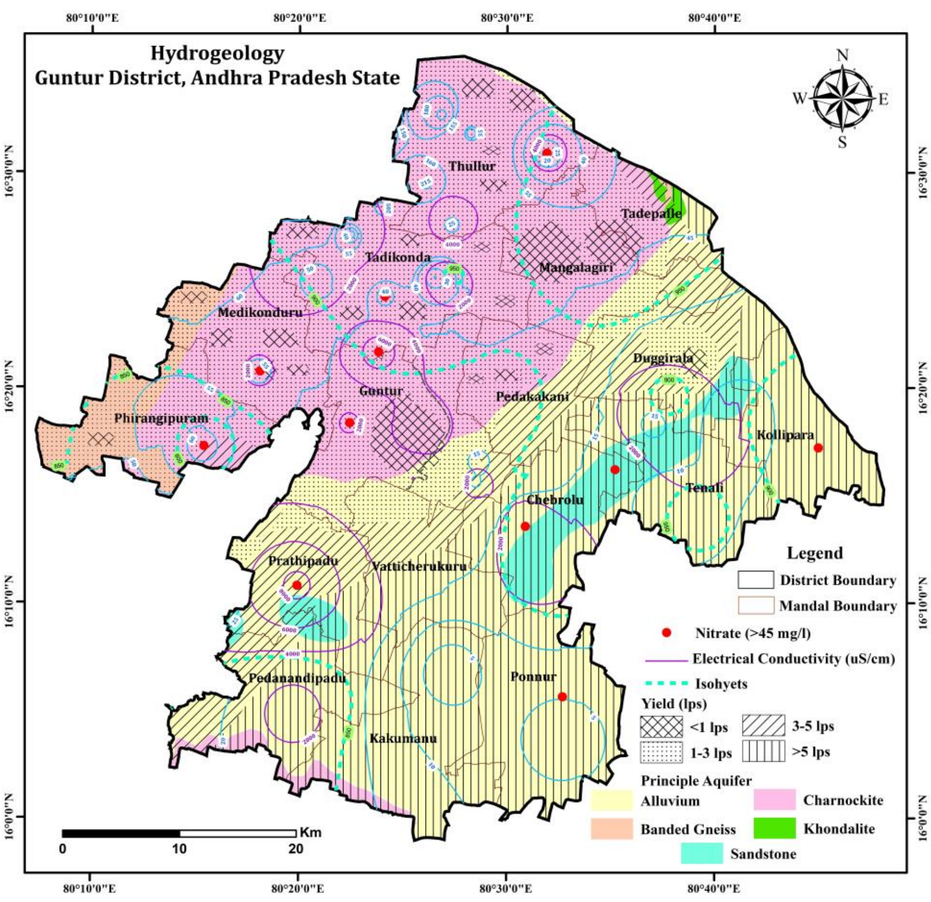



**Fig.5.1: Ground water Yield**

## 5.2 Aquifer Characterization:

### 5.2.1 Weathered zone:

The weathered zone consisting of upper saprolite (~15 m) and lower sap rock (15-25m.), varies from 5 to 30 m.bgl in Charnockite and granitic/gneiss formation. Spatial distribution of weathering depth zone map is given in **Fig. 5.2**. Thickness of weathered zone in the range of 10 to 20 m in most part of area covering ~75% of area, shallow weathering <10 m occurs in 9% of the area, 20 to 30 m in 13% of the area and deep weathering (>30 m) occurs in 3% of the area (**Fig. 5.3)** . Shallow weathering mostly seen in granitic areas along the NW part of the district.

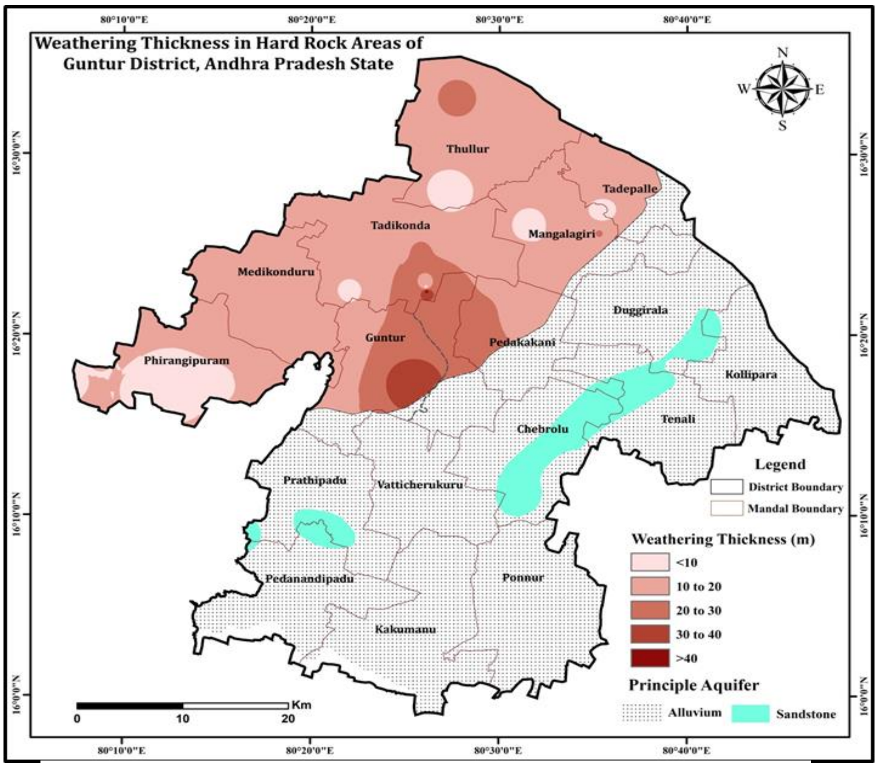



**Fig. 5.2**.: Depth to weathering map of Guntur District

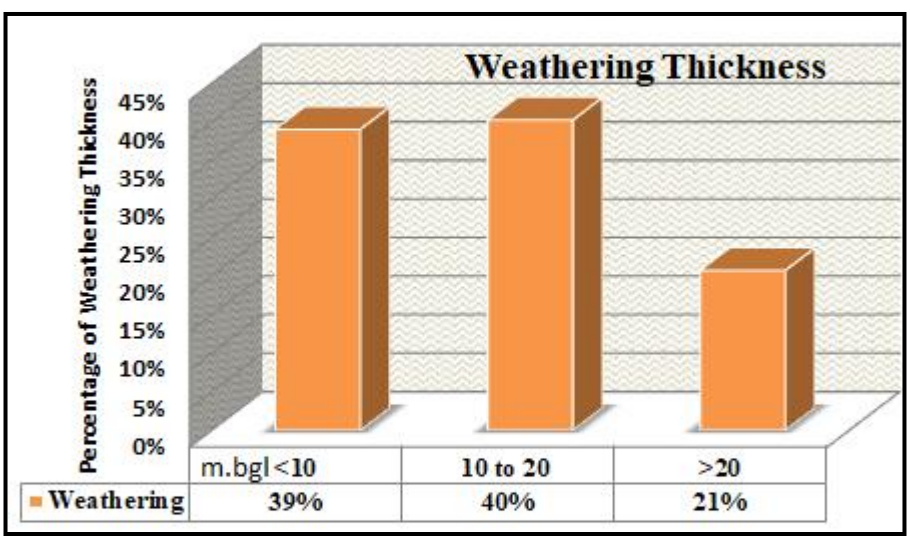



**Fig. 5.3:** Graphical representation of weathering depth in Guntur

**5.2.2 Aquifer Characterization of Shallow Aquifer: (Aquifer-1):** It consists of weathered residuum where ground water occurs under water table condition and is mainly developed by construction of dug wells or shallow bore wells as hand pump. The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. They are unconfined aquifers. Ground water yield in weathered Charnockite/granite/gneiss aquifer is average of <1 lps and 1 to 2 lps (avg: 2 lps) in metasedimentary aquifers. The transmissivity varies from <1 to 70m$^2$/day in weathered Archean crystalline aquifers and varies from <100 m$^2$/day in metasedimentary aquifers.

**5.2.3 Fractured zone:**

Ground water is extracted mainly through bore wells of 30 to 200 m depth from fractured zone (~20 to 123 m). Based on CGWB data, it is inferred that fractures in the range of < 60 m depth are more predominant (78% of the area), 60 - 120 fractures occur in 15 % and >120 m fractures occur in 2 % of area respectively and deep fractures in the range of > 150m occur mostly in Mangalagiri and Pedakakani mandal .

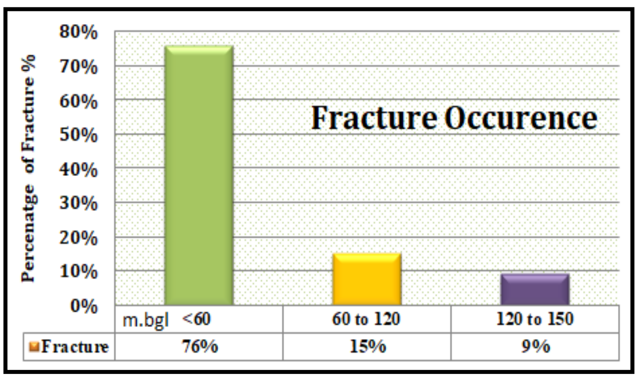



Fig. 5.4. : Graphical representation of fracture depth in Guntur district

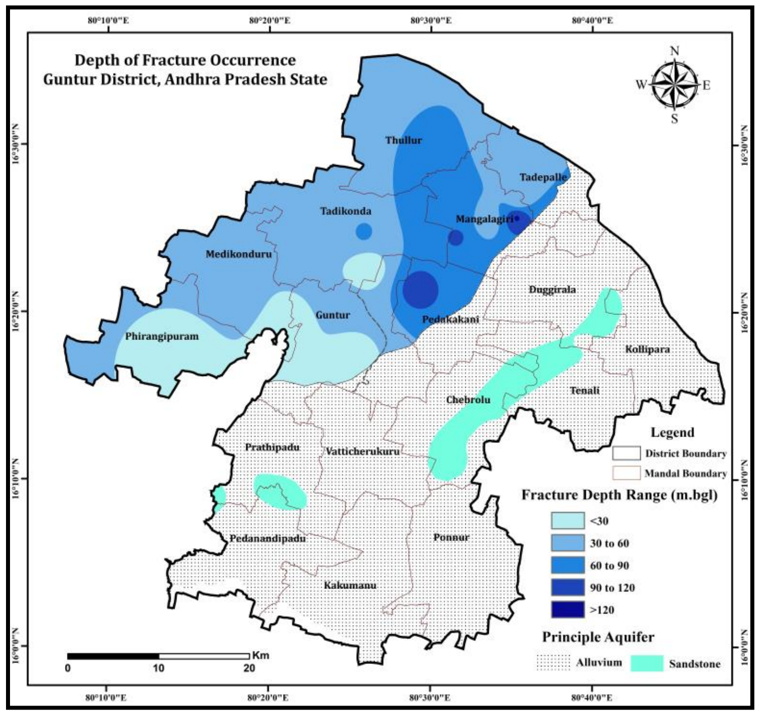



Fig. 5.4. Depth to fracture map of Guntur District

**5.2.4 Aquifer Characterization of Deeper Aquifer (Aquifer II):** The aquifer-II is the deeper aquifer which tapped the fractured zone. Ground water in the second aquifer occurs under semi- confined to confined condition in the fractures up to the maximum depth of the deepest fractured encountered at 123 m at Atmakur in Mangalagiri in charnockite. The depth of fracturing varies from 28 m to 123 m with yield of <1 to 3 lps.The specific capacity of the consolidated formation ranges between 5 and 700 lpm/mdd and transmissivity of consolidated formation varies from <1 to 100 sq.m/day. The storativity in Schists/Charnockite/Gneisses varies from 1x $10^{-6}$ to 0.001.

