**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

## JAYASHANKAR BHUPALAPALLY DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल शक्ति मंत्रालय
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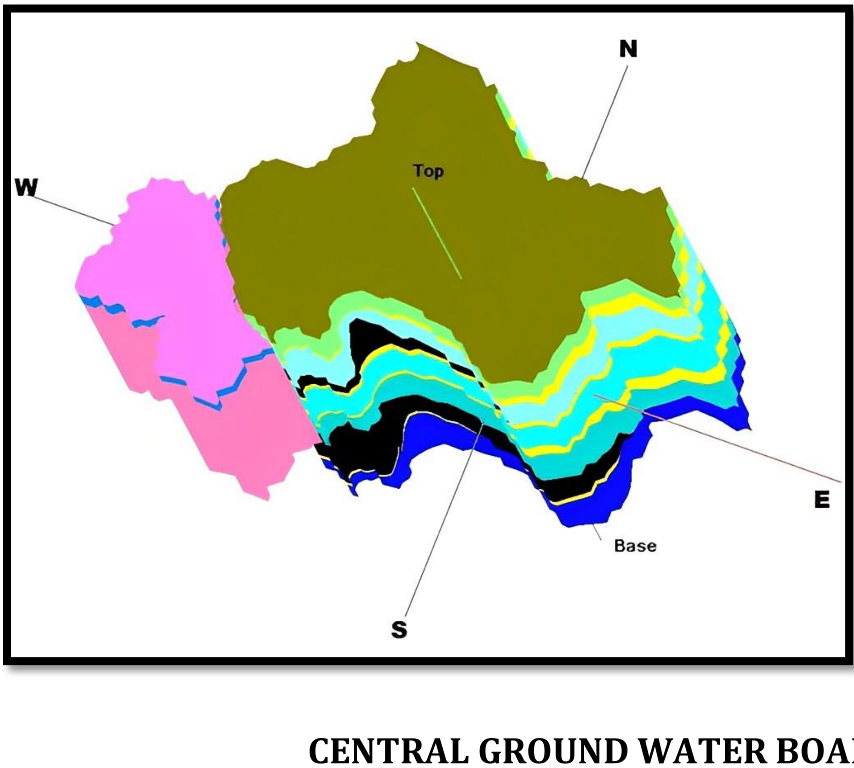
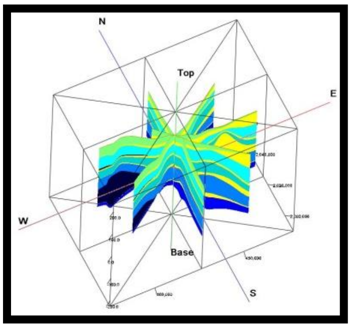
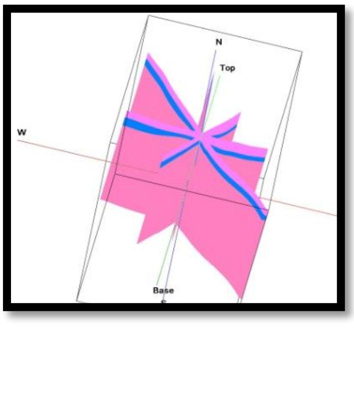
केंद्रीय भूमिजल बोर्ड

**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 JAYASHANKAR BHUPALAPALLY DISTRICT, TELANGANA STATE




**CENTRAL GROUND WATER BOARD**
**SOUTHERN REGION**
**HYDERABAD**
**JANUARY, 2023**

**REPORT ON**

**AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN JAYASHANKAR BHUPALAPALLY DISTRICT, TELANGANA STATE**

**CONTRIBUTOR'S PAGE**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# AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES JAYASHANKAR BHUPALAPALY 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 Jayashankar Bhupalapally district, located in the east of Telangana State, has a geographical area of 2984.96 km2, with north latitudes from 18°09'22.72"N to 18°52'14.11"N and east longitudes from79°33'42.33"E to 80°21'4.86"E. The district is bounded by Mancherial district to the north, Bijapur district of Chhattisgarh to the northeast, Mulugu district to the southeast, Warangal district to the south, and Hanamkonda and Peddapalli districts to the west. The district is divided into 11 revenue mandals and has 223 villages with a population of ~4.16lakhs (2011 census), resulting in a population density of 182 persons per sq.km.

The area is underlain by various geological formation from the oldest Archean rocks comprising granite/gneisses to Purana and Gondwana to the recent alluvium. The Gondwana succession rest unconformabely over Lower Palaeozoic and Archeans. About 79 % of the area is underlain by Gondwana formation, 21% by Granite/Gneiss and Metasedimentary rocks.

The major landform in the area is Pedeplain, which covers approximately 56% of the district. Other landforms present include pediment (15%), structural hills (19%), flood plains (9%), and other landforms (1%). The district is part of the Godavari river basin, with the northern portion bordered by the meandering Godavari river. The district includes two sub-basins, Manair and Lower Godavari, and is drained by minor streams such as Bogullavagu. The drainage pattern in the area is dendritic to sub-dendritic, and lineaments trend along NW-SE and SW-NE directions.

In this district, forest and agriculture are the main land use aspects, covering 52.36% and 29.70% of the total geographical area, respectively. The district is benefited from major and medium irrigation projects such as the Kaleshwaram Lift Irrigation Project and J. Chokka Rao LIS built across Godavari river, respectively. In addition, there is the Boggulavagu project built across the Manair river which provides irrigation to an area of 5150 acres in Kataram and Malhar Rao Mandal. The district also has 916 minor irrigation tanks with an ayacut of 72,172.89 acres and 25,255 irrigation wells, including 12,438 dug wells and 12,817 tube wells.

A total of 39 groundwater monitoring stations are used to monitor water levels during both pre- and post-monsoon seasons. The depth to water levels before the monsoon season ranges from 1.44 mbgl (Ghanpur-Mulugu) to 25.71 mbgl (Regulagudem), while after the monsoon season it ranges from 1.46 m bgl (Ghanpur-Mulugu) to 23.30 mbgl (Regulagudem). The elevation of the water table ranges from 90 to 230 m.amsl during the pre-monsoon period and 94 to 234 m.amsl during the post-monsoon period. Groundwater flow is mainly directed towards the northern and northeastern parts of the district.

According to the analysis of water level fluctuation data, it was found that 92% of the wells showed a rise in water level, while 8% of the wells showed a fall in water level. The minimum water level fluctuation was observed at Kataram, with a fall of 0.64 meters, while the maximum water level fluctuation was observed at Jadalpet, with a rise of 17.27 meters. Trend analysis for the last 10 years (2011-2020) is studied from 21 hydrograph station. The decadal pre-monsoon water level trend analysis indicates that 8 wells show falling trend and 13 wells show rising trend. During post-monsoon season 5 wells show falling trend and 16 wells shows rising trends.

On the basis of occurrence and movement of ground water, rock units of the Jayashankar Bhupalapally district can be broadly classified into two categories: semi-consolidated to unconsolidated formation (Sedimentary rock) which occupies 79 % of the area and consolidated formation (Meta-sedimentary rock) which occupies 21% of the area.

Semi-consolidated formations 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 or unconfined zone varies 7-50 m. 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 V. The yields of exploratory wells drilled in Kamthi formation range from 19 lps to 36 lps with transmissivity of 40 $m^2$/day to 668 $m^2$/day, whereas the yields borewells drilled at Kota and Maleri formation ranges from 13 lps to 14 lps with transmissivity of 28 $m^2$/day to 50 $m^2$/day.

Granites of Achaean Formation and metasediments of Pakhal supergroup represents the consolidated formation. They are devoid of primary porosity. However, subsequent weathering, fracturing and fissuring developed secondary porosity. The main aquifers constitute the weathered zone at the top, followed by a discrete anisotropic fractured/fissured zone at the bottom, generally extending down to 200 m depth. Depth of fracturing varies from 13 m to 191 m. Ground water yield from fractured formation ranges from <1 to 5 lps. The transmissivity varies from 0.98 to 14.403 m2/day and storativity varies from 0.001 to 0.00031.

A total of 68 groundwater samples were analyzed to assess the quality of groundwater in the district. The electrical conductivity (EC) of the groundwater was found to be below 3000 µ Siemens/cm during both pre and post-monsoon seasons. During the pre-monsoon season, the concentration of nitrate (NO3) ranged from 2-346 mg/l, with 51% of the samples exceeding the maximum permissible limit of 45 mg/l set by BIS. The concentration of fluoride (F) varied from 0.05 to 3.47 mg/l, with 20% of the samples exceeding the maximum permissible limit of 1.5 mg/l set by BIS. During the post-monsoon season, the concentration of NO3 ranged from 1.40-306 mg/l, with 41% of the samples exceeding the maximum permissible limit of 45 mg/l set by BIS. The concentration of F varied from 0.06-3.03 mg/l, with 20% of the samples exceeding the maximum permissible limit set by BIS.

Net dynamic replenishable ground water availability is 291.06 MCM, gross ground water draft is 138.79 MCM, provision for drinking and industrial use for the year 2025 is 16.91 MCM and net available balance for future irrigation use is 147.93 MCM. The stages of ground water development is 48 %.

Major issues identified are high fluoride concentration (>1.5 mg/L) and occur in 20 % of the samples during pre and post-monsoon season respectively. High nitrate concentration (> 45 mg/L) occur in 51 % and 41 % of the samples during pre-monsoon and post-monsoon season respectively.

The management strategies mainly include supply side and demand side management. The supply side measure includes ongoing work under Mission Kakatiya where de-silting of existing minor tanks (679 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 plan to import ~19.53 MCM of water for drinking purposes which will save the present ~11.718 MCM of water for drinking and domestic purposes and with this additional ~1953 ha of land can be brought under ID crops.

As the stage of ground water development in the district is 48 % and 1 out of 11 mandals are falling in semi-critical 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 for 1 semi-critical mandal (i.e. Tekumatla) only which includes construction of 24 artificial recharge structures (13 CD's and 11 PT's). In demand side management 860 ha of additional land that can be brought under micro-irrigation (@1000 ha/mandal including existing area in 1 semi-critical mandals (i.e., Tekumatla mandal) costing about 5.16 crores (considering 1 unit/ha @0.6 lakh/ha). With this 1.29 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, the likely benefit would be the net saving of 1.99 MCM of ground water, which can bring down the stage of ground water development by 9 % (from 85 % to76 %) in Tekumatla mandal.

# 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 groundwater. 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 groundwater development concept**" to "**modern groundwater 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 a robust and implementable groundwater management plan. The proposed management plans will provide necessary inputs and recommendations for ensuring sustainable management of groundwater resources of district. The aquifer maps and management plans will be shared with the Administration of Jayashankar Bhupalapally district, Telangana State for its effective implementation.

## 1.1 Objective and Scope

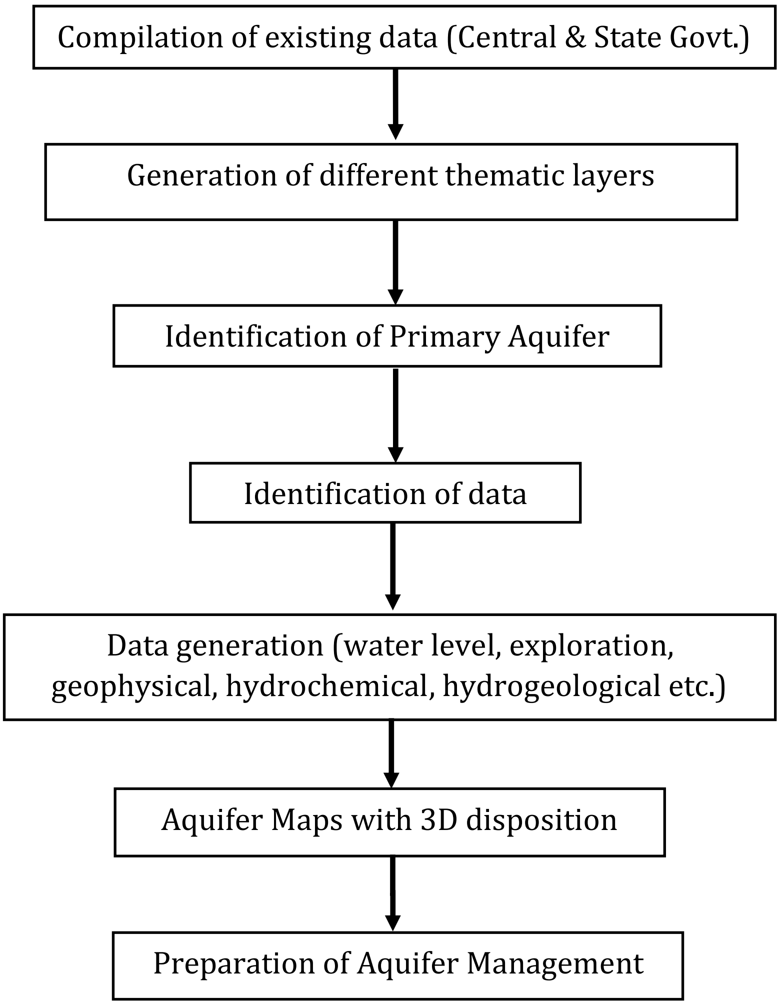
An integrated hydrogeological study was taken up to develop a reliable and comprehensive aquifer map and to suggest suitable groundwater management plan on 1: 50,000 scale. The activities under NAQUIM are aimed at:

- Identifying the aquifer geometry
- Aquifer characteristics and their yield potential
- Groundwater quality
- Aquifer wise assessment of groundwater resources
- Preparation of aquifer maps in 3D and 2D
- Formulate groundwater 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 to the depths of 200- 300 meters.

Considering the objectives of 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 Jayashankar Bhupalapally district having geographical area of 2984.96 km$^2$, lies between north latitudes from 18°09'22.72"N to 18°52'14.11"N and east longitudes from79°33'42.33"E to 80°21'4.86"E located in the east of Telangana State. The location map of the district is presented in **Fig.1.1**.The district is bounded on north by Mancherial district on the northeast by Bijapur district of Chhattisgarh, on the southeast by Mulugu district, on the south by Warangal district, on west by Hanamkonda and Peddapalli districts. The district headquarters is located at Jayashankar Bhupalapally Town and Godavari river flows along the North eastern part and Manair river in Northwestern part of the district. Administratively the district is governed by 11 revenue mandals and 223 villages with a population of ~**4.16**lakhs (2011 census). The density of population in the district is 182 person per Sq.km.

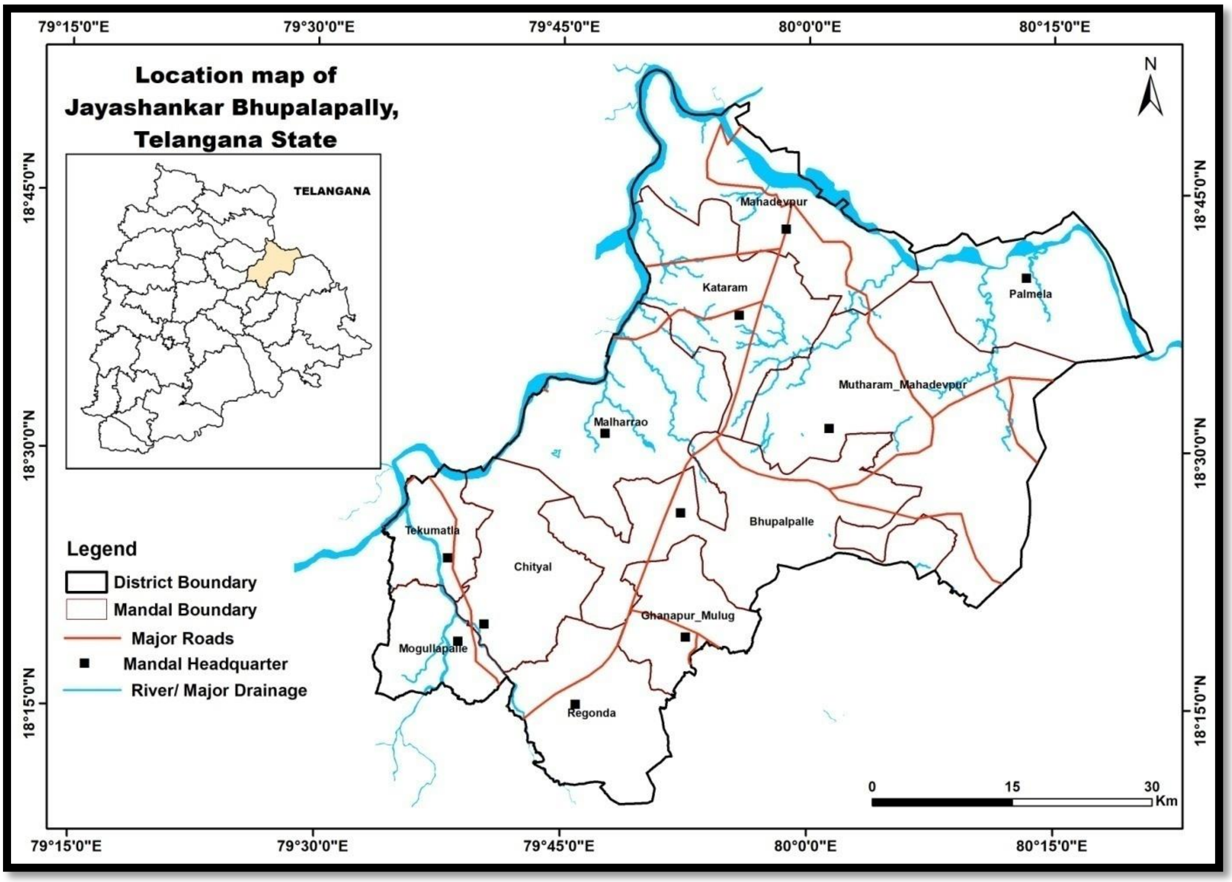



**Fig.1.1: Location map of Jayashankar Bhupalapally district.**

## 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 minimum and maximum temperature recorded is 6.9°C and 48.9 °C between 2013 and 2021. The annual normal rainfall of Jayashankar Bhupalapally district is 1088 mm, which ranges from 851 mm at Ghanpur Mulugu mandal to 1337 mm at Palmela and Mahadevpur mandal. The area receives more than 88 % of the annual rainfall by southwest monsoon between June and September and the rest during the northeast monsoon from October to November. As per Telangana State Development Planning Society (TSDPS) for the year 2021-22, it received average annual rainfall of 1326.7 mm (21.9 % more rainfall than normal rainfall). The Isohyetal map of the district is presented in **Fig.1.2a.**

Analysis of long term rainfall data of 17 years from 2005 to 2021 shows increasing trend in annual rainfall by 35.32mm/year. District received excess rainfall (+20 to +59% from normal) in 2010-11, 2013-14, 2019-20,2020-21 and 2021-22 normal rainfall (+19% to -19% from normal) in 2005-06, 2006-07, 2007-08, 2008-09, 2014-15, 2015-16,2016-17, 2017-18, 2018-19 and deficient rainfall (-20% to –59% from normal) in remaining years (**Fig.1.2b)**.

