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

SANGAREDDY DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
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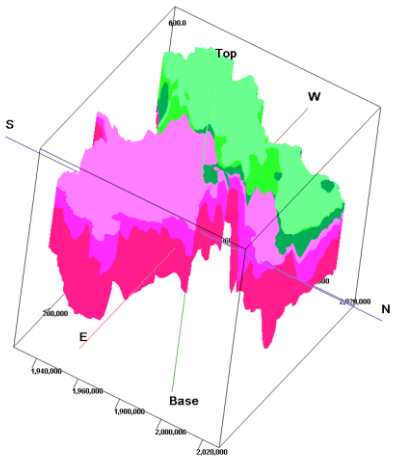
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT &
GANGA REJUVENATION

REPORT ON
AQUIFER MAPPING & MANAGEMENT PLANS FOR SUSTAINABLE GROUND WATER RESOURCES IN SANGAREDDY DISTRICT, TELANGANA STATE



CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD

MARCH 2022

REPORT ON
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CONTRIBUTORS' PAGE

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FOREWORD

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 and Management Plans for Sustainable Ground Water Resources in Sangareddy 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 Dr. S. S. Vittala, Scientist - B (Hydrogeology) & Sh.Bijay Ketan Mohanta, Scientist - B (Hydrogeology), and the efforts made by the officer in preparation of this report is greatly appreciated. Due thanks to Dr. G. Praveen Kumar, Scientist - C (Hydrogeology) and Nodal Officer (NAQUIM) who had prepared the erstwhile NAQUIM report of Medak district in the year 2018-19, from which the present report is carved out and his guidance and support in completing this report. Thanks are due to Sh. Ravi Kumar Gumma, Scientist-C for valuable suggestions in finalizing this document. Thanks, are also due 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
Regional Director
CGWB, SR, Hyderabad

REPORT ON
AQUIFER MAPPING & MANAGEMENT PLANS FOR SUSTAINABLE GROUND WATER RESOURCES IN SANGAREDDY 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.	:	Hector
ham	:	Hector meter
ID	:	Irrigated dry
IMD	:	Indian Meteorological Department
km^2	:	square kilometre
LPS	:	Litres per second
M	:	meter
M^3	:	Cubic meter
m bgl	:	Metres below ground level
MCM	:	Million cubic meter
mg/l	:	Milligram per litre
MI	:	Micro irrigation
Min	:	Minimum
max	:	Maximum
MPT	:	Mini percolation tank
MSP	:	Minimum Support price
NL	:	North Latitude
NO_3	:	Nitrate
OE	:	Over Exploited
PGWM	:	Participatory ground water management
PT	:	Percolation tank
SGWD	:	State Ground Water Department
S	:	Storativity
Sy	:	Specific Yield
T	:	Transmissivity
WCM	:	Water conservation measures

EXECUTIVE SUMMARY

The Sangareddy district covering 4451 km^2 is carved from erstwhile Medak district. Administratively the area is governed by 4 revenue divisions, 27 revenue mandals and 600 revenue villages with a population of 15.28 lakhs (2011 census) (Rural: 65% and Urban: 35%) with average density of 343 persons/km^2.

The annual normal rainfall of the district varies from 712.3 mm (Kondapur mandal) to 945.7 mm (Andhole mandal) with district normal of 844.5 mm. Average number of annual rainy days is around 62 days. Southwest monsoon contributes 78 % (659.5 mm), Northeast monsoon by 13 % (113.1 mm) and rest 9 % by January to May months of normal annual rainfall. Mean monthly rainfall varies from 197.5 mm in July to 4.2 mm in December. The district received excess rainfall of 1220.5 mm (36% above normal) during the water year 2020-21.

The district is contiguous part of Mysore Plateau and characterised by erosional topography with general slope is towards south- east. The total mappable area is 4451 km^2. The pediplain is the major landform followed by pediment in the district

The district falls under Godavari basin and Manjra sub basins. The river “Manjeera” which is a tributary of Godavari River, originates in Bidar district and enters the district from north western direction. The major lineament trend falling along NW-SE directions. Geologically, the district is underlain by crystalline rocks, namely Banded Gneissic Complex, Basalt rocks (Deccan Traps) and Laterites.

The soils from the district are mainly form fine clayey montmorillonitic, clayey skeletal, loamy skeletal, fine mixed, rock land & clayey skeletal soils, etc. Majority of soils are occupied by clayey montmorillonitic and fine montmorillonitic. The forest occupies about 5% of the total geographical area, barren and uncultivable land occupies 3% of area; land put to non-agricultural use is 8%, cultivable wasteland is 2%. With respect to land utilization, out of total area, 17% of the area is falling under current fallows; 10% is under other fallows. The net area sown is about 54% and area sown more than once is 31% which brings gross cropped area to 71%.

Groundwater exploration data revealed that the depth drilled varies from 21 to 200 m bgl and weathering varies from 0.5 to 37 m bgl. The data indicates that 3% of the wells are shallow wells that are drilled up to a depth of <30 m bgl, 30% of the wells between the depth of 30-60

m bgl, 27% of the wells drilled between the depth range of 60 to 100 m bgl, 21% of the wells drilled betwee the drpth of 100 to 150 m bgl and around 19% of the wells are drilled between the depth range of 150 to 200 m bgl. The deeper wells of >150 m bgl are located in Andole, Kalhair, Kangiti, Kohir, Manoor, Manur, Nagalagidda, Narayankhed, Nyalkal, Regode and Zaheerabad mandals. Further, the study reveal that majority of fractures (74%) occur within 100 m depth. The deepest fractures >100 m bgl is noticed in Jharasangam, Kalhair, Kangiti, Kohir, Narayankhed, Nayalkal, Regode, Wargal and Zaheerabad mandals.

Water level data indicates that during pre-monsoon, the majority of the water levels are in the range of majority of the water levels are in the range of 10 to 20 m bgl distributed in 45% of the area (Andole, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Manoor, Mogudampally, Munipally, Narayankhed, Nyalkal, Patancheru, Pulkal, Sadasivpet, Sirgapoor and Zahirabad mandals), followed water levels >20 m bgl in 41% of the area (Andole, Gummadidala, Hathnoora, Kalher, Kandi, Kohir, Kondapur, Manoor, Nagilgidda, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy and Zahirabad mandals). The water levels in the range of 5 to 10 m bgl is noticed in 12% of the area (Gummadidala, Narayankhed, Nyalkal, Patancheru, Pulkal, Vatpally and Zahirabad mandals). There are also water levels of <5 m bgl is noticed in 3% of the area in Ameenpur and Vatpally mandals. During post-monsoon season, majority of the water levels are in the range of 10 to 20 m bgl noticed in 43% of the area (Andole, Gummadidala, Hathnoora, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Nyalkal, Patancheru, Pulkal, Raikode, Sadasivpet, Sirgapoor and Zahirabad mandals), followed by water levels from 5 to 10 m bgl distributed in 29% of the area (Gummadidala, Jharasangam, Kandi, Kangti, Kohir, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Sadasivpet and Zahirabad mandals). The deeper water levels >20 m bgl is noticed in 14% of the area (Andole, Gummadidala, Hathnoora, Kalher, Manoor, Ramchandrapuram and Sangareddy mandals). The shallow water levels of <5 m bgl is distributed in 13% of the area (Ameenpur, Jharasangam, Narayankhed, Nyalkal, Pulkal, Vatpally and Zahirabad mandals).

The data analysed from the groundwater quality indicate that during pre-monsoon season, the Electrical conductivity varies from 330 to 4230 µ Siemens/cm. The EC >3000 µ Siemens/cm is observed in 3% of the samples (Kohir mandal). The NO_3 concentration ranges from 0.44 to 423 mg/l and noticed that in about 42% of the samples (Andole, Gummadidala, Hathnoora, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally, Narayankhed, Pulkal, Sadasivpet, Sangareddy, Vatpally and Zahirabad mandals) it is beyond

drinking water limits of >45 mg/l. The Fluoride concentration varies from 0.13 to 4.6 mg/l and found that high fluoride concentration is observed in 14% of the samples (Andole, Hathnoora, Kandi, Kondapur, Nagilgidda, Pulkal, Raikode, Ramchandrapuram and Sangareddy mandals). During post-monsoon season, the EC varies from 327 to 2030 µ Siemens/cm and in none of the samples, the EC >3000 µ Siemens/cm is observed. The NO_3 concentration ranges from 0.57 to 405 mg/l. In about 44% of the samples (Andole, Gummadidala, Kalher, Kohir, Kondapur, Mogudampally, Munipally, Pulkal, Raikode and Zahirabad mandals), it is exceeding permissible limits. The Fluoride concentration varies from 0.17 to 5.61 mg/l and noticed that in about 15% of the samples (Andole, Kandi, Pulkal, Sangareddy and Sirgapoor mandals), the fluoride concentration is beyond permissible limit.

Conceptualization of 3-D hydrogeological model was carried out by integrating and interpreting representative hydrogeological data points for preparation of 3-D map, panel diagram and hydrogeological sections. The lithological information was generated by using the RockWorks-16 software and generated various 3D map of the district along with panel diagram and hydrogeological sections and presented.

As per GEC 2020 report, the net dynamic replenishable groundwater availability for newly formed Sangareddy district is 322 MCM. The gross groundwater draft for all uses 203 MCM, provision for drinking and industrial use till the year 2025 is 51 MCM and net annual groundwater potential available for future irrigation needs is 94 MCM. Out of 26 mandals, 15 mandals are falling under Safe (Sirgapoor (31%), Nagalgidda (44%), Munipally (45%), Raikode (46%), Andole (48%), Jinnaram (49%), Sadasivpet (49%), Vatpally (50%), Pulkal (51%), Kangti (54%), Narayankhed (57%), Manoor (58%), Mogudampally (67%), Kondapur (68%) and Kandi (69%)) and 10 mandals falling under Semi-Critical (Gummadidala (71%), Hathnoora (71%), Kohir (74%), Kalher (77%), Jharasangam (78%), R.C.Puram (78%), Sangareddy (78%), Ameenpur (80%), Nyalkal (81%) and Zaheerabad (89%)) and the remaining remaining 1 mandals falling under Critical catetory (Patancheru (91%)). The overall average stage of ground water extraction in the district is 63%.

The village wise groundwater management plan is prepared and presented. As per village wise GEC 2020 estimates, the areas spread over 159 villages covering 798 km^2 falls under Priority-1, where the state of groundwater extraction is >100% and required an immediate intervention. In this area, 87 MCM recharge potential and 34 MCM utilizable yield (uncommitted run-off) is available. Around 321 artificial recharge structures viz., 205

mini PT's and 116 CD's with recharge shafts with a total cost of 58 Crores recommended. By constructing these structures, there will be additional groundwater recharge of 7 MCM which will help in sustainability of the groundwater.

Area consisting of 441 villages having 3653 km^2 covered under Priority-2, where the state of groundwater extraction is <100%. In the area, 465 MCM recharge potential and 143 MCM utilizable yield is available. About 1255 artificial recharge structures viz., 687 mini PT's and 568 CD's with recharge shafts with a total cost of 223 Crores are recommended. By constructing these structures, there will be additional groundwater recharge of 31 MCM which will help in sustainability of the groundwater. This will help in arresting the deterioration of groundwater levels.

To help the farmers for early sowing and to meet the needs for intermediate irrigation, it is suggested that, farm ponds construction may be taken up @20 structures per village. Thus, about 12000 farm ponds needs to be constructed at a unit cost of Rs. 25,000/- totalling to 30 Crores. This will create an additional storage capacity of 3.6 MCM.

As per the studies, it is estimated that 10716 ha. of additional land that can be brought under micro-irrigation (where actual area irrigated though MI is less than 1,000 ha.) costing about 64 Crores. By shifting from traditional to micro irrigation practices, 16 MCM of groundwater can be conserved.

The above interventions by investing about Rs. 375 Crores, a net saving of 58 MCM of groundwater can be achieved which will help in net reduction in groundwater extraction by 10% i.e., from the existing 63% to 53%. This will help in arresting the groundwater deterioration and its sustainability. The onetime cost will be 6 paisa/litre and the actual cost of invest will be 0.6 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

1. INTRODUCTION

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

Hard rocks lack primary porosity, and groundwater occurrence is limited to secondary porosity, developed by weathering and fracturing. Weathered zone is the potential recharge zone for deeper fractures and excessive withdrawal from this zone lead to drying up at places and reducing the sustainability of structures. Besides these quantitative aspects, groundwater quality also represents a major challenge which is threatened by both geogenic and anthropogenic pollution. In some places, the aquifers have high level of geogenic contaminants, such as fluoride, rendering them unsuitable for drinking purposes. High utilization of fertilizers for agricultural productions and improper development of sewage system in rural/urban areas lead to point source pollution viz., nitrate and chloride.

1.1 Objectives

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

1.2 Scope of study

The main scope of study is summarised below.

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

1.3 Area Details

The Sangareddy district covering about 4451 km^2 lies between north latitude 17°25'38" - 18°18'37" and east longitude 77°47'10" - 78°35'30" (Fig. 1.1). The district is bounded on the north by Kamareddy district, on the east by Medak and Medchal Malkajgiri districts, on the south by Rangareddy and Vikarabad districts districts and on the west by Bidar district of Karnataka state. The present district is carved from erstwhile Medak district. Administratively, the area is governed by 4 Revenue Divisions, 27 Revenue Mandals and 600 revenue villages with a population of 15.28 lakhs (2011 census) (Rural: 65%, Urban: 35%) with average density of 343 persons/km^2. The hilly and forest area occupying 5% of the total area located in different part of the district.

1.4 Climate and Rainfall

The district experiences tropical climate and is geographically located in semi-arid area. The district falls under Central Telangana Agro-climatic zone based on the geographical characteristics such as rainfall, temperature, nature of soils etc. The Southwest monsoon enters into the district in June and lasts until second week of October (as per IMD report) and Northeast monsoon from October to December. Summer starts in March, and reaches peak in May with average highest temperature of 40.2°C. Winter season starts in late November and lasts until early February with lowest average temperature of 14.0°C in January. The annual normal rainfall of the district varies from 712.3 mm (Kondapur mandal) to 945.7 mm (Andhole mandal) with district normal of 844.5 mm. Average number of annual rainy days is

around 62 days. Southwest monsoon contributes 78 % (659.5 mm), Northeast monsoon by 13 % (113.1 mm) and rest 9 % by January to May months of normal annual rainfall. Mean monthly rainfall varies from 197.5 mm in July to 4.2 mm in December. 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 excess rainfall of 1220.5 mm (36% above normal) during the water year 2020-21.

Fig. 1.1: Location map.

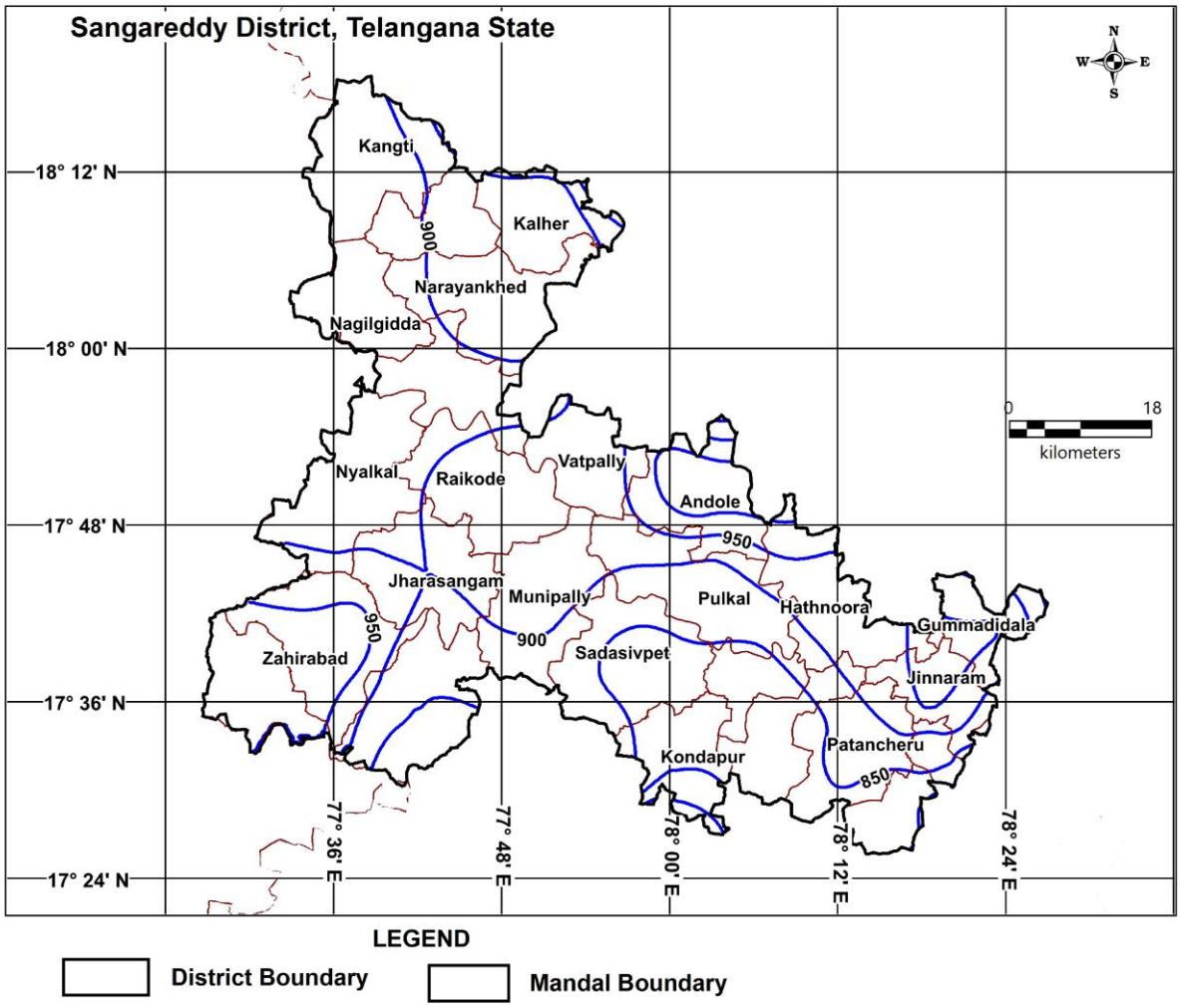

Fig. 1.2: Isohyetal map.