### 5.2.5 Aquifer Characterization of Alluvium in Guntur District

The exploratory drilling within the explored depth of 600 m in Krishna deltaic area by CGWB revealed that the alluvium is underlained by sandstones at varying depths and at places directly by crystallines/ bedrock. The area is underlain by deltaic alluvium consisting of fine to medium sand, silt and gravel with intercalations of clay of recent age followed by sandstones of Mio Pliocene age followed by crystallines and at places alluvium directly underlain by crystallines/ basement. The sand stone formations occur as isolated linear out crops in the north western parts of the area around Chebrolu and also encountered at shallow to greater depths in other parts. Ground Water in alluvium occurs under unconfined conditions in shallow aquifers, whereas confined conditions in the deeper aquifers. Buried/Paleo channels existing in the area are promising potential zones. Shallow aquifer is being tapped by dug wells and by filter points/ shallow tube wells in the area. Ground water is being used as and when required particularly during canal closure times for raising seedbeds and where canal water cannot reach to some extent in the high level patches. The depth of open wells generally ranges from 3 to 12 m bgl and the depth of tube wells/ filter point wells ranges from 10 to 25 m. The ground water extraction from sandstone formations is limited to the area around Chebrolu i.e., in north western part of the delta. Ground water occurs under water table and semi confined conditions. The ground water is being tapped by dug wells and tube wells. The depth of dug wells varies from 5 to 18 m bgl whereas the tube wells are in the range of 30 to 60 m bgl. The yield of tube wells ranges from 28 to 1300 lpm. In the deltaic area in general, the deeper alluvial aquifers contains saline water, even sandstone aquifers encountered below alluvium also yielded saline water except at few places.

The hydrogeological studies reveal that the shallow aquifer is in unconfined condition and the deeper aquifers are confined in nature and the quality of the ground water in general deteriorates from shallow to deeper aquifers. These aquifers have been broadly grouped into two principal aquifers viz., Alluvium aquifers and Sandstone aquifers. The study reveals a stratified aquifer system in the area. The unconfined aquifer (Aquifer I) extends to a maximum depth of 35 meters below ground level (bgl) with a hydraulic conductivity ranging from 9 to 31m/day and a specific yield between 0.04 to 0.20. Aquifer II, III, IV, V, and VI are confined aquifers, each at varying depths and thicknesses. Aquifer II to VI exhibit yields <2 to >10 lps & transmissivity >100 $m^2$/day.

### 5.2.6 Alluvium & Sandstone Aquifers in Krishna Deltaic Area:

The detailed analysis of the data reveals that the alluvium is the principal aquifer system, which is underlain by sandstone aquifer, at places alluvium aquifer is directly underlain by crystallines in the area. Analysis of the data reveals the presence of numerous thick sand beds interspersed with substantial clay beds in the vicinity. These sand beds serve as aquifers, with a total of six distinct beds within the alluvium functioning as regional aquifers, while two aquifers exist within the sandstones. It is essential to acknowledge that thin and pinched beds, though often overlooked, are integral components of the regional aquifer system and contribute significantly to regional groundwater flow. Ground water occurs in unconfined, semi-confined and confined conditions in the study area depending on the availability of impervious beds. In general, the first aquifer which is present up to a maximum of 35 m below MSL is unconfined whereas the deeper aquifers are confined in nature.

**IAquifer I (Unconfined Aquifer - UC):** This quifer generally occurs down to a maximum depth of 35 m bgl. Based on the exploration data, depth to bottom of first aquifer/ unconfined aquifer is prepared.

The yield of the wells and Transmissivity (T) values varies from < 5 to 15 lps and 250 to 5500 m2/day respectively. Hydraulic Conductivity of the Unconfined aquifer varies from 9 to 31m/day with a median of 15m/day whereas the Specific yield of this aquifer varies from 0.04 to 0.20 with a median of 0.13. The quality of the ground water is in general good.

**Aquifer II (Alluvium: Confined Aquifer – C1):** The top of the aquifer is found in depths of 15 to 60 m below surface. Maximum depth to bottom of second aquifer is 104 m bgl. The yield ranges from 2 to 18 lps. Transmissivity values are in the range of 264 to 3051 m2/day. The Hydraulic Conductivity of the Confined aquifer C1 varies from 9 to 122m/day with a median of 21m/day whereas the Specific Storage of this aquifer varies from 5.33X10-6 to 2.12X10-3 with a median of 2.19X10-5.

**Aquifer III (Alluvium: Confined Aquifer – C2):** This aquifer is found at depths between 48 and 185 m below surface, and its thickness ranges from 13 m to 90 m. Discharges of the wells tapping this aquifer ranges from < 2 to 44 lps. Transmissivity of the aquifer is ranges from 288 to 3520 m2/day. The Hydraulic Conductivity of the Confined aquifer C2 varies from 9 to 61 m/day with a median of 13 m/day whereas the Specific Storage of this aquifer varies from 5.00X10- 6 to 5.10X10-5 with a median of 7.95X10-6.

**Aquifer IV (Alluvium: Confined Aquifer – C3):** The thickness of the Alluvial confined aquifer – C2 varies from 18 to 93 m. The yield of the wells constructed in this aquifer varies from < 1 to 38 lps, whereas T is in the range of 144 to 6000 m2/day. The Hydraulic Conductivity of the Confined aquifer C3 varies from 3 to 66m/day with a median of 17m/day whereas the Specific Storage of this aquifer varies from 3.95X10-7 to 4.89X10-5 with a median of 7.59X10-6. EC is in the range of 450 to 29300 µS/cm at 25°C at 25°C (Fig. 41).

**Aquifer V (Alluvium: Confined Aquifer – C4):** This aquifer occurs at depths from 131 to 267 m below the ground level. The thickness varies from 20 to 74 m. Discharges of the wells constructed in this aquifer varies from 1 lps to 25 lps and T ranges from 43 to 1969 m2/day. The Hydraulic Conductivity of the Confined aquifer C4 varies from 1 to 60m/day with a median of 7m/day whereas the Specific Storage of this aquifer varies from 1.11X10-6 to 6.48X10-4 with a median of 8.33X10-6.

**Aquifer VI (Alluvium: Confined Aquifer – C5):**Bottom most confined alluvium aquifers to explored depth of 300 m occurs at a depth from 164 to 300 m with a thickness of 14 to 81 m. Discharge varies from 3 to 25 lps. Transmissivity values are in the range of 97 to 106 m2/day. The Hydraulic Conductivity of the Confined aquifer C5 is 2m/day & the Specific Storage of this aquifer is 4.35x10-6.

**Sandstone Aquifer (Confined - SC1):** This sandstone aquifer occurs at different places at different depths varying from 13 to 283 m below the ground level. The thickness of this aquifer varies from 15 to 93 m. The yield of the wells is in the range of 1 to 9.5 lps and T varies from 144 to 885 m2/day.

**Sandstone Aquifer (Confined – SC2):** The top of this aquifer occurs at depths from 81 to 289 m below ground level. Yield of the wells constructed in this aquifer is in the range of 25 to 35 lps. Transmissivity is varying from 106 to 429 m2/day.

## 6.0 Ground Water Quality

To understand chemical nature of groundwater, total 25 data points is utilized from ground water monitoring wells. During pre-monsoon season of 2022, NHS: 25 wells, (mostly tapping combined aquifers Aq-1 and aq-2) were analyzed. The groundwater quality in the area is generally good. In all the locations PH is within the acceptable limit and shows mildly alkaline nature.

**6.1 Pre-monsoon**: Groundwater is mildly alkaline with pH in the range of 7.09- 8.6 (Avg: 7.79). Electrical conductivity varies from 650-8320 (avg: 2777) µ Siemens/cm. In 10 % of area, EC is within 2000 µ Siemens/cm, in 63 % area, it is between2000-3000µ Siemens and in 26% of area it is beyond permissible limit (**Fig 6.1 & Fig 6.2**). Average concentration of TDS is 1748 mg/L and NO3 ranges from <1-1535 mg/L. Nitrate concentration in 50% of samples is beyond permissible limits of 45 mg/L. Fluoride concentration varies from 0.04-1.48 and all the samples are within the permissible limit . The premonsson quality spatial distribution of EC,Nitrate and fluoride are given in (**Fig 6.3, Fig 6.4 & Fig 6.5**).

