केन्द्रीय 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

Rangareddy District
Telangana State

दक्षिणी क्षेत्र, हैदराबाद

Sourthern Region, Hyderabad

भारत सरकार
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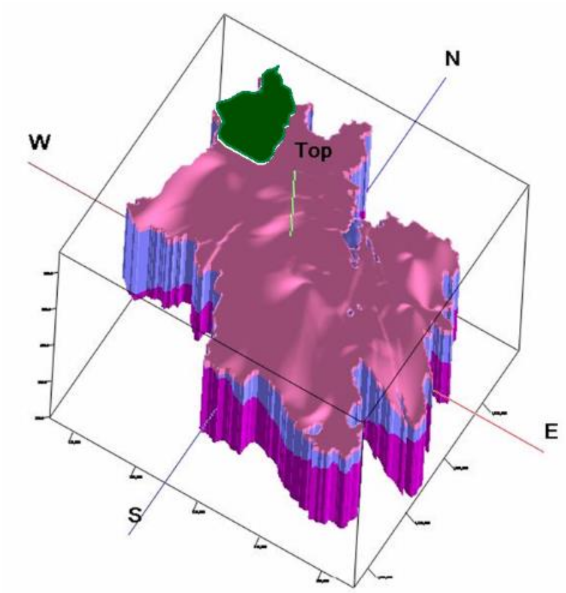
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

REPORT ON AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUNDWATER RESOURCES IN RANGAREDDY DISTRICT, TELANGANA STATE



CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD
MARCH 2022

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

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FOREWARD

India is the largest groundwater user in the world, with an annual groundwater withdrawal of 253 billion cubic meters (BCM). This represents about 25% of the world's groundwater withdrawals. India has about 112.3 BCM of water resources, of which 690 BCM is surface water and the remaining 433 BCM is groundwater. Out of the total available groundwater, 90% is used for irrigation purposes, mainly in agriculture. The remaining 10% is used for domestic and industrial purposes. According to the Composite Water Management Index (CWMI) report released by NITI Aayog in 2018, 21 major cities, including Delhi, Bengaluru, Chennai and Hyderabad, are at risk of running out of groundwater, affecting access for 100 million people. The CWMI report also states that the country's water demand is expected to be twice the available supply by 2030, which would mean serious water shortages for hundreds of millions of people and a 6% loss to the country's GDP.

In view of the above, it is necessary to scientifically plan the development of groundwater and its management in different hydrogeological environments, and develop effective management methods with the involvement of the community to better manage groundwater. The National Aquifer Mapping Project (NAQUIM) is being implemented by the Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India and is being undertaken by the Central Ground Water Board (CGWB) The NAQUIM provides the mapping of aquifers (water-bearing formations), their characterization, and the development of aquifer management plans to enable sustainable management of groundwater resources to delineate and describe aquifers and develop groundwater management plans for their sustainable development with stakeholder participation.

The report titled "Aquifer Mapping for Sustainable Ground Water Resources in Rangareddy District, Telangana State" prepared from the extensive hydrogeological, geophysical and hydro chemical data generated by CGWB over the years and integrated with the of data from various stake holder departments viz., ground water, irrigation, statistics, Rural Development, Mission Bhagiratha, Mission Kakatiya and Micro irrigation etc. The data has been analysed and interpreted using various software tools, GIS and Rockworks for conceptualization of aquifers, their vertical and horizontal disposition and extent, assessment of ground water resources, quality of shallow and deeper aquifers and various aspects of ground water occurrence, distribution, and utilization in the district. The report identified specific groundwater related issues and recommended various supply and demand side management strategies for sustainable ground water development and management in the district.

This report has been prepared by Caroline Louis, Scientist – B (Hydrogeology) and the efforts made by the officer in preparation of this report are greatly appreciated. Special Thanks to Smt Rani V.R, Scientist-C and Sh. Ravi Kumar Gumma, Scientist-C, for valuable suggestions in finalizing this document. Thanks to various organizations of the Government of Telangana for providing data required for compiling this report.

I hope this report will be of great help to District Administration and Stakeholder Departments for planning and sustainable management of groundwater resources in the district.

Sh. J. Siddhardha Kumar
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AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN RANGAREDDY DISTRICT TELANGANA STATE

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EXECUTIVE SUMMARY

The Rangareddy district has a geographical area of 5031 km2, with 27 revenue mandals lies between north latitude north latitude 16.66°N to 17.54°N and east longitude 77.9°E to 78.9°"E. Administratively the district is governed by 27 revenue mandals and 604 villages with a population of ~24.46 lakhs (2011 census) having a population density of 486 per Sq.km.

The district is underlain by Archaean to Proterozoic crystalline banded gneissic complex (95%) and late Cretaceous to early Eocene Deccan trap basalts. Pediplains are the major landforms followed by pediment, and structural hills. The district is drained mainly tributaries of Krishna River. Agricultural land occupies nearly 72% of the area; Built up occupies nearly 16% of the area. Forest occupies 5% the area. Remaining areas are occupied by water bodies, waste land, etc. Gross cropped area during the year 2019-20 is 224700ha. The district is covered by red soil.

The registered ayacut under the medium irrigation project is Palamuru Ranga Reddy Lift Irrigation Scheme is 147265 ha. Total surface water irrigating area is 163179 ha and the total ground water irrigated area is 129873 ha.

In the district, there are 1259 percolation tanks, 890 Check dams and 344 farm ponds. Under Mission Kakatiya (Phase 1, 2, 3, 4) 1025 minor irrigation tanks have been taken under RRR (Repairs, restoration, and Rejuvenation) schemes.

Water level is monitored through 78 wells during pre and post-monsoon season. During pre-water-table elevation ranges from 347-672 meter above mean sea level and post-monsoon season 349-674 meter above mean sea level (m amsl). Depth to water level varies from 1.2 to 37.8 m bgl during pre-monsoon and 0.30-31 m bgl during post-monsoon season. In Majority of the areas, during pre-monsoon water level during this season are in the range of 10-20 m (57% of the area), followed by >20 m bgl (32%) and during post monsoon season majority of the water level during this season are in the range of 10-20 m covering 78% of the area, 5-10 m bgl in 19 % of the area.

Most of the wells in the state records water level rise. The seasonal water level fluctuations vary from 0.02 to 26m.

Trend analysis for the last 10 years (2011-2020) is studied from 41 hydrograph stations of CGWB and SGWD. During pre-monsoon 31 wells shows falling trend in the range of -0.03 m/yr to -1.1 m/yr and 18 wells shows rising trend 0.01-1.16 m/yr. And during post-monsoon season 3 wells show falling trend -0.01- to -1.01 m/yr and 46 wells shows rising trends 0.2-1.6 m/yr.

Total 135 ground water samples (Pre-monsoon:59 and Post-monsoon:76) were analysed for knowing the suitability of ground water for drinking purposes. In 99 % and 96 % of area EC is in the range of < 3000 μ Siemens/cm during pre and post-monsoon season respectively. During pre-monsoon season, concentration of NO_3 ranges from 1.62-515mg/L and found that in 80 % samples nitrate is beyond maximum permissible limit of BIS (45 mg/l) and F concentration varies from 0.05-5.09mg/l and found that in 35% samples it is beyond maximum permissible limits of BIS (1.5 mg/l). During post-monsoon season, concentration of NO_3 ranges from **<2-342** mg/L and found that in 65% of samples it is beyond maximum permissible limit of BIS (45 mg/l). The F concentration varies from **0.32-3.02** mg/l and found that in 29% it is beyond maximum permissible limit of BIS.

The principal aquifer in the area is granites and gneisses, the occurrence and movement of ground water in these rocks is controlled by the degree of interconnection of secondary pores/voids developed by fracturing and weathering.

Aquifers are conceptualized in to two namely; 1) weathered zone (~30 m) and 2) fractured zone (30- 199 m). The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. Ground water yield varies from <0.1 to 2.4 lps. The depth of fracturing varies from 25 m to 199 m with yield of <1-9lps and storativity varies from 0.01 to 5.5×10^{-5}.

As per 2020 GEC report, the net dynamic replenishable groundwater availability is 381 MCM, gross ground water draft for all uses 308 MCM provision for drinking and industrial use for the year 2025 is 49 MCM and net annual ground water potential available for future irrigation needs is 75 MCM. Stage of ground water development varies from 66% (Madgul mandal) to 101% (Serilingampally mandal). Seriligampally mandal is over exploited, 7 mandals are Critical, 15 mandals are semi critical and 5 mandals are safe.

Major issues identified are over-exploitation (Seriligampally mandal), ground water pollution (both anthropogenic (NO_3) and geo-genic (F)), deep water levels > 20 m bgl in 32% of the area during pre-monsoon season and low sustainability of wells (yield less than 1 lps)

The management strategies mainly include both supply side and demand side. The supply side management of ground water resources include artificial recharge of available surplus runoff in check dams and percolation tanks in rural areas and roof top and open space rain water harvesting in urban areas. Construction of 752 artificial recharge structures (376 CD's and 376 mini PT's in 314 villages) with a total cost of **94** crores is recommended as supply side measures. Under Water conservation measures include, construction of 9280 numbers of farm ponds with 42.5crores in all villages. Roof top and open space rain water harvesting for artificial recharge in urban areas.

De-silting of existing minor tanks (1025) was taken under state Govt. sponsored Mission Kaktiya-Phase-1, Phase-2, Phase 3 and 4 to remove 7 MCM of silt and this has created additional surface storage. This will contribute ~ 1.75 MCM to groundwater and with this additional ~290 ha land can be brought under irrigated dry (ID) crops in tank ayacut.

Demand side measure includes micro irrigation in ~74600 ha of additional land that can be brought under micro-irrigation (@200 ha/village in 373 villages) costing about 448 crores (considering 1 unit/ha @0.6 lakh/ha). With this 134 MCM of ground water can be conserved over the traditional irrigation practices (considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha).

Other measure includes providing good quality seeds, improved procurement facilities, mandatory artificial recharge at every Government and industrial units. Capacity building in power supply regulation, application of laser levelling technology in irrigated land, providing proper sewerage system and participatory groundwater management (PGWM) are the other measures recommended.

With the above interventions costing Rs 597crores (Roof top and open space rain water harvesting for artificial recharge in urban areas.), the likely benefit would be the net saving of 147 MCM ground water in draft and recharge of 31MCM of ground water. This will bring down the stage of ground water development by 35% (from 81 % to 46%).

1 Inroduction

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

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

1.1 Objectives

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

1.2 Scope of the study

The main scope of the study is summarised below.

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

1.3 Area Details

The Rangareddy district having geographical area of 5031 km^2, lies between north latitude 16.66° to 17.54° and east longitude 77.9° to 78.9°" located in the South western part of Telangana State. The location map of the study area is presented in **Fig.1.1**.The district is bounded by Medchal Malkajgiri, Hyderabad and Sangareddy districts in the north, Nagarkurnool and Mahabubnagar distrcits in the south, Nalgonda and Yadadri districts in the east, and Vikarabad district in the west. Administratively the district is governed by 27 revenue mandals and 604 villages with a population of ~24.46 lakhs (2011 census) having a population density of 486 per Sq.km.

1.4 Climate and Rainfall

The district is located in semi-arid area and experiences tropical climatic conditions through out the year. The district experiences southwest monsoon from June till second week of October (as per IMD report) and Northeast monsoon from October to December. Winter season starts in late November and lasts until early February with lowest average temperature of 14.1°C in January. Summer starts in March, and reaches peak in May with average highest temperature of 39.8°C. Normal annual rainfall varies between 564 mm (Mudgul) to 838mm (Shakarpalli) with average of 694 mm (**Fig. 1.2**). Average number of annual rainy days is around 61 days. Southwest monsoon contributes 73% (512.4 mm), Northeast monsoon by 17 % (122.3 mm) and rest 10 % by January to May months of normal annual rainfall. Mean monthly rainfall varies from 142.9 mm in July to 2.6 mm in January. Isohyetal map prepared using annual normal rainfall of mandals in the district collected from DES, Govt. of Telangana is shown in **Fig.1.2**. The district received large excess rainfall of 1225mm (77% above normal) during the water year 2020-21.

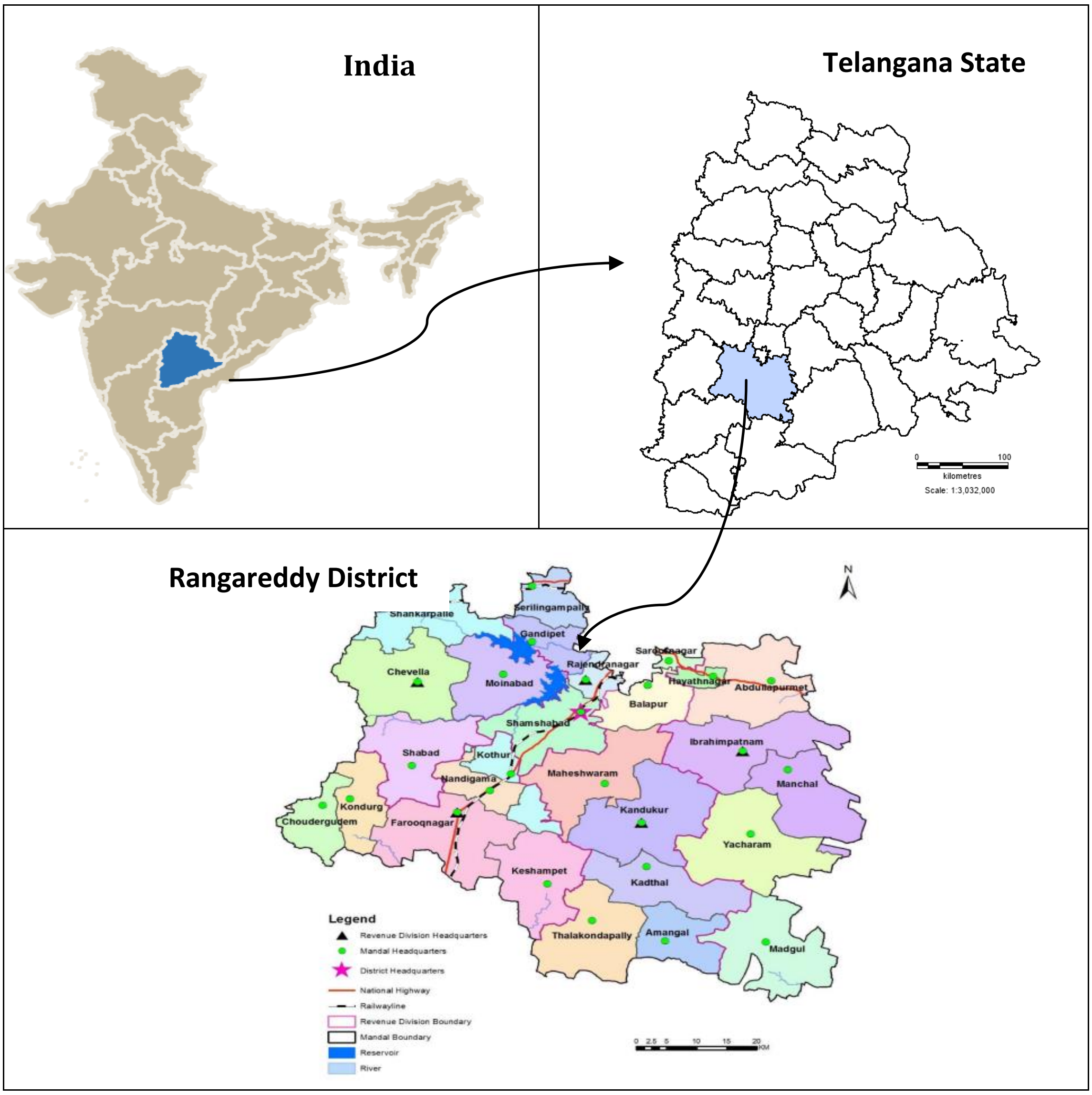


Fig.1.1: Location of Ranga Reddy district.

Analysis of time series annual rainfall (January- December) data for 16 years (2005-2020) collected from TSDPS, Govt. of Telangana shows slightly increasing trend in annual rainfall of 2.1 mm/yr (**Fig.1.3a**). The district received large excess rainfall (>60% departure above normal) in 2020, excess rainfall (+20% to +59%) in 5 years (2005, 2008, 2010, 2013 & 2017), deficient rainfall (-20% & below normal) in 3 years (2011, 2014 & 2018) and remaining 7 years received normal rainfall (-19% to +19%). The monthly rainfall trend graph for 16 years shows increasing trend in rainfall for June (3.1 mm/yr) & October (4.1 mm/yr) months and decreasing trend for July (2.6 mm/yr) & March (2.8 mm/yr) months (**Fig.1.3b**).

