**केंद्रीय भूमि जल बोर्ड**

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

**Central Ground Water Board**

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

# AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

## MAHABUBABAD DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
केंद्रीय भूमिजल बोर्ड

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

# REPORT ON
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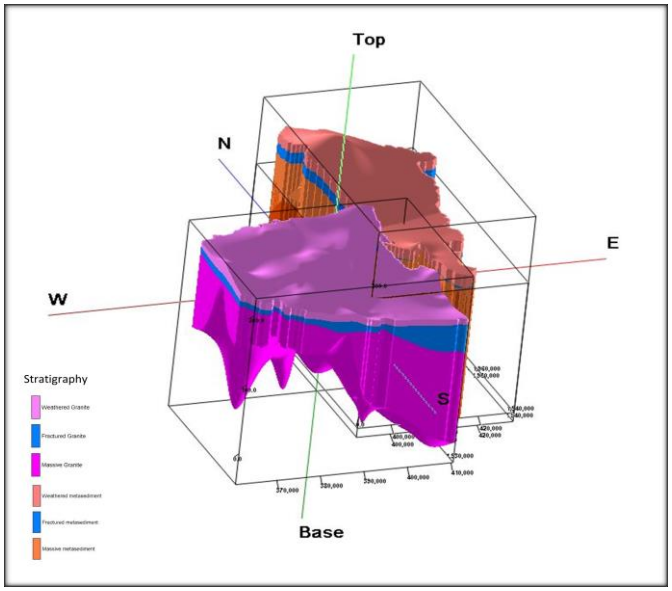


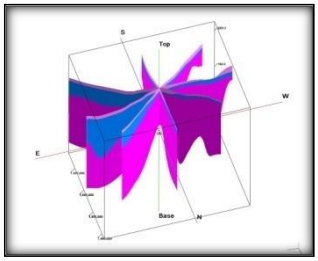

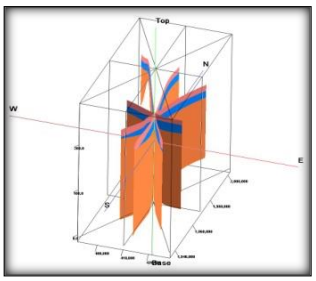

**CENTRAL GROUND WATER BOARD**
**SOUTHERN REGION**
**HYDERABAD**

**MARCH, 2023**

# REPORT ON
# AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN MAHABUBABAD DISTRICT, TELANGANA STATE

## CONTRIBUTORS' PAGE


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# AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN MAHABUBABAD DISTRICT, TELANGANA STATE

**Executive summary**

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# 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 | : | Hectare |
| Ha.m | : | Hectare 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 Mahabubabad district having geographical area of 3579 km$^2$, lies between north latitudes from 17°19'34.81"N to 17°06'38"N and east longitudes from 79°30'49"E to 80°15'33"E located in the east of Telangana State. Administratively the district is governed by 16 revenue mandals and 288 villages with a population of ~7.74 lakhs (2011 census). The density of population in the district is 216 per Sq.km.

The majority of district is underlain by oldest Archaean formation and a small part by Gondwana formation. The basement gneisses and granites constitute the major rock types and found throghout the district. A network of the basic dykes of dolerite and epidiorite traverse the granite. The Gondwanas occurring in the district belong to both the lower as well as the upper divisions. The lower Gondwanas include the Talchirs comprise boulder beds, sandstones and shales.

Mahabubabad district is characterised by undulating topography with hill ranges, valleys and plains. Pediplain is the major landform covering about 78% of the area. The other landforms observed are pediment, structural hills, structural valleys, linear ridges, dissected plateau, residual hills and flood plains along rivers /lineaments. In the district is endowed with a wide variety of soils ranging from less fertile fine mixed to the highly fertile and productive, reddish brown to dark reddish brown soils derived from different pedological environments.

Out of the total geographical area of 3579.46 km$^2$, agriculture and forest are the prominent land use aspects in Mahabubabad district and forms 58.0 % and 39.0 % of total area respectively. The net sown area is 1269.99 km$^2$ while the gross cropped area is 1550.62 km$^2$. Paddy is the major crop grown in the district (55%).

The Pakhal Lake MI project was constructed across Munneru vagu, a tributary of Krishna River which is situated near Ashoknagar Village of Kothaguda mandal in Mahabubabad District and commissioned in the year 1967. It provides ayacut of 22410 acres in villages of Kothaguda mandal of Mahabubabad District. A large Tank Bayyaram is (Medium Irrigation Project) was constructed during the Kakatiya Dynasty i.e 700 years ago at Bayyaram village & mandal of Mahabubabad district. This Project was constructed to irrigate an ayacut of 7200 Acres to benefiting Bayyaram mandal of Mahabubabad district. In the district there are of 1,662 minor irrigation tanks, 62,570 irrigation wells (47987 dug wells and 14583 bore wells), ~1614 percolation tanks and 33 check dams exist.

Water level is monitored through 56 groundwater monitoring stations of both CGWB and SGWD (CGWB:21, SGWD: 35) during pre and post-monsoon season. The pre-monsoon depth to water levels ranged between 1.68 m bgl (Thallapusalapalli, Kesamudram mandal) and 20.02 m bgl (Sadireddypalli, Kothaguda mandal). The post-monsoon depth to water levels ranges between 0.20 m bgl (Yellampet) and 5.96 m bgl (Velubelli, Kothaguda mandal). The water table elevation ranges from 135 to 358 m amsl during pre-monsoon period and 139 to 360 m amsl during post-monsoon period. The groundwater flow is mainly towards south and southeastern direction.

100% (55 no's) of the wells show rise in water level and no wells show fall in water level. The analysis of water level fluctuation data indicates that minimum water level fluctuation was observed at Ayyavaripally (2.13 m) while maximum water level fluctuation was observed at Lankapalli (17.14 m). Rise in water level range of 0 to 5 m cover majority of area with 74%, followed by 5 to 10 m covering 17% and more than 10m covered in 9% of the area in parts of Kothaguda and Gangaram mandals.

Trend analysis for the last 10 years (2011-2020) is studied from 25 hydrograph station (CGWB:14, SGWD:11). The decadal pre-monsoon water level trend analysis indicates that 15 wells show falling trend (-0.5 to 0.05m/yr) and 10 wells show rising trend 0.5-2.0m/yr).. During post-monsoon season 10 wells show falling trend (-0.50m to 0.5m) and 21 wells shows rising trends (0-0.5 m: 3, 1.0 -1.50 m:).

On the basis of occurrence and movement of ground water, rock units of the Mahabubabad district can be broadly classified into two categories: consolidated formation (Archean crystalline and metasedimentary formation) which occupies 70% of the area and semi-consolidated to unconsolidated formation (Sedimentary rock) which occupies 30% of the area.

In consolidated formations, weathered zone forms the unconfined aquifer. Thickness of weathered zone is in the range of 10-18 m in about ~59 % of area, shallow weathering (< 10 m) occurs in 41% The depth of fracturing varies from 3 m to 1152 m (deepest fracture encountered at Fathepuram). Ground water yield from fractured granite/gneiss varies from <0.007 to 2.50 lps. The transmissivity varies from 0.0824-43.3$m^2$/day and storativity varies from 0.00001 to 0.001

Semi consolidated formations, which consists of limestones, sandstones, shales and clays that makes a thick sequence of sediments. Multiple aquifer systems are found in the sandstone formations with intervening clay beds. The first aquifer is unconfined whereas the deeper aquifers are in semi-confined/ confined condition. Depth of aquifers are decided based on the depth of bottom clay layers. The thickness of Aquifer-I varies from 10-13m. The unconfined zone extend from bottom of the soil layer to top of the first clay layer. Unlike Aquifer-I, ground water occurs under confined to semi-confined condition after Aquifer-II. The deeper aquifers identified upto a depth of 300m. Ground water yield of metasediment aquifers varies from <1 to 18 lps . The transmissivity varies from ~146.99 - 570.32 $m^2$/day and storativity varies from ~1.2 to 0.0001.

Total 516 ground water samples (Pre-monsoon:239 and Post-monsoon:277) were analysed for understanding groundwater quality of the district. In 87 % and 97 % of area EC is in the range of < 3000 µ Siemens/cm during pre and post-monsoon season respectively. During pre-monsoon season, concentration of $NO_3$ ranges from 0.10-303 mg/L and found that in 16 % of samples nitrate is beyond maximum permissible limit of BIS (45 mg/l) and F concentration varies from 0.12-4.09 mg/l and found that in 32% samples it is beyond maximum permissible limits of BIS (1.5 mg/l). During post-monsoon season, concentration of $NO_3$ ranges from 0.01-372 mg/L and found that in 37% of samples it is beyond maximum permissible limit of BIS (45 mg/l). The F

concentration varies from 0.07-3.34 mg/l and found that in 27% it is beyond maximum permissible limit of BIS.

As per GEC 2022, net dynamic replenishable ground water availability is 564.84 MCM, gross ground water draft is 286.98 MCM, provision for drinking and industrial use for the year 2025 is 17.18 MCM and net available balance for future irrigation use is 276.80 MCM. The stage of ground water extraction is **50.80 %**. Out of 16 mandals 15 mandals are categorized as safe and 1 mandal is –semi-critical.

Major issues identified are low ground water potential (< 1 lps) in parts of area particularly in consolidated granitic formation, high fluoride concentration (>1.5 mg/L) occur in 32 % and 27 % of the samples during pre and post-monsoon season, high EC concentration (> 3000 micro-seimens/cm) in 1 % and 3% of the area during pre-monsoon and post-monsoon seasons respectively, High nitrate (> 45 mg/L) occur in 16% and 37% of the samples during pre-monsoon and post-monsoon season respectively.

The overall groundwater scenario and regime of the district is good except a minor quality issues and few areas of low groundwater potentiality. However, considering the dependency on ground water and further to maintain the sustainability, few supply side and demand side measures have been recommended. In the granitic area, the artificial recharge structures recommended to improve the overall sustainability and recharge the Aquifer-I which is mainly of weathering part.

The management strategies mainly include supply side management. The supply side measure includes ongoing work under Mission Kakatiya where de-silting of existing minor tanks (1069 no.) was taken under state Govt. sponsored Mission Kakatiya (Phase-1 to 4) to remove silt and this has created additional surface storage and enhance groundwater recharge.

Under Mission Bhagiratha, there is a plan to import ~32.56 MCM of water for drinking purposes which will save the present ~19.53 MCM of water for drinking and domestic purposes and with this additional ~3255 ha of land can be brought under ID (Irrigated Dry) crops.

As the stage of ground water extraction in the district is 50.80 % and 15 out of 16 mandals are falling in safe category as per the GEC 2022 estimation, the artificial recharge structures are proposed in parts of district. To control further increase in stage of ground water extraction, artificial recharge structures are proposed in parts of 12 safe mandals (i.e., Chinagudur, Dornakal, Garla, Gudur, Kesamudram, Kuravi, Mahabubabad, Maripeda, Narsimlupet, Nellikuduru, Peddavangara, and Thorrur mandals) and 1 semi-critical mandal (i.e, Dantalpalli), which includes construction of 63 artificial recharge structures (61 CD's and 2 PT's) with a total cost of **9.55 cores** are proposed as supply side measures. This intervention leads to recharge **2.34 MCM/year**.

**~**789 ha of additional land that can be brought under micro-irrigation (@1000 ha / mandal including existing area in 1 semi-critical mandal costing about **4.74 crores** (considering 1 unit/ha @0.6 lakh/ha). With this **1.14 MCM** of ground water can be conserved over the traditional irrigation practices.

The total 5760 farm ponds (size 10 x 10 x 3m) are recommended (20 in each village in 288 villages of all mandals) at Rs.25000/-each with total cost of **14.40** Crores, this can create an additional storage of **1.73 MCM**.

In addition to this roof top rainwater harvesting structures should be made mandatory to all Government buildings. Other measure includes strict implementation of WALTA and participatory groundwater management (PGWM).

With the above interventions, the likely benefit would be the net saving of 5.25 MCM of ground water, which can bring down the stage of ground water development by 0.5 % (from 50.80 % to 50.30 %).

# 1. INTRODUCTION

National Aquifer Mapping (NAQUIM) had been taken up by CGWB to create robust database of hydrogeological information at 1:50,000 scale for sustainable ground water. Aquifer mapping is a multidisciplinary and a holistic scientific approach wherein a combination of geological, geophysical, hydrological and chemical analysis is applied to characterize the quantity, quality and sustainability of groundwater in aquifers. It had been taken up by CGWB to carry out detailed hydrogeological investigation on toposheet scale of 1:50,000. The vagaries of rainfall, inherent heterogeneity and unsustainable nature of hard rock aquifers, over exploitation of aquifers, insufficient regulation mechanism has a detrimental effect on groundwater scenario of the country in last decade or so. Thus, prompting the paradigm shift from "**traditional ground water development concept**" to "**modern ground water management concept**".

Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. The proposed management plans will provide necessary inputs and recommendations for ensuring sustainable management of ground water resources of district. Finally the aquifer maps and management plans will be shared with the Administration of Mahabubabad district, Telangana State for its effective implementation.

## 1.1 Objective and Scope

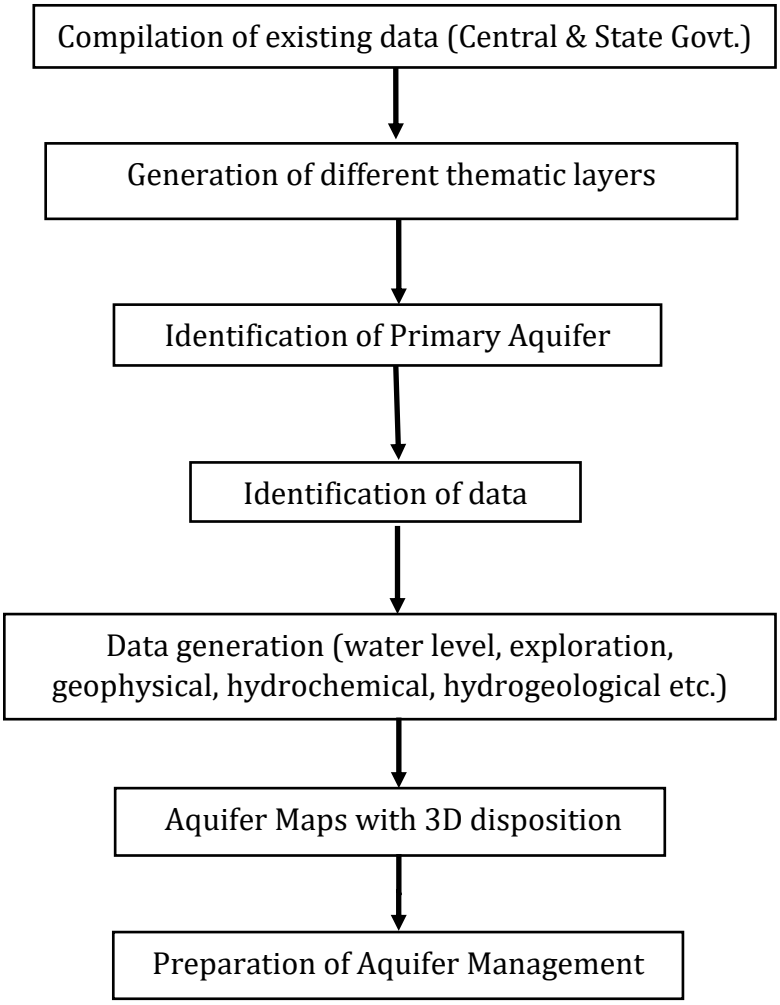
An integrated hydrogeological study was taken up to develop a reliable and comprehensive aquifer map and to suggest suitable ground water management plan on 1: 50,000 scale. The activities under NAQUIM are aimed at:

- Identifying the aquifer geometry
- Aquifer characteristics and their yield potential
- Ground water quality
- Aquifer wise assessment of ground water resources
- Preparation of aquifer maps in 3D and 2D
- Formulate ground water management plan

## 1.2 Approach and Methodology

The ongoing activities of NAQUIM include toposheet wise micro-level hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down the depths of 200-300 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:




## 1.3 Study area

The Mahabubabad district having geographical area of 3579 $km^2$ , lies between north latitudes from 17°19'34.81"N to 17°06'38"N and east longitudes from 79°30'49"E to 80°15'33"E located in the east of Telangana State. The location map of the study area is presented in **Fig.1.1**. The district shares boundaries with (06) Districts i.e., Bhadradri Kothagudem in Eastern side, North side Mulugu, North West side, Warangal, Jangaon districts, in South-West side Suryapet district and in Southeastern side Khammam district of Telangana State. The district headquarters is located at Mahabubabad Town which is located on the bank of the Munneru-Pakala River one of the tributaries of River

Krishna. Administratively, the district is governed by 16 revenue mandals and 288 revenue villages and 461 grampanchayath with a population of ~**7.74** lakhs (2011 census), out of which rural population is 9.1% and Urban is 9.9%. The density of population in the district is 216 per sq.km.

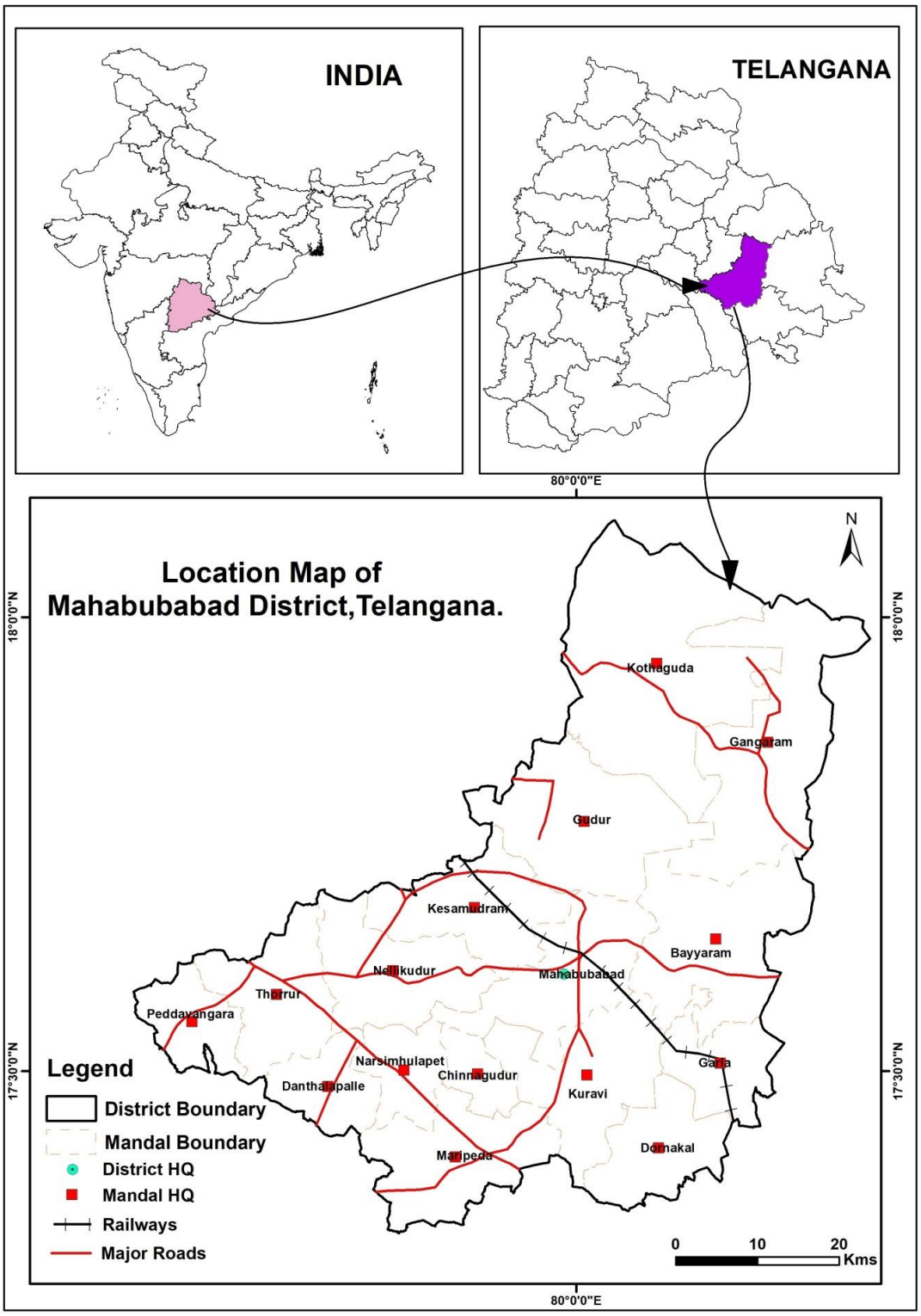



**Fig.1.1: Location map of Mahabubabad district.**

## 1.4 Climate and Rainfall

The climate of the district is characterised by hot summer and cool winters with a fairly good amount of seasonal rainfall. The normal mean daily minimum and maximum temperature is 7.2 °C and 47.9 °C. The annual normal rainfall of Mahabubabad district is 1007 mm, which ranges from 824.6 mm at Chinnagudur & Maripeda Mandals to 1212.3 mm at Bayyaram Mandal. The area receives more than 80 % of the annual rainfall by southwest monsoon between June and September and the rest during the northeast monsoon from October to December, winter & summer. As per Indian Meteorological Department during 2021, the district received average annual rainfall of 1304.5 mm (29.54 % more rainfall than normal rainfall). The isohyetal map of the study area is presented in **Fig.1.2a.**