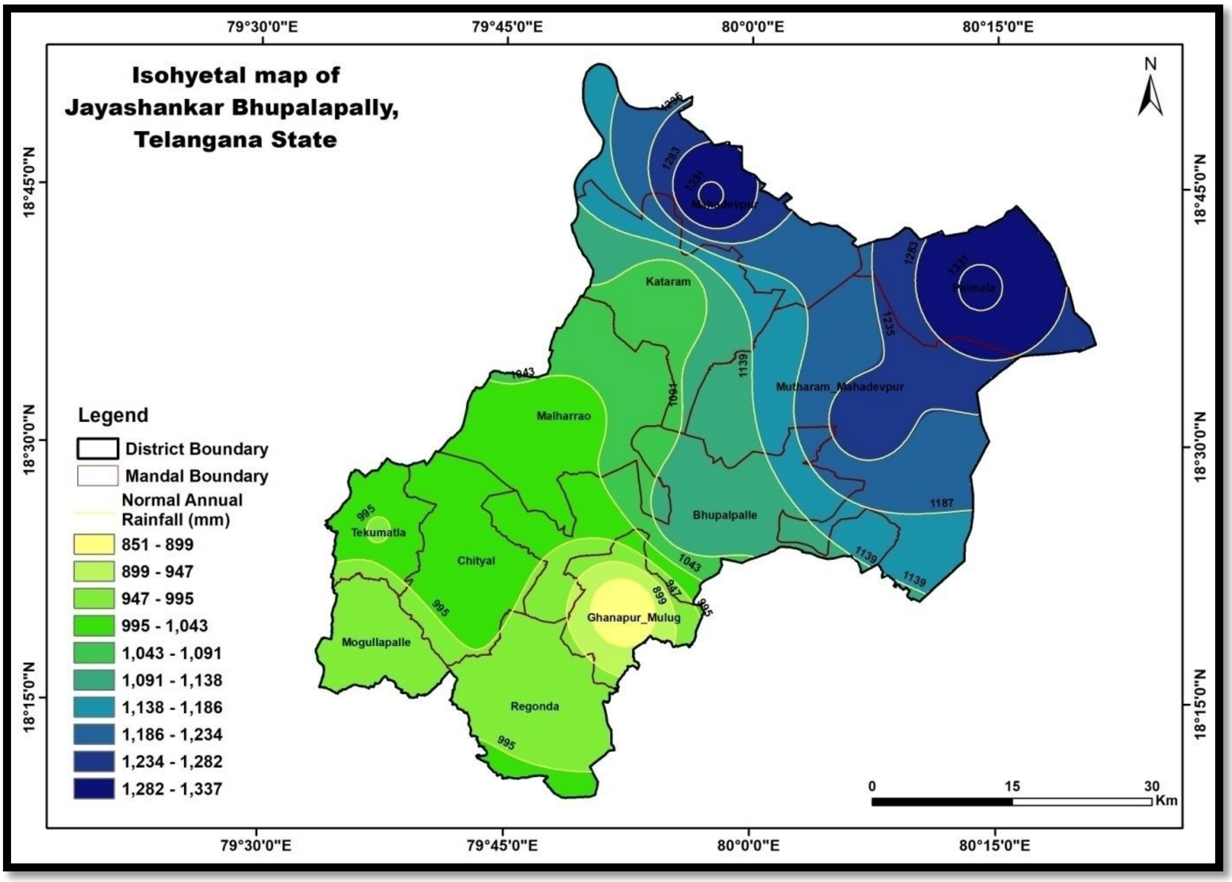



**Fig.1.2a: Isohyetal map of Jayashankar Bhupalapally district.**

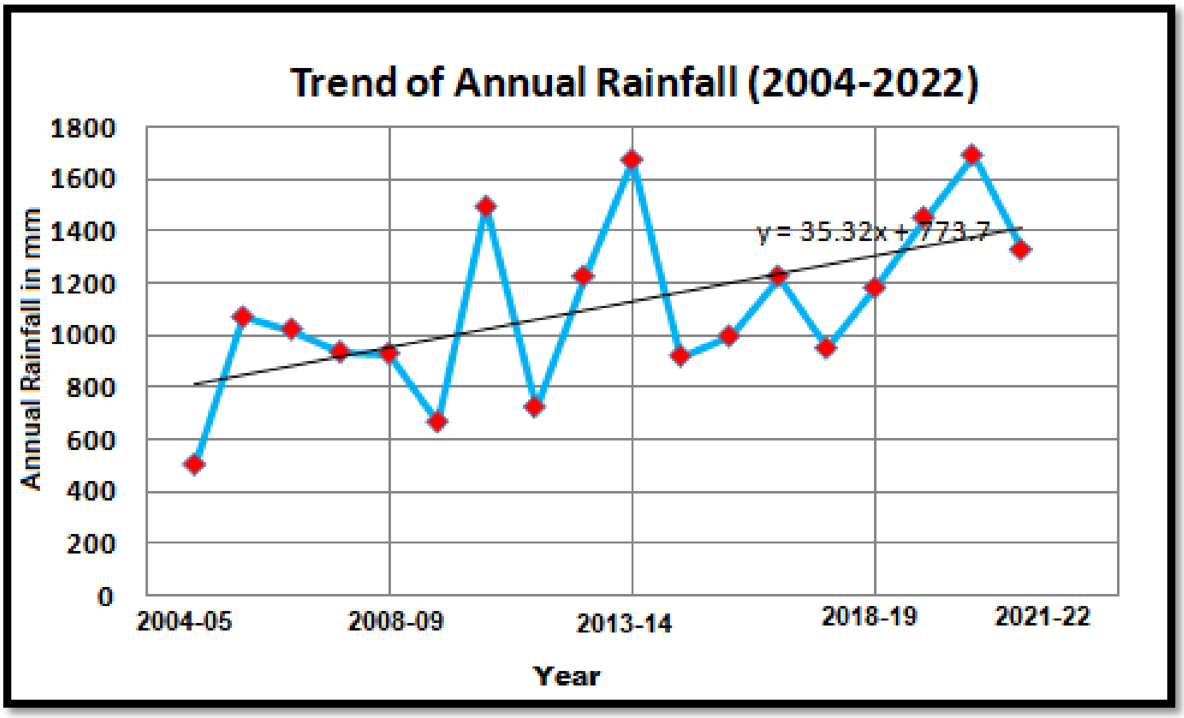



**Fig.1.2b: Annual rainfall trend (2004-2022)**

## 1.5 Geomorphological Set up

Jayashankar Bhupalapally district is characterised by undulating topography with pedeplain, pediment, structural hills, flood plain and piedmont zone. Pedeplain is the major landform covering about 56% of the area. The other landforms observed are pediment (15%), Structural hills (19%), Flood Plains (9%) and others (1%).The geomorphology map of the district is presented in **Fig.1.3**.

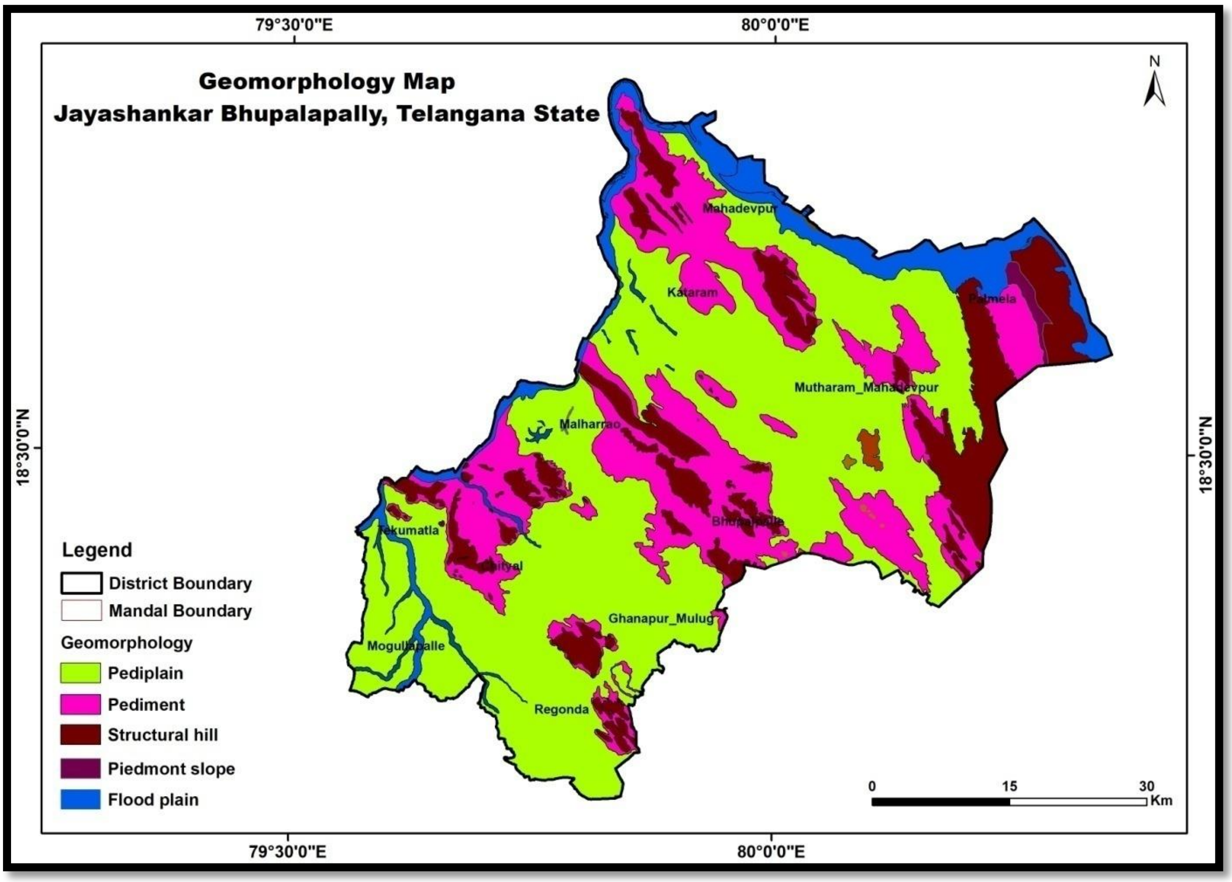



**Fig.1.3: Geomorphology map of Jayashankar Bhupalapally district.**

## 1.6 Drainage and Structures

The district forms a part of Godavari river basin. Northern part of the area is bordered by meandering Godavari river. Manair and Lower Godavari are the two sub-basin constitute the district. The Bogullavagu is the minor streams which drain the area. The drainage pattern in the area is dendritic to sub-dendritic in nature. Lineaments trend along NW-SE and SW-NE directions. Map depicting drainage, lineaments, water bodies, and river is presented in **Fig.1.4.**

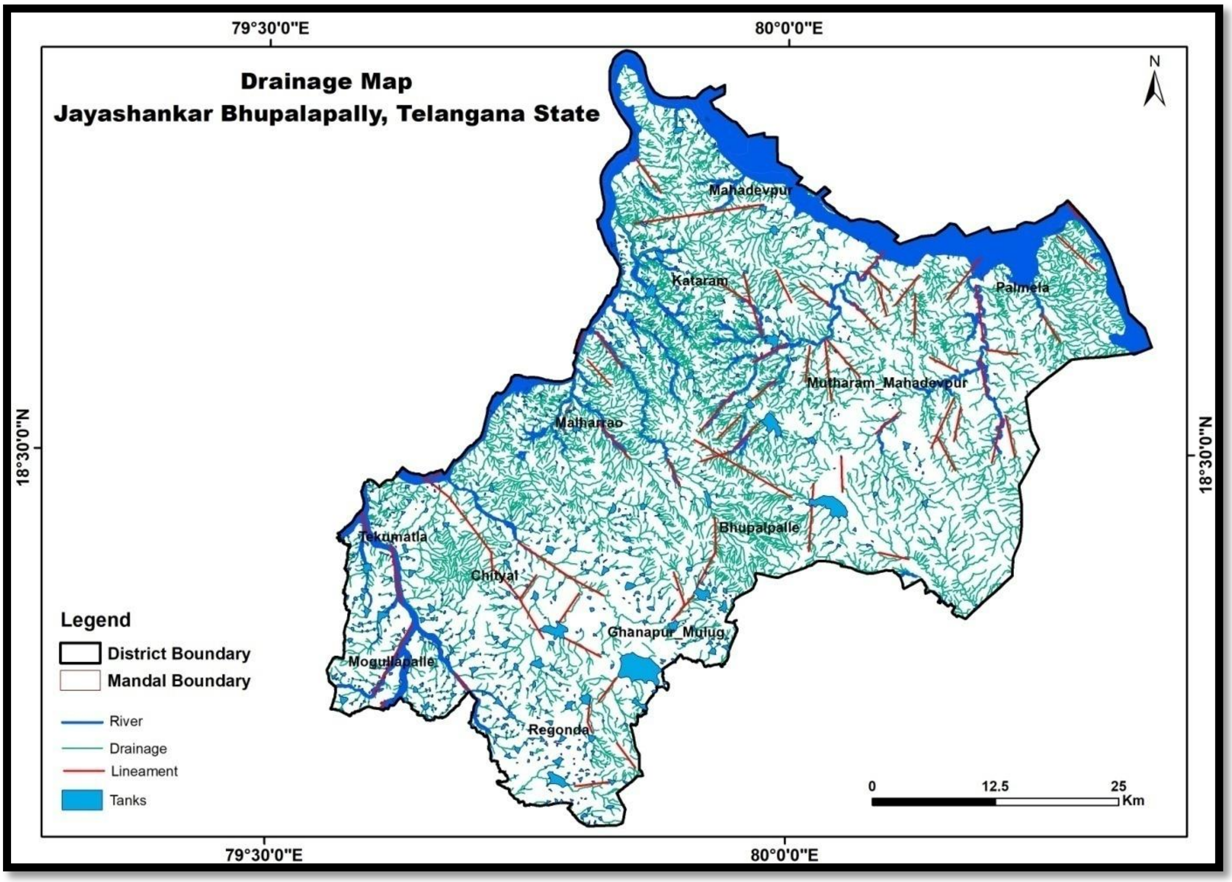



**Fig.1.4: Drainage map of Jayashankar Bhupalapally district**

## 1.7 Land use and cropping pattern

Out of the total geographical area of 2984.96 km$^2$, forest and agriculture are the prominent land use aspects in Jayashankar Bhupalapally district and forms 52.36 % and 29.70 % of total area respectively. The spatial distribution of land use is presented in **Fig. 1.5.**The land utilization of Jayashankar Bhupalapally district is given in Table 1.1 and crop distribution is given in pie diagram **Fig.1.6, Fig.1.7** and **1.8.**

**Table: 1.1 Land utilisation in Jayashankar Bhupalapally District**

| LULC | Land Use Land Cover (in %) |
|---|---|
| Forest | 52.36 |
| Barren & Uncultivable | 2.71 |
| Non Agricultural Use | 3.58 |
| Culturable Waste | 1.65 |
| Permanent Pasture | 2.74 |
| Miscellaneous | 3.10 |
| Current Fallows | 1.96 |
| Other fallows | 2.20 |
| Net Area Sown | 29.70 |
| Area sown more than Once | 4.73 |
| Grossed crop Area | 34.43 |
| **Geographical area** | **100 %** |

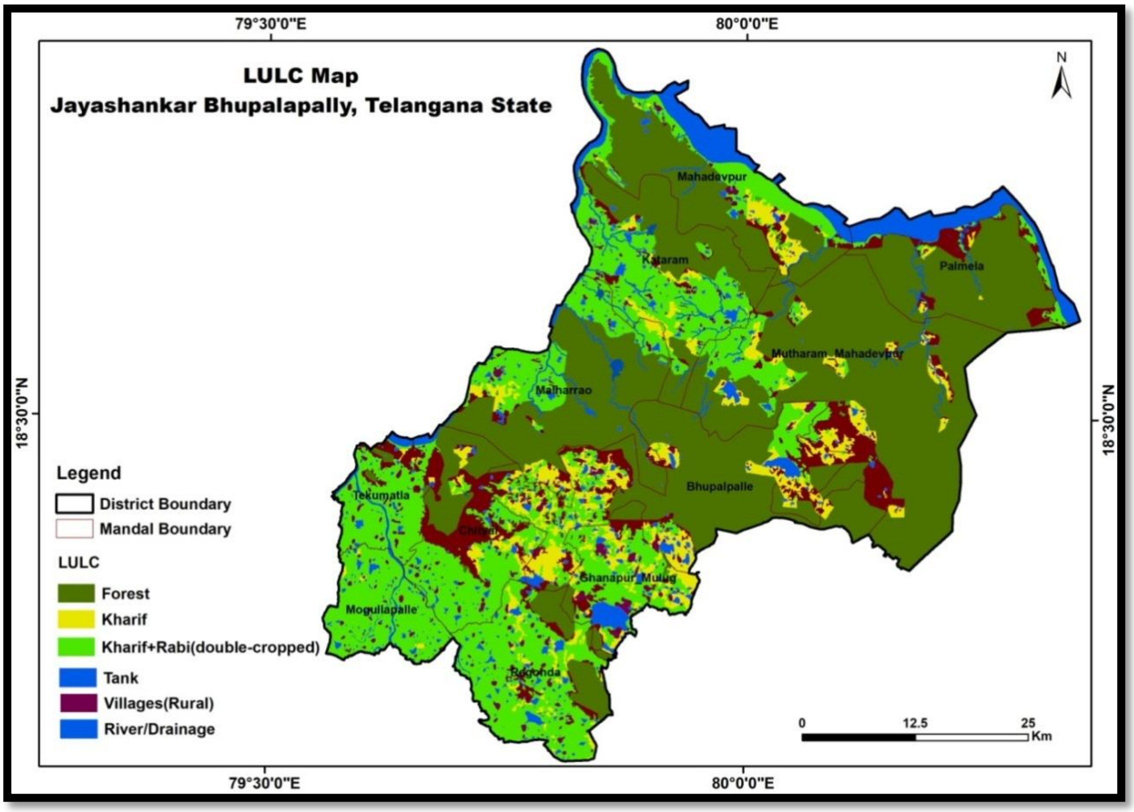



**Fig.1.5: Land use and land cover map of Jayashankar Bhupalapally district.**

The net sown area is 886.53 km² while the gross cropped area is 1027.72 km². There are wide varieties of crops grown in the district. Paddy (54.33%) is the major crop grown in the district during Kharif season followed by cotton (44.43%), coarse grains (0.59%), pulses (0.03%) and oil seeds (0.03%). In Rabi season, Paddy (87.39%) is the major crop grown followed by coarse grain (10.24%), pulses (1.15%) and oil seeds (1%) and other crops (0.27%).

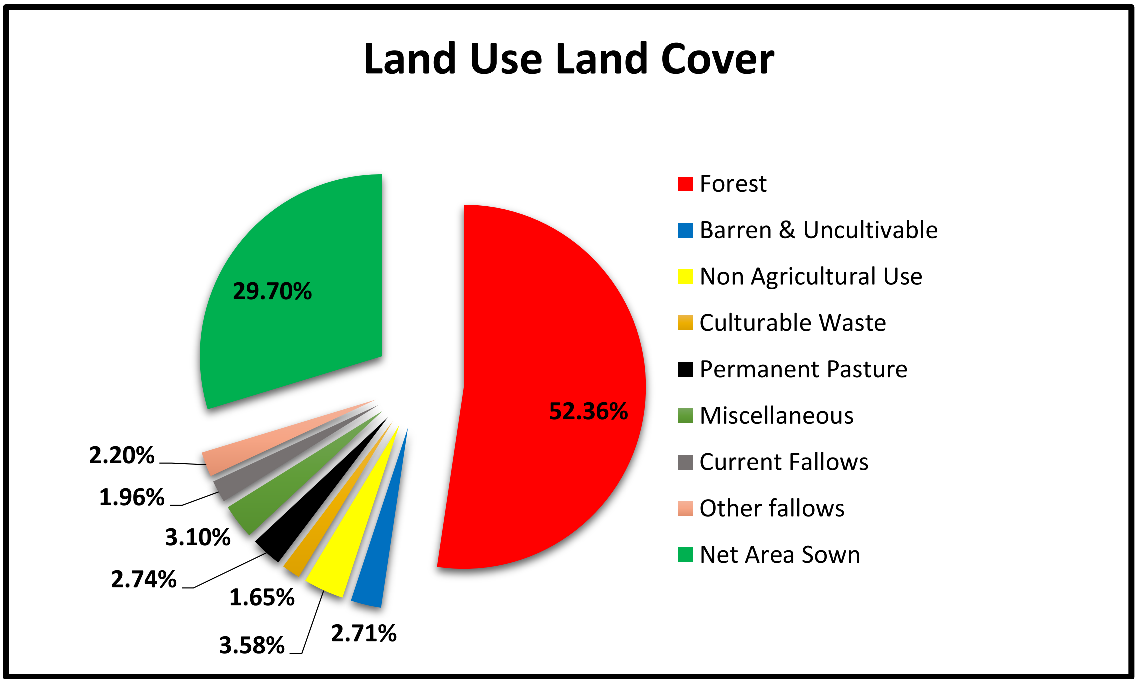



**Fig.1.6: Pie diagram for LULC of Jayashankar Bhupalapally district**

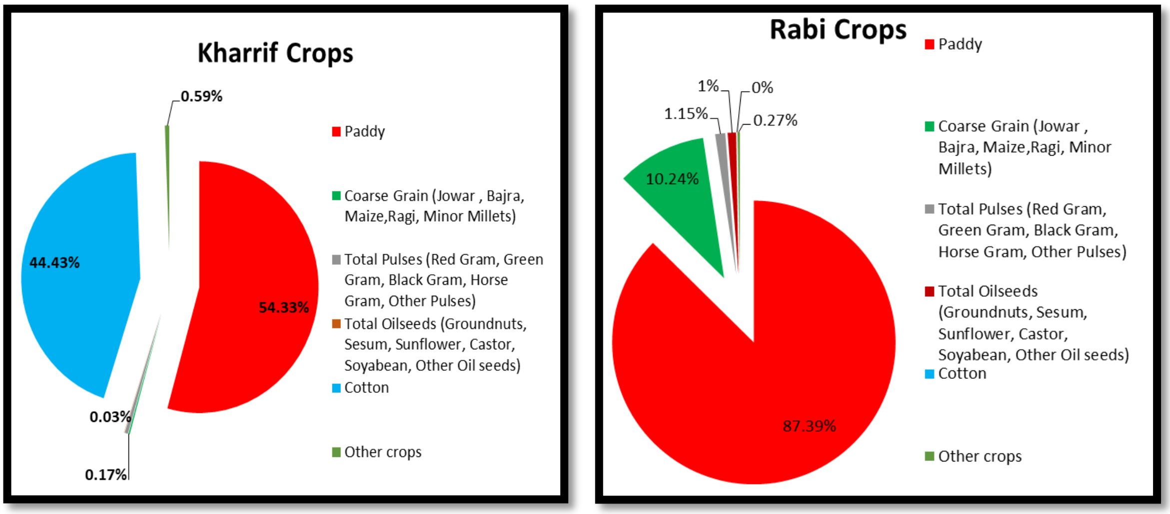



**Fig.1.7 and 1.8: Kharrif and Rabi Crop distribution of Jayashankar Bhupalapally district**

## 1.8 Soils

Jayashankar Bhupalapally district is endowed with a wide variety of soils ranging from loamy to fine mixed, montmorillonite and clayey. The fine loamy soil occupy 42% of the area, fine mixed soil occupy 17% of area, fine montmorillonite soil occupy 16%, loamy soils occupy 17% area and clayey soil 7% . The fine loamy and loamy soils mostly occur in Sullavais, Barakars and Kamthi formations (**Fig.1.7& 1.8**).