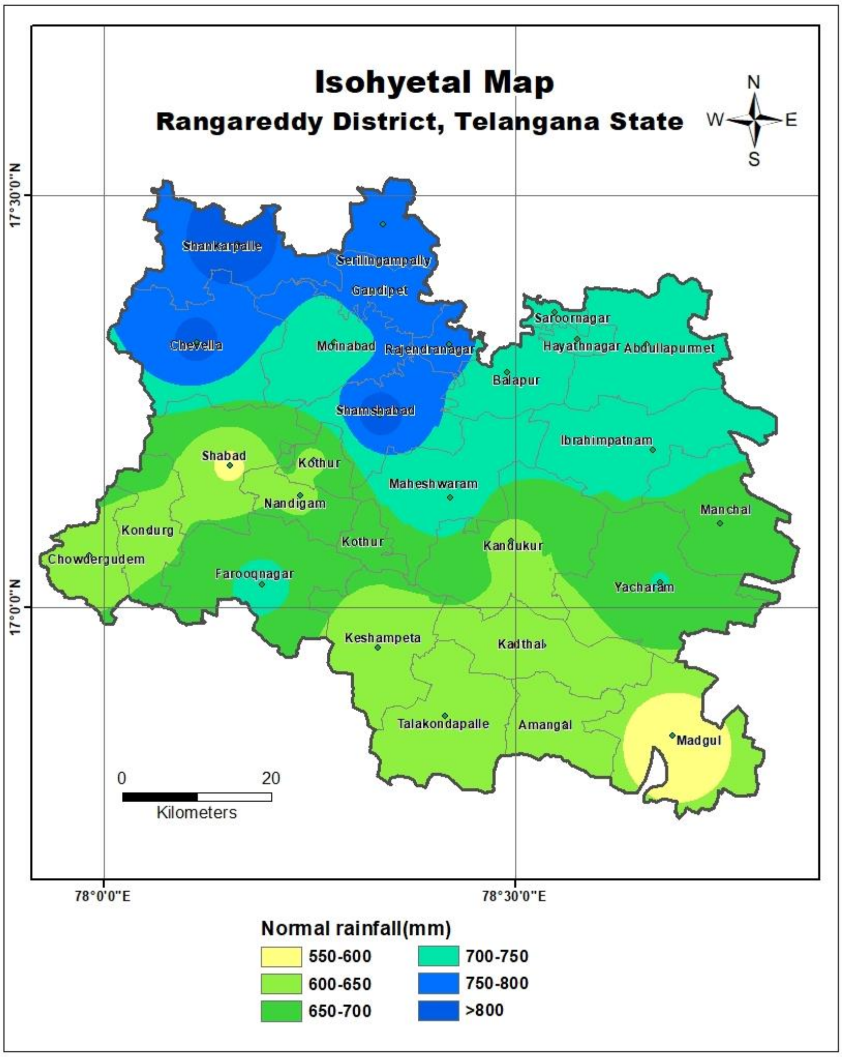
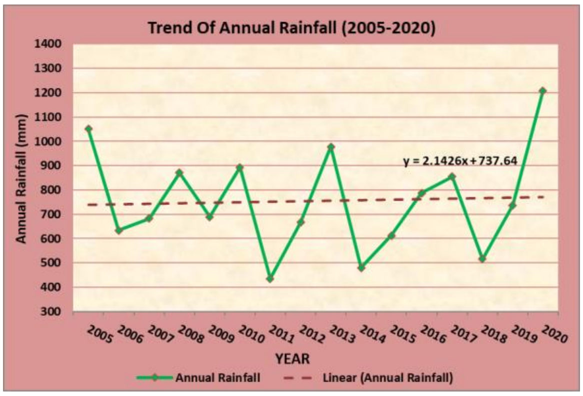
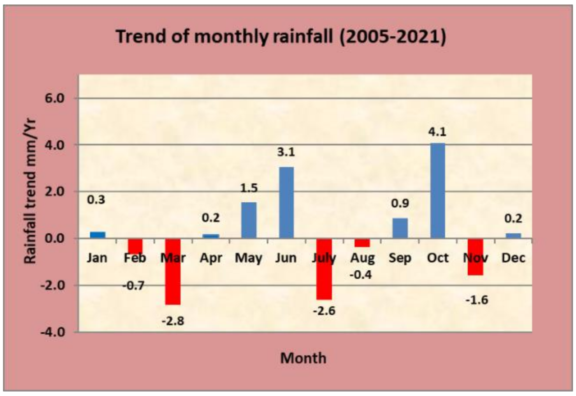


Fig.1.2: Isohyetal map of Ranga Reddy district.





Source: TSDPS, Govt of Telangana

Fig. 1.3a: Trend of Annual Rainfall **Fig. 1.3b:**Trend of monthly rainfall

1.5 Geomorphological Set up

Geomorphologically the study area consists of Pediplain (54% of the area), Pediments (22%of the area), Denundational hills, Dissected plateaus and Channel fills deposits. Physiographically elevation ranges from 370 m.amsl to 690 m.amsl with a regional slope towards the north eastern direction (**Fig.1.4).**

1.6 Drainage

The major part of the district falls in Krishna basin. 67% area of Rangareddy district falls in Lower Krishna sub basin, 30% of the area in Middle Krishna sub basin, 1% of the area falls in Lower Bhima and 2% area falls in Majira sub basin. The area falls in lower Krishna sub basin is drained by Musi River and its tributaries and flows towards north eastern direction (**Fig.1.5)**. The area falls in middle Krishna sub basin is drained by tributaries of Dindubi River (a tributary of Krishna River) and it's tributaries.

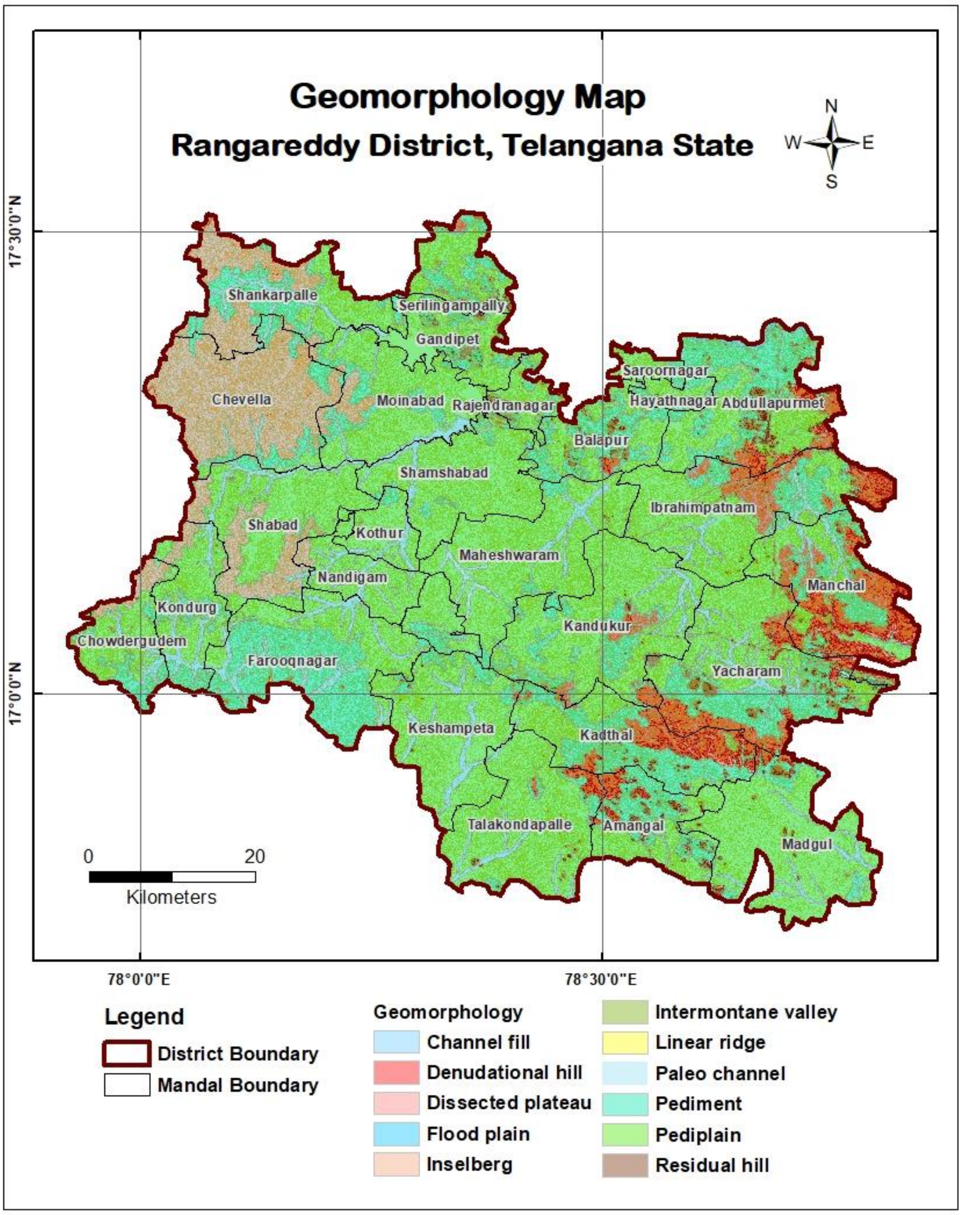


Fig.1.4: Geomorphology map of Ranga Reddy district

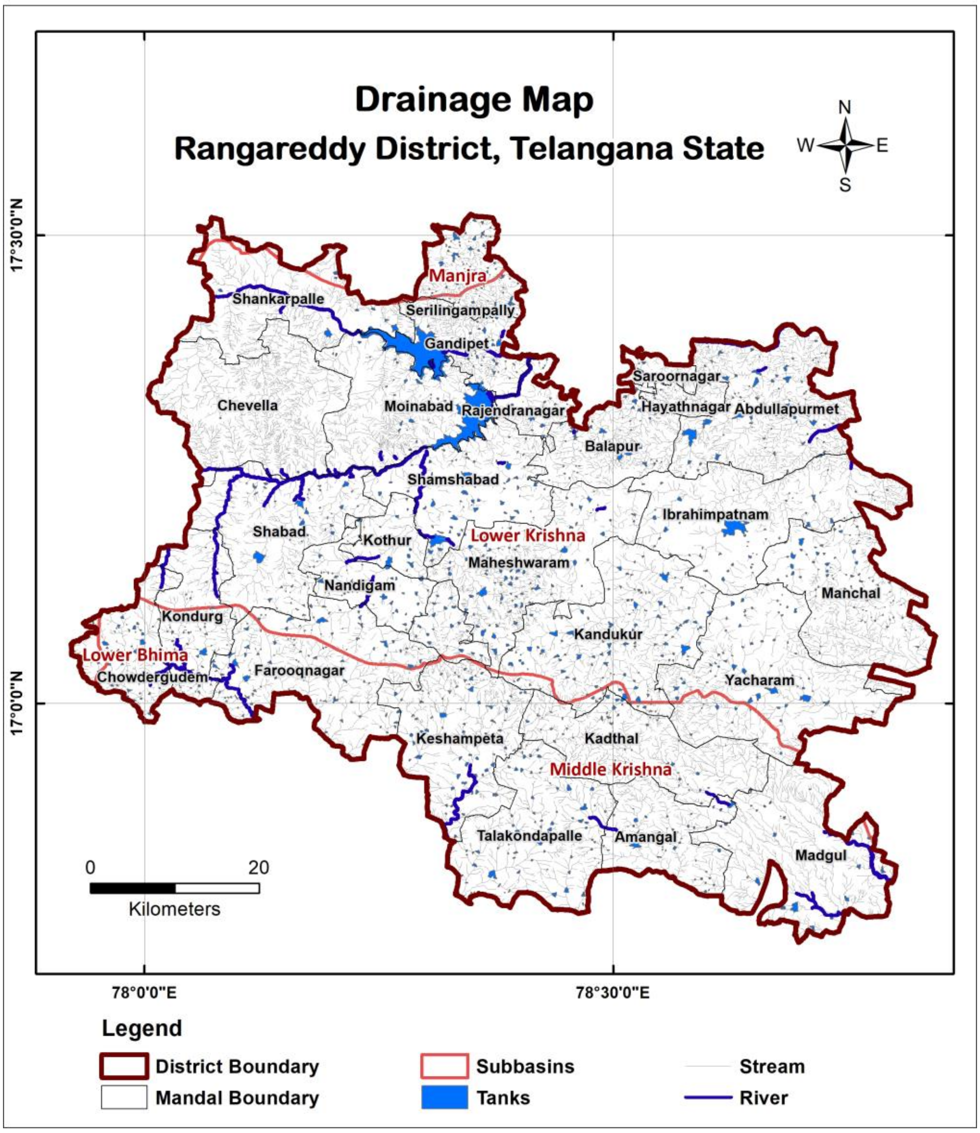


Fig.1.5: Drainage map

1.7 Land use and cropping pattern (2019-2020)

Major part of the district is occupied by agricultural area (72%). In the district, forest occupies nearly 5% of the area. Remaining area is occupied by builtup land, water bodies and waste land (**Fig.1.6**). The total gross cropped area during the year 2019-20 is 2,24,700ha and net sown area is 1,99,724 ha, remaining agricultural land was kept fallow. The gross area cropped during Khariff season is 1, 93,177ha and the major crops grown during kharif season are Millets(21%), Cereals(27%), Cotton(33%) and Paddy(6%). The gross area cropped during Rabi season is 31523 ha and the major crops grown during the period include Paddy (32%), Cereals (33%), fruits and vegetables (33%). Season wise cropping pattern is given in **Fig.1.7a** and **Fig.1.7b.**

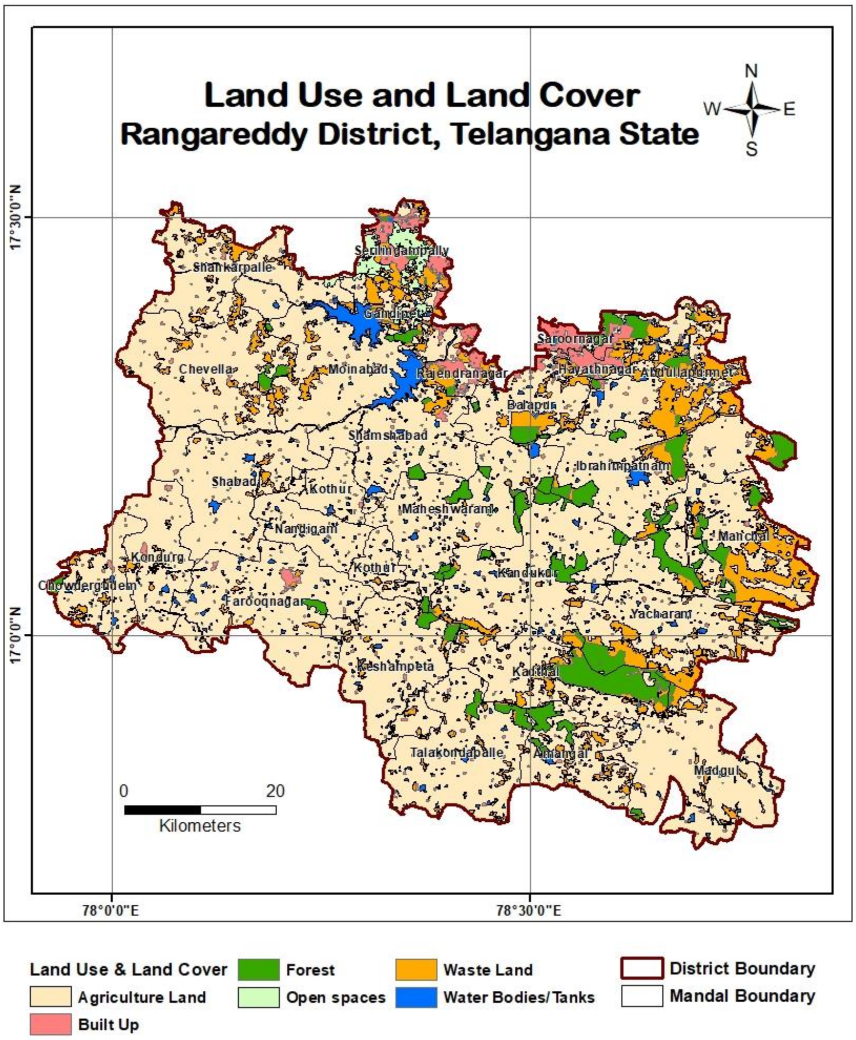
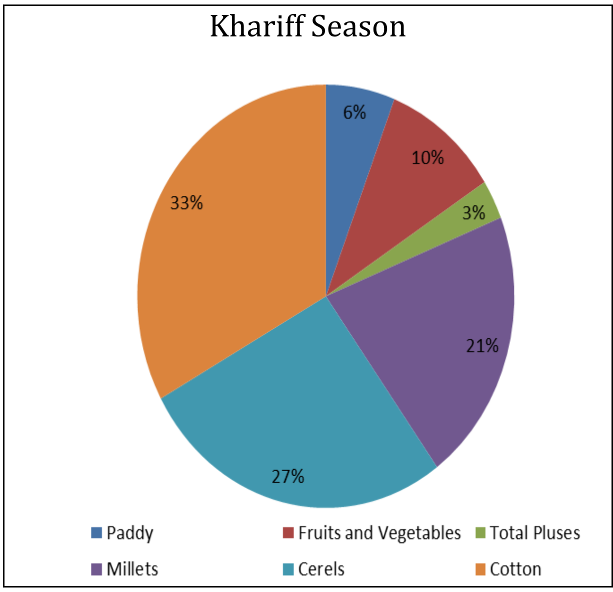


Fig.1.6: Land use and land cover of Ranga Reddy district.



