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

JAGTIAL DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार

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GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

REPORT ON

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

CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD

MARCH, 2023

REPORT ON
AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN JAGTIAL DISTRICT, TELANGANA STATE
(AAP 2022-23)

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CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD
MARCH, 2023

EXECUTIVE SUMMARY

Jagtial district is situated in Northern Telangana zone of Telangana state. The district covers about 2419 km^2 geographical area which lies between North latitude 19.08045 to 19.08046 and East longitude 78.51696 to 79.47135 (Fig. 1.1). Administratively the district is governed by 18 revenue mandals and 287 villages with a population of ~9.8 lakhs (2011 census). The density of population in the district is 407 per Sq.km.

The majority of district is underlain by oldest Archaean formation and small part by Gondwana formation. About 95.5% of the area is underlain by Banded Gneissic Complex, Sandstones are 2.56% and limestone area is 1.82 %. The Peninsular Gneissic Complex are intruded by basic dykes and Quartz Pegmatite Gneissic, basically the dykes are in massive discordant body with North East to South West direction in discontinuous body at surface. The lower Gondwanas include the Talchirs, Barakars, Barren Measures and Kamthis.

Jagtial district is characterised by undulating topography with hill ranges, valleys and plains. The Pedeplain is the major landform covering about 65.38 % of the area. The other landforms observed are pediments (14.62 %), structural hills (1.61 %), channel Fills (1.49 %), intermontane valleys, channel bars and valley fills. Majority of soils are occupied by clayey montmorillonitic and fine montmorillonitic.

Out of the total geographical area of 2419 km^2, agriculture and forest are the prominent land use aspects in Jagtial district and forms 52.35 % and 22.94 % of total area respectively. The net sown area is 1266.56 km^2 while the gross cropped area is 1570.22 km^2. Paddy is the major crop grown in the district (80.66%).

District is benefitted by Sri Ram Sagar Project (SRSP), a major irrigation project on the Godavari river. The Project is serves irrigational needs of district. There is a hydroelectric plant working at the dam site, generating 36 MW electricity. The Project's capacity is 90 tmcft and it has 42 floodgates. It also includes Kakatiya Canal covering 284 km, Laxmi Canal, Sarswati Canal, and Flood flow canal. Kaleshwaram project link 21 is passing through Jagtial district and will be benefited for >19979 acres of land. The project consists of storage tanks, gravity canals, tunnels small reservoirs for lifting the water to provide the irrigation. Kaleshwaram project by making water available through pipeline in the flood flow canal (FFC) and Kakatiya canal (KC) in the district, will be helpful in draught conditions.

In Jagtial there are a total of 1226 water bodies which includes minor irrigation tanks having acute less than 100 Acres, more than 100 Acres, Anicuts, Privata kuntas, Percolation tanks and Check dams. Under these water bodies total 81,322 acres of acute is irrigated.

Data from total 48 Nos. Groundwater level monitoring stations (CGWB 16 nos. and SGWD 32 nos.) analysed to understand the groundwater level trend, current and historical water levels along with water level trend data for pre-monsoon and post-monsoon season. The pre-monsoon depth to water levels ranged between 4.16 mbgl (Vodde lingapur) and 15.65 mbgl (Atmakur). The shallow water levels of <6 mbgl are observed as isolated patches in parts of Raikal and Jagtial urban mandals. The post-monsoon depth to water levels ranges between 1.96 mbgl (Raikal) and 12.24 mbgl (Metpalli). The shallow water levels of <3 mbgl are observed in Beerpur, Raikal and Velgatoor mandals of the district. The water table elevation ranges from 146 to 378 m amsl during pre-monsoon period and 149 to 382 m amsl during post-monosoon period. The groundwater flow is mainly towards Northeastern direction.

100% (48 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 in Pegadapalli Mandal (1.46 m) while maximum water level fluctuation was observed in Korutla mandal (7.9 m). The decadal pre-monsoon water level trend analysis indicates that 23 wells show falling trend (<1.0m at 22 wells) (max fall: 1.22 m/yr at Mannegudem in Medipalli mandal) and 25 wells show rising trend (0-1 at 23 wells) (max rise: 2.03 m/yr at Kandlapalle in Beerpur mandal). During post-monsoon season 06 wells show falling trend and all show >1.0 m/yr fall (maximum fall: 0.39 m/Yr) and 42 wells shows rising trends (< 1 m/yr in 40 wells) (max rise: 1.84 m/yr at Bandalingpur in Metpalli mandal)

On the basis of occurrence and movement of ground water, rock units of the Jagtial district can be broadly classified into two categories: consolidated formation (Archean crystalline and meta-sedimentary formation) which occupies 95.62% of the area and semi-consolidated to unconsolidated formation (Sedimentary rock) which occupies 4.38 % of the area. In consolidated formations, Thickness of weathered zone in the range of <10 m i.e. shallow weathering occur in about ~48.25 % of area, weathering to medium depth of 10-20 m) occurs in 45.37 % while deep weathering of > 20 m is seen only in 6.37 % of the area. The depth of fracturing varies from 5.6 m to 140 m (deepest fracture encountered at Kondapur). Ground water yield from fractured gneiss varies from <0.077 to 8.0 lps. The transmissivity varies from 0.17-412 m^2/day and storativity varies from 0.001 to 0.01.

Semiconsolidatedformations ,which consists of sandstones, shales and clays that makes a thick sequence of sediments. Multiple aquifer systems (1 to 5 aquifers) 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 in Aquifer-II to IV. The deeper aquifers identified upto a depth of 300m. Ground water yield of sandstone aquifers varies from <1 to 18 lps .The transmissivity varies from 146.99 - 570.32 m^2/day and storativity varies from 2.04 x 10^{-4} to 5.50 x 10^{-4}.

A total of 246 samples were analyzed. Groundwater is mildly alkaline to alkaline in nature with pH in the range of 7.38 -8.36 (Avg: 8.07). Electrical conductivity varies from 410-2938 (avg: 1055) µ Siemens/cm. In 100 % of area EC is within 3000 µ Siemens/cm. Nitrate concentration varies from 0.2-256 mg/L and 38 %of the samples it is beyond permissible limits of BIS Standard (>45 mg/L). High Nitrate concentration is observed in Central, Notheastern & Northwestern parts of the district. Fluoride concentration varies from 0.11 to 2.74 mg/L and in 11 % of samples it is beyond permissible limits of BIS standard (>1.5 mg/L). High fluoride concentration is observed mainly in Mallapur, Ibrahimpatnam, Metpalli, Kathlapur, Medipalli, Mallial, Dharmapuri and Golapalli mandals and sparsely in Kodimial, Pegadapalli and Velgatoor mandals. .

The net dynamic replenishable groundwater resources availability is 428.21 MCM, gross ground water draft for all uses is 257.54 MCM and net annual ground water potential available for future irrigation needs is 148.79 MCM. Stage of ground water abstraction varies from 30.6 % at Beerpur to 97.9 % at Kodimial. Out of 18 mandals, 3 are in Semicritical, 2 in Critical and 13 are in Safe categories. 57.77 % of gross groundwater draft is utilized for irrigation purpose.

Major issues identified are sustanaibility of wells (< 1 lps) in some 77% of area particularly in consolidated granitic formation, high fluoride concentration (>1.5 mg/L) occur in 11% of the samples during pre and post-monsoon season, High nitrate (> 45 mg/L) occur in 38% of the samples during pre-monsoon and post-monsoon season each.

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 groundwater and further to maintain the sustainability, few supply side and demand side measures have been recommended. In the gneissi area, the artificial recharge structures recommended to improve the overall sustainability and recharge the Aquifer-I which is mainly of weathering part. The sandstone aquifers though potential, the groundwater occurs at depths, which requires high input costs in tubewell drilling and expertise to tap potential zones in Aquifer-II to Aquifer-IV. It is imperative to

recommend few artificial recharge structures under supply side to recharge Aquifer-I of Sandstone which is mainly unconfined.

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 (712 no.) was taken under state Govt. sponsored Mission Kaktiya (Phase-1 to 4) to remove silt and this has created additional surface storage and enhance groundwater recharge.

Under Mission Bhagiratha, there is plan to import ~32.06 MCM (drinking and industrial needs) and this imported water from surface sources will reduce the present utilized 17 MCM of groundwater (considering 60 lpcd). This can be effectively utilized to irrigate 2872 ha. of additional land under ID crops.

As the stage of ground water development in the district is 60.02 % and 13 out of 18 mandals are falling in safe category as per the GEC 2020 estimation, the artificial recharge structures are not proposed for entire district. To control further increase in stage of ground water development, artificial recharge structures are recommended in 02 Critical i.e. Kodimal & kathlapur and 03 semi-critical i.e, Mallial, medipalli & metpalli mandals, to control further increase in stage of ground water abstraction, which includes construction of 540 artificial recharge structures (278 CD's and 262 PT's) with a total cost of 94.10 cores are recommended as supply side measures. The total unsaturated volume (below the depth of 3 m) available for artificial recharge is 1096.01 MCM, having 21.92 MCM of recharge potential (2%).The available surplus run-off can be utilized for artificial recharge ~2193 ha of additional land that can be brought under micro-irrigation (@438 ha /mandal including existing area in 5 Critiical & semi-critical mandals (i.e. Mallial, Kodimial, Medipalli, Kathlapur & Metpalli) costing about 13.164 crores and with this 7.76 MCM of ground water can be conserved over the traditional irrigation practices.

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 costing Rs. 147.781crores (excluding the cost involved in Mission Kakatiya and Mission Bhagiratha), the likely benefit would be net saving of 56.103 MCM of groundwater. This will bring down the stage of groundwater abstraction by 3 % (i.e. from 60.20 % to 57.20 %). The onetime cost will be 4 paisa/litre and the actual cost of invest will be 0.6 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

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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

1. INTRODUCTION

Large parts of India, particularly hard rock aquifers have become water stressed due to rapid growth in demand for water in response to growth in population, irrigation, urbanization and changing life style. Therefore, in order to have an accurate and comprehensive micro-level picture of ground water in India, aquifer mapping tool has been devised. Aquifer mapping is a scientific process, wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. Systematic aquifer mapping at the appropriate scale can help prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of precious ground water resources. This helps to achieve drinking water security, improved irrigation facilities and sustainability in water resources development for the study area. Also results of these studies contributes significantly to resource management tools such as long-term aquifer monitoring networks and conceptual and quantitative regional ground-water-flow models to be used by planners, policy makers and other stakeholders. Aquifer mapping is expected to improve understanding of the users about geologic framework of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the potability of available ground water. Thus, this study will help reaching the goal-that of ground water management through community participation.

1.1 Objectives & Scope of study

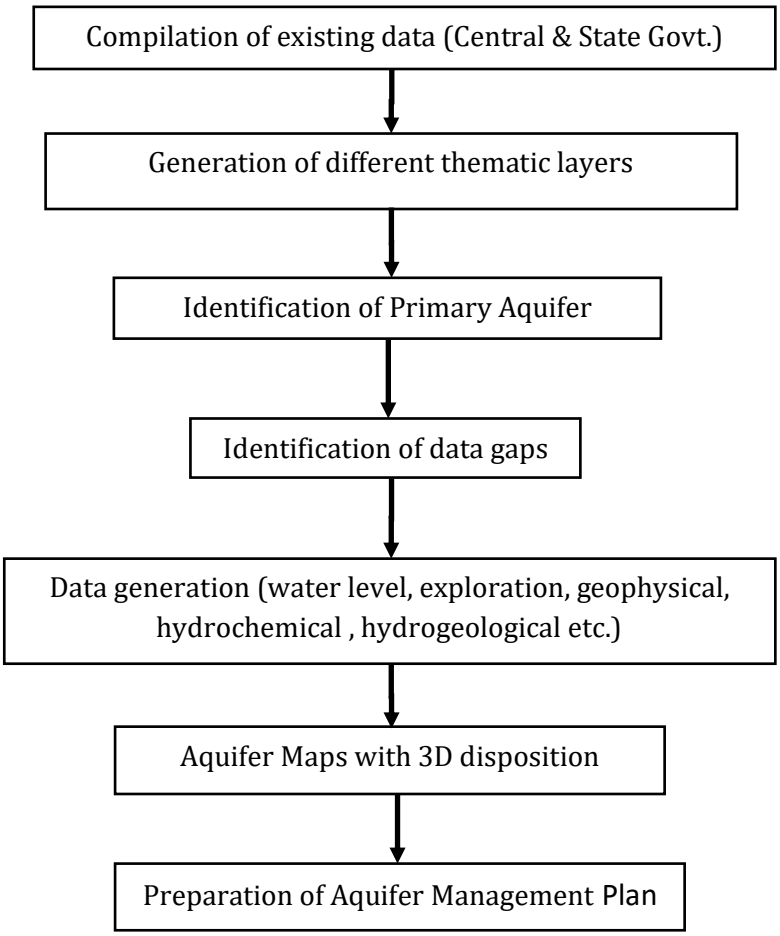
In view of the above, an integrated hydrogeological study was taken up in Jagtial district of Telangana state to develop a reliable and comprehensive aquifer map and to suggest suitable ground water management plan on 1: 50,000 scale. The main scope of study is summarised as below.

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

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 to 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

Jagtial district is situated in Northern Telangana zone of Telangana state. The district covers about 2419 km^2 geographical area which lies between North latitude 18^0 34'14" to 19^0 04'52" and East longitude $78^0$31'29" to $79^0$18'36" (Fig. 1.1). The average elevation is 258 mamsl. The district is bounded on the north by Nirmal district, on the east by Mancherial and Peddapalli districts, on the south by Rajanna Sircilla and Karimanagar districts and on the west by Nizamabad district. The natural boundaries are Godavari in the North and North-eastern side of the District. The present district is carved from erstwhile Karimanagar district. Administratively, the area is governed by 03

Revenue Divisions, 18 Revenue Mandals and 287 revenue villages with a population of 9,85,417 (2011 census : Rural: 77.54%, Urban: 22.46 %) with average density of 407 persons/km^2. The forest area occupy 22.94 % of the total area located in different parts of the district.

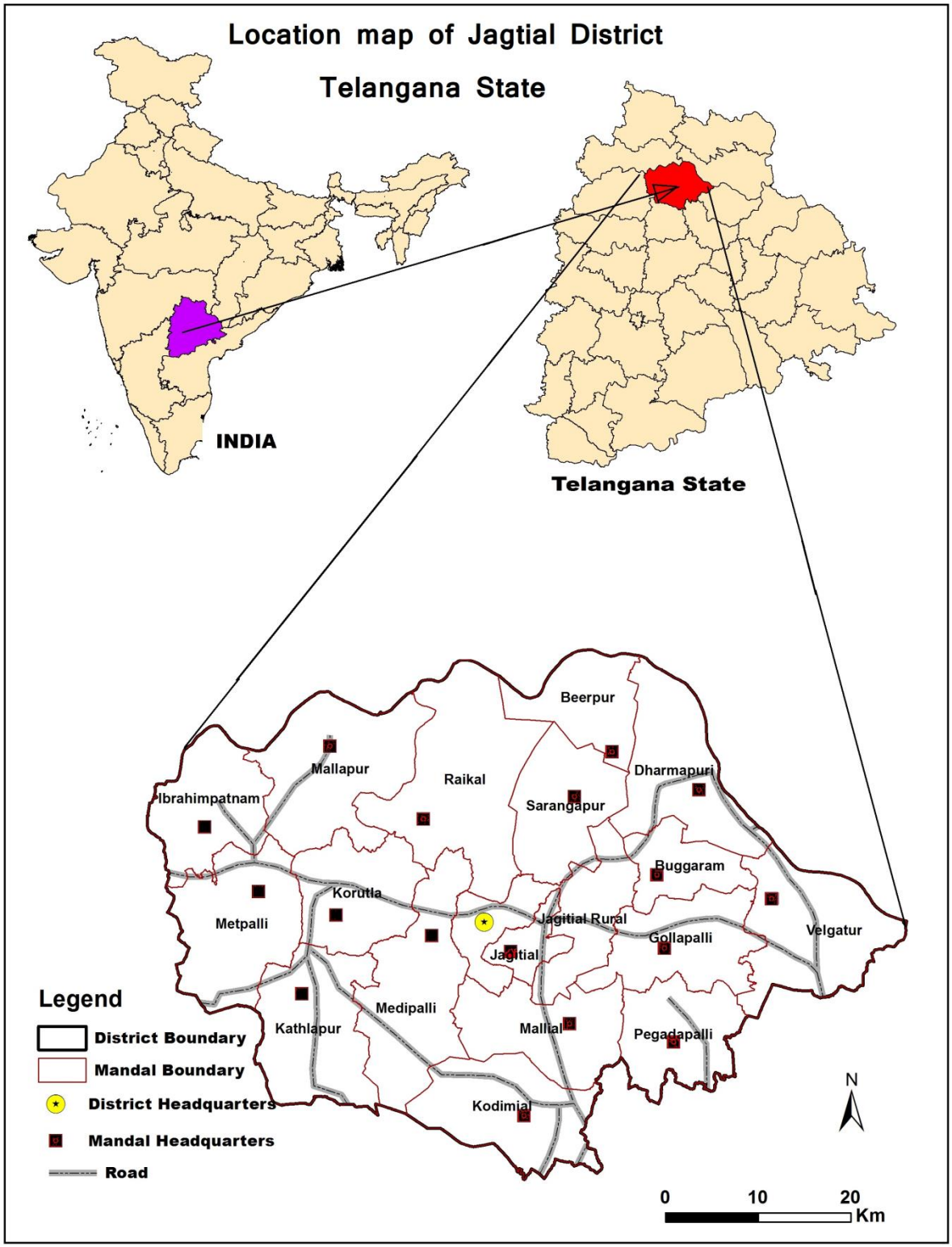


Fig.1.1: Location map of Jagtial district.

1.4 Climate and Rainfall

The district experiences tropical climate and is geographically located in semi-arid area. The district falls under Central Telangana Agro-climatic zone based on the geographical characteristics such as rainfall, temperature and nature of soils. As per IMD report, the Southwest monsoon enters into the district in June and lasts until second week of October and Northeast monsoon from October to December. Summer starts in March, and reaches peak in May with average highest temperature of 40.°C. Winter season starts in late November and lasts until early February with lowest average temperature of 23.0°C in January. In last 10 years, maximum temperature was 48.9 in Dharmapuri mandal as on 21/5/2015 and minimum was 5.2 in Raikal mandal as on 18/12/2014

The annual normal rainfall in the district varies from 897 mm (Kodimial mandal) to 1157.8 mm (Jagtial mandal) with district normal of 1024 mm. Average number of annual rainy days is around 60 days. Southwest monsoon contributes 82 % (839.68 mm), Northeast monsoon by 11 % (112.64 mm) and rest 7 % (71.68 mm) by January to May months of normal annual rainfall.

Isohyetal map prepared using annual normal rainfall of mandals in the district collected from DES, Govt. of Telangana is shown in Fig.1.2a. The district received excess rainfall of 132.91 mm (12.98 % above normal) during the water year 2020-21.