Analysis of time series annual rainfall data for 16 years (2005-2020) collected from TSDPS, Govt. of Telangana shows increasing trend in annual rainfall of around 3 mm/yr (Fig.1.3a). The district received excess rainfall (+20% to +59% departure from normal) in 4 years (2008, 2013, 2016 & 2020), deficient rainfall (-20% & below normal) in 5 years (2007, 2011, 2014, 2015 & 2018) and normal rainfall (-19% to +19%) in remaining 7 years. The monthly rainfall trend graph for 16 years shows increasing trend in rainfall for October (6.4 mm/yr) & June (4 mm/yr) months and decreasing trend for July (3.4 mm/yr) & March (3 mm/yr) months. (Fig.1.3b).

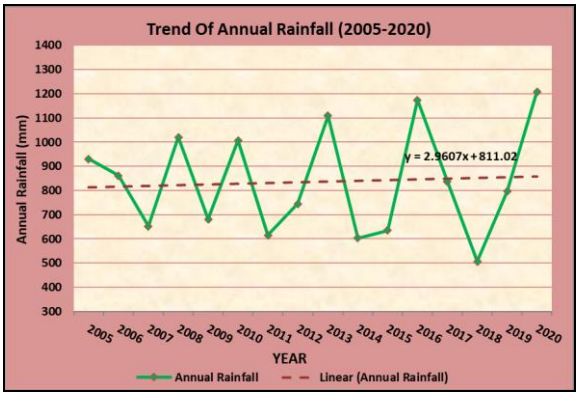

Fig. 1.3a: Annual Rainfall trend

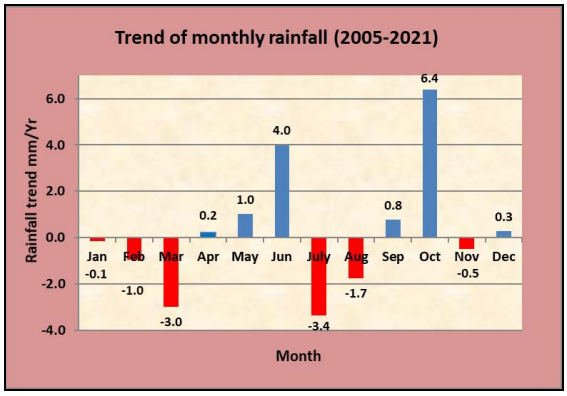

Fig. 1.3b: Monthly Rainfall trend

1.5 Geomorphological Set up

The district is contiguous part of Mysore Plateau and characterised by erosional topography with general slope from northwest to southeast. Pediplain is the major landform followed by pediment, etc (Fig. 1.4).

1.6 Drainage

The district falls under Godavari basin and Manjra sub basins. No major rivers are flowing across the district. The river "Manjeera" which is a tributary of Godavari River, originates in Bidar district and enters the district from north western direction. The major lineament trend falling along NW-SE directions. Map depicting drainage and water bodies is presented in Fig. 1.5.

1.7 Land use/ land cover

Based on the land use study, several classes have been delineated in the district viz., kharif, double crop, forest plantation, waste lands, waterbodies, etc. Out of the total area, majority of the area (>50%) falling under kharif category followed by rabi. Some of the double cropped area also noticed on either side of the stream/river courses with in the district. A patches of of forest plantaion is also observed in the district. The land use / land cover map is given in Fig. 1.6.

1.8 Soils

The soils from the district are mainly form fine clayey montmorillonitic, clayey skeletal, loamy skeletal, fine mixed, rock land & clayey skeletal soils, etc. Majority of soils are occupied by clayey montmorillonitic and fine montmorillonitic. They are grouped into many classes (NBS & LUP) based on geomorphology and landscapes and further sub-divided based on physiography, relief and drainage (Fig. 1.7).

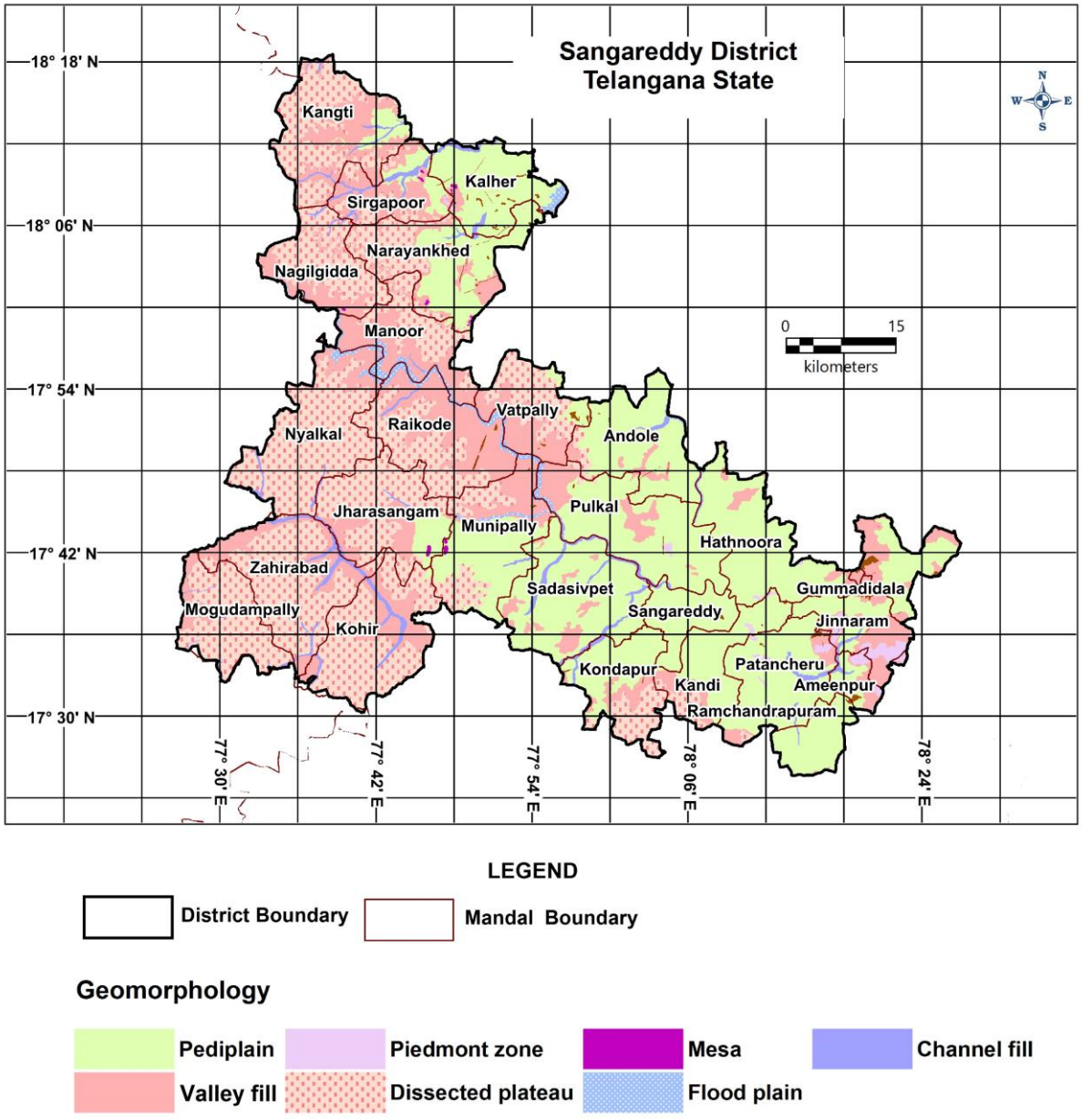

Fig. 1.4: Geomorphology map.

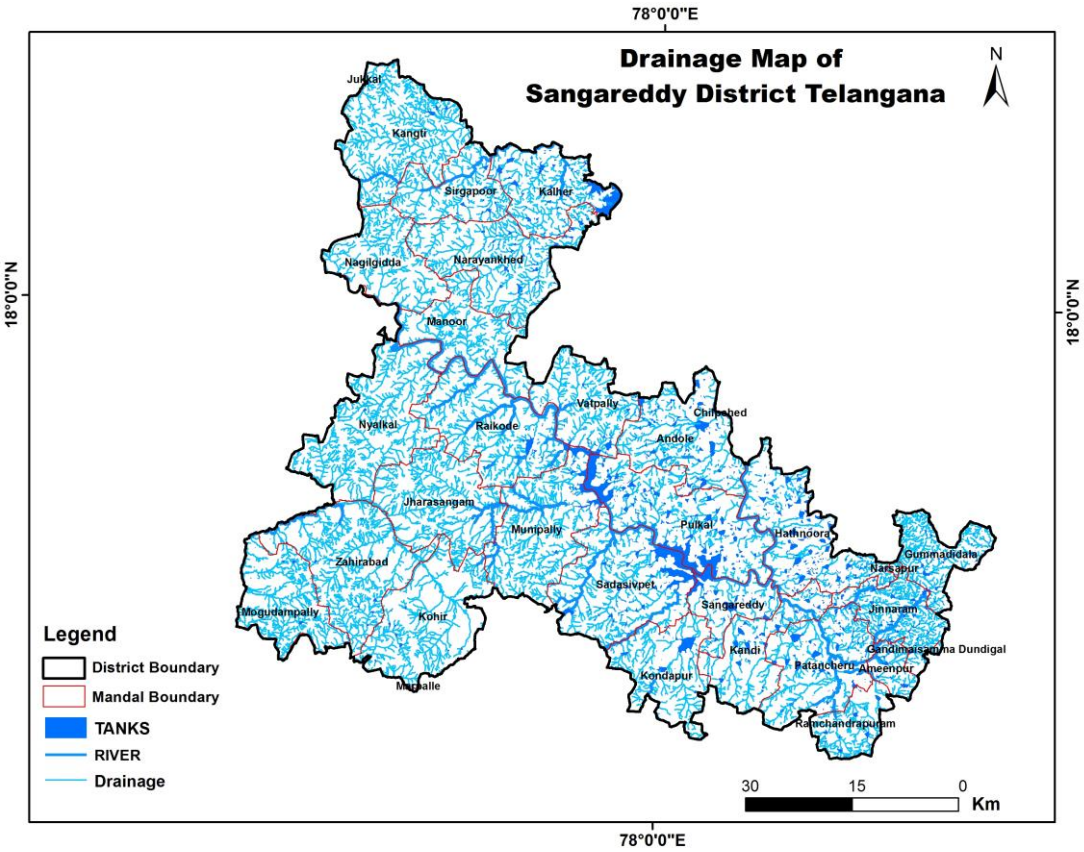

Fig 1.5: Drainage and water bodies map.

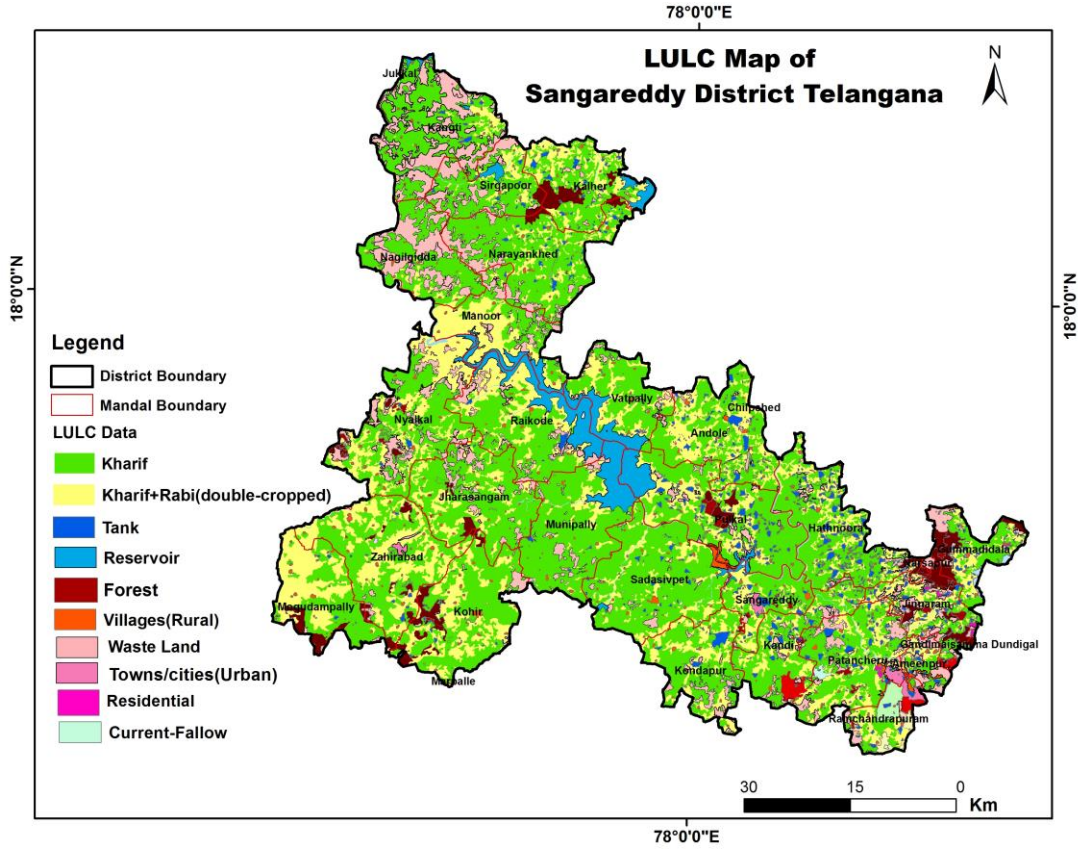

Fig. 1.6: Land use / land cover map

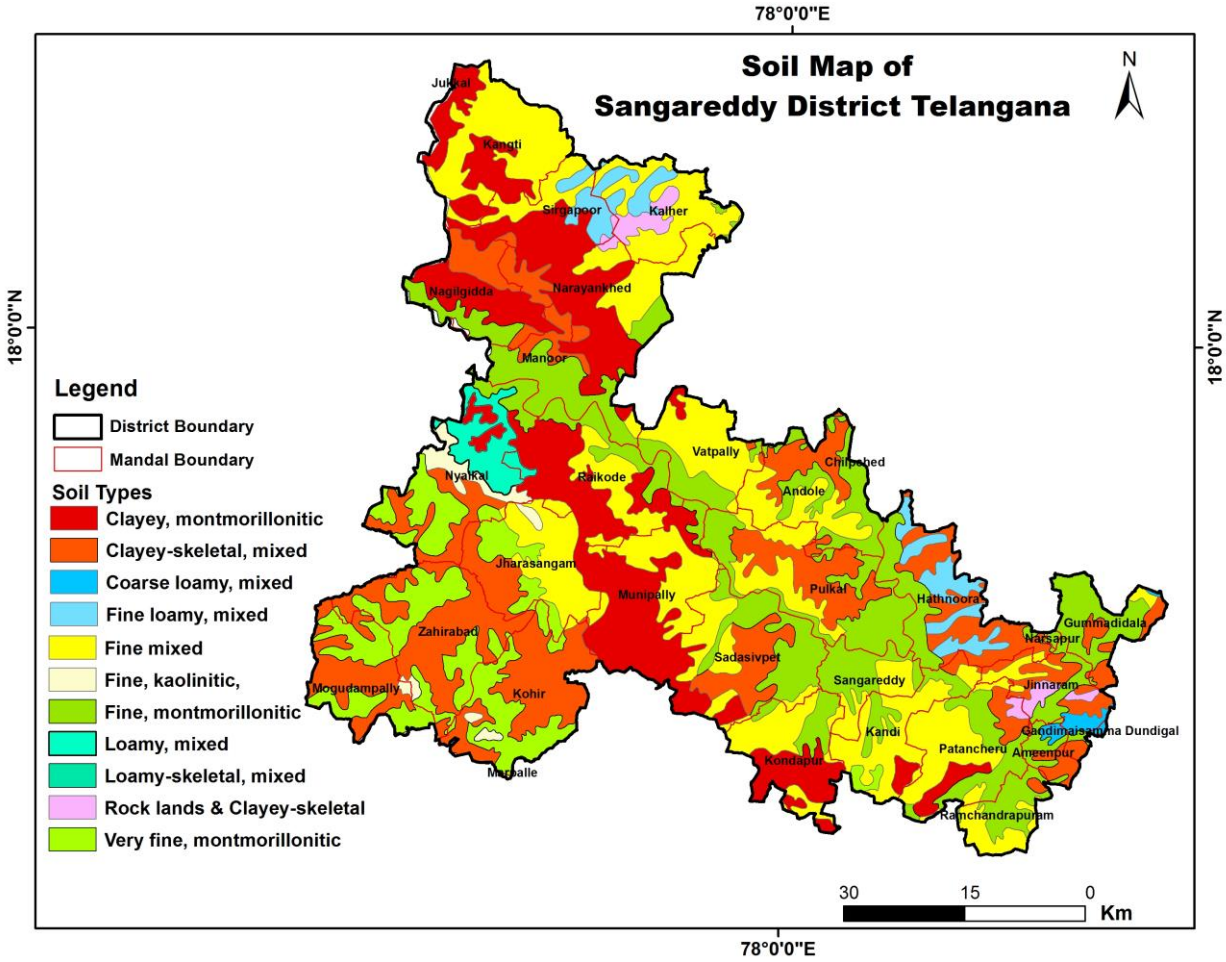

Fig. 1.7: Soil map.