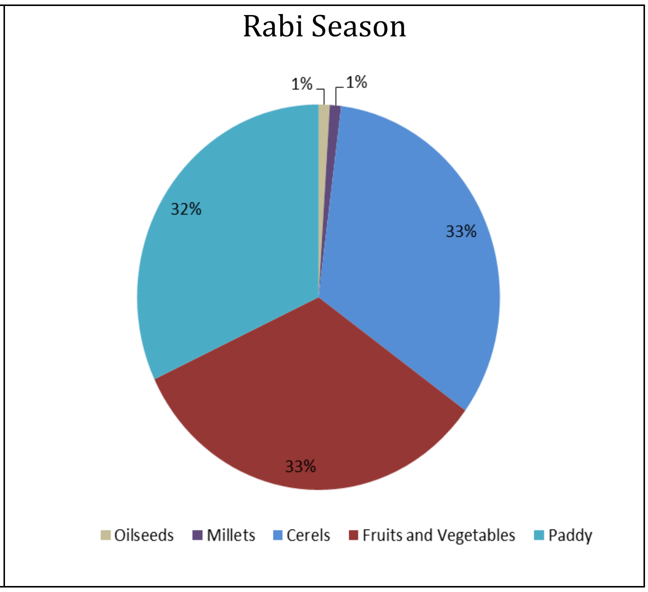


Fig.1.7a:Khariff season **Fig.1.7a:Rabi season**

1.8 Soils

The major part of the district is covered by red soil and based on the texture, they are classified into: fine clayey soil (74% area), Gravelly loamy soil (13 %area), Gravelly clay soil (12% area), and Gravelly soil (12%) (**Fig.1.8**).

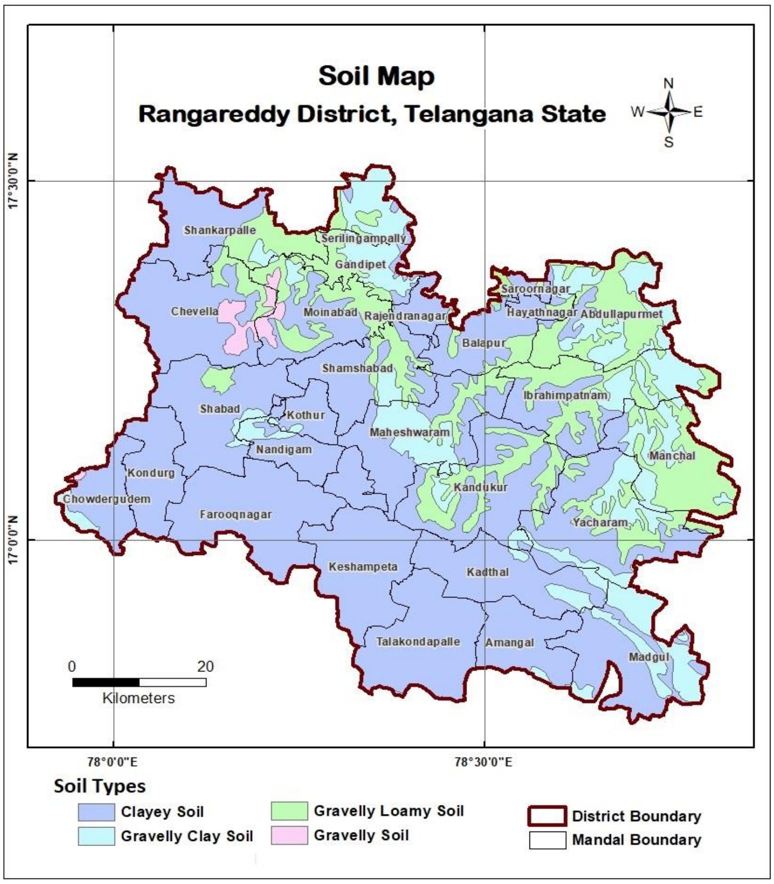


Fig.1.8: Soil map of Ranga Reddy district

1.9 Irrigation:

Medium Irrigation Project:

Palamuru Ranga Reddy Lift Irrigation Scheme is one of the medium irrigation projects, creating irrigation potential in upland areas of Nagarkurnool, Mahabubnagar, Vikarabad, Rangareddy and Nalgonda districts for an ayacut of 10.00 lakh acres. This Project create an irrigation potential of 147265 hectare in Rangareddy district **(Fig 1.8).**

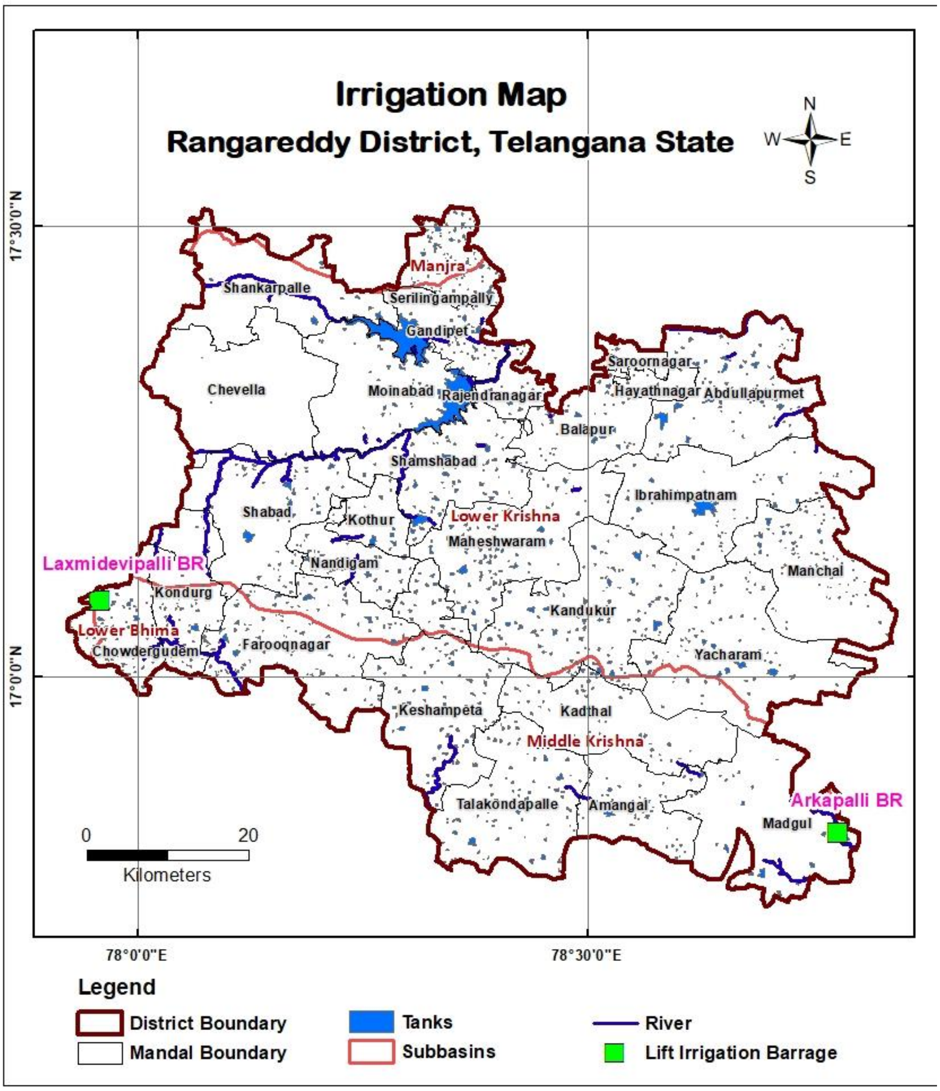


Fig.1.9: Irrigation project map of Rangareddy district

Table-1: Salient features of Irrigation in Ranga Reddy district.

Irrigation	**Numbers irrigated**	**Area irrigated** **ha**
Ground water(**2019-2020)**		
Tube wells	129358	129358
Dug wells	1031	515
Total		**129873**
Minor Irrigation tanks	1848	15914

Total surface water irrigating area is 163179 ha, Total ground water irrigated area=129873 ha

1.10 Prevailing Water Conservation/Recharge Practices

In the district there are ~1259 percolation tanks, 890 Check dams and 344 farm ponds with gross storage of 49 MCM. Under Mission Kakatiya (Phase 1, 2, 3 & 4) 1025tanks have been undertaken under RRR (Repairs, restoration and Rejuvenation) schemes.

1.11 Geology and Hydrogeology

The district is underlain by Archean to Proterozoic crystalline banded gneissic complex (95%) and late cretaceous to early Eocene Deccan trap basalts (5%) (**Fig1.10**). The Archaean crystalline rocks comprise of older metamorphic rocks, peninsular gneissic complex (migmatites) and younger intrusive rocks. The Mesozoic-lower Tertiary (Deccan trap) basaltic flows overlain the Aarcheans in the north western part. The thickness of each flow varies from 15 to 20m. Intra-trappean beds are thin and comprise conglomerates, chert and sandstone. A series of WNW – ESE trending faults are seen in the southeastern part of the area. The principal aquifer in the area is granites gneisses and basalts. The occurrence and movement of ground water in these rock formations are controlled by interconnected secondary pores/voids developed by fracturing and weathering.

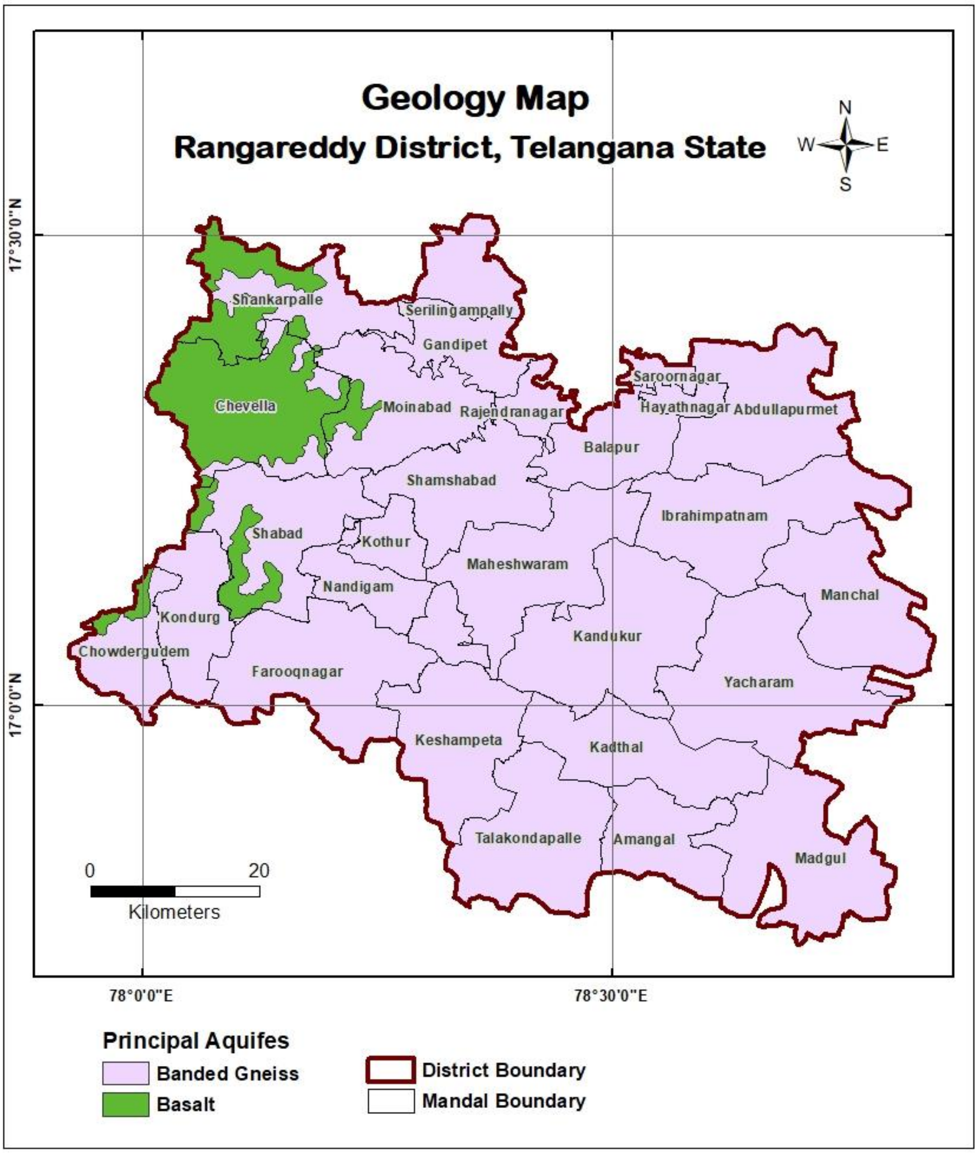


Fig.1.10: Geology map of Ranga Reddy district.

DATA COLLECTION AND GENERATION

Collection and compilation of data for aquifer mapping studies are carried out in conformity with the Expenditure Finance Committee (EFC) document of XII plan of CGWB encompassing various data generation activities **(Table-2.1)**. The historically available data of Geology, Geophysics, Hydrogeology, and Hydrochemistry generated under various studies by the CGWB through Systematic Hydrogeological studies, Reappraisal Hydrogeological studies, Groundwater Management studies, Exploratory drilling, and special studies have been utilized for data gap analysis, along with the data collected from various State and Central government departments.

Table-2.1: 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, Geochemical etc. Creation of data base of Exploration Wells, delineation of Principal aquifers (vertical and lateral) and compilation of Aquifer wise water level and draft data etc.
		Identification of Data Gap	Data gap in thematic layers, 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 etc.
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 and gravity data generation	Vertical Electrical Sounding (VES), bore-hole logging, 2-D imaging etc.
		Hydrological Parameters on groundwater recharge	Soil infiltration studies, rainfall data analysis, canal flow and recharge structures.
		Preparation of Hydrogeological map (1:50, 000 scale)	Water level monitoring, exploratory drilling, pumping tests, preparation of sub-surface hydrogeological sections.
		Generation of additional water quality parameters	Analysis of groundwater for general parameters including fluoride.
3.	Aquifer Map Preparation	Analysis of data and preparation of	Integration of Hydrogeological, Geophysical, Geological and Hydro-

	(1:50,000 scale)	GIS layers and preparation of aquifer maps	chemical data.
4.	Aquifer Management Plan	Preparation of aquifer management plan	Information on aquifer 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 through hydro geological studies, exploration, surface and subsurface geophysical studies in the district. The data used for the integration and interpretation includes:

2.1 Exploratory drilling

Information on aquifer geometry, groundwater potential of various formations, fracture systems, their characterization is primarily inferred from the exploratory drilling data. CGWB has a total of 77 wells in the district. Out of these, 22 wells were drilled in 2019-20 and 2020-21 based on the data gap analysis carried out in the study area as part of NAQUIM. A total of 77 exploratory borewell data of CGWB (77) have been used for the hydrogeological studies. 70 wells are located in Archean crystalline granitic formation and 7 wells in basaltic areas.

2.2 Water Level

Water level monitoring wells of CGWB and SGWD is utilized for the Aquifer Mapping studies. 10 dug wells and 27 Piezometers are presently monitored by CGWB and 41 piezometers by SGWD. 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.

2.3 Hydro chemical Studies

Water quality data of CGWB and SGWD is utilized for understanding the spatial variation of quality in the district. A total of 133 (Pre-monsoon:57(CGWB: 16, SGWD: 41) and post-monsoon: 76(CGWB:35, SGWD: 41) ground water monitoring well data of

Central Ground Water Board, Telangana State Ground Water Department and Telangana Rural Water Supply (mostly tapping combined aquifers Aq-1 and aq-2) is utilized to understand the chemical characteristics of groundwater. 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.

2.4 Geophysical Studies

Geophysical data on VES and profiling are used to extract information on the weathered thickness, fracture depth, thickness of fracture etc of hard rock area. For the interpretation of the aquifer geometry geophysical data in conjunction with the available groundwater exploration data is utilised. The data from 32 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. The data was processed and interpreted by IPI2Win software developed by MoscowState University, after marginally modifying the manually interpreted results in corroboration with geology and hydrogeology.