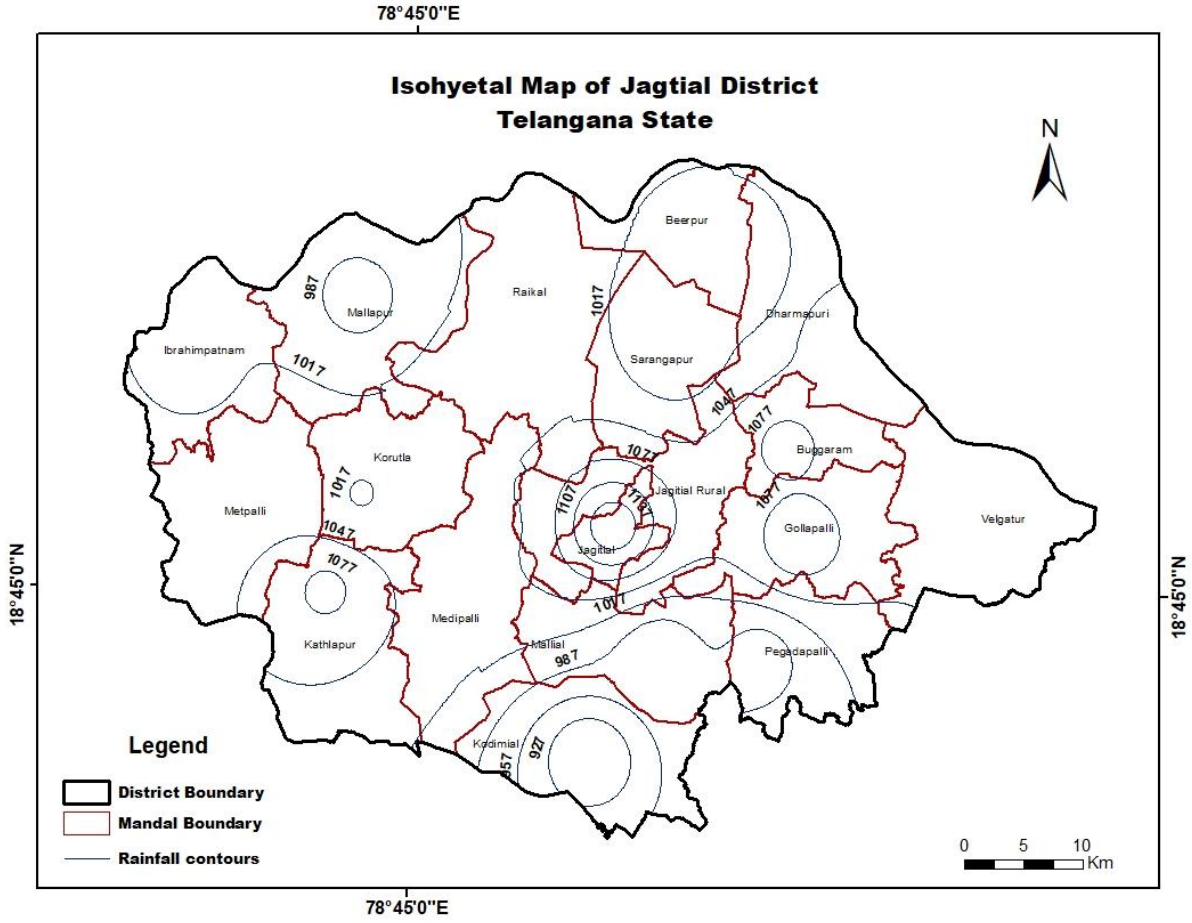


Fig.1.2a: Isohyetal map of Jagtial district.

Analysis of long term rainfall data of 17 years from 2005 to 2021 shows increasing trend in annual rainfall by 0.020 mm/year. District received excess rainfall (+20% and above normal) in 2010 and 2013, deficient rainfall (-20% and below normal) in 2004, 2008, 2011, 2015 and 2017 and normal rainfall (-19% to +19%) in remaining years (**Fig.1.2b)**. The monthly rainfall time series analysis for 17 years from 2005 to 2021 shows less-significant but increasing trend in monthly rainfall for May, June, August, October and December months (0.098, 0.043, 0.054 0.027 & 0.38 mm/Year respectively) and decreasing trend for January, March, September and November (-0.64, -0.02, -0.135, -0.25 mm/year) (**Fig. 1.2c**).

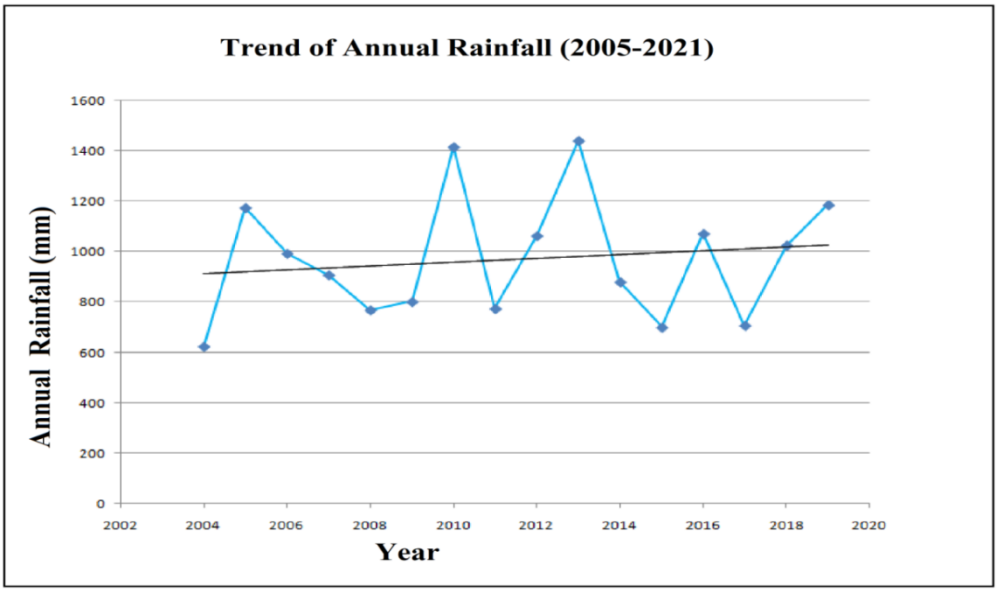


Fig.1.2b: Annual rainfall trend (2005-2021)

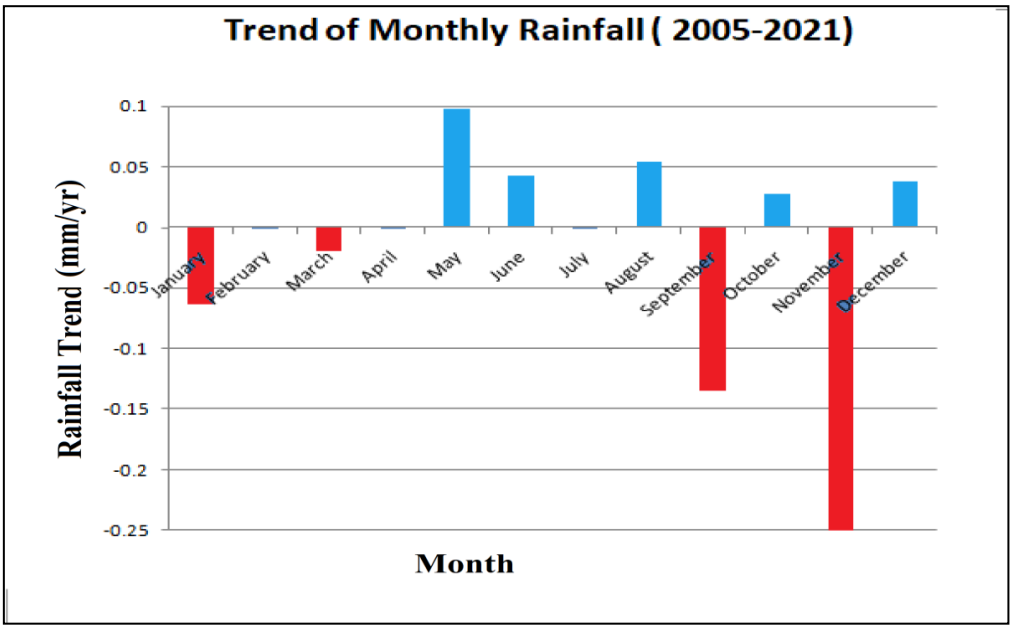


Fig.1.2c: Monthly rainfall trend (2005-2021)

1.5 Geomorphological Set up

Jagtial district is characterised by undulating topography with hill ranges, valleys and plains. The Pediplain is the major landform covering about 65.38 % of the area. The other landforms observed are pediments (14.62 %), structural hills (1.61 %), channel Fills (1.49 %), channel bars and valley fills. The geomorphology map of the district is presented in **Fig.1.3**.

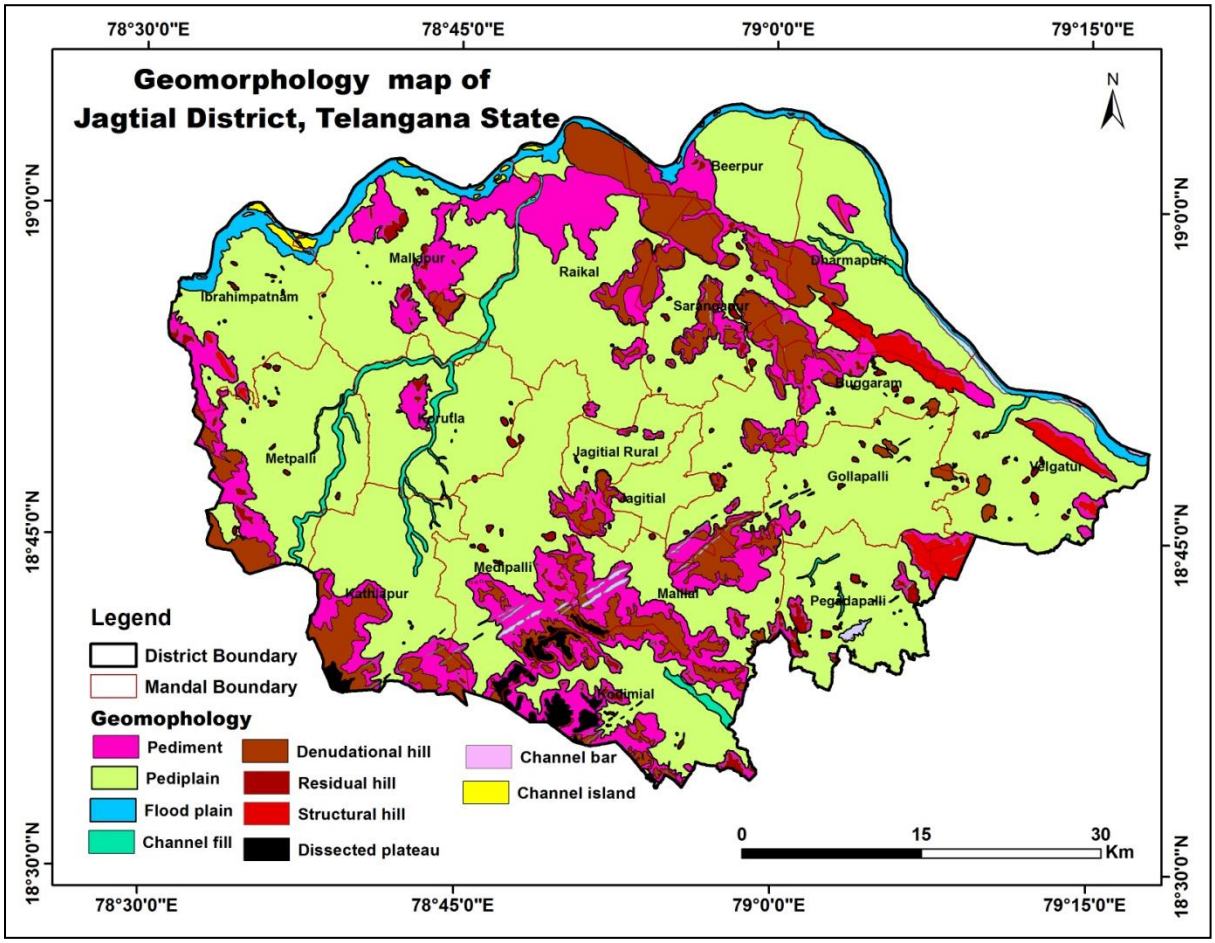


Fig.1.3: Geomorphology map of Jagtial district.

1.6 Drainage and Structures

River Godavari forms the natural boundary to Jagtial district in the northern part. The drainage pattern in the area is dendritic to sub-dendritic in nature. There are small tributary streams like Pedda vagu and Korutla vagu draining western part of the district and Velugavath draining eastern part, ultimately meeting Godavari river. The drainage in the northwestern part of the area is more sparse because there is a gradual relief towards the north east i.e. towards the Godavari river (the lowest elevation is below 190 m and the highest elevation, over 490 with respect to mean sea level). The decrease in observed density drainage in the district is on account of this elevation pattern. The map depicting drainage, water bodies, and river is presented in **Fig.1.4** as below**.**

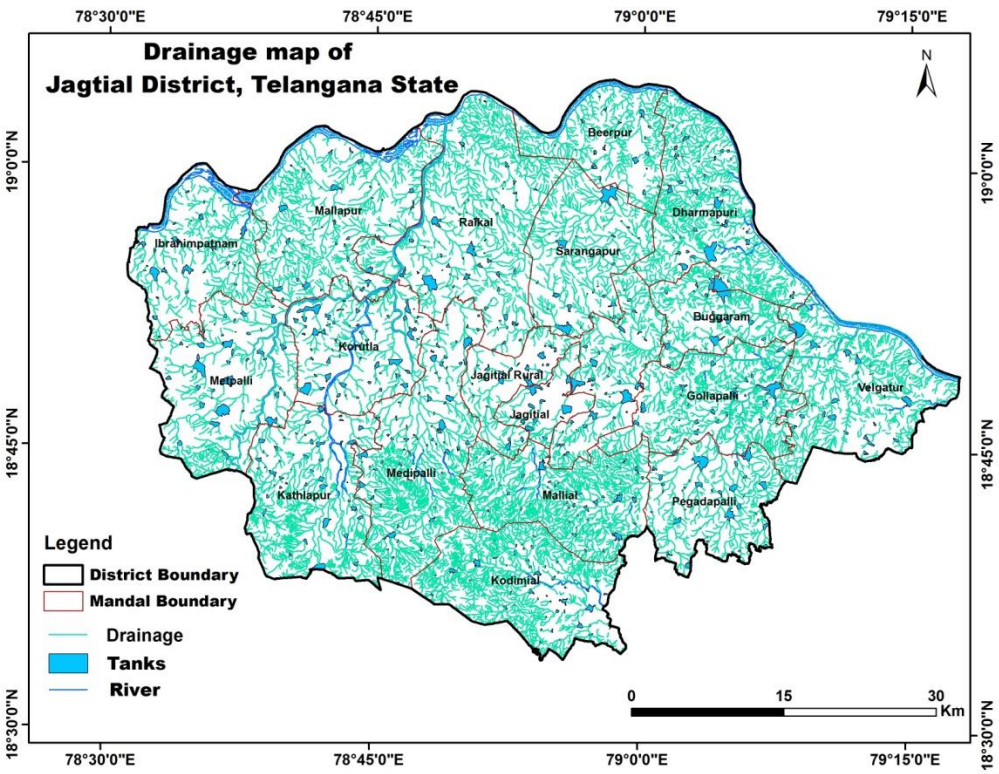


Fig.1.4: Drainage map of Jagtial district

1.7 Land use and cropping pattern

Out of the total geographical area of 2419 km^2, agriculture and forest are the prominent land use aspects in Jagtial district and forms 52.35 % and 22.94 % of total area respectively. The land utilization of Jagtial district is given in **Table 1.1** and the spatial distribution of land use is presented in **Fig. 1.5.**

Table: 1.1 Land utilisation in Jagtial District (2019-20)

Land Utilisation	**Area (in Sq.Km)**	**%age**
Forest	554.91	22.94 %
Barren and Uncultivable	81.28	3.36 %
Land put to Non-Agricultural uses	133.53	5.52 %
Culturable Waste	64.10	2.65 %
Permanent pasture and Other Grazing lands	108.12	4.47 %
Land under Miscellaneous Tree, Crops, Grovers (Not included in Net Sown Area)	52.01	2.15 %
Current Fallow Land	126.27	5.22 %
Other Fallow Land	32.41	1.34 %
Net Area sown	1266.56	52.35 %
Total Geographical Area	**2419**	**100 %**

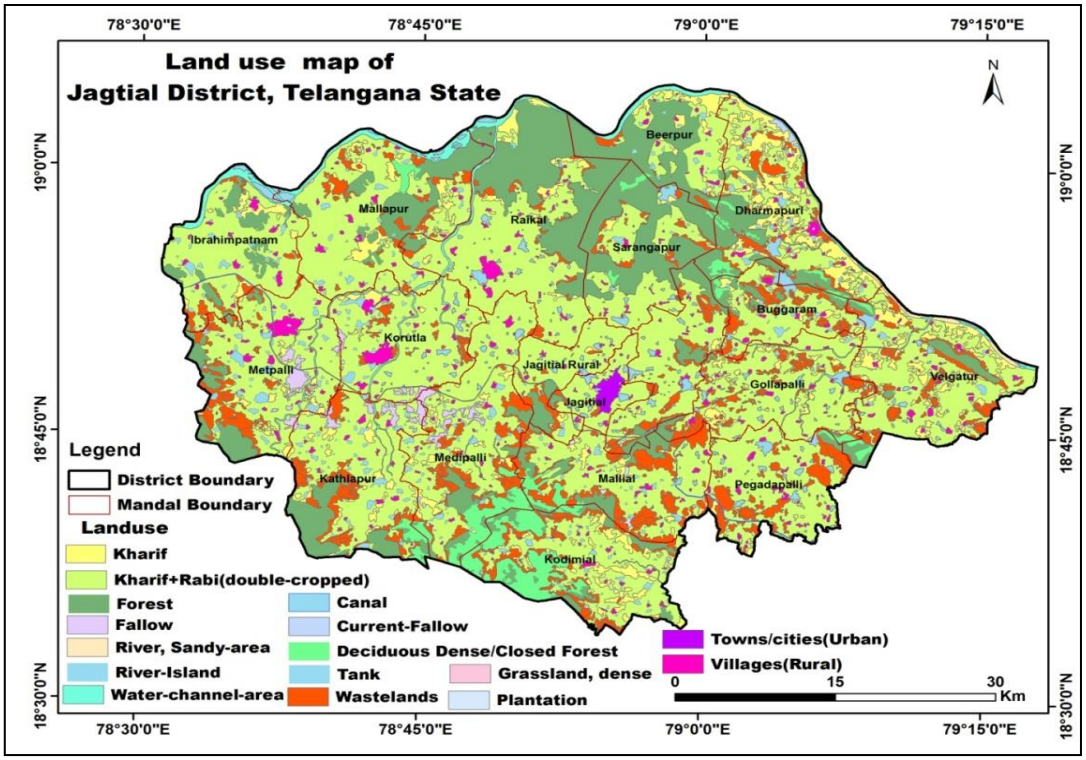


Fig.1.5: Land use and land cover of Jagtial district.