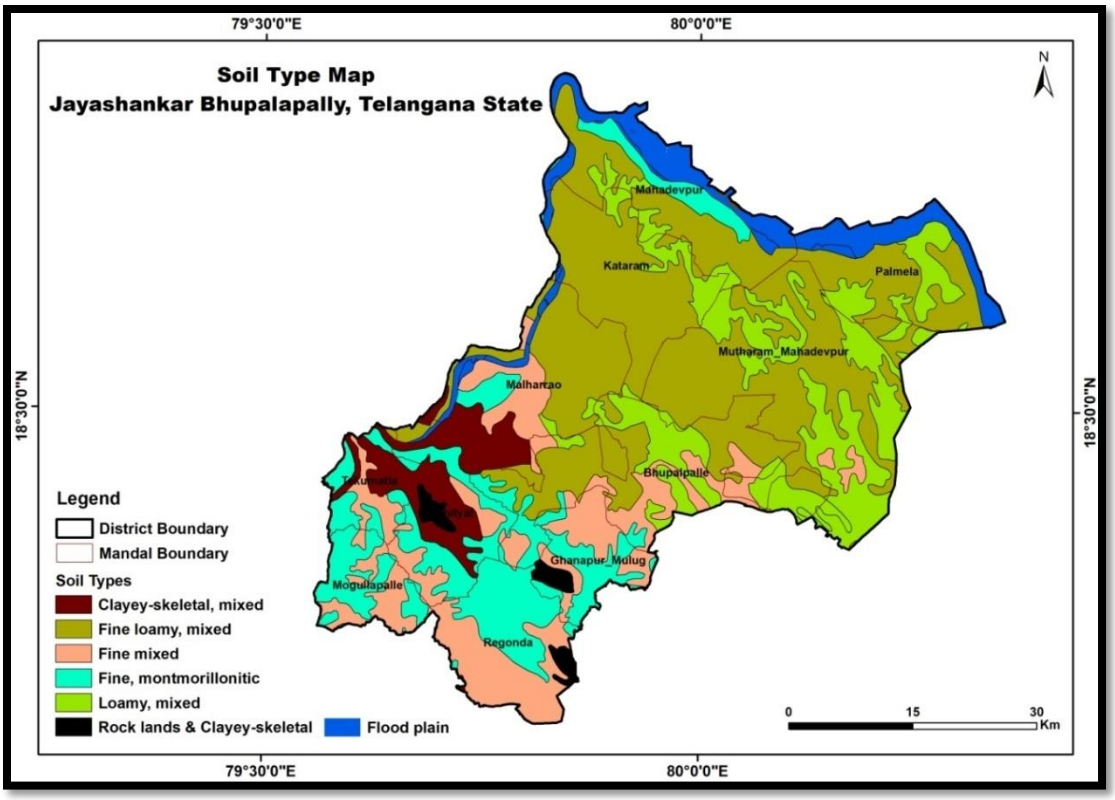



**Fig.1.7: Soil map of Jayashankar Bhupalapally district**

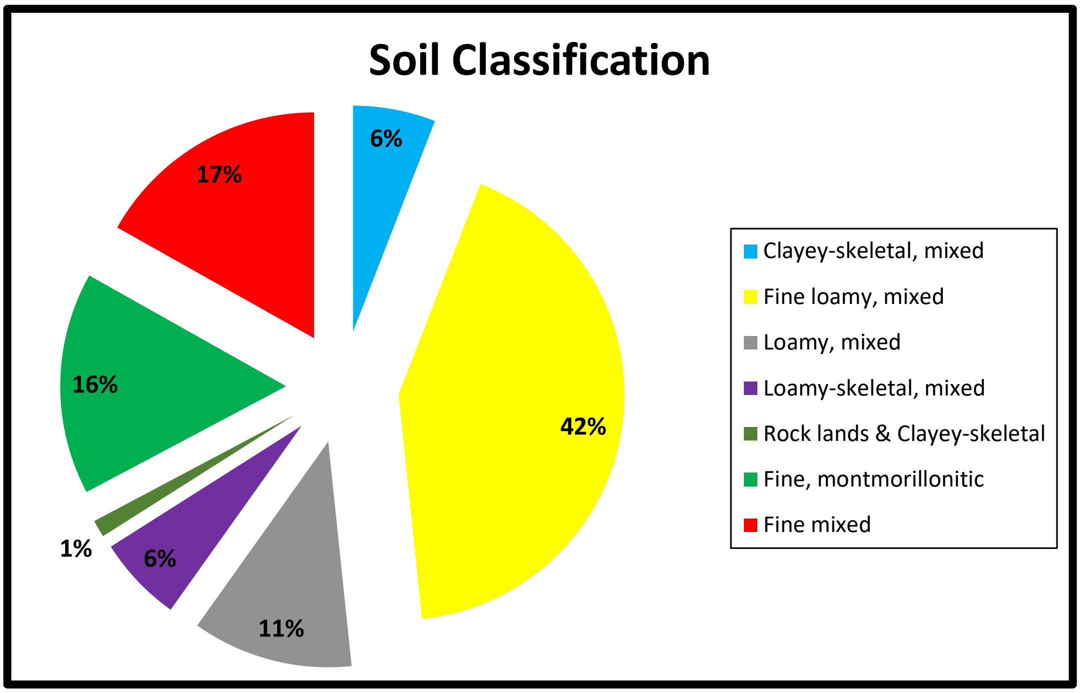



**Fig.1.8: Soil classification of Jayashankar Bhupalapally district**

## 1.9 Irrigation

**Major Irrigation Projects:**

The Kaleshwaram Lift Irrigation Project or KLIP is a multi-purpose irrigation project on the Godavari River in Kaleshwaram, Jayashankar Bhupalpally district. Construction of one barrage across river Godavari at Medigadda near Kaleshwaram, and two more barrages between Medigadda and Sripada Yellampally Project at Annaram and Sundilla and to convey water from Sripada Yellampally Project to the command area spread over in 7 districts of Telangana (now 13 districts after re-organization of districts in the state) through components such as canals, tunnels, lift systems, reservoirs, and distributary network for irrigating an ayacut of 18,25,700 acres against the original proposed ayacut of 16,40,000 acres (**Fig.1.9).**

J. Chokka Rao Devadula Lift Irrigation Scheme envisaged with lifting of water from Godavari River near Gangaram (V), Eturunagaram (M), Mulugu District to irrigate 6.21 Lakh Acres in upland drought prone areas of Karimnagar, Warangal (U), Warangal (R), Jayashankar Bhupalpally, Siddipet, Yadadri, Jangaon and Suryapet districts from an Elevation +71 m to +540 m.

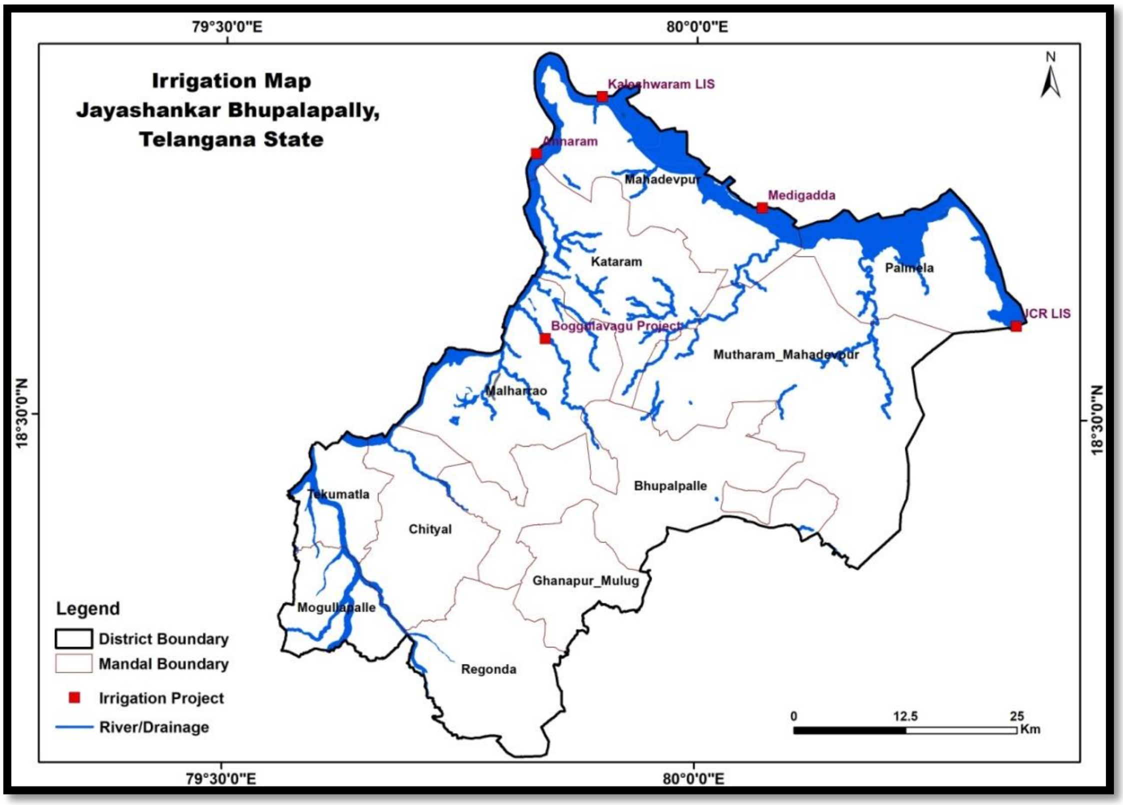



**Fig. 1.9 Irrigation project in Jayashankar Bhupalapally district**
(Source:https://irrigation.telangana.gov.in/icad/projects)

**Medium Irrigation Projects:**

Boggulavagu project is a medium irrigation scheme proposed across a local stream called Boggulavagu a tributary of Manair river of Godavari basin to benefit backward areas of Jayashankar Bhupalapally district. The site of the Boggulavagu Reservoir across Boggulavagu stream is situated about 6.5 Km south west of Rudraram (V), Malhar Rao Mandal, Jayashankar Bhupalapally district and 96 Km from Karimnagar at latitude 18° 33' 25.26" and longitude 79° 15' 36.35"It was constructed to provide Irrigation facilities to an extent of 5150 acres in Kataram and Malhar Rao Mandal of Jayashankar Bhupalapally district.

**Minor Irrigation Tanks:**

A total of 916 minor irrigation tanks exist in the district with an ayacut of 72,172.89 acres. In the district there are 25,255 irrigation wells (12,438dugwells and 12,817tubewells). (Source: Telangana state statistical abstract-2021).

## 1.10 Prevailing Water Conservation/Recharge Practices

In the district there exist 265 percolation tanks and 178 check dams. Under Mission Kakatiya (Phase 1 to 4), 679 tanks have been undertaken for desiltation.

## 1.11 Geology

Major part of the district is underlain by Gondwana formation and remaining by Archean to Precambrian formation. The geology map of the district is given in **Fig-**

**1.10.**Sandstone is the major lithology covering 79% of the area and rest of area is covered by Granites and Limestone, Shales (Metasediments).

The general geological succession of the area is presented as **Table-1.2**.

**Table- 1.2: General Geological Succession**

| Age | Group/System | Series | Lithology |
|---|---|---|---|
| Recent to Pleistocene | | | Alluvium and laterites |
| Lower Cretaceousto Middle Triassic | Upper Gondwanas | Chikialas | Conglomerates sandstones and clays. |
| | | Kotas | Clays, sandstones and limestones |
| Lower Triassic to Upper Carboniferous | Lower Gondwanas | Kamthis | Ferruginous sandstones, clay and shales |
| | | Barakars | Feldspathic sandstones, Clays and coal seams |
| | | Talchirs | Shales and sandstones, Boulder beds and tillites |
| ---Unconformity--- | | | |
| Upper Pre-Cambrain to Lower Palaeozoic | Kurnool Group | Sullavais | Conglomerates sandstones and shales |
| Upper Pre-Cambrian | Pakhal Super Group | Mulug group | Cherts, ConglomeratesQuartzites,dolomites and shales |
| | | Mallampalli group | Basal conglomerates, Dolomites,Arkosic Glauconitic Sandstones and Shales |
| ---Unconformity--- | | | |
| Archean | | | Banded Gneissic Complex |

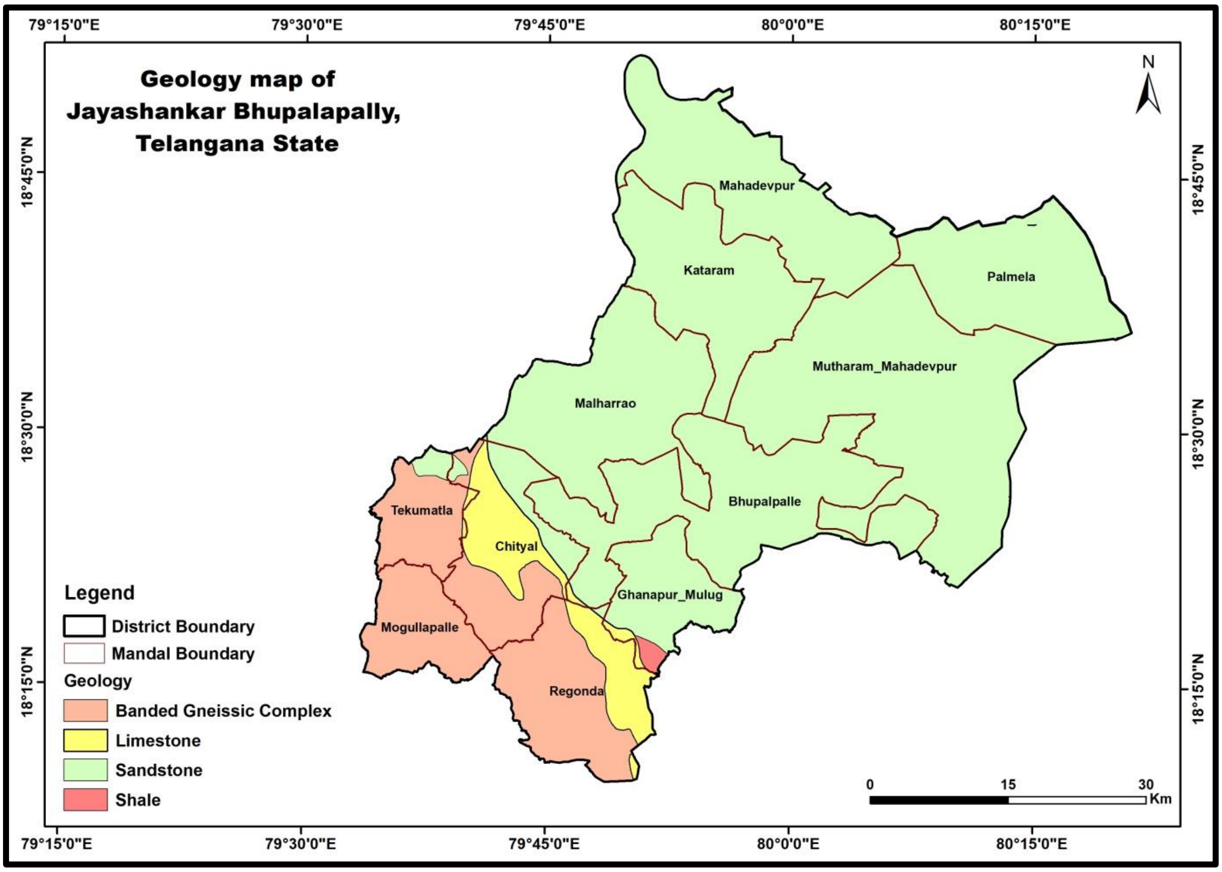



**Fig.1.10: Geology map of Jayashankar Bhupalapally district.**

# 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 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 ground water recharge | Soil infiltration studies, rainfall data analysis, canal flow and recharge structures. |
| | | Preparation of Hydrogeological map<br>(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 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 hydro geological, exploration, surface and subsurface geophysical studies in the district. The data used for the integration and interpretations are explained in the following sections:

## 2.1 Ground Water Exploration

CGWB has constructed 24 borewells, 4 by SGWD and 6 by SCCL at different depths in the Jayashankar Bhupalapally district (Table 2.2). Out of these, 21 borewells were drilled in unconsolidated/semi-consolidated formation and 14 were drilled in consolidated formation. Data analysed from CGWB/SGWD wells indicates that 4 well of shallow depth (<30 m), 6nos in the range of 30 to 100 m, 9 nos in the range of 100-200 m, and 15nosin the range of 200-300 m depth. The locations of exploratory wells are shown in **Fig. 2.1**.

## 2.2 Ground Water Monitoring Wells

Ground water level monitoring wells of 26 wells were utilized for the Aquifer mapping studies. In order 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 of 21wellshas 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 groundwater monitoring wells were used in order to understand the spatio-temporal behaviour of the groundwater regime.The locations of monitoring wells are shown in **Fig. 2.1.**

## 2.3 Ground Water Quality

To understand chemical nature of ground water, 68 (CGWB: 6, SGWD: 62) water quality data for pre-monsoon season and post-monsoon season were utilized in the analysis. 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 sampling wells are shown in **Fig. 2.1.**

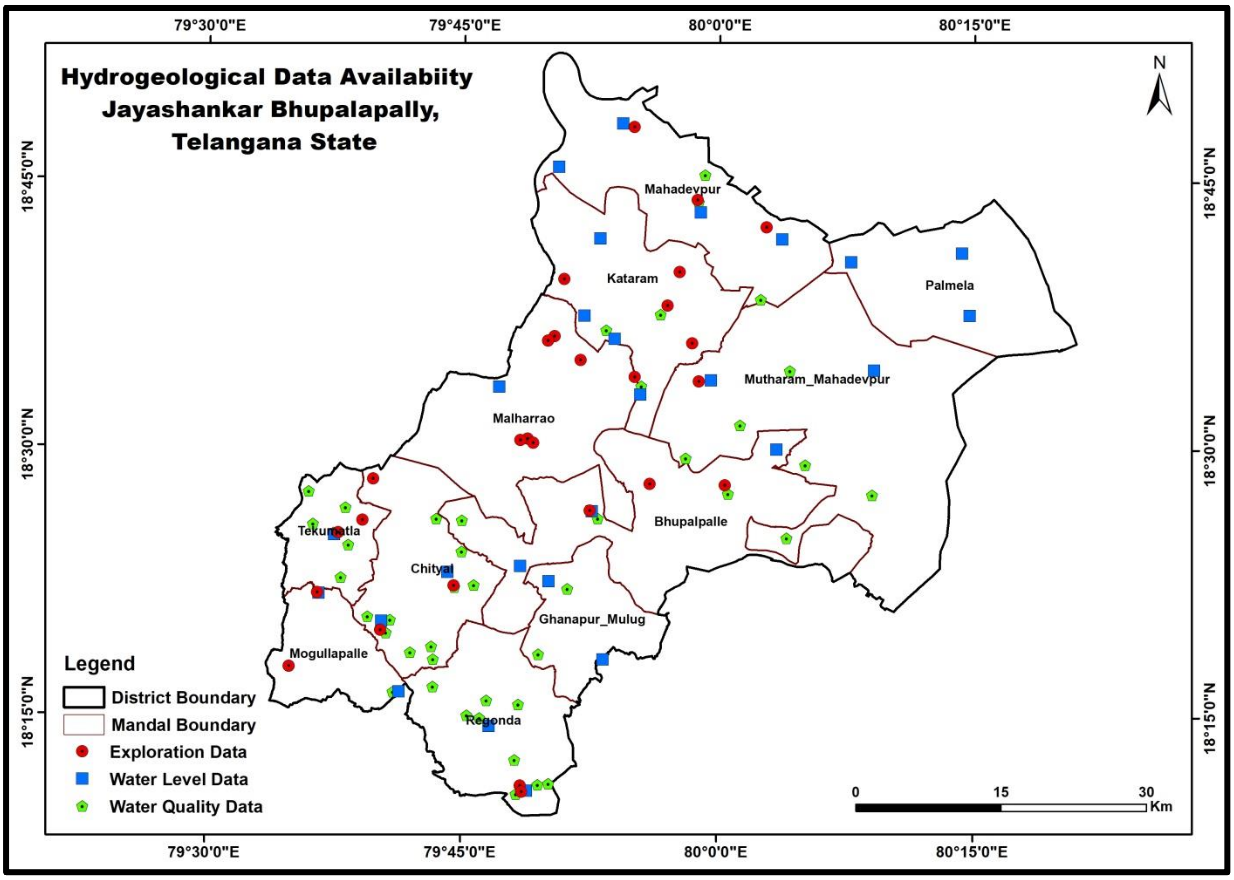



**Fig.2.1: Hydrogeological Data Availability**

# 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 (Average: 2011-2020) was generated by utilizing water level data of 39 monitoring wells. The pre-monsoon depth to water levels ranges between 1.44mbgl (Ghanpur-Mulugu) and 25.71 mbgl (Regulagudem). The shallow water level in range of 0-5 mbgl are observed as isolated patches in parts of Ghanpur-Mulugu, Bhupalapally and Kataram (3% of area).The water level in the range of 5-10 m bgl is observed mainly in Ghanpur-Mulugu, Bhupalapally, Mutharam-Mahadevpur mandals (45 % of area).The deeper water levels of >10 m bgl are observed mainly in Tekumatla, Regonda, Chityal, Mahadevpur, Palmela and Kataram mandal (51% of area). The pre-monsoon depth to water level map is given in**Fig.3.1.**