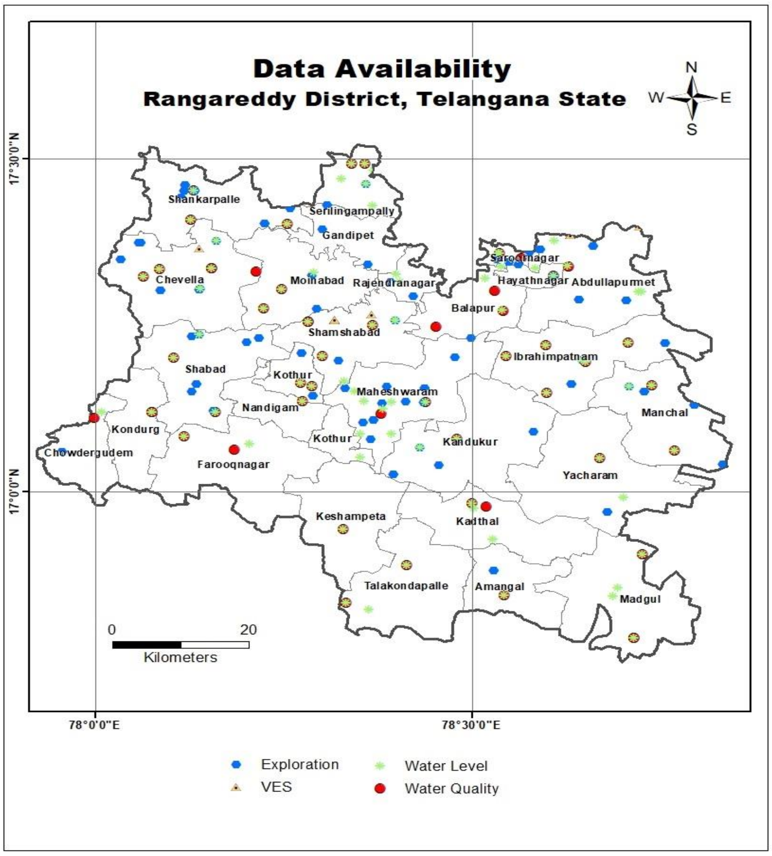


Fig. 2.1: Data availability

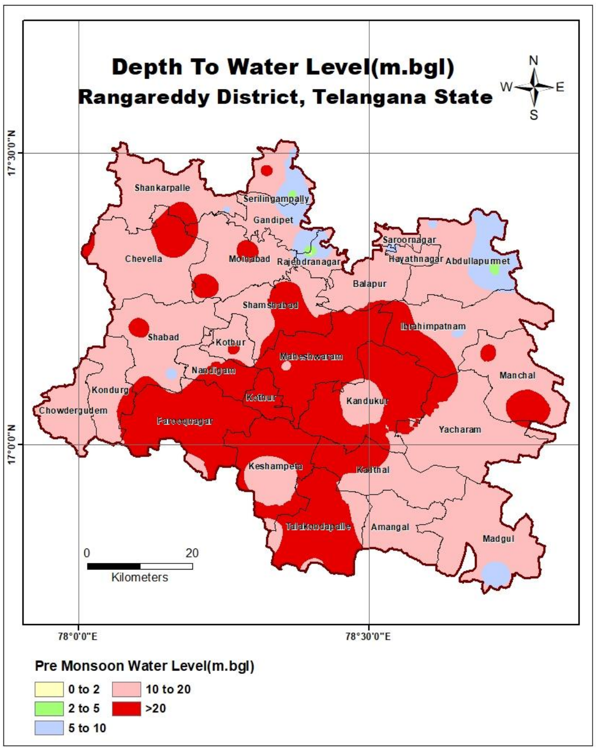
3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1. Ground water Level Scenario

3.1.1 Depth to ground water level

Analysis of the pre and post monsoon water level data from 78(CGWB: 37, SGWD: 41 PZ) groundwater monitoring wells shows that depth to water level varies from 1.2 to 37.8 m bgl during pre monsoon and 0.30-31 m bgl during post-monsoon season.

Pre-monsoon season: In majority of the areas, water level during this season are in the range of 10-20 m (57% of the area), followed by >20 m bgl (32%). Deeper water level in the range of > 20 m bgl occupy about 32 % of the area falling in parts of Maheshwaram, Kothur, Farooqnagar and Talakondapalle mandals (**Fig.3.1**). Shallow water level <10 mbgl occupy about 2% of the area.



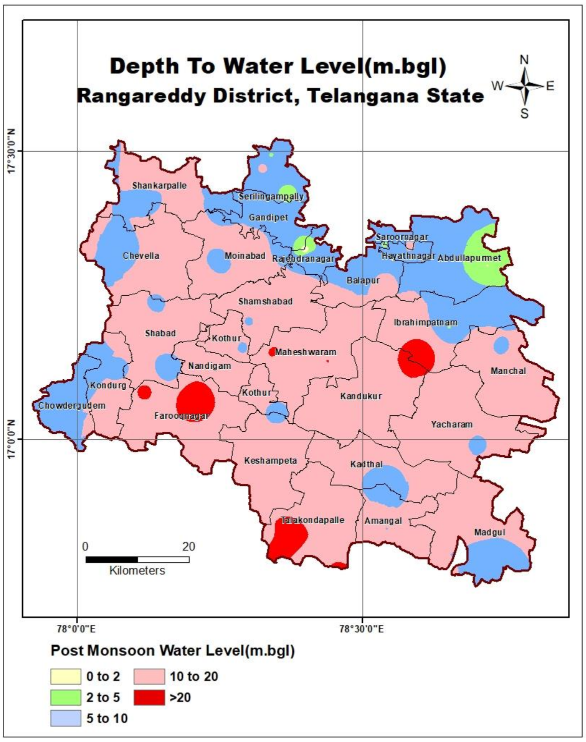


Fig.3.1: Depth to water levels Pre-monsoon **Fig.3.2:** Depth to water levels Post-monsoon

Post-monsoon season: Majority of the water level during this season are in the range of 10-20 m covering 78% of the area, 5-10 m bgl in 19 % of the area. (**Fig.3.2**). Shallow water level < 5 mbgl) occupy about 4% of the area in parts mainly in parts of Abdullampet, Gandipet and Rajendra nagar mandals. Deep water level in the range of >

20 m bgl occupies about 2 % of the area falling in parts of Kandukur, Farooqnagar and Talakondapalle mandals.

3.1.2 Seasonal Water Level Fluctuations (May vs. November): Out of 78 wells, 76 wells in the state records water level rise. The water level rise varies from 0.02 to 6.5 m in all the wells (Fig.2.6). 56% of the area have >5m rise in water level and 34% of the area have 2 to 5 m rise. Water level fall is recorded in two wells.

3.1.3 Long term water level trends: Trend analysis for the last 10 years (2011-2020) is studied from 49 hydrograph stations of CGWB and SGWD. It is observed that during pre-monsoon season 31 wells shows falling trend in the range of -0.03 m/yr to -1.1 m/yr and 18 wells shows rising trend 0.01-1.16 m/yr. During post-monsoon season 3 wells show falling trend -0.01- to -1.01 m/yr and 46 wells shows rising trends 0.2-1.6 m/yr(**Fig 3.4)**.

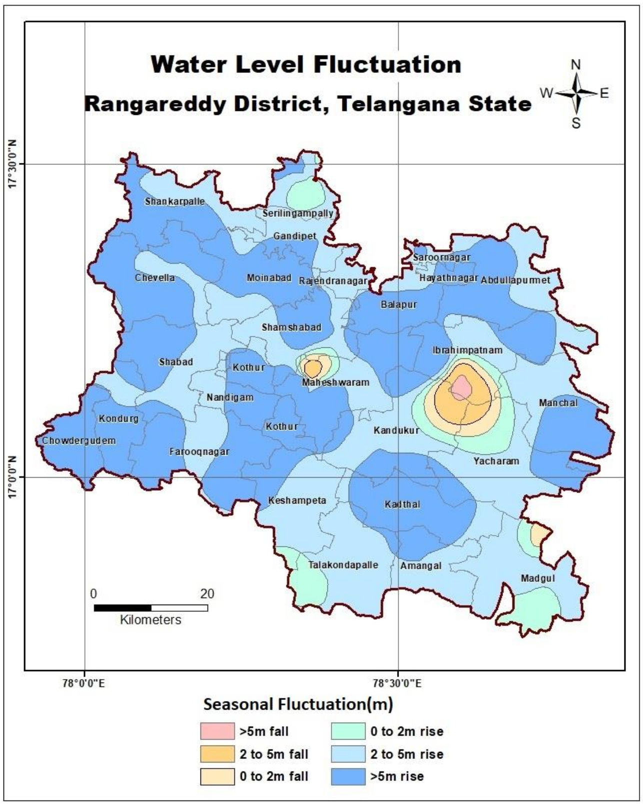


Fig.3.3: Water Level Fluctuation (m) (Nov with respect to May)

3.1.4 Water Table Elevation: During pre monsoon water-table elevation ranges from 347-672 meter above mean sea level and post-monsoon season 349-674 meter above mean sea level (m amsl). The ground water flow follows the drainage flow direction. In the lower Krishna subasin the ground water flow is towards north eastern direction. In the Middile Krishna subasin the ground water flow is towards South and South eastern direction. (**Fig.3.5)**

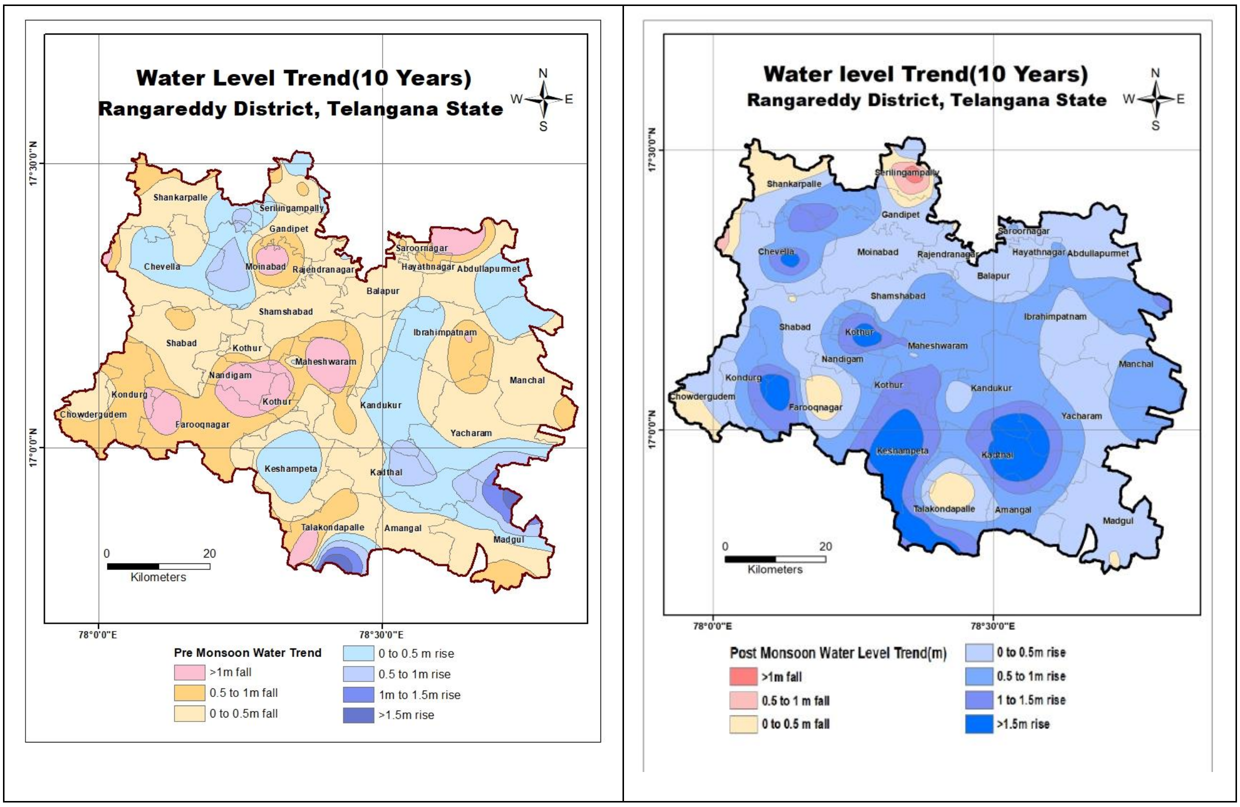


Fig. 3.4a-b: Long-term water level trends (5 yrs)

3.2 Ground Water Quality

The groundwater quality in the area is generally good for all purposes. In all the locations PH is within the acceptable limit and shows mildly alkaline to alkaline.

Pre-monsoon:

Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 6.02-9.21 (Avg: 8.03). Electrical conductivity varies from 538-5200 (avg: 1485) μ Siemens/cm**.** In 99% of area EC is within 3000 μ Siemens/cm, in 1 % area, it is more than 3000 μ Siemens. (**Fig.2.6).** Average concentration of TDS is 938 mg/L and NO_3 ranges from 1.62-515 mg/L. Nitate concentration in 80 % of samples is beyond permissible limits of 45 mg/L (**Fig.2.7**). Fluoride concentration varies from 0.05-5.09(**Fig 2.10**) and 69% of samples is within the permissible limits of BIS and rest is beyond the permiss ible limit of 1.5 mg/L.

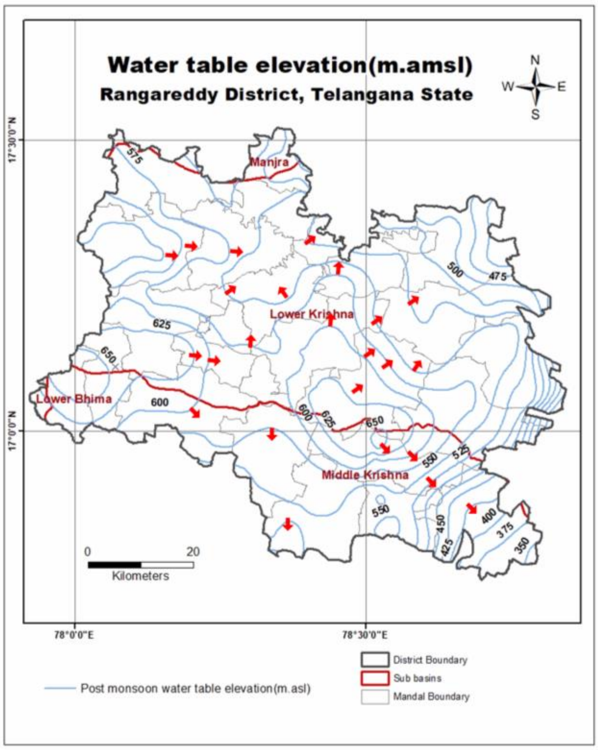


Fig.3.5: Water table elevations (m amsl) during pre and post-monsoon season

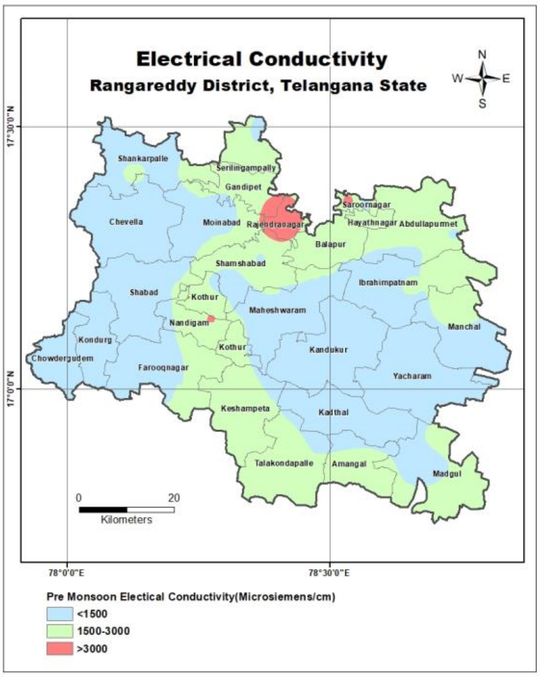


Fig.3.6: Pre monsoon EC distribution

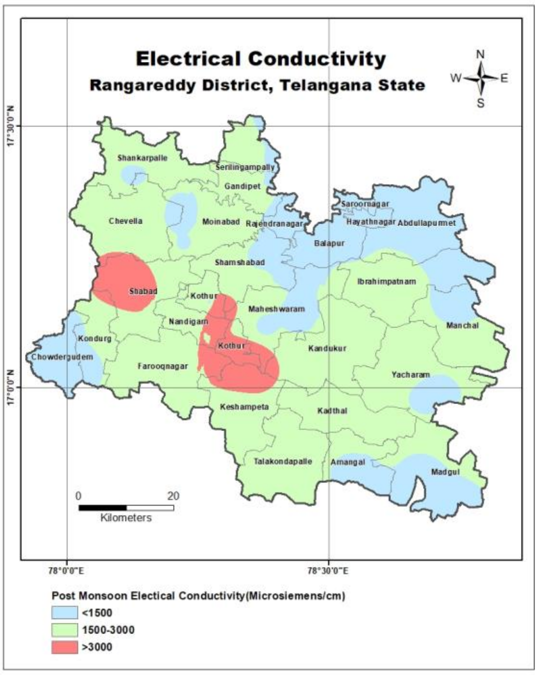


Fig.3.7: Post monsoon EC distribution

Post-monsoon

Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 7.02-8.48 (Avg: 7.68). Electrical conductivity varies from 556-5560 (avg: 1880) µ

Siemens/cm. In 96% of area EC is within 3000 μ Siemens/cm and in 3 percentage of the area EC>3000 μ Siemens/cm **(**Fig.2.11). Average concentration of TDS is 1203 mg/L and NO_3 ranges from <2-342 mg/L. Nitate concentration in 65% of samples is beyond permissible limits of 45 mg/L (Fig.2.12). Fluoride concentration varies from 0.32-3.02 (Fig 3.10) and 71% of area is within permissible limits of BIS and rest is beyond permissible limits of 1.5 mg/L.