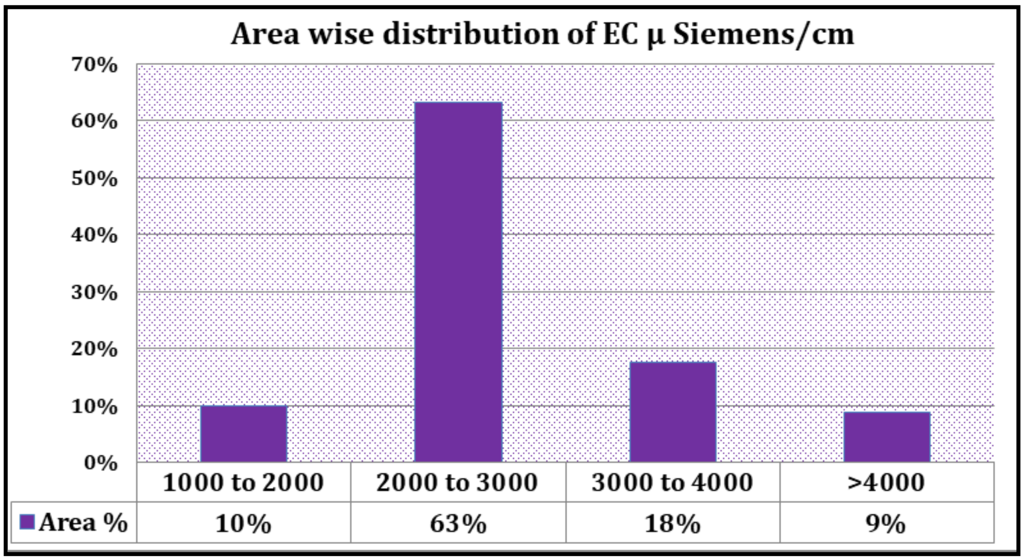



**Fig 6.1 : Percentage of area EC**

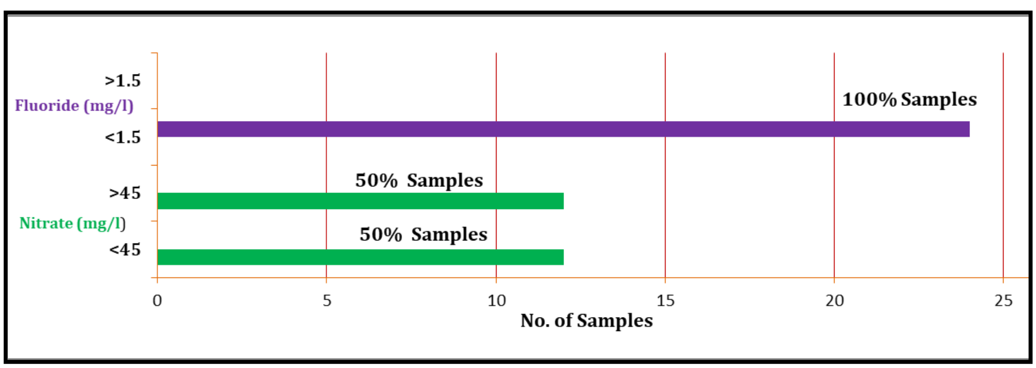



**Fig 6.2: Nitrate and Fluoride Samples**

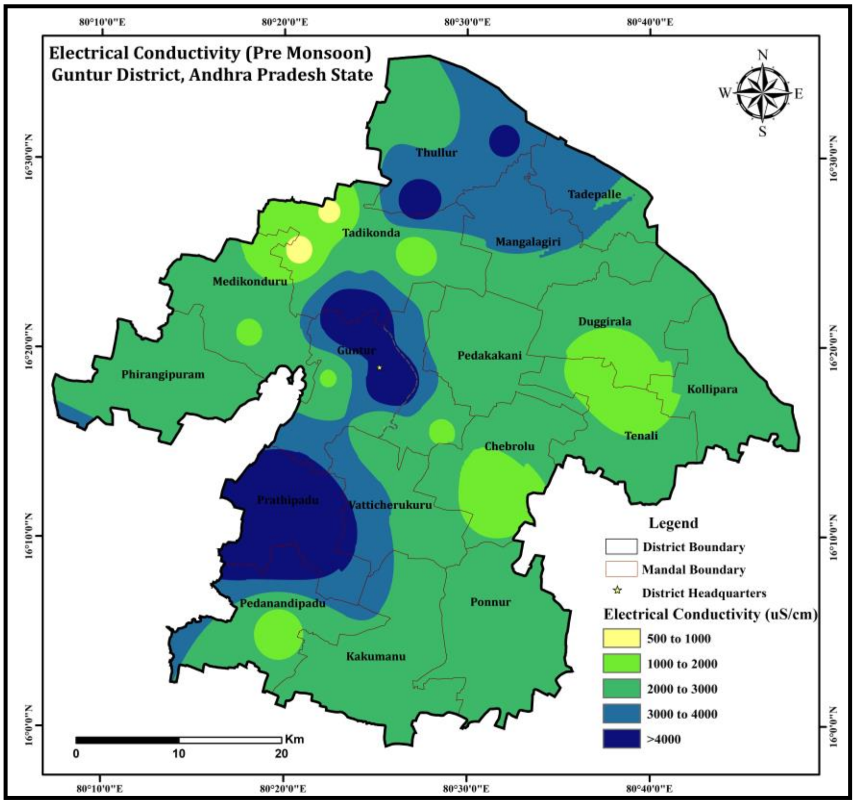



Fig 6.3 : Pre monsoon EC distribution

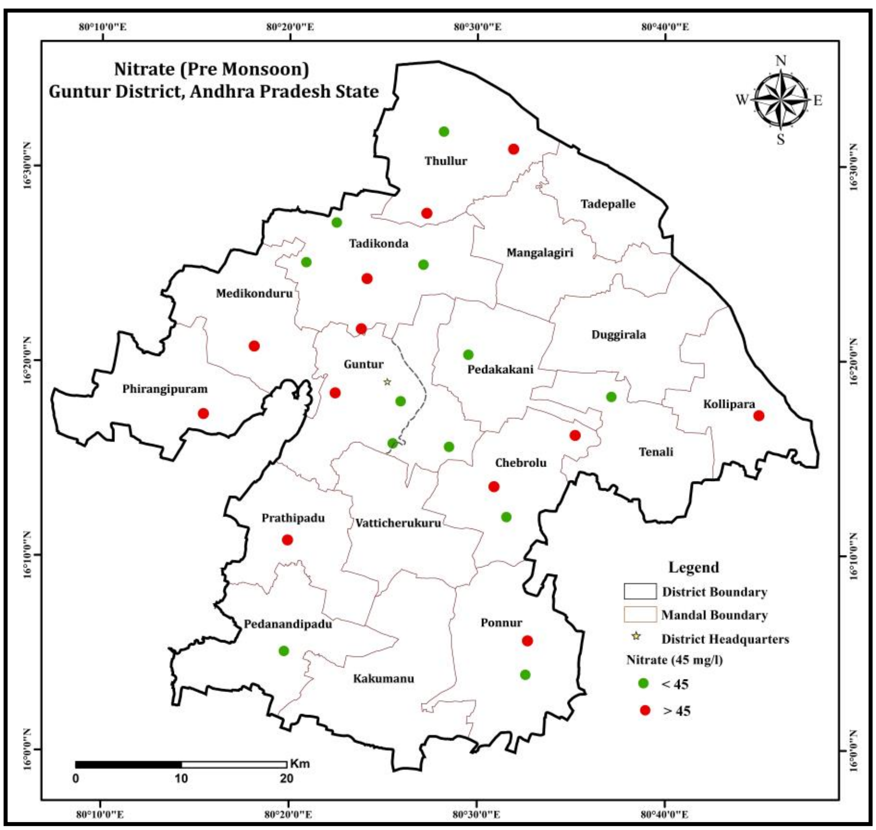



Fig 6.4: Pre monsoon Nitrate distribution

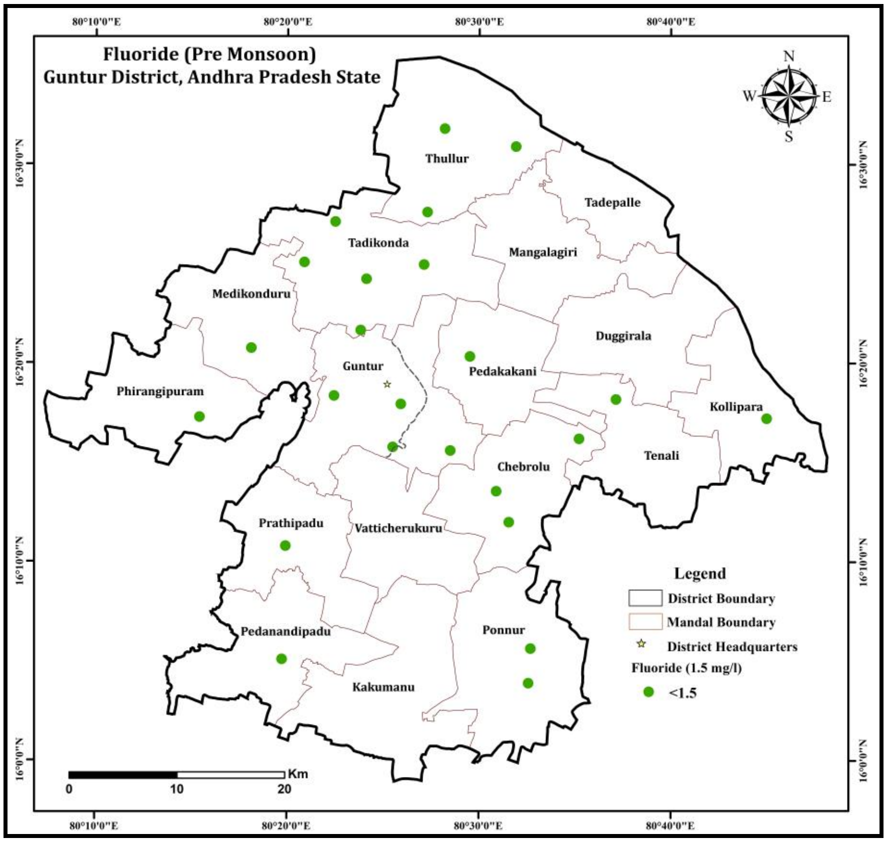



**Fig 6.5:** Pre monsoon Fluoride distribution

In an earlier study conducted in Krishna Delta during 2021, the hydro chemical data reveals that the quality of Ground Water varies vertically among aquifers. Based on the vertical variation of ground water quality, following 9 scenarios identified in the area and shown in **Fig. 6.6.**

- **1** Fresh water aquifers all through
- **2** Saline water aquifers all through
- **3** Saline water aquifers overlying Highly Saline
- **4** Fresh water aquifers overlying Brackish
- **5** Fresh water aquifers overlying Brackish - Saline
- **6** Fresh water aquifers overlying Saline - Brackish
- **7** Brackish water aquifers overlying Saline
- **8** Saline water aquifers overlying Fresh - Saline
- **9** Saline water aquifers overlying Brackish – Saline

And in the deltaic Part of Guntur district, vertical variation of Ground water quality aquifers are identified of 4 Scenario ( Saline water aquifers all through, Saline water aquifers overlying Highly Saline, Fresh water aquifers overlying Brackish & Fresh water aquifers overlying Brackish – Saline) as given in Fig

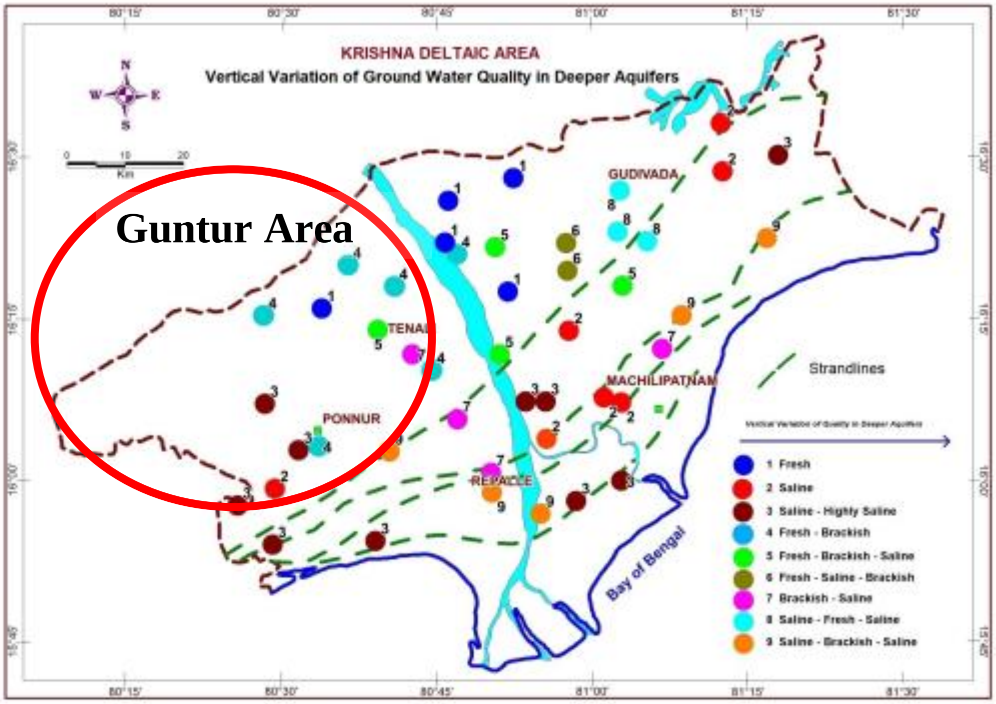



**Fig 6.6 :** Quality of Ground Water varies vertically among aquifers (Previous study on Krishna Delta)

## 6.2 SUITABILITY OF GROUNDWATER FOR IRRIGATION PURPOSE

The chemical quality of irrigation water significantly impacts agricultural productivity. Accumulation of salts in the soil from irrigation can impede plant growth by disrupting osmotic processes. In addition to problems caused by excessive concentration of dissolved solids, certain constituents in irrigation water are especially undesirable and some may be damaging even when present in small concentrations. Irrigation indices viz. Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) have been evaluated to assess the suitability of ground water for irrigation purposes.