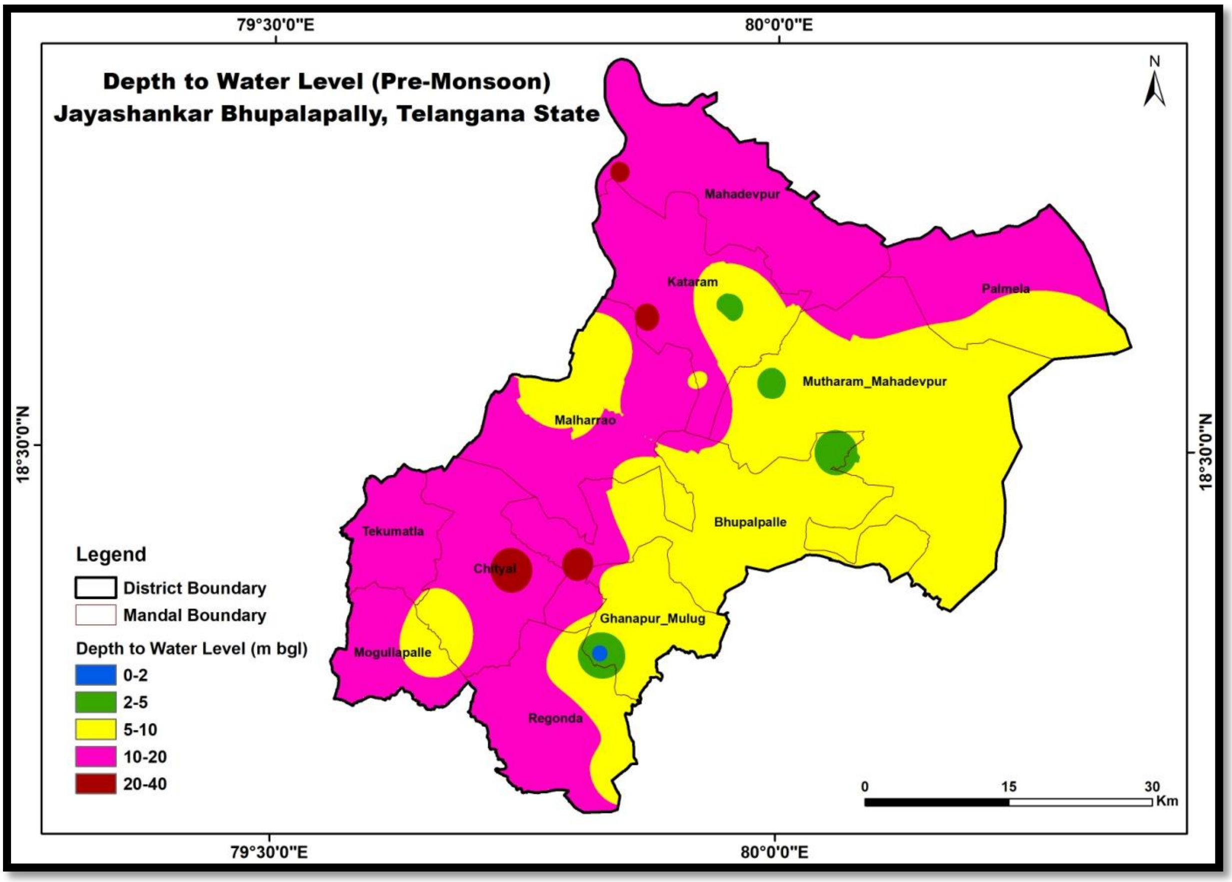



**Fig.3.1: Depth to water level map of pre-monsoonseason (Average:2011-2020)**

The post-monsoon depth to water levels ranges between 1.46 m bgl (Ghanpur- Mulugu) and 23.30 mbgl (Regulagudem). The shallow water levels of <2 mbgl are observed as isolated patches in Ghanpur-Mulugu mandal and 2-5 m bgl are observed in Ghanpur-Mulugu, Bhupalapally and Mutharam Mahadevpur mandal of the district (17% of area).The water levels between 5-10 m bgl are observed in major parts of the district (66% of area). The deeper water levels of >10 mbgl are observed in parts of Mahadevpur, Kataram and Palimela mandal (16% of area). The post-monsoon depth to water level map is given in **Fig.3.2.**

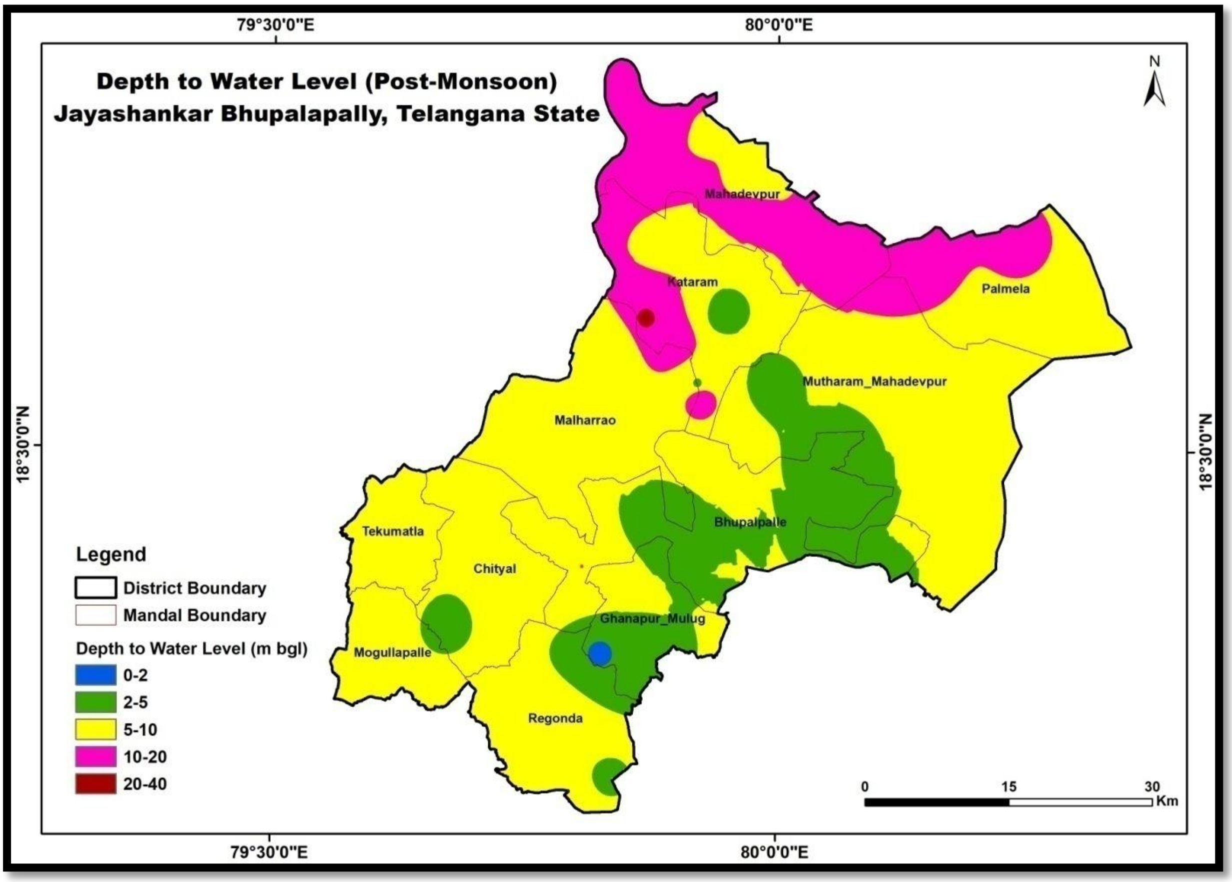



**Fig.3.2: Depth to water level map of post-monsoon season (Average:2011-2020)**

### 3.1.1 Water Level Fluctuation

The water level measured during pre and post monsoon period was used to compute the seasonal fluctuation.92% of the wells show rise in water level and 8%of wells show fall in water level. The analysis of water level fluctuation data indicates that minimum water level fluctuation was observed at Kataram (- 0.64) m) while maximum water level fluctuation was observed at Jadalpet (17.27 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 5m | 87% |
| 2. | Moderate water level fluctuation | 5to 10m | 10% |
| 3. | High water level fluctuation | >10m | 3% |

The analysis indicates that majority of the area (87%) are falling in less fluctuation range indicating good aquifer storage, whereas moderate water level fluctuations are observed in 10 % area and high water level fluctuation of more than 10m were observed in the 3% of area. 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 10 m is observed in parts of Chityal and Bhupalapally mandal.

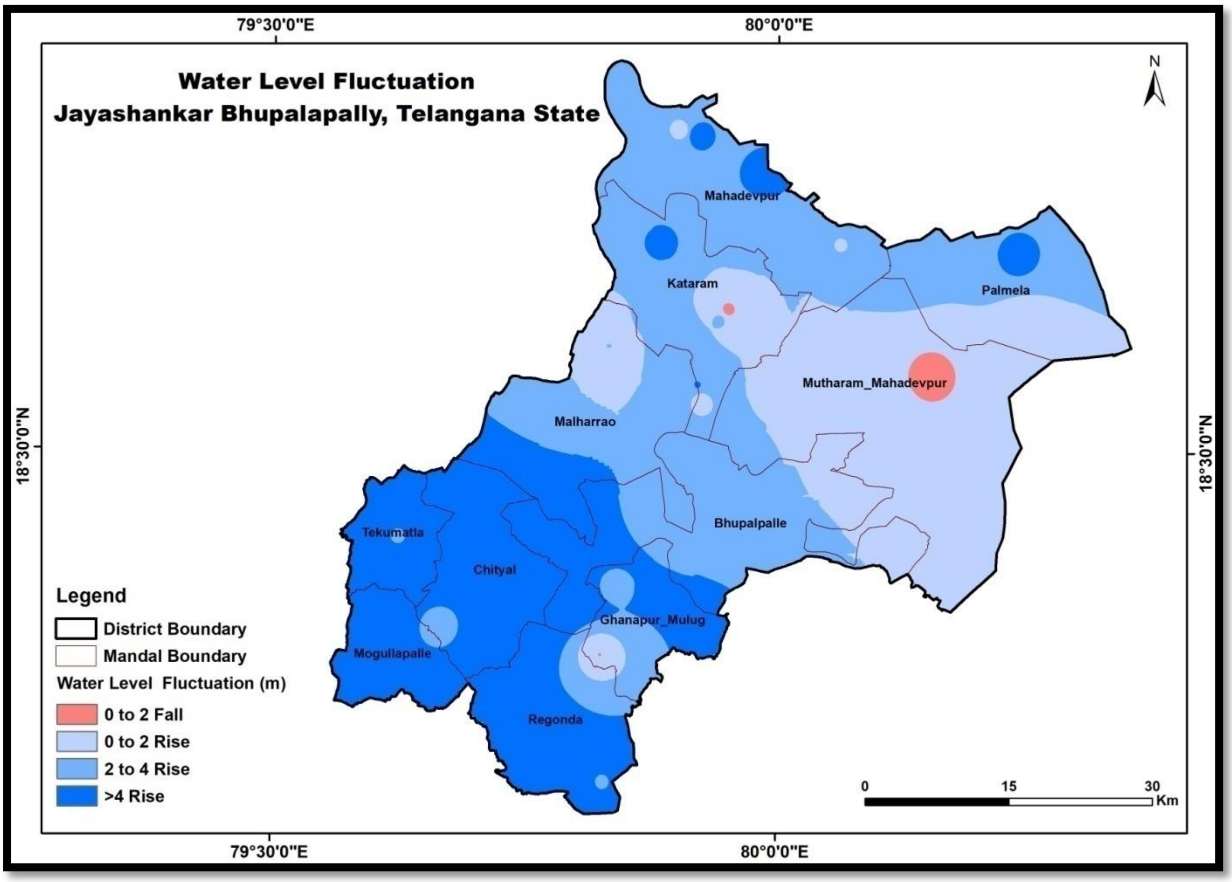



**Fig.3.3: Seasonal Water Level Fluctuations (m) (post-monsoon with respect to pre-monsoon (Average:2011-2020))**

## 3.1.2 Water Table Elevation

The water table elevation map for pre-monsoon and post-monsoon period was also prepared (**Fig.3.4(a) & 3.4(b)**) to understand the ground water flow directions. The water table elevation ranges from 90 to 230 m.amsl during pre-monsoon period and 94 to 234 m.amsl during post-monsoon period. The groundwater flow is mainly towards Northern and North Eastern direction.

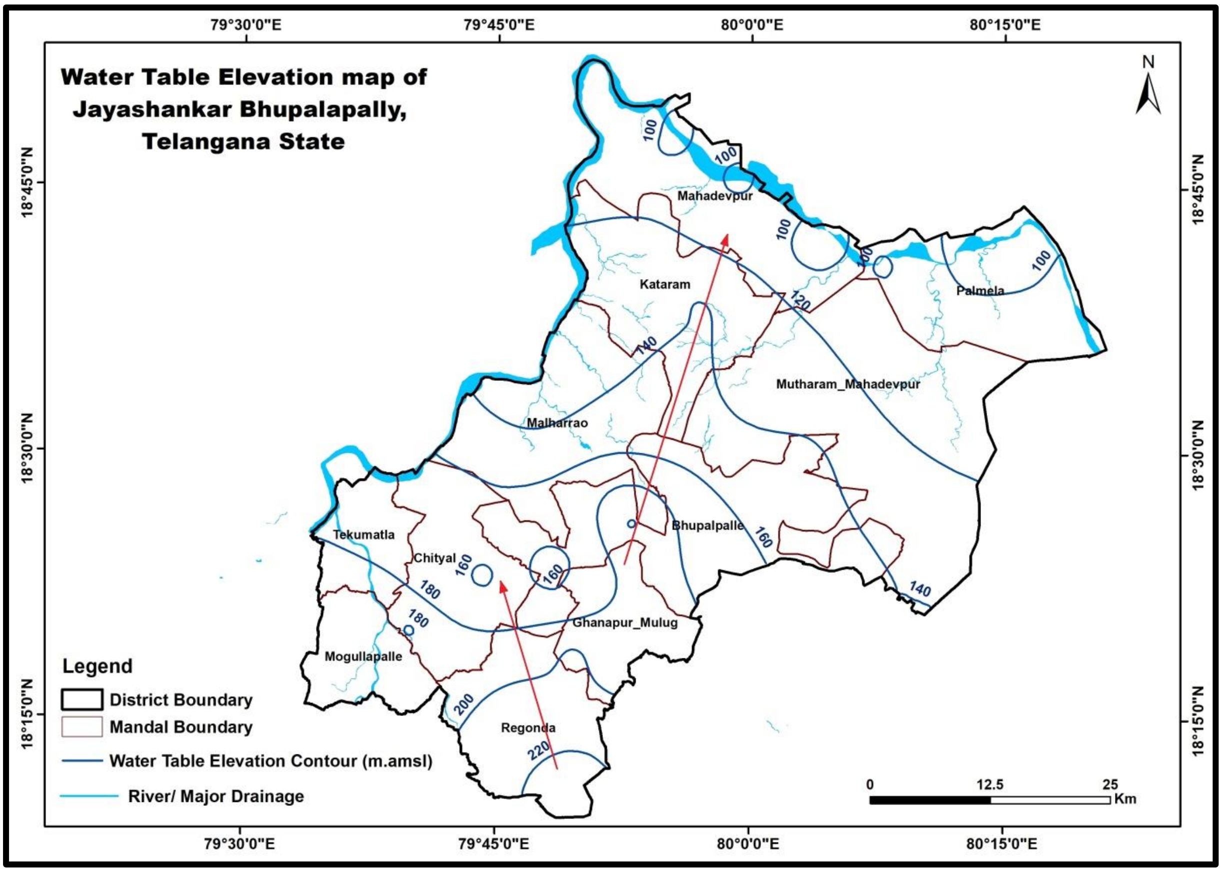



**Fig.3.4(a): Water table elevations (m amsl) during pre-monsoon season (Average:2011-2020)**

### 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 21 hydrograph stations for the period 2011-20 have been computed and analyzed. The decadal pre-monsoon water level trend analysis indicates that 8wells show falling trend (>2 m:1, 0-1 m: 7 wells) (max fall: 2.72 m/yr) and 13wells show rising trend (0-1 m: 2, 1-2 m: 11 wells) (max rise: 1.69 m/yr).During post-monsoon season 5wells show falling trend (> 2 m: 1, 1-2 m: 1, 0-1: 3) (maximum fall: 2.44 m/Yr) and 16wells shows rising trends (>2 m: 3, 1-2 m: 3, 0-1 m: 10 wells) (max rise: 2.39 m/yr). 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.**

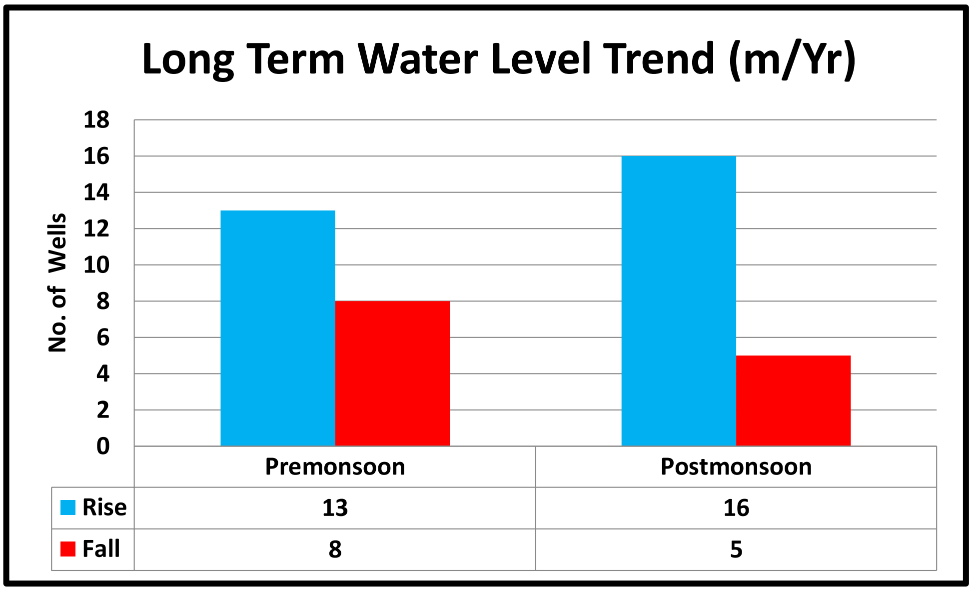



**Fig. 3.5: Graphical representation of water level trends (2011-2020)**

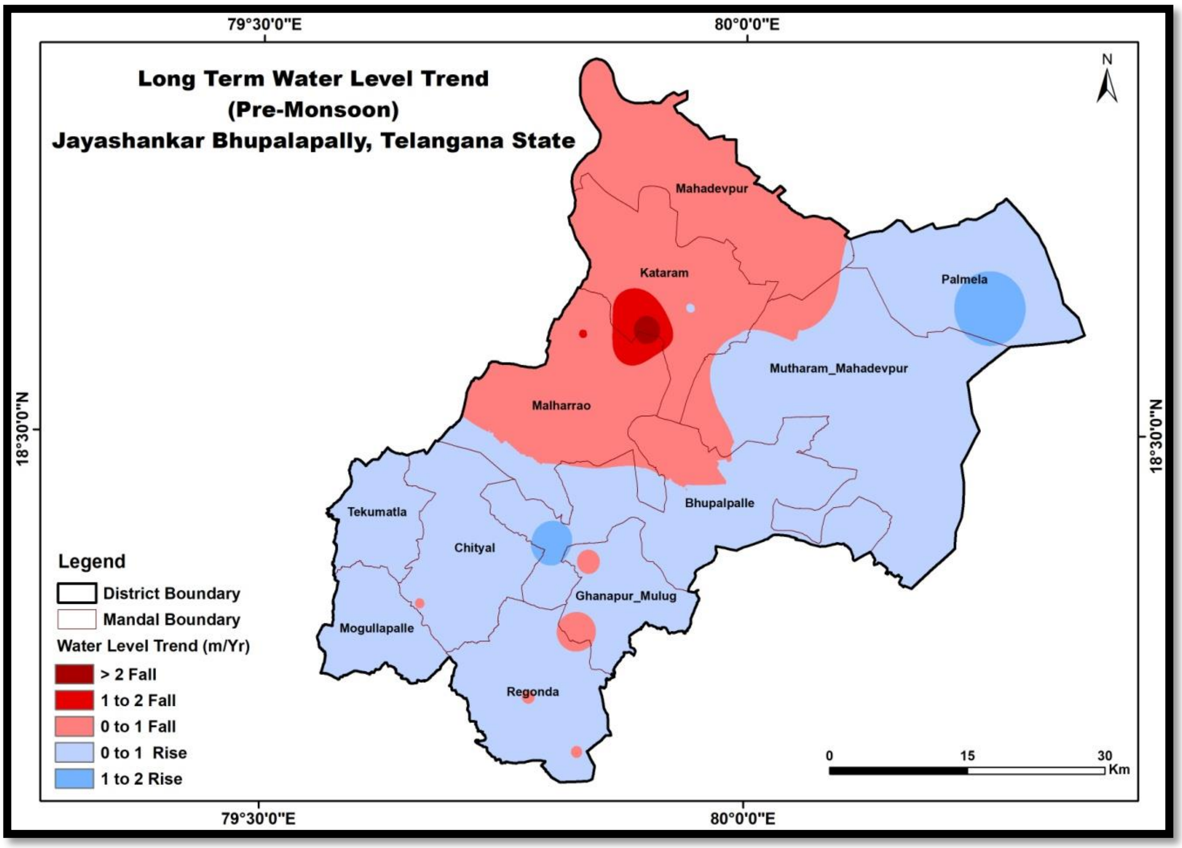



**Fig. 3.6: Long-term water level trend, Pre-monsoon (2011-2020)**

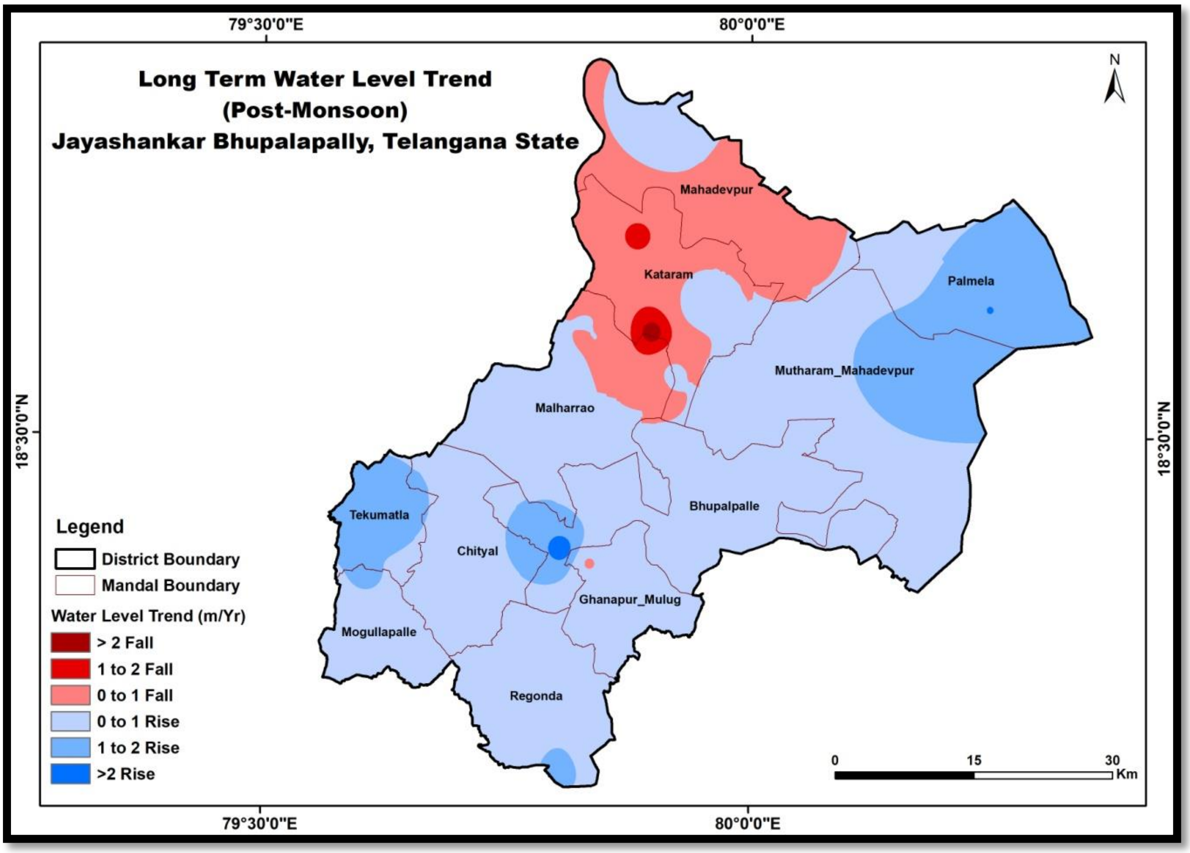



**Fig. 3.7: Long-term water level trend, Post-monsoon (2011-2020)**

## 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, 68 samples were utilised from monitoring wells. 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 68 samples were analyzed. Groundwater is mildly alkaline to alkaline in nature with pH in the range of 7.42-8.79 (Avg: 8.16). Electrical conductivity varies from 158-3016 (avg: 1077) µ Siemens/cm. EC is with in3000 µ Siemens/cm throughout the district (**Fig.3.8**). Nitrate concentration varies from 2-346 mg/l and 51 %of the samples it is beyond permissible limits of BIS Standard (>45 mg/l) (**Fig.3.9**).High Nitrate concentration is observed in parts of Mahadevpur, Regonda, Chityal, Kataram, Palimela, Tekumatla and Mutharam - Mahadevpur mandal. Fluoride concentration varies from 0.05 to 3.47 mg/l (**Fig 3.10**) and in 20% of the samples it is beyond permissible limits of BIS Standard (>1.5 mg/l). High Fluoride concentration is observed in parts of Tekumatla, Regonda, Chityal, Mutharam Manthani, Mogulapally and Malhalrao mandal.