1.9 Cropping Pattern (2019-20 in ha.)

The forest occupies about 5% of the total geographical area, barren and uncultivable land occupies 3% of area; land put to non-agricultural use is 8%, cultivable wasteland is 2%. With respect to land utilization, out of total area, 17% of the area is falling under current fallows; 10% is under other fallows. The net area sown is about 54% and area sown more than once is 31% which brings gross cropped area to 71%. During kharif season, out of total gross cropped area, the Paddy is is grown in 52% of the area followed by Soyabean in 7 %, Paddy in 8%, Redgram in 7%, Maize in 5% of the area and other crops in 19% of the area while during rabi season, Paddy and Bengal gram is grown in 26% each of the area followed by Maize in 3% and others in 45% of the area (Fig. 1.8).

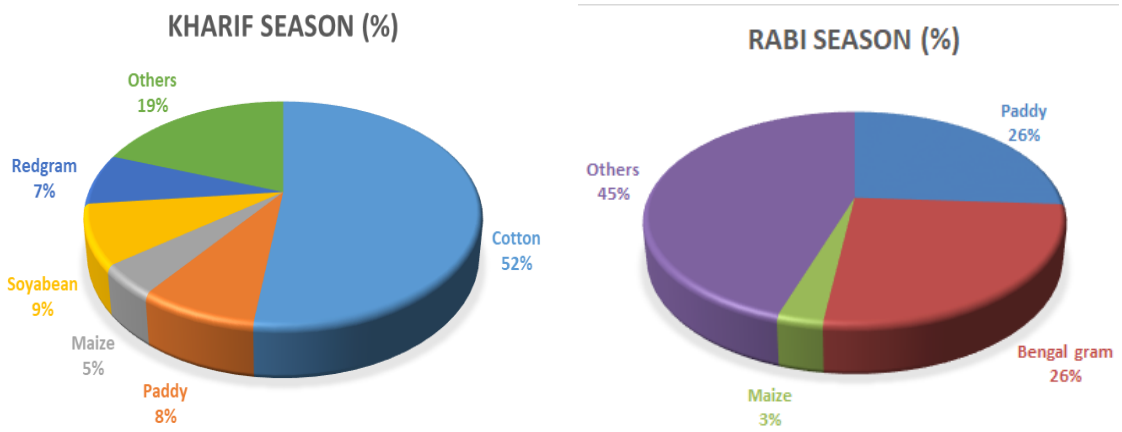

Fig. 1.8: Cropping pattern.

1.10 Irrigation

River Manjeera a tributary to the River Godavari, originates in Bidar district of Karnataka state and enters the district from southwestern direction. In the district, there are 2 contemplated/completed Irrigation Potential (IP) projects viz., M Baga Reddy Singur Project (15323 ha.) and Nallavagu Project (1800 ha.). Singur project on Manjira River at Singur village is dedicated to drinking water supply to Hyderabad city. About 2427 number of minor irrigation tanks covering 76075 ha. of ayacut. As per the latest GEC 2020 report, there are about more than 45000 numbers of bore wells (irrigation, domestic and industrial) and about more than 7700 dug wells are existing in the district.

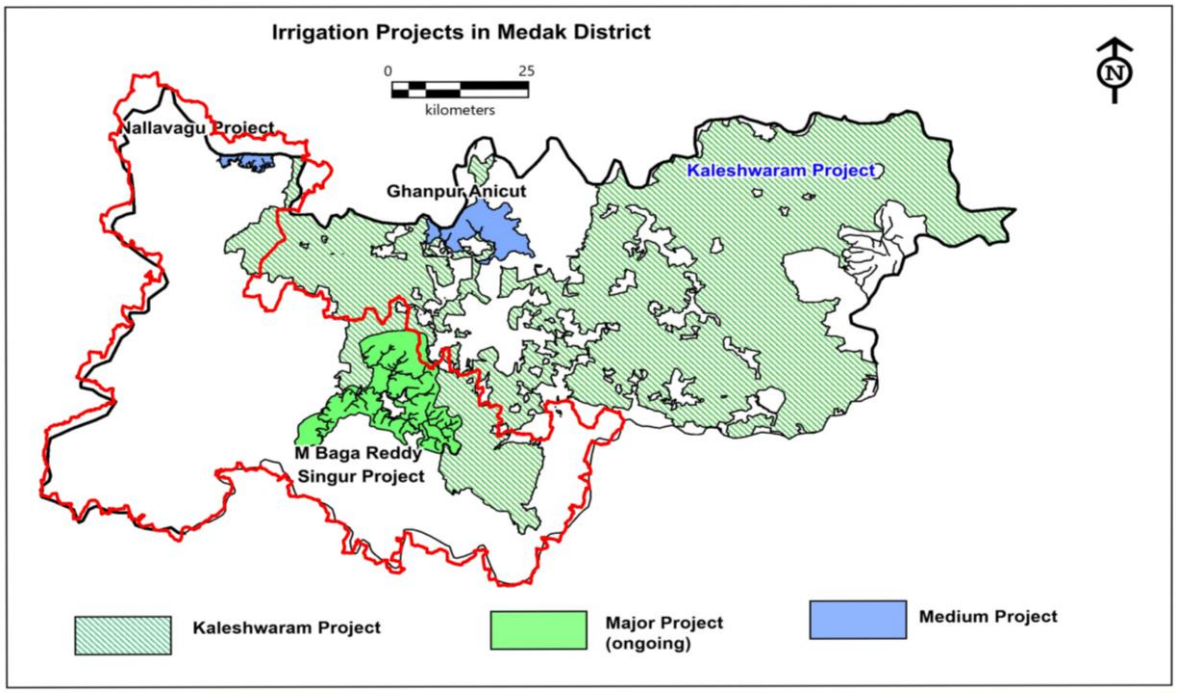

Fig. 1.9: Irrigation Projects in the district (Sangareddy district boundary overlaid in red color).

1.11 Cropping Pattern trend

To understand the long term cropping pattern changes, it is observed from the cropping area trend that the cropping areas of Cotton, Paddy and Bengal gram increasing and the cropping areas of Millets and Oil seeds are decreasing. Over all the cropping area of the district is increasing.

The observations made from the analysis are given below:

- There is a gradual change in cropping pattern in the past 15 years.
- The extent of Paddy, Cotton and Pulses in gross cropped area is increasing for past 20 years, whereas the extent of Millets and Oil seeds are decreasing during the same period.
- Average gross cropped area is increased during last 10 years (2009-19).

1.12 Prevailing Water Conservation/Recharge Practices

In the district, there are 205 artificial recharge structures (PT's: 80 and CD's: 125) are existing with combine storage capacity of 6 MCM. Under Mission Kakatiya (Phase-1 to 4), out of 2427 minor irrigation tanks, 976 tanks are desilted.

1.13 Geology

The area is underlain by crystalline rocks, namely (i) Banded Gneissic Complex (50%) of Archaean to Proterozoic age, (ii) volcanic Basalt rocks (Deccan Traps) (30%) of late Cretaceous to early Eocene age and (iii) Laterites. The Deccan Trap formations and Laterites occur in the western part of the district while the eastern part is completely occupied by Gneisses (Fig. 1.11). The Deccan traps are mostly remnants of huge lava flows that poured out from extensive fissures. The major lineaments in the area trend in NW – SE direction

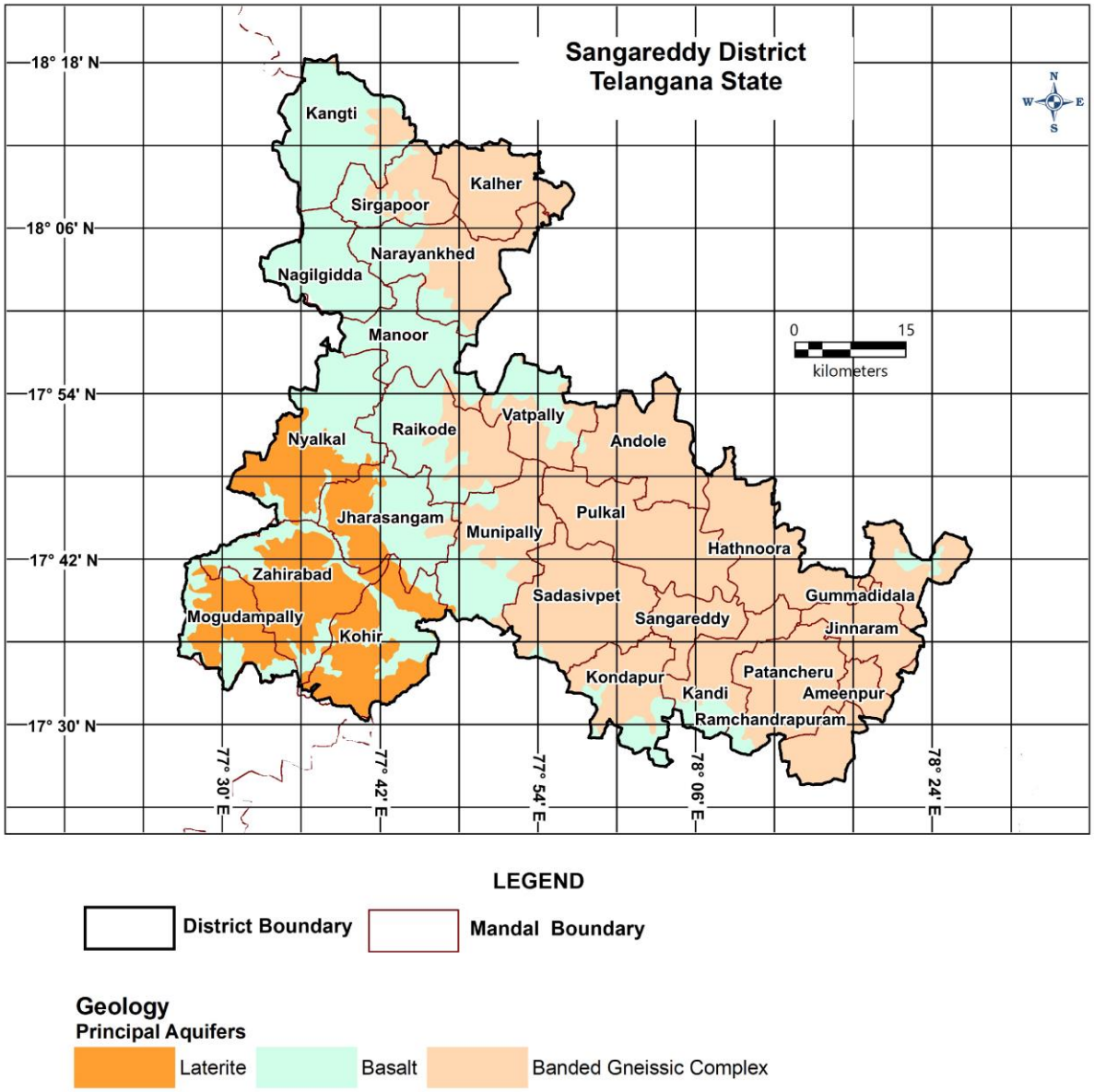

Fig. 1.11: Geology map.

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 (Table2.1).

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, 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 (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 through training to administrators, NGO's progressive farmers and stakeholders etc. and putting in public domain.

2.1 Hydrogeological Studies

Hydrogeology is concerned primarily with mode of occurrence, distribution, movement of groundwater occurring in the subsurface in relation to the geological environment. It is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is gneisses and 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. Based on various hydrogeological data points collected through exploration, well inventory, VES, quality and other relevant data collected from state line departments, the hydrogeological map is prepared (Fig. 2.1).

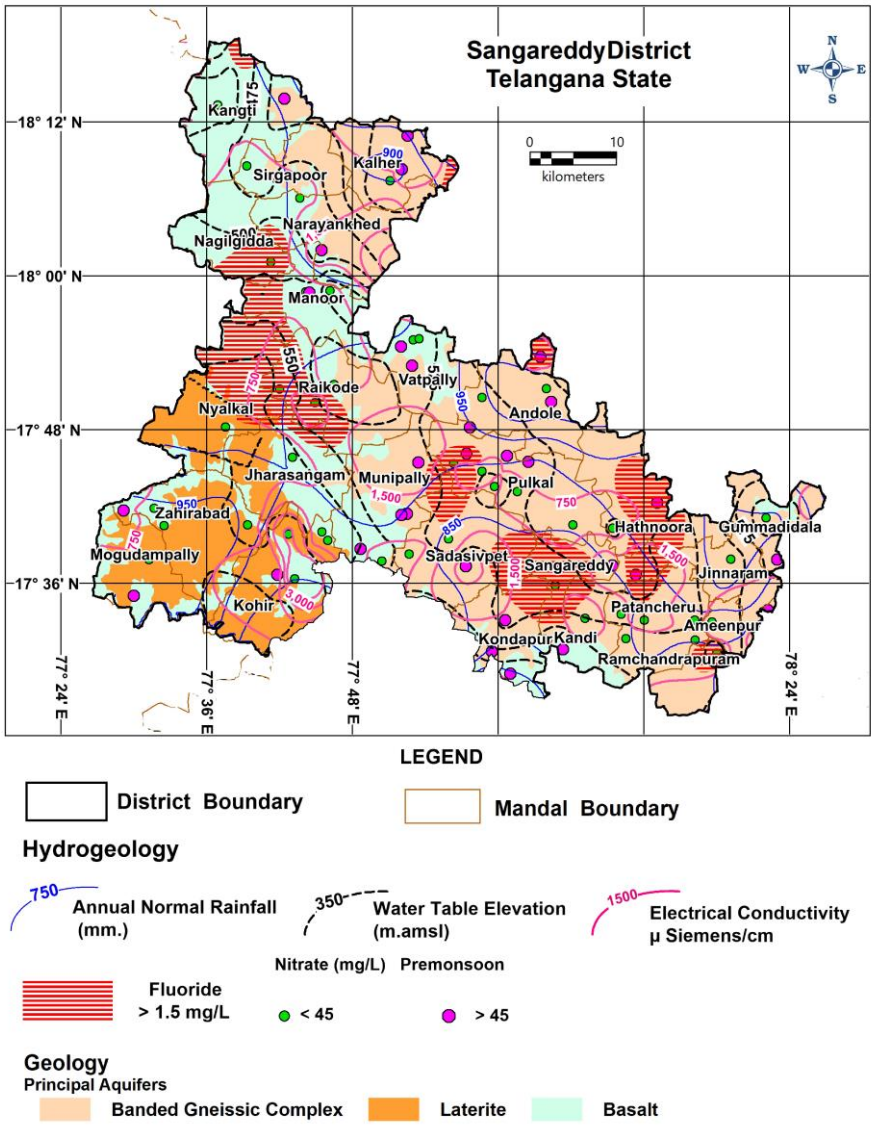

Fig. 2.1: Hydrogeology map.

2.1.1 Ground water occurrences and movement

Ground water occurs under unconfined and semi-confined conditions and flows downward from the weathered zone into the fracture zone. 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 the depth of 200 m bgl. The storage in gneissic formation is primarily confined to the weathered zone and its over-exploitation has resulted in desaturation at many places and reduced recharge to the underlying fractures. Presently, the extraction of groundwater is mainly through bore wells. The sustainability of the bore wells is dependent on the water availability in the weathered zone.

2.1.2 Exploratory Drilling

Groundwater exploration started in the district in the year in four phases (1971-75, 1989-92, 1999-2004 and 2014-16). As on 31/03/2020, CGWB drilled 101 bore wells (exploratory, observation, piezometers) and SGWD drilled 16 wells (piezometers) in the district. The depth drilled varies from 21 to 200 m bgl and weathering varies from 0.5 to 37 m bgl. The data analysed from the exploratory wells indicates 3% of the wells are shallow wells that are drilled up to a depth of <30 m bgl, 30% of the wells between the depth of 30-60 m bgl, 27% of the wells drilled between the depth range of 60 to 100 m bgl, 21% of the wells drilled betwee the drpth of 100 to 150 m bgl and around 19% of the wells are drilled between the depth range of 150 to 200 m bgl. The deeper wells of >150 m bgl are located in Andole, Kalhair, Kangiti, Kohir, Manoor, Manur, Nagalagidda, Narayankhed, Nyalkal, Regode and Zaheerabad mandals. Further, the study reveal that majority of fractures (74%) occur within 100 m depth. The deepest fractures >100 m bgl is noticed in Jharasangam, Kalhair, Kangiti, Kohir, Narayankhed, Nayalkal, Regode, Wargal and Zaheerabad mandals.