Cropping Pattern: Jagtial district is rich in natural resources for agriculture. Due to improved irrigation facilities, there is a lot of scope for agriculture in Jagtial district and farmers are going to get huge profits in coming days. The gross cropped area in the district is 1570.22 km^2 while the net sown area is 1266.56 km^2. Paddy is the major crop grown in the district (80.66 %). Other important crops grown in the district are Cotton, Maize, Turmeric, Groundnut and Chilli. The important fruit crops are Mango and Sweet orange, of late Banana, Papaya and vegetable cultivation also gaining momentum in the district. The crop distribution in Jagtial district is given in **table 1.2** as below.

Table: 1.2 Crop distributions in Jagtial district (2019-20)

Kharif Season		**Rabi Season**
Crops	**Area (Sq. Km)**	**Area (Sq. Km)**
Rice	1141.75	1025.46
Maize	209.21	78.65
Turmeric	137.91	-
Tomatoes	1.90	3.79
Red Gram	16.37	-
Soyabean	6.86	-
Cotton	112.91	-
Mangoes	138.00	-
Groundnut	-	2.19
Bengalgram	-	4.79

1.8 Soils

Jagtial district is fully endowed with various types of soils ranging from less fertile to fertile soils like fine clayey montmorillonitic, clayey skeletal, loamy skeletal, fine mixed, rock land and clayey skeletal soils. Majority of soils are occupied by clayey montmorillonitic and fine montmorillonitic. They are grouped into many classes (NBS & LUP) based on geomorphology and landscapes and further sub-divided based on physiography, relief and drainage .Soil distribution in Jagtial district is given in **Table 1.3** as below and is presented in **Fig. 1.6** as below.

Table 1.3 : Soil distribution in Jagtial district

SN	Soil type	%age	SN	Soil type	%age
1	Clayey-skeletal, mixed	7.6	6	Rock lands & Clayey-skeletal	10.42
2	Coarse loamy, mixed	2.95	7	Very fine, montmorillonitic	7.55
3	Fine loamy, mixed	0.98	8	Clayey, montmorillonitic	0.16
4	Loamy, mixed	5.4	9	Fine, montmorillonitic	14.35
5	Loamy-skeletal, mixed	6.0	10	Fine mixed	44.72

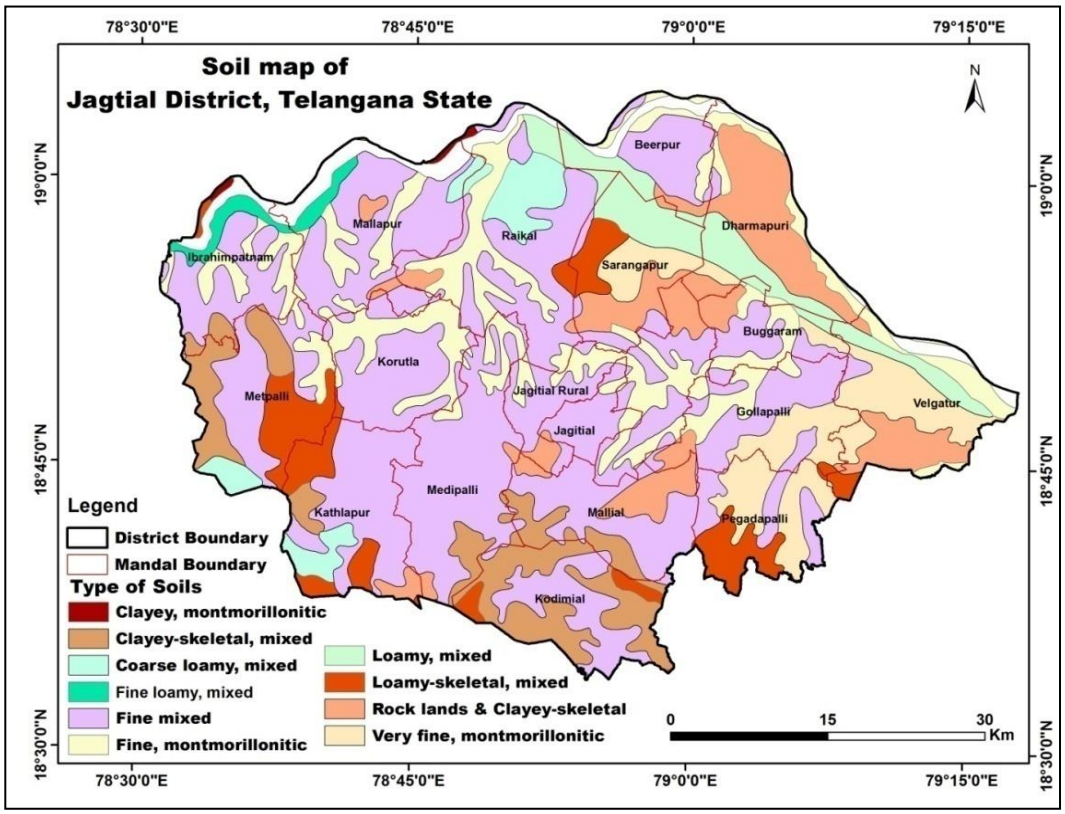


Fig.1.6 : Soil map of Jagtial district

1.9 Irrigation Projects

The district has made rapid strides in Agriculture and Horticulture production since establishment of Sri Ram Sagar Project (SRSP) which irrigates 15 mandals out of 18 mandals in the district. Major source of irrigation in the Jagtial district is canals linked with tanks, open wells, and borewells.

Sri Ram Sagar Project (SRSP)

This is a major irrigation project, also known as the Pochampadu Project, an Indian flood-flow project on the Godavari river. The project is located in Nizamabad district, serves irrigational needs of erstwhile Karimnagar, Warangal, Adilabad, Nizamabad and Khammam districts. It also provides drinking water to Karimnagar and Warangal cities and meets the water demands of National Thermal Power Corporation at Ramagundam. There is a hydroelectric plant working at the dam site, generating 36 MW electricity. The project's capacity is 90 tmcft and it has 42 floodgates. It also includes Kakatiya Canal covering 284 km, Laxmi Canal, Sarswati Canal, and Flood flow canal. The locations of the irrigation projects shown in Fig 1.8 as below.

Kaleshwaram project (link number 21)

The project link is passing through Jagtial district and will be benefited for >19979 acres of land. The project consists of storage tanks, gravity canals, tunnels, small reservoirs for lifting the water to provide the irrigation. Inspite, SRSP available in the district, at times some mandals still face water scarcity, Kaleshwaram project by making water available through pipeline in the flood flow canal (FFC) and Kakatiya canal (KC) in the district, will be helpful in draught conditions. The people who have migrated from this area due to over exploitation of ground water, Kaleshwaram project will a boon and certainly help bring them back.

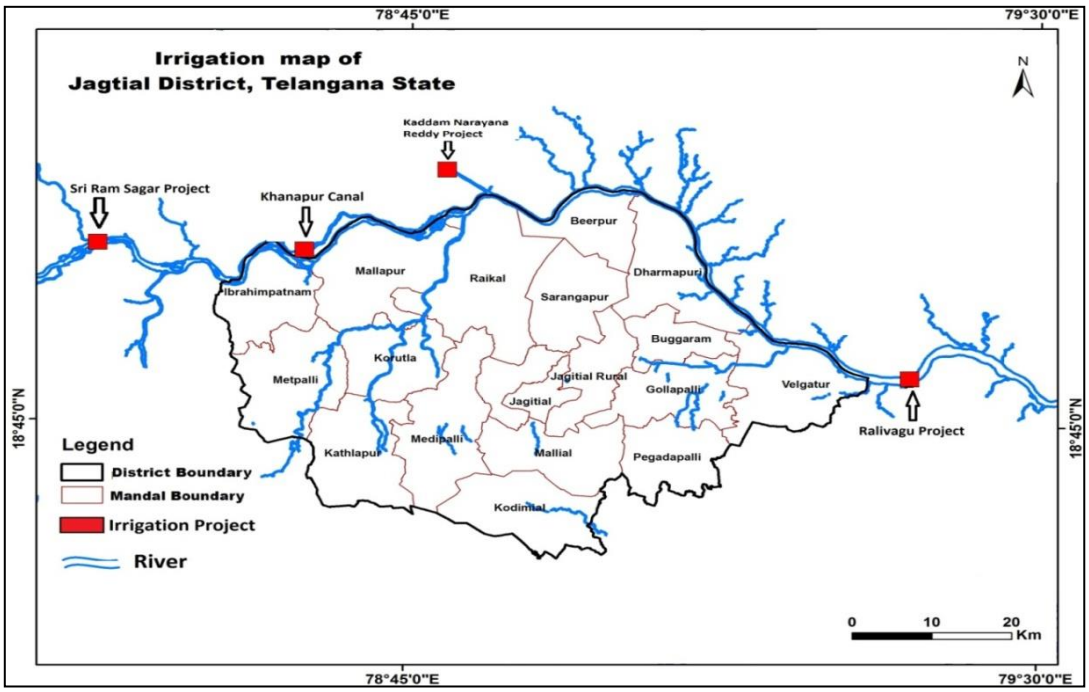


Fig. 1.8 Irrigation project in Jagtial district

Minor Irrigation : In Jagtial there are a total of 1226 water bodies which includes minor irrigation tanks having acute less than 100 Acres, more than 100 Acres, Anicuts, Privata kuntas, Percolation tanks and Check dams. Under these water bodies total 81,322 acres of acute is irrigated.

1.10 Prevailing Water Conservation/Recharge Practices

The topography and rainfall pattern in Telangana have made tank irrigation, an ideal type of irrigation by storing and regulating water flow for agricultural use. The sheer size of command area under tank irrigation makes it a large centre for agricultural production and provides a critical opportunity for commercial agriculture through market linkages.

The Mission Kakatiya

The objective is to enhance the development of agriculture based income for small and marginal farmers through sustainable irrigation resources by accelerating the development of MI infrastructure, strengthening community based irrigation management and adopting a comprehensive programme for restoration of tanks. Restoration of the tanks involve the components like,

1. Silt Removal.
2. Restoration of Feeder Channel to the tank (Part of chain of tanks).
3. Repairs of Bund, Weir & Sluices.
4. Re-sectioning of Irrigation Channels.
5. Raising of FTL, wherever possible//necessary.

Advantages/ benefits of scheme

Under Mission Kakatiya (Phase 1 to 4), 712 tanks have been benefitted under RRR (Repairs, restoration and Rejuvenation) schemes in Jagtial district and the following are the observations in area.

1. Decrease in consumption of chemical fertilizers by 35–50% resulting in reduced expenditure on fertilizers by 27.60% compared to year 2014. The decrease in expenditure ranges from Rs. 1500 to Rs. 3000 per acre per season, depending on the crops.
2. Further, the tank silt application contributed to increase in crop yields, reduction on soil erosion, increase in soil moisture retention, levelling of plot sizes etc.
3. Increase in ground water levels in the tank influence areas. Though the rainfall during the year e. 2013-14 was similar to 2016, the rise in ground water levels was found more in the year 2016 and still rising. This is due to larger and longer storage of water in the tanks. The average rise in ground water level was 6.91 m till 2014 but it was 9.02 m in the year 2016 from September to February.

4. In the year 2013-14, the gap ayacut was 42.40% whereas it is 23.20% in the year 2016-17, after implementation of the Mission Kakatiya Phase – I.
5. Irrigation Intensity (total cropped area Khariff & Rabi in ayacut) has been increased by 45.60% compared to year 2014. Iit is mainly due to the improved water retention capacity in the tanks post restoration works which directly increased the water retention capacity in the tanks. In the year 2014, the irrigation intensity was 88.40% and it is increased to 134% with implementation of Mission Kakatiya.
6. Increase is witnessed in the yields of Paddy, Cotton and Jowar after Mission Kakatiya Phase – I over the base year. The increase is more significant in Rabi Paddy (19.60% and Cotton (11.60%)
7. Apart from the farmers, the other major beneficiary of Mission Kakatiya is the fishermen community. Longer storage period of water in the tanks has resulted in the increased fish weight, and so the yield. On an average, there is an increase of 36- 39% yield, particularly in the Rohu, Katla and Mrigala types of fish.
8. There is an increase of household agricultural income by 78.50% in the tank ayacut area. The reason for increase can be attributed to increase in irrigated area and also the yields.

   (Source:https://irrigation.telangana.gov.in/icad/projects)

1.11 Geology

The rocks in the district belongs to Archaean & Mesozoic age. The Peninsular Gneissic Complex are intruded by basic dykes and Quartz Pegmatite Gneissic, basically the dykes are massive discordant body with North East to South West direction in discontinuous body at surface. Gondwana sediments which overlie the rocks of Peninsular Gneisses Complex occupy the eastern and north-eastern parts of the district. These sediments have been classified in to Chikkialas, Kota, Maleris, Kanthis, Barakars & Talchir formations. 95.51 % of the district area is underlain by Banded Gneissic Complex and Sandstones occur only 2.56% and limestone represent 1.82 % only. The general geological succession of the area is presented below in the **as Fig1.9 and Table-1.4.**

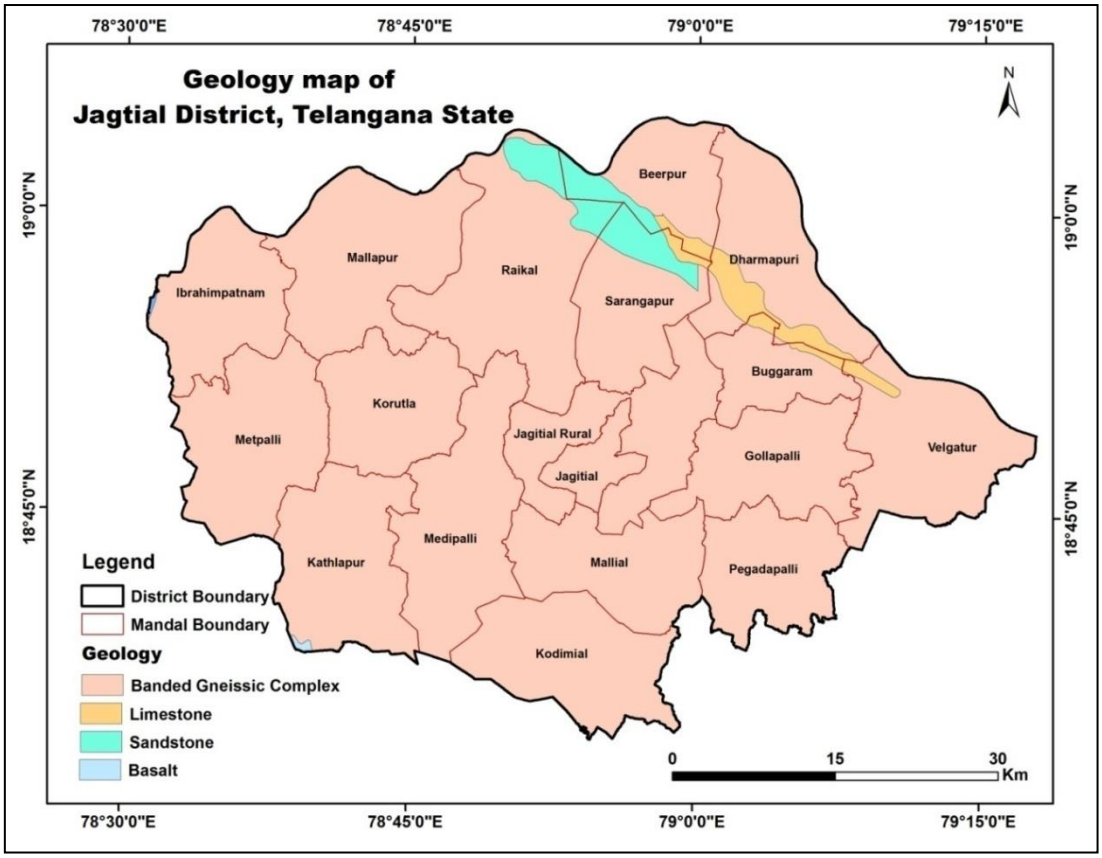


Fig.1.9: Geology map of Jagtial district.

Table-1.4: Stratigraphic Succession of Jagtial district

Era	Period	Group	Formation	Lithological Description
Mesozoic	Jurassic to Upper Carboniferous	Upper Gondwanas	Chikkialas Kota Maleris	Sandstone, Clay, Grit and Limestone
		Lower Gondwanas	Kamthis Barren Measures Barakars Talchirs	Sandstones, Shales and Clays, Coal seams and boulder beds
Unconformity				
Azoic	Archaeans	Archaeans		Granites and Gneisses

2. DATA COLLECTION AND GENERATION

Collection and compilation of data for aquifer mapping studies is 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 under Aquifer mapping programme.

S. No.	Activity	Sub-activity	Task
1	Compilation of existing data & Identification of Principal Aquifer Units and Data Gaps	Compilation of Existing data on ground water	Preparation of base map and various thematic layers, compilation of information on Hydrology, Geology, Geophysics, Hydrogeology and Geo-chemical. Creation of database 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 ground water 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 ground water for general parameters including fluoride.
3.	Aquifer Map	Analysis of data and	Integration of Hydrogeological, Geophysical,

	Preparation(1: 50,000 scale)	preparation of GIS layers and preparation of aquifer maps	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 aquifers has been established by utilising the data generated through various hydro geological, exploration, surface and subsurface geophysical studies in the district. The data used for the integration and interpretation is explained in the following sections:

2.1 Ground Water Exploration

Total 37 wells were analyzed as exploration record at different depths in the Jagtial district. Out of these, 27 borewells were constructed by CGWB and 10 borewells drilled by SGWD **(Table 2.2).** The locations of all data points for exploration are shown in **Fig. 2.1**.

All these borewells were drilled in consolidated formation. Data analysed indicates that, 06 wells are of shallow depth i.e. ≤30 mbgl, 26 wells are in the range of 30 to 100 mbgl depth and 05 wells are in the range of 100-200 mbgl depth. Deepest fracture was encountered at 110 m.bgl at Bomena, Kathlapur Mandal.