## 3.2.2 Post-Monsoon

A total of 68 samples were analyzed. Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 7.85-8.45 (Avg: 8.17). Electrical conductivity varies from 162-2032 (avg: 1009) µ Siemens/cm. EC is within 3000 µ Siemens/cm throughout the district (**Fig.3.11**). Nitrate concentration varies from 1.40-306 mg/l and in 41% of the samples it is beyond permissible limits of BIS Standard (>45 mg/l) (**Fig.3.12**). High Nitrate concentration is observed in parts of Bhupalapally, Regonda, Chityal, Tekumatla, Palimela, Mogulapally and Mutharam - Mahadevpur mandals. Fluoride concentration varies from 0.06-3.03 mg/l **(Fig 3.13**) and in 20 % of samples it is beyond permissible limits of BIS standard (>1.5 mg/l). High fluoride concentration is observed in Chityal, Mogulapally, Tekumatla, Regonda and Mahalrao mandal.

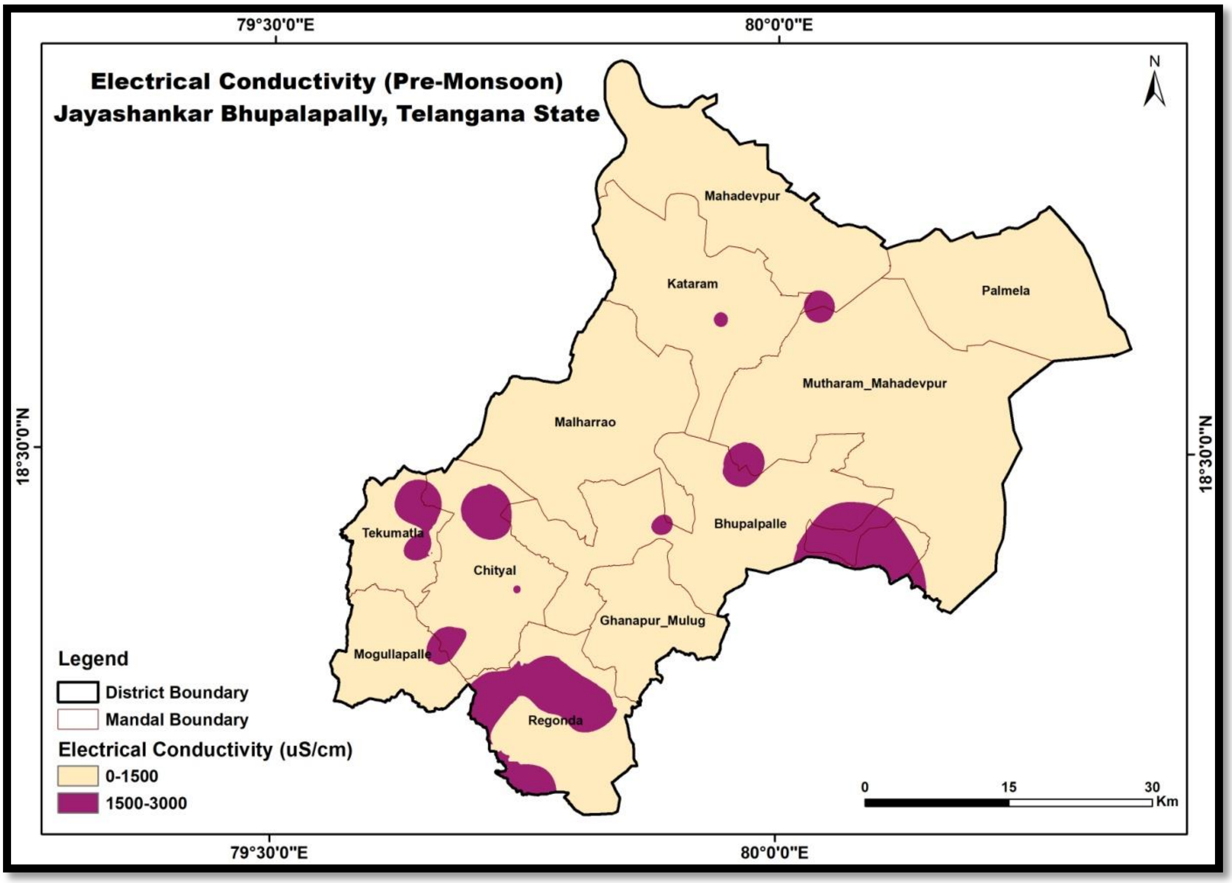



**Fig.3.8: Distribution of Electrical conductivity (Pre-monsoon).**

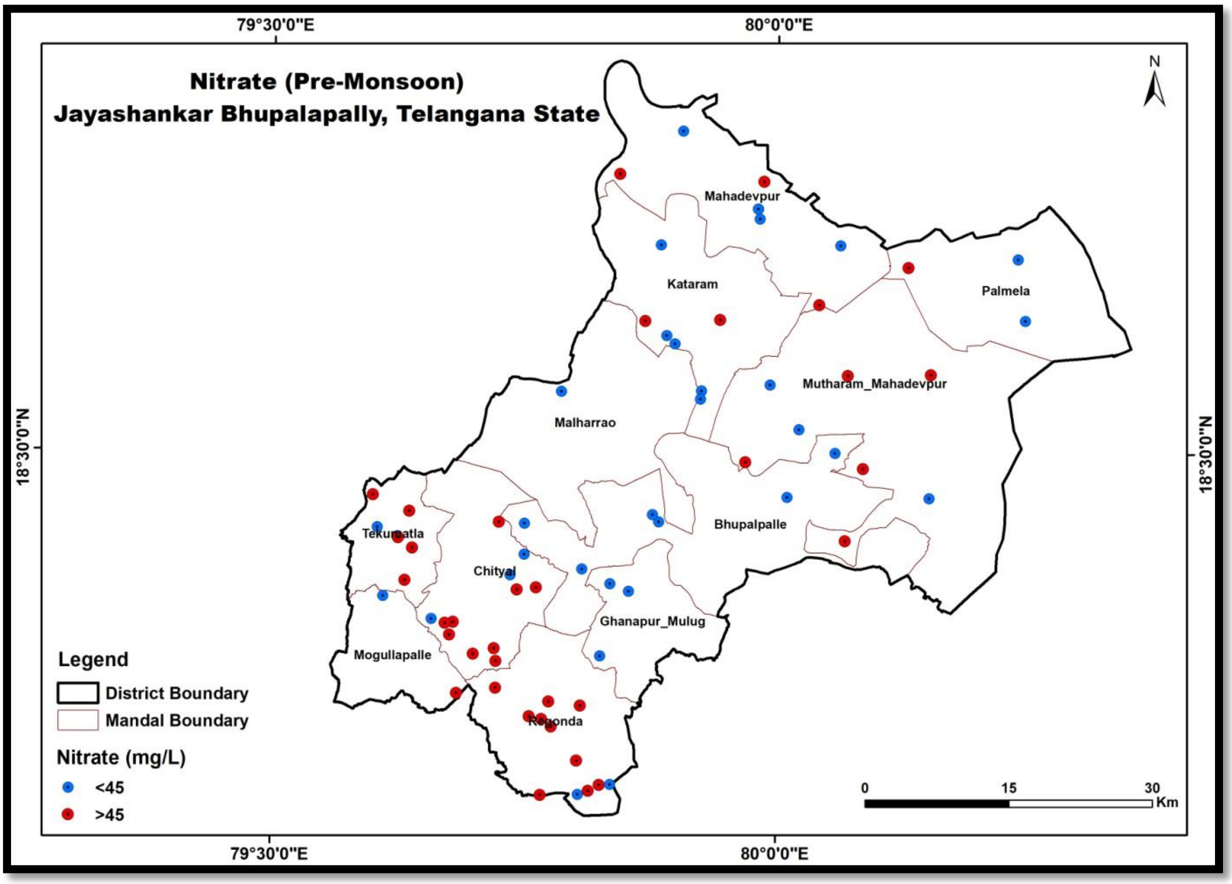



**Fig.3.9: Distribution of Nitrate (Pre-monsoon)**

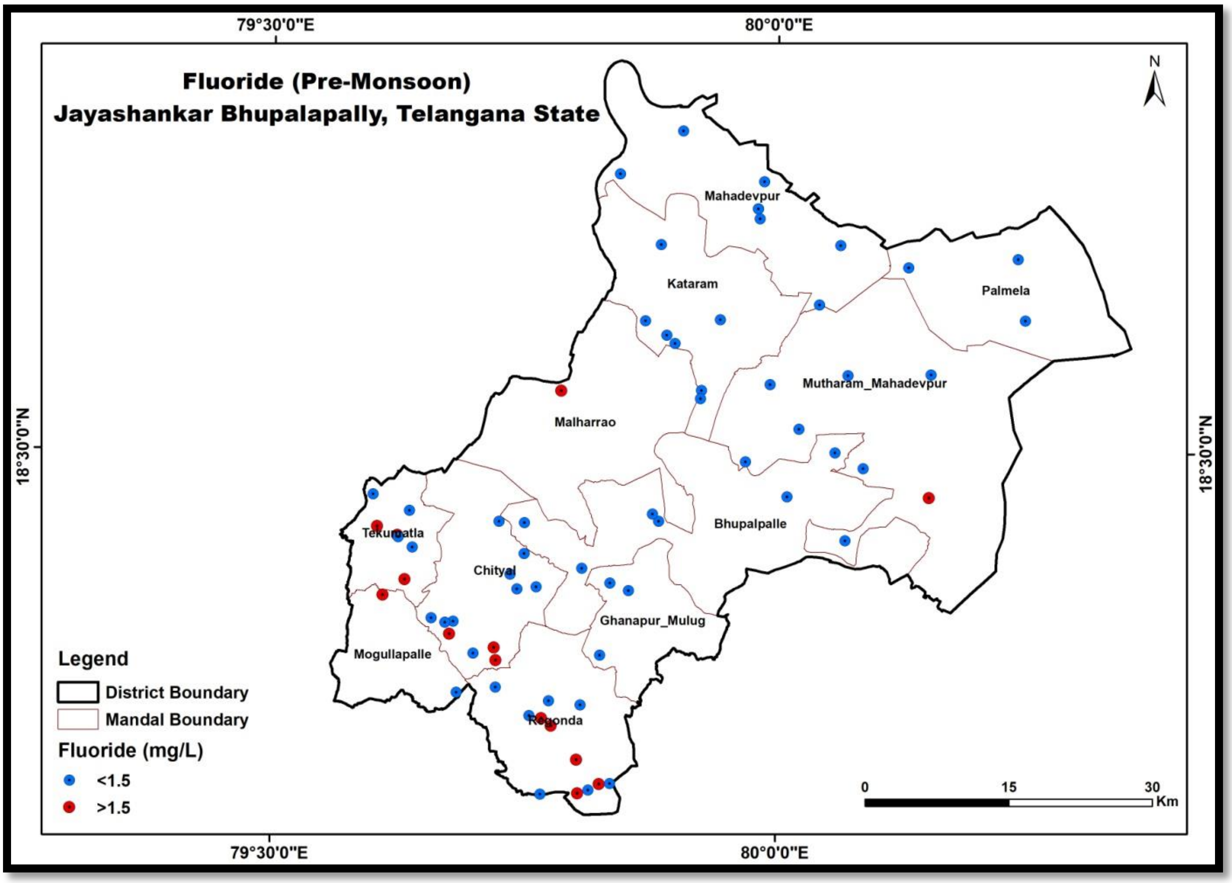



**Fig.3.10: Distribution of Fluoride (Pre-monsoon)**

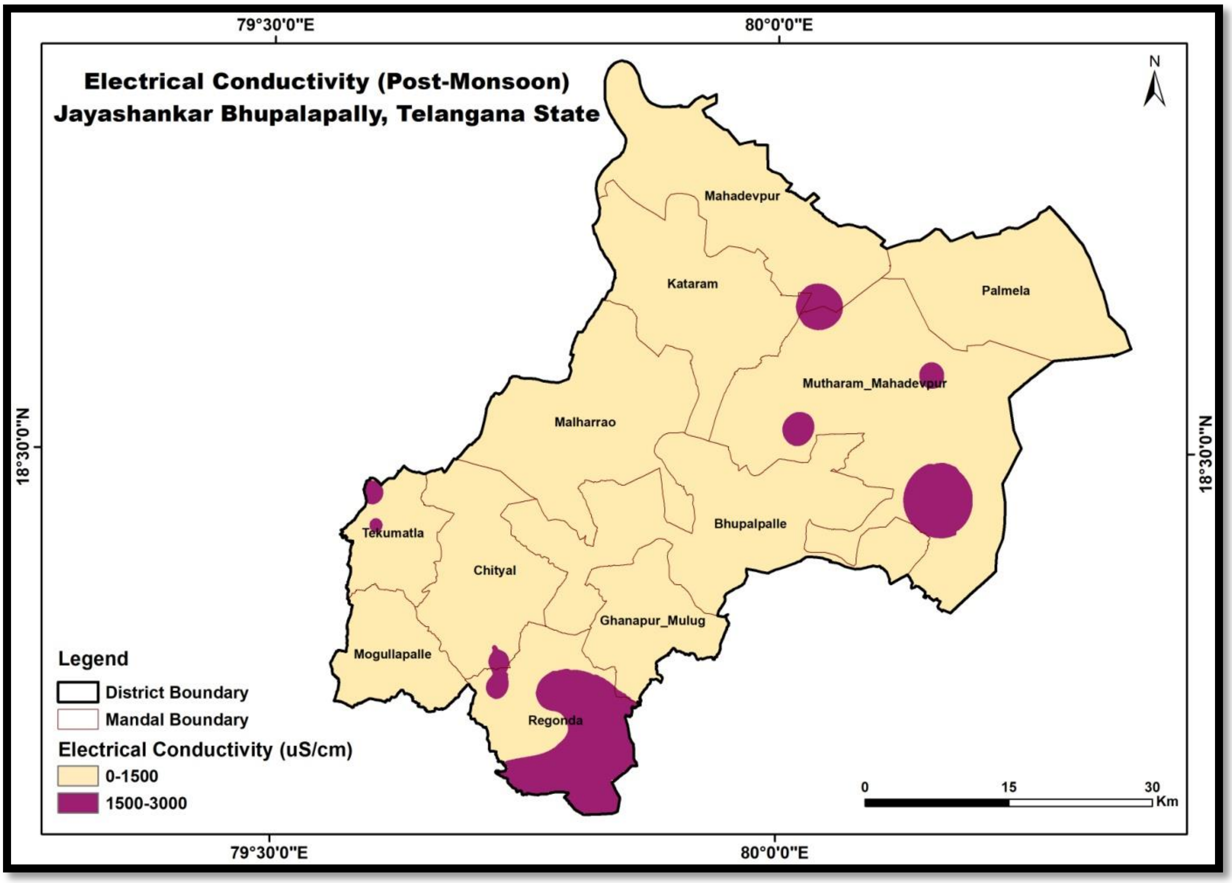



**Fig.3.11: Distribution of Electrical conductivity (Post-monsoon)**

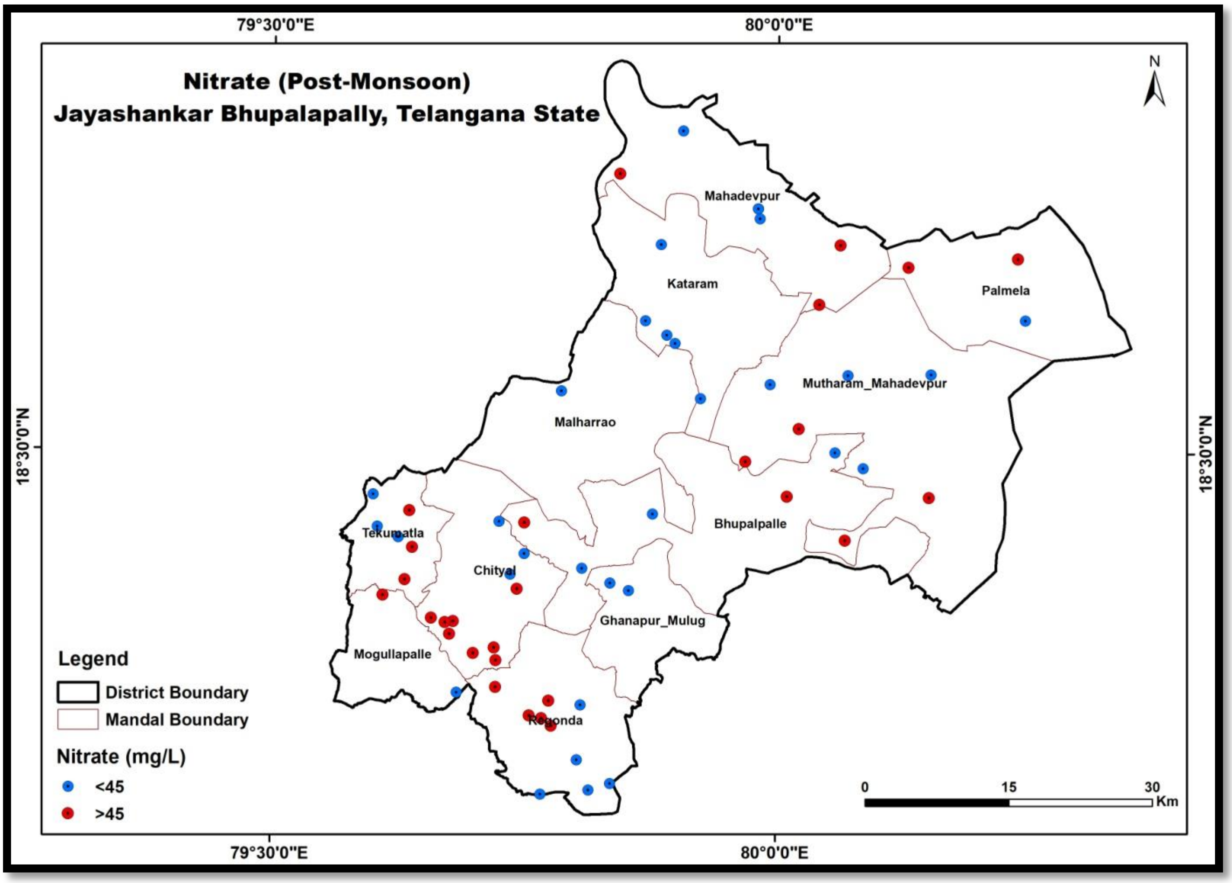



**Fig.3.12: Distribution of Nitrate (Post-monsoon)**

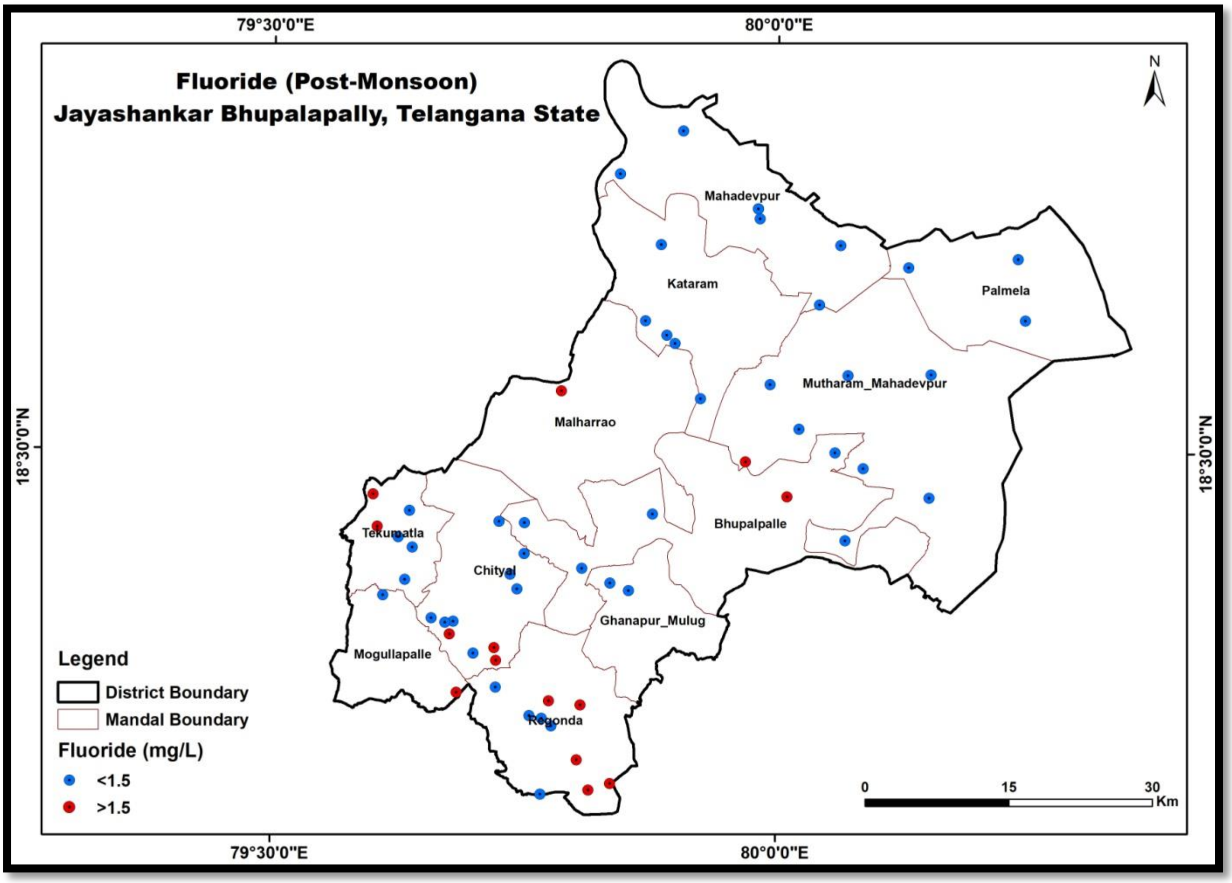



**Fig.3.13: Distribution of Fluoride (Post-monsoon)**

## 3.3 Aquifer Mapping

The aquifer geometry for shallow and deeper aquifer has been established through 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 types, depth of weathering and extension of weak zones like fractures, joints etc, in hard rocks, while in sedimentary rocks it depends on porosity, granularity, cementing matrix, permeability, bedding plains and faults. Based on 114 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 Jayashankar Bhupalapally district can be broadly classified into two categories: semi-consolidated to unconsolidated formation (i.e., Sandstone) which occupies 79 % of the area and consolidated formation (i.e., Granites, Shale & Limestone) which occupies 21% of the area.