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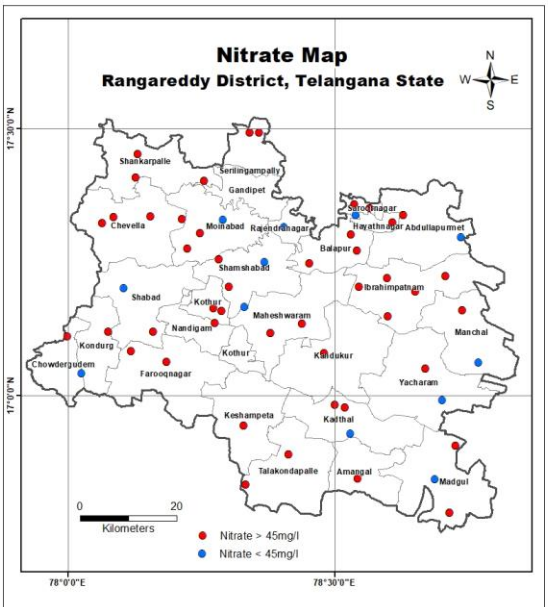
<td>
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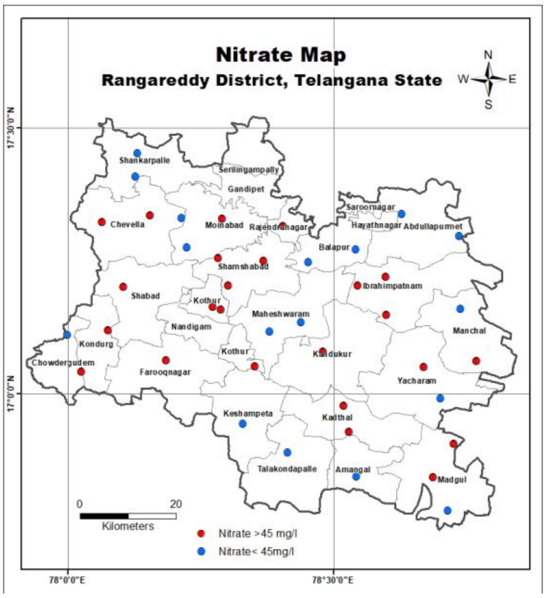
<td>
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<td>Fig.3.8: Pre monsoon Nitrate distribution</td>
<td>Fig.3.9: Post monsoon Nitrate distribution</td>
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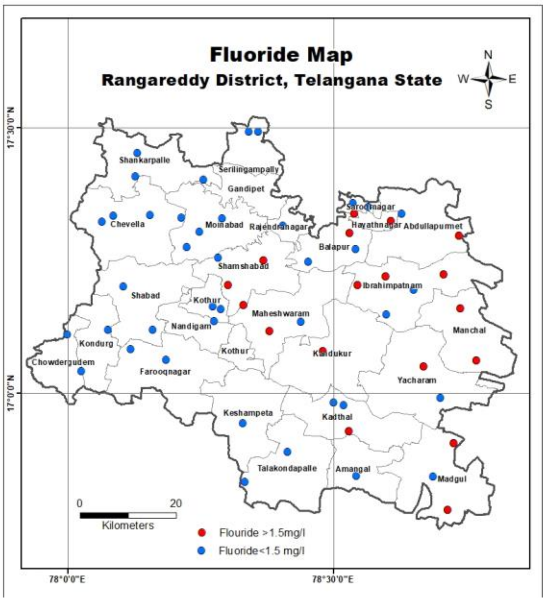
<td>
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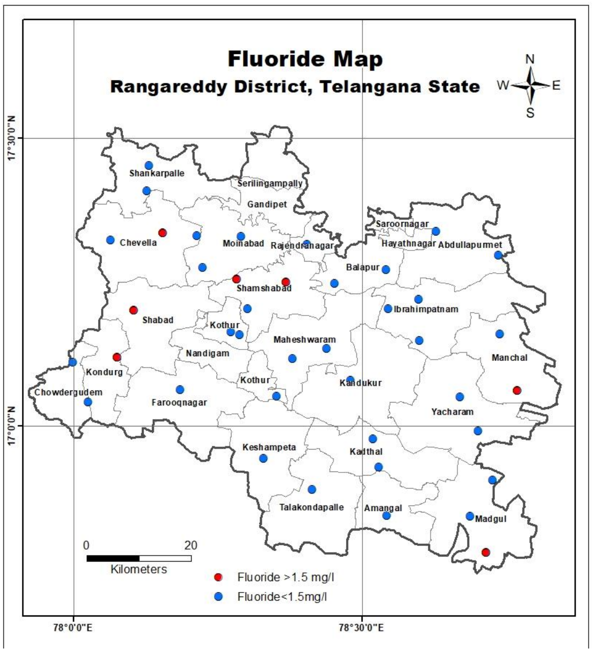
<td>
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<td>Fig.3.10:Premonsoon Fluoride distribution</td>
<td>Fig.3.11: Postmonsoon Fluoride distribution</td>
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3.3 AQUIFER MAPPING

3.3.1 Hydrogeology:

The aquifer geometry for shallow and deeper aquifer has been established through hydro geological studies, exploration, surface and subsurface geophysical studies in the district. Aquifers were characterized in terms of potential and quality. The principal aquifers in the area are granites gneisses and basalts and the occurrence and movement of ground water in these rocks is controlled by interconnection of secondary pores/voids developed by fracturing and weathering. Hydrogeology map is depicted in Fig. 3.11.

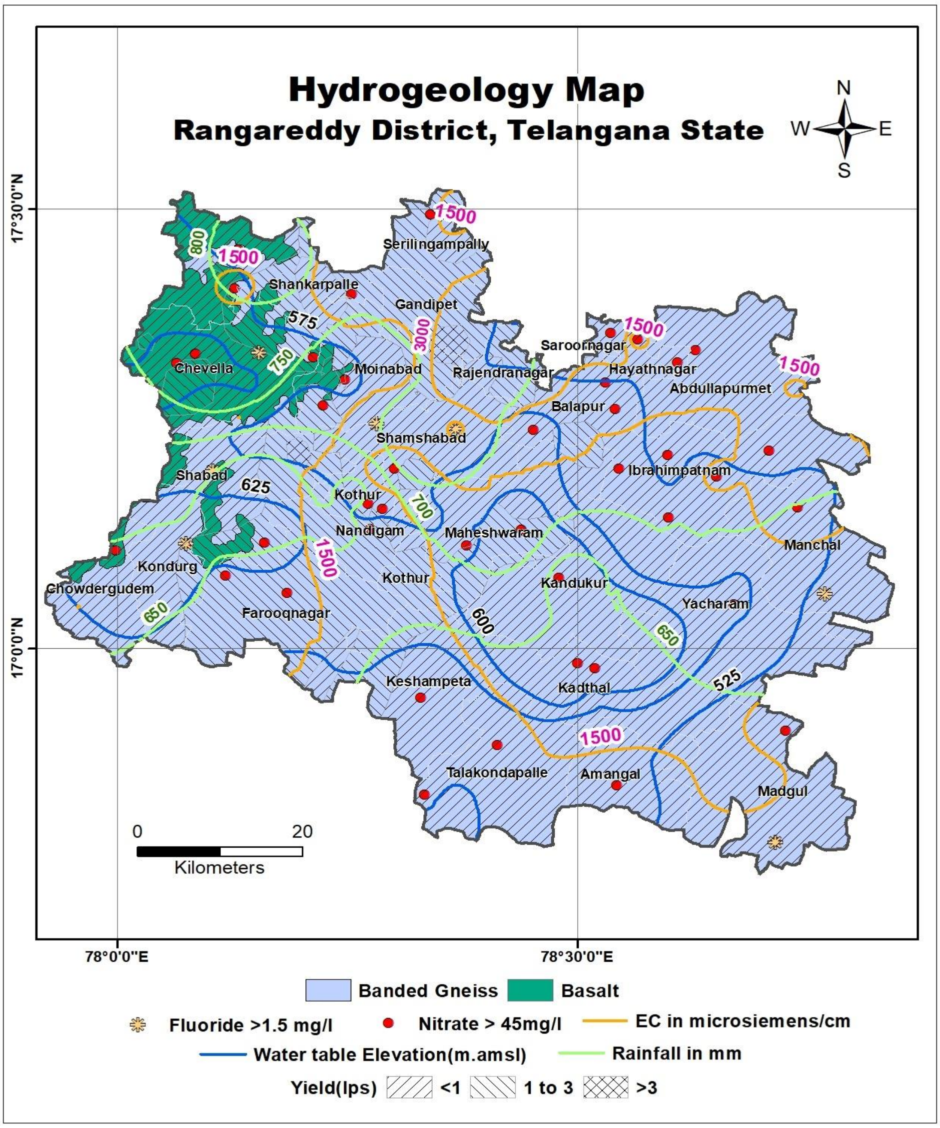

Fig.3.11: Hydrogeology map of Ranga Reddy district.

Thickness of weathering

Thickness of weathering ranges from 10-20 m in ~78 % of area, shallow weathering (< 10 m) in 14% of the area and deep weathering (> 20 m) in remaining part of Rangareddy district (**Fig.3.12)**

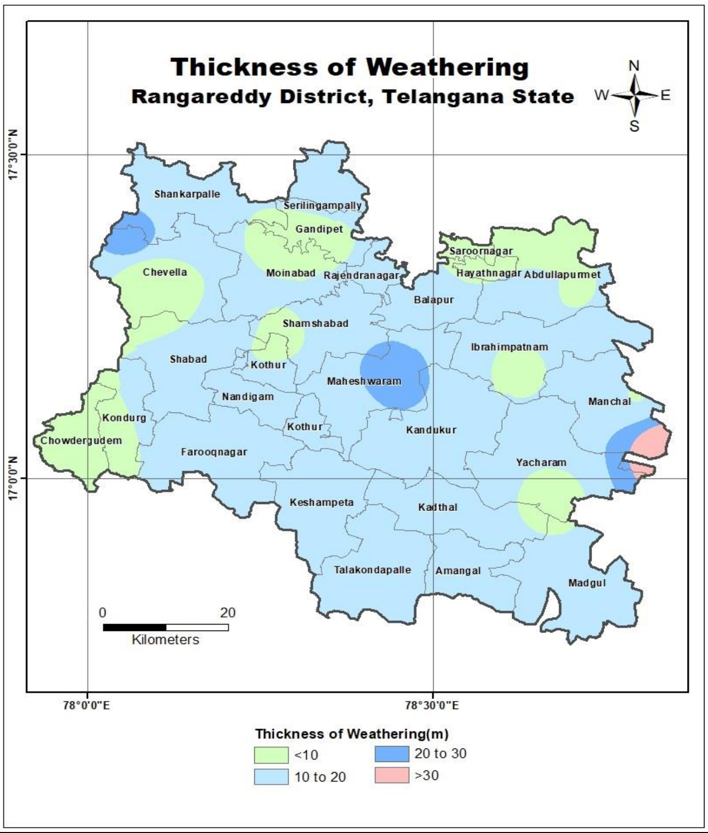

Fig.3.12: Thickness of weathering in Ranga Reddy district.

Depth of occurrence of Fractures:

Ground water is extracted mainly through bore wells of 20 to 200m depth from fractured zone (~20 to 199 m). The fracture are more predominant upto the depth of < 60 m in 83 % of the area, 60-100 and 100-150 fractures occur in 4% and 9% of area respectively and deep fractures in the range of 150-192 m occur in Chowdergudem, Serligampally and Shampal mandals. Analysis of occurence of fractures (117 nos from 75wells) reveal that majority of fractures (~84 %) occur within 100 m depth (**Fig. 3.13**).

Aquifer systems of Rangareddy District

The aquifers are the weathered zone at the top, followed by a discrete anisotropic fractured zone at the bottom, generally extending down to 200m depth. Weathered and fractured granites and gneisses form the major aquifer system. Basaltic aquifer system overlies granitic aquifer system in parts of Chevella and Shakarapalle mandals. Ground water occurs under unconfined and semi-confined conditions and flows downward from the weathered zone (saprolite and sap rock) into the fracture zone. The storage in granite rocks is primarily confined to the weathered zone and its overexploitation, mainly for irrigation purpose, has resulted in desaturation of weathered zone at many places. The aquifer units identified includes.

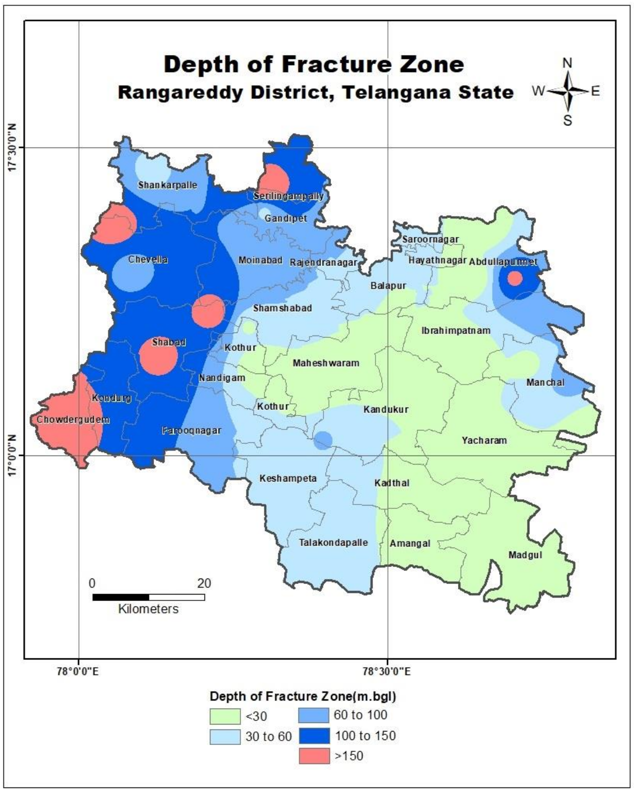

Fig.3.13: Depth of occurrence of fracture zone in Ranga Reddy district

Shallow Aquifer (Aquifer-I): consists of weathered residuum where ground water occurs under water table condition and is mainly developed by construction of dug wells or shallow bore wells as hand pump. The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. They are unconfined aquifers. Ground water yield varies from <0.1 to 2.4 lps (avg: 1.0 lps in weathered granite/gneiss aquifer and from 0.01 to 1.2 lps (avg: 1.0 lps) in basalt aquifers. The transmissivity varies from <1 to 85m^2/day in weathered granite/gneiss aquifer and varies from <1-160.7 m^2/day in basalts

Deeper Aquifer (Aquifer II): The second aquifer is the deeper aquifer which tapped the fractured zone. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures upto the maximum depth of 199 m bgl (Deepest fracture encountered). The depth of fracturing varies from 25 m to 199 m with yield of <1-9lps. The specific capacity of the consolidated formation ranges between 6 and 102 lpm/mdd; transmissivity between <1 and 240sq.m/day. The aquifer characterization is depicted in **Table 3.1**

	Archean Crystalline	
Prominent Lithology	**Granite gneiss**	
Aquifers	**Aquifer-1 (Weathered Zone)**	**Aquifer-2 (Fracture Zone)**
Thickness range	**<10-30m**	**upto 199m**
Depth of range of occurrence of fractures	**-**	**86% fracture encountered between 30 to 100m**
Range of yield potential	**<1 to 2**	**<1 to 5**
Transmissivity (m2/day)	**Upto 240**	
Specific Capacity (lpm/mdd)	**6 to 102**	
Specific yield/Storativity	**0.01 to 1x10^{-5}**	

3.3.2 Aquifer Disposition 3D and 2D

Conceptualization of 3-D hydrogeological model was carried out by interpreting and integrating representative 99 data points (both hydrogeological and geophysical down to 200 m) for preparation of 3-D map, panel diagram and hydrogeological sections. The lithological information was generated by using the RockWorks-16 software and generated 3-D map for Rangareddy district (**Fig.3.14)** along with panel diagram (**Fig. 3.15a-b**).