Table-2.2: Ground Water Exploration wells

Source	Exploratory wells	Observation wells
CGWB	18	09
SGWD	08	02

2.2 Geophysical Studies

Geophysical data on VES and profiling 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 ground water exploration data is utilised. The data from 11 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. 2.1)**. The data was processed and interpreted by IPI2Win software, after marginally modifying the 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.**

Table-2.3: Resistivity values for various formations

Formation	Resistivity range (ohm-m)	Thickness (m)
Weathered Gneisses	5-76	2-25
Fractured/Jointed/Semi-weathered Gneisses	100-400	30-90
Hard/compact Gneisses	More than 500	

2.3 Ground Water Monitoring Wells

Data from total 48 Nos. ground water level monitoring stations (CGWB 16 nos. and SGWD 32 nos.) has been analysed to understand the ground water level trend, current and historical water levels along with water level trend data for pre-monsoon and post-monsoon season. CGWB wells being monitored four times (January, April, August and November) in a year whereas; the monitoring wells of State Ground Water Department (SGWD) are monitored every month. The information from thesse ground water monitoring wells was used in order to understand the spatio-temporal behaviour of the ground water regime in the district. The data is given in **Table-2.4** and locations of monitoring wells are shown in **Fig. 2.1.**

Table-2.4: Ground Monitoring wells

Source	No. of wells
CGWB	16
SGWD	32
Total	**48**

2.4 Ground Water Quality

To understand chemical quality of ground water, water quality data for pre-monsoon season and post-monsoon season respectively were utilized for the analysis for 246 stations including CGWB NHS stations, SGWD monitoring Stations and 31 Pzs. 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. The locations of these monitoring well stations are shown in **Fig. 2.1.**

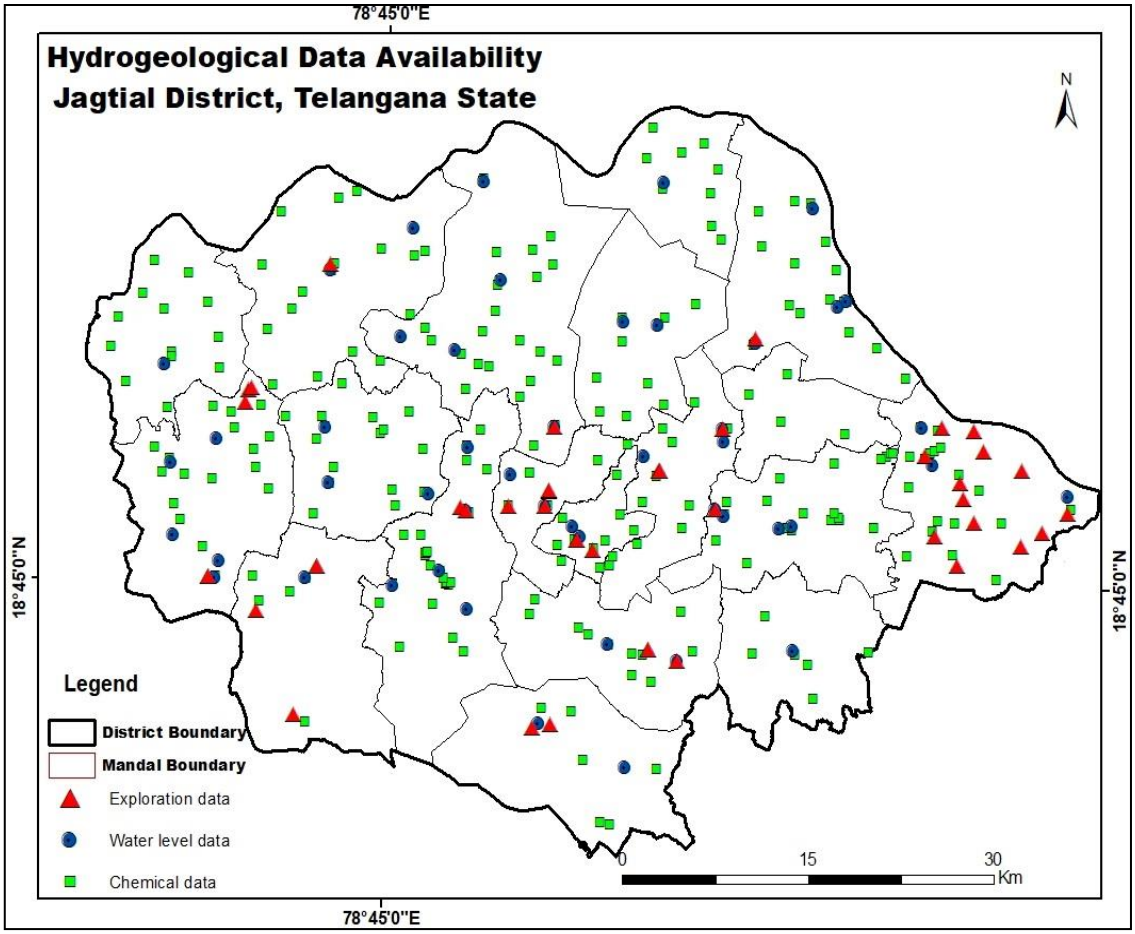


Fig.2.1: Hydrogeological Data availability

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, ground water resources were generated and are discussed in detail in following sections .

3.1 Water Level Scenario

The present depth to water level scenario for pre-monsoon and post-monsoon season was generated by utilizing water level data of 48 (CGWB: 18, SGWD: 30) monitoring wells.

Pre-monsoon

The pre-monsoon depth to water levels ranges between 4.16 mbgl (Vodde lingapur) and 15.65 mbgl (Atmakur). The shallow water levels of <6 mbgl are observed as isolated patches in parts of Raikal and Jagtial urban mandals. (0.001 % of area), whereas water levels between 5-10 mbgl are mainly observed in majority mandals of the district except in Kodimial mandal (80.38 % of area). The deeper water levels of >10 mbgl observed in parts of Metpalli, Kathlapur, Korutla, Mallial and Kodimial mandals (18.79 %). The pre-monsoon depth to water level map is given in **Fig.3.1.**

Post-monsoon

The post-monsoon depth to water levels ranges between 1.96 mbgl (Raikal) and 12.24 mbgl (Metpalli). The shallow water levels of <3 mbgl are observed in Beerpur, Raikal and Velgatoor mandals of the district (8.99 % of area). The water levels between 3-5 m bgl are observed in most parts of the district (47.14% of area). Moderate water levels between 5-10 mbgl are observed mainly in parts of Mallapur, Ibraahimpatnam, Metpalli, Korutla, Kathlapur, Medipalli, Mallial, Kodimial and Jagtial rural mandals (43.44 % of the area). The deeper water levels of >10mbgl are observed as isolated patches in Metpalli mandal (0.43 % of area). The post-monsoon depth to water level map is given in **Fig.3.2.**

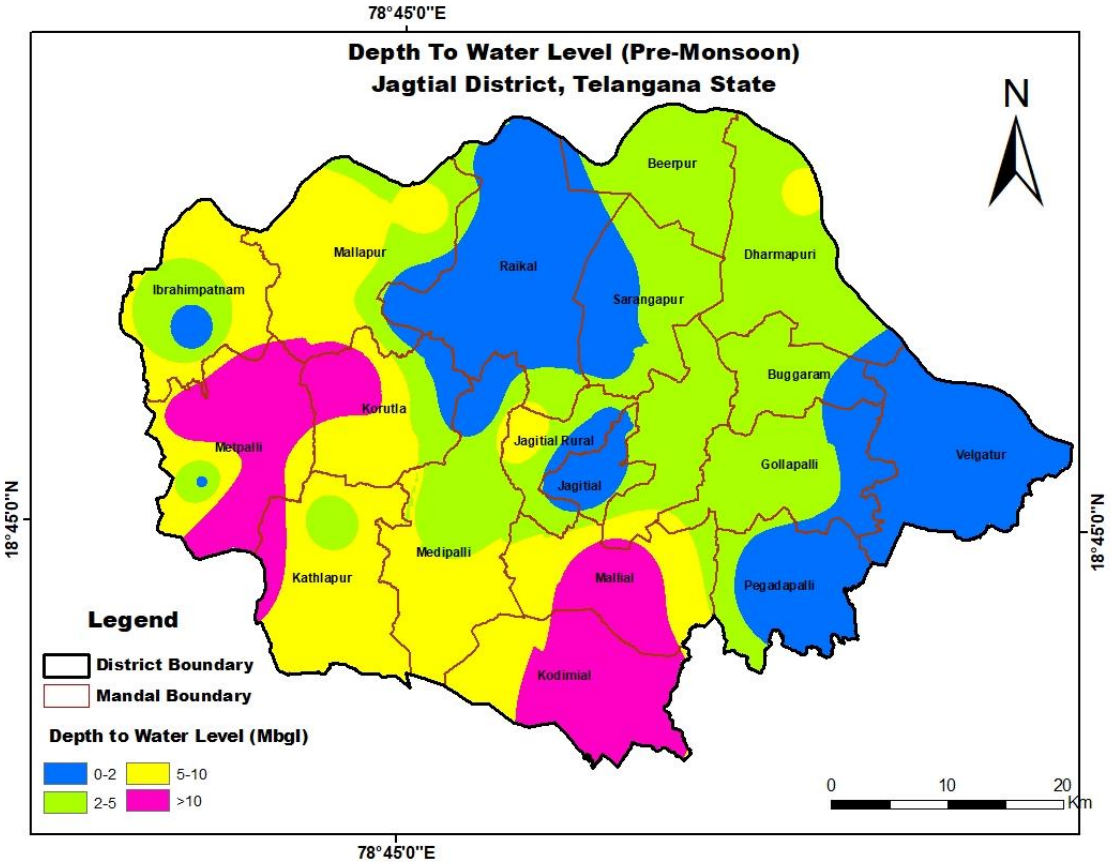


Fig.3.1: Depth to water level map of pre-monsoonseason (Average:2011-2020)

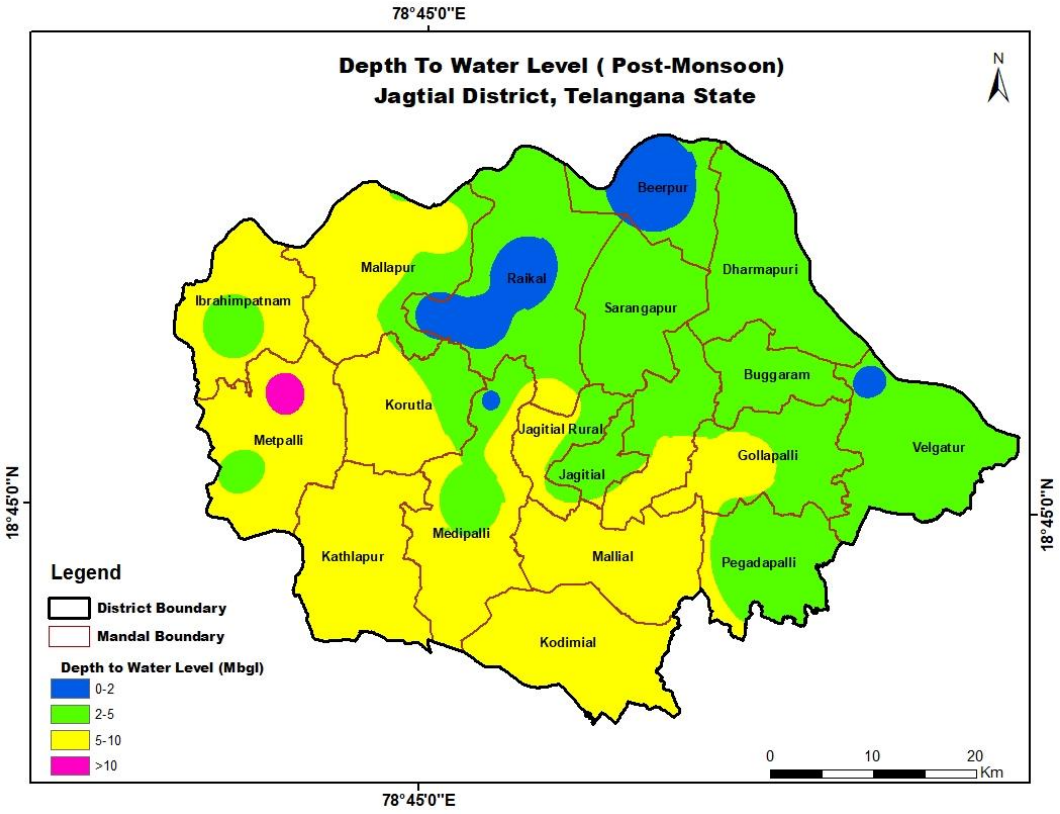


Fig.3.2: Depth to water level map of post-monsoon season (Average:2011-2020)

3.1.1 Water Level Fluctuation

The water level measured during pre and post monsoon period was used to compute the seasonal fluctuation. 100% (48 no's) of the wells show rise in water level. The analysis of water level fluctuation data indicates that minimum water level fluctuation was observed in Pegadapalli Mandal (1.46 m) while maximum water level fluctuation was observed in Korutla mandal (7.9 m). The water level fluctuations were grouped under three categories i.e., less, moderate and high and the percentage of wells in each category was analysed (**Table-3.1**). The seasonal fluctuation map is presented as **Fig.3.3**.

Table-3.1: Analysis of Water Level Fluctuation

S. No.	Category	Fluctuation Range	% of area
1.	Less water level fluctuation	< 3 m	42.11 %
2.	Moderate water level fluctuation	3-6 m	57.23 %
3.	High water level fluctuation	>6 m	0.65 %

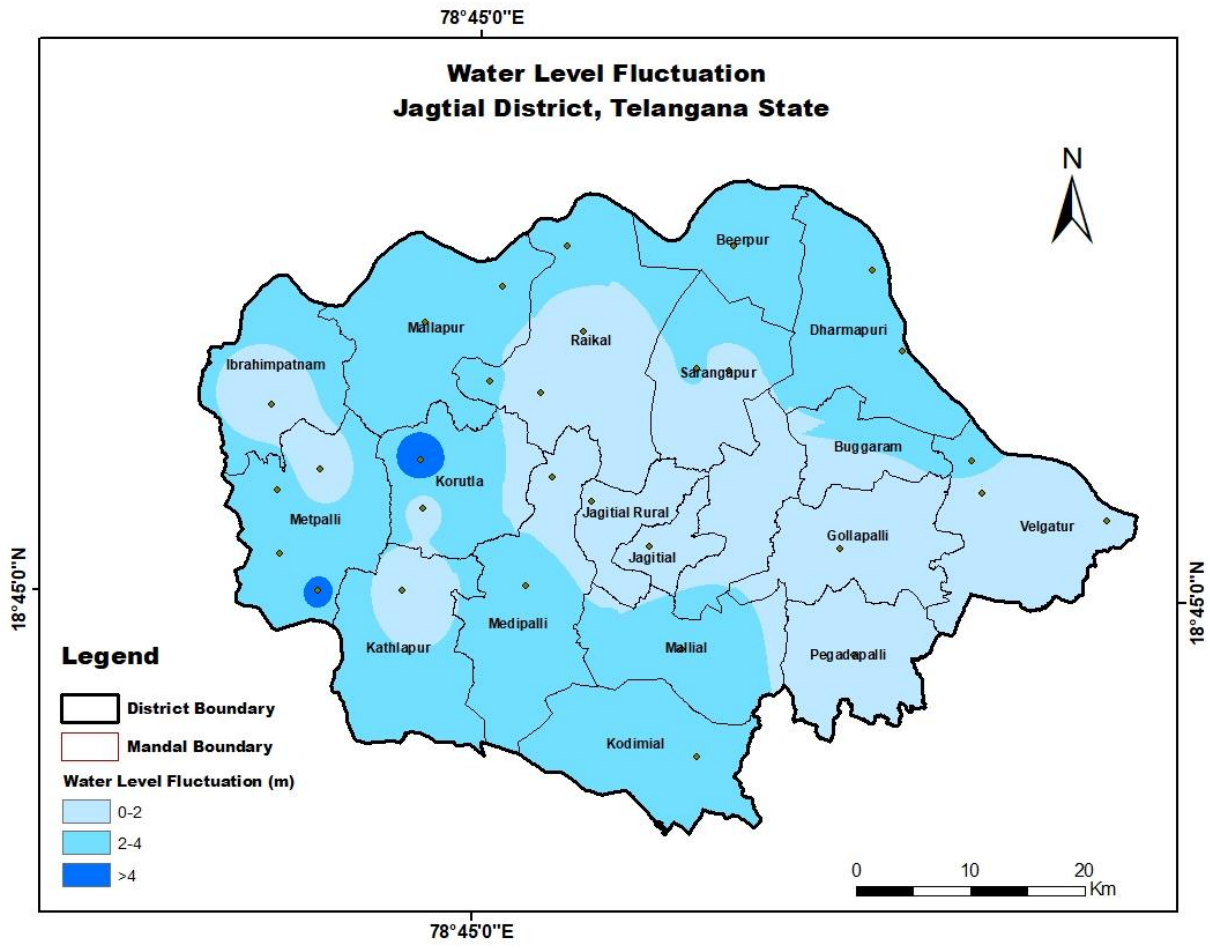


Fig.3.3: Seasonal Water Level Fluctuations (m) (post-monsoon with respect to pre-monsoon (Average:2011-2020))

The perusal of map indicates that fluctuation of upto 6 m is observed in major part of the district, whereas fluctuation of more than 6 m is observed in parts of Korutla and Metpalli mandals. This analysis indicates that majority of the area (99.34 %) is falling in less to moderate fluctuation range indicating a very good aquifer storage, whereas high water level fluctuations > 6 m are observed only in 0.65 % area i.e. parts of Metpalli and Korutla mandals.

3.1.2 Water Table Elevation

The water table elevation map for pre-monsoon and post-monsoon period was also prepared (**Fig.3.4(a),3.4(b)**) to understand the ground water flow directions. The water table elevation ranges from 146 to 378 m amsl during pre-monsoon period and 149 to 382 m amsl during post-monosoon period. The ground water flow is mainly towards Northeastern direction.