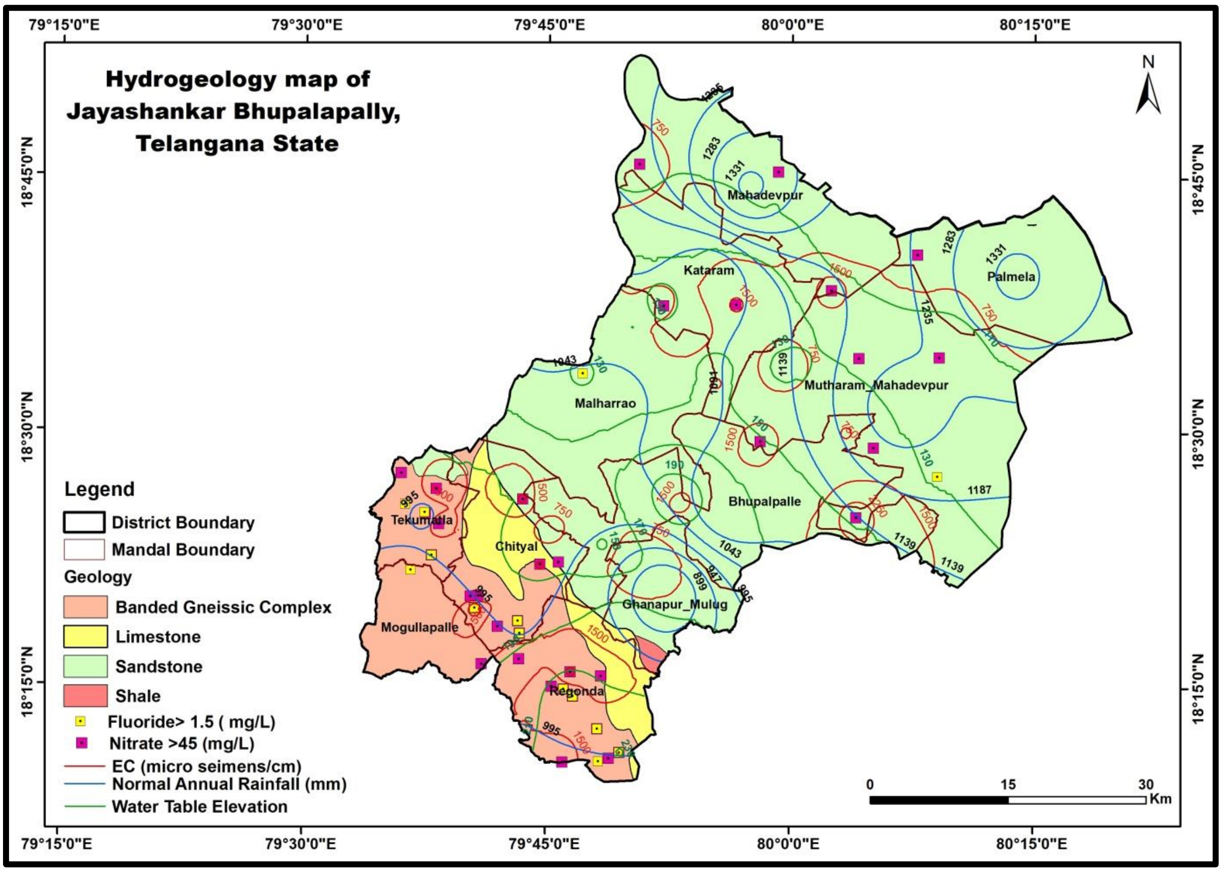



**Fig.3.14: Hydrogeological map of Jayashankar Bhupalapally district**

Gondwana formations represent the semi-consolidated rocks, which consists of 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. 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 are decided based on the depth of bottom clay layers.

Consolidated formation consists of Achaean rocks 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 Aquifer Characterization

### 3.3.1.1 Unconfined aquifer

The unconfined aquifer thickness in unconsolidated formation ranges from 7 to 50 m.
In hard rock area (Granitic formation), weathered zone (~20 m) varies from meagre to 15 m.bgl.
Ground water yield of unconfined aquifer varies from <1 to 2 lps (avg: 1 lps) with transmissivity of 25 to 50 m2/day. Ground water yield of weathered granite/gneiss aquifer varies from <0.1 to 2 lps (avg: 1 lps).

### 3.3.1.2 Confined/Semi-confined aquifer (Aquifer-II to Aquifer-V)

The confined aquifers extend below unconfined aquifer occurring underneath semipervious and impervious clayey strata. Based on the extension of clay strata, the confined aquifers area demarcated into 4 aquifer units, viz. Aquifer-II, Aquifer-III, Aquifer-IV and Aquifer-V.

Aquifer-II present below unconfined aquifer in the depth range of 30 to 150 m. separated by clay layer with considerable thickness of 5 to 30 m and Aquifer-III to Aquifer-V present below Aquifer-II in the depth range of 140 to 300 m separated by clay layer. The transmissivity of these aquifers vary from 28 $m^2$/day to 668 $m^2$/day with storativity ranging from $5x10^{-4}$ to $2.3x10^{-4}$. The coarse grained Kamthi sandstones encountered with 160 m thickness at Koyyuru and Isthambampalli (Kattaram area) encountered potential aquifers with semi-artesian to artesian condition. The Kamthi sandstones at Suraram village (Mahadevpur mandal) also recorded free flowing artesian conditions. The yields of exploratory wells drilled in Kamthi formation range from 19 lps to 36 lps with transmissivity of 40 $m^2$/day to 668 $m^2$/day. whereas the yields of Exploratory borewells constructed at Dhanwada and Mulugupalli villages of Kattaram area tapping Kota and Maleri ranges from 13 lps to 14 lps with transmissivity of 28 $m^2$/day to 50 $m^2$/day.

Shallow borewells tapping river alluvial formations exists in Nagapalli. Allamkunta, Gangaram, Allasagar in Kattaram mandal have yield ranges upto 2 lps.

In consolidated rock, depth of fracturing varies from 13 m to 191 m. Ground water yield from fractured formation ranges from <1 to 5 lps. The transmissivity varies from 0.98 to 14.403 m2/day and storativity varies from 0.001 to 0.00031.

## 3.4 3D and 2D Aquifer Disposition

The data generated from ground 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. 3.15**

The detailed analysis of the data reveals that Sandstones and Granites are the principal aquifer system. Ground water occurs in unconfined, semi-confined and confined conditions in the study area depending on the availability of impervious beds. Aquifers are classified into 5 Aquifer units in Sandstone formation, viz. Unconfined Aquifer (Aquifer-I), Confined Aquifers i.e., Aquifer-II, Aquifer-III, Aquifer-IV and Aquifer-V. 2 units are identified in Granites i.e., Weathered (Unconfined) and Fractured (Confined) formation. Based on the available hydrogeological data a fence diagram and a panel diagram showing the aquifer disposition were prepared and presented in **Fig.3.16.**

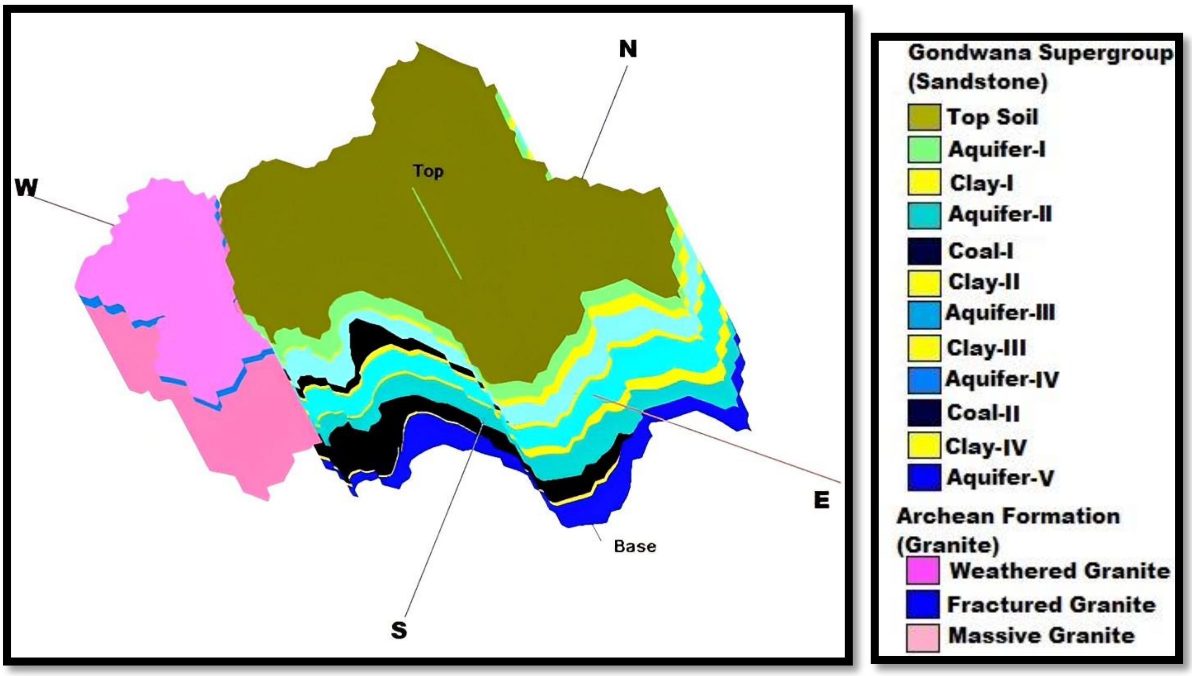



**Fig.-3.15: 3-D disposition of Aquifers**

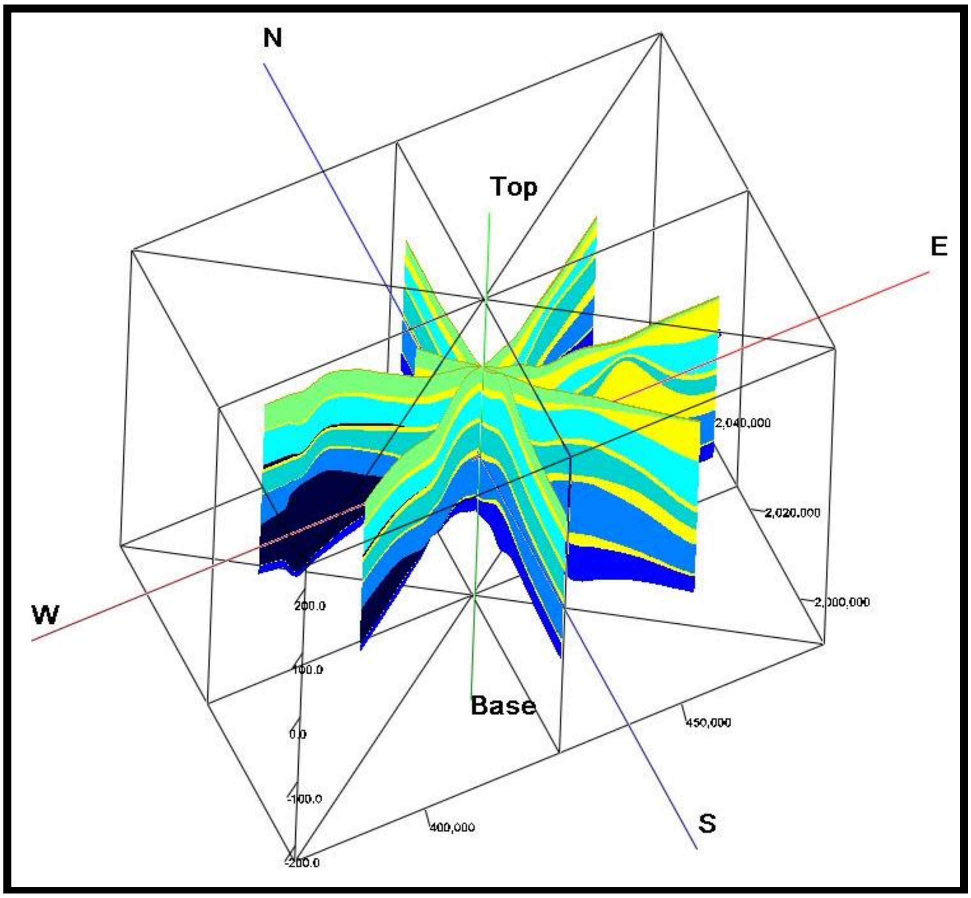



**Fig.-3.16: Fence diagram of Unconsolidated/Semiconsolidated Formation**

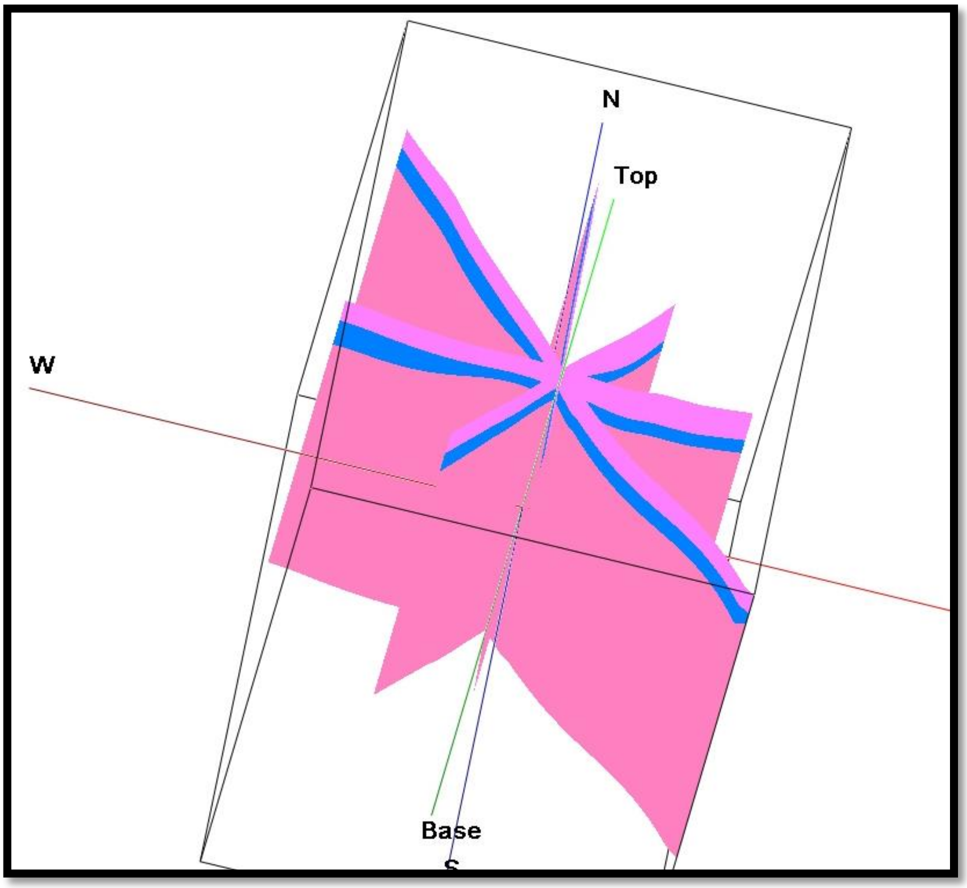



**Fig.-3.16: Fence diagram of Consolidated Formation**

### 3.4.1 Hydrogeological Cross Sections

The perusal of the data indicates that there are multiple aquifers in the area with intervening thick clay beds. The sandstone bed, that act as aquifers in the area consist of five distinct beds that behave as regional aquifers. Thin beds and pinched beds are neglected while making out the regional aquifer system. Hydrogeological cross sections drawn along different directions of the area are presented as **Fig. 3.19 to 3.22**. The study of the different sections indicates that the clay thickness is increasing from west to east and there are five aquifers exist upto a depth of 300m in Jayashankar Bhupalapally district. The shallow aquifer thickness is varying from place to place. The first aquifer which is present upto a maximum of 111 m below MSL is unconfined whereas the other aquifers are confined.

To study the aquifer disposition in detail, various hydrogeological cross sections indicating aquifer geometry has been prepared viz. N-S, E-W, SW-NE direction in sandstone formation and NW-SE directions in Granitic formation (**Fig. 3.18**).

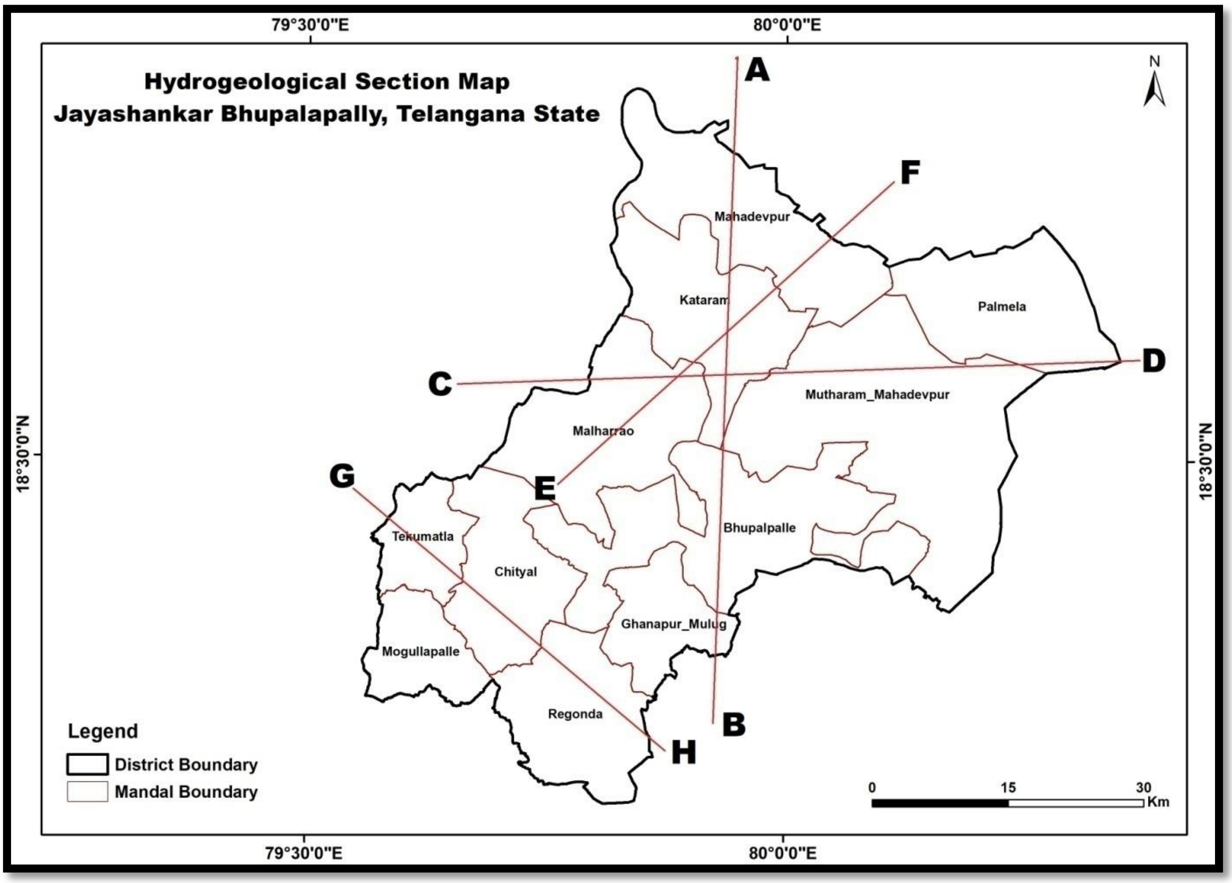



**Fig. 3.18: Map showing orientation of hydrogeological sections**

### 3.4.1.1 Hydrogeological Cross Section A-B

Hydrogeological cross section A-B (**Fig.3.19**) represents north- south direction covering a distance of ~44 kms. It can be clearly seen from the section that as we move from north to south direction i.e. from Mahadevpur to Ghanpur-Mulugu the number of aquifer increases from 4 to 5.As many as 4 aquifers are demarcated in the sandstone formation of Mahadevpur, separated by 3 intervening clay layers. At Kataram, 2 aquifers are identified, separated by 1 intervening clay layers. At Rampur, 5 aquifers are identified, separated by 4 intervening clay layers. The thickness of unconfined zone varies from 33 m at Nasthatarpalli to 46 m at Mahadevpur.