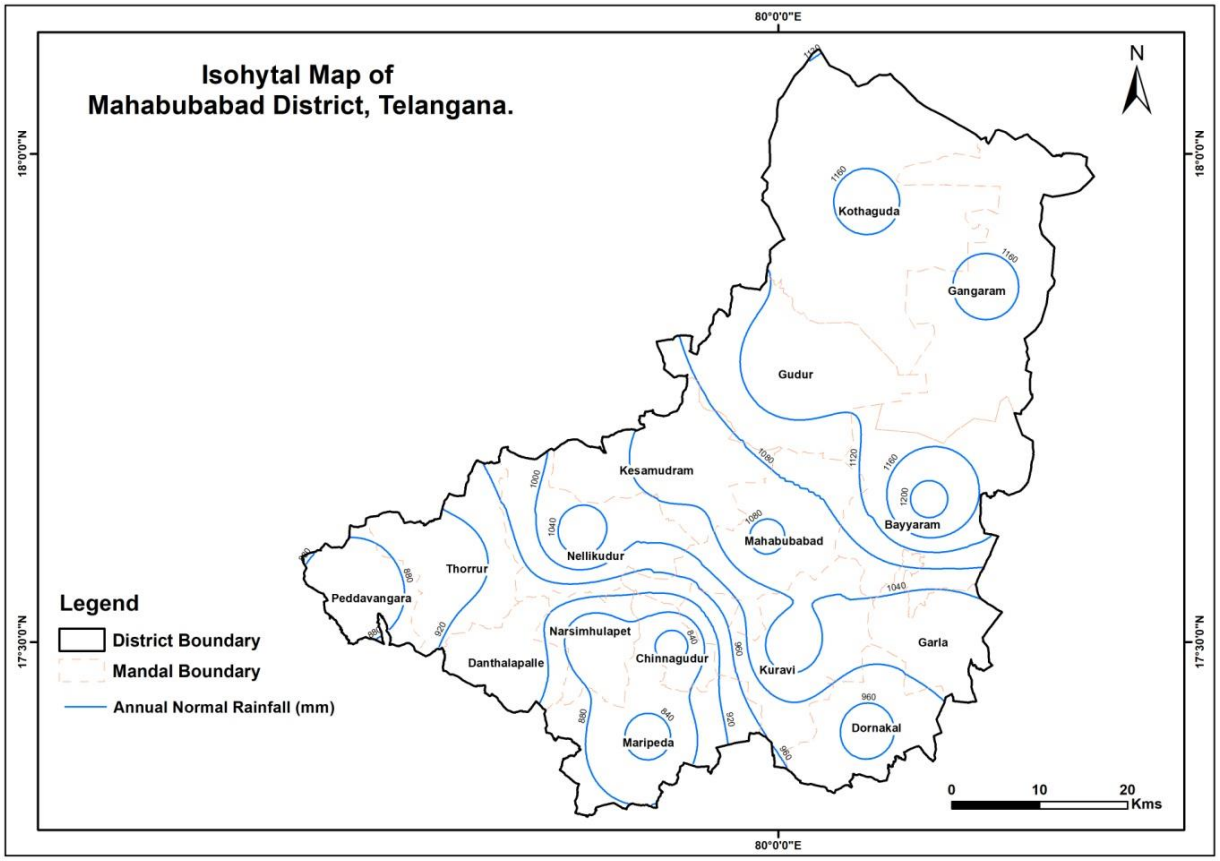



**Fig.1.2a: Isohyetal map of Mahabubabad district.**

Analysis of long term rainfall data of 18 years from 2004 to 2021 shows increasing trend in annual rainfall by 14.03 mm/year. District received excess rainfall (above normal) in 2005, 2007, 2008, 2010, 2012, 2013, 2015, 2016, 2019, 2020 and 2021, deficient rainfall (below normal) in 2004, 2006, 2009, 2011, 2014, 2017 and 2018. (**Fig.1.2b**).

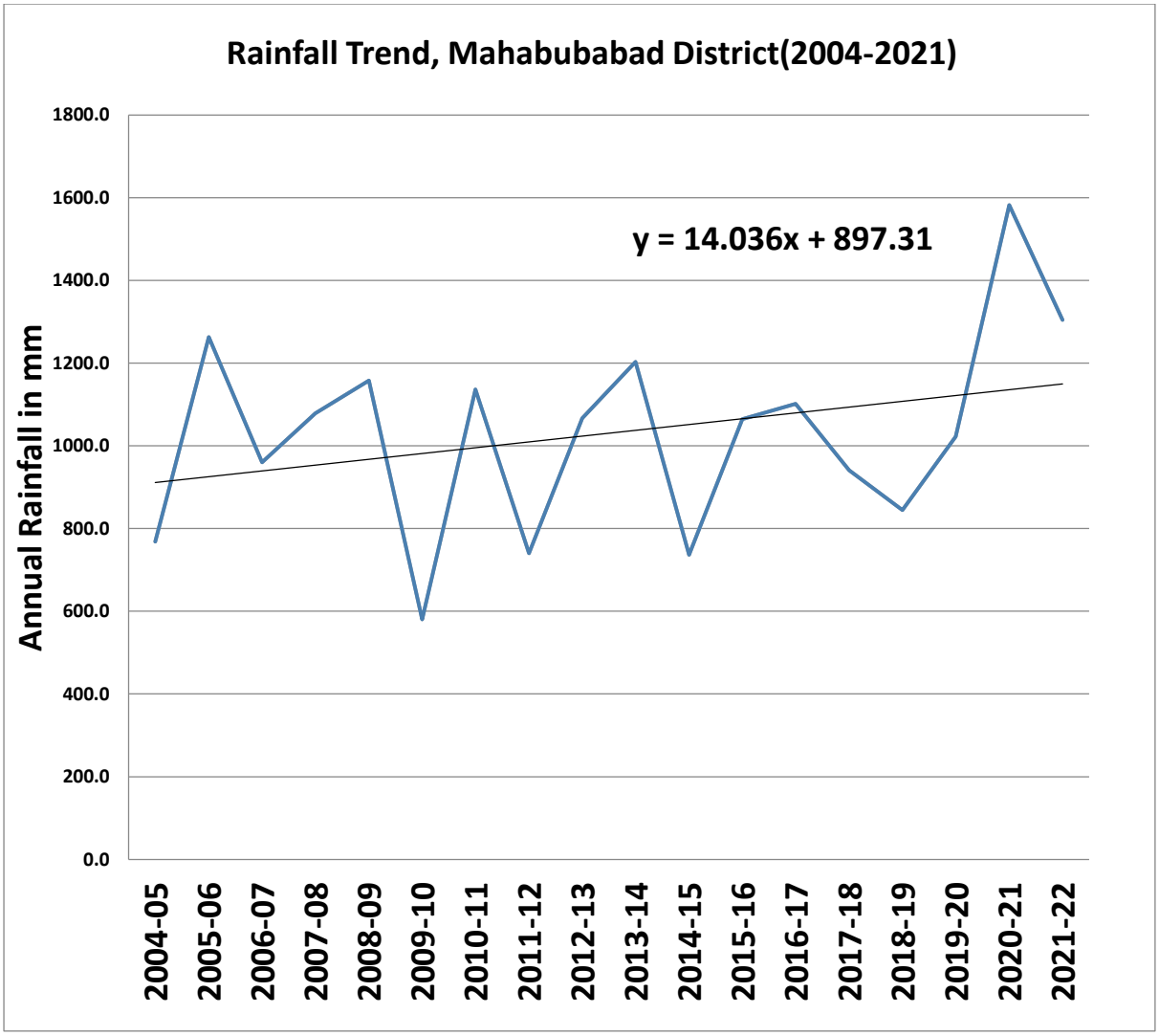



**Fig.1.2b: Annual rainfall trend (2004-2021)**

## 1.5 Geomorphological Set up

Mahabubabad district is characterised by undulating topography with hill ranges, valleys and plains. Pediplain is the major landform covering about 78% of the area. The other landforms observed are pediment, structural hills, structural valleys, linear ridges, dissected plateau, residual hiss and flood plains along rivers /lineaments. The geomorphology map of the study area is presented in **Fig.1.3**.

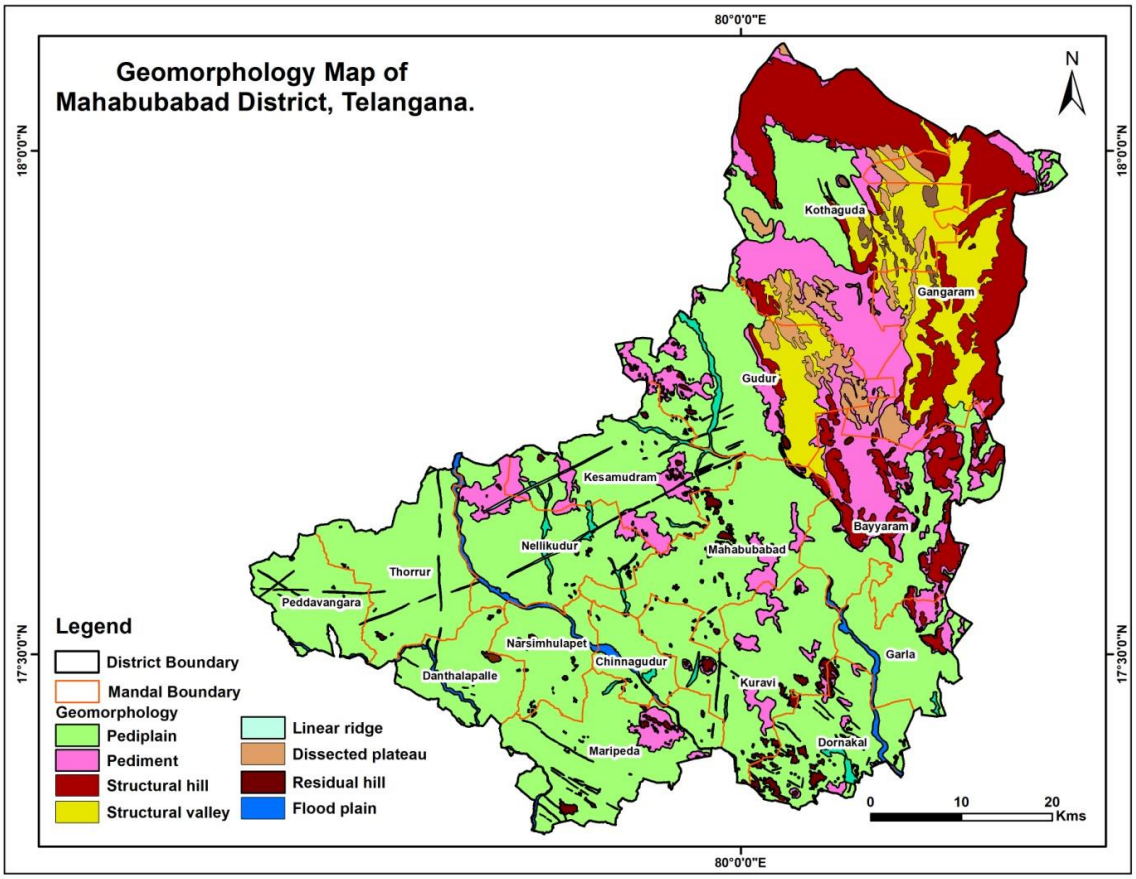



**Fig.1.3: Geomorphology map of Mahabubabad district.**

## 1.6 Drainage and Structures

The area forms a part of Krishna river basin, Muneru, Akeru and Paleru are sub basins. The south and south western part of the district is drained by these tributaries of Krishna River while minor area of district in north forms parts of Godavari basin. The river Muneru rising in the Warangal district flows Southwards passing through Gudur, Mahabubabad, Garla and Dornkal revenue mandals and the river Akeru also rises in Warangal district, flows in the Southeastern direction and joins the Muneru at Tirthala village of Khammam district. The river Paleru flows almost parallel to Akeru and Muneru, which passes through Dantalpalli and Mariped mandal of Mahabubabad district almost it separates two districts i.e. Suryapet and Mahabubabad. The drainage pattern in the area is dendritic to sub-dendritic in nature. Map depicting drainage, water bodies, and river is presented in **Fig.1.4.**

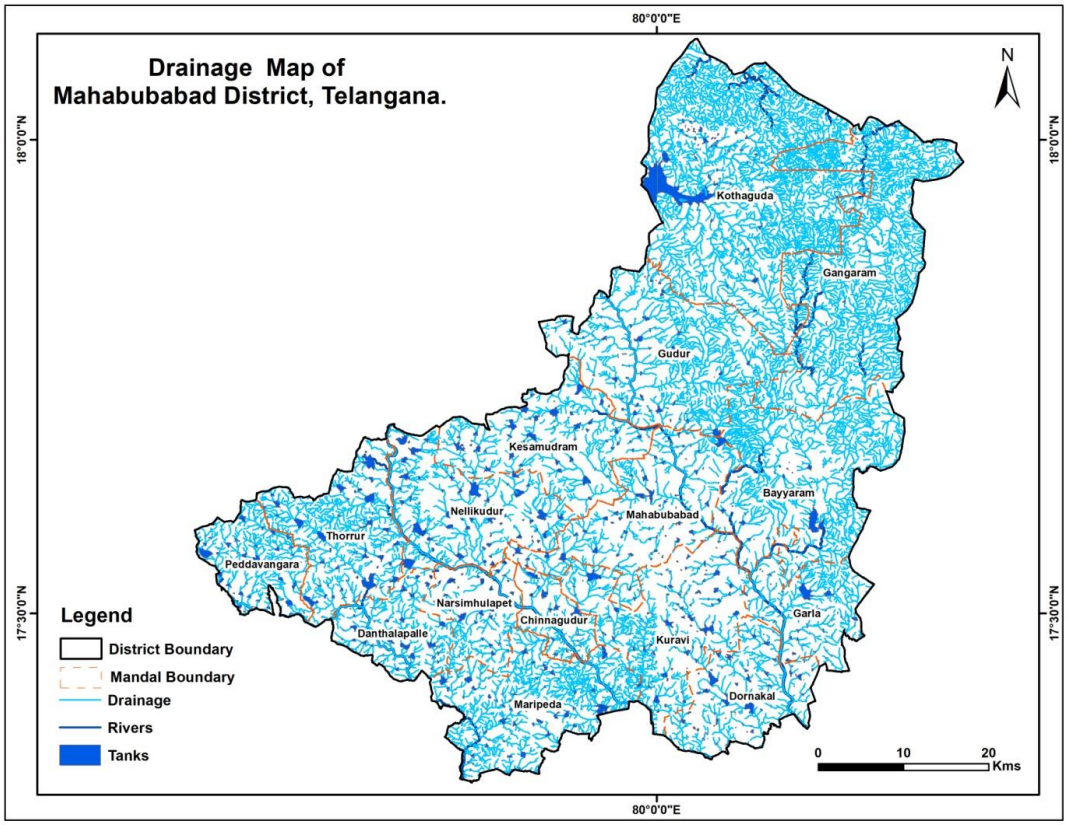



**Fig.1.4: Drainage map of Mahabubabad district**

## 1.7 Land use and cropping pattern

Out of the total geographical area of 3579.46 km$^2$, agriculture and forest are the prominent land use aspects in Mahabubabad district and forms 58.0 % and 39.0 % of total area respectively. The spatial distribution of land use is presented in **Fig. 1.5.**

The land utilization of Mahabubabad district is given in Table 1.1 and crop distribution is given in table 1.2.

**Table: 1.1 Land utilisation in Mahabubabad District 2021-22)**

| Land Utilisation | Area (in Sq.Km) | % to Geographical Area |
|---|---|---|
| Forest | 1395.27 | 38.98 % |
| Barren and Uncultivable | 135.66 | 3.79 % |
| Land put to Non-Agricultural uses | 178.61 | 4.99 % |
| Culturable Waste | 24.34 | 0.68 % |
| Permanent pasture& Other Grazing lands | 79.82 | 2.23 % |
| Land under Miscellaneous Tree, Crops, Grovers (Not included in Net Sown Area) | 60.13 | 1.68 % |
| Current Fallow Land | 260.22 | 7.27 % |
| Other Fallow Land | 175.39 | 4.90 % |
| Net Area sown | 1269.99 | 35.48 % |
| **Total Geographical Area** | **3579.43** | **100 %** |

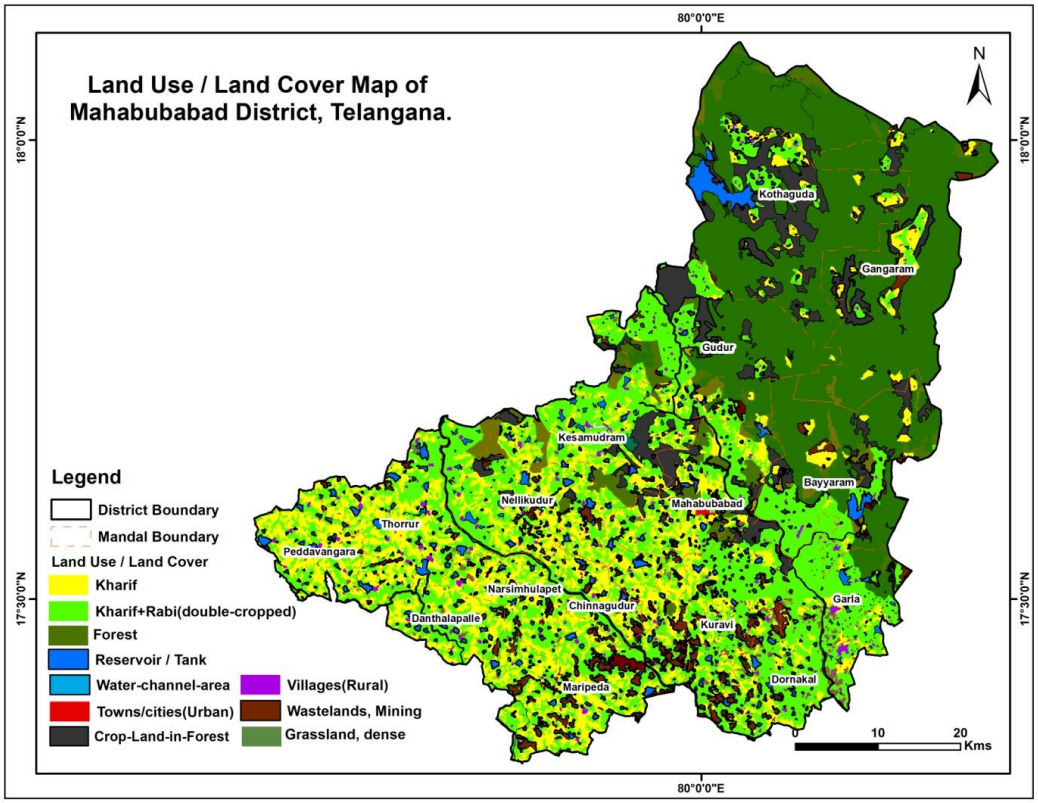



**Fig.1.5: Land use and land cover of Mahabubabad district.**

The net sown area is 1269.99 km$^2$ while the gross cropped area is 1550.62 km$^2$. There are wide varieties of crops grown in the district. Paddy is the major crop grown in the district (58%). Among various crops grown, the climate is most favourable for Maize, pulses and chillies. Other crops grown here include maize, jowar, bajra, red gram, green gram, horse gram, bengal gram, cowpea, ground nut, sesam, cantor, sunflower, chillies, sugarcane and tobacco. Wide range of horticulture crops like mango, banana, cashew, coconut, palm oil, cocoa, pepper, areca nuts are also grown.

## Cropping Pattern (2019-20 in ha.)

The forest occupies about 39% of the total geographical area, barren and uncultivable land occupies 4% of area; land put to non-agricultural use is 5%, cultivable wasteland is 1%. With respect to land utilization, out of total area, 7% of the area is falling under current fallows; 5% is under other fallows category. The net area sown is about 35% and area sown more than once is 8% which brings gross cropped area to 43%. During kharif season, out of total gross cropped area, Paddy grown in 36% of the area followed by Cotton in 32%, Maize in 9% and other crops in 23% of the area while during rabi season, Paddy is grown in 64% of the area followed by groundnut in 3% and others crops in 33% of the area (Fig. 1.6).

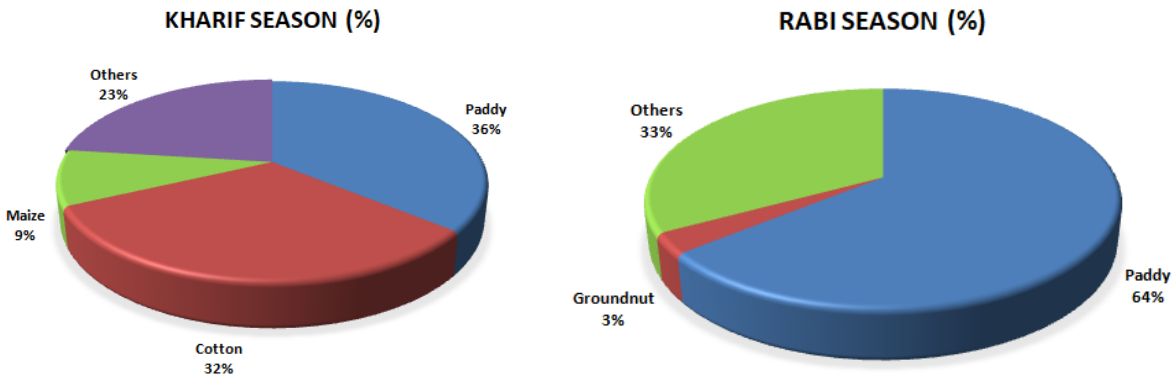



**Fig. 1.6: Pie chart showing Cropping pattern trend during Kharif & Rabi seasons**

**Table: 1.2 Crop distribution in Mahabubabad district (Vanakalam & Yasangi 2021-22)**

| Crops | Area (Sq.Km) |
|---|---|
| **Cereals and Millets** | |
| Rice | 1543.05 |
| Jowar | 12.56 |
| Maize | 349.36 |
| **Total** | **1904.97** |
| **Pulses** | |
| Red gram | 19.67 |
| Green gram | 33.95 |
| Black gram | 9.02 |
| Horse gram | 0 |
| Cow gram | 26.88 |
| Other Pulses | 0 |
| **Total** | **89.52** |
| **Total Food grains** | **1994.49** |

## 1.8 Soils

Mahabubabad district is endowed with a wide variety of soils ranging from less fertile fine mixed to the highly fertile and productive, reddish brown to dark reddish brown soils derived from different pedological environments. Clayey to gravelly clayey moderately deep dark brown soils occupy nearly 46% of the land area covered in Kothaguda, Gangaram , Bayyaram and Gudur mandals. The loamy to granually clay deep dark reddish brown soils occupies in Mahabubabad, Kurvi, Dornakal mandals and moderately calcareous block soils in Peddavangara, Thorrur, Danthalapalli, Narsimlupet and Maripeda mandals. Occurrence of iron oxides at various hydrated forms might have resulted in dark brown colour to the soils.