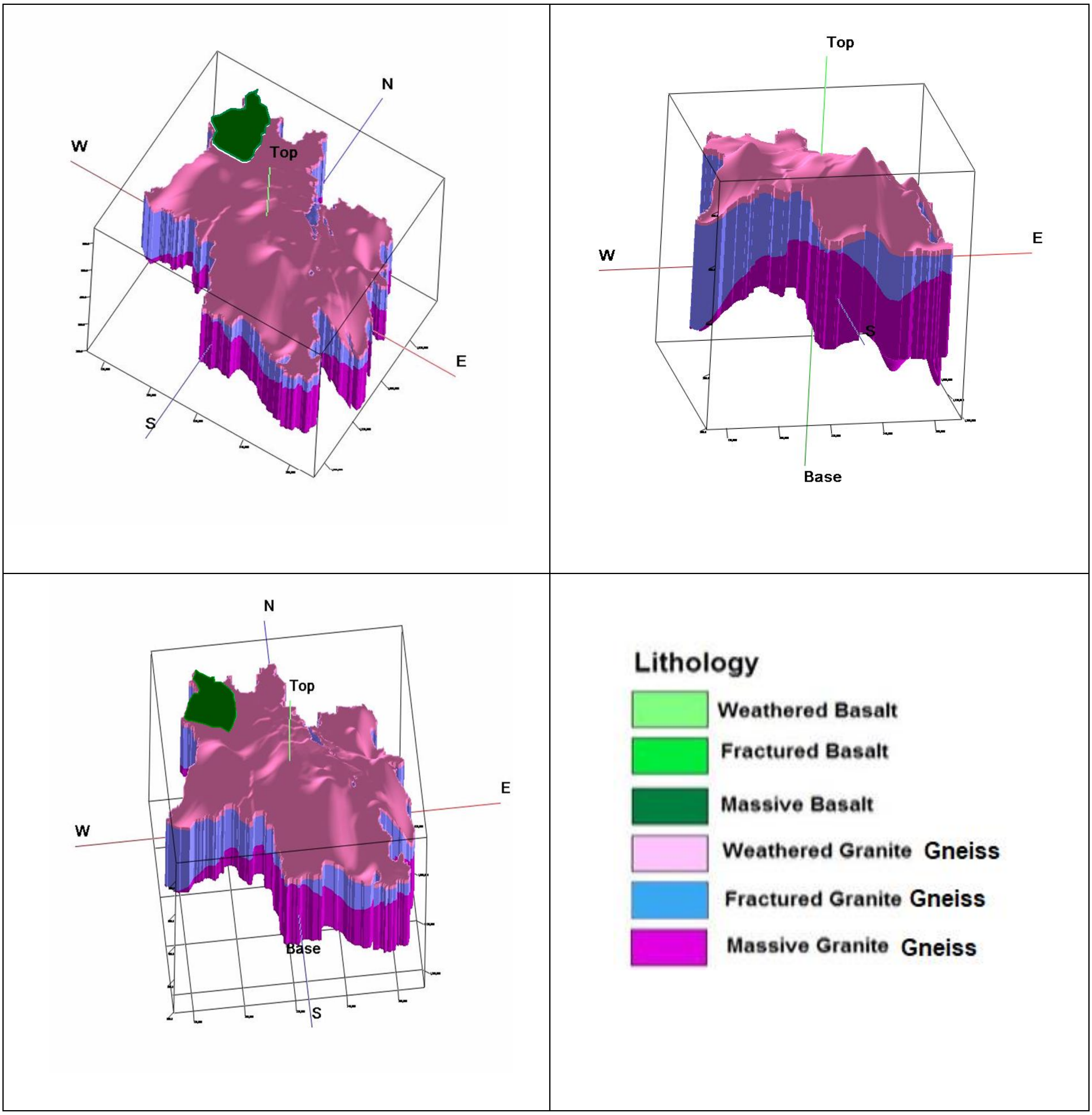

Fig.-3.14:3-D Model for study area

Aquifer Disposition 2D

Two hydrogeological sections are prepared in N-S and NW-SE directions (**Fig. 3.16**).

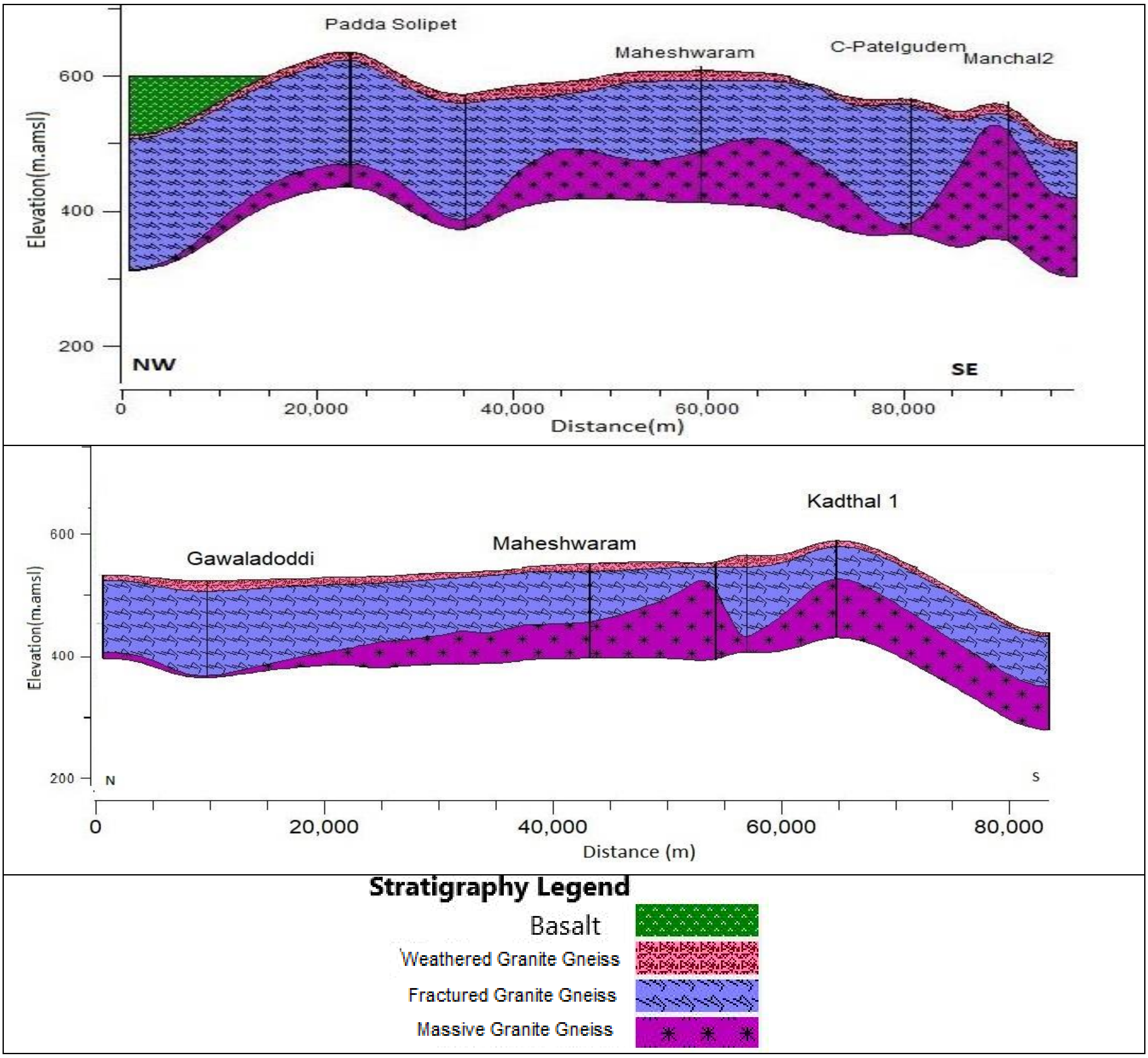

Fig.3.15 (a-b): Hydrogeological profile in different directions

North West and South East Section: The section drawn along the NW-SE direction covering distance of 74kms (**Fig.3.15a**). A thin stretch of basalt extends upto 15 km into the district from NW boundary and the depth of basalt occurance gradually decrease from NW –SE direction.

North and South Section: The section drawn along the North- South covering distance of ~85 kms (**Fig.3.15b**). It depicts thick fractured zone in the north and reduces in the central part.

4. GROUND WATER RESOURCES (2020)

Village wise dynamic and in-storage ground water resources are computed as per the guidelines laid down in GEC methodology. Summarized mandal wise resources are given in **Table-4.1.**

As per 2020 GEC report, the net dynamic replenishable groundwater availability is 381 MCM, gross ground water draft for all uses 308 MCM provision for drinking and industrial use for the year 2025 is 49 MCM and net annual ground water potential available for future irrigation needs is 75 MCM. Stage of ground water development varies from 66% (Madgul mandal) to 101% (Serilingampally mandal). Seriligampally mandal is over exploited, 7 mandals are Critical, 15 mandals are semi critical and 5 mandals are safe.

Table-4.1: Computed Dynamic, In-storage ground water resources, Rangareddy district.

Parameters	**Total**
As per GEC 2020	MCM
Dynamic (Net GWR Availability)	**381**
• Monsoon recharge from rainfall	261
• Monsoon recharge from other sources	40
• Non-Monsoon recharge from rainfall	62
• Non-monsoon recharge from other sources	60
• Total Natural Discharges (Ham)	42
Gross GW Draft	**308**
• Irrigation	241
• Domestic and Industrial use	49
Provision for Drinking and Industrial use for the year 2025	49

Net GW availability for future irrigation	75
Stage of GW development (%)	81

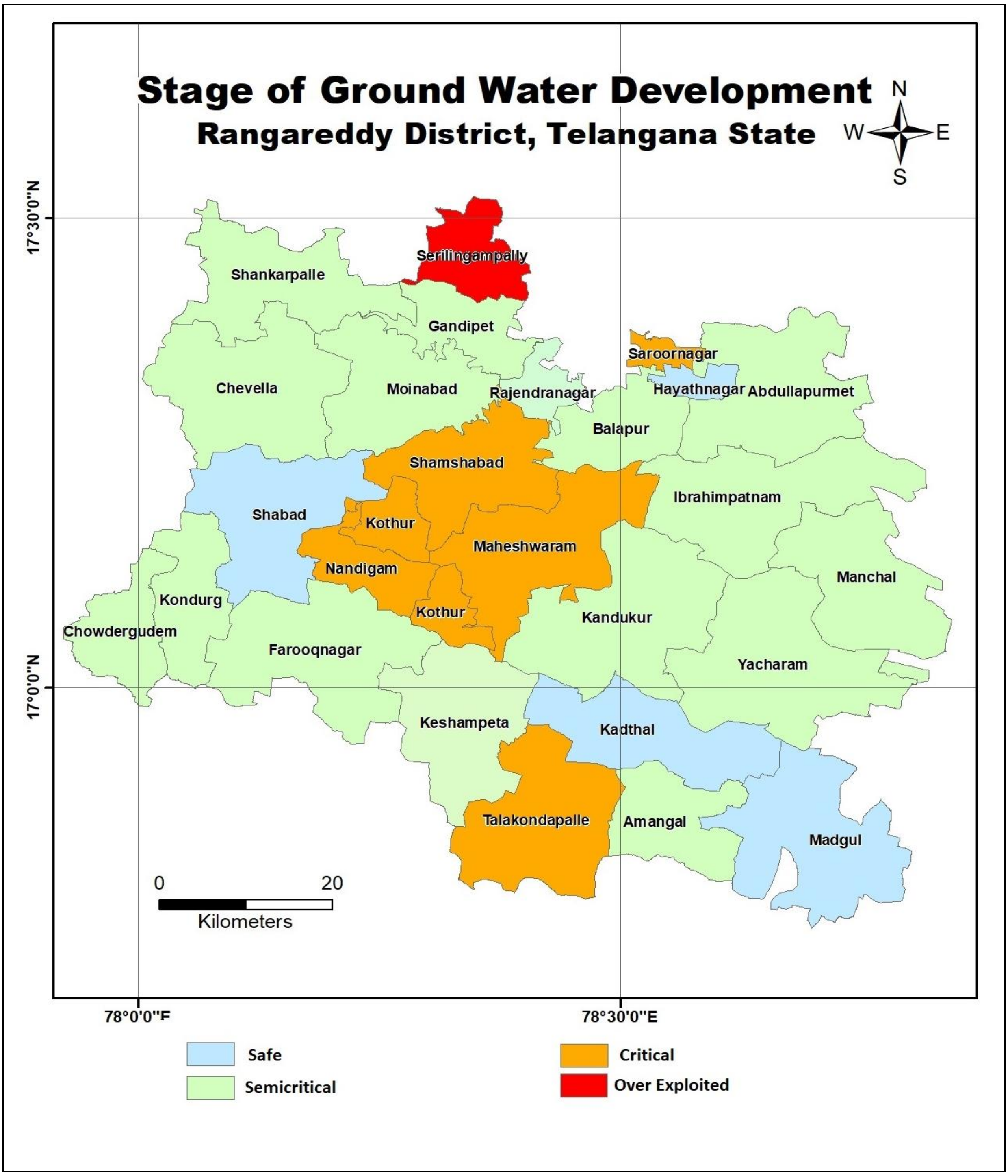

Fig.4.1 Mandal wise stage of ground water development

5. GROUND WATER RELATED ISSUES AND REASONS FOR ISSUES

5.1 Issues.

Few mandals are fluorosis endemic where fluoride (geogenic) as high as 5.09 mg/L during pre-monsoon and 3.02 mg/L during post-monsoon season is found in groundwater. The high fluoride concentration (>1.5 mg/L) occur in 31% and 29 % of the wells during pre-monsoon and post-monsoon season.

- High nitrate (> 45 mg/L) concentration due to anthropogenic activities is observed in 80% and 65% of samples during pre-monsoon and post-monsoon season respectively.
- The high concentration of EC (> 3000 micro-seimens/cm) in 2% and 3 % of ground water samples are reported during pre-monsoon and post-monsoon season.

Over-exploitation

- Seriligampally mandal is over exploited with a stage of ground water development of 101%

Deep water levels

- Deep water levels (> 20 m bgl) are observed during pre as well as post-monsoon season in 32 % and 2 % of the area respectively.
- Out of 49 wells analysed, 31 wells during pre-monsoon and 18 wells during post-monsoon shows falling trend in the last 10 years (@-0.03to -1.1 and -0.01 to -1.01 m/yr) respectively.

Sustainability

- Low yield (<1 lps) occurs in ~65% of area. The yield from bore wells have reduced over a period of time and some bore wells which used to yield sufficient quantity of water have gone dry due to low rainfall in the last two years.

Water Marketing and other Issues

- Water marketing is present in almost all over the area and people are buying bottled water from the market for drinking purposes as there is no sufficient supply of surface water.

- Change in land use from agricultural land to residential purposes and cropping pattern from traditional crops to cash crops (spices, cotton) is observed.

- Based on ground water resource availability paddy is grown during rabi season in non-command area leading to heavy withdrawal of ground water during non-monsoon period.

5.2 Reasons for Issues

Geo-genic pollution (Fluoride)

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

Anthropogenic pollution (Nitrate)

- 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.

Over-exploitation and Deeper water levels

- Over-extraction, paddy cultivation during Rabi season (32 % to total crops of rabi) ground water mining, limited artificial measures etc.

Sustainability

- Absence of primary porosity, negligible development of secondary porosity, low rainfall, desaturation of weathered zone and urbanization.

6. MANAGEMENT STRATEGIES

High dependence on groundwater coupled with absence of augmentation measures has led to a fall in water level and desaturation of weathered zone in some parts of the district. The sustainability of existing groundwater structures, food and drinking water security are challenging tasks in the preparation of management plan. Higher NO_3^- concentrations (> 45 mg/L) in weathered zone is due to sewage contamination and higher concentration of F^- (>1.5 mg/L) in weathered zone and fractured zone is due to local geology (granite/gneiss rock), high weathering, longer residence time and alkaline nature of groundwater. 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.

6.1 Management plan

The management plan comprises of two components namely supply side management and demand side management. The supply side management is proposed, based on surplus surface water availability and the unsaturated thickness of aquifer whereas the demand side management is proposed by use of micro irrigation techniques. Supply side management has been prepared separately for urban mandals Rajendranagar, Seriligampally, Gandipet, Balapur and Saroor nagar.

6.2 Supply side management

The supply side management of ground water resources include artificial recharge of available surplus runoff in check dams and percolation tanks in rural areas and roof top and open space rain water harvesting in urban areas. More over repair renovation & restoration of existing tanks will also help in ground water recharge. Telangana Government has already started Repair Renovation and Restoration of existing tanks under the name Mission Kakatiya.

The area suitable for ground water augmentation through artificial recharge has been demarcated based on the analysis of average post-monsoon depth to water level data of the observation wells for the period of 2012-2021 and the existing data on artificial recharge structures constructed under various schemes of Mahatma Gandhi

National Rural Employment Guarantee Scheme (MNREGS) and Integrated Watershed Management Programs (IWMP) by Rural Development department, Govt. of Telangana.

The availability of sub-surface storage volume of aquifers in each district is computed as the product of area, thickness of aquifer zone between 5 m. bgl and the average post-monsoon water level. The recharge potential/sub surface space of the aquifers is calculated by multiplying the sub surface storage volume with 2% specific yield.

The source water availability is estimated from the rain fall and run off correlations. The runoff was calculated by taking into account of normal monsoon rainfall of the mandal and corresponding runoff yield from Strangers Table for average catchment type. Out of the total run off available in the mandal, 20 % run off yield is considered as un-committed yield and for recommending artificial recharge structures in intermittent areas.