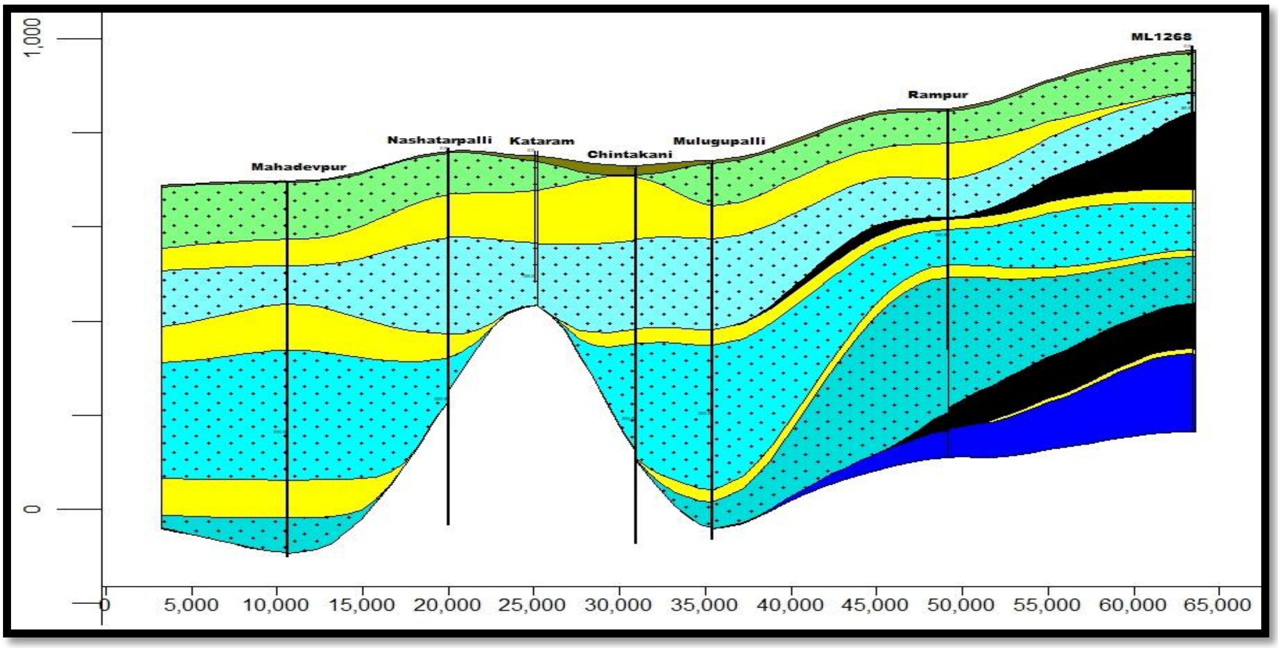



**Fig.3.19: Hydrogeological cross section A-B**

### 3.4.1.2 Hydrogeological Cross Section C-D

Hydrogeological cross section C-D (**Fig.3.20**) represents East-West direction covering a distance of ~57 kms. As many as 5 aquifers are demarcated in the sandstone formation of Palimela mandal, separated by 4 intervening clay layers. At Vallamkunta, 4 aquifers found with 3 intervening clay layers. The thickness of unconfined zone is 51 m at Vallamkuntawhere as at Chintakani top clay layer present.

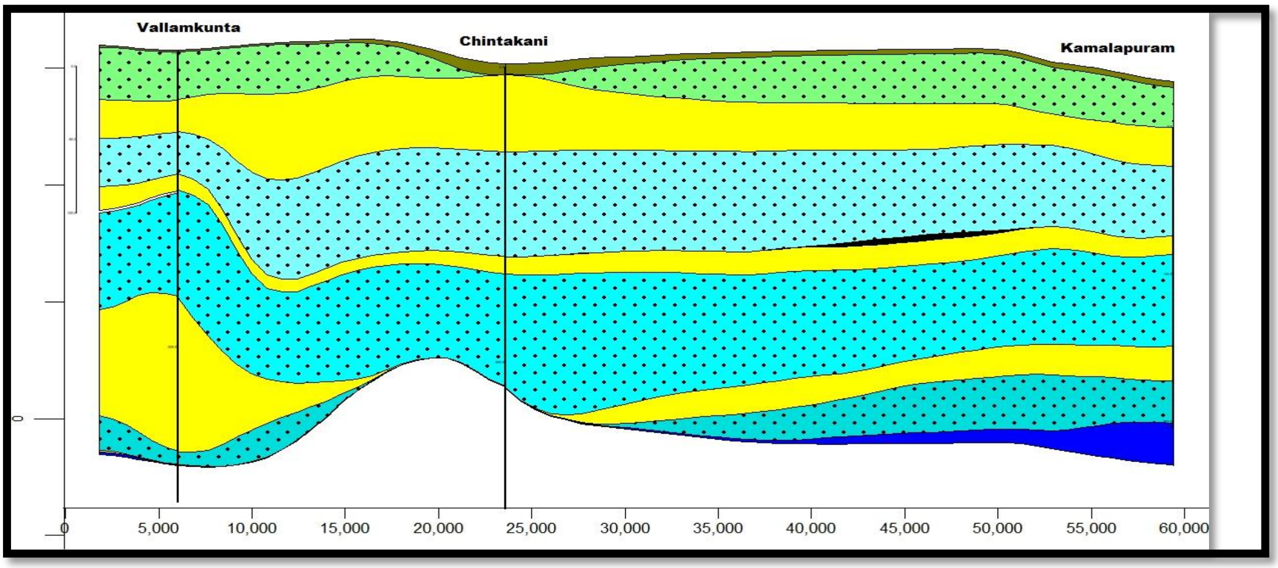



**Fig.3.20: Hydrogeological cross section C-D**

### 3.4.1.3 Hydrogeological Cross Section E-F

Hydrogeological cross section E-F (**Fig.3.21**) represents Southwest-Northeast direction covering a distance of ~40 kms. As many as 5 aquifers are demarcated in the sandstone formation of Malhalrao mandal, separated by 4 intervening clay layers. At Suraram, 3 aquifers found with 3 intervening clay layers. Similarly at Basavapuram 4 aquifers found with 3 intervening clay layers. The thickness of unconfined zone varies from 16 m at Basavapuram, 26m at Malhalrao to 75 m at Suraram respectively.

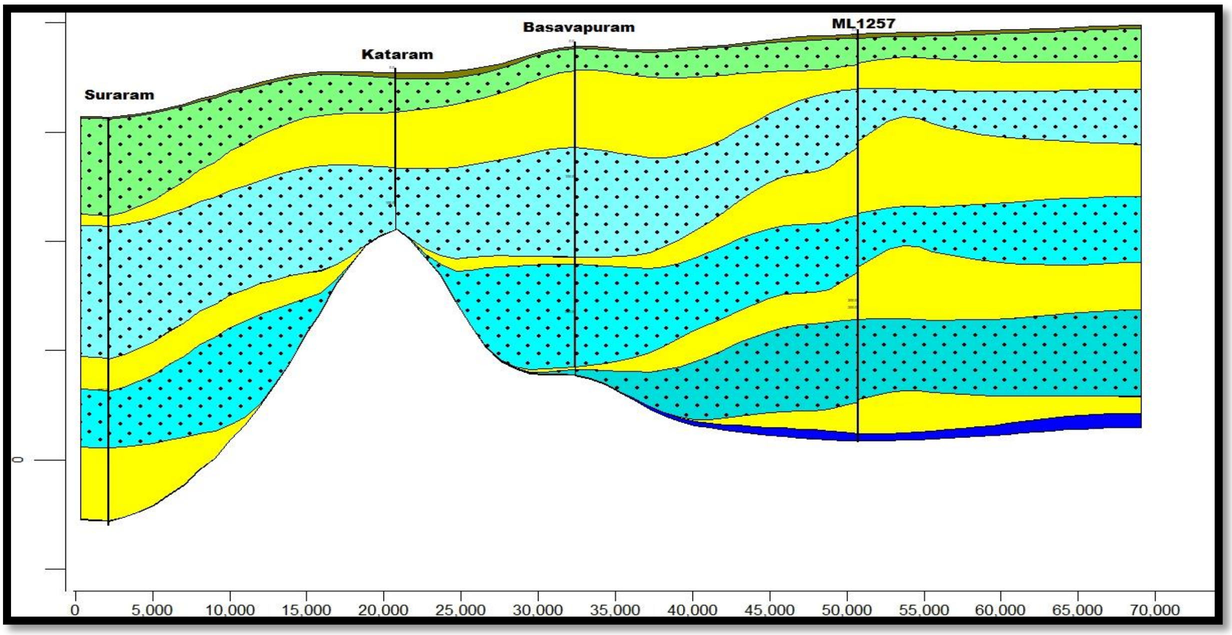



**Fig.3.21: Hydrogeological cross section E-F**

### 3.4.1.3 Hydrogeological Cross Section G-H

Hydrogeological cross section E-F **(Fig.3.22)** represents northwest–southeast direction in Granitic formation covering a distance of ~37kms. 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 30 m bgl at Ramakistapuram to 20 m bgl at Chityal. The maximum depth of weathering ranging from 12 m bgl at Kothapallegori to 30 m bgl Jadalpet.

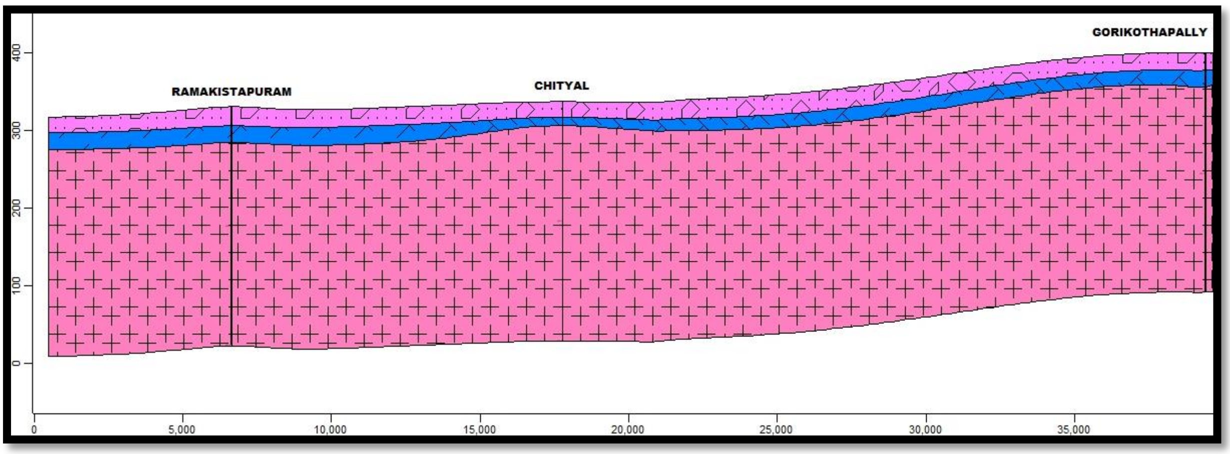



**Fig.3.22: Hydrogeological cross section G-H**

## 3.5 Hydrogeology of Kakathiya Khani coal mine area (SCCL)

The Kakathiya Khani-1 and 1A Incline Mine (KTK-1&1A incline) is located in Mulugu coal belt of Godavari Valley Coalfield. It is an operating underground coal mine, with a mine take area of 506.75 ha. It is located in the Jangedu (Village), Bhupalpalli (Mandal), Jayashankar Bhupalpalli (District). The block area located between N 18°27'43" to 18°28'49" and E 79°49'57" to 79°51'56" and falls in the Survey of India Toposheet No.56 N/15. The hydrogeology of the area within 10km radius buffer zone around Kakathiya Khani-1&1A Incline Mine (506.75 sq.km) has been studied by SCCL, The salient features of the study is given below.

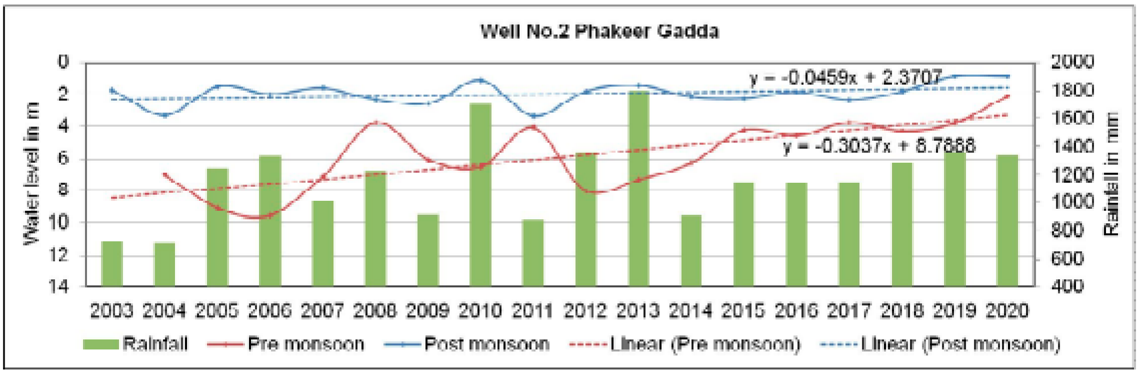
- The buffer area of the project is covered by 26 villages falling in Malharrao (17), Bhupalapalli (7+ 1CT), Ghanpur (M) (1) mandals of Jayashankar Bhupalapalli District.
- The drainage of this area is effected by ephemeral streams of Maner and Laknavaram rivers, which are in turn tributaries of River Godavari. A structural hill range SE to NW trending is located in the eastern periphery of the buffer zone that acts as a drainage divide between Maner and Laknavaram rivers.
- 8,148 ha is covered by forest, 1,309 ha is barren and uncultivable land, 2,073 ha is land put to non-agricultural uses, 107 ha is culturable waste, 524 ha is permanent pastures and grazing lands, 242 ha of Land under Misc.
- The total area irrigated during Kharif and Rabi seasons are 7,607 ha, 1,542 ha respectively. The main crops cultivated in this area are Paddy, Chilies, Cotton, Maize and Grams.
- Geologically, the area is covered by Proterozoic and Lower Gondwana formations. The sandstones, shales, phyllites and dolamites of Sullavai and Phakal formations form the basement rocks, over which the Gondwana sequence is unconformably deposited.
- The general trend of the formations is NW-SE with northeasternly dips ranging from 150 to 220 with local variations.
- Ground water occurs in both water table and semi-confined conditions in the buffer zone.
- The depth to water level (2020) varies from 1.75m to 10.63m during pre-monsoon season and 0.75m to 7.20m during post-monsoon season. The depth of

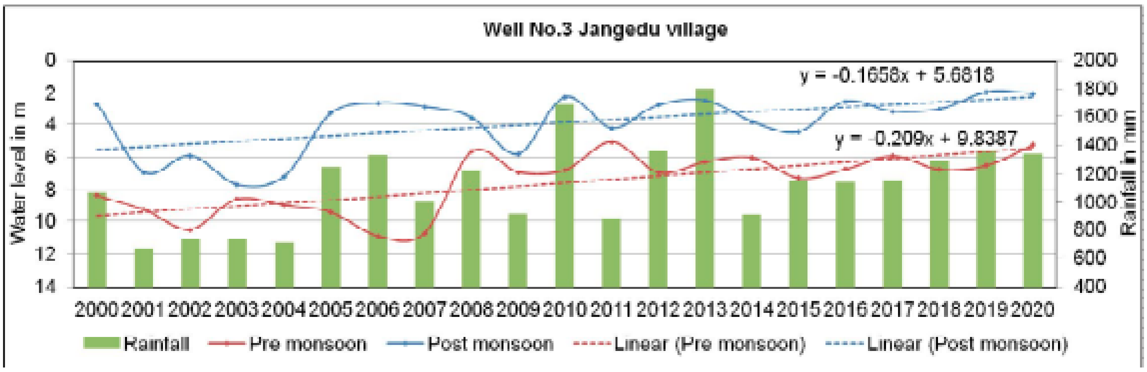
these wells is from 4.15 m to 14.00m. The water level fluctuation varies from 0.17m o 7.01m with an average of 2.61m.

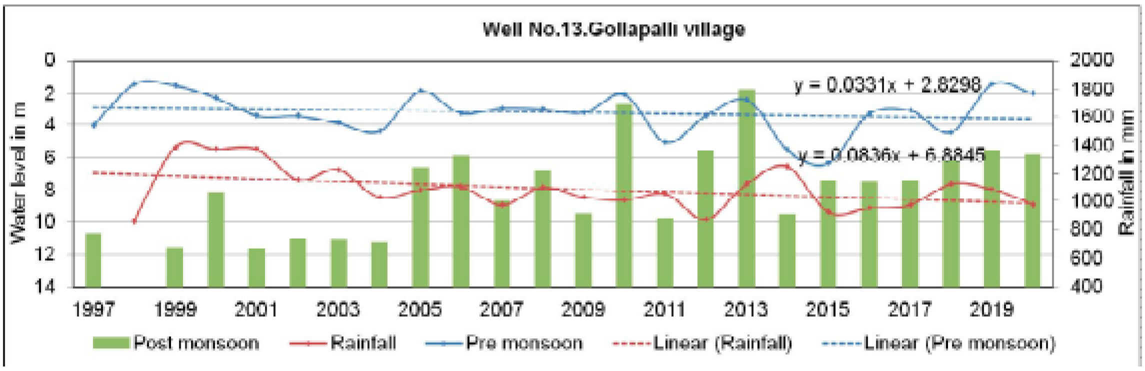
- The piezometric heads vary from 2.18 m to 32.55 m bgl during pre-monsoon and 2.01m to 33.00m bgl during post monsoon.
- The excess water from the existing mines in this area (i.e., about 6577 m3 /day or 240.06 ha.meters/year) is being let out into the local streams/tanks. It is being utilised by the local community for their agricultural needs and it also augment the ground water recharge.
- The mine workings in KTK-1 &1A Incline is planned upto 325m bgl. There are several permeable and impermeable formations above the working seams. Due to stratification, the permeable beds act as individual units and develop multi-aquifer system as such, the propagation of drawdown cone is limited to a small distance from the edge of the mine workings.
- The long term monitoring data of phreatic and piezometric water levels in this area revels that, there is no considerable impact of mining on surface and ground water regime in this area.
- As per the Ground water Resource Estimation (GEC-2015), the Annual Extractable Ground Water Resource in the buffer area is 7006.19 ha.meter/year and Current annual gross ground water extraction is 5252.65 ha.meter/year.

| Sl. No. | Name of the mine | Total quantity of water ($m^3$/day) | | | | |
|---|---|---|---|---|---|---|
| | | Pumped per day | Mine requirement | Domestic use | For plantation | Let out into streams |
| 1 | KTK 1&1A | 6856 | 2053 | 218 | 120 | 4465 |
| 2 | KTK 5&5A | 3300 | 640 | 1360 | 630 | 670 |
| 3 | KTK 6 | 8825 | 1739 | 6145 | 45 | 896 |
| 4 | KTK 8 (KLP) | 720 | 370 | 54 | 20 | 276 |
| 5 | KTK OC-II | 1490 | 1343 | 77 | 10 | 60 |
| 6 | KTK OC-III | 3011 | 2633 | 150 | 18 | 210 |
| Total | | 24202 | 8778 | 8004 | 843 | 6577 |