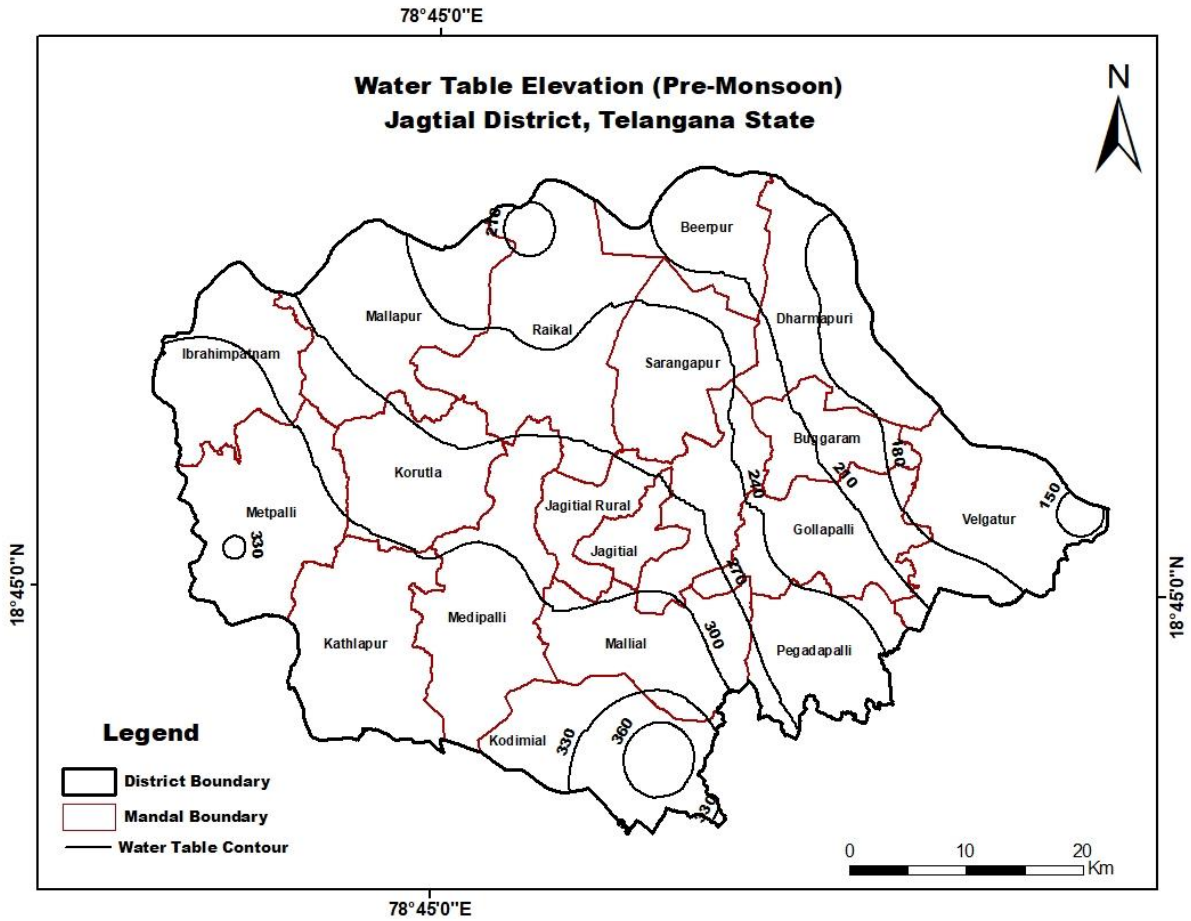


Fig.3.4(a): Water table elevations (m amsl) during pre-monsoon season (Average:2011-2020)

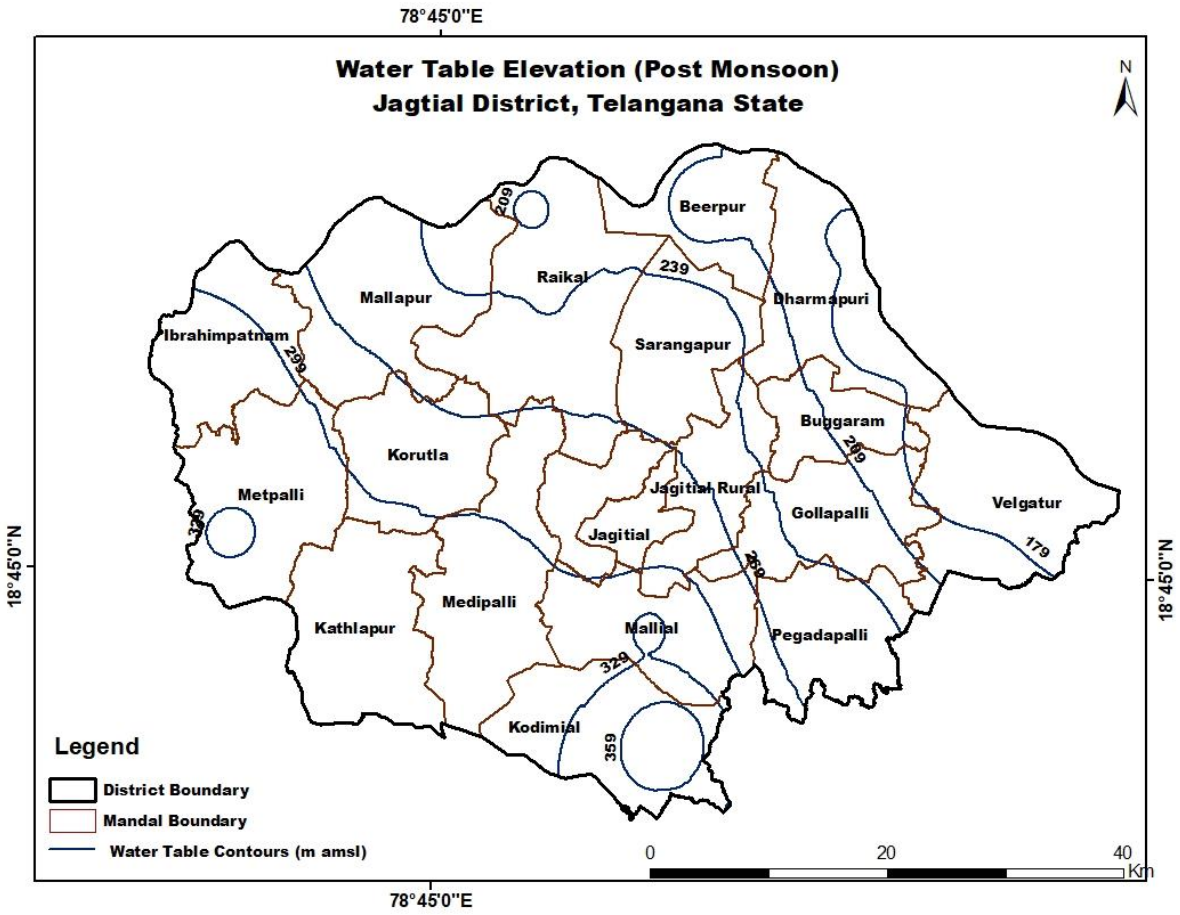


Fig.3.4(b): Water table elevations (m amsl) during post-monsoon season (Average:2011-2020)

3.1.3 Long Term Water Level Trend (2011-20)

In order to study long term behavior of water levels and also the effect of various developmental activities with time, the data from 48 hydrograph station (CGWB:18, SGWD:30) for the period 2011-20 have been computed and analyzed (**Fig.3.6** and **3.7)** The decadal pre-monsoon water level trend analysis indicates that 23 wells show falling trend (<1.0m at 22 wells) (max fall: 1.22 m/yr at Mannegudem in Medipalli mandal) and 25 wells show rising trend (0-1 at 23 wells) (max rise: 2.03 m/yr at Kandlapalle in Beerpur mandal). During post-monsoon season 06 wells show falling trend and all show >1.0 m/yr fall (maximum fall: 0.39 m/yr) and 42 wells shows rising trends (< 1 m/yr in 40 wells) (max rise: 1.84 m/yr at Bandalingpur in Metpalli mandal). The graphical representation of fall and rise is shown in **Fig.3.5**

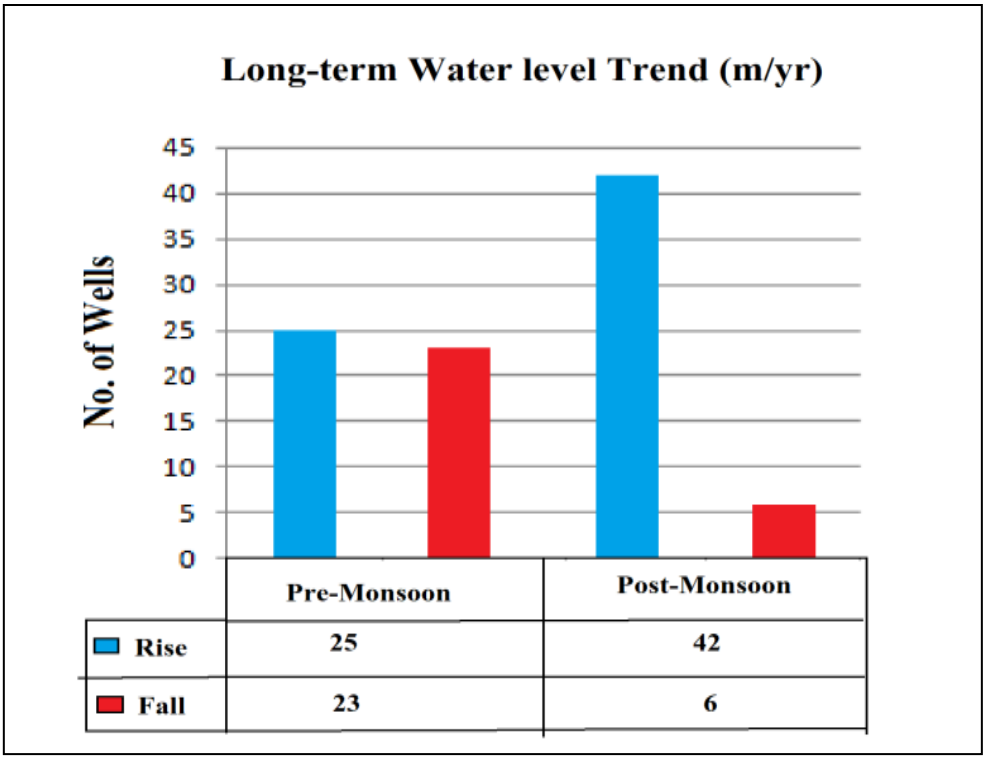


Fig. 3.5: Graphical representation of water level trends (2011-2020)

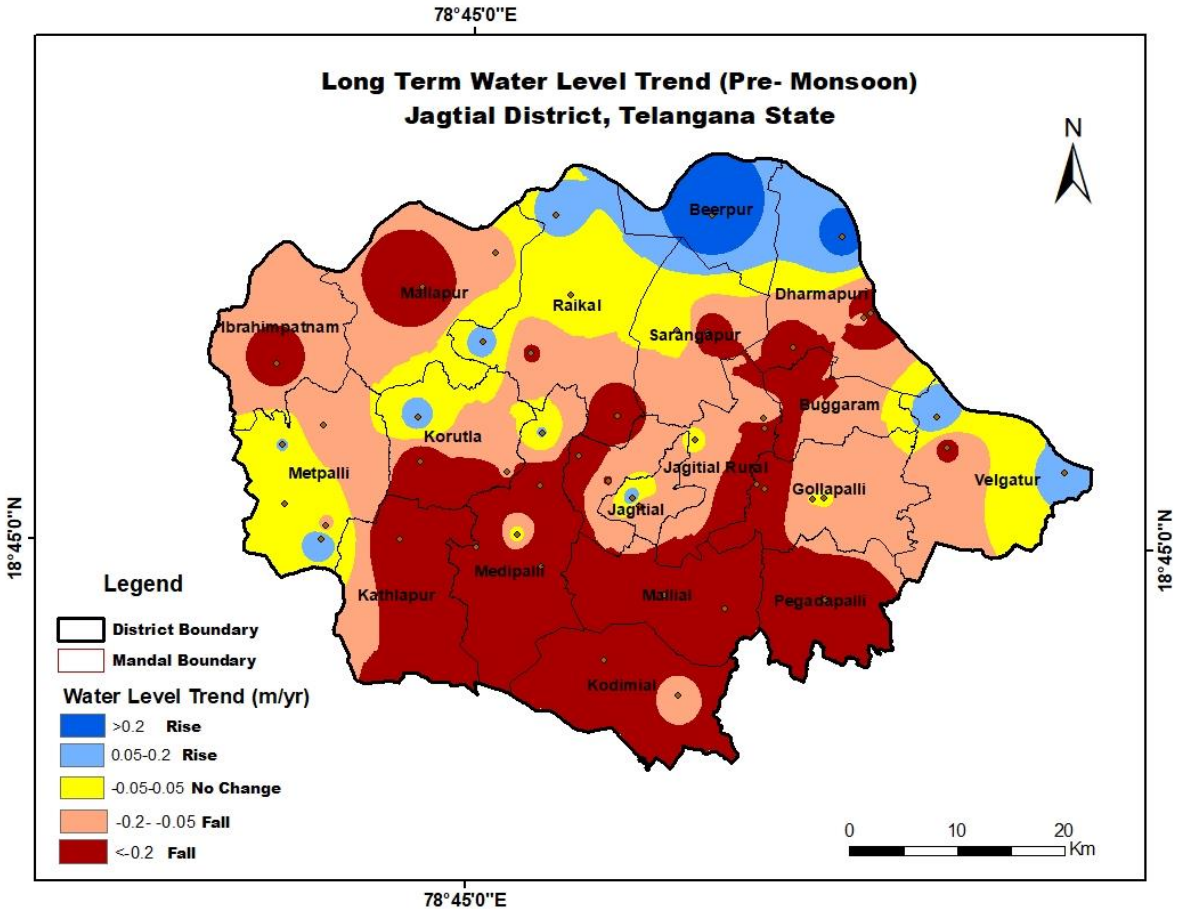


Fig. 3.6: Long-term water level trend, Pre-monsoon (2011-2020)

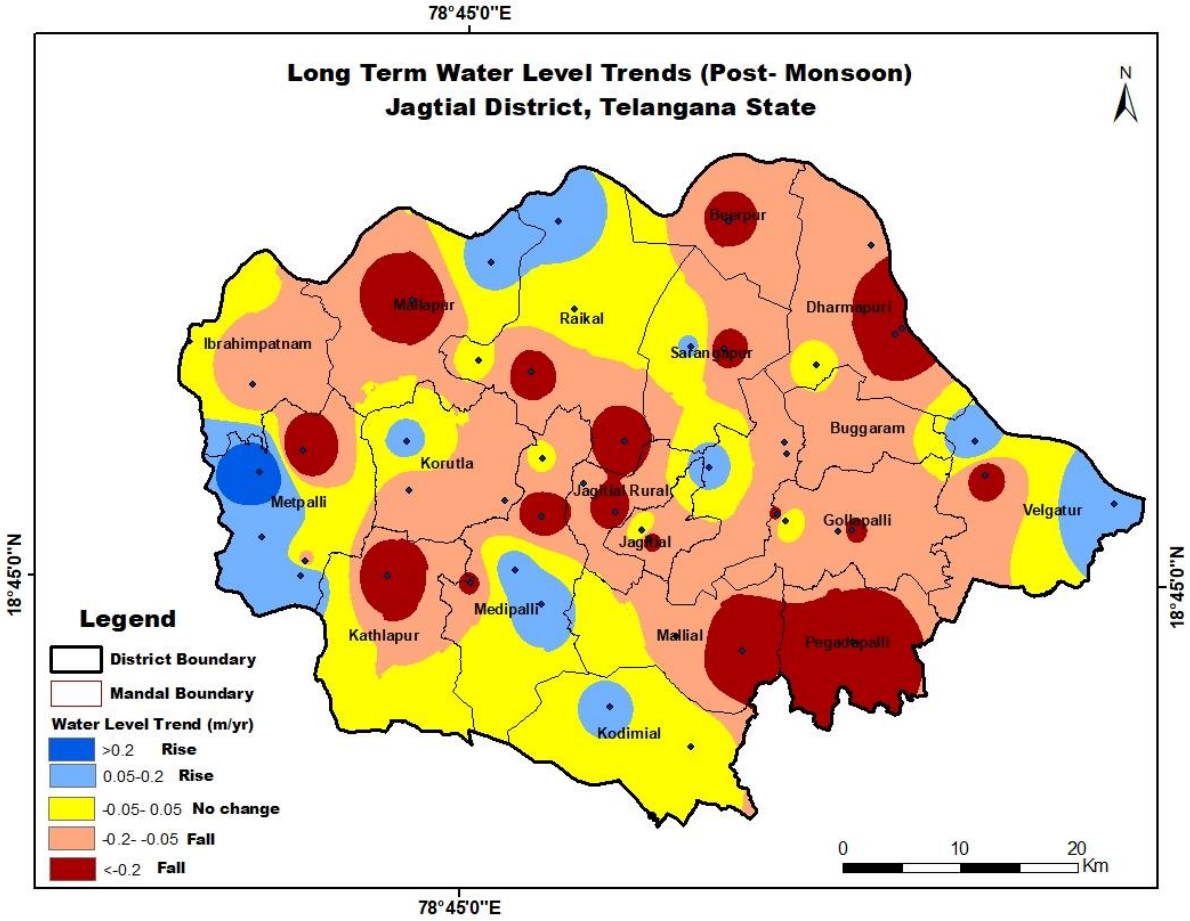


Fig. 3.7: Long-term water level trend, Post-monsoon (2011-2020)

3.2 Ground Water Quality

The suitability of ground water 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, 493 samples (Pre-monsoon:246 and post-monsoon:247) were utilised from monitoring wells of CGWB and 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 246 samples were analyzed. Ground water is mildly alkaline to alkaline in nature with pH in the range of 7.38 -8.36 (Avg: 8.07). Electrical conductivity varies from 410-2938 (avg: 1055) µ Siemens/cm. In 100 % of area EC is within 3000 µ Siemens/cm (**Fig.3.8**). Nitrate concentration varies from 0.2-256 mg/l and 38 %of the samples it is beyond permissible limits of BIS Standard (>45

mg/L) (**Fig.3.9**). High Nitrate concentration is observed in Central, Notheastern & Northwestern parts of the district. Fluoride concentration varies from 0.11 to 2.74 mg/L (**Fig 3.10**) and in 11 % of samples it is beyond permissible limits of BIS standard (>1.5 mg/L). High fluoride concentration is observed mainly in Mallapur, Ibrahimpatnam, Metpalli, Kathlapur, Medipalli, Mallial, Dharmapuri and Golapalli mandals and sparsely in Kodimial, Pegadapalli and Velgatoor mandals. .

3.2.2 Post-Monsoon

A total of 247 samples were analyzed . Ground water from the area is mildly alkaline to alkaline in nature with pH in the range of 7.32-8.98 (Avg:8.16). Electrical conductivity varies from 150-4105 (avg: 985) µ Siemens/cm. In 99.2% of area EC is within 3000 µ Siemens/cm and in 0.8 % of area EC is beyond 3000 µ Siemens/cm (**Fig. 3.11**). Nitrate concentration varies from 0.2-332.2 mg/l and in 54 % of the samples it is 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 0.04-2.87 mg/l **(Fig 3.13**) and in 11 % of samples it is beyond permissible limits of BIS standard (>1.5 mg/l). High fluoride concentration is observed mainly in Medipalli, Metpalli, Kathlapur, Ibrahimpatnam and Kathlapur mandals .