The red soils are suitable for cultivation of paddy, sugarcane and other wet crops and all dry crops under rain fed and irrigated dry (ID) conditions. As these soils are usually found deficient in nitrogen and phosphrous content, the application of super phosphate as basal dressing and optimum doses of nitrogeneous fertilisers at frequent intervals is recommended for higher yields of crops. The black soils being calcareous, require the application of super phosphate. These soils are particularly suitable for the cultivation of paddy and sugarcane with a provision of surface drains and also rabi dry crops under rain fed conditions (**Fig.1.7**).

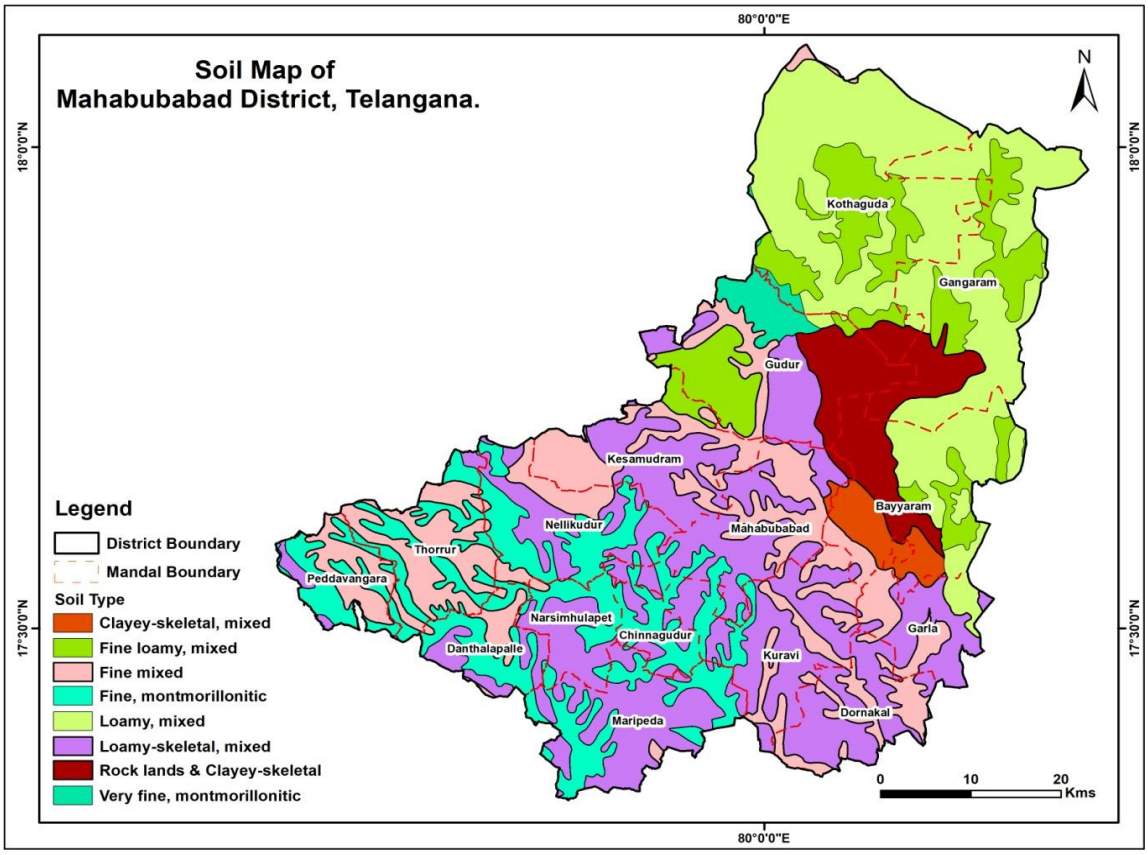



**Fig.1.7: Soil map of Mahabubabad district**

## 1.9 Irrigation

### Medium Irrigation Projects:

**Table: 1.3 Medium Irrigation Project**

| Name of the Project | IP (Irrigation Project) (in Acres) |
|---|---|
| Pakhal Lake Medium Irrigation Project | 18,192 |
| Bayyaram Tank Medium Irrigation Project | 7,200 |
| **Total** | **25,392** |

The Pakhal Lake MI project was constructed across Munneru vagu, a tributary of Krishna River which is situated near Ashoknagar Village of Kothaguda

mandal in Mahabubabad District and commissioned in the year 1967. It provides ayacut of 22410 Acres in villages of Kothaguda mandal of Mahabubabad District.

A large Tank Bayyaram (Medium Irrigation Project) was constructed during the Kakatiya Dynasty i.e 700 years ago at Bayyaram Village & Mandal of Mahabubabad district. This Project was constructed to irrigate an ayacut of 7200 Acres benefiting Bayyaram mandal of Mahabubabad district. **(Fig 1.8, Table: 1.3).**

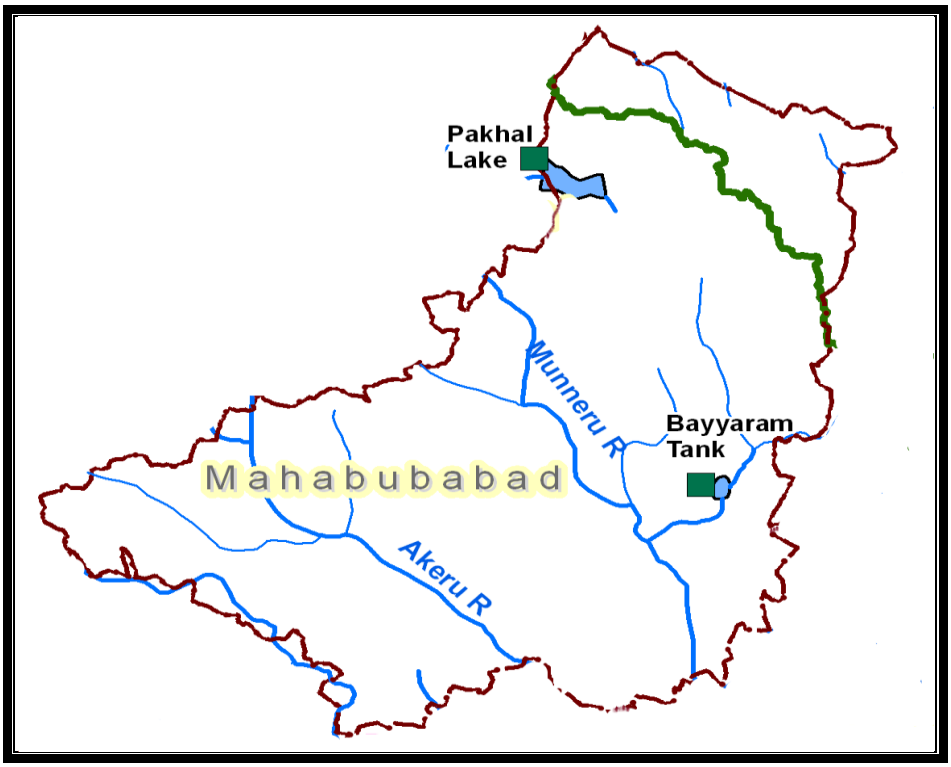



**Fig. 1.8 Irrigation project in Mahabubabad district**
(Source: https://irrigation.telangana.gov.in/icad/projects)

**Minor Irrigation Tanks:**

A total of 1,662 minor irrigation tanks exist in the district with an ayacut of 58,917 acres. In the district, there are 62,570 irrigation wells (47,987 dug wells and 14,583 tube wells). (Source: Telangana state statistical abstract-2021).

## 1.10 Prevailing Water Conservation/Recharge Practices

In the district, water conservation/Recharge practices exists 1614 percolation tanks and 33 check dams Under Mission Kakatiya (Phase 1 to 4) and 1069 MI tanks have been undertaken de-siltation of work etc.

## 1.11 Geology

The majority of district is underlain by oldest Archaean formation and small part by Gondwana formation. The general geological succession of the area is presented in the **Table-1.4.** Around 70% of the area is underlain by Banded Gneissic Complex and 30% area by soft rock formations i.e Sandstone, Lime stone and Shale of Gondwana group (**Fig1.9**).

| Era | Period | Group | Formation | Lithological Description |
|---|---|---|---|---|
| **Mesozoic** | Jurassic to Upper Carboniferous | Upper Gondwanas | Chikkialas<br>Kota<br>Maleris | Sandstone, Clay, Grit and Limestone |
| | | Lower Gondwanas | Kamthis<br>Barren Measures<br>Barakars<br>Talchirs | Sandstone, Shale and Clays |
| **Unconformity** | | | | |
| **Azoic** | Archaeans | Archaeans | | Granites and Gneisses |

**Table-1.4: Stratigraphic Succession of Mahabubabad district**

The basement gneisses and granites constitute the major rock types and found throghout the district. The granites are either biotitic or hornblendic type. Veins of quartz and pegmatite traverse through most of the Archaean rocks and Pakhals. A network of the basic dykes of dolerite and epidiorite traverse the granite. Gondwanas occurring in the district belong to both the lower as well as the upper divisions. The lower Gondwanas include the Talchirs, Barakars, Barren Measures and Kamthis and Maleries, Kota and Chikkialas in Upper Gondwana. The Talchirs comprise boulder beds, sandstones and shales. The boulder beds contain, boulders, cobbles and pebbles of different rocks of the Archaean and cemented in arenaceous matrix. The sandstones are brown in colour, medium to coarse grained and feldspathic.

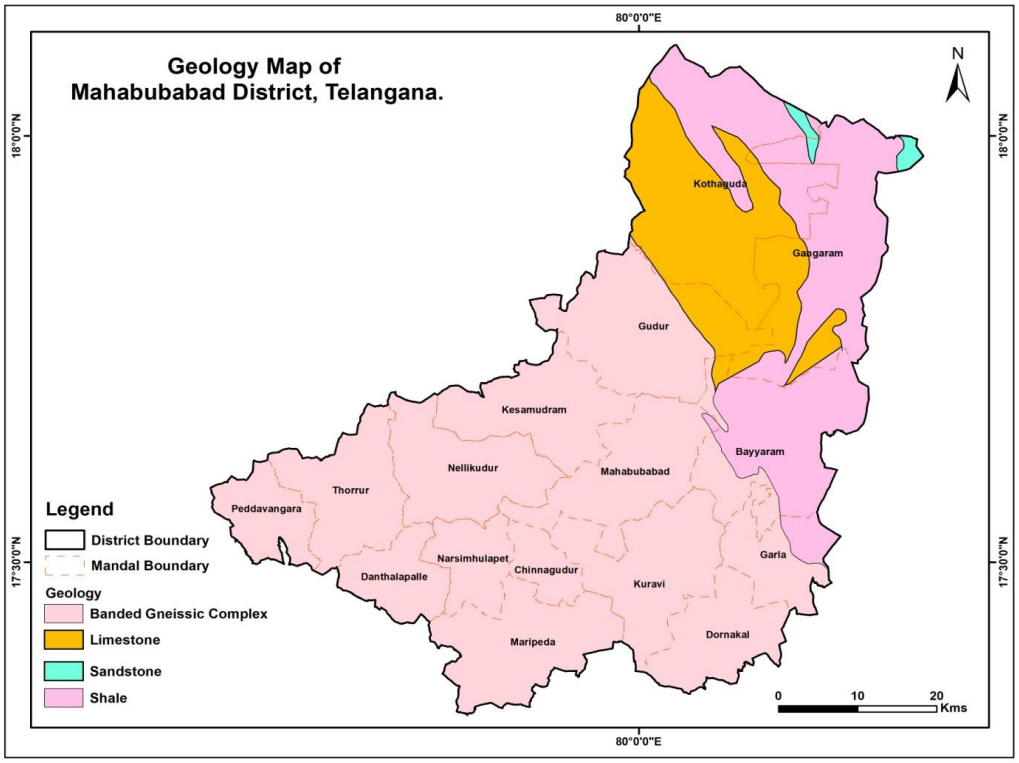



**Fig.1.9: Geology map of Mahabubabad district.**

# 2. DATA COLLECTION AND GENERATION

Collection and compilation of data for aquifer mapping studies has been carried out in conformity with Expenditure Finance Committee (EFC) document of XII plan of CGWB encompassing various data generation activities (**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 Existing data on groundwater | Preparation of base map and various thematic layers, compilation of information on Hydrology, Geology, Geophysics, Hydrogeology and Geo-chemical. Creation of data base of Exploration Wells, delineation of Principal aquifers (vertical and lateral) and compilation of Aquifer wise water level and draft data. |
| | | Identification of Data Gap | Data gap in sub-surface information and aquifer parameters, information on hydrology, geology, geophysics, hydrogeology, geochemical, in aquifer delineation (vertical and lateral) and gap in aquifer wise water level and draft data. |
| 2. | Generation of Data | Generation of geological layers (1:50,000) | Preparation of sub-surface geology, geomorphologic analysis, analysis of land use pattern. |
| | | Surface and sub-surface geo-electrical data generation | Vertical Electrical Sounding (VES), bore-hole logging, 2-D imaging. |
| | | 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 additional water quality parameters | Analysis of groundwater for general parameters including 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 management plan | Information on aquifer and dissemination through training to administrators, NGO's, progressive farmers and stakeholders etc. and putting in public domain. |

The aquifer geometry for shallow and deeper aquifer has been established by utilising the data generated through various hydrogeological, exploration, surface and subsurface geophysical studies in the district. The data used for the integration and interpretation are explained in the following sections:

## 2.1 Ground Water Exploration

CGWB had constructed 18 bore wells at different depths in the Mahabubabad district (Table 2.2). Almost all the wells were drilled in consolidated formation. Data analysed from CGWB wells indicates that 5 wells are of shallow depth (upto 30 m), 4 no's in the range of 30 to 100m and 9 no's in the range of 100-200 m depth. Deepest fracture was encountered at 151 m.bgl at Fathepur, Thorrur mandals in consolidated granitic formation. The locations of exploratory wells are shown in **Fig. 2.1**.

**Table-2.2: Ground Water Exploration wells**

| Source | Exploratory wells | Observation wells | Total wells |
|---|---|---|---|
| CGWB | 14 | 04 | 18 |

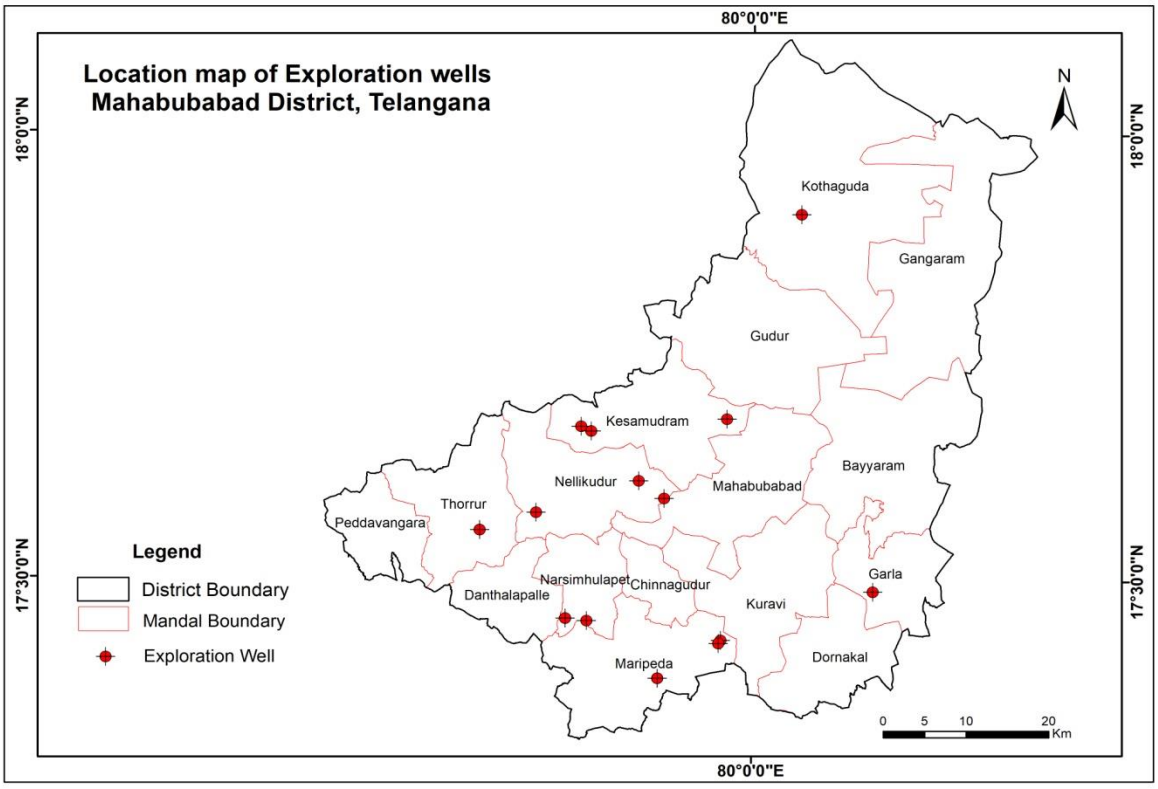



**Fig.2.1: Location of Exploratory Wells of Mahabubabad district**

## 2.2 Ground Water Monitoring Wells

Groundwater level monitoring wells of CGWB (21 nos.) and SGWD (35 nos.) were utilized for the Aquifer mapping studies. In order to understand the groundwater level trend, current and historical water levels along with water level trend data for pre-monsoon and post-monsoon season has been used**.** CGWB wells are being monitored four times (January, April, August and November) in a year whereas; the monitoring

wells of State Ground Water Department (SGWD) are being monitored every month. These ground water monitoring wells were used in order to understand the spatio-temporal behaviour of the ground water regime. The data is given in **Table-2.3** and locations of monitoring wells are shown in **Fig. 2.2.**

**Table-2.3: Groundwater Monitoring wells**

| Source | No. of wells |
|---|---|
| CGWB | 21 |
| SGWD | 35 |
| **Total** | **56** |

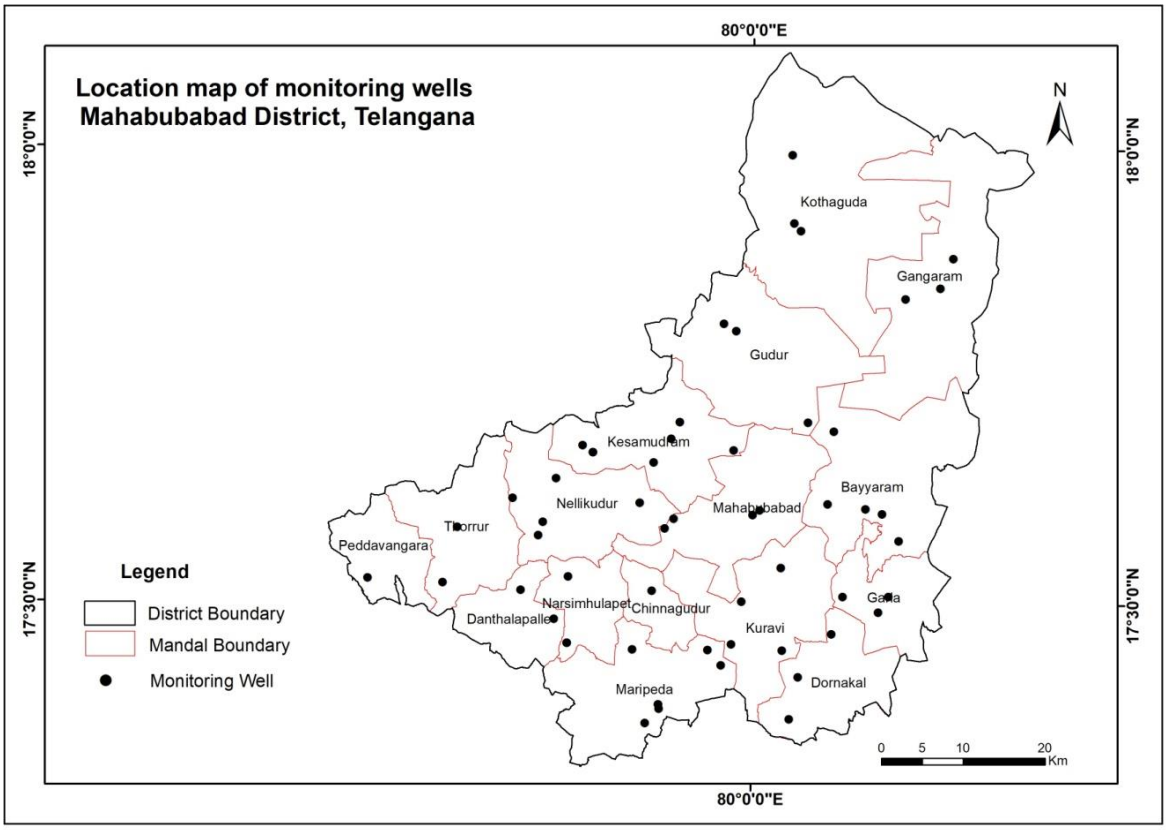



**Fig.2.2: Location of Groundwater Monitoring wells of Mahabubabad district**

## 2.3 Ground Water Quality

To understand chemical nature of groundwater, water quality data for pre-monsoon season (239 samples) and post-monsoon season (277 samples) were utilized in the analysis (**Table 2.4**.) . Parameters namely pH, EC (in µS/cm at 25° C), TH, Ca, Mg, Na, K, $CO_3$, $HCO_3$, Cl, $SO_4$, $NO_3$ and F were analyzed and locations of monitoring wells are shown in **Fig. 3.8 to 3.13.**