2.2 Water Levels (DTWL) (Average of 10 years: 2010 to 2019)

To study the behaviour of ground water in time and space, the wells were established and monitored at different places of the district by CGWB and State Ground Water Department (SGWD). These data were utilized for preparation of depth to water level maps. From the data, it is revealed that the depth to water level in the district varies from 3.63 to 33.63 m bgl (average: 18 m bgl) and 1.47 to 27 m bgl (average: 12.32 m bgl) during pre-monsoon (May) and post-monsoon (November) seasons respectively.

2.2.1 Water Table Elevations (m amsl)

During pre and post-monsoon season, water-table elevation ranges from 4.8 to 632 and 421 to 635 m amsl respectively. The general ground water flow is towards NW-SE and ultimately joins River Manjeera (Fig.2.2).

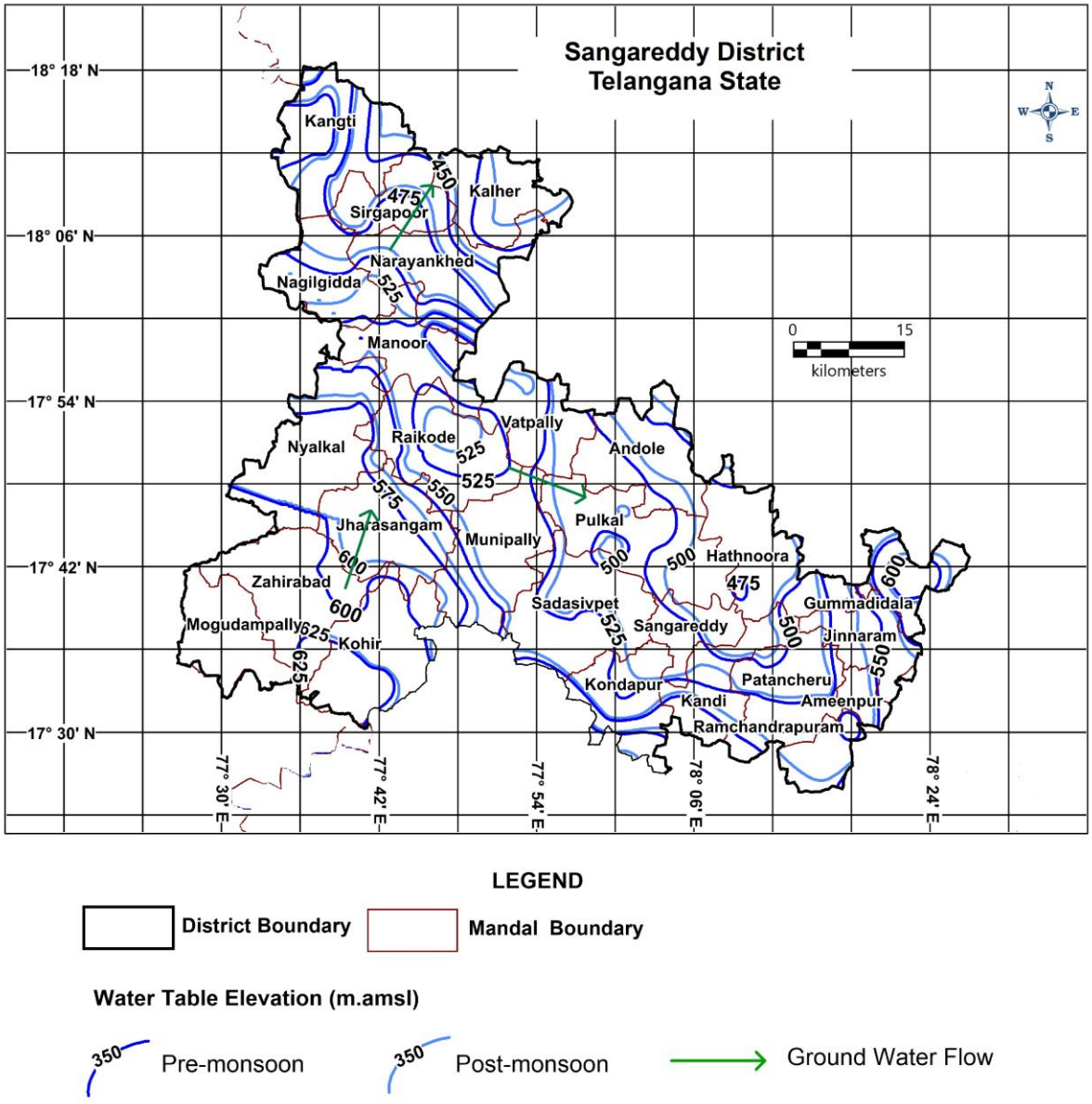

Fig. 2.2: Water table elevation (m amsl) map.

2.2.2 Pre-monsoon Season

Majority of the water levels during this season are in the range of 10 to 20 m bgl and distributed in 45% of the area located in Andole, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Manoor, Mogudampally, Munipally, Narayankhed, Nyalkal, Patancheru, Pulkal, Sadasivpet, Sirgapoor and Zahirabad mandals followed water levels >20 m bgl (41%

of the area) noticed from Andole, Gummadidala, Hathnoora, Kalher, Kandi, Kohir, Kondapur, Manoor, Nagilgidda, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy and Zahirabad mandals. The water levels in the range of 5 to 10 m bgl is noticed in 12% of the area falling in Gummadidala, Narayankhed, Nyalkal, Patancheru, Pulkal, Vatpally and Zahirabad mandals. There are also water levels of <5 m bgl is noticed in 3% of the area in Ameenpur and Vatpally mandals during this season (Fig. 2.3).

2.2.3 Post-monsoon Season

Here also the majority of the water levels during this season are in the range of 10 to 20 m bgl and noticed in 43% of the area located in Andole, Gummadidala, Hathnoora, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Nyalkal, Patancheru, Pulkal, Raikode, Sadasivpet, Sirgapoor and Zahirabad mandals followed by water levels from 5 to 10 m bgl distributed in 29% of the area falling in Gummadidala, Jharasangam, Kandi, Kangti, Kohir, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Sadasivpet and Zahirabad mandals. The deeper water levels >20 m bgl is noticed in 14% of the area in Andole, Gummadidala, Hathnoora, Kalher, Manoor, Ramchandrapuram and Sangareddy mandals. The shallow water levels of <5 m bgl (13% of the area) is observed in Ameenpur, Jharasangam, Narayankhed, Nyalkal, Pulkal, Vatpally and Zahirabad mandals.

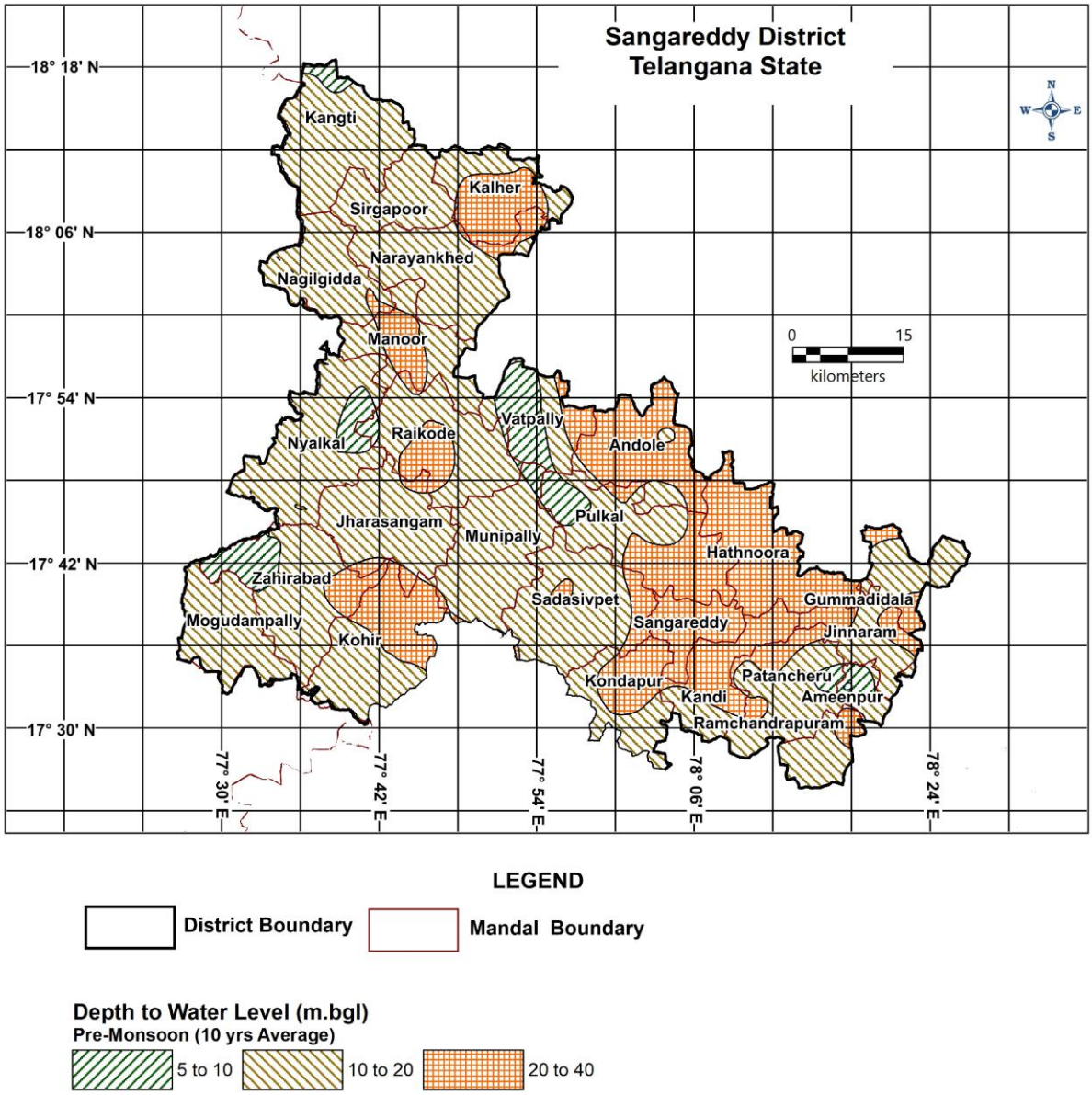

Fig.2.3: Depth to water levels Pre-monsoon (avg. of 10 years: 2010 to 2019).

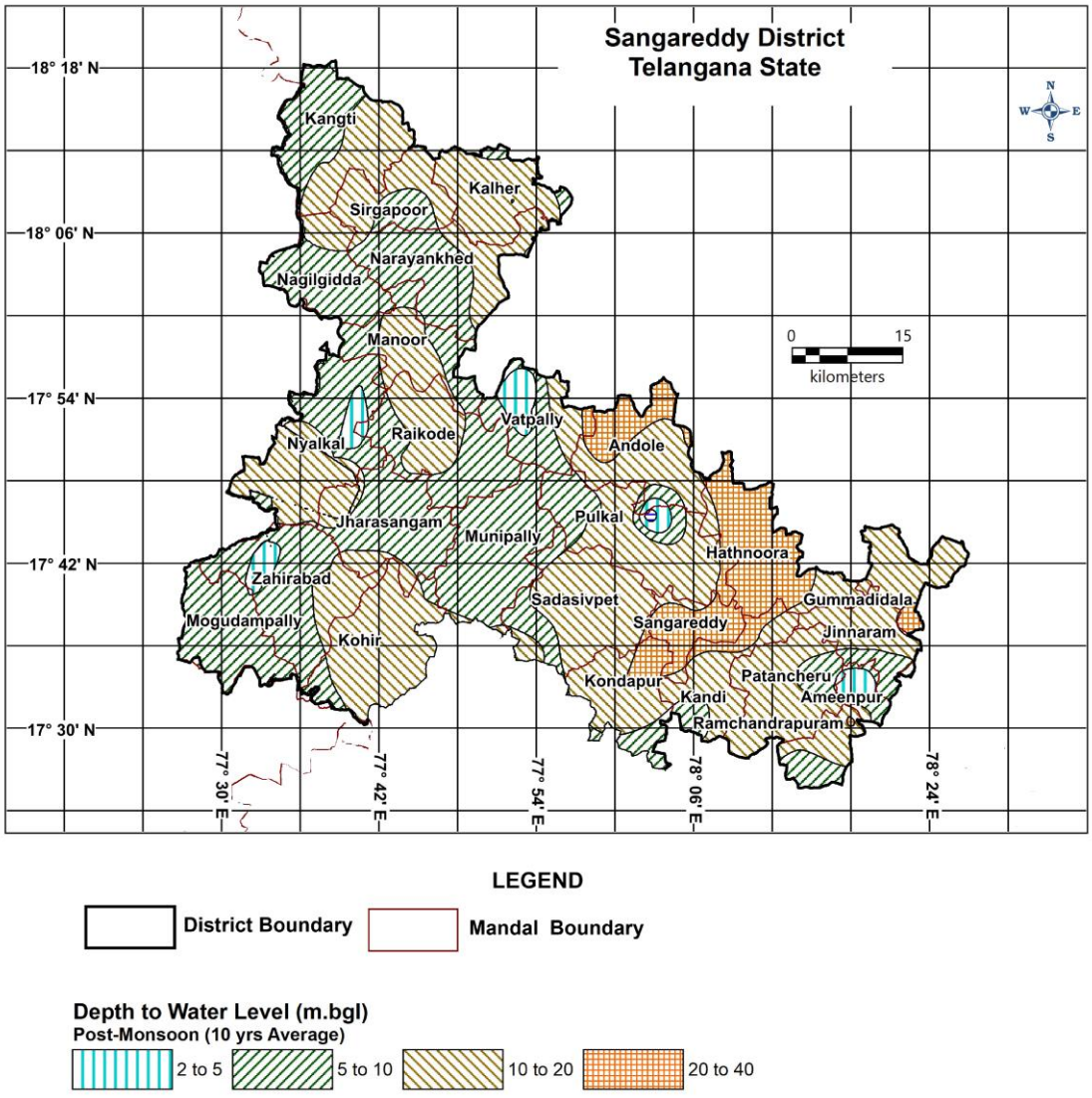

Fig.2.4: Depth to water levels Post-monsoon (avg. of 10 years: 2010 to 2019).

2.2.4 Water Level Fluctuations (November vs. May)

Almost all wells show Rise in water levels in the range of 0.93 to 6.2 m (Fig. 2.5). With respect to the rising in water levels, most of the wells (46% of the area) shows water level rise from 5 to 10 m located in Andole, Hathnoora, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Mogudampally, Munipally, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Vatpally and Zahirabad mandals, followed by 2 to 5 m in 34% of the area located in Ameenpur, Gummadidala, Hathnoora, Kangti, Kohir, Kondapur, Manoor, Nyalkal, Patancheru, Pulkal, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals. The water level rise between 10 to 20 m (12% of thea area) is noticed in Jharasangam, Kalher, Kandi, Kohir, Manoor, Nagilgidda, Pulkal and Raikode

mandals. In Kohir, Narayankhed, Nyalkal, Patancheru and Vatpally mandals, the water level rise of <2 m is noticed in 8% of the area (Fig. 2.5).

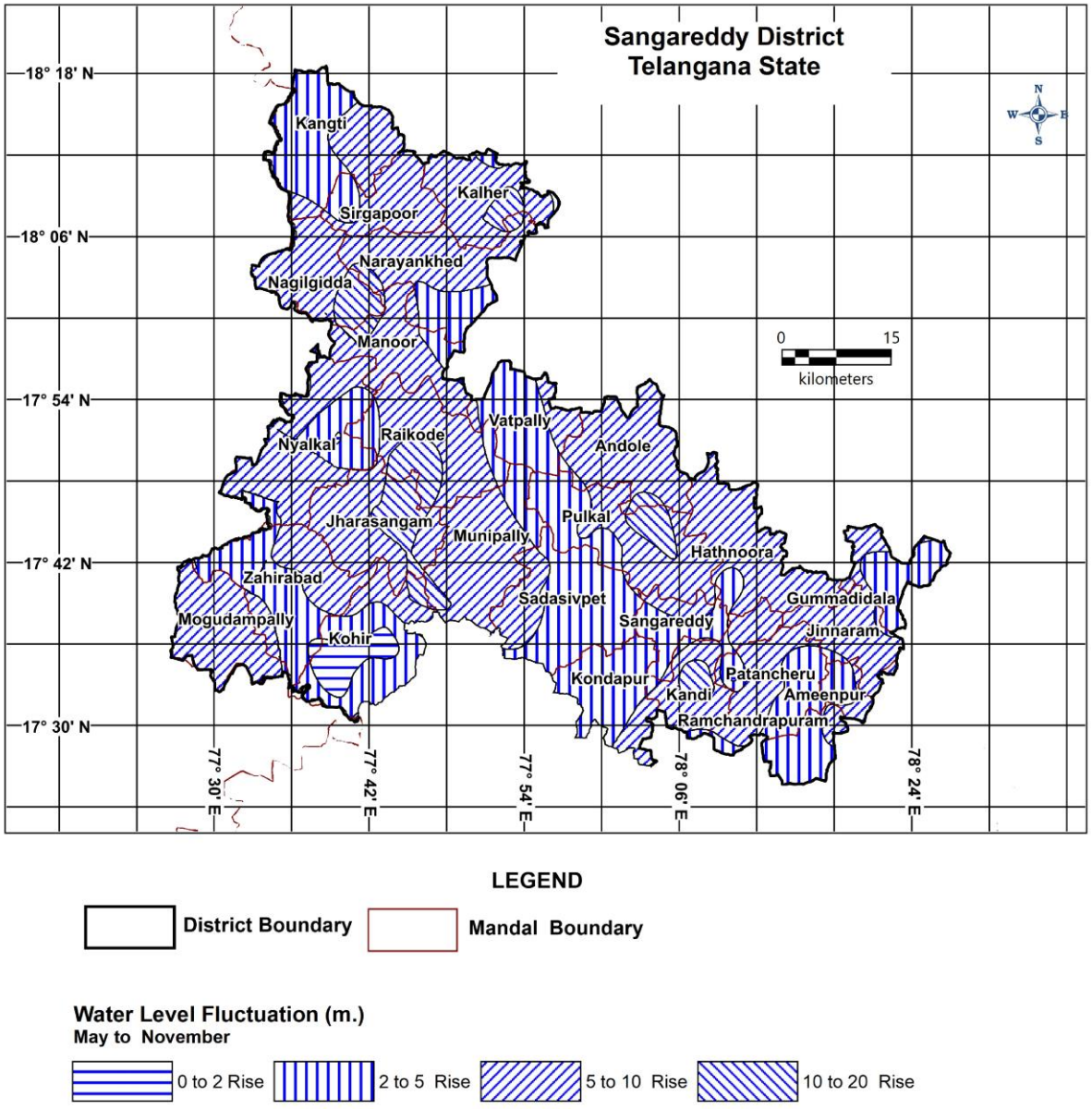

Fig. 2.5: Water Level Fluctuations (m) (Nov vs. May2019).