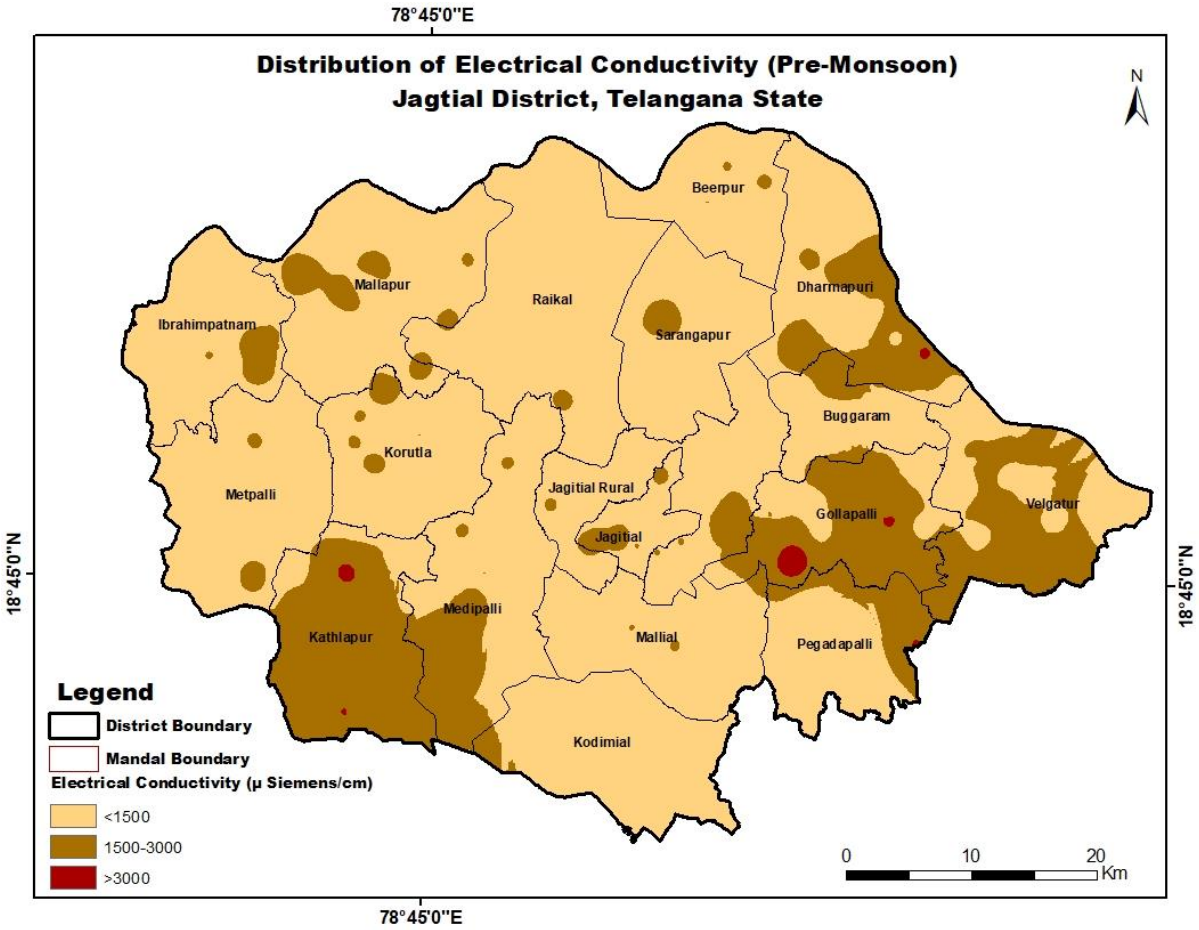


Fig.3.8: Distribution of Electrical conductivity (Pre-monsoon).

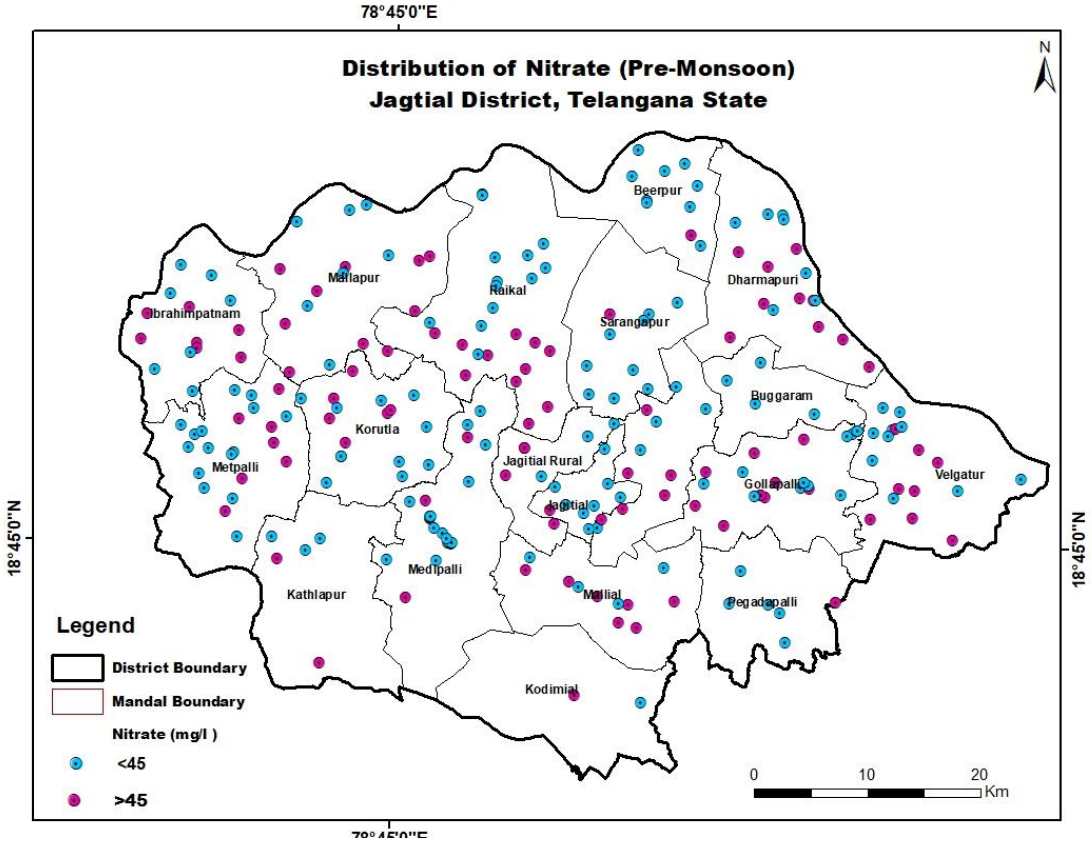


Fig.3.9: Distribution of Nitrate (Pre-monsoon)

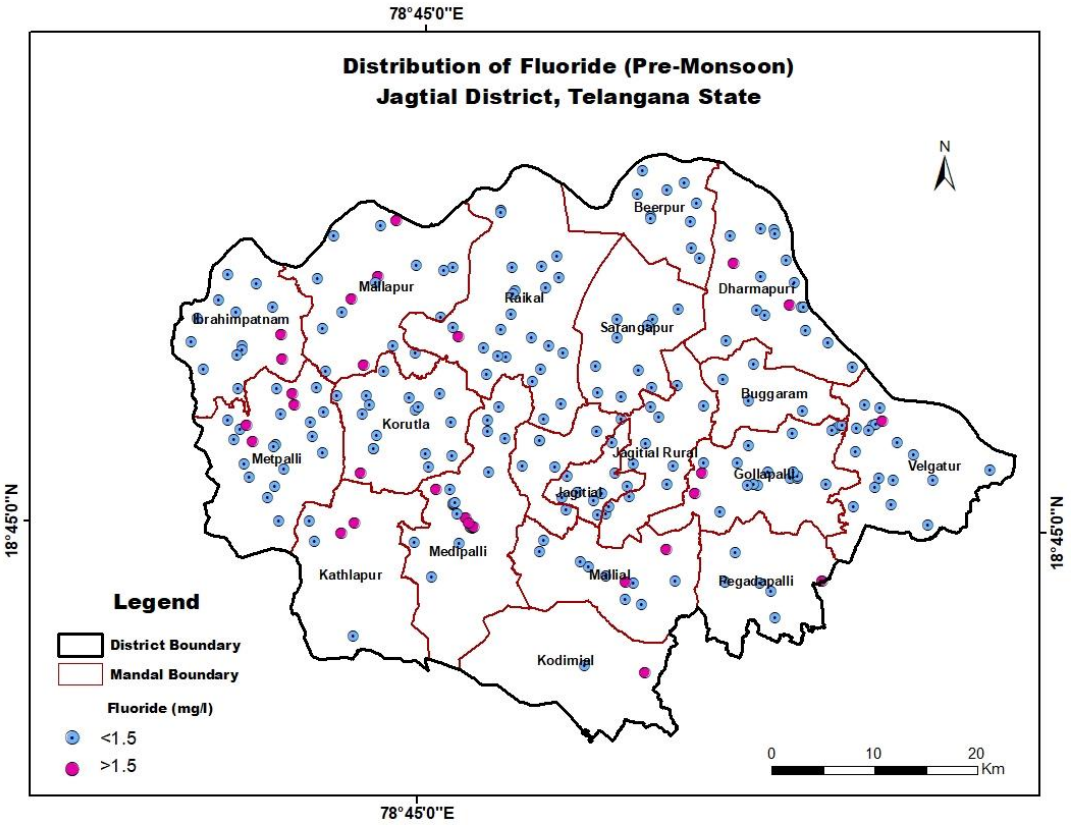


Fig.3.10: Distribution of Fluoride (Pre-monsoon)

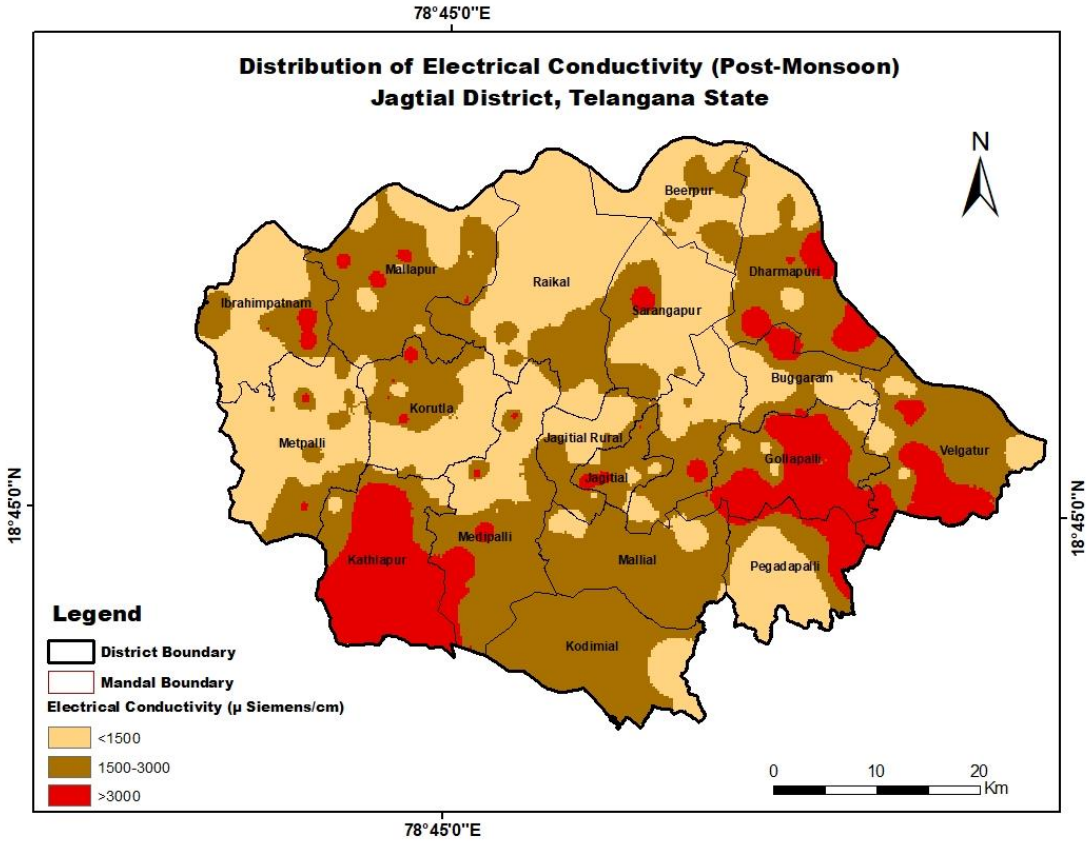


Fig.3.11: Distribution of Electrical conductivity (Post-monsoon)

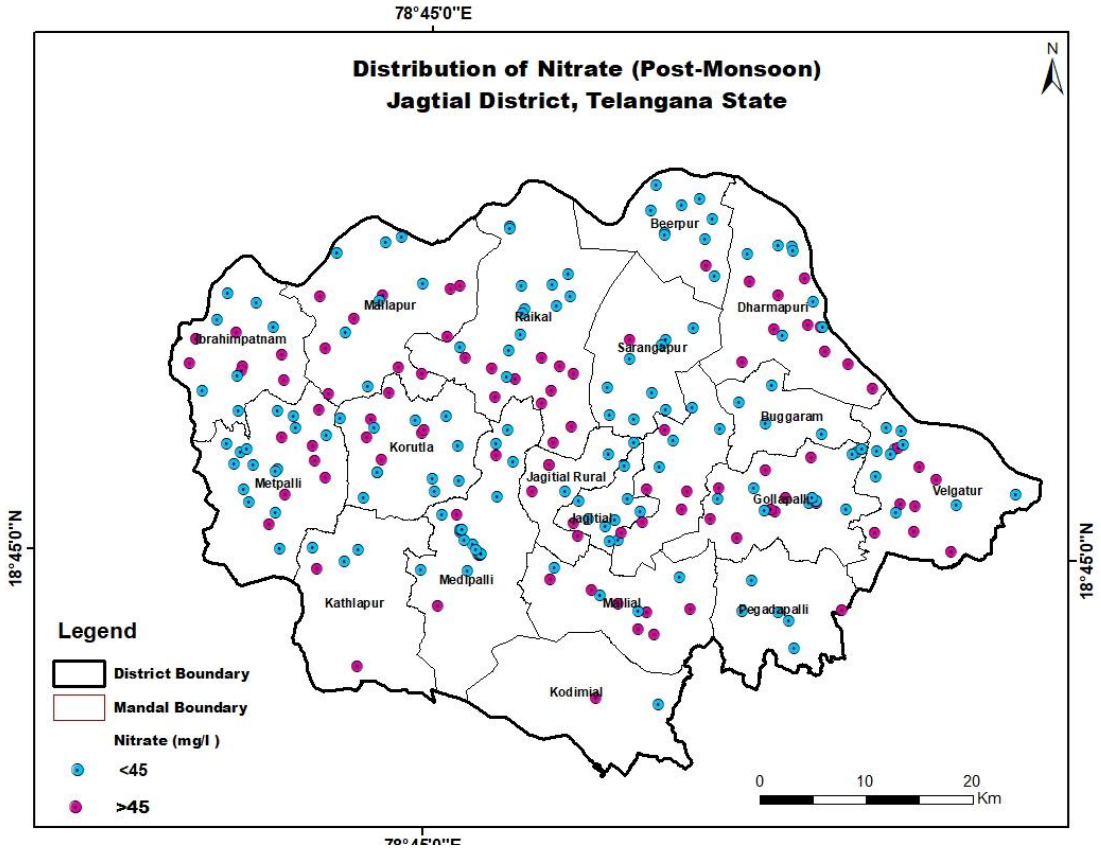


Fig.3.12: Distribution of Nitrate (Post-monsoon)

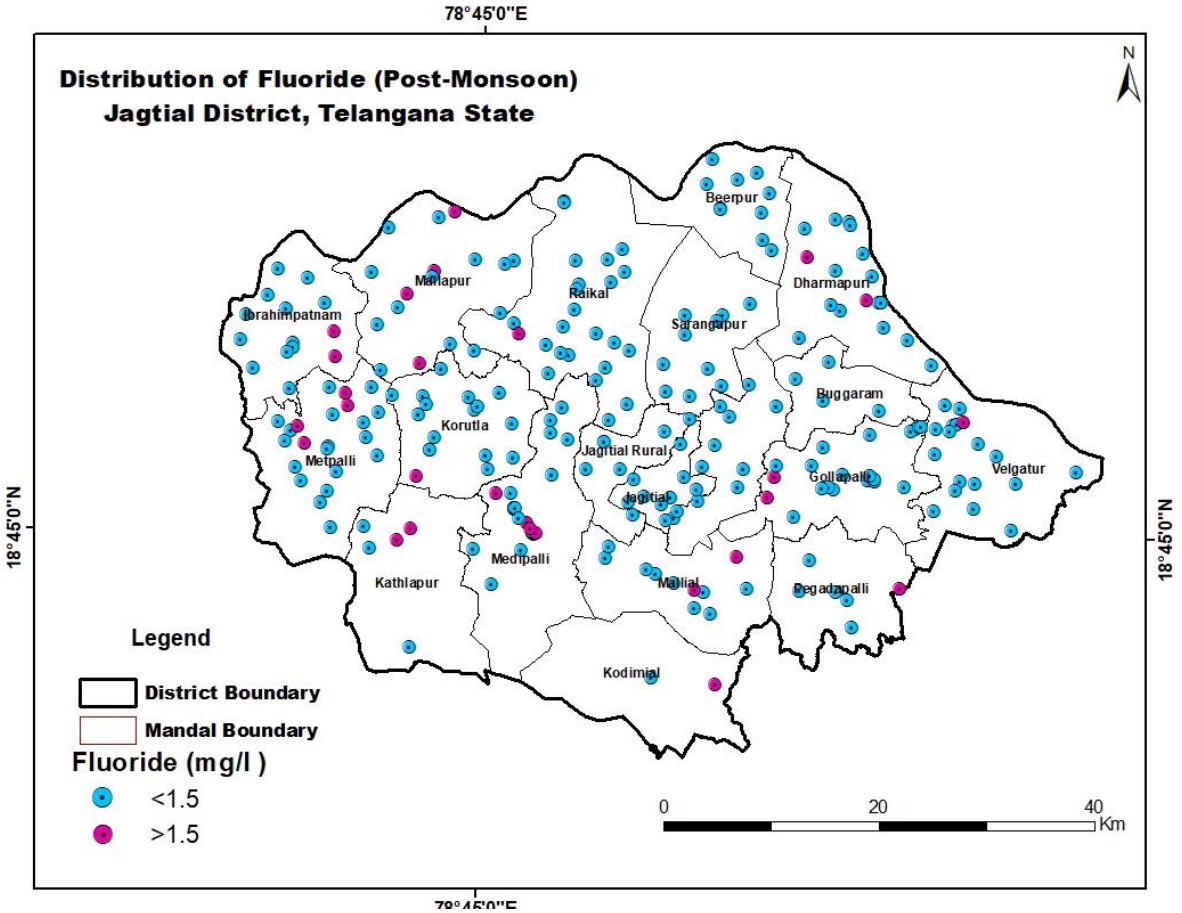


Fig.3.13: Distribution of Fluoride (Post-monsoon)

3.3 Aquifer Mapping

The aquifer geometry for shallow and deeper aquifer has been established through analysing 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 and joints in hard rocks, while in sedimentary rocks it depends on porosity, granularity, cementing matrix, permeability, bedding plains and faults. Based on 223 hydrogeological 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 Jagtial district can be broadly classified into two categories: consolidated formation (Archean crystalline and meta-sedimentary formation) which occupies 95.62% of the area and semi-consolidated to unconsolidated formation (Sedimentary rock) which occupies 4.38 % of the area.