**Table-2.4: Ground Water Sampling wells**

| Source | Pre-monsoon | Post-monsoon |
|---|---|---|
| SGWD | 239 | 277 |

## 2.4 Geophysical Studies

Geophysical data on VES and profiling has been used to extract information on the weathered thickness, fracture depth and thickness of fractures in hard rock area. For the interpretation of the aquifer geometry, geophysical data in conjunction with the available groundwater exploration data is utilised. The data from 13 Vertical Electrical Soundings (VES) employing the Schlumberger electrode configuration with the maximum electrode separation (AB) of 400 meters is used for the aquifer mapping studies **(Fig. 2.3)**. The data was processed and interpreted by IPI2Win software enveloped by Moscow State University, after marginally modifying manually interpreted results in corroboration with geology and hydrogeology. The details of resistivity with change for various formations encountered in the district is given in **Table-2.5.**

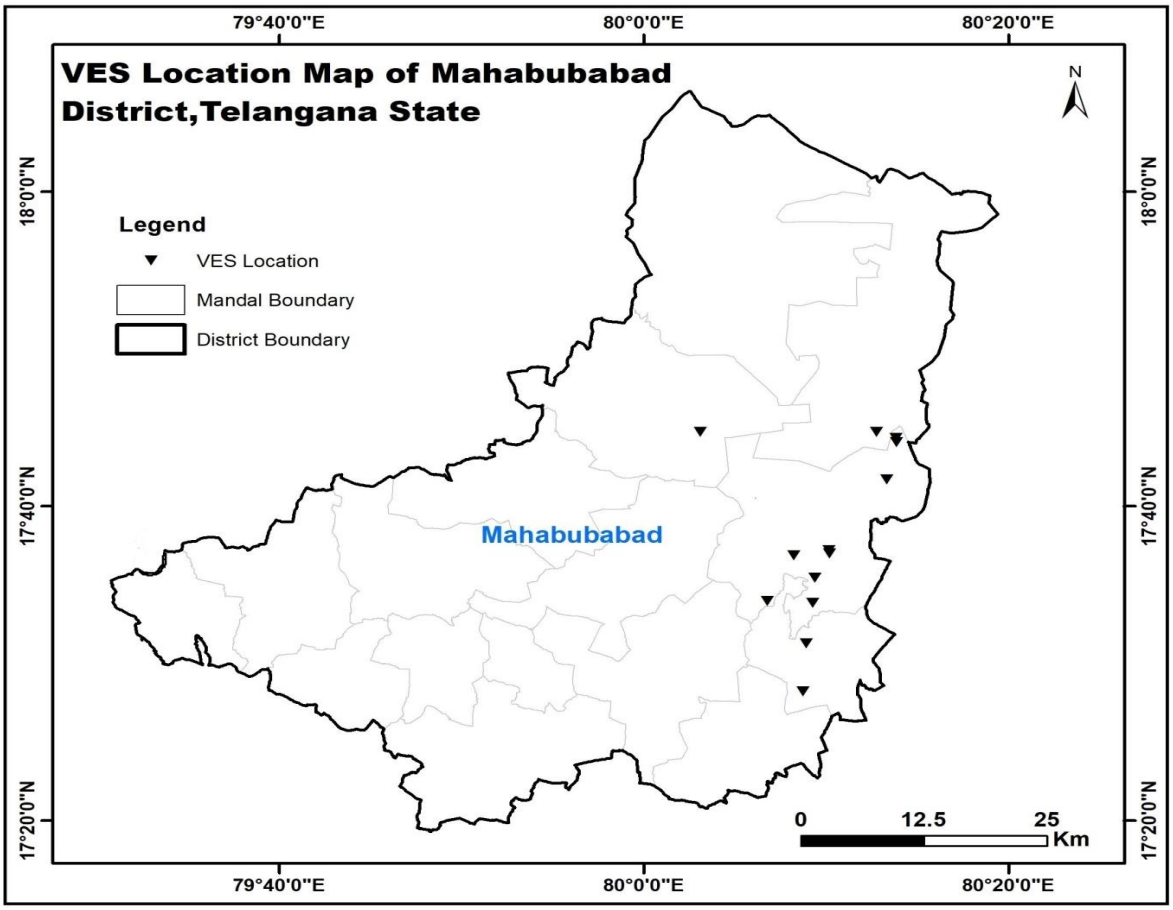



**Fig.2.3: Location of Vertical Electrical Soundings (VES) of Mahabubabad dist.**

**Table-2.5: Resistivity values for various formations**

| Formation | Resistivity range (ohm-m) | Thickness (m) |
|---|---|---|
| Granite/Gneiss | 15.5 to 5700 | 3.9 to 13.0 |
| Shale/Lime stone etc | 17.5 to 1265 | 5.0 to 32.5 |

# 3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation was interpreted and integrated. Based on this, various thematic layers such as hydrogeology, water level scenario of both current and long term scenarios, aquifer wise ground water quality, 2-D and 3-D sub surface disposition of aquifers by drawing fence and lithological sections, yield potential, groundwater resources were generated and are discussed in detail in following sections .

## 3.1 Ground Water Level Scenario (DTWL)

The depth to water level scenario for pre-monsoon and post-monsoon season was generated by utilizing water level data of Pre-monsoon (239 wells) & Post Monsoon (277 wells) of SGWD monitoring wells. The pre-monsoon depth to water levels ranged between 1.68 m bgl (Thallapusalaplli, Kesamudarm mandal) and 20.02 m bgl (Sadireddypalli, Kothaguda mandal). The shallow water levels of < 2 m bgl are observed as isolated patches in parts of Kuravi, Kesamudarm, Nellikuduru, Dornakal mandals (1 % of area), whereas water levels between 2-5 m bgl are mainly observed in parts of Dornakal, Kuravi, Garla, Kesamudram, Gudur, Nellikuduru and Maripeda mandals (42 % of area). The water level in the range of 5-10 m bgl is observed in majority parts of the district (53%). The deeper water levels of >10 m bgl are observed in parts of Kothaguda, Gangaram, Vemsoor, Sathupalli, Enkur, Singareni, Kusumanchi and Kamepalli mandals (4 % of area). The pre-monsoon depth to water level map is given in **Fig.3.1.**

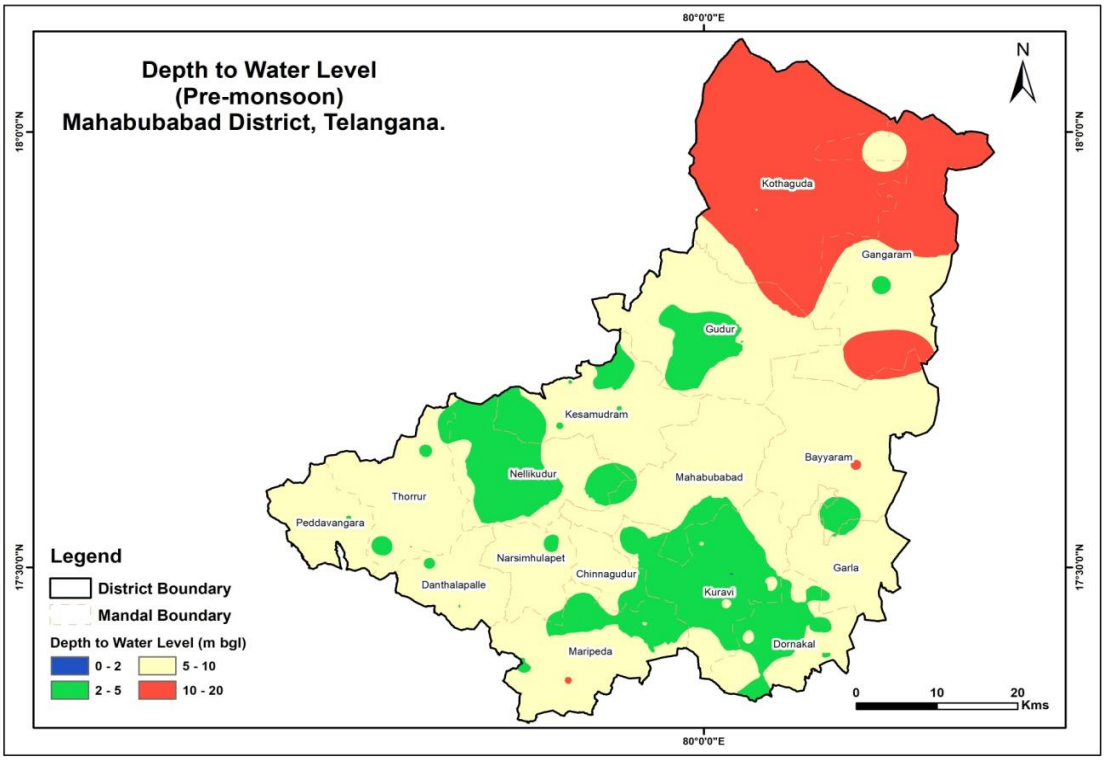



**Fig. 3.1: Depth to water level map of pre-monsoon season (Average:2011-2020)**

The post-monsoon depth to water levels ranges between 0.2 m bgl (Yellampet) and 5.96 m bgl (Velubelli, Kothaguda mandal). The shallow water levels of <2 m bgl are observed in parts of Maripeda, Mahabubabad, Kuravi, Gudur and Dornakal mandals (22% of area). The water levels between 2-5 m bgl are observed in majority part of the district (71% of area). Moderate water levels between 5-10 m bgl are observed mainly in parts of Kothaguda mandal (18% of the area). The deeper water levels of >10 mbgl are not observed in the area. The post-monsoon depth to water level map is given in **Fig.3.2.**

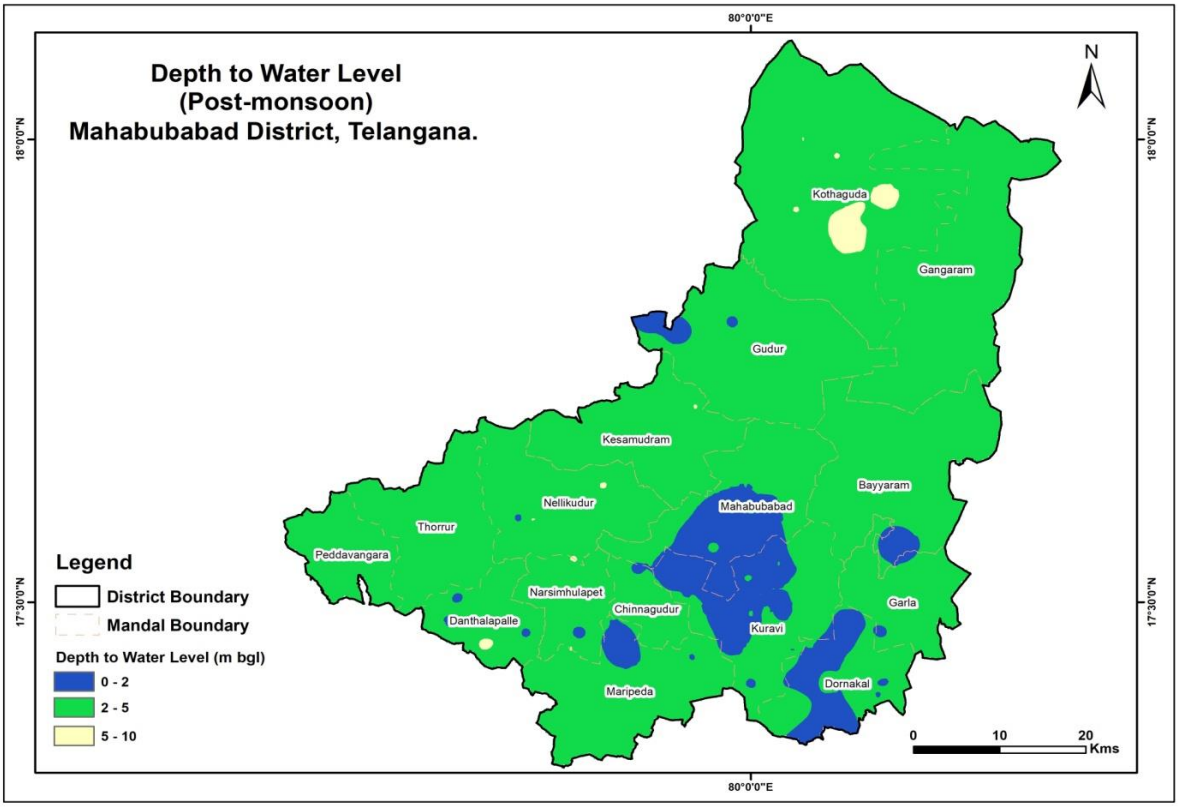



**Fig.3.2: Depth to water level map of post-monsoon season (Average: 2011-2020)**

## 3.1.1 Water Level Fluctuation

The water level measured during pre and post monsoon period was used to compute the seasonal fluctuation. 100% (35 no's) of the wells show rise in water level and no wells show fall in water level. The analysis of water level fluctuation data indicates that minimum water level fluctuation was observed at Ayyavaripally (2.13 m) while maximum water level fluctuation was observed at Kothaguda(17.14 m). The water level fluctuations were grouped under three categories i.e., less, moderate and high and the % of wells in each category was analysed (**Table-3.1**).

**Table-3.1: Analysis of Water Level Fluctuation**

| S. No. | Category | Fluctuation Range | % of area |
|---|---|---|---|
| 1. | Less water level fluctuation | 0 to 5 m | 74% |
| 2. | Moderate water level fluctuation | 5 to 10 m | 17% |
| 3. | High water level fluctuation | >10m | 9% |

The analysis indicates that majority of the area (74%) are falling in less fluctuation range indicating good aquifer storage, whereas moderate water level fluctuations are observed in 17 % area and high water level fluctuation of more than 9 m observed in the district. The seasonal fluctuation map is presented as **Fig.3.3**, the perusal of map indicates that fluctuation of upto 5 m is observed in major part of the district, whereas moderate fluctuation of more than 5 m is observed in parts of Kothaguda, Mahabubabad mandal.

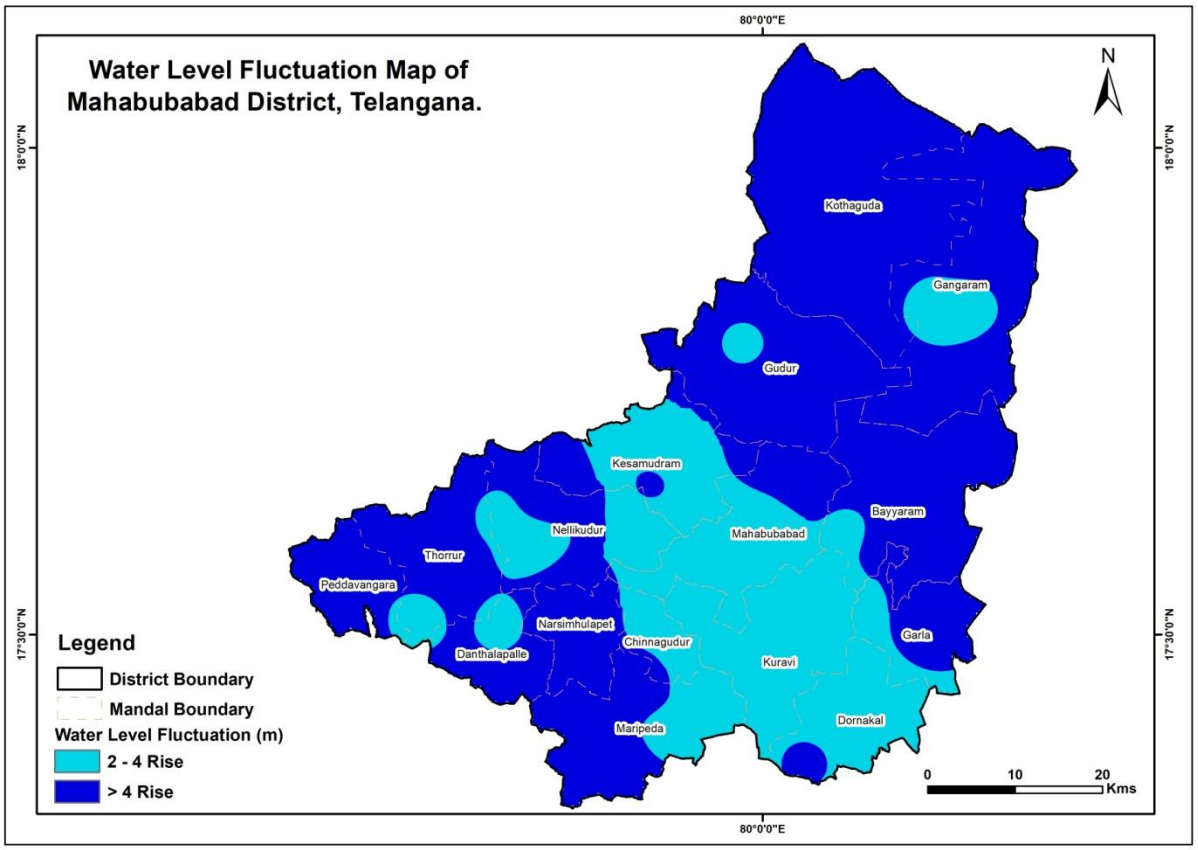



**Fig.3.3: Seasonal Water Level Fluctuations (m) (post-monsoon with respect to pre-monsoon (Average:2011-2020)**

## 3.1.2 Water Table Elevation

The water table elevation map for pre-monsoon and post-monsoon period was also prepared (**Fig. 3.4**) to understand the ground water flow directions. The water table elevation ranges from 135 (Dornakal) to 358 m amsl (Gangaram) during pre-monsoon period and 139 (Dornakal) to 360 m amsl (Gangaram) during post-monsoon period. The ground water flow is mainly towards south and south eastern direction.

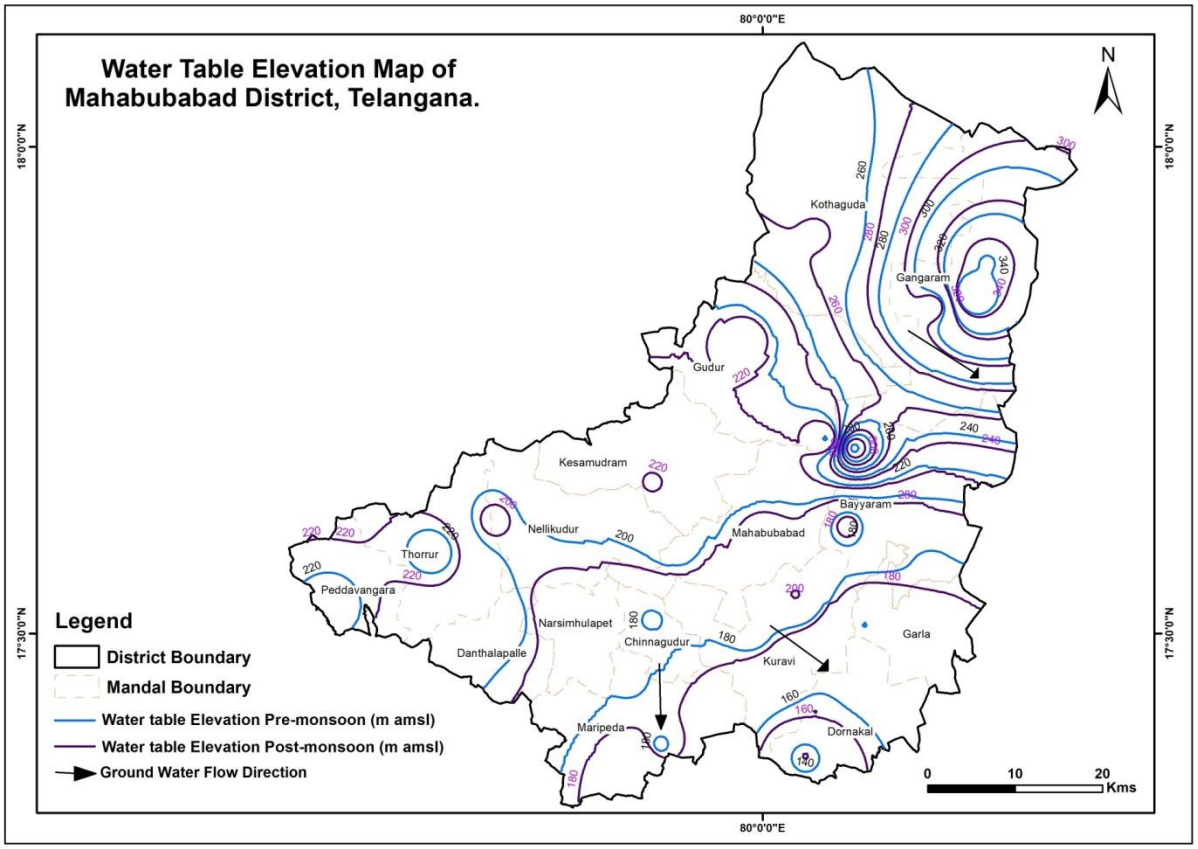



**Fig.3.4: Water table elevations (m amsl) during Pre-monsoon & Post Monsoon season (Average:2011-2020)**

### 3.1.3 Long term Water Level Trend (2011-20)

In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data from 25 hydrograph station (CGWB:14, SGWD:11) for the period 2011-20 have been computed and analyzed. The decadal pre-monsoon water level trend analysis indicates that 15 wells show falling trend (-0.5 to 0.05m/yr) and 10 wells show rising trend (0.5-2.0m/yr). During post-monsoon season 04 wells show falling trend (-0.50m to 0.5m) and 21 wells shows rising trends (0-0.5 m: 3, 1.0 -1.50 m:) The graphical representation of fall and rise is shown in **Fig.3.5** and spatial distribution map is shown in **Fig.3.6** and **3.7.**