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

The recharge and runoff available in the district is given in **Table 6.1**

Table 6.1: Recharge and Runofff available in the district

Total geographical area of district (Sq.km)	**5031**
Area feasible for recharge (Sq.km)	**3663**
Unsaturated Volume (MCM)	**38898**
Recharge Potential (MCM)	**778**
Runoff available (MCM)	**286**
Surplus runoff available for recharge (MCM)(20% of runoff)	**57**

6.1.1 Supply side measures:

6.1.1.1a Artificial Recharge Structures in rural areas

50% of the available surplus runoff is considered for the recommendation of artificial recharge strutcures, as the remaining 50 % is recommended for implementing water conservation measures in recharge areas through MGNREGS.(Table 6.2)

Table 6.2 Proposed artificial recharge structures	
Percolation Tanks (@ Rs.15 lakh Capacity of the tank: 0.007MCM, Av. Gross storage in an year =0.007 MCM*2 fillings = 0.014 MCM Volume of Water expected to be recharged (in MCM) Estimated Expenditure (in Crores)	**376** **5.3** **56**
Check Dams (@ Rs.10 lakh, Av. Gross storage in an year =0.007 MCM* 5 fillings = 0.035 MCM Volume of Water expected to be recharged(in MCM) Estimated Expenditure (in Crores)	**376** **13.2** **38**
Total volume of water expected to be recharged (in MCM)	**19**
Total Estimated Expenditure for Artificial Recharge (Rs. in Cr.)	**94**

752 artificial recharge structures (376 CD's and 376 mini PT'in 314 villages) with a total cost of **94** crores can be taken up. (Considering CDS with recharge shafts with 5 fillings with a unit cost of Rs 10 lakhs each and mini PT's with 12fillings with a unit cost of Rs 15 lakhs each)

- After effective utilization of this yield, there will be 19MCM of ground water recharge (50 % of total utilizable yield).
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).

For sustainable development and management of the groundwater resources the above recommendations are made and summarised in **Annexure-2**.

6.1.1.1b Roof top and open space rain water harvesting for artificial recharge in urban areas.

Around 162 sq.km of the land in the Serilingampally, Hayathnagar, Balapur, Rajendra nagar and Gandipet urban mandals are developed by builtup and 54 Sq.km of the land as open land. The thickness of weathering varies from 8-15 m and the depth of occurrence of shallow fractures ranges between 12-40 m. The rain water from the builtup and open spaces can be harvested by the construction of open pits and trenches. The recharge pits (Fig: 6.2) of dimensions 3.0*3.0*4.0 m length*width*depth is porposed to harvest rain water from the roof top and the recharge pits of dimensions

3.0*5.0*4.0 m (Fig:6.2) length*width*depth is porposed to harvest rainwater from the open land areas. The details of the proposed units are furnished in table 6.3.

Table 6.3 Proposed structures for roof top and openspace harvesting

Recharge potential available	:12 MCM				
Run off considered from buit up	: 10 MCM				
Run off considered from open space	: 2 MCM				
Recharge pits recommended for individual buildings					
Pit/Trench for AR	**Width (m)**	**Length (m)**	**Depth (m)**	**No. of Pits/trenches Feasible**	**Total Pit volume (Cu.m)**
No. of pits for roof top@36 cu.m (Avg. 5 fillings/yr for 1800 sq. m)	**3**	**3**	**4**	**268777**	**9676000**
No. o f pits for Open area@60 cu.m (Avg. 5 fillings/yr)	**3**	**5**	**4**	**43333**	**2600000**

It is observed that mainly 3 sets of fracture systems (shallow zone: 20-30, intermediate: 40-60 m and deeper >60 m) exist in the area. Of these, shallow fractures are more prevalent, intermediate fractures, and often connected to shallow fractures are more productive, which need to be harnessed through rooftop rain water harvesting. Considering that each apartment complex/household has one functioning/abandoned bore well, it is recommended that each house/apartment complex should have recharge unit/ fast filtration unit, above or below ground (preferably above ground) which is dug and filled with coarse gravel (bottom 2/3 portion) and keeping the remaining part open. The rooftop water is allowed to pass through recharge unit/filtration unit and recharge existing well/abandoned well. There should be proper maintenance of the structure and surveillance.

Fig 6.1:Trench

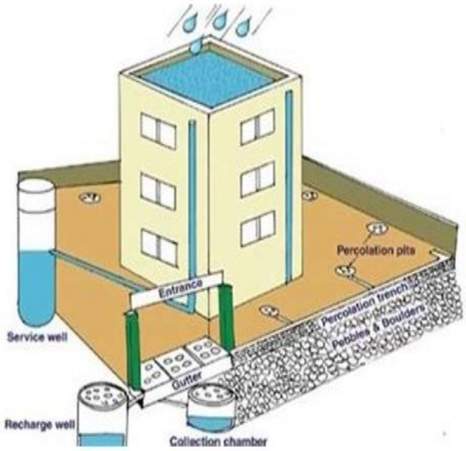

Fig:6.2: Recharge Pit

Storm Water Management in Open areas

Storm water management in urban areas involves both natural and man-made drains and water bodies. The entire surface run-off finally finds its way into the River Musi and many surrounding lakes. There are various reasons for the flooding of city area, including lack of specific infrastructure for storm water discharge, impervious surface, clogging of drains and the blockage of natural drains from improper waste management, lack of systems to recharge groundwater with runoff or to harvest rainwater, and unplanned urban development with relation to the drainage patterns.

Source Control & Prevention Techniques:

INFILTRATION TRENCHES *are* shallow, excavated trench that has been backfilled with porous material to create an underground reservoir. Storm water runoff flowing into the trench gradually infiltrates into subsurface.

INFILTRATION BASINS: Infiltration basins are shallow, surface impoundments where storm water runoff is stored until it gradually infiltrates through the soil of the basin floor.Infiltration basins can serve larger catchment areas than infiltration trenches because a larger volume of water can be stored on the surface.

PERMEABLE PAVEMENTS: Commonly used paved surfaces, such as asphalt and concrete, do not allow water to infiltrate and convert almost all rainfall into runoff. Permeable pavement is an alternative to conventional paving in which water permeates through the paved structure rather than draining off it(Fig 6.3).

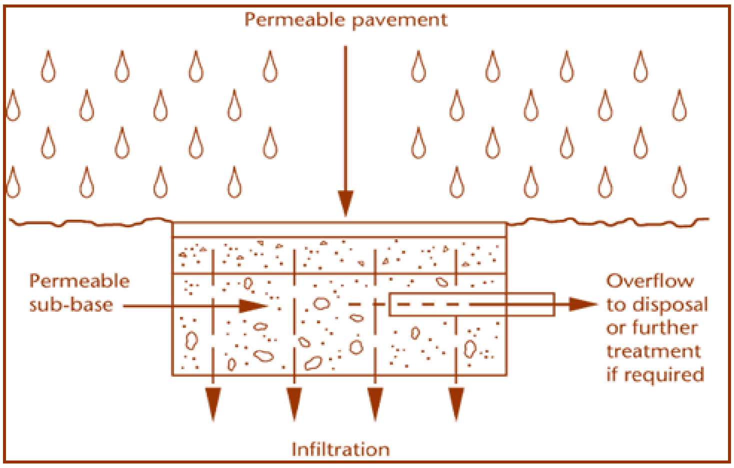

Fig 6.3. Permeable pavement

Depending on design, paving material, soil type, and rainfall, permeable paving can infiltrate as much as 70% to 80% of annual rainfall. It also provides onsite storm water run-off attenuation allowing infiltration thus reducing the risk of water-logging and flooding in low-lying areas, thus reduces the need for storm water conveyances and treatment structures, reduces the amount of land needed for onsite storm water management and cost savings. It is also highly effective in dealing with the UHIE (urban heat island effect).

Fig 6.4: Paved Pervious Surfaces

GREEN ROOFS: The system offers significant benefits in terms of reductions in the amount of water running off the roof, the rate of runoff and quality improvements. Many conventional flat roof systems used in industrial buildings could be converted to green roofs without exceeding design loadings and with the additional benefit of improving insulation and extending roof life. Green roofs built with the most appropriate base and vegetation has the potential to absorb 15 – 90% of roof run-off.

PERMEABLE CONVEYANCE SYSTEMS: These move runoff water slowly towards a receiving watercourse, allowing storage, filtering and some loss of runoff water through evaporation and infiltration before the discharge point. There are two main types:

- Underground systems, such as filter drains (or French drains) and
- Surface water swales.

Filter (or French) drains: The underground systems are known as Filter (or French) drains. They comprise a trench, filled with gravel wrapped in a geo-textile membrane into which runoff water is led, either directly from the drained surface or via a pipe system. The gravel in the filter drain provides filtering of the runoff, trapping sediment, organic matter and oil residues that can be broken down by bacterial action through time. Runoff velocity is slowed, and storage of runoff is also provided. Filter drains system have been widely used by the highway authorities for roads drainage.

Ongoing projects

6.1.1.2Repair, Renovation and Restoration of existing tanks:

- De-silting of existing minor tanks (1025) was taken under state Govt. sponsored Mission Kakatiya-Phase-1, Phase-2, Phase 3 and 4 to remove 7 MCM of silt and this has created additional surface storage. This will contribute ~ 1.75 MCM to groundwater and with this additional ~290 ha land can be brought under irrigated dry (ID) crops in tank ayacut.

- There is need to take remaining tanks in next phases for de-silting, this will greatly help in stabilisation of tank ayacut and ground water augmentation.

6.1.1.3 Water Conservation Measures (WCM) (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. In the district total 710 farm pond exists in 63 villages and additional **9280** farm ponds are recommended (20 in each village in 461 villages) with total cost of **23.20** crores.

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

6.12.1 Rain Water Harvesting for Storage & Reuse in City areas

Rainwater from roofs can be stored and used. The collected water can be used for non-potable purposes, such as flushing toilets, washing machines, and irrigation etc. Rainwater systems may be able to provide potable water, after treatment to ensure compliance with Drinking Water quality standards of ISO/WHO. The design of rain water storage tanks is dependent on demand requirements, contributing surface area, storm water management requirements and seasonal rainfall characteristics. In addition, a facility to flush out the first flush and floating debris is useful. Systems collecting runoff from the ground surface should incorporate a good filtration system or oil separator upstream of the rainwater tank increasing the water quality benefit. These systems work best when dealing with small quantities of water, and are most effective when distributed throughout a catchment at the point where runoff arises, capturing rainwater at or near the point where the rain falls (Fig 6.5)

Runoff	**Quantity**
Runoff generated from the roof top area	118 MCM
Runoff generated from the open area	8 MCM
Runoff utilized from roof top area for ground water recharge	10MCM
Runoff utilized from open area for ground water recharge	2 MCM
Available surplus runoff from built up area for storage and domestic purposes	117 MCM

Fig 6.5 Storage Tank (for direct use)

Other supply side measures:

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.

Ongoing Work

In the area as on date ~**7740ha** area is irrigating through microirrigation saving ~13MCM(considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha).

Proposed Work

~80000 ha of additional land that can be brought under micro-irrigation (@150 ha/village in 535 villages) costing about 480 crores (considering 1 unit/ha @0.6 lakh/ha). With this 144 MCM of ground water can be conserved over the traditional irrigation practices (considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha).

Change in cropping pattern from water intensive paddy/spices (turmeric) to irrigated dry crops like pulses and oil seeds are recommended, particularly in water stress/Over-exploited/Critical areas. If necessary some regulatory rules may be framed and implemented.

To avoid the interference of cone of depression between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism.

Power supply should be regulated by giving power in 4 hour spells two times a day in the morning and evening by the concerned department so that pumping of the bore well is carried out in phased manner to allow recuperations of the aquifer and increase sustainability of the bore wells.

As a mandatory measure, every groundwater user should recharge rainwater through artificial recharge structures in proportionate to the extraction.

6.1.3 Other measures

A participatory groundwater management (PGWM) approach in sharing of groundwater and monitoring resources on a constant basis along with effective implementation of the existing 'Water, Land and Trees Act' of 2002 (WALTA-2002) are the other measures suggested. Subsidy/incentives on cost involved in sharing of groundwater may be given to the farmers involved.

In urban and rural areas the sewerage line should be constructed to arrest leaching of nitrate.

6.2 Expected Results and Out come

With the above interventions costing Rs 597crores (Roof top and open space rain water harvesting for artificial recharge in urban areas.), the likely benefit would be the net saving of 147 MCM of ground water for draft and recharge of 31MCM of ground water. This will bring down the stage of ground water development by 35% (from 81 % to 46%).

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Annexure-I: Proposed Supply side interventions

Sl.No	Mandal	Village Name	Longitude	Latitude	Proposed Check Dams	Proposed Recolation Tanks
1	Abdullapurmet	Thurkayamjal	78.58	17.27	3	3
2	Abdullapurmet	Pedda amberpet	78.64	17.32	2	2
3	Abdullapurmet	Injapur	78.6	17.3	2	2
4	Abdullapurmet	Koheda	78.64	17.28	2	2
5	Abdullapurmet	Kuntloor	78.63	17.34	2	2
6	Abdullapurmet	Thorur	78.62	17.29	2	3
7	Abdullapurmet	Tattiannram	78.6	17.36	1	1
8	Abdullapurmet	Qutbullapur	78.64	17.38	1	1
9	Abdullapurmet	Omarkhandaira	78.67	17.27	1	1
10	Abdullapurmet	Marripally	78.61	17.38	1	1
11	Abdullapurmet	Munganoor	78.62	17.3	1	1
12	Abdullapurmet	Manneguda	78.59	17.25	1	1
13	Amangal	Ramanuthula	78.55	16.91	1	1
14	Amangal	Akuthotapalle	78.6	16.87	1	1
15	Amangal	Polepalle	78.61	16.81	1	1
16	Amangal	Settipalle	78.62	16.89	1	1
17	Amangal	Chennampalle	78.59	16.84	1	1
18	Amangal	Amangal	78.54	16.85	1	1
19	Chevella	Kandawada	78.18	17.28	4	4
20	Chevella	Mudimiyal	78.2	17.33	3	3
21	Chevella	Nyalata	78.11	17.35	2	2
22	Chevella	Tangadapally	78.06	17.37	2	2
23	Chevella	Kammeta	78.16	17.38	2	2
24	Chevella	Orella	78.13	17.36	2	2
25	Chevella	Aloor ii	78.07	17.33	2	2
26	Chevella	Gundal	78.16	17.25	2	2
27	Chevella	Aloor iii	78.07	17.33	2	2
28	Chevella	Regadighanapur	78.07	17.27	2	2
29	Chevella	Aloor i	78.06	17.35	1	1
30	Chevella	Devuniyerravally	78.14	17.34	1	1
31	Chevella	Gollapally	78.17	17.36	1	1
32	Chevella	Malkapur	78.17	17.32	1	1
33	Chevella	Kowkuntla	78.04	17.35	1	1
34	Chevella	Kummera	78.18	17.34	1	1
35	Chevella	Kesaram	78.16	17.31	1	1

36	Chevella	Earlapally	78.14	17.4	1	1
37	Chevella	Mirjaguda	78.08	17.31	1	1
38	Chevella	Tallaram	78.06	17.36	1	1
39	Chevella	Yenkepally	78.14	17.38	1	1
40	Chevella	Nawlaipally	78.04	17.34	1	1
41	Chevella	Khanapur	78.07	17.28	1	1
42	Chevella	Ravulapally(khurd)	78.2	17.35	1	1
43	Chevella	Hasthepur	78.02	17.33	1	1
44	Chevella	Naincheru	78.06	17.29	1	1
45	Chevella	Antharam	78.03	17.33	1	1
46	Chevella	Devarampally	78.07	17.25	1	1
47	Chowdergudem	Edira	78.01	17.03	2	2
48	Chowdergudem	Malkapahad	77.94	17.03	1	1
49	Chowdergudem	Gurrampalle	78	17.07	1	1
50	Chowdergudem	Jilled	77.99	17.08	1	1
51	Chowdergudem	Thoompalle	78.01	17.1	1	1
52	Chowdergudem	Tummalapalle	78.02	17.13	1	1
53	Chowdergudem	Padmaram	77.96	17.09	1	1
54	Chowdergudem	Raviryal	78.01	17.05	1	1
55	Chowdergudem	Indranagar	78	17.08	1	1
56	Chowdergudem	Hazipet	77.93	17.06	1	1
57	Chowdergudem	Veerannapeta	77.97	17.06	1	1
58	Farooqnagar	Chowlapalle (wes	78.12	17.04	3	3
59	Farooqnagar	Farooqnagar	78.2	17.08	2	2
60	Farooqnagar	Solipur	78.21	17.04	2	2
61	Farooqnagar	Elkatta	78.16	17.08	2	2
62	Farooqnagar	Burgul	78.22	16.99	2	2
63	Farooqnagar	Madhurapur	78.26	16.98	2	2
64	Farooqnagar	Seriguda-madhura	78.27	16.99	2	2
65	Farooqnagar	Nagulapalle	78.2	17.1	2	2
66	Farooqnagar	Kangaguda	78.3	17.05	1	1
67	Farooqnagar	Ramakrishnapur	78.21	17	1	1
68	Farooqnagar	Suryaraoguda	78.25	17.03	1	1
69	Farooqnagar	Jagammaguda	78.18	17.01	1	1
70	Farooqnagar	Kondannaguda	78.28	17.05	1	1
71	Farooqnagar	Raikal	78.19	17.01	1	1
72	Farooqnagar	Dooskal	78.25	17.07	1	1
73	Farooqnagar	Kammadanam	78.23	17.02	1	1
74	Farooqnagar	Chattanpalle	78.23	17.08	1	1
75	Farooqnagar	Mogalagidda	78.12	17.09	1	1
76	Farooqnagar	Gantlavelli	78.23	17	1	1