2.2.5 Long term water level trends (2010-2019)

The trend analysis for last 10 years (2010-2019) is studied from the different hydrograph stations of CGWB and SGWD. During pre-monsoon season, 15% of the area shows rising trends ranging from 0.13 to 1.89 m/yr (Ameenpur, Gummadidala, Jharasangam, Kalher, Kohir, Narayankhed and Pulkal mandals) and in remaining 85% of the area, it shows falling trend in the range of -0.02 to -2.26 m/yr (Andole, Gummadidala, Hathnoora, Jharasangam,

Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals) (Fig. 2.6). Whereas, during post-monsoon season, 44% of the area is showing rising trend ranging from 0.02 to 1.99 m/yr which is noticed in Ameenpur, Gummadidala, Hathnoora, Jharasangam, Kalher, Kandi, Kangti, Kohir, Mogudampally, Munipally, Narayankhed, Patancheru, Pulkal, Vatpally and Zahirabad mandals and in remaining 56% of the area, it is showing the falling trend of (-0.01 to -2.33 m/yr) observed in Andole, Gummadidala, Hathnoora, Jharasangam, Jinnaram, Kalher, Kohir, Kondapur, Manoor, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandal (Fig. 2.7).

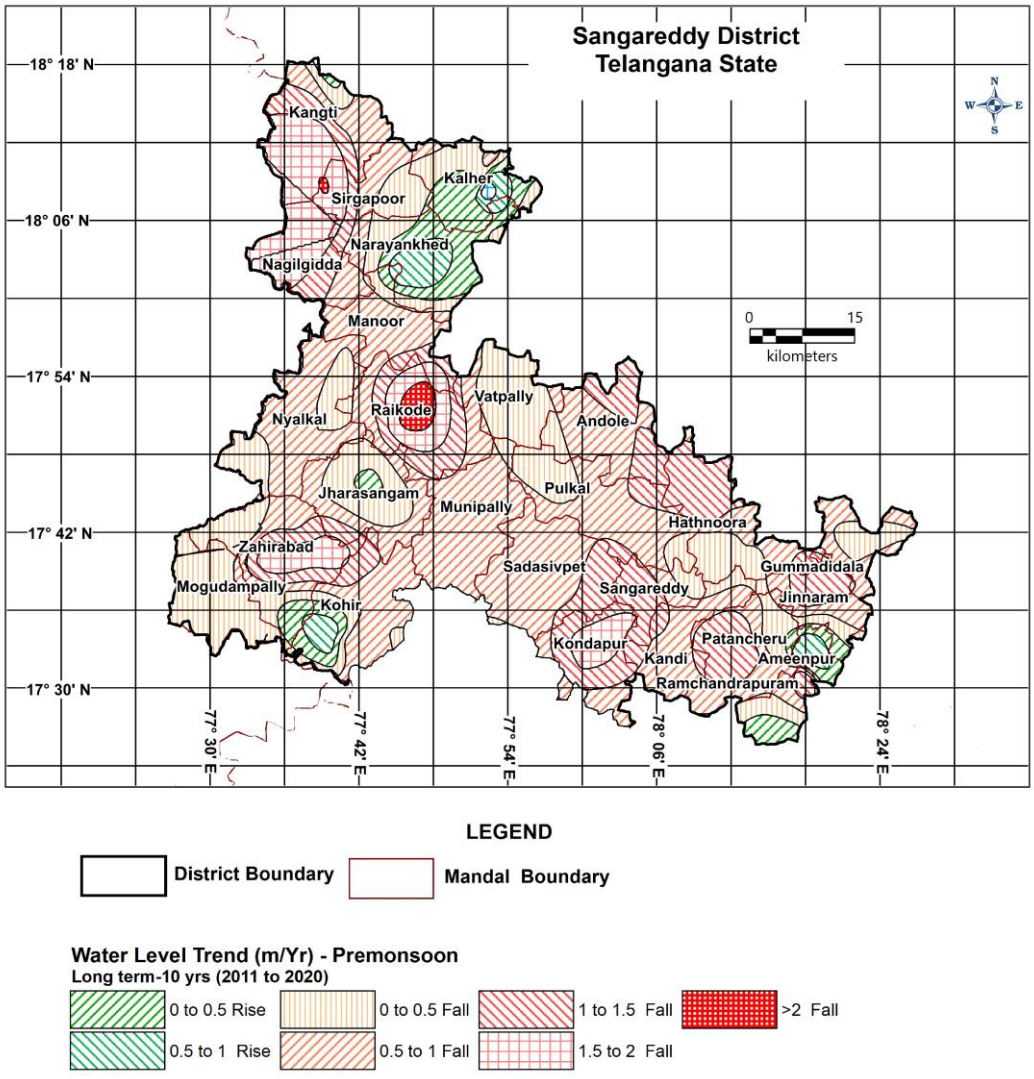

Fig. 2.6: Long-term water level trends (Pre-monsoon 2010-19).

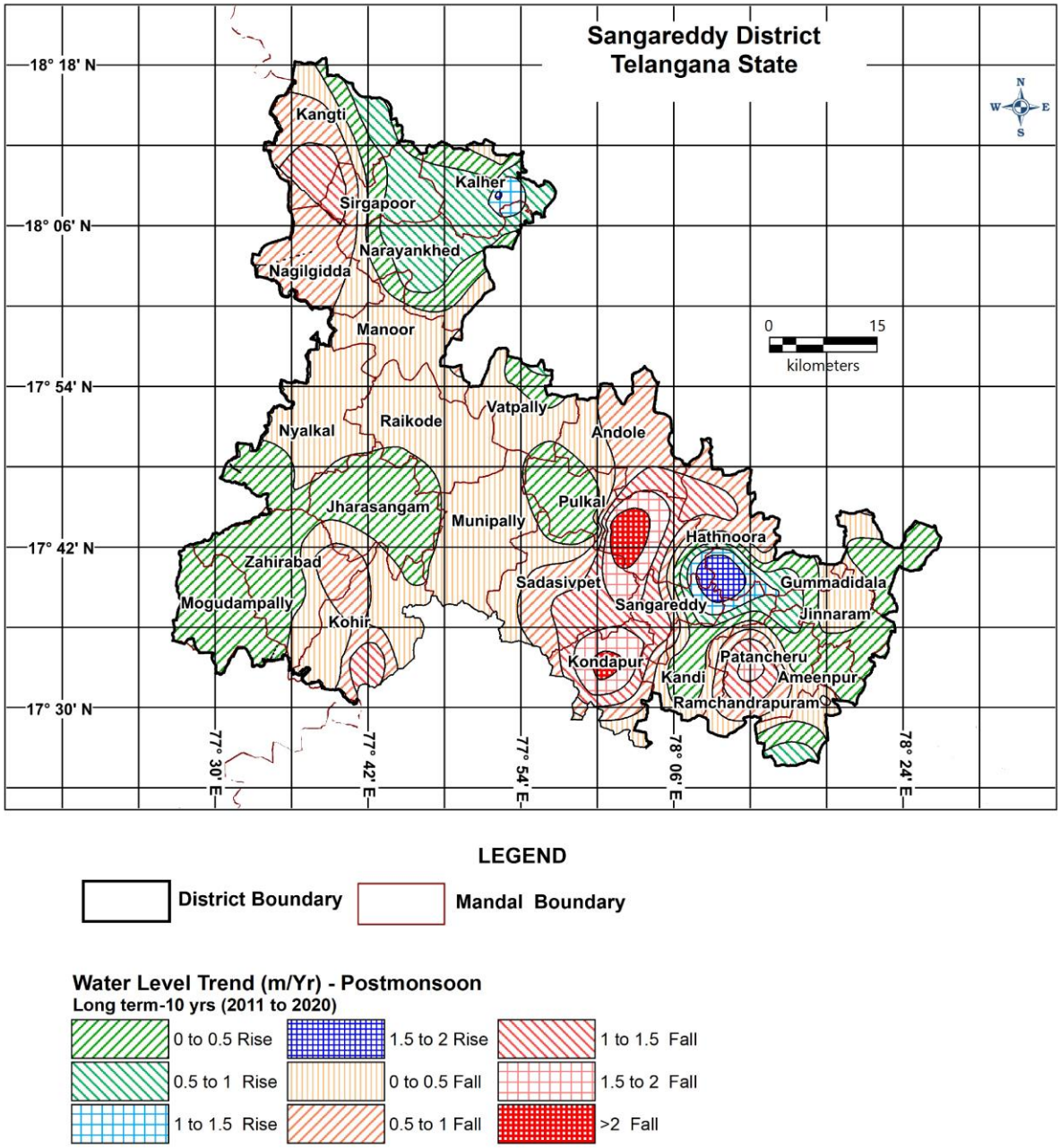

Fig. 2.7: Long-term water level trends (Post-monsoon 2010-19).

2.3 Geophysical Studies

From the analysis of VES data reveal that the resistivity is <30 Ohm (Ω) m for highly weathered, 30-60 Ωm for underlying semi weathered, between 60 to 375 Ωm is fractured and >350 Ωm for massive formations.

2.4 Hydro-chemical Studies

To understand chemical quality of groundwater, water samples in the year 2019 collected from CGWB and SGWD were utilized. Various chemical 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. Out of which, five parameters namely pH, EC, TDS, NO_3 and F were interpreted for suitability for drinking purposes and is assessed as per BIS standards (2012) and irrigation suitability as per electrical conductivity.

2.4.1 Pre-monsoon

Groundwater from the area is mildly alkaline in nature with pH in the range of 2.2 to 10 (avg. 7.87). The Electrical conductivity varies from 330 to 4230 µ Siemens/cm (avg. 1140 µ Siemens/cm). In about 83% of the samples from Andole, Gummadidala, Hathnoora, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals the EC is within 1500 µ Siemens/cm, while in 14% of the samples from Ameenpur, Kalher, Kandi, Munipally, Narayankhed, Patancheru, Raikode, Sadasivpet and Sangareddy mandals it is in the range of 1500-3000 µ Siemens/cm. In about 3% of the samples located in Kohir mandal, the EC of >3000 µ Siemens/cm is observed (Fig. 2.8). The concentration of TDS varies from 188 to 2363 mg/l (avg. 701 mg/l) and found that in 99% of samples, it falls within maximum permissible limits of BIS (<2000 mg/l) (Ameenpur, Andole, Gummadidala, Hathnoora, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals) whereas in the remaining 1% of the samples, it is exceeding the permissible limit (>2000 mg/l) (Kohir mandals). The NO_3 concentration ranges from 0.44 to 423 mg/l and noticed that in about 58% of the samples from Ameenpur, Andole, Gummadidala, Hathnoora, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Manoor, Mogudampally, Munipally, Nagilgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals is falling within the permissible limits of <45 mg/l and in about 42% of the samples from Andole, Gummadidala, Hathnoora, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally, Narayankhed, Pulkal, Sadasivpet, Sangareddy, Vatpally and Zahirabad mandals, the quality is not suitable for drinking water purpose (>45 mg/l) (Fig. 2.9). The Fluoride concentration varies from 0.13 to 4.6 mg/l (avg. 1.02 mg/l) and in 86% of the samples, it is within the permissible limit of <1.5 mg/l (Ameenpur, Andole, Gummadidala, Hathnoora, Jharasangam, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Manoor, Mogudampally, Munipally,

Narayankhed, Nyalkal, Patancheru, Pulkal, Raikode, Sadasivpet, Sangareddy, Sirgapoor, Vatpally and Zahirabad mandals) and in remaining 14% of the samples, it is beyond permissible limit of >1.5 mg/l (Andole, Hathnoora, Kandi, Kondapur, Nagilgidda, Pulkal, Raikode, Ramchandrapuram and Sangareddy mandals) and not suitable for drinking water purpose (Fig. 2.10).

2.4.2 Post-monsoon

Groundwater from the area is mildly alkaline in nature with pH in the range of 7.14 to 8.45 (avg. 8). The Electrical conductivity varies from 327 to 2030 µ Siemens/cm (avg. 1187 µ Siemens/cm). In 65% of the samples from Andole, Hathnoora, Jinnaram, Kalher, Kangti, Kohir, Kondapur, Mogudampally, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sangareddy, Sirgapoor and Zahirabad mandals, the EC is within 1500 µ Siemens/cm while in 35% of the samples from Ameenpur, Gummadidala, Kalher, Kandi, Kondapur, Munipally, Patancheru and Zahirabad mandals, it is in the range of 1500-3000 µ Siemens/cm. In none of the samples, the EC >3000 µ Siemens/cm is observed (Fig. 2.11). The concentration of TDS varies from 209 to 1299 mg/l (avg. 759 mg/l). In all the samples from Ameenpur, Andole, Gummadidala, Hathnoora, Jinnaram, Kalher, Kandi, Kangti, Kohir, Kondapur, Mogudampally, Munipally, Patancheru, Pulkal, Raikode, Ramchandrapuram, Sangareddy, Sirgapoor and Zahirabad mandals it is within the maximum permissible limits of BIS (<2000 mg/l). The NO_3 concentration ranges from 0.57 to 405 mg/l with an average of 101 mg/l. It is noticed that in about 56% of the samples from Ameenpur, Hathnoora, Jinnaram, Kalher, Kandi, Kangti, Patancheru, Pulkal, Ramchandrapuram, Sangareddy, Sirgapoor and Zahirabad mandals it is within the permissible limit (<45 mg/l) while in 44% of the samples from Andole, Gummadidala, Kalher, Kohir, Kondapur, Mogudampally, Munipally, Pulkal, Raikode and Zahirabad mandals, it is beyond the permissible limit (>45 mg/l) and not suitable for drinking water purpose (Fig. 2.12). The Fluoride concentration varies from 0.17 to 5.61 mg/l with an average of 1 mg/l. In about 85% of the samples, it is falling within permissible limit of <1.5 mg/l (Ameenpur, Gummadidala, Hathnoora, Jinnaram, Kalher, Kangti, Kohir, Kondapur, Mogudampally, Munipally, Patancheru, Pulkal, Raikode, Ramchandrapuram and Zahirabad mandals) while in 15% of the samples from Andole, Kandi, Pulkal, Sangareddy and Sirgapoor mandals are having high fluoride concentration beyond permissible limits (>1.5 mg/l) and are not suitable for drinking water purpose (Fig. 2.13).