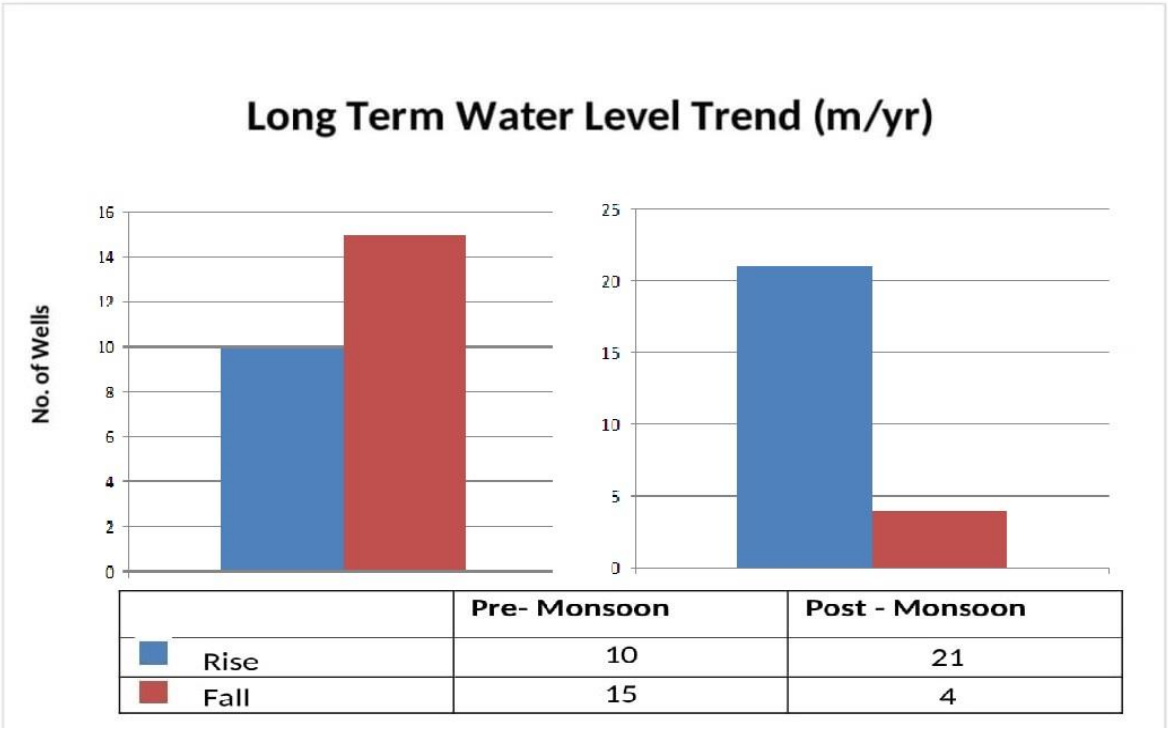



**Fig. 3.5: Graphical representation of water level trends (2011-2020)**

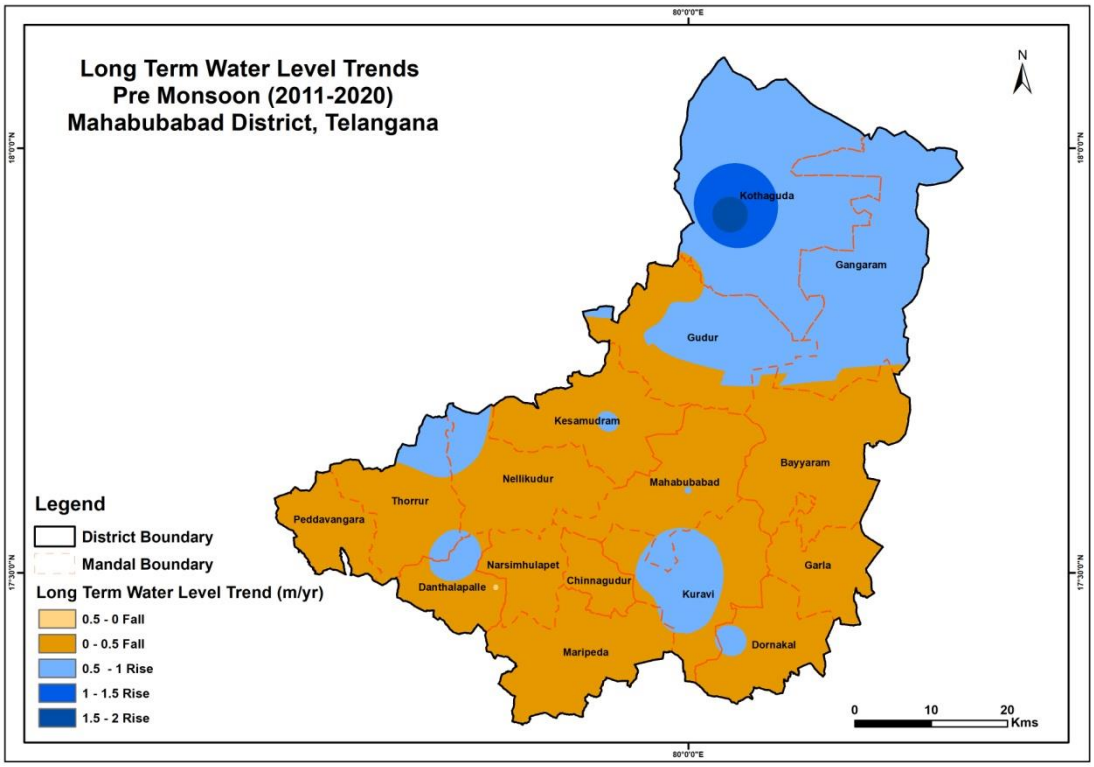



**Fig. 3.6: Long-term water level trend, Pre-monsoon (2011-2020)**

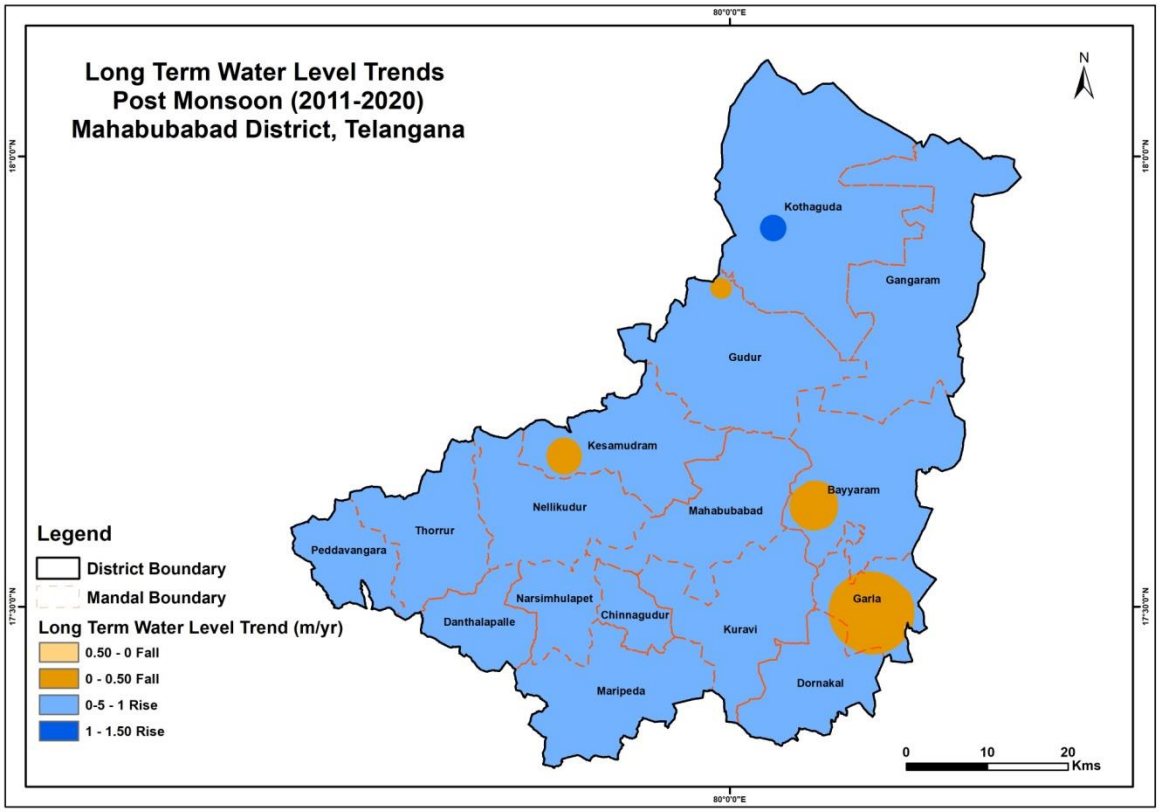



**Fig. 3.7: Long-term water level trend, Post-monsoon (2011-2020)**

## 3.2 Ground Water Quality

The suitability of groundwater for drinking/irrigation/industrial purposes is determined keeping in view the effects of various chemical constituents present in water on the growth of human being, animals, various plants and also on industrial requirement. Though many ions are very essential for the growth of plants and human body but when present in excess, have an adverse effect on health and growth. For assessment of ground water quality, 516 samples (Pre-monsoon: 239 and post-monsoon:277) were utilised from monitoring wells of SGWD. The ground water samples were analysed for major chemical constituents. Parameters namely pH, EC (in µS/cm at 25° C), TH, Ca, Mg, Na, K, $CO_3$, $HCO_3$, Cl, $SO_4$, $NO_3$ and F were analysed.

### 3.2.1 Pre-Monsoon

A total of 239 samples were analyzed, ground water is alkaline in nature with pH in the range of 7.02-8.46 (Avg: 7.81). Electrical conductivity varies from 257-3952 (avg: 1031) µ Siemens/cm. In 87 % of area EC is below 1500 µ Siemens/cm, between 1500-3000 µ Siemens/cm, in 12% of area and beyond 3000 µ Siemens/cm is 1% of the area(Nellikuduru and Maripeda mandals) (**Fig.3.8**). Nitrate concentration varies from 0.10-303 mg/L and 84 % of the samples it is below 45 mg/L and 16% of samples shows its beyond permissible limits of BIS Standard (>45 mg/L) (**Fig.3.9**). High Nitrate concentration is observed in parts of the district i.e Kuravi, Garla, Nellikuduru, Kesamudram, Gangavaram etc. The Fluoride concentration varies from 0.12 to 4.09 mg/L (**Fig 3.10**) and in 32 % of samples it is beyond permissible limits of BIS standard

(>1.5 mg/L). High fluoride concentration is observed mainly in Thorrur, Nellikuduru, Kuravi, Danthalpalli,Dornkal, Kesamudram and Mariped mandals.

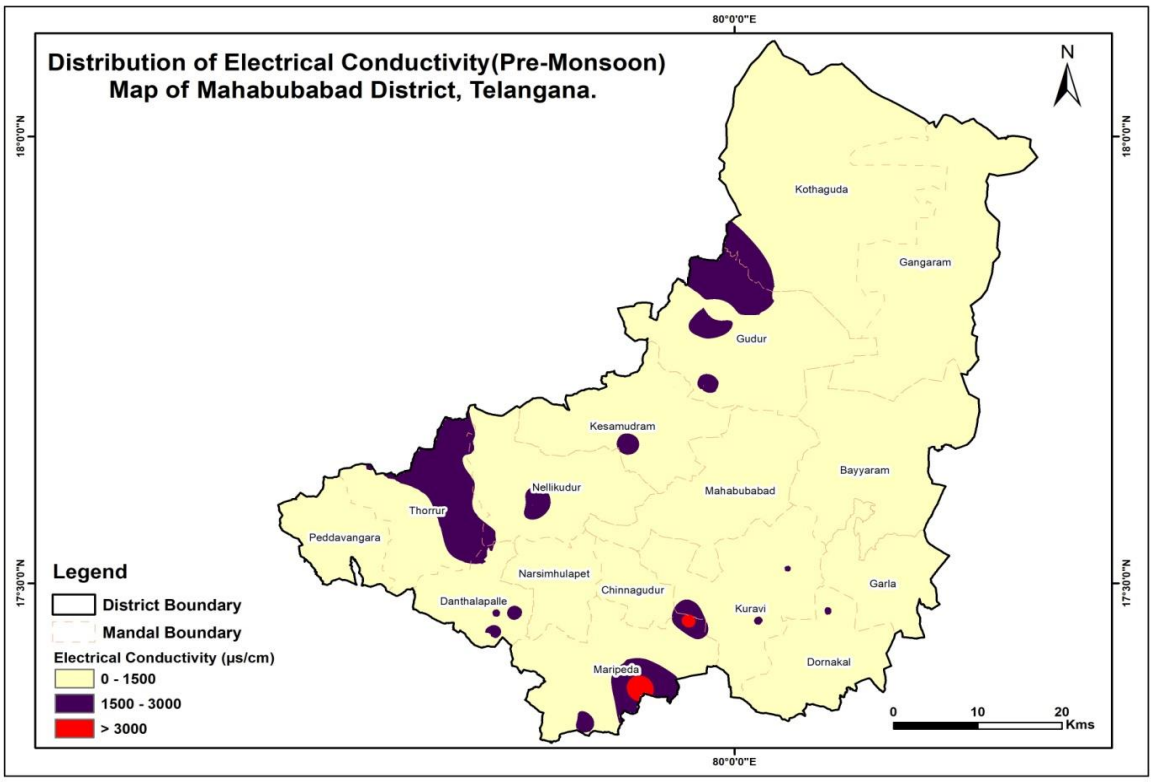



**Fig.3.8: Distribution of Electrical conductivity (Pre-monsoon).**

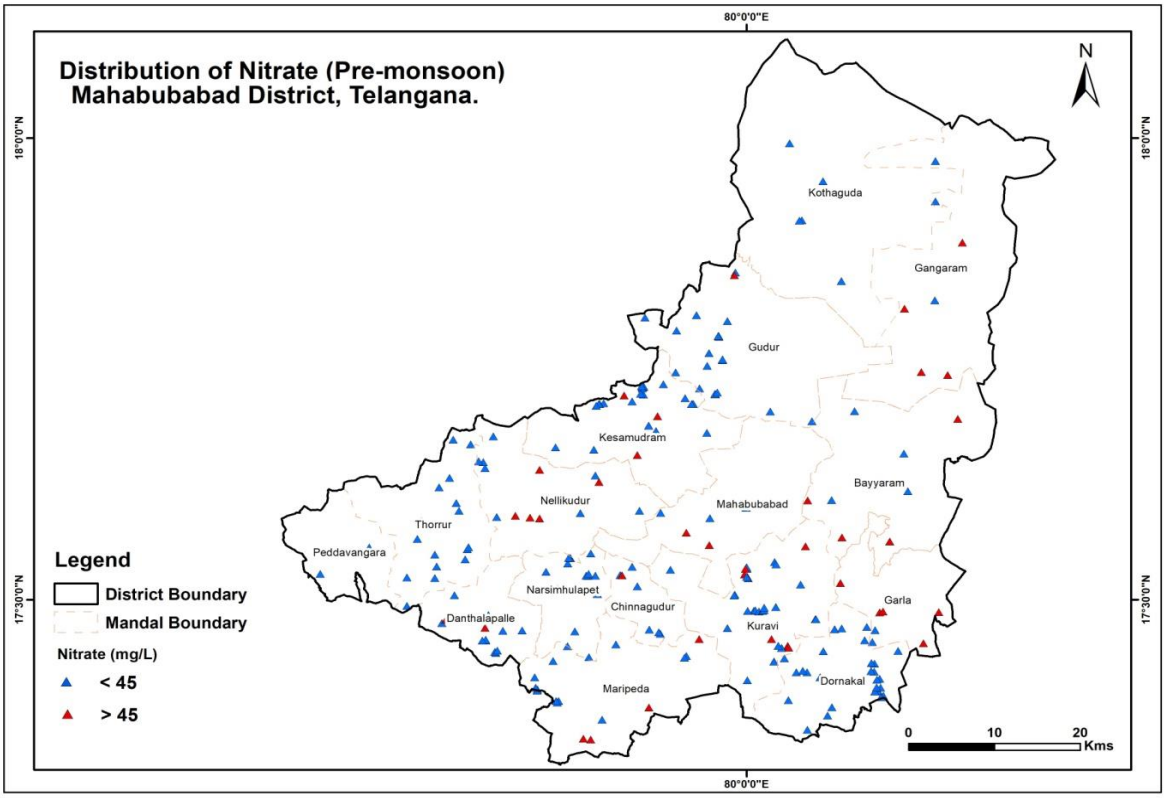



**Fig.3.9: Distribution of Nitrate (Pre-monsoon)**

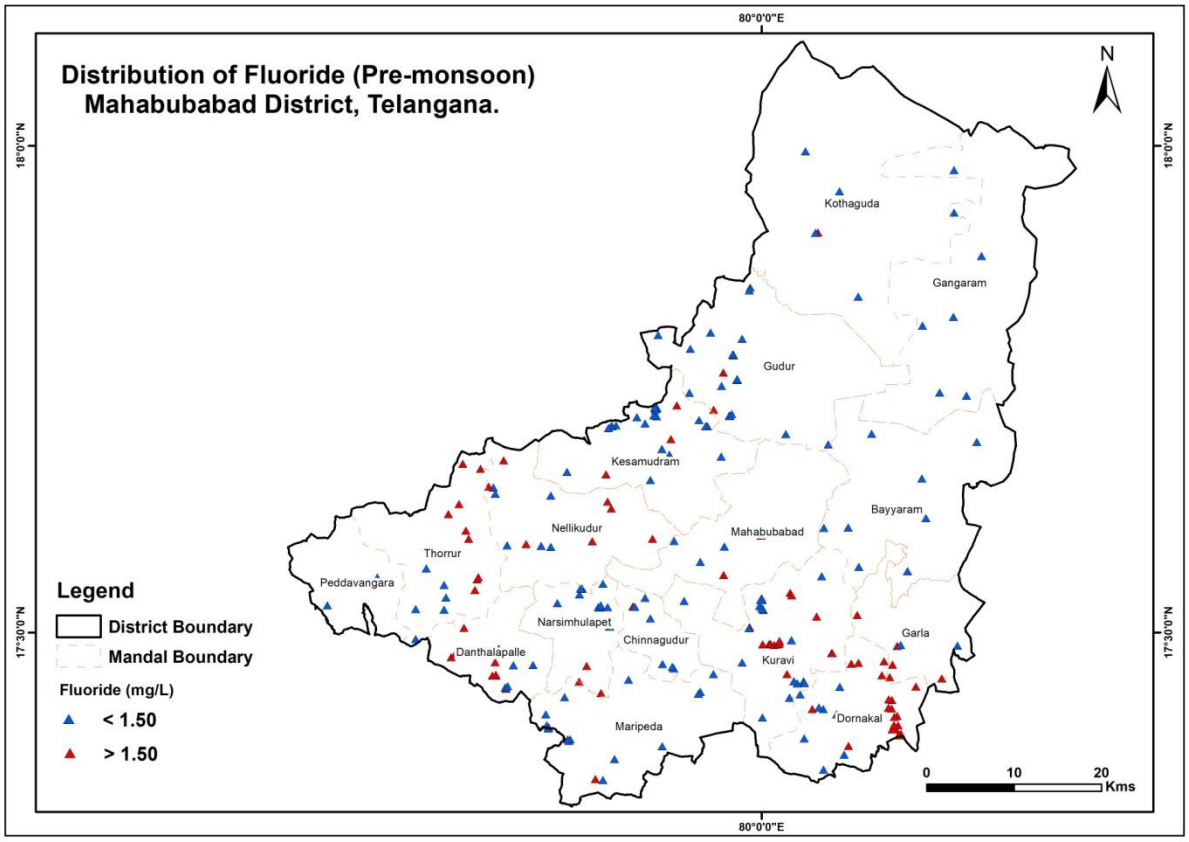



**Fig.3.10: Distribution of Fluoride (Pre-monsoon)**

## 3.2.2 Post-Monsoon

A total of 277 samples of SGWD were analyzed. Ground water from the area is alkaline in nature with pH in the range of 7.21-9.31 (Avg:8.28). Electrical conductivity varies from 146-3549 (avg: 1028) µ Siemens/cm. In 85 % of area EC is within 1500 µ Siemens/cm and between 1500 to 3000 µ Siemens/cm in 12% of area and EC is beyond 3000 µ Siemens/cm shows in 3 % of samples.(**Fig.3.11**). Nitrate concentration varies from 0.01-372 mg/L and in 63 % of the samples are within the limit and 37 % of samples shows concentration beyond permissible limits of BIS Standard (>45 mg/L) (**Fig.3.12**). High nitrate concentration is observed in majority parts of the district. Fluoride concentration varies from 0.07-3.34 mg/L **(Fig 3.13)** and in 27 % of samples it is beyond permissible limits of BIS standard (>1.5 mg/L). High fluoride concentration is observed mainly in Kuravi, Dornakal, Garla, Narsimlupet, Danthalapalli, Nellikuduru, Kesamudram, Kothguda mandal.