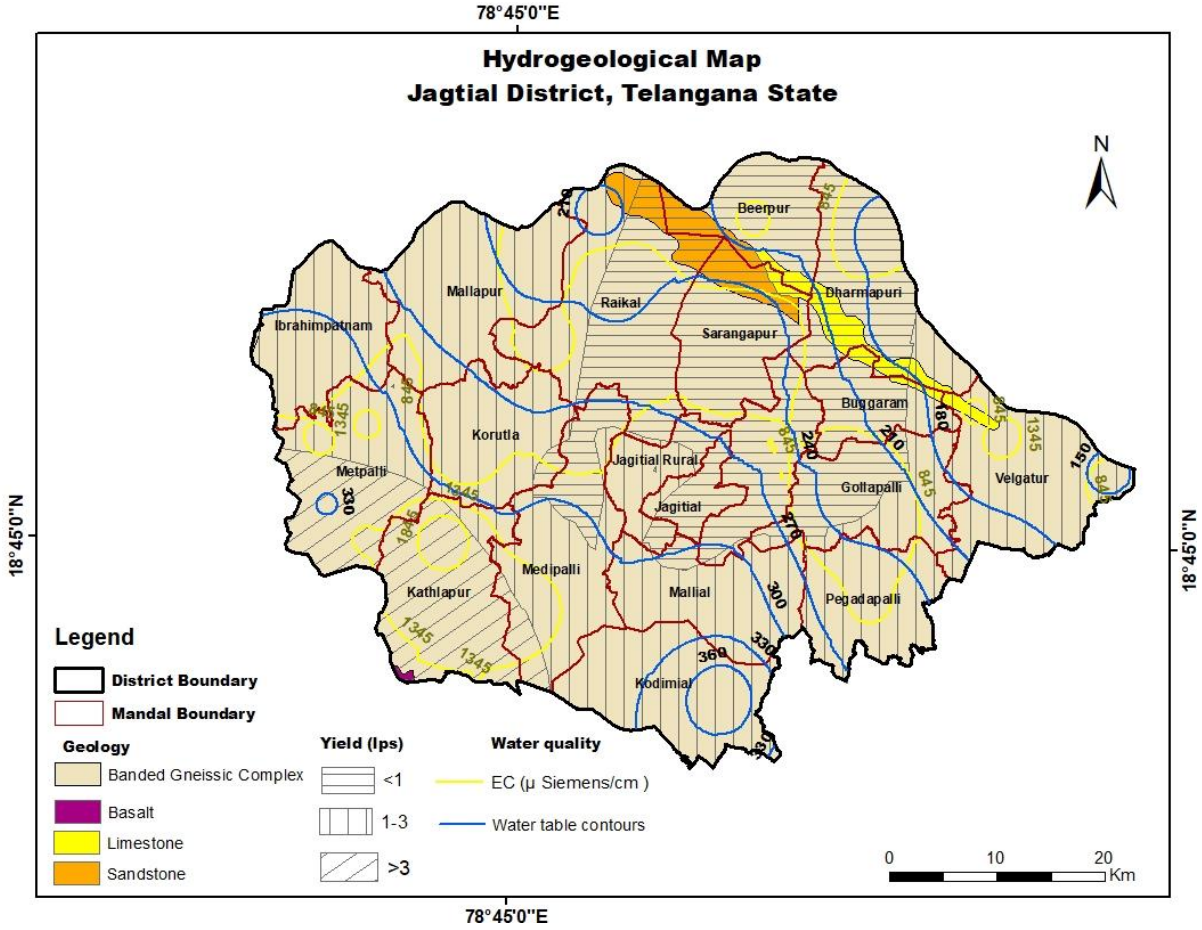


Fig.3.14: Hydrogeological map of Jagtial district

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 intergranular pore spaces of weathered mantle and is mainly developed by construction of dug wells or shallow bore wells with hand pumps. The storage in gneissic rocks is primarily confined to the weathered zone and it has been used mainly for irrigation purpose, which extends upto depth of 26.52 m in Jagtial district. Thickness of weathered zone is in the range of <10 m i.e. shallow weathering occur in about ~48.25 % of area, weathering to medium depth of 10-20 m occurs in 45.37 % while deep weathering of > 20 m is seen only in 6.37 % of the area (**Fig 3.15**).

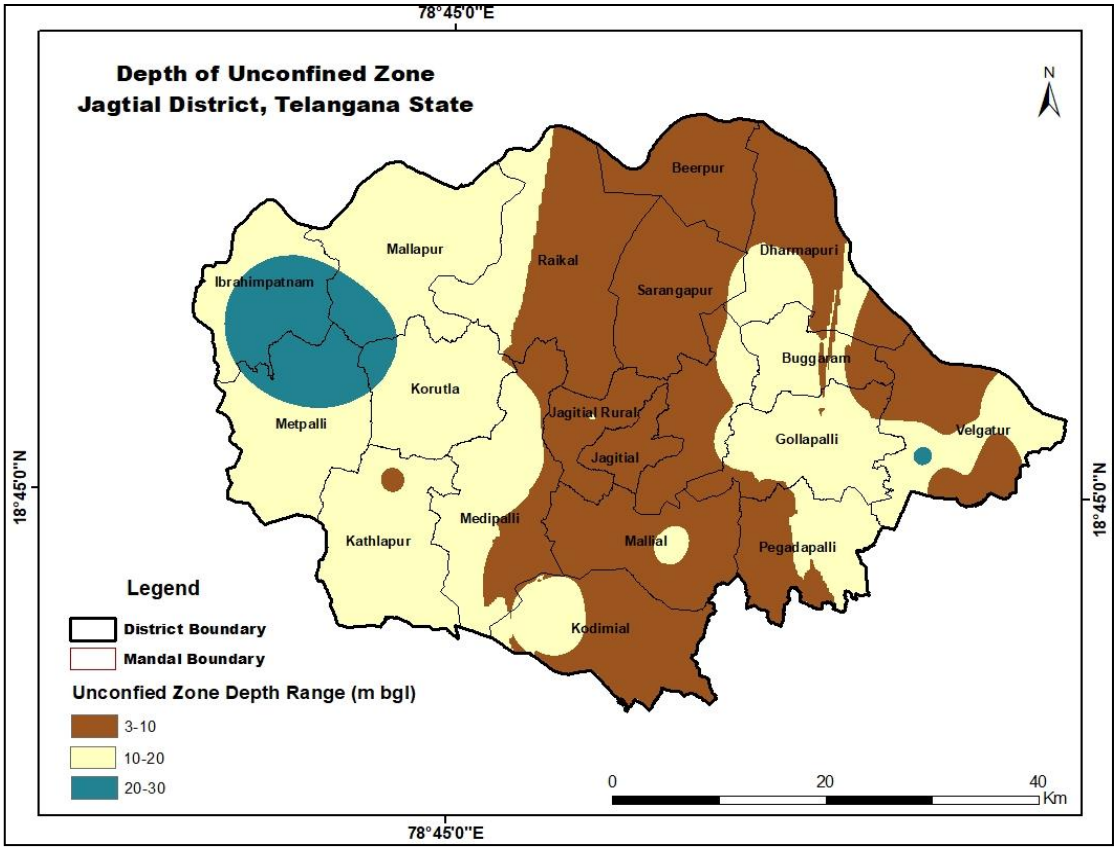


Fig.3.15: Unconfined zone map of Jagtial district

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 borewells. The depth of fracturing varies from 5.6 m to 140 m (deepest fracture encountered at Kondapur). Ground water yield from fractured gneiss varies from <0.077 to 8.0 lps. The transmissivity varies from 0.17-412 m^2/day and storativity varies from 0.001 to 0.01(**Fig 3.16**).

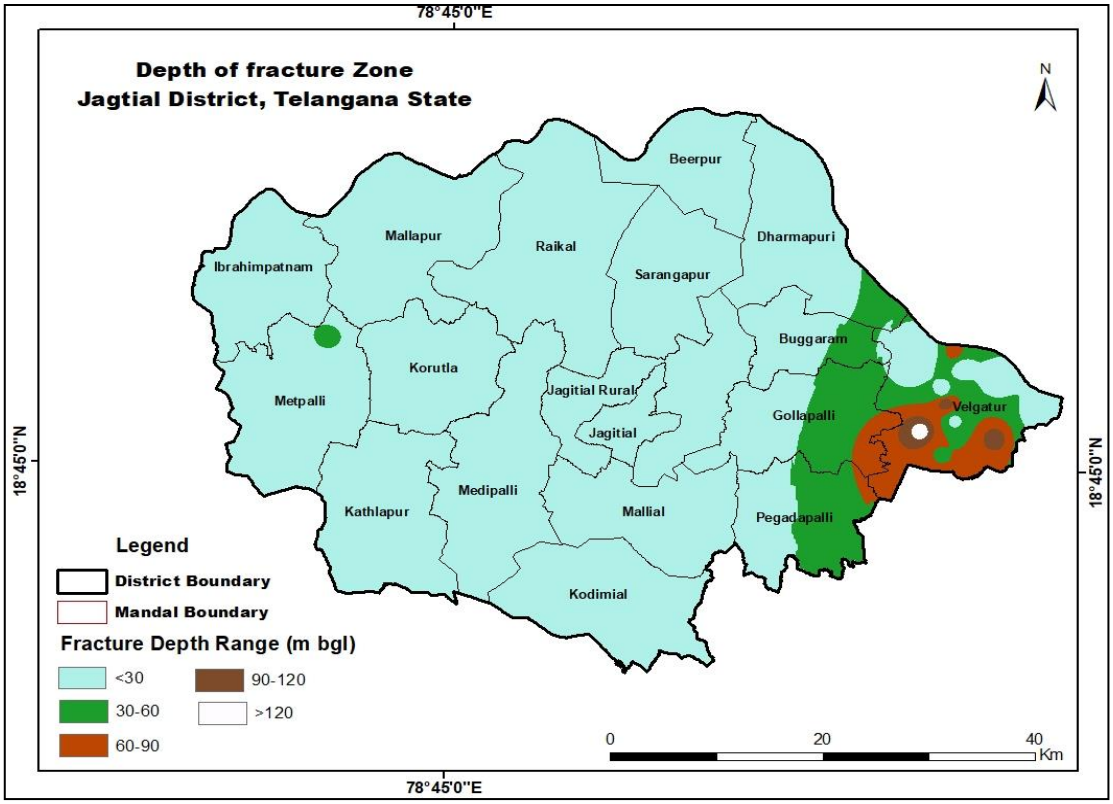


Fig.3.16: Fracture zone map of Jagtial district

3.3.2 Aquifer system in semi-consolidated/unconsolidated formation

Gondwana formations represent the semi-consolidated formation, which consists of sandstones and limestones 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 formations occurs under both water table and confined conditions.

Multiple aquifer systems (1 to 5 aquifers) 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 is 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 ground water depends on porosity, granularity, cementing matrix, permeability, bedding plains and faults. The deeper aquifers identified upto a depth of 300 m and are mainly composed of fine to coarse grained sandstone. Ground water yield of sandstone aquifers varies from <1 to 18 lps. The transmissivity varies from 146.99-570.32 m^2/day and storativity varies from 2.04 x 10^{-4} to 5.50 x 10^{-4} .

Table 3.2 Salient features of Aquifer system in Jagtial district

	Archean Crystalline		**Gondwana**	
Prominent Lithology	Gneisses		Sandstone & Limestones	
Aquifers	Weathered Zone (Aquifer-1)	Fracture Zone (Aquifer-2)	Unconfined Zone (Aquifer-1)	Semiconfined/ Confined Zone (Aquifer-II to V)
Thickness range	Upto 26.52 m	5.6-140 m	10 to 13 m	Upto 300 m at different depth ranges
Range of yield potential	0.077 to 8.0 lps		upto 18 lps	
Transmissivity (m^2/day)	0.17-412 m^2/day		146.99-570.32 m^2/day	
Storativity	0.001 to 0.01		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 Aquifer Disposition 3D & 2D

The data generated from ground water 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 fence diagram indicating the disposition of various aquifers is presented in **Fig. 3.17**. In major part of district, gneiss can be seen. The disposition of weathered and fractured zone followed by massive granite/gneiss can be observed in the fence.

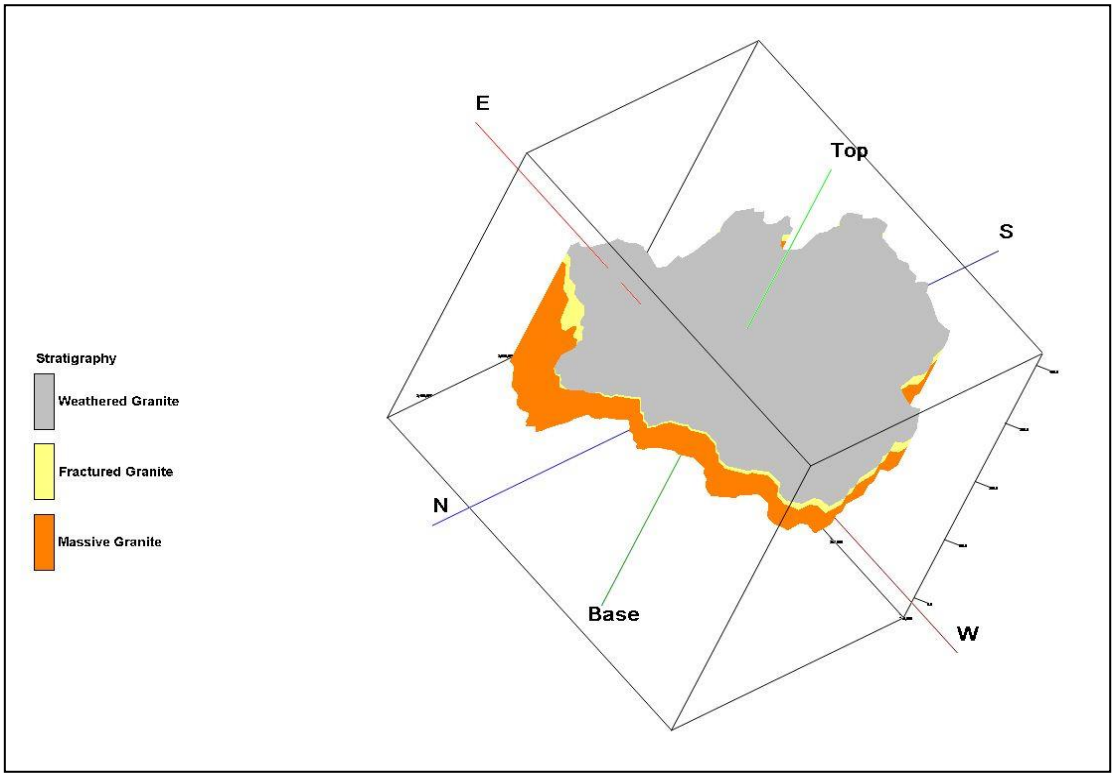


Fig.-3.17: 3-D disposition of Aquifers

Hydrogeological Cross Sections

To study the aquifer disposition in detail, various hydrogeological cross sections indicating aquifer geometry has been prepared for E-W and NW- SE direction as shown in **Fig. 3.18**.

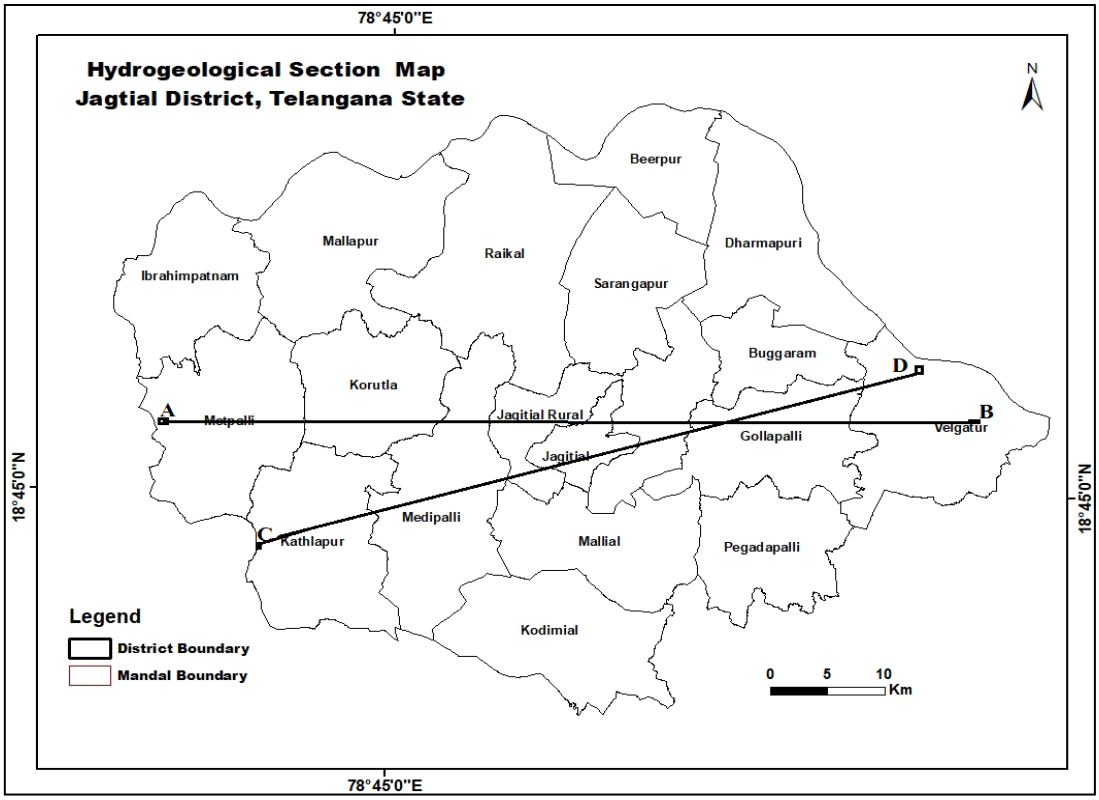


Fig.-3.18: Map showing orientation of hydrogeological sections

3.4.1 Hydrogeological Cross Section A-B

Hydrogeological cross section A-B (**Fig.3.19**) represents East- West direction covering a distance of ~70 kms. It depicts thick fractured zone overlaid by thin weathered zone. As we move from East to West direction, depth of fracture zone varies from 18.89 m bgl at Atmakuru to 110 m bgl at Ramnuru. The maximum depth of weathering ranging from 17.6 bgl at Atmakuru to 5.5 m bgl at Polassa.

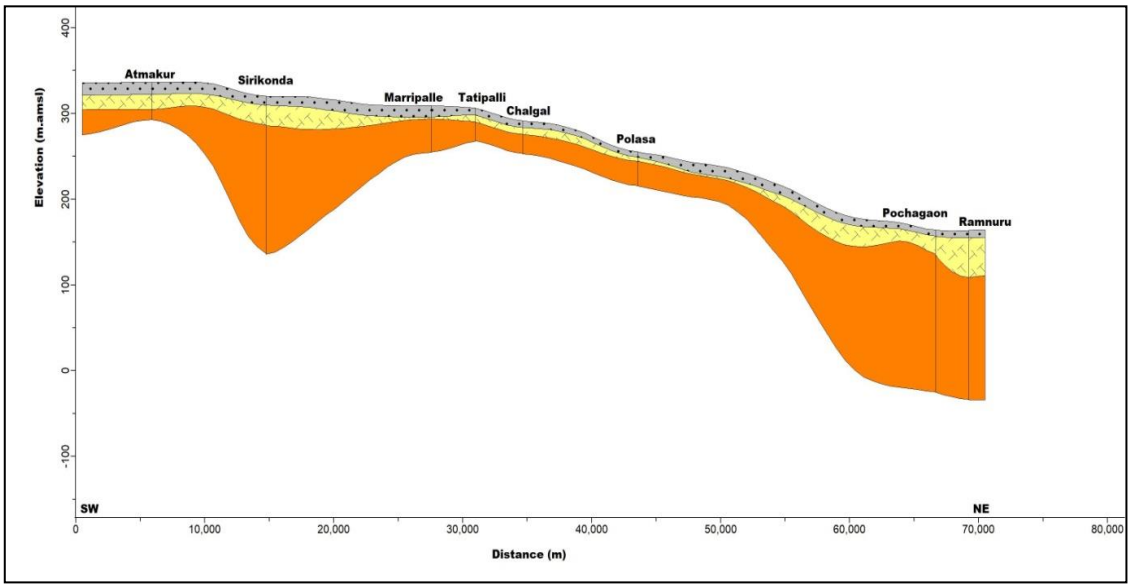


Fig.3.19: Hydrogeological cross section A-B

3.4.2 Hydrogeological Cross Section C-D

Hydrogeological cross section C-D (**Fig.3.20**) represents Northwest–Southeast direction covering a distance of ~78 kms. It depicts thick fractured zone overlaid by thin weathered zone. As we move from Northwest to Southeast direction, depth of fracture zone varies from 140 m bgl at Kondapur to 18.89 m bgl at Atmakuru. The maximum depth of weathering ranging from 15.1 m bgl at Cheggam to 5.5 m bgl at Atmakuru.