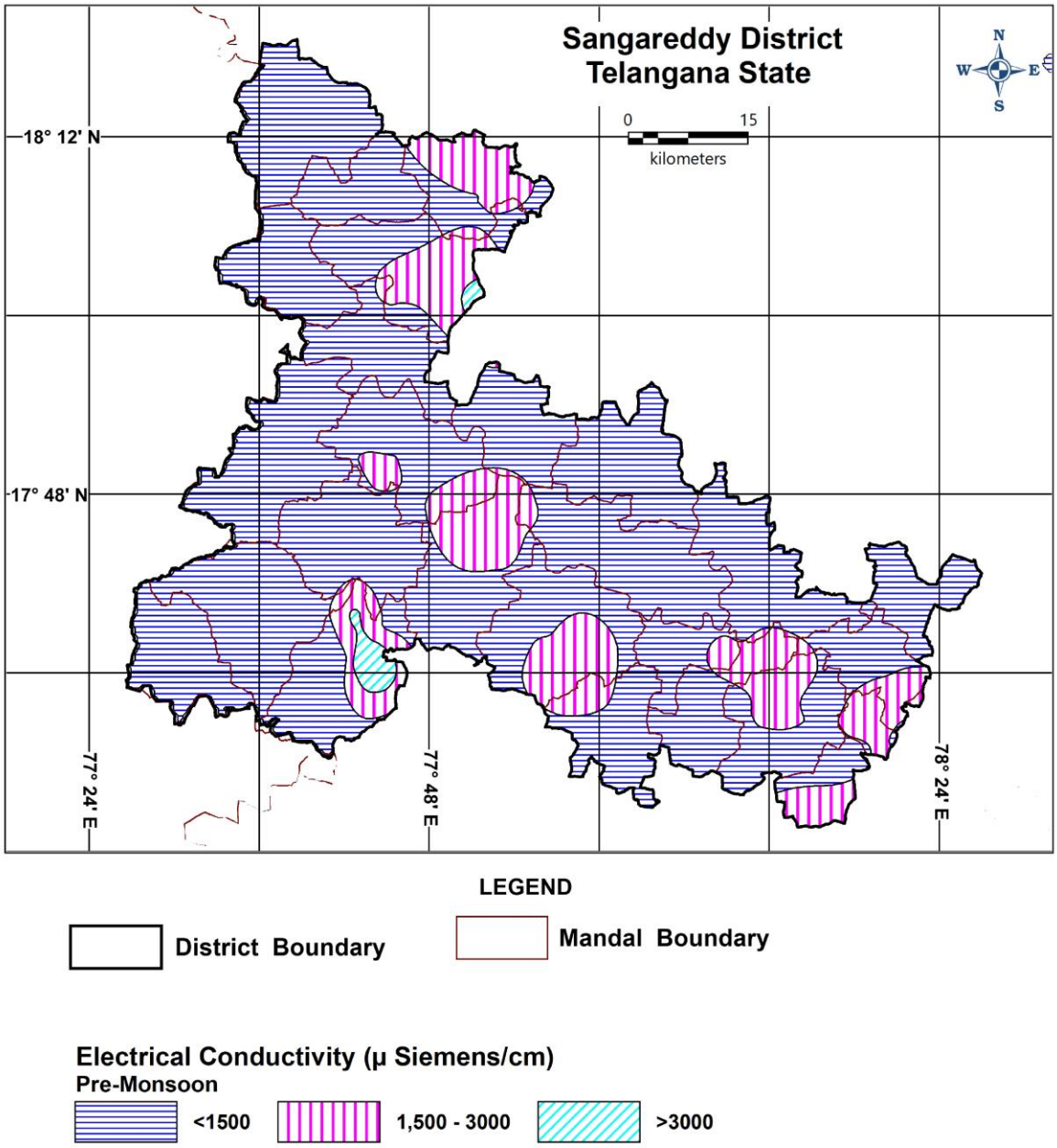

Fig.2.8: Distribution of Electrical conductivity (Pre-monsoon 2019).

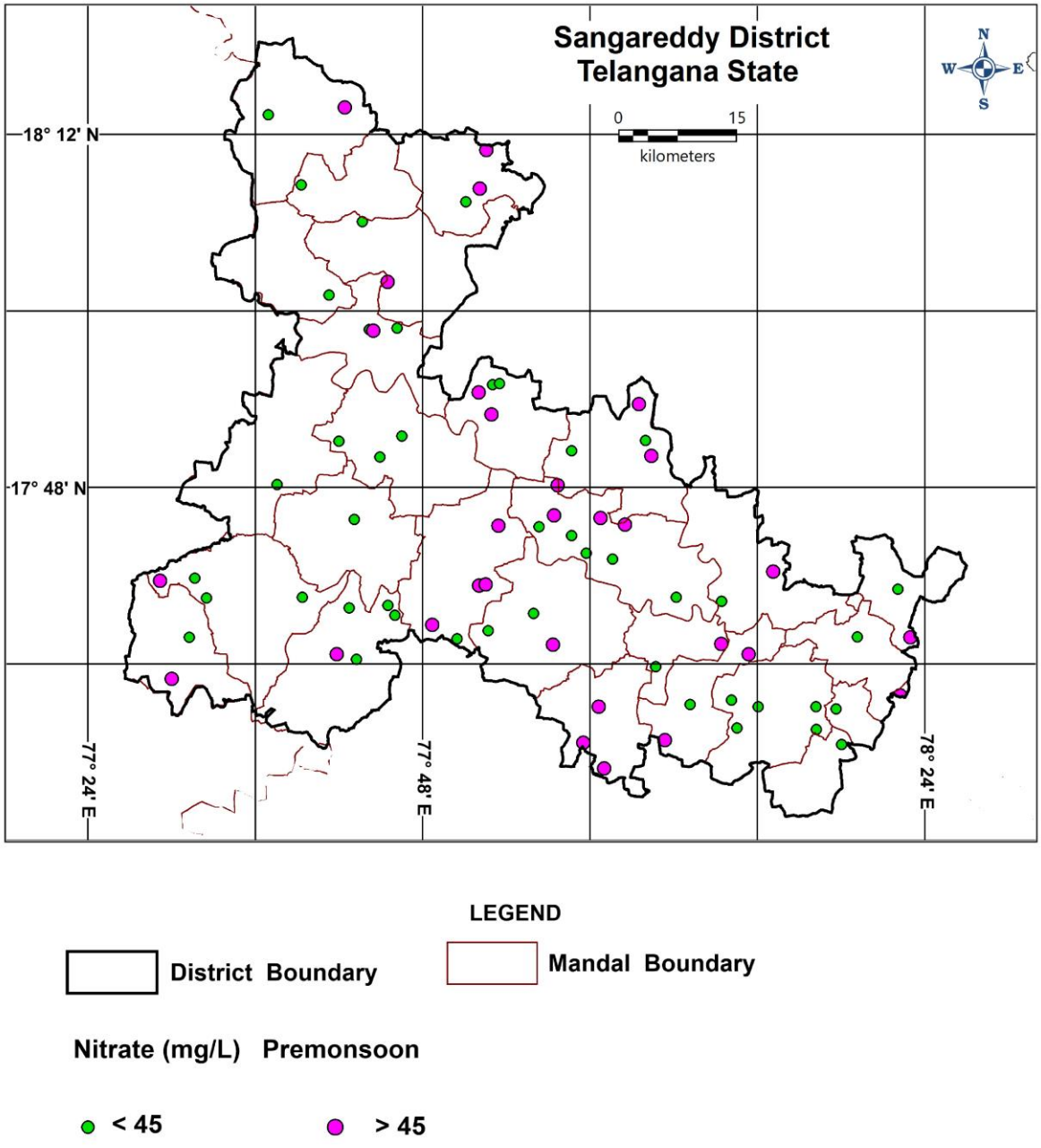

Fig. 2.9: Distribution of Nitrate (Pre-monsoon 2019).

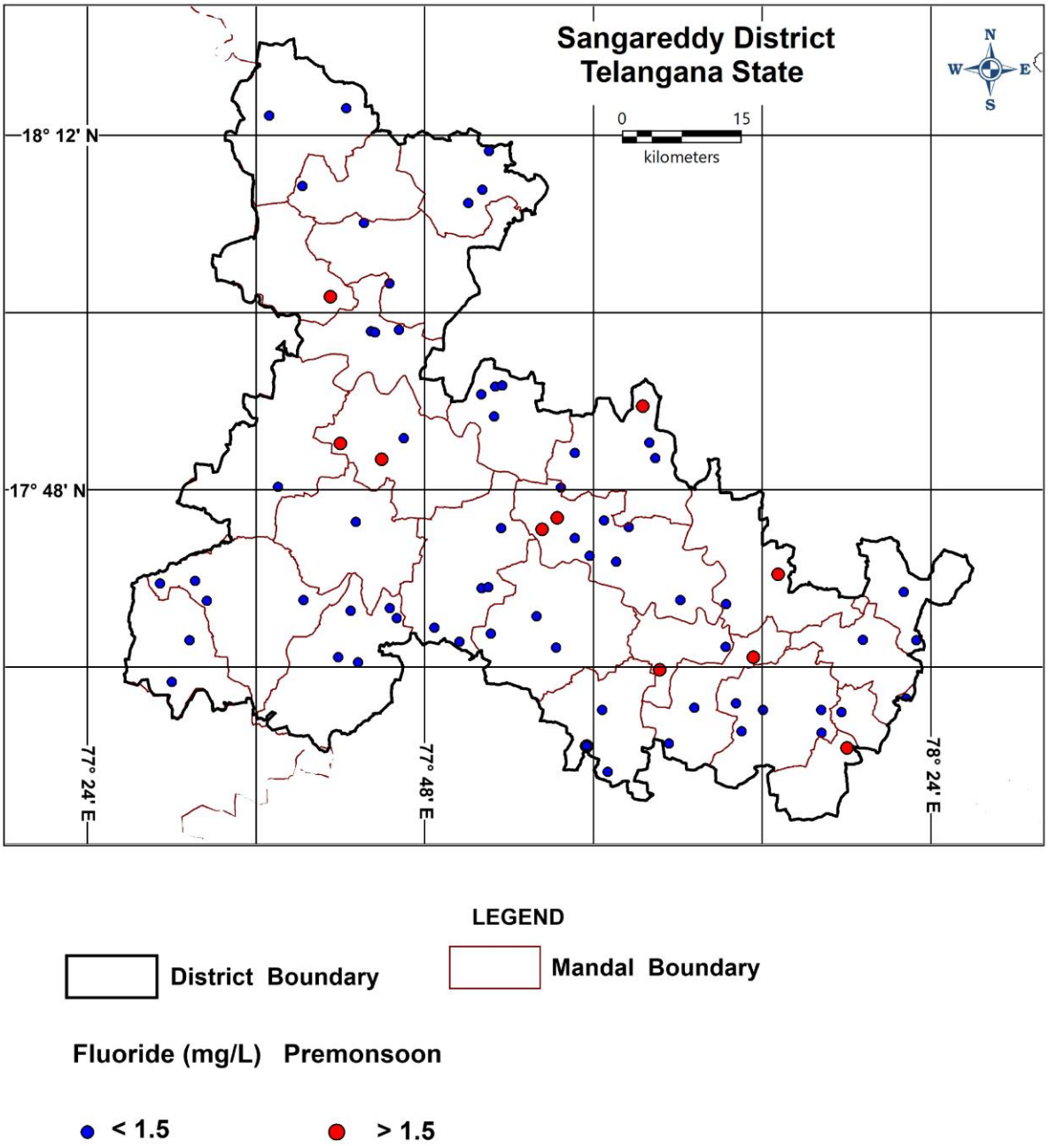

Fig. 2.10: Distribution of Fluoride (Pre-monsoon 2019).

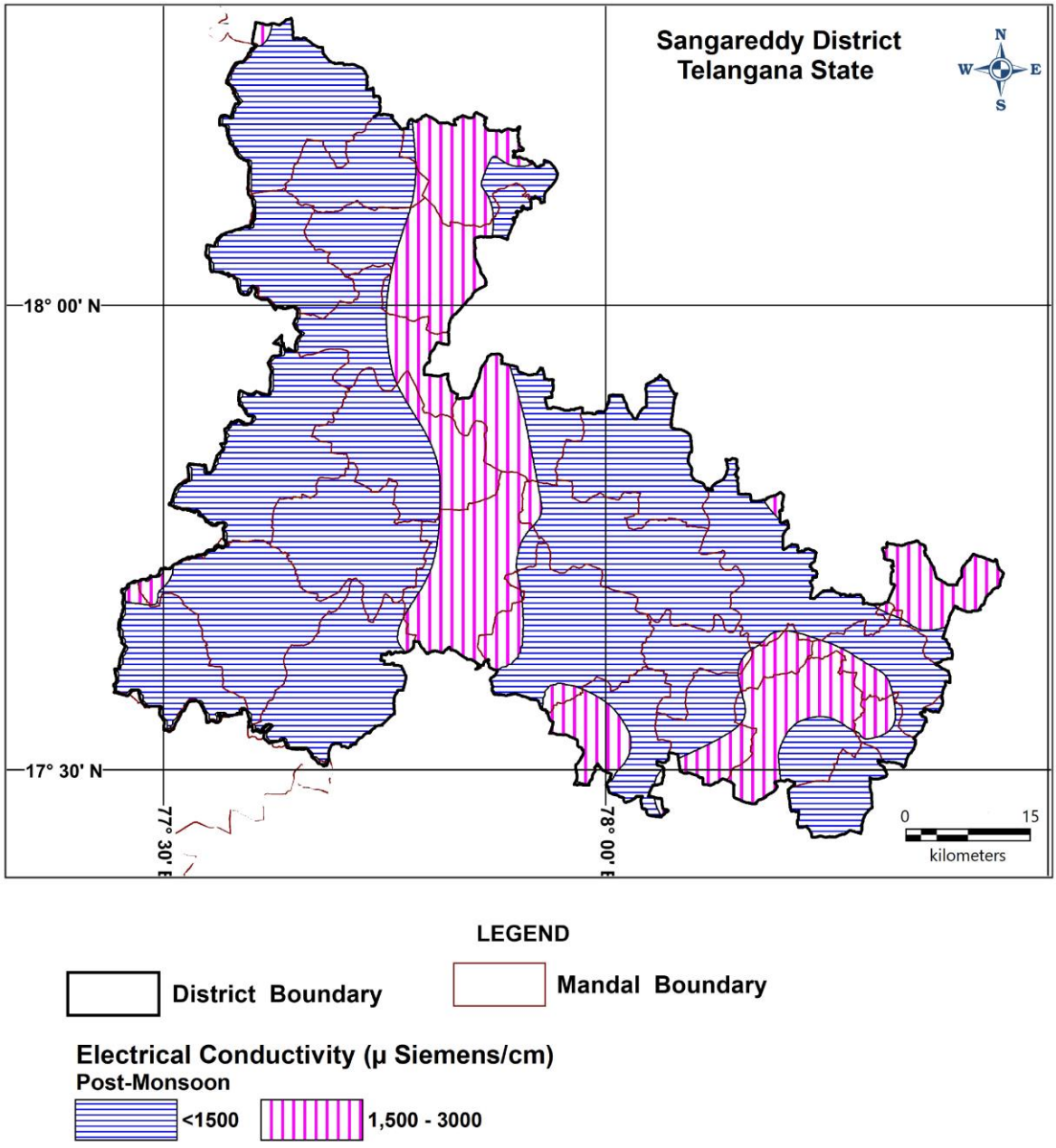

Fig.2.8: Distribution of Electrical conductivity (Post-monsoon 2019).

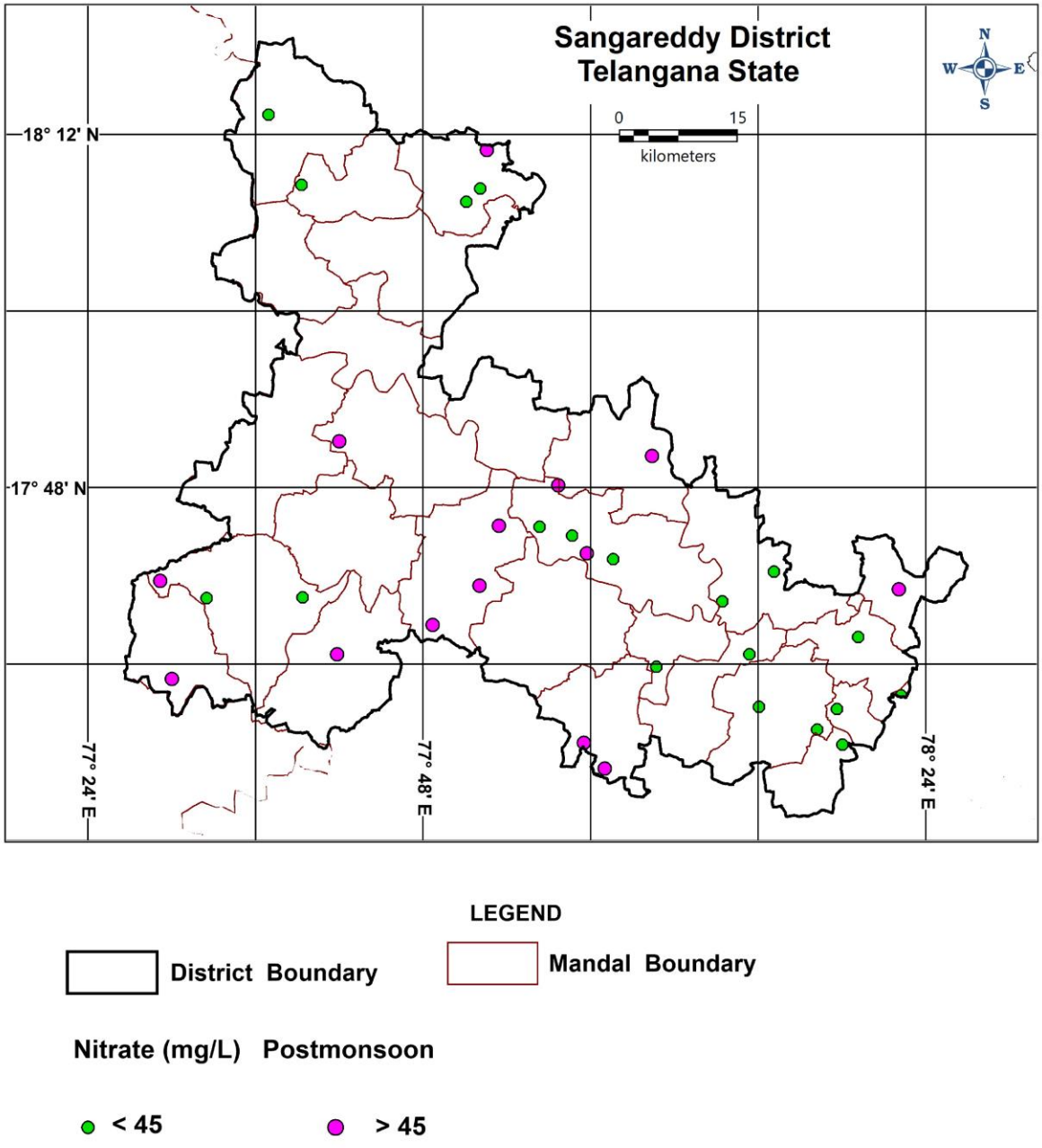

Fig.2.9: Distribution of Nitrate (Post-monsoon 2019).