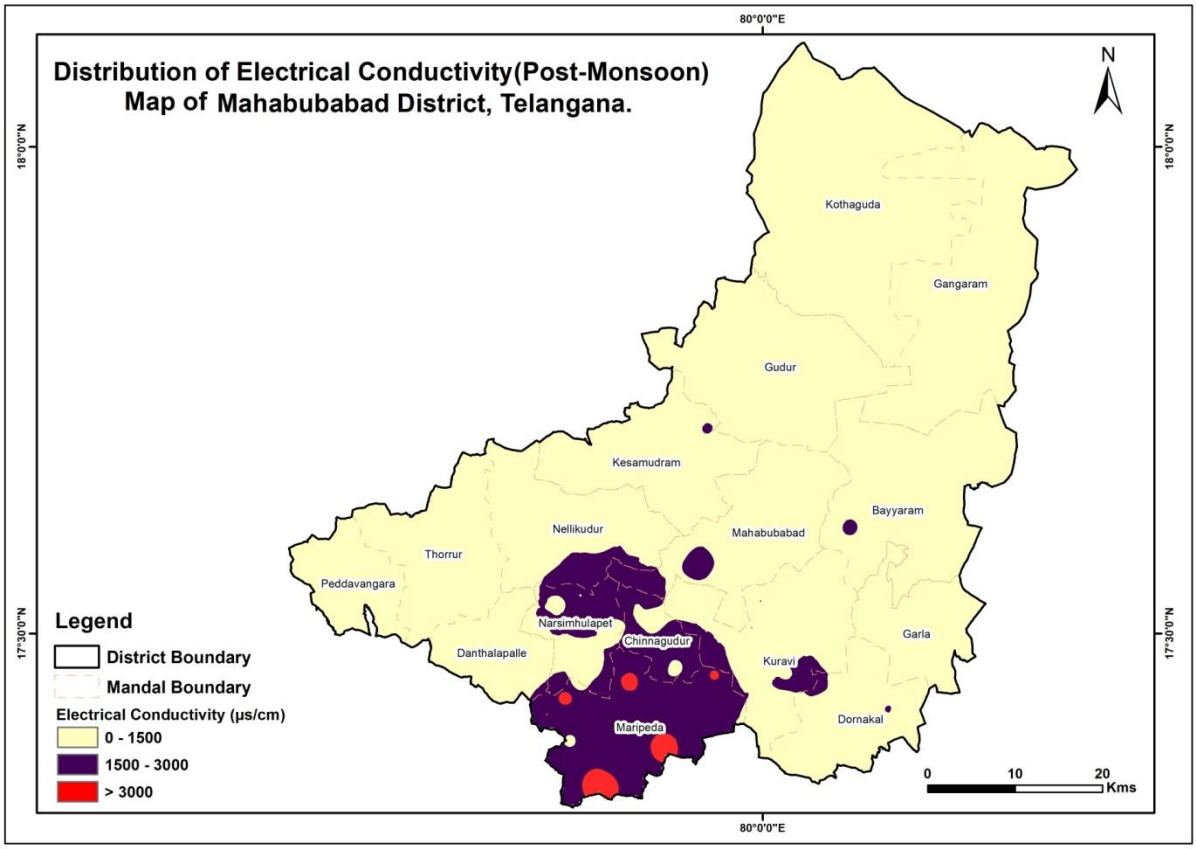



**Fig.3.11: Distribution of Electrical conductivity (Post-monsoon)**

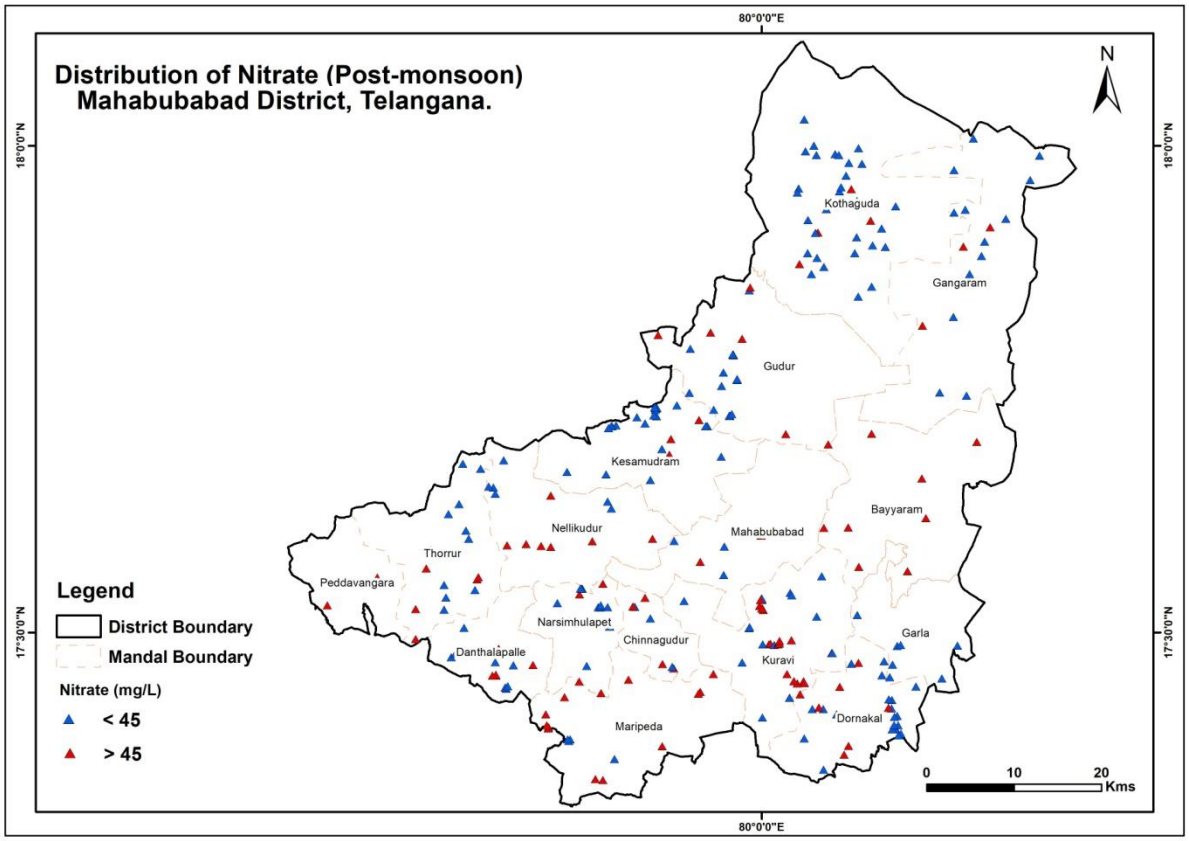



**Fig.3.12: Distribution of Nitrate (Post-monsoon)**

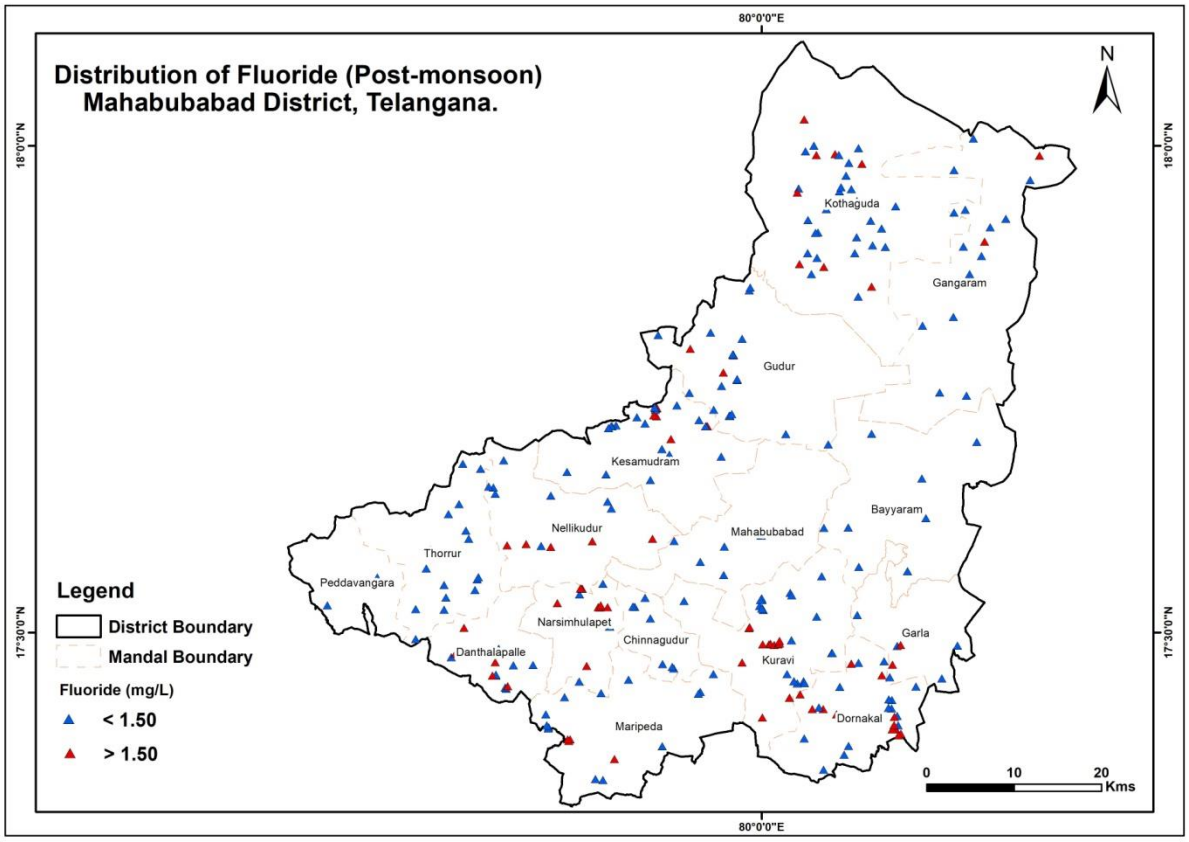



**Fig.3.13: Distribution of Fluoride (Post-monsoon)**

## 3.3 Aquifer Mapping

The aquifer geometry for shallow and deeper aquifer has been established through analyzing data generated through various hydrogeological, exploration, surface and subsurface geophysical studies in the district. The occurrence and movement of water in the subsurface is broadly governed by geological frameworks. It depends on rock type, depth of weathering and extension of weak zones like fractures, joints in hard rocks, while in sedimentary rocks it depends on porosity, granularity, cementing matrix, permeability, bedding plains and faults. Based on above data points hydrogeological map is prepared and is presented in **Fig 3.14**.

On the basis of occurrence and movement of ground water, rock units of the Mahabubabad district can be broadly classified into two categories: consolidated formation (Archean crystalline and metasedimentary formation) which occupies 70% of the area and semi-consolidated to unconsolidated formation (Sedimentary rock) which occupies 30 % of the area.

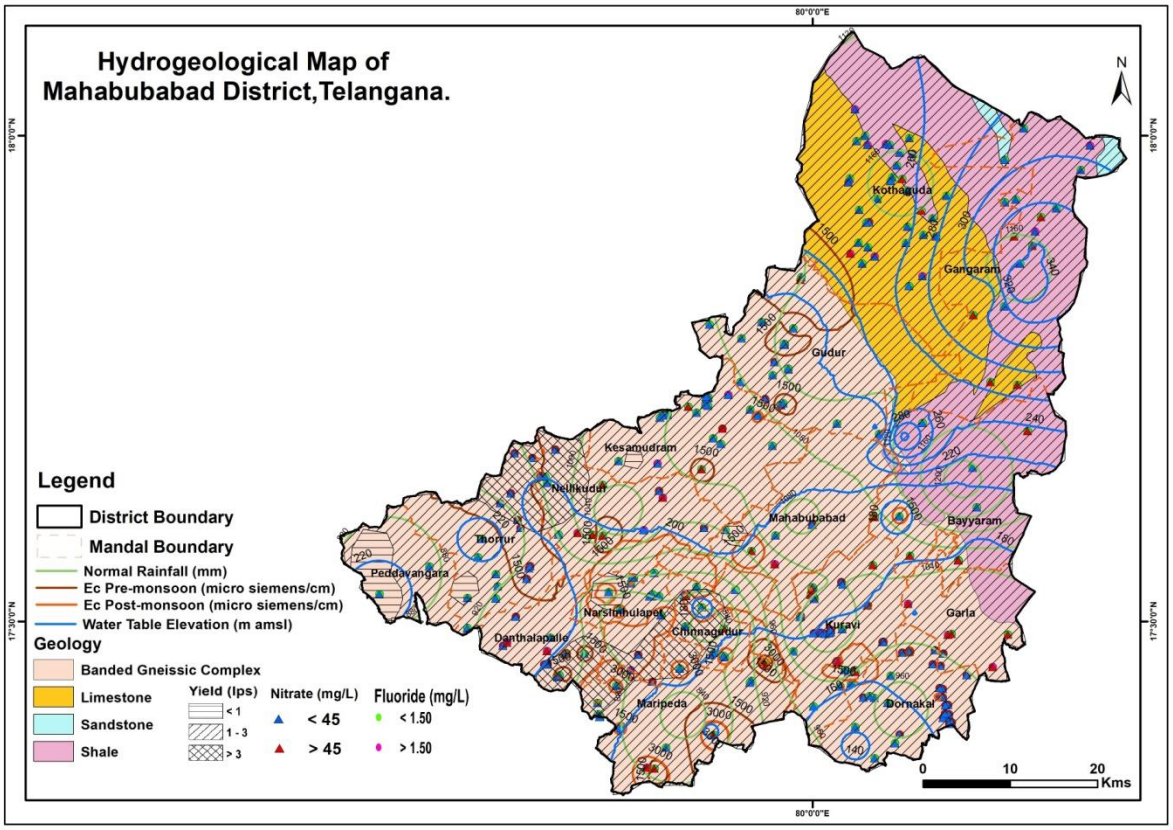



**Fig.3.14: Hydrogeological map of Mahabubabad district**

## 3.3.1 Aquifer system in consolidated formation

Consolidated formation consists of Archean crystalline formation comprising crystalline granites and gneisses that are devoid of primary porosity. However, subsequent weathering, fracturing and fissuring developed secondary porosity. These main aquifers possess a weathered zone at the top, followed by a discrete anisotropic fractured/fissured zone at the bottom, generally extending down to 200 m depth.

## 3.3.1.1 Weathered Zone (Aquifer -I)

It consists of weathered residum where ground water occurs under unconfined conditions in the inter granular pore spaces of weathered mantle and is mainly developed by construction of dug wells or shallow bore wells with hand pumps. The storage in granite rocks is primarily confined to the weathered zone and it has been used mainly for irrigation purpose, which extends upto depth of 17.87 m in Mahabubabad district. Thickness of weathered zone is in the range of 10-18 m in about ~59 % of wells, shallow weathering (< 10 m) occurs in 41 % of the wells (**Fig 3.15**).

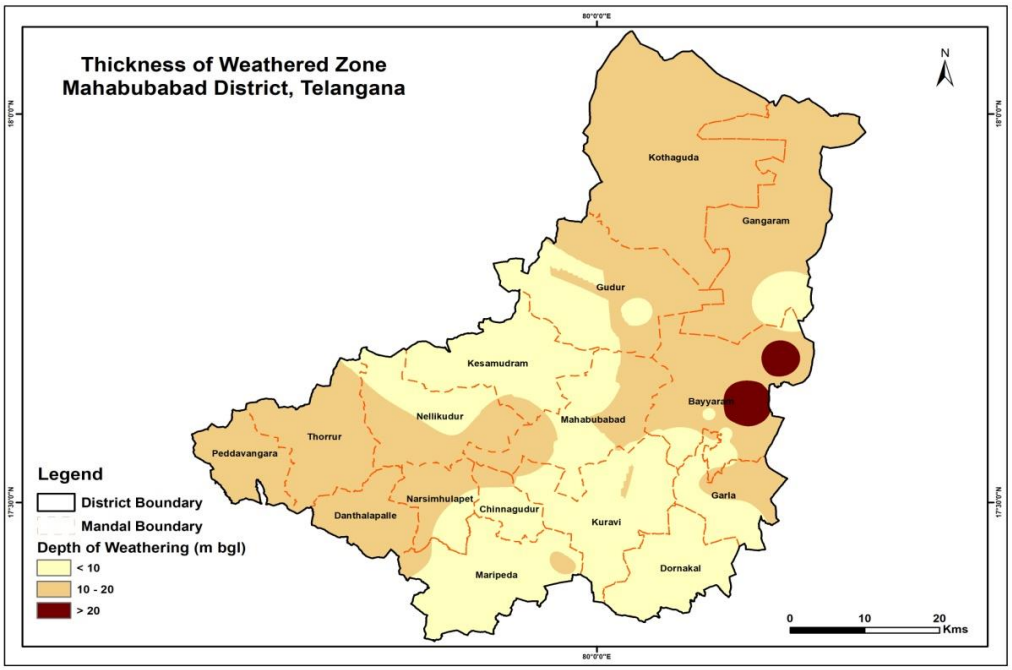



**Fig.3.15: Unconfined zone map of Mahabubabad district**

## 3.3.1.2 Fractured Zone (Aquifer -II)

In the fractured zone, ground water occurs under semi-confined to confined conditions. The fractured zone is considered from bottom of weathered zone to the top of deepest fracture. Ground water in fractured zone is developed through construction of shallow/deep bore wells and dug-cum bore wells. The depth of fracturing varies from 3 m to 152 m (deepest fracture encountered at Fathepuram). Ground water yield in fractured granite/gneiss varies from <0.007 to 2.50 lps. The transmissivity varies from 0.0824 – 43.3 $m^2$/day and storativity varies from 0.00006 to 0.001 (**Fig 3.16**).

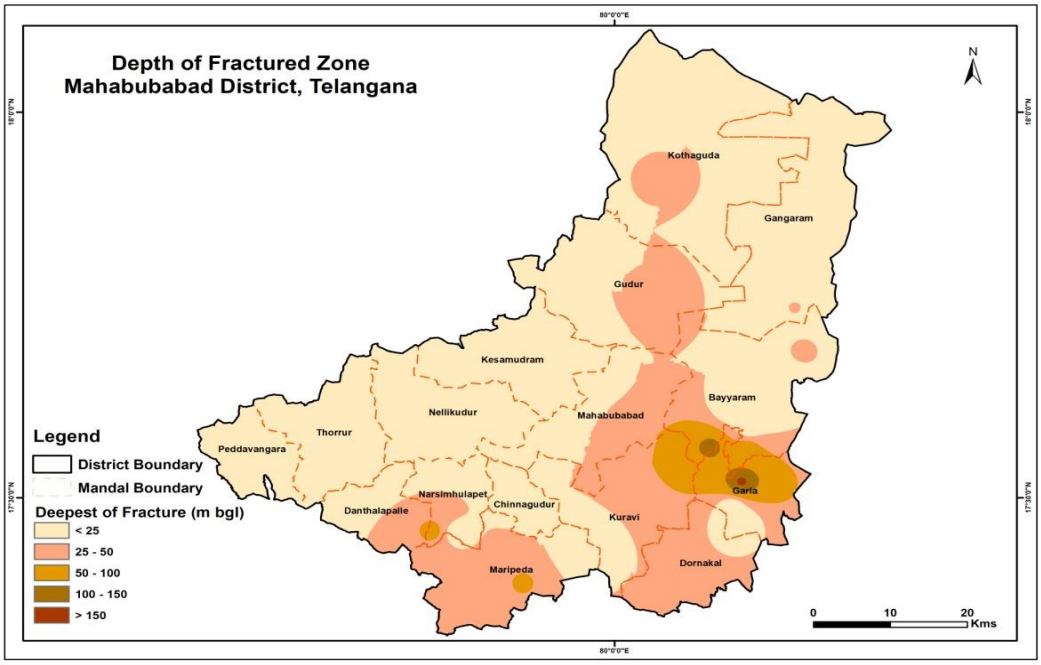



**Fig.3.16: Fracture zone map of Mahabubabad district**

### 3.3.2 Aquifer system in semi-consolidated/unconsolidated formation

Gondwana formations represent the semi-consolidated formation, which consists of limestone, sandstone, shale and clay that makes a thick sequence of sediments. They are generally bedded deposits with well-defined lithologic units and had undergone structural disturbances. Hence the area shows lateral and vertical variation within short distances, due to which the hydrogeological properties of the formation vary widely. The sandstones are generally medium to coarse, friable and loose due to weathering. The sandstones form the principal aquifers except in areas where thin intercalations of clays exist. The ferruginous kankary material formed on the surface due to weathering augments the infiltration and saturates the underlying sandstones. The ground water in the Gondwana formation occurs under both water table and confined conditions.

Multiple aquifer systems are found in the metasediments & sandstone formations with intervening clay beds. The first aquifer is unconfined whereas the deeper aquifers are in semi-confined/ confined condition. Depth of aquifers are decided based on the depth of bottom clay layers.

#### 3.3.2.1 Unconfined aquifer (Aquifer-I)

In the Aquifer-I, ground water occurs under phreatic/unconfined condition. The unconfined zone extends from bottom of the soil layer to top of the first clay layer. Thickness of the unconfined zone is in the range of 10-13 m in the area.

#### 3.3.2.2 Confined/Semi-confined aquifer (Aquifer-I to Aquifer-V)

Unlike Aquifer-I, ground water occurs under confined to semi-confined condition in these aquifers. The occurrence of groundwater depends on porosity, granularity, cementing matrix, permeability, bedding plains and faults. The deeper aquifers identified upto a depth of 300m are mainly composed of fine to coarse grained sandstone.

In general, ground water yield of soft rock aquifers varies from <1 to 18 lps. The transmissivity varies from 146.99 - 570.32 $m^2$/day and storativity varies from $2.04 \times 10^{-4}$ to $5.50 \times 10^{-4}$

**Table 3.2 Salient features of Aquifer system in Mahabubabad district**

| | **Archean Crystalline** | | **Gondwana Formation** | |
|---|---|---|---|---|
| **Prominent Lithology** | Granite, Gneiss | | Metasediments | |
| **Aquifers** | Weathered Zone (Aquifer-1) | Fracture Zone (Aquifer-2) | Unconfined Zone (Aquifer-1) | Semiconfined/ Confined Zone (Aquifer-II & above) |
| **Thickness range** | Upto 17.87 m | 6-152 m | 10 to 13 m | Upto 300 m at different depth ranges |
| **Range of yield potential** | <0 to 2.50 lps | | upto 18 lps | |
| **Transmissivity ($m^2$/day)** | 0.0824 – 43.3 $m^2$/day | | 146.99 - 570.32 $m^2$/day | |
| **Storativity** | 0.00006 to 0.001 | | 1.2 to 0.0001 | |
| **Specific Yield** | 2% | | 3% | |
| **Quality (Suitability of Irrigation)** | Yes | Yes | Yes | Yes |
| **Suitability of domestic purpose** | Yes | Yes | Yes | Yes |

## 3.4 3D and 2D Aquifer Disposition

The data generated from groundwater monitoring wells, hydrogeological inventories, exploratory wells and geophysical studies as well as various thematic layers were utilized to decipher the aquifer disposition of the area. This particularly includes the information on 3D geometry of aquifers, panel diagram and hydrogeological information of these aquifers. RockWorks-16 software was used for this purpose. The data is calibrated for elevations with Shuttle Radar Topography Mission (SRTM) data. The 3-D representation of Aquifer disposition is presented in **Fig. 3.17**

The fence diagram indicating the disposition of various aquifers is presented in **Fig.3.18 and Fig.3.19**. In major part of district, granites/gneiss can be seen. The disposition of weathered and fractured zone followed by massive granite/gneiss can be observed in the Fence. In the eastern parts (Garla mandal) multi-aquifers system of sandstone can be seen separated by intervening clay layers.