**6.2.1 Alkali Hazard**: In the irrigation water, it is characterized by absolute and relative concentrations of cations. If the sodium concentrations are high, the alkali hazard is high and if the calcium & magnesium levels are high, this hazard is low. The alkali soils are formed by the accumulation of exchangeable sodium and are characterized by poor tilt and low permeability. The U.S. Salinity laboratory has recommended the use of sodium adsorption ratio (SAR) as it is closely related to adsorption of sodium by the soil.

SAR is derived by the following equation:

$$\mathbf{SAR} = \frac{\mathbf{Na}}{\sqrt{(\mathbf{Ca} + \mathbf{Mg})/2}}$$

| Table 6.1 : SAR Category | |
|---|---|
| **SAR Category** | **Brief Description** |
| S1 – Low Sodium Water (SAR <10) | Such waters can be used on practically all kinds of soils without any risk or increase in exchangeable sodium. |
| S2 – Medium Sodium Water (SAR 10-18) | Such waters may produce an appreciable sodium hazard in fine textured soil having high cation exchange capacity under low leaching. |
| S3 – High Sodium Water (SAR >18-26) | Such waters indicate harmful concentrations of exchangeable sodium in most of the soil and would require special management, good drainage, high leaching and addition of organic matter to the soil. If such waters are used on gypsiferrous soils the exchangeable sodium could not produce harmful effects. |
| S4 – Very High Sodium Waters (SAR >26) | Such waters are unsatisfactory for irrigation purposes except at low or perhaps at medium salinity where the solution of calcium from the soil or addition of gypsum or other amendments makes the use of such waters feasible. |

The SAR category is given in above **Table 6.1**. The computed SAR values ranges from 1.96 to 13.35. The maximum SAR value has been found at Tadikonda mandal. 96% samples belong to excellent category (S1), 4% water samples are associated with Medium sodium category (S2).

**6.2.2 Wilcox Diagram:** The Wilcox diagram categorizes irrigation water based on Electrical Conductivity (EC) and Sodium Adsorption Ratio (SAR). Here's a concise summary of the classes for water samples from monitoring wells in Guntur district. The Wilcox diagram (Wilcox 1948) relating EC and SAR shows (Fig. 9). The samples collected from the monitoring wells in Guntur District fall into C3S1, C3S2, C4S2,C4S3,C2S1,C3S3,C4S1 classes as described below in **Table 6.2**

| | Table 6.2 : Wilcox classes |
|---|---|
| **WILCOX Classes** | **Brief Description** |
| C1S1 | Low salinity and low sodium waters are good for irrigation and can be used with most of the crops with no restriction on use on most of the soils. |
| C2S1 | Medium salinity and low sodium water can be used for irrigation on almost all soils with little danger of Na problem/hazard, if a moderate amount of leaching occurs. Crops can be grown without any special consideration for salinity control. |
| C3S1 | The high salinity and low sodium waters require good drainage. Crops with good salt tolerance should be selected. |
| C3S2 | The high salinity and medium sodium waters require good drainage and can be used on coarse textured or organic soils having good permeability. |
| C3S3 | These high salinity and high sodium waters require special soil management, good drainage, high leaching and organic matter additions. Gypsum amendments make feasible the use of these waters. |
| C4S1 | Very high salinity and low sodium waters are not suitable for irrigation unless the soil must be permeable and drainage must be adequate. Irrigation waters must be applied in excess to provide considerable leaching. Salt tolerant crops must be selected. |
| C4S2 | Very high salinity and medium sodium waters are not suitable for irrigation on fine textured soils and low leaching conditions and can be used for irrigation on coarse textured or organic soils having good permeability. |
| C4S3 | Very high salinity and high sodium waters produce harmful levels of exchangeable sodium in most soils and will require special soil management, good drainage, high leaching and organic matter additions. Gypsum amendment makes feasible the use of these waters. |
| C4S4 | Very high salinity and very high sodium waters are generally unsuitable for irrigation purpose. These are sodium chloride type of waters and can cause sodium hazard. It can be used on coarse textured soils with very good drainage for very high salt tolerant crops. Gypsum amendments make feasible the use of these waters |

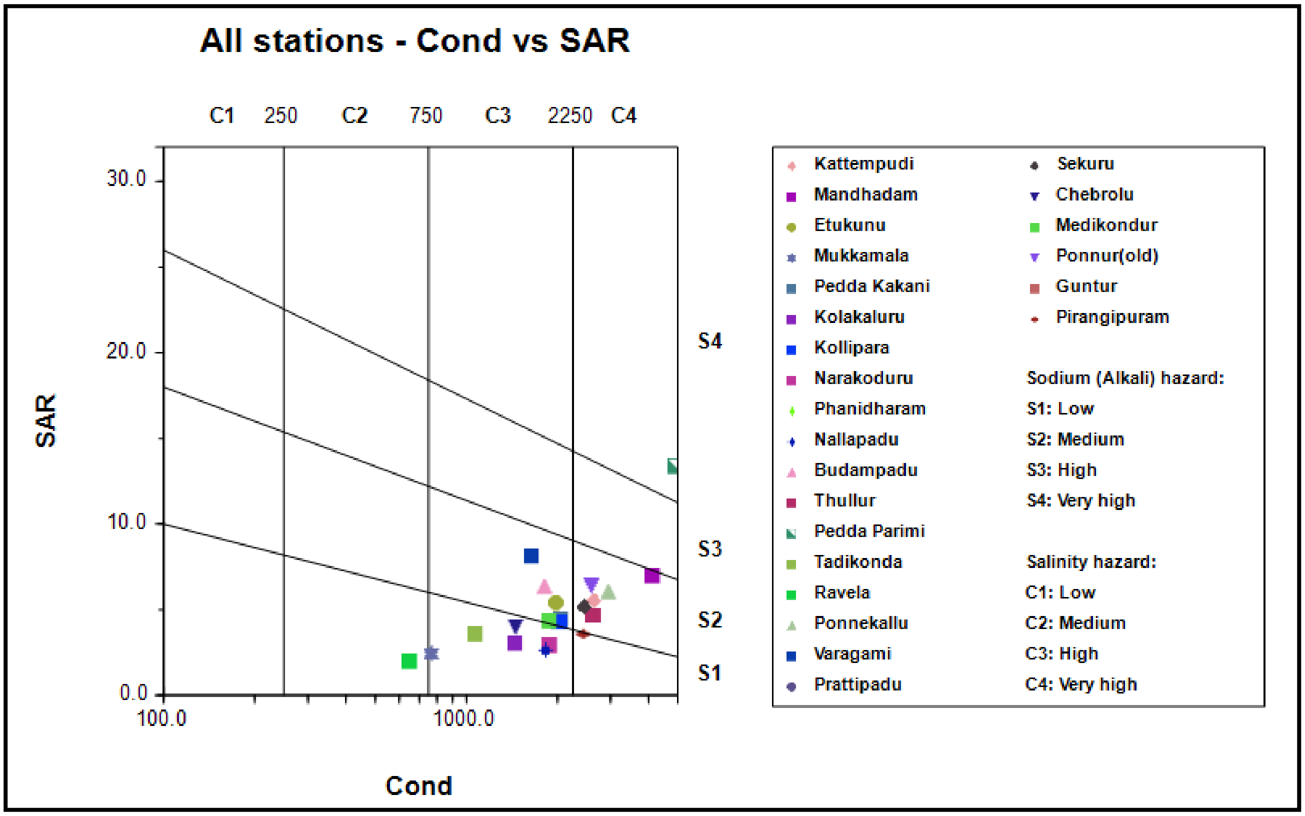



**Fig 6.7:** US Salinity Laboratory diagram

From the US Salinity Laboratory diagram (**Fig.6.7**) and it is observed that 38% of water samples are falling in $C_3S_1$ class, 21% in $C_3S_2$ class, 17% in $C_4S_2$ class, 8 % each in $C_2S_1$ & $C_4S_3$ , 4 % each in $C_3S_3$ & $C_4S_1$ ,about 1% each of the samples falling in $C_3S_3$ & $C_4S_1$ classes (**Table 6.2**).

### 6.2.3 Piper diagram

Piper diagram (Piper 1944) describes the process responsible for the evolution of hydro geochemical parameter in groundwater. Based on the major Cation and major anion content in the water samples and plotting them in the trilinear diagram, hydro chemical facies could be identified. Hydro-chemical facies are very useful in investigating diagnostic chemical character of water in hydrologic systems. Different types of facies within the same group formations are due to characteristic ground water flow through the aquifer system and effect of local recharge. The types of facies are inter-linked with the geology of the area and distribution of facies with the hydro geological controls. Hydro chemical facies are delineated by plotting percentage reacting value of major ions on tri-linear diagrams know as Piper Diagram.

For identification of different water facies of groundwater, Piper diagram is widely used as it gives best graphical representation (Hill, 1940; Piper 1944) for finding out type of water. Groundwater can be grouped broadly into 5 types (**Fig: 6.8**). Ground water samples from Guntur district is mainly of Mixed Type like Na-Mg- $HCO_3$-Cl, Ca-Na- $HCO_3$-Cl and Mg-Ca-Na- $HCO_3$-Cl type and Na-K type. The dominance of a mixed-type signature in groundwater samples is typically due to the interaction of different aquifer systems, varied water-rock interactions, human activities, and hydrological processes. This complexity underscores the need for careful management and understanding of groundwater resources to ensure their sustainability and quality.