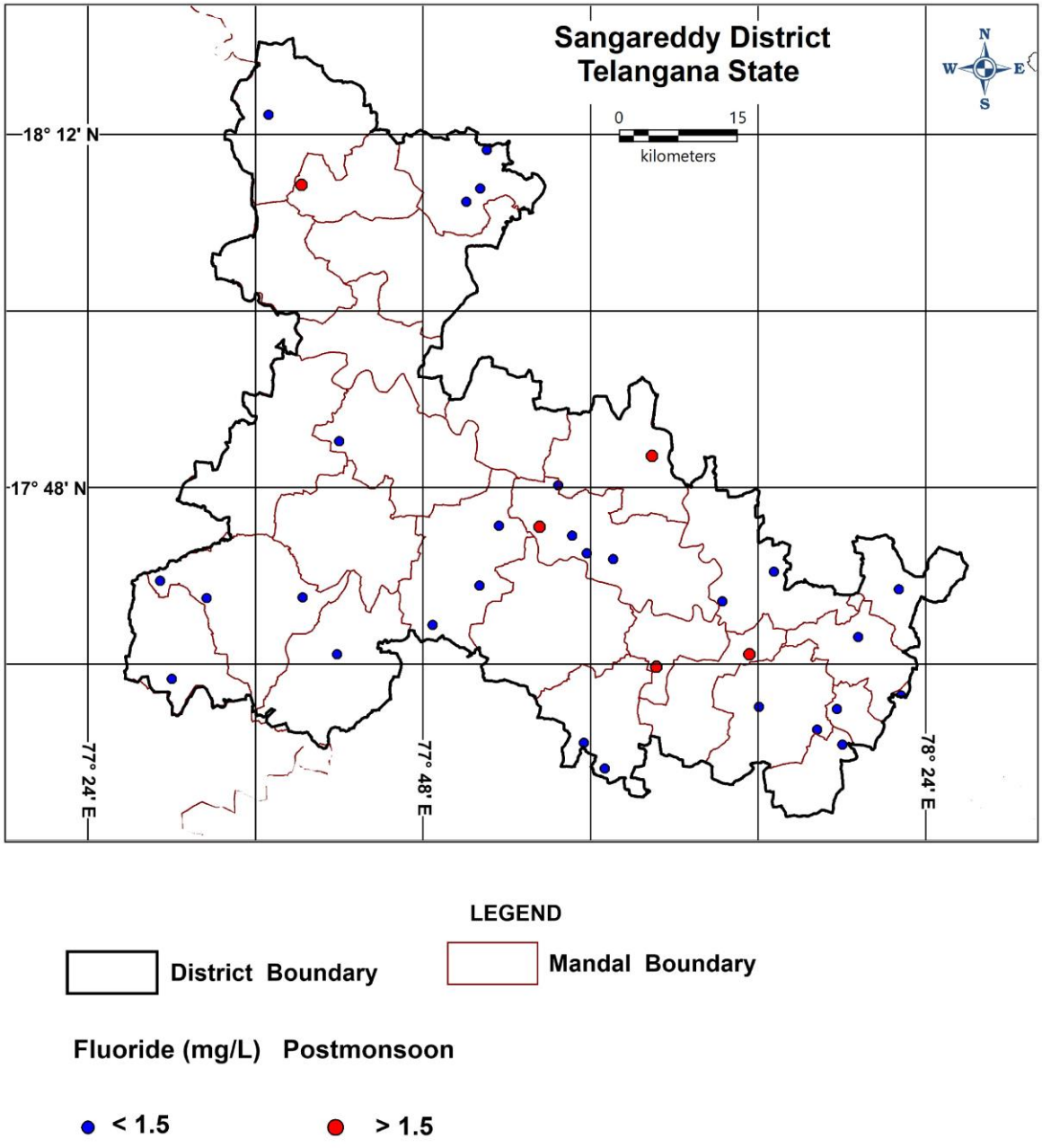

Fig. 2.13: Distribution of Fluoride (Post-monsoon 2019).

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

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

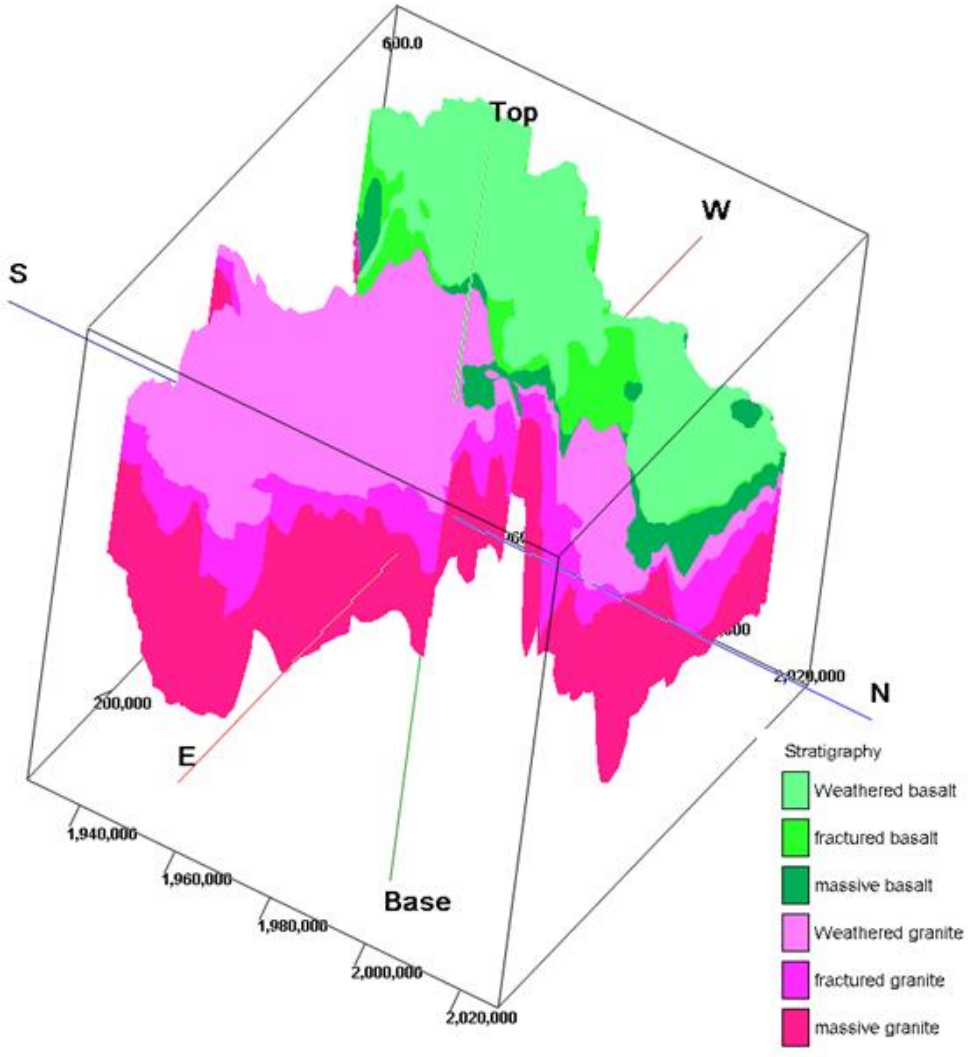

Fig. 3.1: 3D Model.

3.1 Conceptualization of aquifer system in 3D

Aquifers were characterized in terms of their potential and quality based on integrated hydrogeological data and various thematic maps. The depth of investigation carried out was up to 200 m bgl. The weathered zone is ranging from 0.5 to 37 m bgl. The weathering >20 m bgl is observed in Andole, Hathnoora, Jharasangam, Kalher, Kangti, Kohir, Manoor, Munipally, Nyalkal, Regode, Sadasivapet, Sirgapur, Wargal and Zaheerabad mandals. The fractured zone is ranging from 1.5 to 192 m bgl with the yield ranging from <1 to 25 lps with an average of 1.5 lps. About 74% of the fractures were encountered within 100 m bgl depth noticed in Andole, Hathnoora, Jharasangam, Jinnaram, Kalher, Kangti, Kodapur, Kohir, Kondapur, Kowdipalle, Manoor, Munipally, Nagalgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, R.C.Puram, Raikod, Regode, Sadasivapet, Sangareddy, Sirgapur and Zaheerabad. The deeper fractures beyond 100 m bgl (264%) are encountered in Jharasangam, Kalher, Kangti, Kohir, Narayankhed, Nyalkal, Regode, Wargal and Zaheerabad mandals.

3.2 Hydrogeological Sections

Two hydrogeological sections were prepared along NW-SE (a) and NE-SW (b) directions.

3.2.1 NW-SE Section (a)

The section drawn along the NW-SE direction covering distance of ~95 kms. It depicts uniform weathered zone throughout the section. The thickness of fractured zone is more between 15 and 40 km and 80 to 95 kms stretch of the section (Fig. 3.3a).

3.2.2 NE-SW Section (b)

The section drawn along the NE-SW direction covered a distance of ~62 kms. It depicts a uniform weathered zone. The thick fractured zone is noticed between the distance of 12 to 37 kms (Fig. 3.3b).

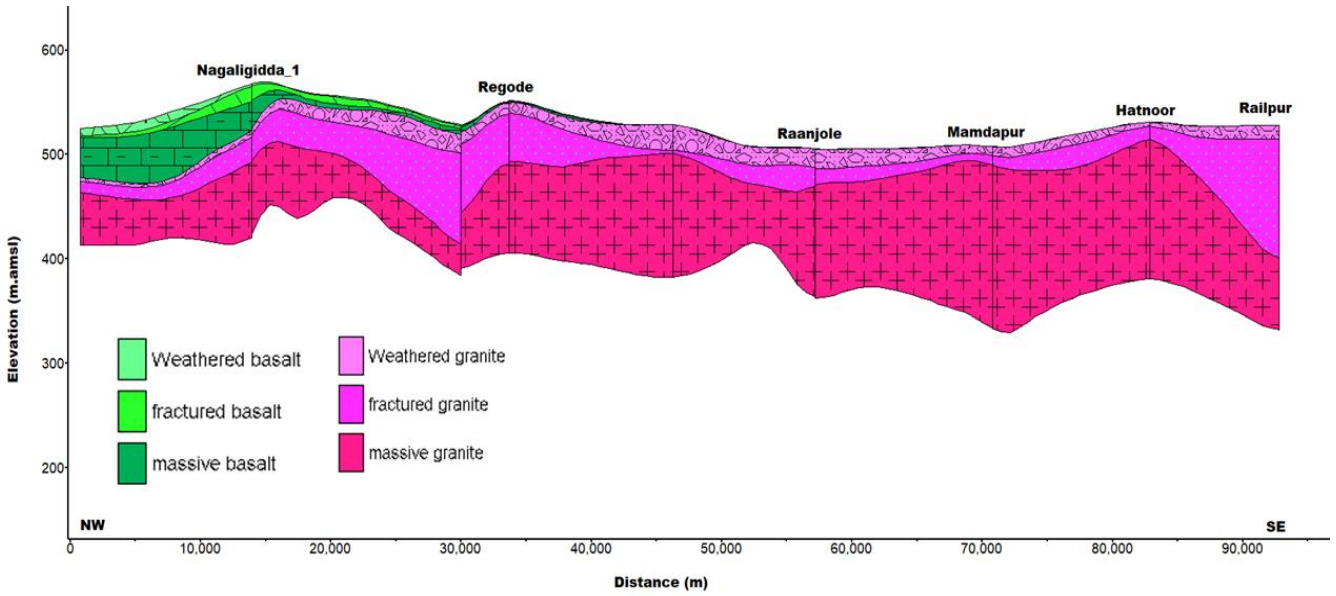

Fig. 3.3(a): E-W Section.

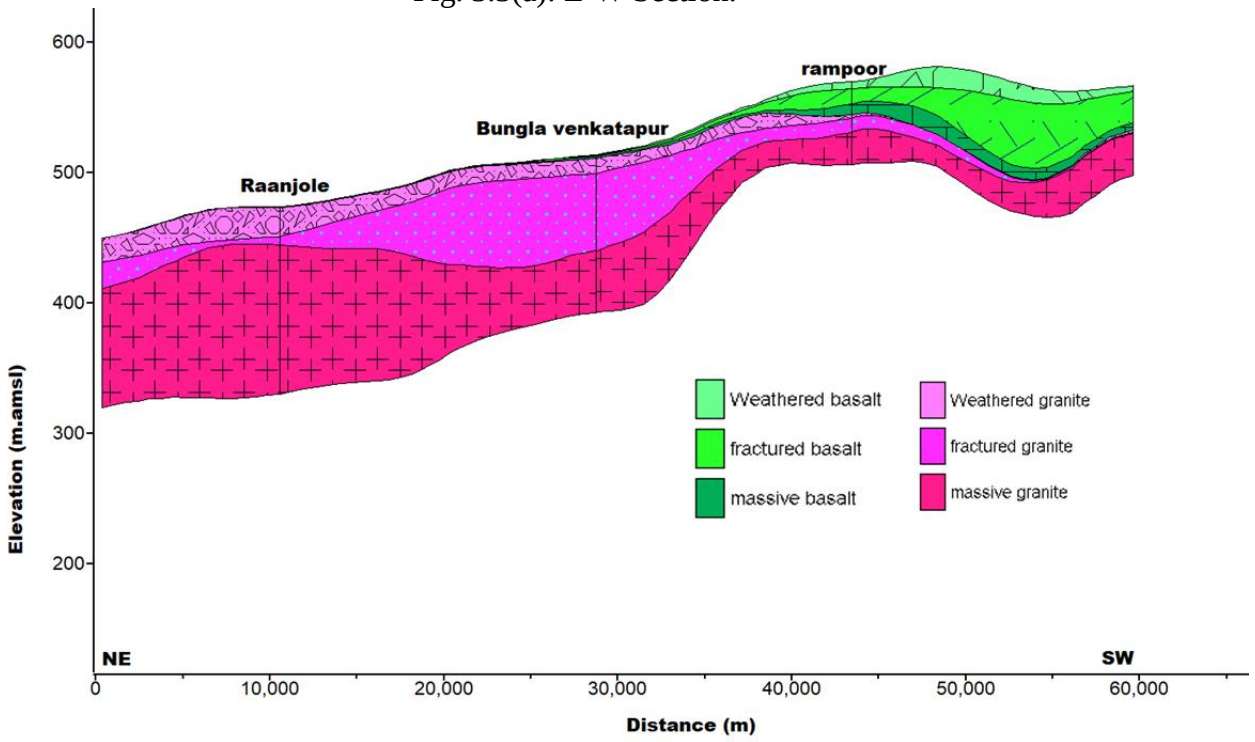

Fig. 3.3(b): N-S Section.

Fig.3.3: Hydrogeological sections along different directions.

3.3 Aquifer Characterization

3.3.1 Weathered zone

The weathered zone thickness is more over the gneissic formation. The dug wells, which were in operational earlier, have gradually becoming dry and defunct due to over-exploitation particularly during pre-monsoon season. The depth of weathering ranging from 0.5 to 37 m bgl. In majority of the district (44% of the area), the depth of weathering is <10 m bgl and is mostly observed in Andole, Hathnoora, Jharasangam, Jinnaram, Kalher, Kangti, Kohir, Kondapur, Manoor, Munipally, Nagalgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, R.C.Puram, Sangareddy and Zaheerabad mandals, while the depth of weathering ranging from 10 to 20 m bgl (30% of the area) is observed in Andole, Gummadidalla, Hathnoora, Jharasangam, Jinnaram, Kalher, Kangti, Kohir, Kowdipalle, Manoor, Munipally, Narayankhed, Nyalkal, Patancheru, Sangareddy and Zaheerabad mandals. The weathering depth >20 m bgl (25% of the area) is noticed in Andole, Hathnoora, Jharasangam, Kalher, Kangti, Kohir, Manoor, Munipally, Nyalkal, Sangareddy, Sirgapur, Wargal and Zaheerabad mandals (Fig.3.4 and Fig.3.5). The transmissivity varies from 1 to 30 m^2/day with average of 7 m^2/day. The specific yield varies from 1 to 3 with average of 2.