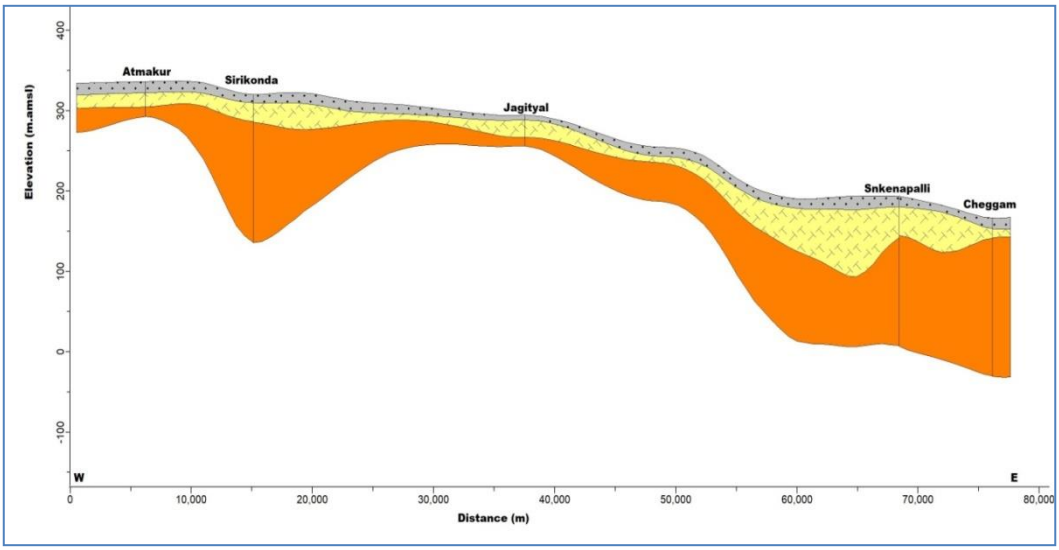


Fig.3.20: Hydrogeological cross section C-D

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.

While computing the in-storage resources, the general depth of deepest fractures in the area, pre-monsoon water levels and 2% of granular zone (depth below pre-monsoon water level and down to deepest fracture depth in the village) is considered. Dynamic ground water resources are computed as per the guidelines laid down in GEC-2015 methodology. As per 2020 GEC report, the net dynamic replenishable ground water resources availability is 428.21 MCM, gross ground water draft for all uses is 257.54 MCM and net annual ground water potential available for future irrigation needs is 148.79 MCM. Stage of ground water abstraction varies from 30.6 % at Beerpur to 97.9 % at Kodimial. Out of 18 mandals, 3 are in Semicritical, 2 in Critical and 13 are in Safe categories. 57.77 % of gross ground water draft is utilized for irrigation purpose. Computed Dynamic ground water resources of the district is given in **Table-4.1** and **Fig 4.1**.

Table-4.1: Computed Dynamic ground water resources.

As per GEC 2020	**MCM**
Dynamic (Net GWR Availability)	**428.21**
• Monsoon recharge from rainfall	195.09
• Monsoon recharge from other sources	102.09
• Non-Monsoon recharge from rainfall	1.44
• Non-monsoon recharge from other sources	168.88
• Natural Discharge	39.28
Gross GW Draft	**257.54**
• Irrigation	148.79
• Domestic and Industrial use	10.20
Provision for Drinking and Industrial use for the year 2025	32.08
Net GW availability for future irrigation	148.70
Stage of GW Extraction (%)	**60.20 %**
Categorization : Out of total 18 mandals , 02 Critical, 03 Semi-critical, 13 Safe	

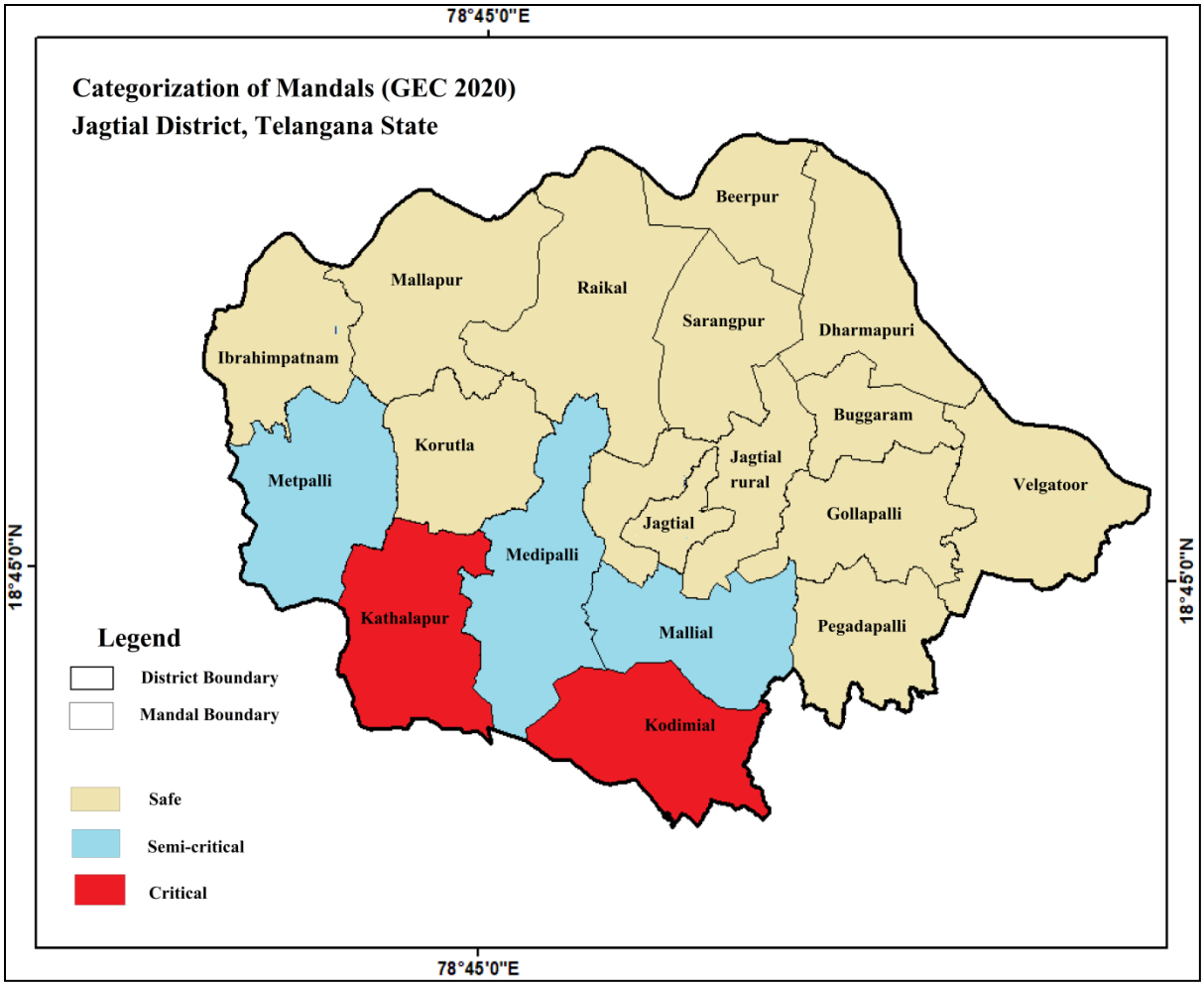


Fig.4.1 : Categorization of mandals of Jagtial district (GEC-2020)

5. GROUND WATER RELATED ISSUES

5.1 Sustainability of wells

- High 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. Low yield (<1 lps) occurs in >77 % of the exploratory wells drilled in the various parts of the district. Sustainability of the aquifer is limited and the wells normally sustain pumping for 0.5 to 2 hours only.
- Inspite of facilities of irrigation provided through SRSP in recent times, 351 km^2 area (18% of area) of the district still facing the water issues viz. 02 mandals Kathalpur and Kodimial covering 34 villages are categorized as 'Critical' where ground water balance for future irrigation is negligible or nil.
- The formation characteristics like absence of primary porosity, negligible development of secondary porosity, restricted depth of weathering and area being drought prone, such circumstances result in low yield potential.
- The occurrence of fractures beyond weathered zone are very limited in extent, as the compression in the rock reduces the opening of fractures at depth and the majority of fractures normally occured within 100 m depth and further exploitation is happening beyond 100 m bgl till to the depth 200 m bgl.
- The increasing urbanization also affects the potential. The yield from borewells have reduced over a period of time and some borewells which earlier used to yield sufficient quantity of water have gone dry due to higher dependence and reduction in recharge because of low rainfall.
- Over-extraction for paddy cultivation during rabi season leads to more ground water extraction in proportion to recharge, limited artificial measures and low rainfall are the causes of deeper water levels in the area.
- Change in land use from agricultural land to residential purposes and cropping pattern from traditional crops to cash crops (cotton and paddy) is observed leading to more water abstractions.
- In non-command area, the paddy crop grown during rabi season is completely dependent on ground water which leads to heavy withdrawal of ground water during non-monsoon period.

5.2 Pollution

- Most of the mandals are fluorosis endemic where fluoride (geogenic) in ground water is as high as 2.36 mg/l during pre-monsoon and 2.87 mg/l during post-monsoon season.
- The high fluoride concentration (>1.5 mg/l) occur in 11% of samples each during pre and post-monsoon season of the year 2021.
- Higher concentration of fluoride in ground water is attributed due to source rock (i.e., granite), rock - water interaction where acid-soluble fluoride bearing minerals (fluorite, fluoro-apatite) gets dissolved under alkaline conditions when higher residence time of ground water in deeper aquifer.
- High nitrate (>45 mg/l) due to anthropogenic activities is observed in 38% of the samples and 54% of the samples during pre 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.

5.3 Water Marketing

- Water marketing is present in critical, semi critical and other areas also and people are buying bottled water from the market for drinking purposes.

6. MANAGEMENT STRATEGIES

The uneven distribution of ground water availability and its utilization indicates that, no single management technique can be adopted to develop appropriate management strategy but it requires integrated hydrogeological aspects alongwith socio-economic conditions. The study suggests notable measures for sustainable ground water management, which involves a combination of 1) Supply side measures and 2) Demand side measures.

6.1 Supply side measures

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, 1096.01 MCM of unsaturated volume (below the depth of 5 m) is available during post-monsoon, having 21.92 MCM of recharge potential and 31.32 MCM of uncommitted runoff. This can be utilized for implementing management strategy.

Ongoing Projects

6.1.1 Mission Kakatiya (Repair, Renovation and Restoration of existing tanks)

- Under State Govt. sponsored Mission Kakatiya, during Phase-1 to Phase-4, out of 1226 minor irrigation tanks, 713 tanks were desilted. This helped in strengthening of water bodies and created additional surface storage, thereby increased ground water augmentation in the district.
- There is a need to take remaining tanks in the next phases for de-siltation. This will greatly help in stabilisation of tank ayacut and ground water augmentation.

6.1.2 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 water grid covering entire district to provide protected water from surface reservoirs. The scheme is to enhance the existing drinking water scheme and to provide 100, 135 and 150 lpd/person of water in rural, municipal and Municipal Corporation respectively.
- The total water import will be 32.06 MCM (drinking and industrial needs) and this imported water from surface sources will reduce the present utilized 17 MCM of ground water (considering 60 lpcd). This can be effectively utilized to irrigate 2872 ha. of additional land under ID crops.

6.1.3 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 mbgl. 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 Govt. 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 development in the district is 63 % and 13 out of 18 mandals are falling in safe category as per the GEC 2020 estimation, the artificial recharge structures are proposed only for remaining mandals of the district. Artificial recharge structures are recommended in 02 Critical i.e. Kodimal & kathlapur and 03 semi-critical i.e, Mallial, medipalli & metpalli mandals, to control further increase in stage of ground water abstraction.

Table 6.1: Area feasible and volume available for artificial recharge

Total geographical area of district (Sq.km)	2419
Area feasible for recharge (Sq.km) (in 05 mandals)	863
Unsaturated Volume (MCM)	1096.01
Recharge Potential (MCM)	21.92
Surplus run-off available for recharge (MCM)	31.32
PROPOSED ARTIFICIAL RECHARGE STRUCTURES	
Percolation Tanks(@ Rs.20 lakh, Av. Gross Capacity=0.007 MCM*2 fillings = 0.0140 MCM)	262
Volume of Water expected to be conserved / recharged (in MCM)	3.668
Estimated Expenditure (in Crores)	52.40

Check Dams(@ Rs.15 lakh, Av. Gross Capacity=0.007 MCM* 5 fillings = 0.035 MCM) Volume of Water expected to be conserved / recharged (in MCM) Estimated Expenditure(in Crores)	278 9.73 41.70
Total volume of water expected to be recharged(in MCM)	13.398
Total Estimated Expenditure for Artificial Recharge (Rs. in Cr.)	**94.10**

The total unsaturated volume (below the depth of 3 m) available for artificial recharge is 1096.01 MCM, having 21.92 MCM of recharge potential (2%).The 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 31.32 MCM of surplus water can be utilised for recharge, which is given in **Table 6.1**. This surplus water can be utilized for constructing 278 check dams and 262 percolation tanks at suitable sites. 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 13.398 MCM/year.

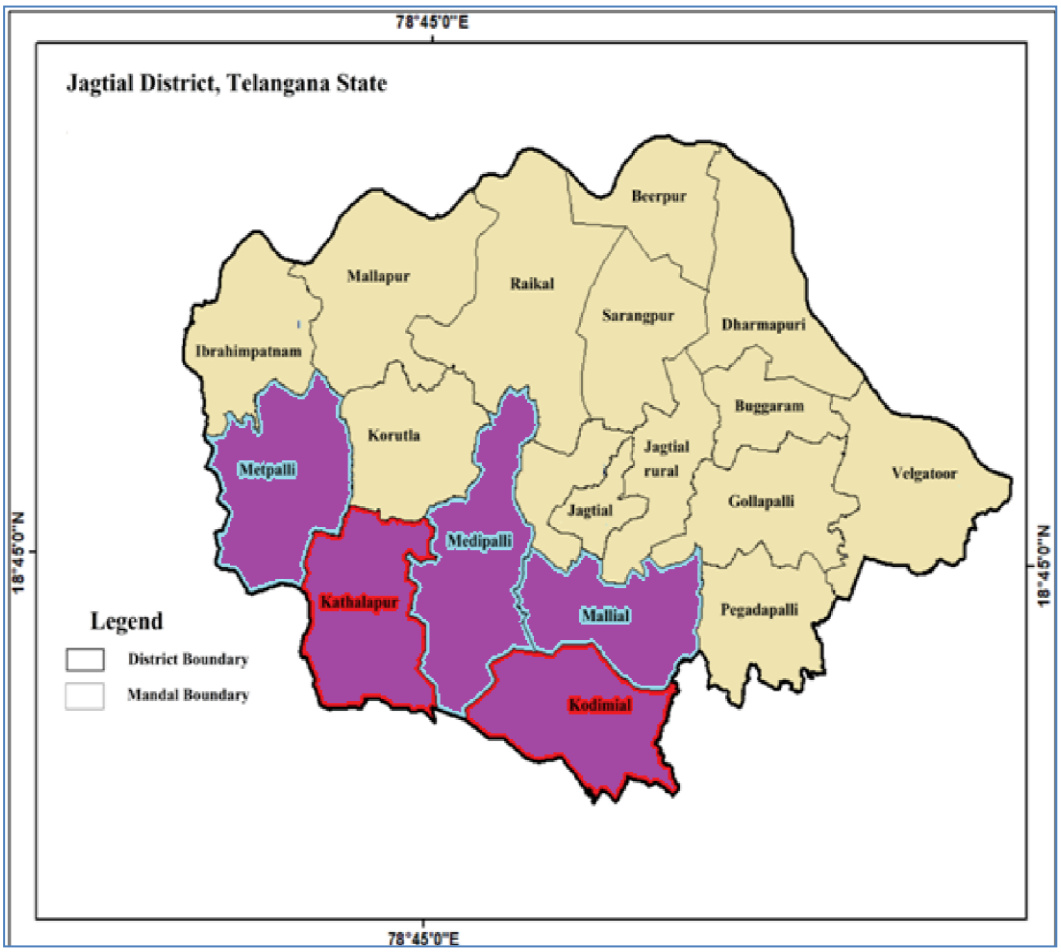


Fig. 6.1: Priority area for sustainable management plan of ground water resources.

6.1.4 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 form ponds can be 10 x 10 x 3 m. The total 2100 farm ponds are recommended (25 in each village in 84 villages), this can create an additional storage of 6.3 MCM.

6.1.5 Other Supply Side Measures

- Existing ARS like percolation tanks, 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 Measures

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

1. In the district, till date 35254 no's drip and 1207 no's sprinklers are sanctioned which has irrigated ~19094 ha under ID crops saving ~28.641 MCM (considering 25% saving of 0.006 MCM/ha) of ground water from the basin. Considering the current scenario of ground water development, existing number of structures and shallow water levels, demand side intervention such as change in cropping pattern and further 2193 micro irrigation has been proposed only for 05 mandals.
2. ~2193 ha of additional land that can be brought under micro-irrigation (@438 ha /mandal including existing area in 5 Critiical & semi-critical mandals (i.e. Mallial, Kodimial, Medipalli, Kathlapur & Metpalli) costing about 13.164 crores (considering 1 unit @0.6 lakh/ha). With this 7.76 MCM of ground water can be conserved over the traditional irrigation practices.
3. Change in cropping pattern from water intensive paddy to irrigated dry crops like pulses and millets are recommended particularly in 5 mandals viz, Mallial, Kodimial, Medipalli, Kathlapur & Metpalli.
4. To avoid the interference of cone of depression between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism.
5. 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 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 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 ground water, improving oral hygiene conditions.

6.4 Expected results/outcomes

With the above interventions costing Rs. 147.781crores (excluding the cost involved in Mission Kakatiya and Mission Bhagiratha), the likely benefit would be net saving of 56.103 MCM of ground water. This will bring down the stage of ground water extraction by 3 % (i.e. from 60.20 % to 57.20 %).

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Acknowledgments

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