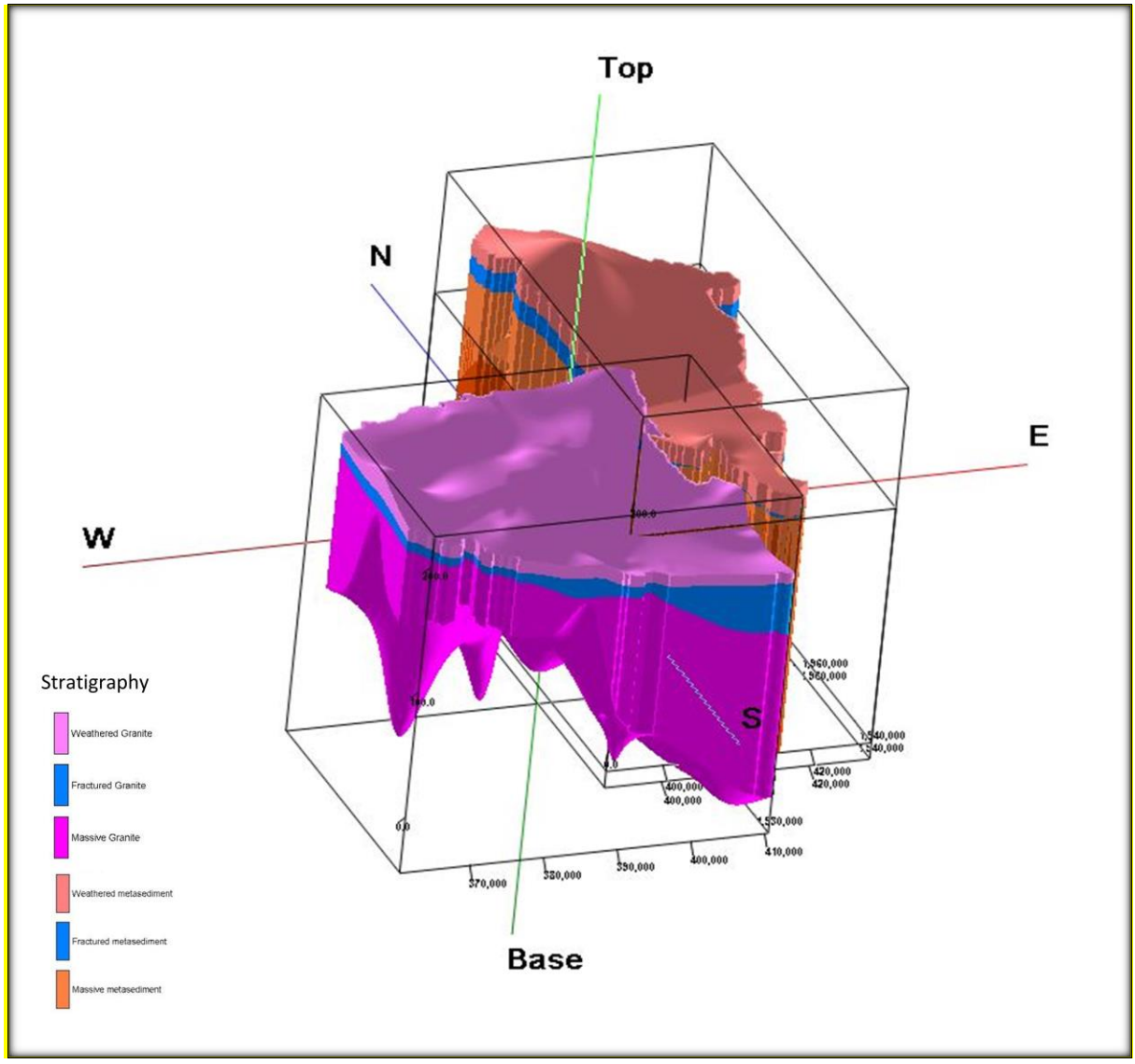



**Fig.-3.17: 3-D disposition of Aquifers**

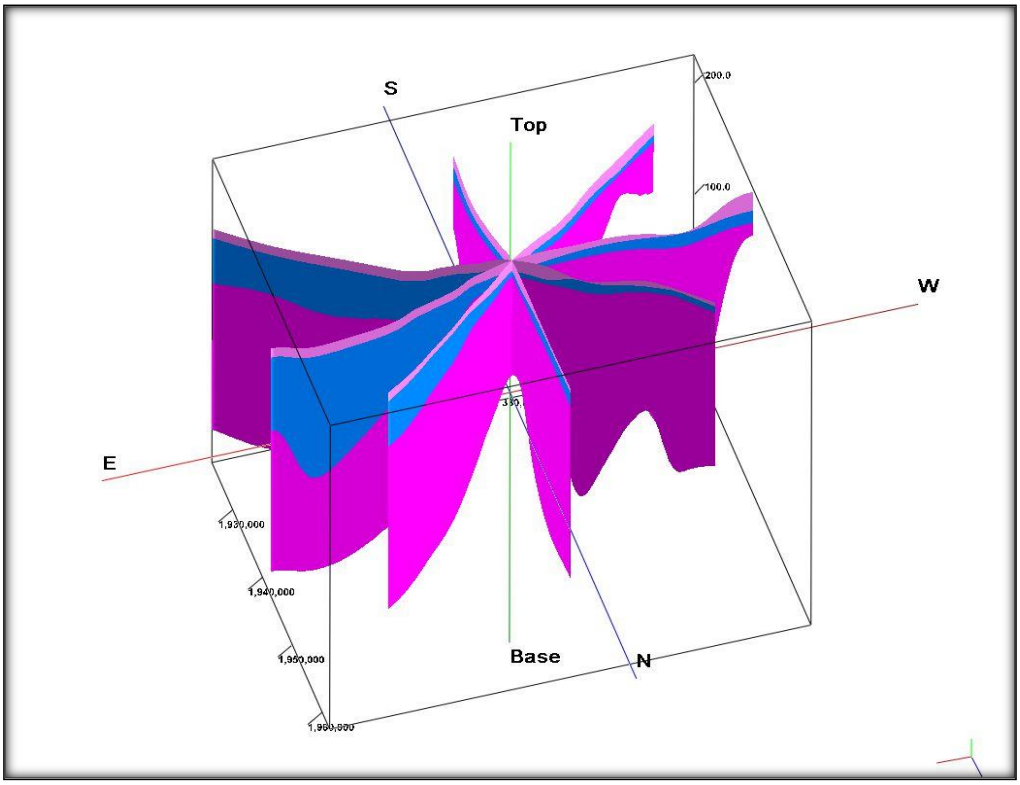



**Fig.-3.18: Fence diagram-Hard rock area**

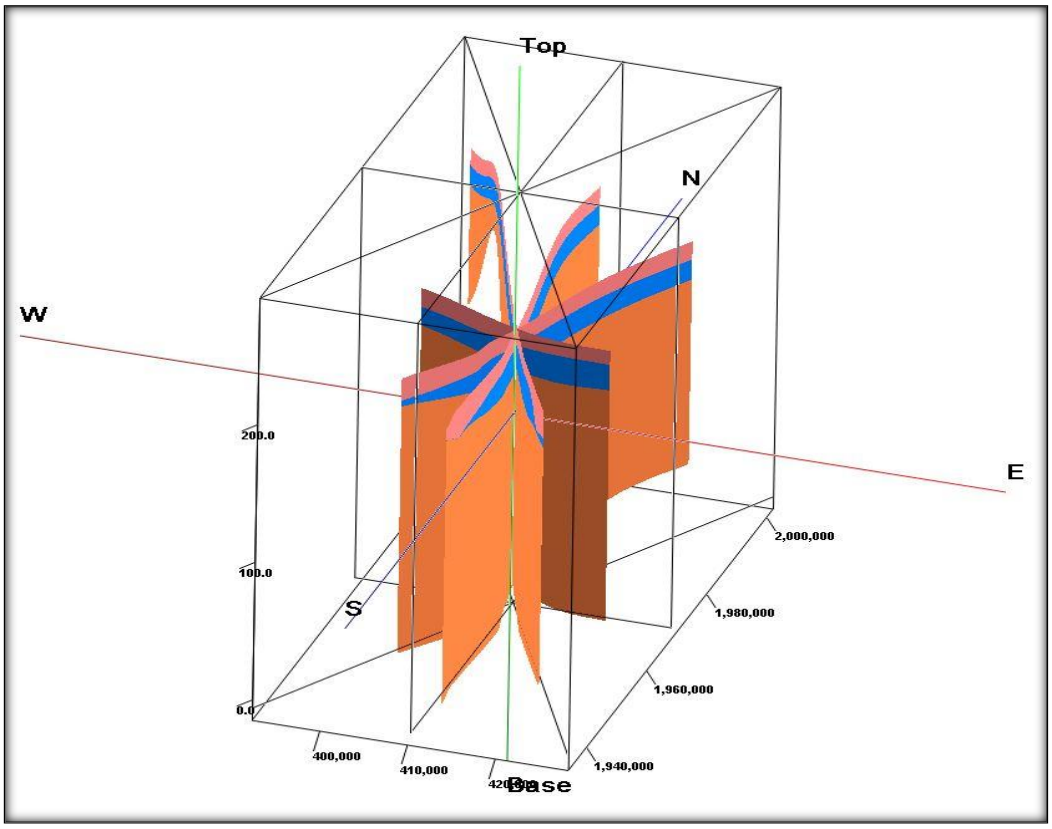



**Fig.-3.19: Fence diagram-Soft rock area**

### 3.4.1 Hydrogeological Cross Sections

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. NE-SW, NW-SE direction in Granitic area and NE-SW direction in Sandstone area (**Fig. 3.18**).

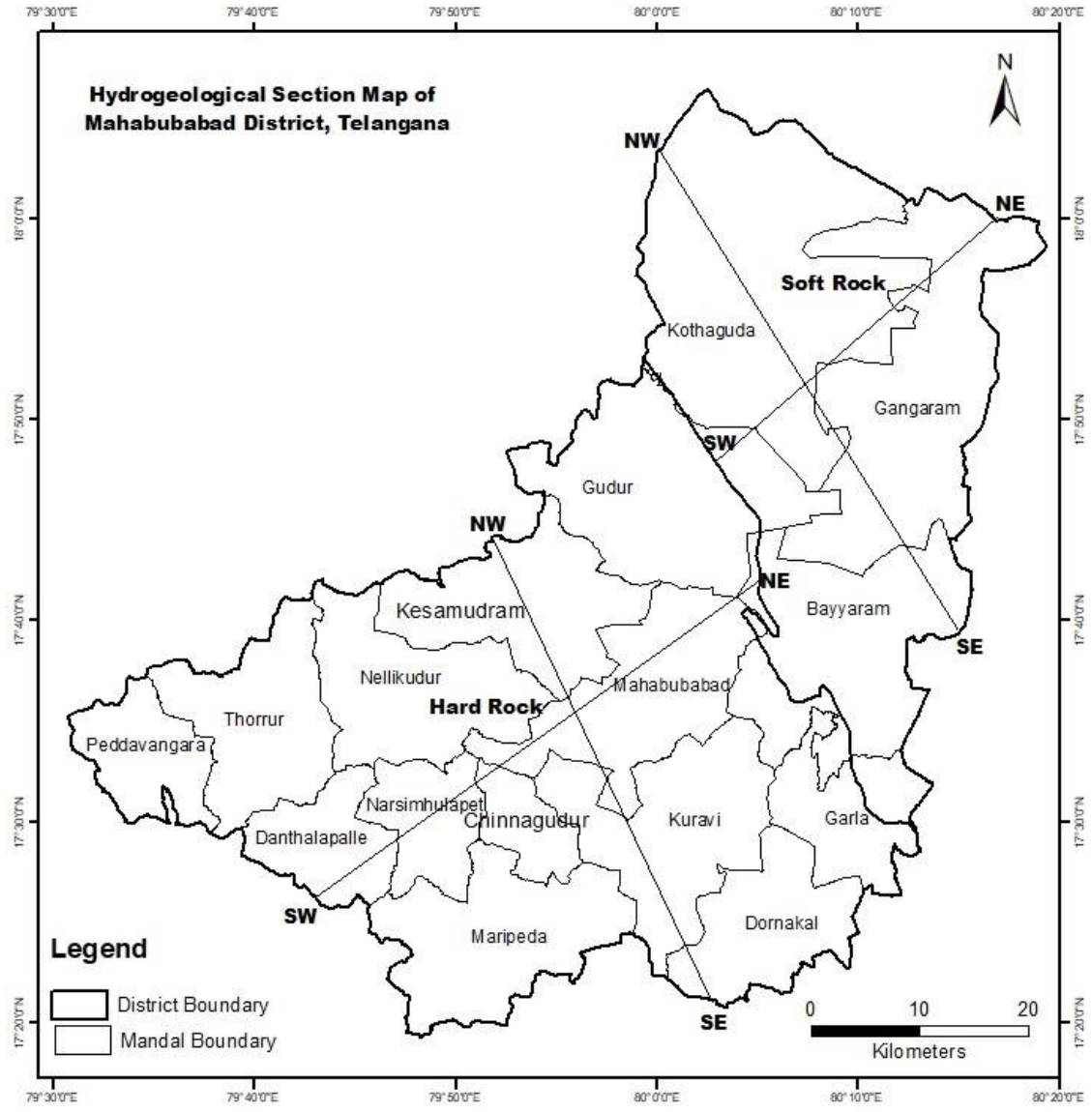



**Fig.-3.20: Map showing orientation of hydrogeological sections**

### 3.4.1.1 Hydrogeological Cross Section NE-SW(Hard rock)

Hydrogeological cross section NE-SW(Hard rock) (**Fig.3.21**) represents northeast-southwest direction covering a distance of ~46 kms. It depicts thick fractured zone overlaid by thin weathered zone in granites. As we move from northeast to southwest direction, depth of fracture zone varies from 40 m bgl at Kothapalli to 12.0 m bgl at Vanthedupu. The maximum depth of weathering ranging from 15.00 m bgl at Vanthedupu to 9.7 m bgl at Kothapalli.

### 3.4.1.2 Hydrogeological Cross Section NW-SE (Hard rock)

Hydrogeological cross section NW-SE (Hard rock) (**Fig.3.22**) represents northwest–southeast direction covering a distance of ~48 kms. It depicts thick fractured zone overlaid by thin weathered zone in granites. As we move from northwest to southeast direction, depth of fracture zone varies from 116 m bgl at Mariped to 12 m bgl at Ingurthi. The maximum depth of weathering ranging from 11.0 m bgl at Maripeda to 7.5 m bgl at Ingurthi.

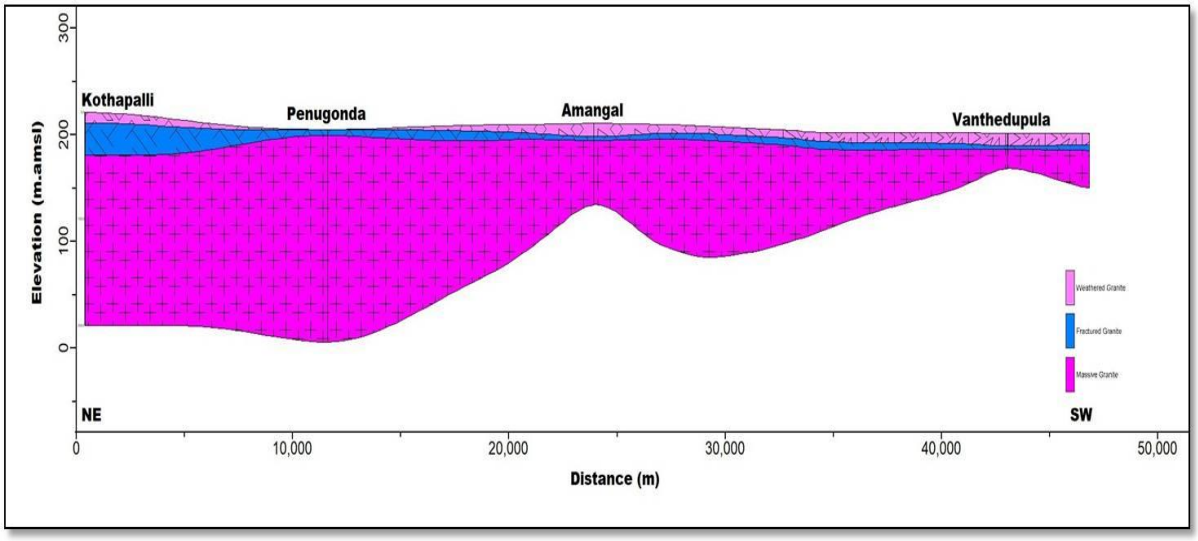



**Fig.3.21: Hydrogeological cross section NE-SW-Hard rock**

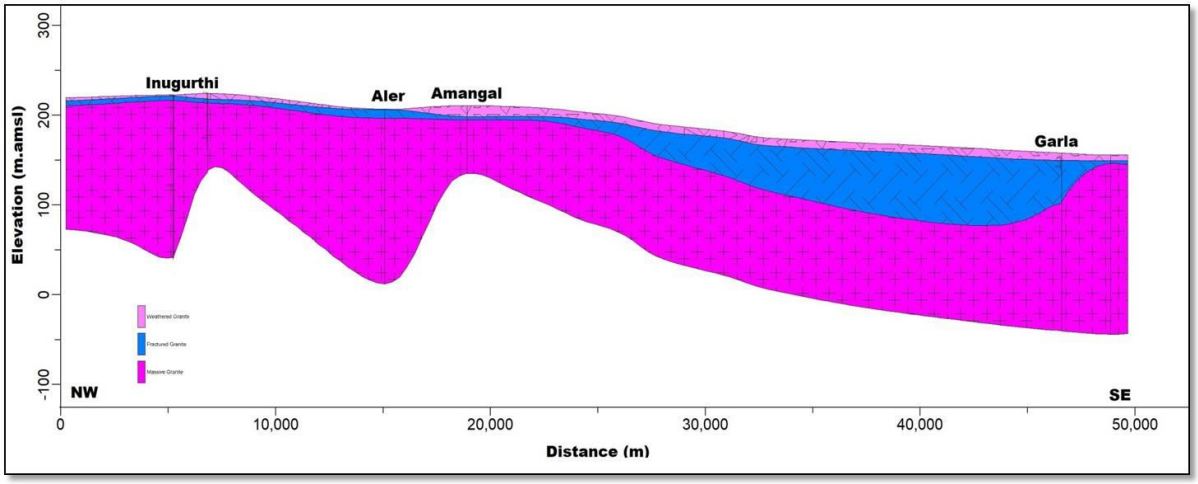



**Fig.3.22: Hydrogeological cross section NW-SE-Hard rock**

### 3.4.1.3 Hydrogeological Cross Section NE-SW (Soft rock)

Hydrogeological cross section NE-SW (Soft rock) (**Fig.3.23**) represents northeast–southwest direction in soft area covering a distance of ~32 kms. The thickness of the unconfined aquifer varies from 25m to 30 m depth. The confined aquifers extend upto depth of 300m.

### 3.4.1.4 Hydrogeological Cross Section NW-SE (Soft rock)

Hydrogeological cross section NE-SW(Soft rock) (**Fig.3.24**) represents northeast–southwest direction in sandstone area covering a distance of ~50kms in soft area. The thickness of the unconfined aquifer varies from 25 m to 30 m depth. The confined aquifers may be extending upto depth of 300m.