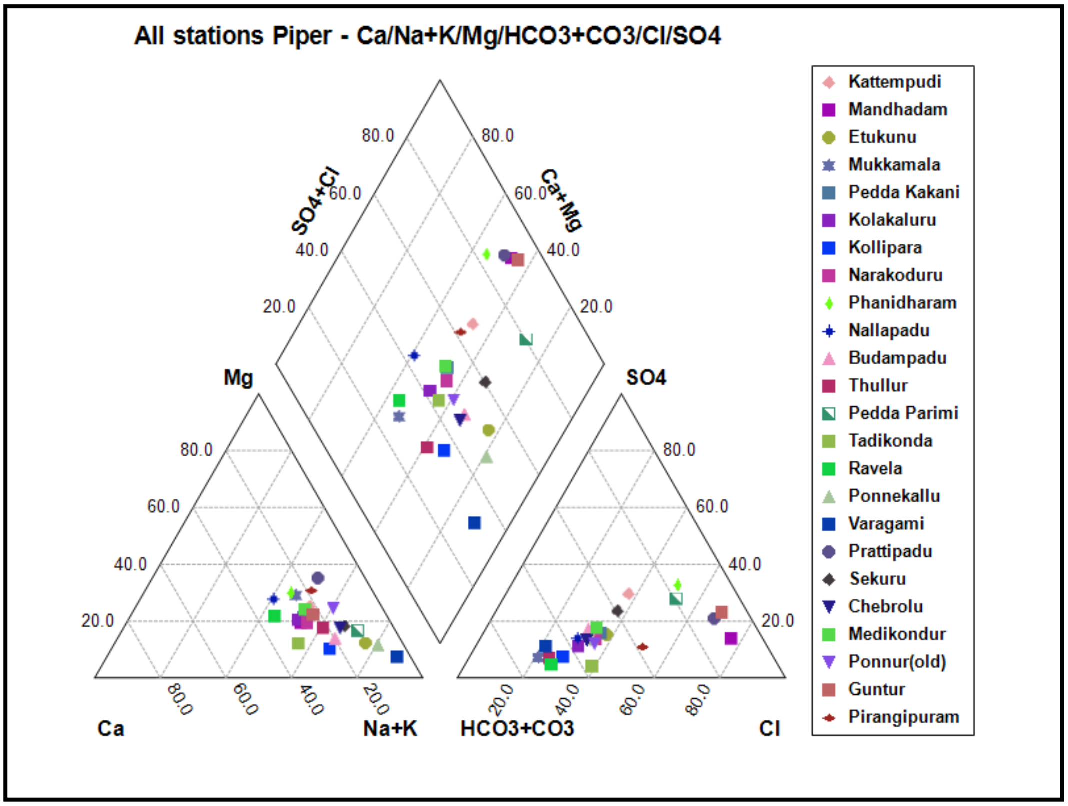



**Fig 6.8:** Piper diagram

## 7. GROUND WATER RESOURCES (2023)

In hard rocks, for practical purpose it is very difficult to compute zone wise (aquifer wise) ground water resources, because the weathered zone and fractured zone are inter-connected with fractures/joints and fractured zone gets recharged through weathered zone. Therefore, it is very difficult to demarcate the boundary between two aquifers; hence the resources are estimated considering entire area as a single aquifer system. Recent Alluvium, Older Alluvium and Coastal Alluvium are by and large important unconsolidated formations constituting major alluvial aquifers. In these areas, in addition to the Annual Replenishable Ground Water Resources available in the zone of Water Level Fluctuation (Dynamic Ground Water Resource), there exists a huge ground water reserve in the deeper part below the zone of fluctuation as well as in the deeper confined aquifers. The coastal aquifers show wide variation in water quality, both laterally and vertically, thus imposing quality constraints for groundwater development. Village wise dynamic and in-storage ground water resources are computed as per the guidelines laid down in GEC methodology. The mandal wise Dynamic Ground Water Resources of the Guntur District, Andhra Pradesh (2023) are given in **Annexure No 1.** The summarized dynamic ground water resources of the Guntur District, Andhra Pradesh given in **Table-7.1**

| Table 7.1: Details of GWRA 2023 | |
|---|---|
| **Parameters** | **Total (MCM)** |
| **Dynamic (Net GWR Availability)** | **550.78** |
| • Monsoon recharge from rainfall | 103.5 |
| • Monsoon recharge from other sources | 225.27 |
| • Non-monsoon recharge from rainfall | 43.21 |
| • Non-monsoon recharge from other sources | 207.83 |
| • Total Natural Discharge | 28.98 |
| **Gross GW Draft** | **106.52** |
| ✓ Irrigation | 79.03 |
| ✓ Domestic and Industrial use | 27.50 |
| Allocation of Ground Water Resource for Domestic Utilisation for projected year 2025 | 27.88 |
| Net GW availability for future use | 441.78 |
| **Stage of GW development (%)** | **19.34** |

**7.1 Ground Water Recharge** : The Annual Ground Water Recharge varies from 1.64 MCM (Kakumanu Mandal) to 127.32 MCM (Tenali Mandal). The Gross Annual Ground Water Recharge in the district is 579.77 MCM. The net available recharge after leaving natural discharge from monsoon period varies from 1.57 MCM (Kakumanu Mandal) to 120.95 MCM (Tenali Mandal). The net available recharge in the district is 550.78 MCM. (Fig 7.1)

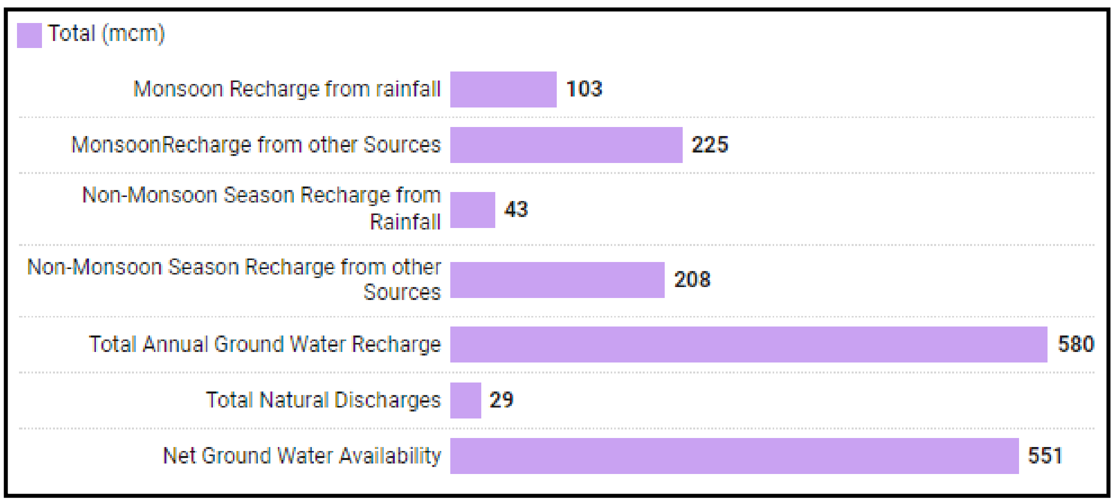
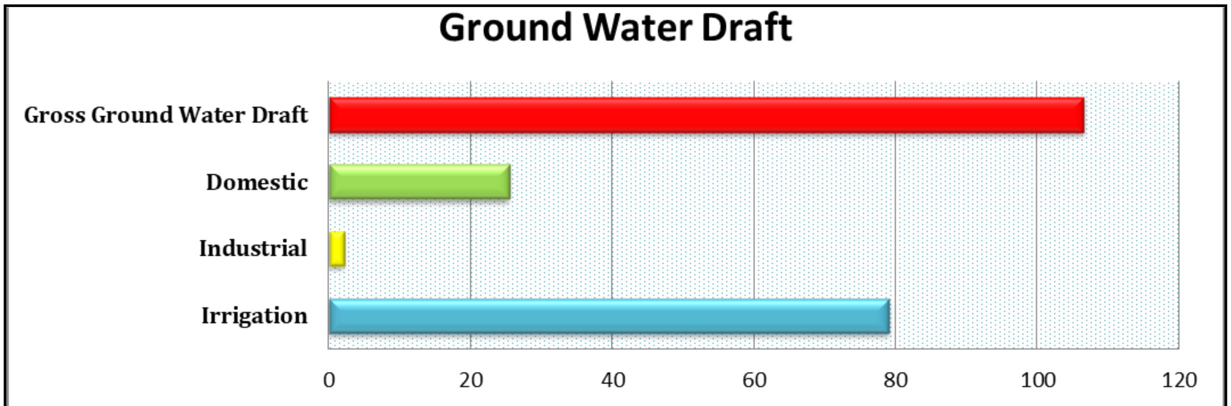



**Fig 7.1:Ground Water Recharge**

**7.2 Ground Water Draft :** The ground water draft from irrigation and Domestic /Industrial sources is presented in **Table:7.1 .** The Existing Gross Ground Water Draft for all uses varies from 0.05 MCM (Kakumanu) to 199.48 MCM (Kollipara). The Gross Ground Water Draft for All uses in the district is 106.52MCM. **(Fig 7.2 )**




| | Irrigation | Industrial | Domestic | Gross Ground Water Draft |
|---|---|---|---|---|
| MCM | 79.03 | 2.09 | 25.4 | 106.52 |

Fig 7.2: Ground Water Draft

**7.3 Stage of Ground Water Extraction :** The stage of ground water extraction in Guntur district varies from 3.5 (Kakumanu) % to 34.75% (Ponnur) and all assessment (mandals) units have been categorized as Safe and **Pedanandipadu and Vatticherukuru mandals are saline (Fig 7.3) as per Ground Water Resources Assessment – 2023.** The overall stage of groundwater development of Guntur districtis **19.34 %.**

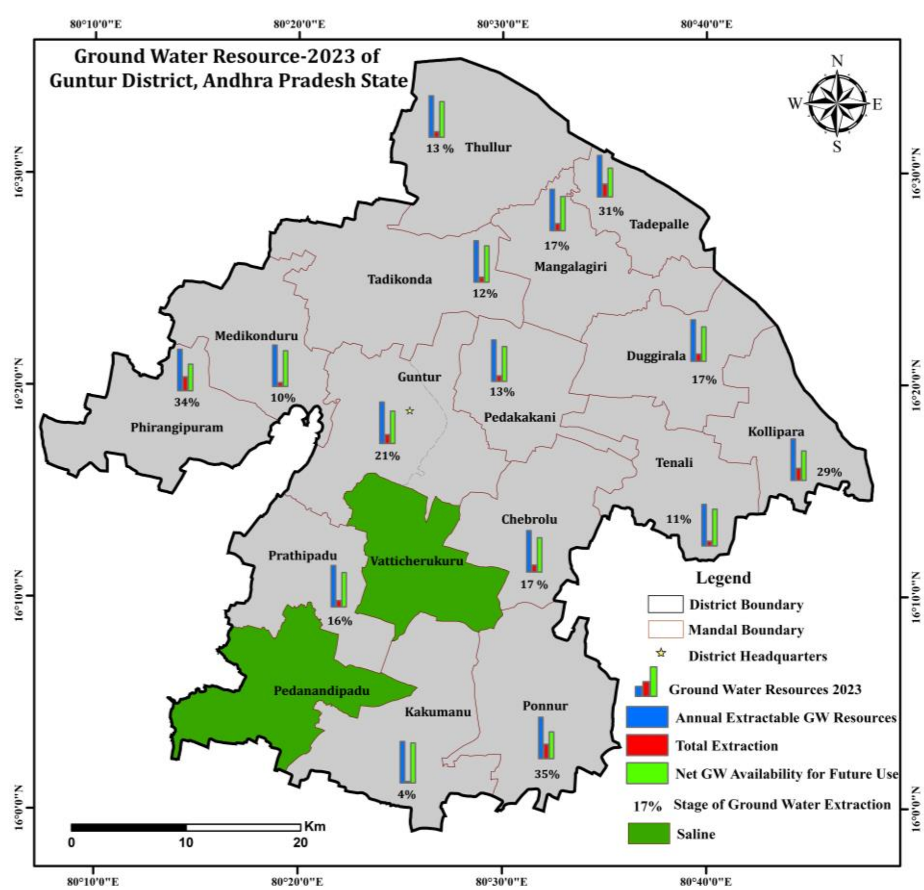



**Fig 7.3: Dynamic Ground Water resources -2023**

## 8.0 GROUND WATER RELATED ISSUES AND REASONS FOR ISSUES

The southern part of Guntur district is covered by delta system which has emerged due to the depositional cycles of the river Krishna, debouching the inland sediments into the Bay of Bengal. Since the area is just few meters above mean sea level with very low gradient and large quantum of water from the river Krishna and canal system are applied from landward side on one hand and on the other hand it is bounded by the large saline water body in the form of Bay of Bengal, naturally problems like water logging, in situ ground water salinity and saline water intrusion etc., are of great concern. During the last two decades with the advent of prawn culture some of the paddy fields have been converted into tanks for growing the prawns and salt water fish.