77	Farooqnagar	Rangasamudram	78.1	17.08	1	1
78	Farooqnagar	Veljerla ii	78.25	17.05	1	1
79	Farooqnagar	Kishannagar	78.17	17.05	1	1
80	Farooqnagar	Thimmajipalle	78.22	17	1	1
81	Farooqnagar	Veljerla iii	78.27	17.04	1	1
82	Farooqnagar	Buchiguda	78.25	17.06	1	1
83	Farooqnagar	Chilkamarri (che	78.22	17.02	1	1
84	Farooqnagar	Gundlakunta	78.18	17.04	1	1
85	Farooqnagar	Hajipalle	78.18	17.06	1	1
86	Hayathnagar	Kalvancha	78.6	17.32	1	1
87	Ibrahimpatnam	Mangalpalle	78.6	17.21	2	2
88	Ibrahimpatnam	Pocharam	78.6	17.18	1	1
89	Ibrahimpatnam	Yeliminedu	78.59	17.14	1	1
90	Ibrahimpatnam	Kongarakalan	78.55	17.2	1	1
91	Ibrahimpatnam	Ramdaspally	78.63	17.23	1	1
92	Ibrahimpatnam	Naganpally	78.69	17.22	1	1
93	Ibrahimpatnam	Malikarjunaguda	78.66	17.18	1	1
94	Ibrahimpatnam	Narrepally	78.73	17.26	1	1
95	Ibrahimpatnam	Bongloor	78.58	17.23	1	1
96	Ibrahimpatnam	Yarrakunta	78.61	17.16	1	1
97	Ibrahimpatnam	Adibatla	78.55	17.23	1	1
98	Ibrahimpatnam	Chintapalle guda	78.61	17.22	1	1
99	Kadthal	Mudwin	78.61	16.91	1	1
100	Kadthal	Cherikonda(patti	78.65	16.92	1	1
101	Kadthal	Ravichedu	78.42	16.98	1	1
102	Kadthal	Makthamadharam	78.45	16.97	1	1
103	Kadthal	Chellampalle	78.48	16.95	1	1
104	Kadthal	Cherikonda(k.kur	78.66	16.94	1	1
105	Kadthal	Vampuguda	78.49	16.96	1	1
106	Kadthal	Nyamathapur	78.44	16.98	1	1
107	Kandukur	Lemoor	78.52	17.14	4	4
108	Kandukur	Gummadavelly	78.58	17.09	3	3
109	Kandukur	Nednoor	78.45	17.04	3	3
110	Kandukur	Meerkhanpet	78.58	17.05	2	2
111	Kandukur	Mucherla	78.52	17.01	2	2
112	Kandukur	Kandukur	78.49	17.06	2	2
113	Kandukur	Rachulur	78.54	17.11	2	2
114	Kandukur	Thimmapur	78.56	17.13	2	2
115	Kandukur	Kufarchandguda	78.42	17.07	1	1
116	Kandukur	Dasarlapally	78.48	17.01	1	1
117	Kandukur	Peruguguda	78.47	17.05	1	1

118	Kandukur	Sarlaravulapally	78.54	17.05	1	1
119	Kandukur	Pulimamidi	78.42	17.07	1	1
120	Kandukur	Dannaram	78.41	17.04	1	1
121	Kandukur	Mahammed nagar	78.48	17.06	1	1
122	Kandukur	Gudur	78.5	17.1	1	1
123	Kandukur	Madhapur	78.58	17.13	1	1
124	Keshampeta	Alwal	78.35	16.99	1	1
125	Keshampeta	Kakunoor	78.34	16.92	1	1
126	Keshampeta	Keshampeta	78.35	16.95	1	1
127	Keshampeta	Bhairkhanpalle	78.35	17.03	1	1
128	Keshampeta	Chowlapalle(east	78.37	16.97	1	1
129	Keshampeta	Nirdavally	78.35	16.9	1	1
130	Keshampeta	Vemulanarva	78.32	16.98	1	1
131	Keshampeta	Dattaipalle	78.3	17	1	1
132	Keshampeta	Ippalapalle	78.29	16.98	1	1
133	Keshampeta	Chintakuntapalle	78.31	16.96	1	1
134	Keshampeta	Kothapeta	78.37	16.99	1	1
135	Keshampeta	Bodanampalle	78.36	16.93	1	1
136	Kondurg	Ummethyal lalapet	78.03	17.16	2	2
137	Kondurg	Agiryal	78.07	17.02	1	1
138	Kondurg	Tangellapalle	78.05	17.04	1	1
139	Kondurg	Uttaraspalle	78.07	17.11	1	1
140	Kondurg	Venkiryal	78.04	17.03	1	1
141	Kondurg	Chukkammet	78.08	17.14	1	1
142	Kondurg	Kondurg(west)	78.05	17.1	1	1
143	Kondurg	Mahadevpoor	78.07	17.1	1	1
144	Kondurg	Tekulapalle	78.07	17.14	1	1
145	Kondurg	Srirangapur	78.09	17.09	1	1
146	Kondurg	Cherukupalle	78.03	17.06	1	1
147	Kondurg	Govindapur	78.03	17.05	1	1
148	Kondurg	Regadi chilakama	78.07	17.18	1	1
149	Kondurg	Bhirampalle	78.08	17.12	1	1
150	Kothur	Chegur	78.23	17.18	4	4
151	Kothur	Siddapur	78.35	17.06	1	1
152	Kothur	Theegapur	78.27	17.16	1	1
153	Kothur	Kothur	78.29	17.15	1	1
154	Madgul	Brahmanapalle	78.73	16.84	1	1
155	Madgul	Madgul	78.69	16.85	1	1
156	Madgul	Appareddipalle	78.68	16.89	1	1
157	Madgul	Kulkulepalle	78.73	16.92	1	1
158	Maheshwaram	Mankhal	78.47	17.2	4	4

159	Maheshwaram	Tummaloor	78.46	17.13	3	3
160	Maheshwaram	Maheshwaram	78.44	17.13	2	2
161	Maheshwaram	Golluru	78.36	17.18	2	2
162	Maheshwaram	Thupra khurd	78.33	17.15	2	2
163	Maheshwaram	Sri nagar	78.48	17.2	1	1
164	Maheshwaram	Porandla	78.38	17.06	1	1
165	Maheshwaram	Kongara khurd (a)	78.52	17.21	1	1
166	Maheshwaram	Kalvakole	78.36	17.13	1	1
167	Maheshwaram	Dabilguda	78.38	17.14	1	1
168	Maheshwaram	Nagireddypally	78.37	17.16	1	1
169	Maheshwaram	Sirigiripur	78.44	17.15	1	1
170	Maheshwaram	Subhanpur	78.35	17.1	1	1
171	Maheshwaram	Dubbacherla	78.37	17.11	1	1
172	Maheshwaram	Seriguda	78.36	17.08	1	1
173	Maheshwaram	Ameerpet	78.34	17.15	1	1
174	Maheshwaram	Mallikdhan guda	78.48	17.18	1	1
175	Maheshwaram	Gafoor nagar	78.45	17.1	1	1
176	Maheshwaram	Pendyal	78.37	17.13	1	1
177	Maheshwaram	Dilawarguda	78.36	17.09	1	1
178	Maheshwaram	Nandupally	78.4	17.19	1	1
179	Maheshwaram	Gangaram	78.43	17.16	1	1
180	Maheshwaram	Kongara khurd(b)	78.52	17.21	1	1
181	Maheshwaram	Akhanpally	78.39	17.09	1	1
182	Maheshwaram	Sardar nagar	78.49	17.22	1	1
183	Maheshwaram	Raviryal	78.5	17.23	1	1
184	Manchal	Loyapally	78.83	17.04	2	2
185	Manchal	Bodakonda	78.78	17.06	2	2
186	Manchal	Nomula	78.69	17.17	1	1
187	Manchal	Agapally	78.67	17.13	1	1
188	Manchal	Srimanthguda	78.78	17.02	1	1
189	Manchal	Manorabad	78.7	17.19	1	1
190	Manchal	Thallapalliguda	78.74	17.19	1	1
191	Manchal	Bandalemoor	78.8	17.09	1	1
192	Manchal	Khagazghat	78.69	17.13	1	1
193	Manchal	Lingampally	78.71	17.18	1	1
194	Manchal	Tippaiguda	78.78	17.18	1	1
195	Manchal	Dadpally	78.73	17.05	1	1
196	Manchal	Asmathpur	78.73	17.13	1	1
197	Manchal	Rangapur	78.72	17.09	1	1
198	Moinabad	Chinna mangalaram	78.23	17.39	2	2
199	Moinabad	Pedda mangalaram	78.26	17.34	2	2

200	Moinabad	Chilkur	78.29	17.35	2	2
201	Moinabad	Aziznagar	78.33	17.33	2	2
202	Moinabad	Nagireddiguda	78.34	17.3	1	1
203	Moinabad	Medipally	78.2	17.37	1	1
204	Moinabad	Sriramnagar	78.26	17.27	1	1
205	Moinabad	Surangal	78.27	17.3	1	1
206	Moinabad	Kanakamamidi	78.25	17.3	1	1
207	Moinabad	Amadapur	78.29	17.28	1	1
208	Moinabad	Chinna shapur	78.24	17.32	1	1
209	Moinabad	Tholkatta	78.21	17.3	1	1
210	Moinabad	Bengaliguda	78.32	17.32	1	1
211	Moinabad	Nakkalpalle	78.21	17.26	1	1
212	Moinabad	Yenkepalle	78.31	17.32	1	1
213	Moinabad	Yethbarpalle	78.21	17.27	1	1
214	Moinabad	Murthuzaguda	78.28	17.31	1	1
215	Moinabad	Bakaram jagir	78.31	17.29	1	1
216	Moinabad	Nazeebnagar	78.29	17.3	1	1
217	Moinabad	Himayathnagar	78.31	17.34	1	1
218	Moinabad	Reddypally	78.25	17.37	1	1
219	Moinabad	Venkatapur	78.24	17.25	1	1
220	Moinabad	Mothukupally	78.25	17.38	1	1
221	Moinabad	Sajjanpalle	78.22	17.3	1	1
222	Nandigam	Nandigama	78.26	17.12	4	4
223	Nandigam	Mamidipalle	78.19	17.16	1	1
224	Nandigam	Veerlapalle	78.22	17.13	1	1
225	Nandigam	Edulapalle	78.2	17.13	1	1
226	Shabad	Shabad	78.13	17.16	6	6
227	Shabad	Tadlapally	78.13	17.24	2	2
228	Shabad	Manmarry	78.1	17.11	1	1
229	Shabad	Solipet	78.22	17.23	1	1
230	Shabad	Damarlapally	78.2	17.19	1	1
231	Shabad	Machanpally	78.17	17.2	1	1
232	Shabad	Maddur	78.23	17.21	1	1
233	Shabad	Nagrikunta	78.17	17.19	1	1
234	Shabad	Pothugal	78.14	17.22	1	1
235	Shabad	Etlayerravally	78.09	17.25	1	1
236	Shabad	Peddaveed	78.2	17.21	1	1
237	Shabad	Rudraram	78.16	17.23	1	1
238	Shabad	Hythabad	78.2	17.22	1	1
239	Shabad	Kesaram	78.18	17.13	1	1
240	Shamshabad	Kothwalguda	78.37	17.29	4	4

241	Shamshabad	Narkhuda	78.34	17.26	2	2
242	Shamshabad	Palamakole	78.3	17.19	2	2
243	Shamshabad	Ramanujapur	78.25	17.23	2	2
244	Shamshabad	Peddagolkonda	78.4	17.19	2	2
245	Shamshabad	Sangiguda	78.39	17.2	1	1
246	Shamshabad	Shankarapur	78.38	17.21	1	1
247	Shamshabad	Peddatupra	78.31	17.16	1	1
248	Shamshabad	Devathala bowli	78.37	17.23	1	1
249	Shamshabad	Ammapally	78.35	17.26	1	1
250	Shamshabad	Gandiguda	78.36	17.23	1	1
251	Shamshabad	Muchintal	78.33	17.17	1	1
252	Shamshabad	Ghansmiyaguda	78.36	17.23	1	1
253	Shamshabad	Rasheedguda	78.4	17.23	1	1
254	Shamshabad	Rayannaguda	78.29	17.24	1	1
255	Shamshabad	Sayyedguda	78.42	17.23	1	1
256	Shamshabad	Shamshabad	78.4	17.26	1	1
257	Shamshabad	Maqtabahaduralli	78.38	17.25	1	1
258	Shamshabad	Peddagollapalli	78.42	17.24	1	1
259	Shamshabad	Satamrai	78.42	17.29	1	1
260	Shamshabad	Cherlaguda	78.39	17.22	1	1
261	Shamshabad	Ootpally	78.37	17.25	1	1
262	Shamshabad	Pashambanda	78.41	17.27	1	1
263	Shamshabad	Shahzadibegum	78.42	17.28	1	1
264	Shankarpalle	Mokila	78.19	17.42	7	7
265	Shankarpalle	Janwada	78.26	17.4	6	6
266	Shankarpalle	Dhobipet	78.09	17.47	5	5
267	Shankarpalle	Kondakal	78.2	17.46	2	2
268	Shankarpalle	Parveda kalsa	78.1	17.41	2	2
269	Shankarpalle	Tangatoor	78.18	17.41	2	2
270	Shankarpalle	Yelwarthy	78.15	17.43	2	2
271	Shankarpalle	Proddatur	78.2	17.4	2	2
272	Shankarpalle	Masaniguda	78.09	17.39	2	2
273	Shankarpalle	Shankerpallly	78.13	17.45	2	2
274	Shankarpalle	Bhulkapur	78.16	17.44	1	1
275	Shankarpalle	Singapur	78.13	17.47	1	1
276	Shankarpalle	Parveda chanchalam	78.1	17.4	1	1
277	Shankarpalle	Fathepur	78.12	17.45	1	1
278	Shankarpalle	Chandippa	78.11	17.44	1	1
279	Shankarpalle	Donthanpally	78.23	17.41	1	1
280	Shankarpalle	Ramanthapur	78.13	17.44	1	1
281	Shankarpalle	Ravulapalle kalan	78.08	17.44	1	1

282	Shankarpalle	Anthappaguda	78.05	17.4	1	1
283	Shankarpalle	Gopularam	78.22	17.4	1	1
284	Shankarpalle	Sankepally kalsa	78.06	17.4	1	1
285	Shankarpalle	Hussainpur	78.09	17.37	1	1
286	Shankarpalle	Sankepally paiga	78.07	17.4	1	1
287	Shankarpalle	Yervaguda	78.13	17.41	1	1
288	Talakondapalle	Talakondapalle	78.42	16.89	2	2
289	Talakondapalle	Padakal	78.4	16.94	2	2
290	Talakondapalle	Badnapur	78.4	16.88	1	1
291	Talakondapalle	Julapalle	78.36	16.86	1	1
292	Talakondapalle	Seriramakrishnap ur	78.38	16.94	1	1
293	Talakondapalle	Lingaraopalle	78.38	16.93	1	1
294	Talakondapalle	Venkatapurpatti	78.34	16.82	1	1
295	Talakondapalle	Chennaram	78.49	16.88	1	1
296	Talakondapalle	Garvipalle	78.48	16.85	1	1
297	Talakondapalle	Thimmapur	78.37	16.8	1	1
298	Yacharam	Gungal	78.68	17.11	4	4
299	Yacharam	Nallavelly	78.73	17	3	3
300	Yacharam	Nandiwana parthy	78.64	17.04	2	2
301	Yacharam	Kurmidda	78.58	17.03	2	2
302	Yacharam	Yacharam	78.67	17.05	2	2
303	Yacharam	Toole khurd	78.61	17.08	2	2
304	Yacharam	Medipally	78.65	17	2	2
305	Yacharam	Tulekalan	78.63	17.1	1	1
306	Yacharam	Kothapally	78.68	16.97	1	1
307	Yacharam	Takkallapally	78.68	16.99	1	1
308	Yacharam	Chowder pally	78.65	17.06	1	1
309	Yacharam	Mondigowrelly	78.7	17.04	1	1
310	Yacharam	Nanaknagar	78.63	16.99	1	1
311	Yacharam	Manthangoud	78.76	16.99	1	1
312	Yacharam	Nazdiksingaram	78.61	17.04	1	1
313	Yacharam	Mogullavampu	78.66	17.04	1	1
314	Yacharam	Nakkartha	78.65	17	1	1