## HYDROGRAPHS OF PHREATIC WELLS IN THE BUFFER AREA



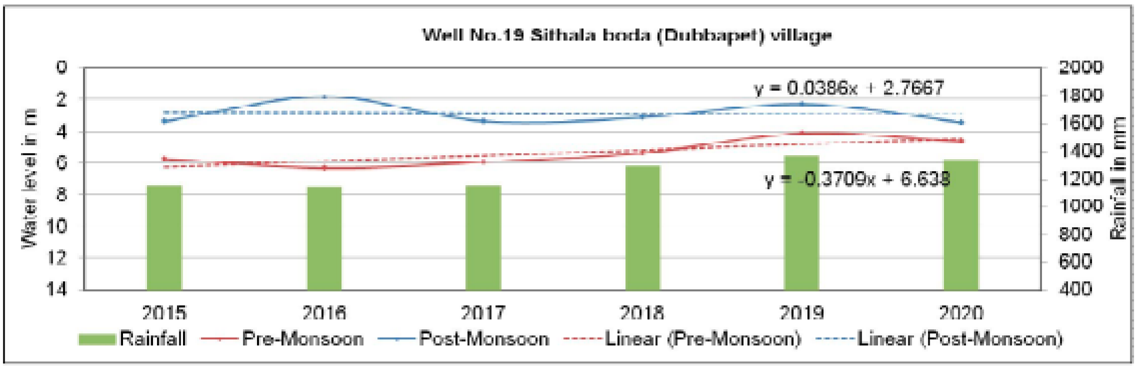




**Fig.3.33a: Hydrographs of Piezometric wells in Buffer area**

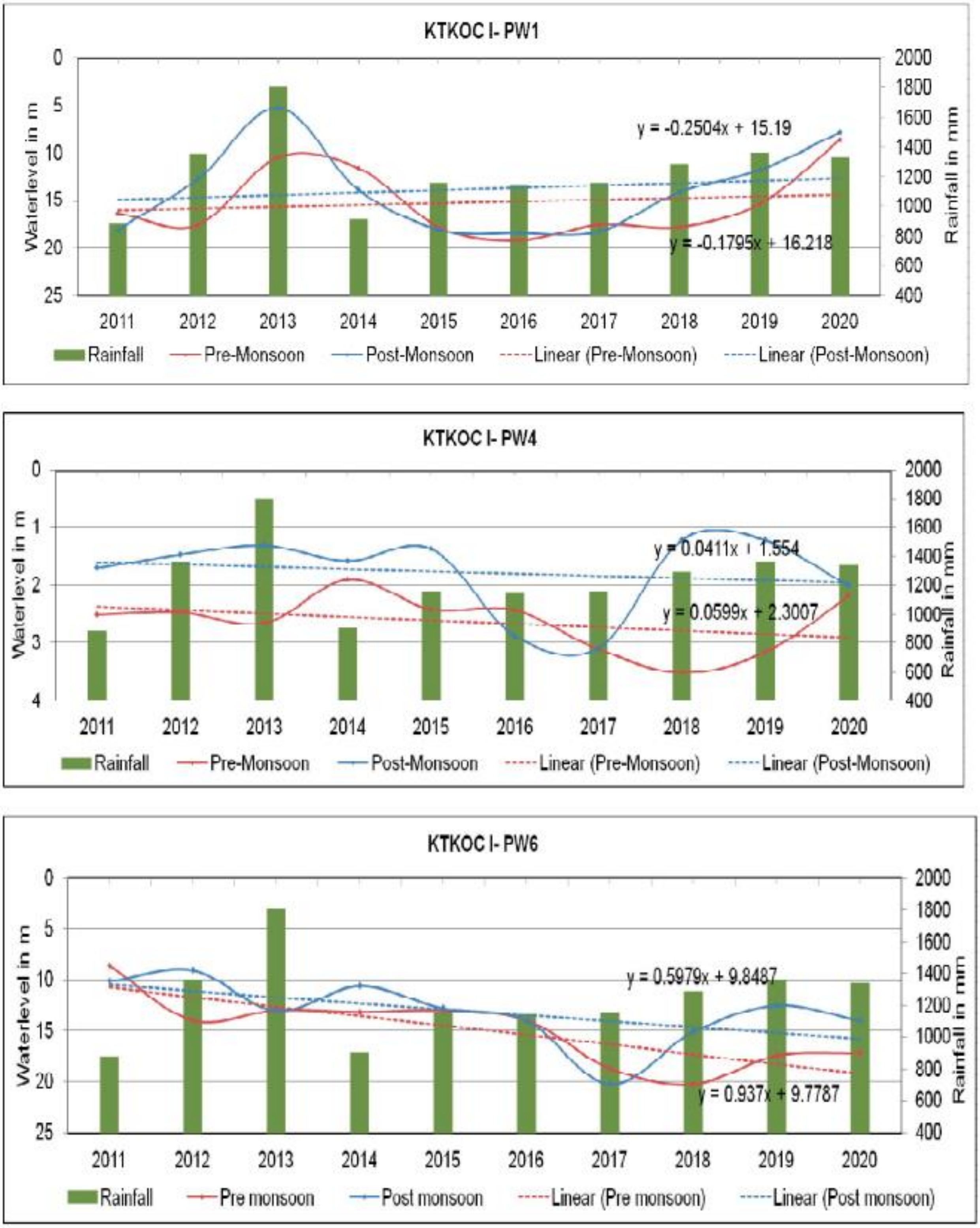



**Fig.3.33b: Hydrographs of Piezometric wells in Buffer area**

# 4. GROUND WATER RESOURCES

Dynamic ground water resources are computed as per the guidelines laid down in GEC-15 methodology. As per 2020 GEC report, the net dynamic replenishable groundwater resources availability is 291.06 MCM, gross ground water draft for all uses 138.79 MCM and net annual ground water potential available for future irrigation needs is 147.93 MCM. Stages of ground water development varies from 14 % to 85 % with average of 48 %. Out of 11 mandals, 1 mandal fall in Semi-critical category (i.e., Tekumatla). 91% (MCM) of gross ground water draft is utilized for irrigation purpose only. Computed Dynamic ground water resources of the district is given in **Table-4.1**.

**Table-4.1: Computed Dynamic ground water resources.**

| As per GEC 2020 | MCM |
|---|---|
| **Dynamic (Net GWR Availability)** | **291.06** |
| • Monsoon recharge from rainfall | 198.02 |
| • Monsoon recharge from other sources | 48.66 |
| • Non-Monsoon recharge from rainfall | 1.61 |
| • Non-monsoon recharge from other sources | 69.99 |
| • Natural Discharge | 27.21 |
| **Gross GW Draft** | **138.79** |
| • Irrigation | 126.22 |
| • Domestic and Industrial use | 12.57 |
| **Provision for Drinking and Industrial use for the year 2025** | 16.91 |
| **Net GW availability for future irrigation** | 147.93 |
| **Stage of GW development (%)** | **48 %** |

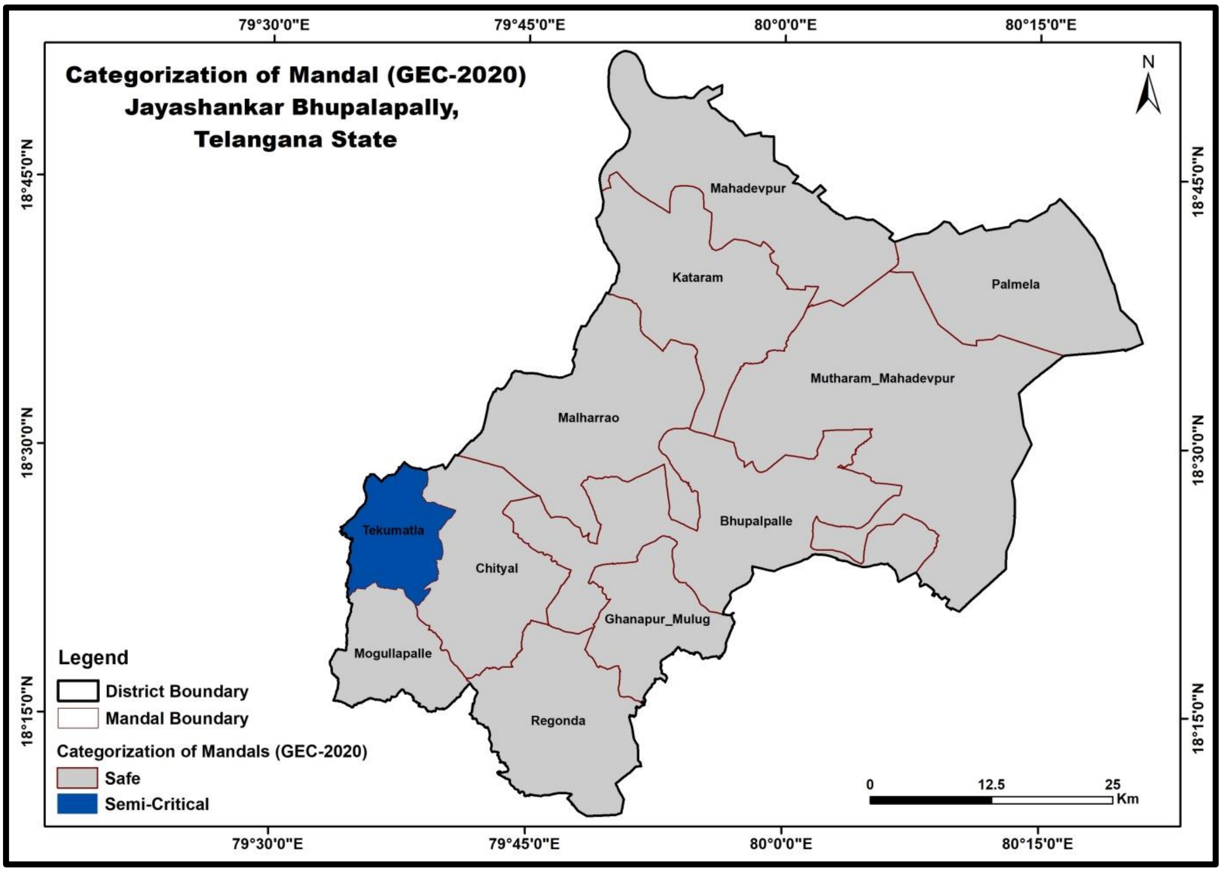



**Fig.4.1: Categorization of mandals (GEC-2020)**

# 5. GROUND WATER RELATED ISSUES

## 51 Inferior groundwater quality

- Some mandals (i.e., Regonda, Mogulapally, Tekumatla, Chityal, Mahalrao and Mutharam Mahadevpur) are fluorosis endemic where fluoride (geogenic) is as high as 3.47mg/l during pre-monsoon and 3.03 mg/l during post-monsoon season. The high fluoride concentration (>1.5 mg/l) occur in 20 % of the samples during pre-monsoon and post-monsoon season.

  Higher concentration of fluoride in ground water is attributed due 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 most of the mandals (i.e. Regonda, Mogulapally, Tekumatla, Chityal, Kataram, Palimela and Mutharam Mahadevpur) as high as 346 mg/l during pre-monsoon and 306 mg/L during post-monsoon season. The high nitrate concentration (>45 mg/l) occur in 51% and 41 % 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.

## 5.2 Higher Ground water Development

Tekumatla mandal is categorized as semi-critical as per GEC-2020 estimations, where stage of ground water development is 85%.

# 6. MANAGEMENT STRATEGY

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

### 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 average 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 5mbgl.The recharge potential of aquifer is calculated by multiplying the unsaturated volume with specific yield of the aquifers(0.02 for crystalline rock).

The source water availability is estimated from 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 48% and 1 out of 11mandalis falling in semi-critical 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 for 1 semi-critical mandal (i.e. Tekumatla) only.

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

| | |
|---|---|
| Total geographical area of district (Sq.km) | 2, 293 |
| Area feasible for recharge (Sq.km) (in Tekumatla mandal) | 100 |
| Unsaturated Volume (MCM) | 460 |
| Recharge Potential (MCM) | 9.21 |
| Surplus run-off available for recharge (MCM) | 3.80 |
| **PROPOSED ARTIFICIAL RECHARGE STRUCTURES** | |
| Percolation Tanks | 11 |
| Check Dams | 13 |

The total unsaturated volume (below the depth of 3 m) available for artificial recharge is 460 MCM, having 9.21 MCM of recharge potential. The available surplus run-off can be utilized for artificial recharge through construction of percolation tanks, check dams 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 3.80 MCM of surplus water can be utilised for recharge, which is given in **Table 6.1**. This surplus water can be utilized for constructing 13 check dams and 11 percolation tanks. The amount of recharge from these artificial recharge structures was calculated by considering 0.0105 MCM per percolation tanks and 0.042 MCM per check dam. This intervention would lead to recharge of about 0.70 MCM/year (**Fig. 6.1 & 6.2**). The details are given in **Annexure-1.**

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

### 6.1.2 State Government Projects

- **Mission Kakatiya:**
  De-silting of existing minor tanks (679 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 ground water recharge.

**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 two water grids with intake from Ramappa lake in Godavari segment and Ghanpur Reservoir in Manthani-Bhupalapally segment to provide protected water from surface reservoirs. The scheme is to enhance the existing drinking water scheme and to provide safe drinking water to 103245 no. of households.

The total water requirement as per 2020 census is 19.53 MCM and this imported water from surface sources will reduce the present utilized ~11.718 MCM of ground water (considering 60 lpcd). This can be effectively utilized to irrigate ~1953 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 groundwater 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 4239 no's of drip and sprinkler irrigation existing under operation which has irrigated ~4002 ha under ID crops saving ~6 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 micro irrigation has not been proposed.
- ~860 ha of additional land that can be brought under micro-irrigation (@1000 ha/mandal including existing area in1 semi-critical mandals (i.e., Tekumatla mandal) costing 5.16 crores (considering 1 unit/ha @0.6 lakh/ha).With this 1.29 MCM of ground water can be conserved over the traditional irrigation practices.
- Change in cropping pattern from water intensive paddy to irrigated dry crops like pulses and millets are recommended particularly in 1 mandal viz, Tekumatla 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 a phased manner to allow recuperations of the aquifer and increase sustainability of the bore wells.

## 6.30 Other Recommendations

- In villages/mandals (Regonda, Kataram, Palimela, Mogulapally, Tekumatla, Chityal, Mahalrao and Mutharam Mahadevpur mandal) where concentration of Fluoride and Nitrate is beyond the permissible limit, supply drinking water through Mission Bhagiratha and installation of water treatment plant is recommended.
- 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.

## 6.4 Expected results and outcomes

With the above interventions (excluding Mission Kakatiya and Mission Bhagiratha), the likely benefit would be net saving of 1.99 MCM of ground. This will bring down the stage of groundwater development by 9 % (from 85 % to76 %) in Tekumatla mandal.

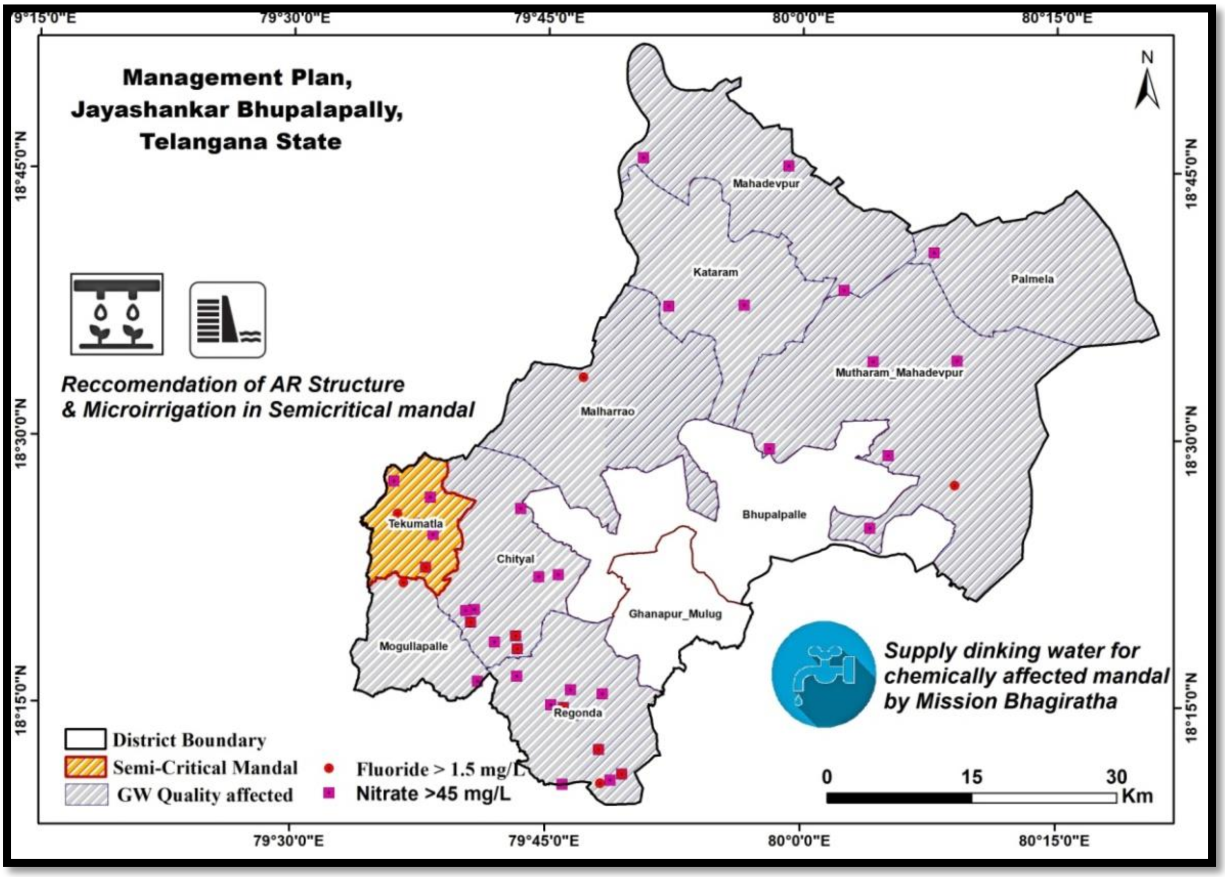
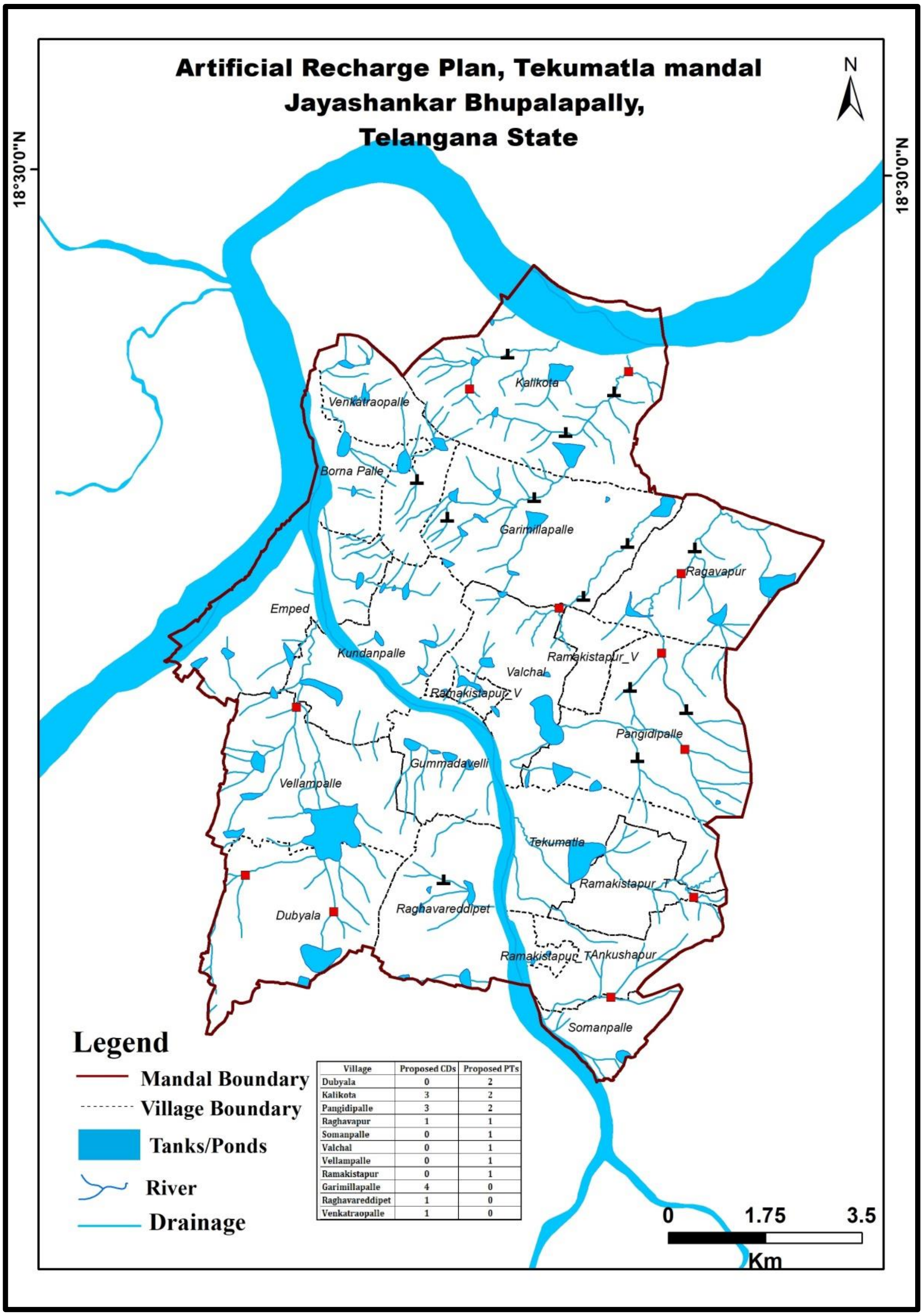



**Fig.6.1: Management Plan of Jayashankar Bhupalapally district**




| Village | Proposed CDs | Proposed PTs |
|---|---|---|
| Dubyala | 0 | 2 |
| Kalikota | 3 | 2 |
| Pangidipalle | 3 | 2 |
| Raghavapur | 1 | 1 |
| Somanpalle | 0 | 1 |
| Valchal | 0 | 1 |
| Vellampalle | 0 | 1 |
| Ramakistapur | 0 | 1 |
| Garimillapalle | 4 | 0 |
| Raghavareddipet | 1 | 0 |
| Venkatraopalle | 1 | 0 |

**Fig. 6.2: Proposed Artificial Recharge Structure in Tekumatla mandal**

## Acknowledgment

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**Annexure-1**

# Proposed supply side interventions for ARS

| Mandal | Village | Proposed CDs | Proposed PTs |
|---|---|---|---|
| Tekumatla | Dubyala | 0 | 2 |
| Tekumatla | Kalikota | 3 | 2 |
| Tekumatla | Pangidipalle | 3 | 2 |
| Tekumatla | Raghavapur | 1 | 1 |
| Tekumatla | Somanpalle | 0 | 1 |
| Tekumatla | Valchal | 0 | 1 |
| Tekumatla | Vellampalle | 0 | 1 |
| Tekumatla | Ramakistapur | 0 | 1 |
| Tekumatla | Garimillapalle | 4 | 0 |
| Tekumatla | Raghavareddipet | 1 | 0 |
| Tekumatla | Venkatraopalle | 1 | 0 |