The major considerable ground water issues in the Krishna delta of Guntur districts are:

**8.1 Water Logging:** Water logging is a common feature in irrigation commands of surface water projects. It is also observed that shallow water level <2m is observed in an area of about ~105 sq.km (4%) during pre-monsoon period, whereas during post-monsoon period it is extended to ~900 sq.km (37%). Irrigation by surface water, flat topography, poor drainage and nature of soils are responsible for the water logging conditions in the area.

**8.2 Ground Water Salinity:** In deltaic part, ground water in shallow aquifers is fresh except in the area near the coast and as isolated patches in inland, whereas in the deeper aquifers ground water is invariably saline. The origin of the salinity in any coastal area can be due to the following three reasons viz., palaeo salinity, due to leakage from the bottom aquifer, direct recharge of saline water from back waters and due to sea water intrusion caused by human activity.

**8.3 Impact of Aqua Culture on Ground Water Reservoir in respect of salinity and contamination due to Aqua feed and Medicinal chemicals:**

In Guntur district, aqua culture farming has been taken up and this includes prawn culture and pisciculture. In aquaculture, lot of organic feed as well as chemicals are being applied, due to this the drains carry high level saline water, organic content and nutrients, this causing the pollution of shallow aquifers and disturbs the eco system. Further, storing of water in the tanks at higher than specified levels is leading to water logging in the neighbouring areas.

### 8.4 Inferior ground water Quality

EC: High Electrical Conductance (EC) (>3000 µ Siemens/cm) is noticed in 21% of the samples during pre-monsoon season (Thullur, Prathipadu, Guntur and Tadikonda mandals),which is unsuitable for irrigation.

- Nitrate: High nitrate contamination (>45 mg/l) due to anthropogenic activities is also observed in 50% of the samples during pre-monsoon season (Tadikonda, Prathipadu, Thullur, Guntur, Chebrolu, Phirangipuram, Kollipara and Ponnur mandals. The higher concentration is due to unscientific sewage disposal of treated and untreated effluents in urban and rural areas. Use of NPK fertilizers and nitrogen fixation by leguminous crops.

### 8.5 Hard Areas with Ground Water Sustainability Issues

Exploratory well data shows that around 37% of the area has a low yield (<1 lps) and exhibits low ground water potential in hard rock areas. This is because of the absence of primary porosity, minimal development of secondary porosity, shallow weathering depth, and low rainfall. Over time, many bore wells have experienced reduced yields, and some have dried up due to excessive groundwater extraction. These trends are linked to the lack of primary porosity, limited secondary porosity development, low precipitation, and desaturation of the weathered zone.

### 8.6 Water Marketing and other Issues

Water marketing is prevalent across most mandals, with individuals purchasing water cans or bottled water for drinking purposes. There's been a noticeable shift in land use, transitioning from agricultural land to residential purposes and paddy cultivation during the rabi season relies entirely on groundwater, resulting in substantial groundwater extraction during non-monsoon periods.

# 9.0 MANAGEMENT STRATEGIES

The uneven distribution of groundwater availability and its utilization indicates that a single management strategy cannot be adopted and requires integrated hydrogeological aspects along with socio-economic conditions to develop appropriate management strategy. The study suggests notable measures for sustainable groundwater management.

## 9.1 Management plan

The management plan comprises of two components namely supply-side management and demand side management. The supply side management is proposed, based on surplus surface water availability and the unsaturated thickness of aquifer whereas the demand side management is proposed by use of micro irrigation techniques.

### 9.1.1 Supply side management

The supply side management of ground water resources includes artificial recharge of available surplus runoff in check dams and percolation tanks. More over repair renovation & restoration of existing tanks will also help in ground water recharge.

The area suitable for artificial recharge has been demarcated based on the analysis of average post-monsoon depth to water level data of the observation wells for the period 2013-2022 and specific yield of the formation in Guntur district. The number of new structures recommended based on the unsaturated volume and already existing artificial recharge structures.

Government of Andhra Pradesh had already created a total 39 recharge structure (36 Check damsand 3 percolations tanks, 3846 farm ponds and 9212 other structures: source: (https://emms.ap.gov.in/nregs_ap/Reports/) & APWRIMS though MGNREGSand IWMP scheme **(Fig 6.1)**. Mandal wise Water Conservation Structures in the study Areais given below. Table 9.1

Table 9.1: Mandal wise Water Consrvation Structures in the study Area

Farm Ponds  Check Dams (E)  Percolation Tanks  Other Structures  Total

| | Farm Ponds | Check Dams (E) | Percolation Tanks | Other Structures | Total |
|---|---|---|---|---|---|
| CHEBROLE | 471 | 1 | 0 | 2,927 | 3,399 |
| DUGGIRALA | 94 | 0 | 0 | 2,574 | 2,668 |
| GUNTUR MANDAL | 129 | 2 | 0 | 876 | 1,007 |
| KAKUMANU | 211 | 2 | 1 | 4,801 | 5,015 |
| KOLLIPARA | 160 | 0 | 0 | 2,086 | 2,246 |
| MANGALAGIRI | 61 | 2 | 0 | 679 | 742 |
| MEDIKONDURU | 324 | 2 | 0 | 3,261 | 3,587 |
| PEDAKAKANI | 138 | 3 | 0 | 1,773 | 1,914 |
| PEDANANDIPADU | 403 | 3 | 0 | 2,324 | 2,730 |
| PHIRANGIPURAM | 478 | 0 | 2 | 4,299 | 4,779 |
| PONNUR | 180 | 0 | 0 | 5,599 | 5,779 |
| PRATHIPADU | 254 | 12 | 0 | 874 | 1,140 |
| TADIKONDA | 367 | 2 | 0 | 2,597 | 2,966 |
| TENALI | 341 | 1 | 0 | 2,420 | 2,762 |
| THADEPALLE | 12 | 0 | 0 | 278 | 290 |
| THULLUR | 84 | 5 | 0 | 305 | 394 |
| VATTICHERUKURU | 139 | 1 | 0 | 1,539 | 1,679 |
| TOTAL | 3,846 | 36 | 3 | 39,212 | 43,097 |

Considering the available run-off and recharge potential, there is a scope for construction of artificial recharge structures, which can be taken up as per requirement in the district. The availability of sub-surface storage volume of aquifers in entire district is computed as the product of area, thickness of aquifer zone between 5 m. bgl and the average post-monsoon water level. The recharge potential/sub surface space of the aquifers is calculated by multiplying the sub surface storage volume with 2-3% specific yield. The source water availability is estimated from the rain fall and run off correlations. The runoff was calculated by taking into account of normal monsoon rainfall of the mandal and corresponding runoff yield from Strangers Table for average catchment type. Out of the total run off available in the mandal, 20 % run off yield is considered as non-committed yield and for recommending artificial recharge structures in intermittent areas. The storage required for existing artificial recharge structures by State Govt. departments under different IWMP and MNREGS schemes is deducted to find the available surplus run off for recommending the additional feasible structures.

As the stage of ground water extraction in the district is 19 % and 15 mandals are falling in safe category and 2 mandals (Pedanandipadu and Vatticherukuru) are saline as per the GEC 2023 estimation, the artificial recharge structures are not proposed for entire district. Areas where water level is shallow are not considered for recharge, because it may lead to water logging condition which in turn would affect the yield of agricultural crops. Recharge and Runoff available in the study area is given in **Table 9.2.**

**Table 9.2:** Recharge and Runofff available in the district

| | |
|---|---|
| Total geographical area of study area (Sq.km) | **2413** |
| Area feasible for recharge (Sq.km) | **90** |
| Run off required to recharge the unsaturated volume (MCM) considering 77% of the efficiency of the structures | **4.6** |
| Surplus runoff available for recharge (MCM) (20% of runoff) | **2** |

### 9.1.2 Artificial Recharge Structures in the District:

The area feasible for artificial recharge is 90 sq.kms. The run off required to recharge the unsaturated volume 4.6 MCM. The Surplus runoff available for recharge 2 MCM calculated as 20% of the totals run-off available in the district. The details in this regard are provided in the **Table 9.3.**

**Table 9.3:** Study Area Details

| **Guntur district covering 3 Mandals** | |
|---|---|
| Recharge worthy area (Sq. Km) | **90** |
| Runoff Village wise (MCM) | **9** |
| Uncommitted Runoff (20%) | **2** |
| Existing Check Dams | **36** |
| Existing Percolation Tanks | **03** |
| Number of CDs Feasible | **36** |
| Number of PTs feasible | **30** |

In the district a total of 39 artificial recharge structures (36 CDs and 3 PTs) are already in existence which is constructed under Integrated Watershed Management Programs (IWMP), Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS) and various schemes were considered before recommending new Check dams and Percolation Tanks. The number of artificial recharge structures is recommended based on the surplus run off availability. The total number of Check dams and Percolation Tanks are recommended by taking 5 fillings for Check dams and 2 fillings for Percolation Tanks. Accordingly, 66 number of artificial recharge structures (30 number of percolation tanks, 36 number of check dams) are recommended for 90 sq. kms spread over in 9 villages in 3 mandals in Guntur districts of the State. The estimation of source water availability stems from analysis of rainfall and runoff correlations. This calculation integrates data derived from normal monsoon rainfall and corresponding runoff yield from Strange Table for average catchment type. It's imperative to emphasize that out of the entire runoff available, only a conservative 20% is deemed suitable for the recommendation of artificial recharge structures. This pragmatic consideration is influenced by factors such as riparian rights and logistical feasibility, ensuring the practicality and sustainability of the proposed artificial recharge initiatives. **(Annexure II).** In addition, roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing). **Fig 9.1**