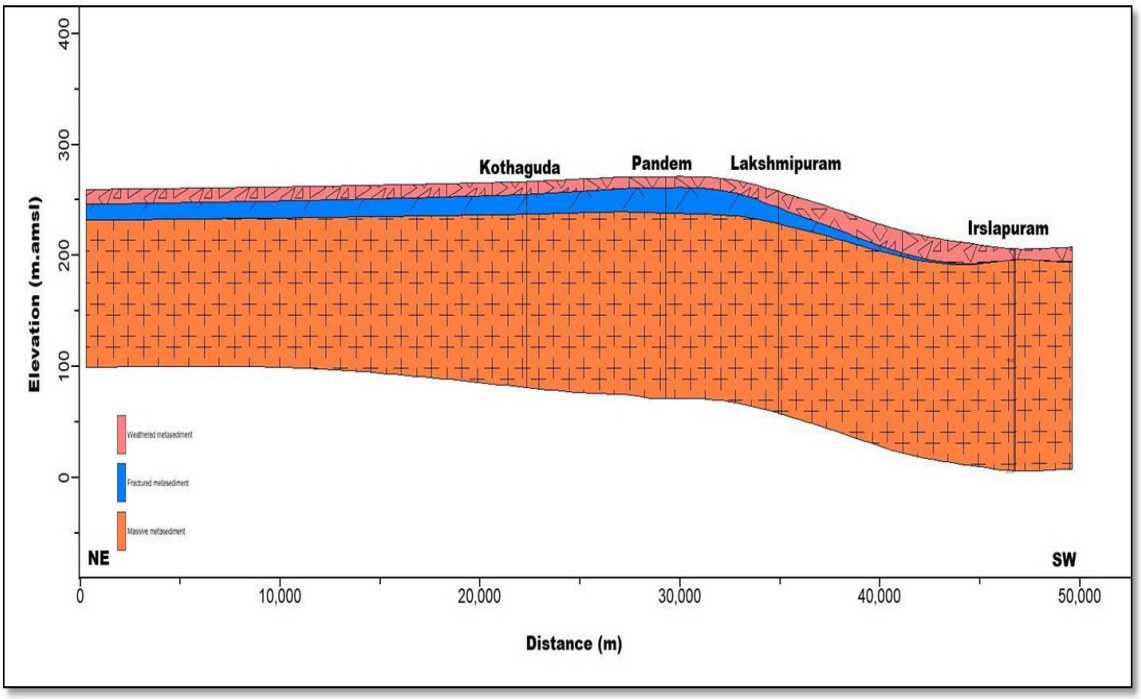



**Fig.3.23: Hydrogeological cross section NE-SW-Soft rock**

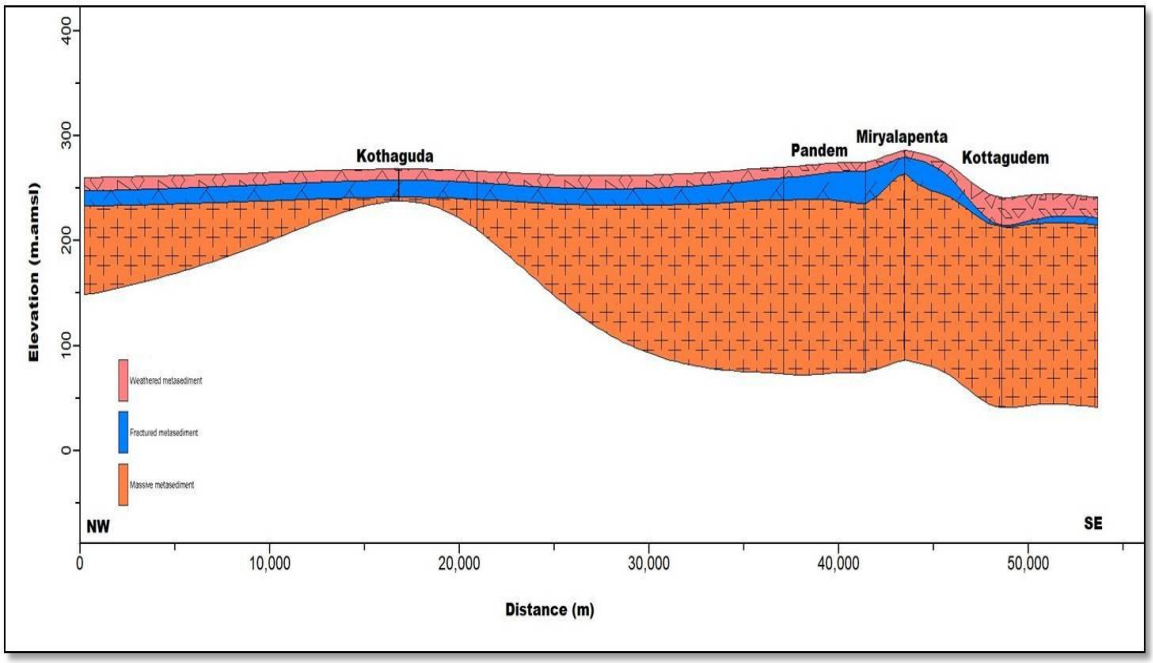



**Fig.3.24: Hydrogeological cross section NW-SE-Soft rock**

# 4. GROUND WATER RESOURCES

In hard rocks, for practical purpose it is very difficult to compute zone wise (aquifer wise) ground water resources, because the weathered zone (WZ) and fractured zone (FZ) are inter-connected with fractures/joints and fractured zones get 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. Village wise dynamic and in-storage ground water resources are computed as per the guidelines laid down in GEC 2015 methodology.

As per 2022 GEC report, the net dynamic replenishable ground water resources availability is 564.84 MCM, gross ground water draft for all uses is 286.98 MCM and net annual ground water potential available for future irrigation needs is 276.81 MCM. Stage of ground water extraction varies from 21.2 % at Gangaram mandal to 75.8 % at Dhantalapalli mandal. Out of 16 mandals, 1 is in Semi-Critical and 15 are in Safe categories (**Fig 4.1)**. 92 % of gross ground water draft is utilized for irrigation purpose only. A computed dynamic ground water resource of the district is given in **Table-4.1**.

**Table-4.1: Computed Dynamic Ground Water Resources.**

| | **As per GEC 2022** |
|---|---|
| | **MCM** |
| **Dynamic (Net GWR Availability)** | **564.84** |
| • Monsoon recharge from rainfall | 316.43 |
| • Monsoon recharge from other sources | 141.35 |
| • Non-Monsoon recharge from rainfall | 0.19 |
| • Non-monsoon recharge from other sources | 169.63 |
| • Natural Discharge | 62.76 |
| **Gross GW Draft** | **286.98** |
| • Irrigation | 264.48 |
| • Domestic and Industrial use | 22.50 |
| Provision for Drinking and Industrial use for the year 2025 | 17.18 |
| Net GW availability for future irrigation use | 276.80 |
| Stage of GW extraction (%) | **50.80** |

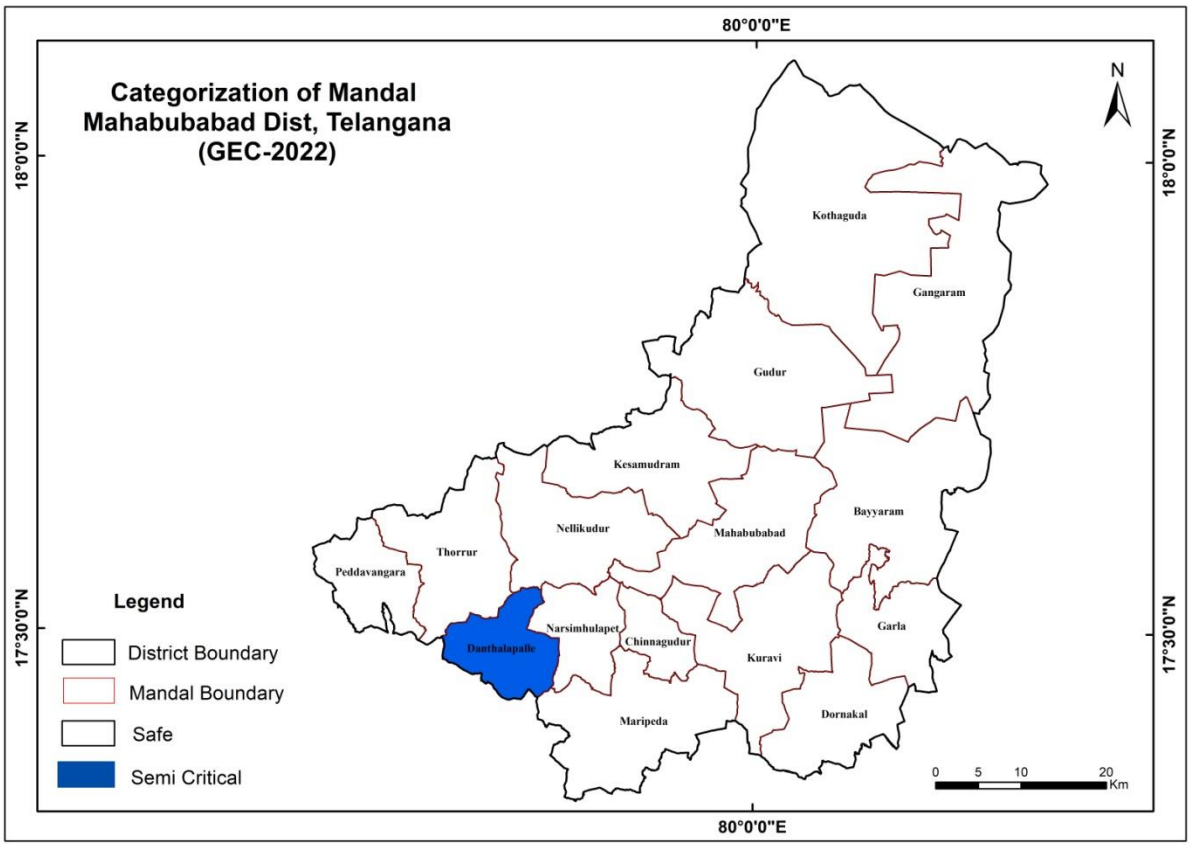



**Fig.4.1 : Categorization of mandals (GEC-2022)**

# 5. GROUND WATER RELATED ISSUES

## 5.1 Low Ground Water Potential

In Mahabubabad district, low ground water potential (< 1 lps) has been identified in south and south western and southeastern parts mostly due to granitic terrain (absence of primary porosity, negligible development of secondary porosity) and restricted depth of weathering. The occurrence of less rainfall and urbanization also affects the potential. The yield from bore wells have reduced over a period of time and some bore wells which used to yield sufficient quantity of water have gone dry due to low rainfall. Sustainability of the aquifer is limited and the wells normally sustain pumping for limited hours only.

## 5.2 Inferior groundwater quality

- Few mandals are fluorosis endemic where fluoride (geogenic) is as high as 4.09 mg/L during pre-monsoon and 3.34 mg/L during post-monsoon season. The high fluoride concentration (>1.5 mg/L) occur in 63% and 73% of the samples during pre-monsoon and post-monsoon season. Fluoride concentration 2-3 mg/L observed in Dornkal, Kesamudram, Danthalpalli, Narsimlupet and >3.0 mg/L observed in parts of Garla and Kothaguda mandals of district.

  Higher concentration of fluoride in ground water is attributed to source rock water interaction where acid-soluble fluoride bearing minerals (fluorite, fluoro-apatite) gets dissolved under alkaline conditions and higher residence time of ground water in deeper aquifer.

- High nitrate (> 45 mg/L) due to anthropogenic activities are observed in few mandals as high as 303 mg/L during pre-monsoon and 372 mg/L during post-monsoon season. The high nitrate concentration (>45 mg/L) occur in 16 % and 37 % of the samples during pre-monsoon and post-monsoon season respectively.

  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.

- The high concentration of EC (> 3000 micro-seimens/cm) is observed in 1 % and 3 % of the area during pre-monsoon and post-monsoon seasons respectively.

# 6. MANAGEMENT STRATEGY

Dependence on ground water coupled with absence of augmentation measures has led to a steady fall in water levels and de-saturation of weathered zone in some parts, raising questions on sustainability of existing ground water structures, food and drinking water security. The occurrence of fractures beyond weathered zone is very limited in extent at depth and majority of fractures normally occur within 100m depth.

The uneven distribution of ground water 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 management plan comprises 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.

## 6.1 Supply side management

The supply-side management of ground water resources can be done through artificial recharge by computing surplus runoff available within river sub-basins and also by repairing, renovation & restoration of existing tanks. In the district, 5006 MCM of unsaturated volume (below the 3 meter depth) is available during post-monsoon, having 100 MCM of recharge potential. This can be utilized for implementation of management strategy.

### 6.1.1 Artificial Recharge Structures (To be taken up)

The areas feasible for construction of recharge structures has been demarcated based on the analysis of post-monsoon depth to water level data and existing data on artificial recharge structures constructed under various schemes of MGNREGA and IWMP by Rural Development department, Govt. of Telangana. The availability of unsaturated volume of aquifer was computed by multiplying the area feasible for recharge and unsaturated depth below 3 m bgl. The recharge potential of aquifer is calculated by multiplying the unsaturated volume with specific yield of the aquifers (0.02 for hard rock and 0.03 for soft rock).

The source water availability is estimated from the rainfall 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, only 20% is considered for recommending artificial recharge structures in intermittent areas.

The storage required for existing artificial recharge structures by state government departments under different IWMP and MNREGS schemes is deducted to find the available surplus run-off for recommending the additional feasible artificial recharge structures.

50% of the available surplus run-off is considered for the recommendation of artificial recharge structures, as the remaining 50 % is recommended for implementing

water conservation measures in recharge areas through MGNREGS. The **Table 6.1** gives the area feasible and volume available for the recharge.

As the stage of ground water extraction in the district is 50.80 % and 15out of 16 mandals are falling in safe category as per the GEC 2022 estimation, the artificial recharge structures are not proposed for entire district. To control further increase in stage of ground water extraction, artificial recharge structures are recommended in 12 safe mandals (i.e., Chinagudur, Dornakal, Garla, Gudur, Kesamudram, Kuravi, Mahabubabad, Maripeda, Narsimlupet, Nellikuduru, Peddavangara, and Thorrur mandals) and 1 semi-critical mandal (i.e, Dantalpalli) only.

**Table 6.1: Area feasible and volume available for artificial recharge**

| | |
|---|---|
| Total geographical area of district (Sq.km) | 3579 |
| Area feasible for recharge (Sq.km) (in 9 mandals) | 1780.87 |
| Unsaturated Volume (MCM) | 5006.11 |
| Recharge Potential (MCM) | 100.12 |
| Surplus run-off available for recharge (MCM) | 43.59 |
| **PROPOSED ARTIFICIAL RECHARGE STRUCTURES** | |
| **Percolation Tanks** (@ Rs.20 lakh, Av. Gross Capacity=0.007 MCM*2 fillings = 0.0140 MCM)<br>Volume of Water expected to be conserved / recharged (in MCM)<br>Estimated Expenditure (in Crores) | 2<br><br>0.028<br>0.40 |
| **Check Dams** (@ Rs.15 lakh, Av. Gross Capacity=0.007 MCM* 5 fillings = 0.035 MCM)<br>Volume of Water expected to be conserved / recharged (in MCM)<br>Estimated Expenditure (in Crores) | 61<br><br>2.315<br>9.150 |
| Total volume of water expected to be recharged (in MCM) | 2.343 |
| **Total Estimated Expenditure for Artificial Recharge (Rs. in Cr.)** | **9.55** |

In the district, the total unsaturated volume (below the depth of 3 m) available for artificial recharge is 5006.11 MCM, having 100.12 MCM of recharge potential (2%). This available surplus run-off can be utilized for artificial recharge through construction of percolation tanks, check dams with recharge shafts at suitable sites. The number of percolation tanks, and check dams are decided based on the number of suitable streams available in the district.

Thus, after taking into consideration all the factors, only 43.59 MCM of surplus water can be utilised for recharge, which is given in **Table 6.1**. This surplus water can be utilized for constructing 61 check dams with estimated expenditure of Rs. 9.15 crores and 2 percolation tanks with estimated expenditure of Rs. 0.40 crores at suitable sites as shown in District Recharge Plan **(Fig-6.1).** The amount of recharge from these artificial recharge structures was calculated by considering 0.0140 MCM per percolation tanks and 0.035 MCM per check dam. This intervention would lead to recharge of about 2.343 MCM/year. The details are given in **Annexure-1.**

In addition to this roof top rainwater harvesting structures should be made mandatory to all Government buildings.

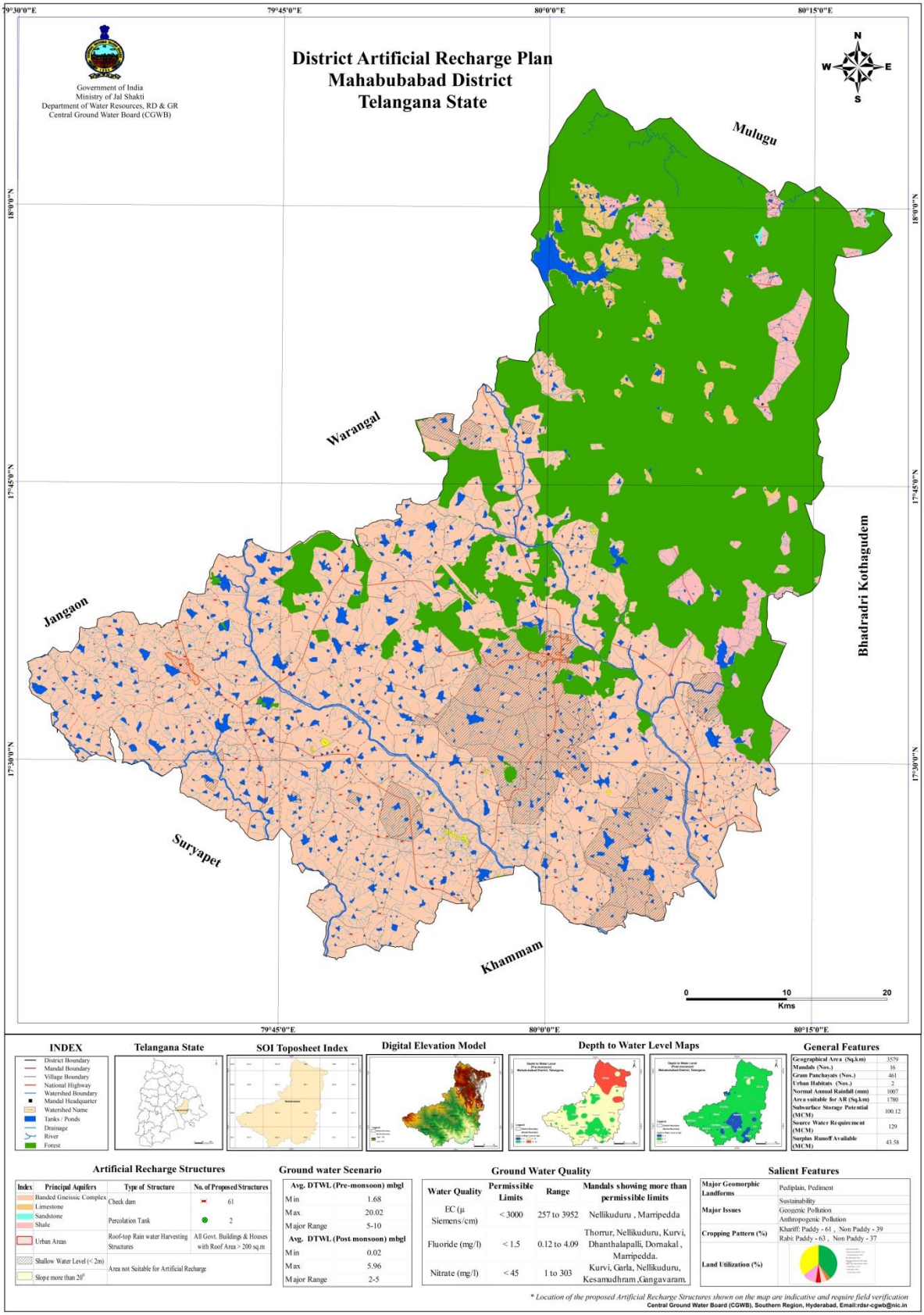



**Fig-6.1. Proposed District Recharge Plan of Mahabubabad district**

### 6.1.2 Water Conservation Measures (Farm Ponds)

The farm ponds are the ideal water conservation structures, which are constructed in the low lying areas of the farm. The size of farm ponds can be 10 x 10 x 3m. The total 5760 farm ponds are recommended (20 in each village in 288 villages of all mandals) at Rs.25000/-each with total cost of 14.40 Crores, this can create an additional storage of 1.73 MCM.

### State Government ongoing Projects

- **Mission Kakatiya (Repair, Renovation and Restoration of existing tanks):**

De-silting of existing minor tanks (1069 no.) was taken under state Govt. sponsored Mission Kakatiya (Phase-1 to 4) to remove silt and this has created additional surface storage and enhance groundwater recharge.

There is a need to take remaining tanks in the next phase for de-siltation; this will help greatly in stabilization of tank ayacuts and groundwater augmentation.

- **Mission Bhagiratha**:

Under Telangana Drinking Water Supply Project (TDWSP), also known as Mission Bhagiratha, all the villages and towns are proposed to be covered from the three water grids with intake from 1) Godavari River (Segment-Godavari-Pusuru), 2) Palair Reservoir (Segment- Palair-Warangal), 3) Yellampally Reservoir(tapping by HMWSSB from Yellampally Reservoir to provide protected water from surface reservoirs. The scheme is to enhance the existing drinking water scheme and to provide safe drinking water to 198871 no. of households in the district.

The total water requirement as per 2020 census is 32.56 MCM and this imported water from surface sources will reduce the present utilized ~19.53 MCM of ground water (considering 60 lpcd). This can be effectively utilized to irrigate ~3255 ha of additional land under ID crops.

Existing ARS like percolation tanks and check dams and dried dug wells can be de-silted involving people's participation through the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) (NREGA 2005). This will also help in sustainable management of ground water resources.

## 6.2 Demand side management

In order to manage the available resources more effectively the following measures are recommended.

- In the district, till date 3561 no's drip and sprinklers are sanctioned which has irrigated ~3807.71 ha in 16 mandals under ID crops saving ~5.71 MCM (considering 25% saving of 0.006 MCM/ha) of ground water from the basin. Considering the current scenario of ground water extraction, existing number of structures and shallow water levels, demand side intervention such as change in cropping pattern and micro irrigation has not been proposed.
- ~789 ha of additional land that can be brought under micro-irrigation (@1000 ha /mandal proposed in 1mandal (i.e., Danthalapalli) costing about 4.74 crores

(considering 1 unit/ha @0.6 lakh/ha). With this 1.18 MCM of ground water can be conserved over the traditional irrigation practices.

- Change in cropping pattern from water intensive paddy to irrigated dry crops (ID Crops) like pulses and millets are recommended particularly in where paddy cultivated area is ~ 80% of the Gross cropped area.
- 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.

## 6.3 Other Recommendations

- A participatory ground water 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 farmers involved.
- In urban and rural areas, the sewerage line should be constructed to arrest leaching of nitrate.
- The other measures that are recommended include supplementary calcium and phosphorous rich food to the children in fluoride endemic mandals. Creating awareness about safe drinking water habits, side effects of high fluoride and nitrate rich groundwater, improving oral hygiene conditions.

## 6.4 Expected results and outcomes

With the above interventions costing Rs 28.69 Crores (excluding the cost involved in Mission Kakatiya and Mission Bhagiratha), the likely benefit would be net saving of 5.25 MCM of groundwater. This will bring down the stage of groundwater exploration by 0.5 % (from 50.80 % to 50.30 %).

## Acknowledgment

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