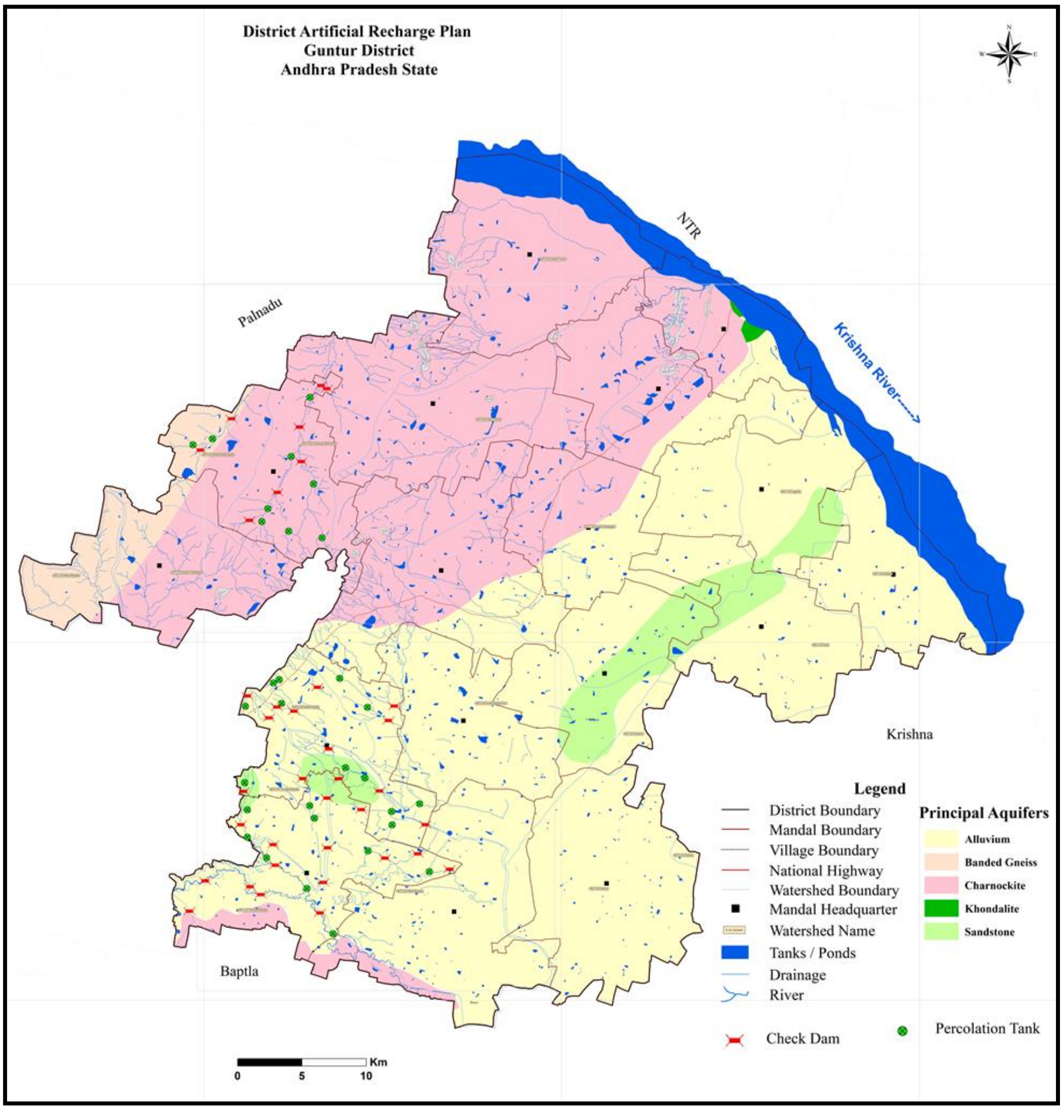



**Fig 9.1: District Recharge Plan**

### 9.1.3 Demand side management

- The yield of bore well is < 1 lps identified in ~37% of the area of hard rock areas of the district. As sustainability of bore well is low, the sprinkler and drip irrigation system with suitable cropping pattern is recommended in where recharge potential is more than the total run off and surplus run off availability. Particularly in the hard rock areas of the district as a measure for groundwater conservation, protection and management.

- The post-monsoon decadal average depth to ground water level shows that <2 m b.g.l Water Level is in 37% of the area which mainly covers deltaic area of the district. To prevent water logging condition in future, it is recommended to follow the anti-water logging measures for conjunctive use of surface and ground water in the coastal mandals of the district.

- In Guntur District there are 44 Minor Irrigation Tanks having a registered ayacut 1545 Hectares and actual irrigated area is 527 Hectares. Considering low sustainability of bore wells in the hard rock areas of the district and limited no. of existing MI tanks, it is recommended for de siltation and cascading of existing MI tanks and filling up MI tanks with surface water schemes. This can result in increase in Ayacut/Irrigation area, sustain the bore well yields and decrease the ground water irrigation.

- A participatory groundwater management (PGWM) approach in sharing of groundwater and monitoring resources on a constant basis along with effective implementation of the existing ‘Water, Land and Trees Act’ of 2002 (WALTA-2002) are the other measures suggested. Subsidy/incentives on cost involved in sharing of groundwater may be given to the concerned farmers.
- In urban and rural area, the sewerage line should be constructed to arrest leaching of nitrate.

**9.1.4. Demand side measures**: In order to manage the available resources more effectively, following measures are recommended.

**9.1.4.1 Proposed Work**

- **Micro-irrigation:** The area faces low sustainability in terms of ground water yield. The recharge potential is more than the total run off and surplus run off availability. Particularly in hard rock formations in northern parts, the massive Charnockite making the ground water yield unpredictable and posing serious challenges to agriculture sustainability. Considering these, the sprinkler and drip irrigation system with suitable cropping pattern wherever feasible may be practiced as a measure for ground water conservation, protection and management. An about 5500 ha of land can be brought under micro-irrigation (@50 ha/village in 110 villages, considering 1 unit/ha @0.6 lakh/ha). With adoption of micro irrigation practices, the total water requirement for irrigation can be reduced upto 60% to 70%. With this ~9.9MCM of ground water can be conserved over the traditional irrigation practices, considering @ 0.006 MCM/ha for ID crops with traditional irrigation methods).

- Change in cropping pattern from water intensive paddy to irrigated dry crops like pulses and oil seeds are recommended, particularly in water stress areas. If necessary some regulatory rules may be framed and implemented.
- To avoid the interference of cone of depression between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism.
- Power supply should be regulated by giving power in 4 hour spells two times a day in the morning and evening by the concerned department so that pumping of the bore well is carried out in phased manner to allow recuperations of the aquifer and increase sustainability of the bore wells.
- As a mandatory measure, every ground water user should recharge rainwater through artificial recharge structures in proportionate to the extraction.

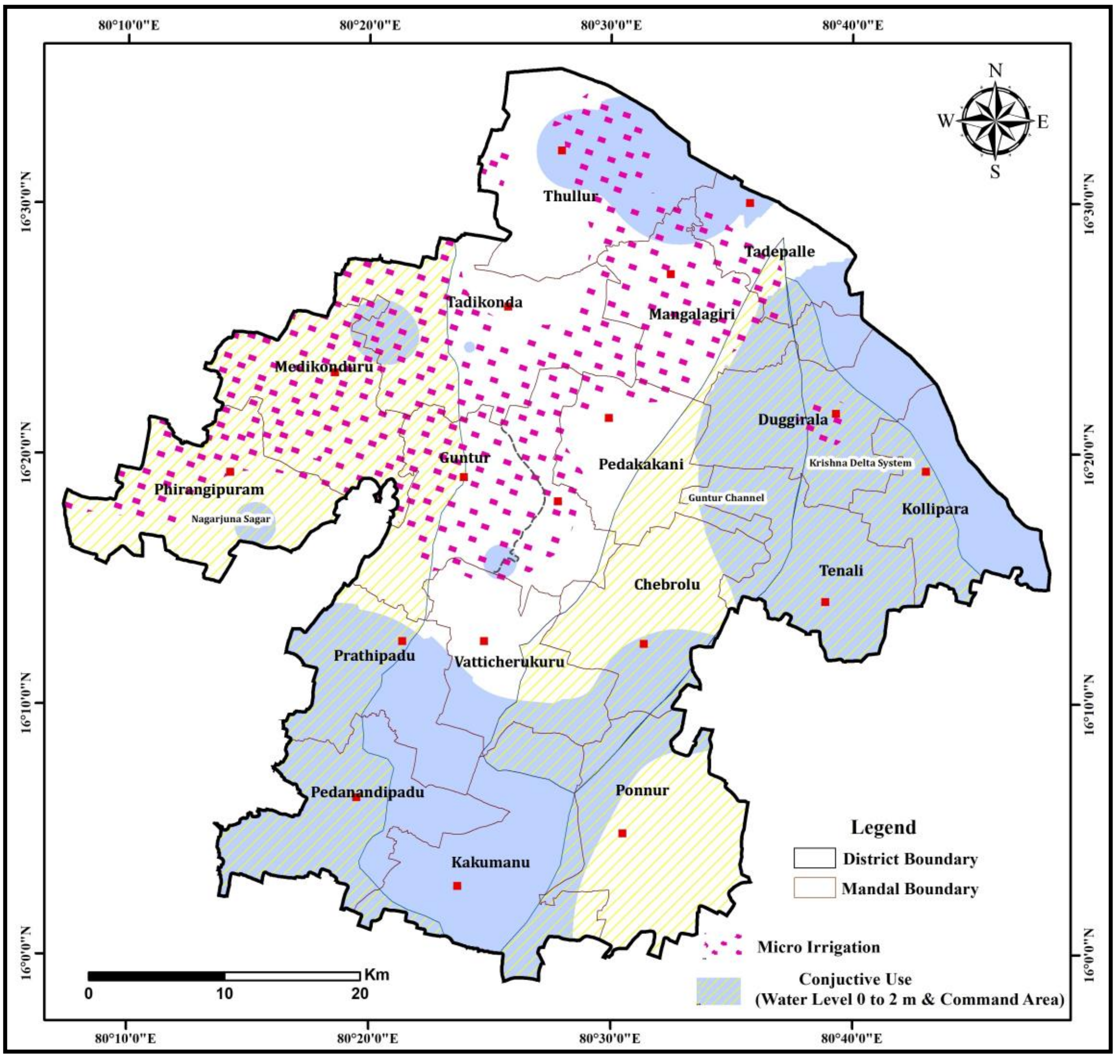



**Fig 9.2**: District Recharge Plan

#### 9.1.4.2 Other measures

- A participatory ground water management (PGWM) approach in sharing of ground water and monitoring resources on a constant basis along with effective implementation of the existing ‘Water, Land and Trees Act’ of 2002 (WALTA-2002) are the other measures suggested. Subsidy/incentives on cost involved in sharing of ground water may be given to the concerned farmers.
- The open stone quarries / abandoned quarries can be filled with soil and covered with vegetation; it will prevent further erosion and weathering of salts and minerals and also escalation of the salinity levels in aquifers.
- In urban and rural areas the sewerage line should be constructed to arrest leaching of Nitrate.
- Restrict use of extensive chemical fertilizers as it will eventually degrade soil and leach to join ground water which already has high salinity.
- Recommend to cultivate high EC tolerant crops like cotton, safflower, sesame etc.
- As a mandatory measure, every ground water user should recharge rainwater through artificial recharge structures in proportionate to the extraction.
- Capacity building in power supply regulation (4 hour each in morning and evening) will increase the sustainability of wells.
- As mandatory measures power connection may be given to only those farmers who are adopting micro irrigation for all new bore well to be constructed.
- Change in cropping pattern from water intensive paddy to other irrigated dry and drought resistant crops that have a short growing season is recommended.
- To avoid the interference of cone of depression between two productive wells, intermittent pumping of borewells is recommended through regulatory mechanism.
- Complete ban on paddy cultivation during rabi season under ground water irrigation in non-command areas and semi-critical mandals.
- Roof top rainwater harvesting structures should be made mandatory to all Government/industrial buildings (new and existing). As a mandatory measure, every groundwater user should recharge rainwater through artificial recharge structures in proportionate to the extraction.

#### 9.1.4.3 State Government Projects

**Repair, Renovation and Restoration of existing tanks (Competed):Neeru-Chettu Mission**

Neeru Chettu is interdepartmental convergence activity among water conserving departments viz., Irrigation, Rural Development, Ground water, Forest, APSAC and water utilizing departments viz., Agriculture, Horticulture, Fisheries, Animal Husbandry, RWS, Municipal Administration and Urban Development.

**Important activities by the Neeru-Chettu Mission**

a) Inventory of existing water harvesting structures and repairs needed.

b) Construct new water harvesting structures using remote sensing technology.

c) Construction of targeted recharge structures (roof water harvesting, artificial recharge of aquifers and defunct wells).

d) Restoration of major, medium and minor irrigation systems (repair of breach to structures and supply channels, desilting of tanks).

e) Participatory Hydrological Monitoring (surface and ground water) for community water audit and crop water budgeting.

### 9.2 Expected Results and Outcome:

With the above interventions, the likely benefit would be the net saving of 11.9 MCM of ground water either through water conservation measures like adoption of drip and sprinkle irrigation and artificial recharge to ground water.

**Acknowledgment**

I would like to express my sincere thanks to Shri Sunil Kuma Ambast, Chairman, CGWB, Shri G. Krishnamurthy, Regional Director, CGWB, for encouragement, guidance and support. I am grateful to all officers and officials of CGWB, Hyderabad. Andhra Pradesh Water Department, Ground Water and Water Audit Department, Rural Development department, Rural Water Supply department, Directorate of Economics and Statistics, Minor Irrigation, Govt of Andhra Pradesh for providing the data for the preparation of report.

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## Annexure I : Ground Water Resources -2023 AP

| District | Assessment Unit Name | Total Area of Assessment Unit (Ha) | Recharge Worthy Area(Ha) | Annual Extractable Ground Water Resource (Ham) | Ground Water Extraction for Irrigation Use (Ham) | Ground Water Extraction for Industrial Use (Ham) | Ground Water Extraction for Domestic Use (Ham) | Total Extraction (Ham) | Net Ground Water Availability for future use (Ham) | Stage of Ground Water Extraction (%) | Categorization (Over-Exploited/Critical/Semi-Critical/Safe/Saline) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Guntur | CHEBROLE | 15131 | 15131 | 4034 | 391 | 61 | 230 | 683 | 3342 | 17 | safe |
| Guntur | DUGGIRALA | 13403 | 13403 | 8329 | 1174 | 11 | 248 | 1434 | 6886 | 17 | safe |
| Guntur | GUNTUR MANDAL | 18463 | 18315 | 1938 | 50 | 57 | 307 | 413 | 1514 | 21 | safe |
| Guntur | KAKUMANU | 17853 | 17853 | 157 | 0 | 0 | 6 | 6 | 151 | 4 | safe |
| Guntur | KOLLIPARA | 11999 | 11999 | 6893 | 1769 | 0 | 226 | 1995 | 4889 | 29 | safe |
| Guntur | MANGALAGIRI | 13365 | 13365 | 7649 | 981 | 23 | 287 | 1290 | 6321 | 17 | safe |
| Guntur | MEDIKONDURU | 13289 | 12489 | 826 | 19 | 4 | 56 | 79 | 712 | 10 | safe |
| Guntur | PEDAKAKANI | 10949 | 10949 | 1631 | 68 | 0 | 152 | 220 | 1374 | 13 | safe |
| Guntur | PEDANANDIPADU | 14098 | 14098 | 0 | 0 | 0 | 0 | 0 | 0 | | salinity |
| Guntur | PHIRANGIPURAM | 14346 | 13946 | 915 | 218 | 0 | 92 | 310 | 586 | 34 | safe |
| Guntur | PONNUR | 18815 | 18815 | 4177 | 1225 | 0 | 226 | 1451 | 2709 | 35 | safe |
| Guntur | PRATHIPADU | 12289 | 12289 | 513 | 33 | 5 | 43 | 81 | 427 | 16 | safe |
| Guntur | TADIKONDA | 19416 | 19216 | 1231 | 88 | 0 | 59 | 147 | 1082 | 12 | safe |
| Guntur | TENALI | 13181 | 13181 | 12095 | 965 | 28 | 350 | 1342 | 10716 | 11 | safe |
| Guntur | THADEPALLE | 7990 | 6667 | 3350 | 890 | 18 | 117 | 1025 | 2318 | 31 | safe |
| Guntur | THULLUR | 19066 | 18966 | 1340 | 33 | 2 | 142 | 176 | 1150 | 13 | safe |
| Guntur | VATTICHERUKURU | 11649 | 11649 | 0 | 0 | 0 | 0 | 0 | 0 | | salinity |

## Annexure II : Proposed Check Dam & Percolation Tank List

| Sl.No. | District | SiteName | Type of Structure | Lat | Long |
|---|---|---|---|---|---|
| 1 | Pedanandipadu | Pusulur | Check Dam | 16.1023 | 80.3995 |
| 2 | Pedanandipadu | Kopparru | Check Dam | 16.1226 | 80.2759 |
| 3 | Pedanandipadu | Gorinjavoluguntapalem | Check Dam | 16.1547 | 80.344 |
| 4 | Pedanandipadu | Katrapadu | Check Dam | 16.061 | 80.3312 |
| 5 | Pedanandipadu | Rajupalem | Check Dam | 16.0793 | 80.2823 |
| 6 | Pedanandipadu | Annaparru | Check Dam | 16.0943 | 80.3 |
| 7 | Pedanandipadu | Pusulur | Check Dam | 16.0993 | 80.3766 |
| 8 | Pedanandipadu | Pusulur | Check Dam | 16.0915 | 80.4217 |
| 9 | Pedanandipadu | Uppalapadu | Check Dam | 16.0622 | 80.24 |
| 10 | Pedanandipadu | Ravipadu | Check Dam | 16.1331 | 80.36 |
| 11 | Pedanandipadu | Uppalapadu | Check Dam | 16.0834 | 80.251 |
| 12 | Pedanandipadu | Annaparru | Check Dam | 16.1087 | 80.2985 |
| 13 | Pedanandipadu | Gorijavoluguntapalem | Check Dam | 16.1412 | 80.3361 |
| 14 | Pedanandipadu | Varagani | Check Dam | 16.1065 | 80.3364 |
| 15 | Pedanandipadu | Varagani | Check Dam | 16.0823 | 80.3335 |
| 16 | Pedanandipadu | Palaparru | Check Dam | 16.0738 | 80.2898 |
| 17 | Prathipadu | Prathipadu | Check Dam | 16.1755 | 80.3373 |
| 18 | Prathipadu | Mallayapalem | Check Dam | 16.1462 | 80.3727 |
| 19 | Prathipadu | Nadimpalem | Check Dam | 16.2019 | 80.313 |
| 20 | Prathipadu | Gottipadu | Check Dam | 16.1548 | 80.3192 |
| 21 | Prathipadu | Vangipuram | Check Dam | 16.1226 | 80.4048 |
| 22 | Prathipadu | Kondepadu | Check Dam | 16.2055 | 80.3831 |
| 23 | Prathipadu | Kondepadu | Check Dam | 16.1954 | 80.379 |
| 24 | Prathipadu | nADIMPALEM2 | Check Dam | 16.2048 | 80.3011 |
| 25 | Prathipadu | nADIMPALEM3 | Check Dam | 16.2125 | 80.2805 |
| 26 | Prathipadu | nADIMPALEM4 | Check Dam | 16.1972 | 80.2955 |
| 27 | Prathipadu | Ganikapudi | Check Dam | 16.1459 | 80.2778 |
| 28 | Prathipadu | Enamadala | Check Dam | 16.2186 | 80.3294 |

| Sl.No. | District | SiteName | Type of Structure | Lat | Long |
|---|---|---|---|---|---|
| 29 | Medikonduru | Korrapadu | Check Dam | 16.3842 | 80.2476 |
| 30 | Medikonduru | PALADUGU | Check Dam | 16.4061 | 80.2694 |
| 31 | Medikonduru | Siripuram | Check Dam | 16.4003 | 80.3169 |
| 32 | Medikonduru | Medikonduru-2 | Check Dam | 16.3547 | 80.3014 |
| 33 | Medikonduru | Medikonduru-1 | Check Dam | 16.3352 | 80.2818 |
| 34 | Medikonduru | Velavarthipadu | Check Dam | 16.3762 | 80.3182 |
| 35 | Medikonduru | Varagani | Check Dam | 16.4271 | 80.3359 |
| 36 | Medikonduru | Varagani | Check Dam | 16.4293 | 80.3319 |
| 37 | Medikonduru | Korrapadu | Percolation Tank | 16.3879 | 80.2425 |
| 38 | Medikonduru | PALADUGU | Percolation Tank | 16.3921 | 80.2561 |
| 39 | Medikonduru | Medikonduru-2 | Percolation Tank | 16.3343 | 80.2906 |
| 40 | Medikonduru | Velavarthipadu | Percolation Tank | 16.3797 | 80.3111 |
| 41 | Medikonduru | Varagani | Percolation Tank | 16.4211 | 80.3242 |
| 42 | Medikonduru | Medikonduru | Percolation Tank | 16.3433 | 80.2948 |
| 43 | Medikonduru | Visadala | Percolation Tank | 16.3606 | 80.3267 |
| 44 | Medikonduru | Pericherla | Percolation Tank | 16.323 | 80.3327 |
| 45 | Medikonduru | Dokiparru | Percolation Tank | 16.3276 | 80.3093 |
| 46 | Prathipadu | Prathipadu | Percolation Tank | 16.1624 | 80.349 |
| 47 | Prathipadu | Nadimpalem | Percolation Tank | 16.2073 | 80.3044 |
| 48 | Prathipadu | Vangipuram | Percolation Tank | 16.1225 | 80.3816 |
| 49 | Prathipadu | Enamadala | Percolation Tank | 16.2248 | 80.345 |
| 50 | Prathipadu | nADIMPALEM | Percolation Tank | 16.2053 | 80.2791 |
| 51 | Prathipadu | nADIMPALEM3 | Percolation Tank | 16.2239 | 80.3027 |
| 52 | Prathipadu | nADIMPALEM 4 | Percolation Tank | 16.2216 | 80.2986 |
| 53 | Prathipadu | gANIKAPUDI | Percolation Tank | 16.152 | 80.2786 |
| 54 | Prathipadu | vANGIPURAM | Percolation Tank | 16.1372 | 80.4008 |
| 55 | Prathipadu | mALLAYAPALEM | Percolation Tank | 16.1552 | 80.3626 |
| 56 | Prathipadu | vANGIPURAM | Percolation Tank | 16.1318 | 80.3812 |
| 57 | Prathipadu | Enamadala | Percolation Tank | 16.2046 | 80.3644 |
| 58 | Pedanandipadu | Pusulur | Percolation Tank | 16.0898 | 80.4076 |
| 59 | Pedanandipadu | Kopparru | Percolation Tank | 16.1139 | 80.2805 |

| Sl.No. | District | SiteName | Type of Structure | Lat | Long |
|---|---|---|---|---|---|
| 60 | Pedanandipadu | vARAGAMI | Percolation Tank | 16.1272 | 80.3273 |
| 61 | Pedanandipadu | Annaparru | Percolation Tank | 16.0996 | 80.2939 |
| 62 | Pedanandipadu | Kopparru | Percolation Tank | 16.133 | 80.2805 |
| 63 | Pedanandipadu | Ravipadu | Percolation Tank | 16.1043 | 80.3648 |
| 64 | Pedanandipadu | Gorijavoluguntapalem | Percolation Tank | 16.1359 | 80.324 |
| 65 | Pedanandipadu | Pedanandipadu | Percolation Tank | 16.0781 | 80.3221 |
| 66 | Pedanandipadu | Katrapadu | Percolation Tank | 16.0465 | 80.3403 |