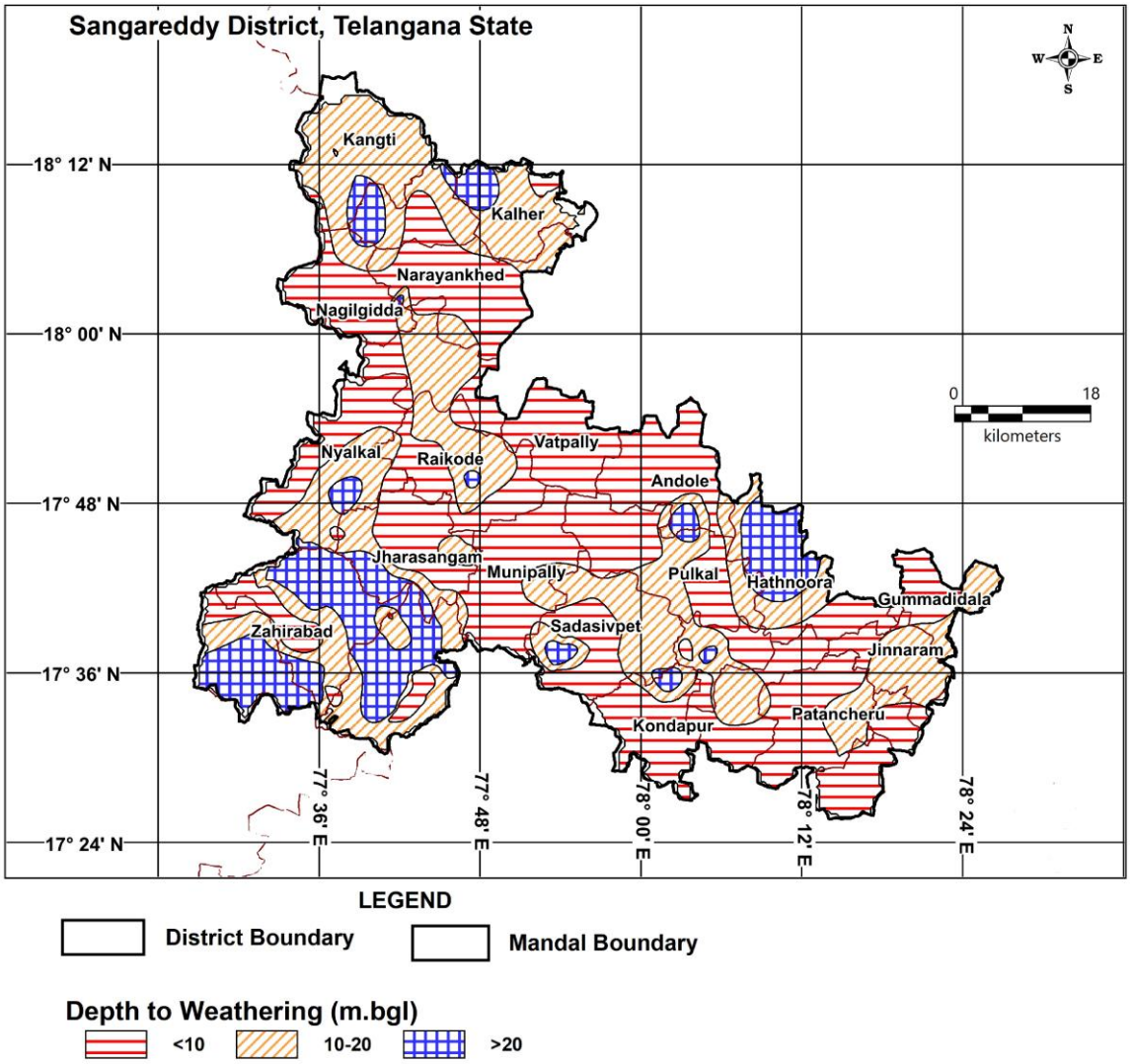

Fig.3.4: Thickness of Weathered zone.

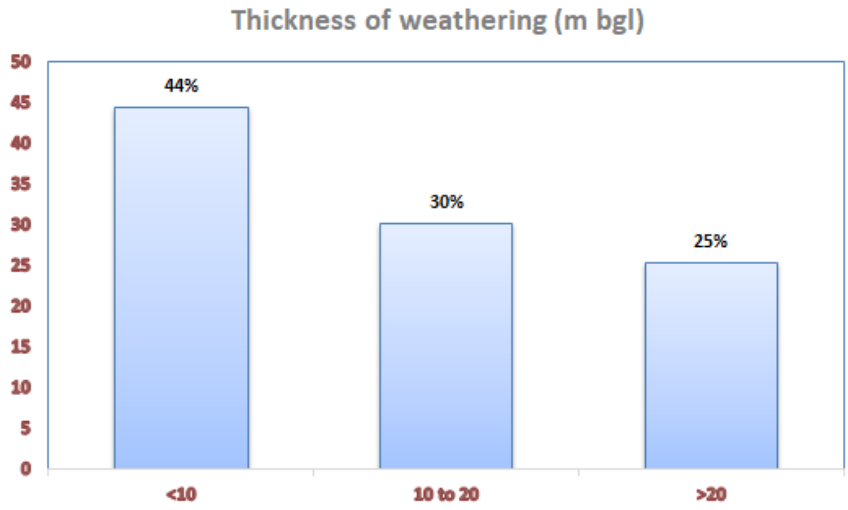

Fig.3.5: Depth wise distribution of weathering zone.

3.3.2 Fractured zone

Groundwater is extracted mainly through bore wells tapping fractured zone till to the depth 200 m bgl. Based on CGWB and SGWD exploration data, it is inferred that 36% of the fractures occur within 30 m bgl with yield ranging from 0.014 to 6.6 lps observed at Andole, Hathnoora, Jharasangam, Jinnaram, Kalher, Kangti, Kondapur, Manoor, Munipally, Nagalgidda, Narayankhed, Nyalkal, Patancheru, Patancheru, Pulkal, Raikod, Sadasivapet, Sangareddy and Zaheerabad mandals. About 26% of the fractures occur within depth range of 30 to 60 m bgl with yields varying from 0.014 to 6.6 lps and are observed at Manoor, Munipally, Nyalkal, Patancheru, Pulkal, R.C.Puram, Raikod, Sadasivapet, Sangareddy, Sirgapur and Zaheerabad mandals. About 12% of the fractures occurring within the depth range of 60 to 100 m bgl with yield varying from 0.038 to 12.7 lps (Andole, Jharasangam, Kangti, Kowdipalle, Munipally, Nagalgidda, Nyalkal, Raikod, Sadasivapet and Zaheerabad mandals) (Fig. 3.6). About 26% of the fractures have occurred beyond 100 m bgl with yield varying 0.07 to 25 lps (Jharasangam, Kalher, Kangti, Kohir, Narayankhed, Nyalkal, Wargal and Zaheerabad mandals). The deepest fracture tapped at the depth of 192 m bgl is observed in Kalher mandal. Over all, the yield varies from 0.07 to 25 lps in the terrain with an average of 1.5 lps. The Transmissivity varies up to 90 m^2/day. The Storativity varies up to 0.0005. From the fracture analysis, it is revealed athat the area most potential fractres were notied within 100 m bgl and it is also noticed that further exploitation also continued beyond 100 m bgl.

The yield wise data representation shows that in about 53% of the wells, the yield is <1 lps (Andole, Hathnoora, Jharasangam, Kalher, Kangti, Kohir, Kondapur, Manoor, Munipally, Nagalgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, R.C.Puram, Raikod, Sangareddy, Sirgapur and Zaheerabad mandals) while in 21% each of the wells, the yield is ranging from 1 to 2 lps (Andole, Hathnoora, Jharasangam, Jinnaram, Kohir, Kondapur, Manoor, Narayankhed, Patancheru, Pulkal, Raikod, Raikod, Sadasivapet and Zaheerabad mandals). In about 8% of the wells, the yield is ranging from 2 to 3 lps (Kangti, Kohir, Nyalkal, Patancheru, R.C.Puram, Sangareddy and Zaheerabad mandal) and in 19% of the wells, the yield is >3 lps (up to 25 lps) noticed in Jharasangam, Kohir, Kowdipalle, Munipally, Nagalgidda, Nyalkal, Sadasivapet, Sangareddy and Zaheerabad mandals.

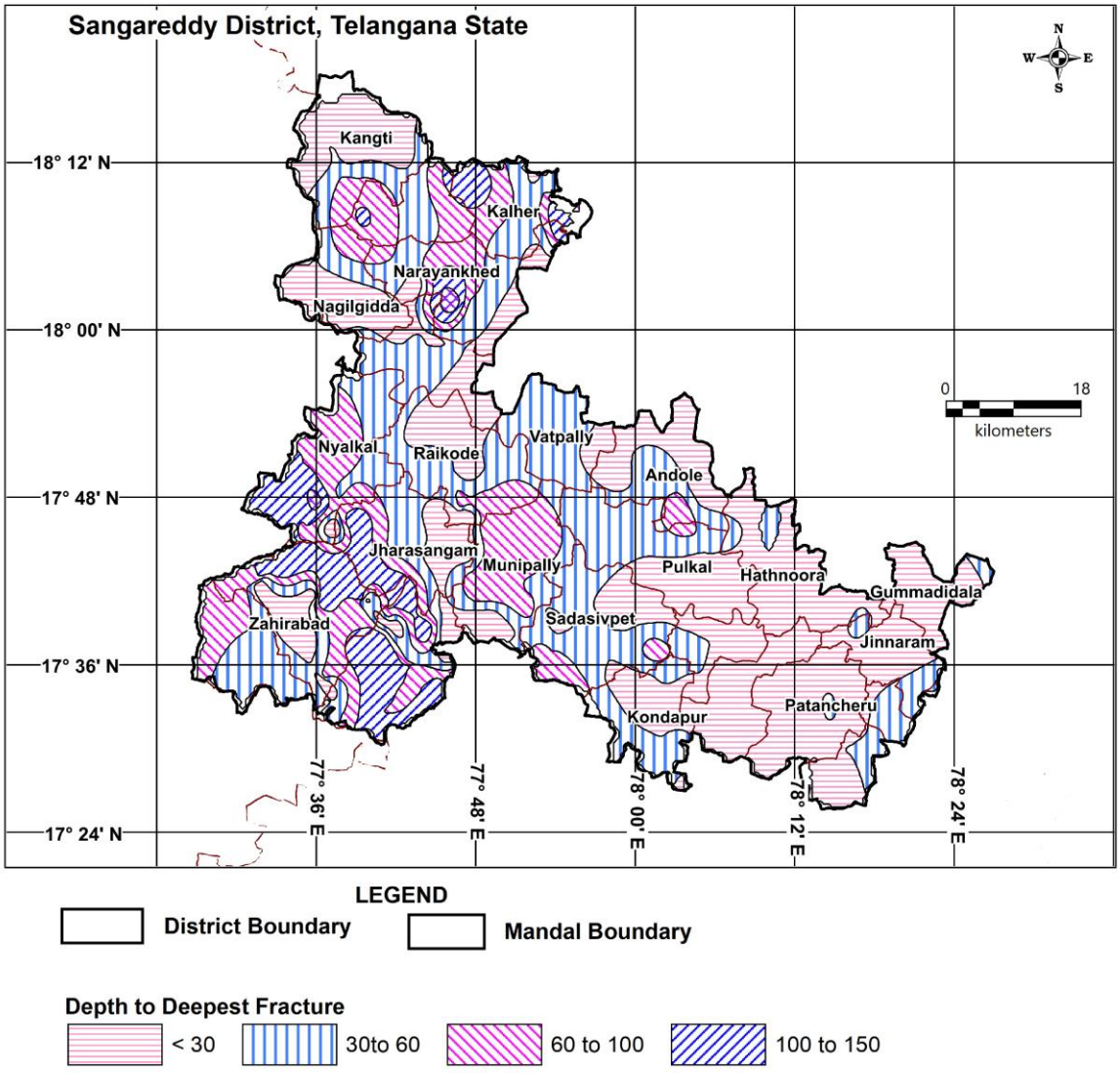

Fig.3.6: Depth of Fractured zone.

4. GROUND WATER RESOURCES (2020)

In hard rocks, for practical purpose it is very difficult to compute zone wise (aquifer wise) ground water resources, because the weathered zone (WZ) and fractured zone (FZ) are inter-connected with fractures/joints and fractured zone gets recharged through weathered zone. Therefore, it is very difficult to demarcate the boundary between two aquifers; hence the resources are estimated considering entire area as a single aquifer system. Village wise dynamic and in-storage ground water resources are computed as per the guidelines laid down in GEC methodology (Table 4.1).

As per GEC 2020 report, the net dynamic replenishable ground water availability for newly formed Sangareddy district is 322 MCM, gross ground water draft for all uses 203 MCM, provision for drinking and industrial use for the year 2025 is 51 MCM and net annual ground water potential available for future irrigation needs is 94 MCM.

Out of 26 mandals, 15 mandals are falling under **Safe** (Sirgapoor (31%), Nagalgidda (44%), Munipally (45%), Raikode (46%), Andole (48%), Jinnaram (49%), Sadasivpet (49%), Vatpally (50%), Pulkal (51%), Kangti (54%), Narayankhed (57%), Manoor (58%), Mogudampally (67%), Kondapur (68%) and Kandi (69%)) and 10 mandals falling under **Semi-Critical** (Gummadidala (71%), Hathnoora (71%), Kohir (74%), Kalher (77%), Jharasangam (78%), R.C.Puram (78%), Sangareddy (78%), Ameenpur (80%), Nyalkal (81%) and Zaheerabad (89%)) and the remaining remaining 1 mandals falling under **Critical** catetory (Patancheru (91%)). The overall average stage of ground water extraction in the district is 63%.

Table 4.1: Computed dynamic ground water resources.

Parameters	Resources (GEC 2020) in MCM
Dynamic (Net GWR Availability)	322
• Monsoon recharge from rainfall	213
• Monsoon recharge from other sources	39
• Non-Monsoon recharge from rainfall	44
• Non-monsoon recharge from other sources	46
• Natural Discharge	19
Gross Recharge	341
Gross GW Draft	
• Irrigation	177
• Domestic and Industrial use	26
Provision for Drinking and Industrial use for the year 2025	51
Net GW availability for future irrigation	94
Average Stage of GW extraction (%)	63
Categorization of mandals	**Safe: 15, Semi-Critical: 10 and Critical:1** **Safe:** Sirgapoor (31%), Nagalgidda (44%), Munipally (45%), Raikode (46%), Andole (48%), Jinnaram (49%), Sadasivpet (49%), Vatpally (50%), Pulkal (51%), Kangti (54%), Narayankhed (57%), Manoor (58%), Mogudampally (67%), Kondapur (68%) and Kandi (69%) **Semi-Critical:** Gummadidala (71%), Hathnoora (71%), Kohir (74%), Kalher (77%), Jharasangam (78%), R.C.Puram (78%), Sangareddy (78%), Ameenpur (80%), Nyalkal (81%) and Zaheerabad (89%) **Critical:** Patancheru (91%)

5. GROUND WATER RELATED ISSUES AND REASONS FOR ISSUES

5.1 Issues

Over-exploitation

- 798 km^2 area (18% of area) covering 159 villages are categorized as over-exploited where ground water balance for future irrigation is negligible or nil.

Pollution (Geogenic and Anthropogenic)

- Few mandals are fluorosis endemic where fluoride (geogenic) in ground water is as high as 4.6 mg/l during pre-monsoon and 5.61 mg/l during post-monsoon season. The high fluoride concentration (>1.5 mg/l) occur in 14% of samples and 15% of samples respectively during pre and post-monsoon season of the year 2019.
- High nitrate (>45 mg/l) due to anthropogenic activities is observed in 42% of the samples and 44% of the samples during pre and post-monsoon season respectively.

Deep water levels

- Deep water levels (>20 m bgl) are observed during pre-monsoon season in 41% of the area and it 14% during post-monsoon season.

Sustainability

- Low yield (<1 lps) occurs in 51% of the exploratory wells covering in Andole, Hathnoora, Jharasangam, Kalher, Kangti, Kohir, Kondapur, Manoor, Munipally, Nagalgidda, Narayankhed, Nyalkal, Patancheru, Pulkal, R.C.Puram, Raikod, Sangareddy, Sirgapur and Zaheerabad mandals. 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 more exploitation.

Water Marketing and other Issues

- Water marketing is present in critical, semi critical and other areas also and people are buying bottled water from the market for drinking purposes.
- Change in land use from agricultural land to residential purposes and cropping pattern from traditional crops to cash crops (cotton and paddy) is observed.
- In non-command area, the paddy crop grown during rabi season is completely dependent on ground water which leads to heavy withdrawal of ground water during non-monsoon period.

5.2 Reasons

Geo-genic pollution (Fluoride)

- Higher concentration of fluoride in ground water is attributed due to source rock (i.e., granite), rock water interaction where acid-soluble fluoride bearing minerals (fluorite, fluoro-apatite) gets dissolved under alkaline conditions.
- 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.

Deep water levels

- Over-extraction for paddy cultivation during rabi season leads to more ground water extraction in proportion to recharge, limited artificial measures and low rainfall etc., are the causes of deeper water levels in the area.

6. MANAGEMENT STRATEGIES

High dependence on groundwater coupled with absence of augmentation measures has led to a steady fall in water levels and desaturation of weathered zone in some parts, raising questions on sustainability of existing groundwater structures, food and drinking water security. The occurrence of fractures beyond weathered zone are very limited in extent, as the compression in the rock reduces the opening of fractures at depth and the majority of fractures normally occured within 100 m depth and further exploitation is happening beyond 100 m bgl till to the depth 200 m bgl. The 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, high weathering, longer residence time and alkaline nature of groundwater.

6.1 Management plan

The uneven distribution of groundwater availability and its utilization indicates that a single management strategy cannot be adopted and requires integrated hydrogeological aspects along with socio-economic conditions to develop appropriate management strategy. The study suggests notable measures for sustainable groundwater management, which involves a combination of 1) Supply side measures and 2) Demand side measures.

6.1.1 Supply side measures

In the district, 27613 MCM of unsaturated volume (below the depth of 5 m) is available during post-monsoon, having 552 MCM of recharge potential and 176 MCM of uncommitted runoff. This can be utilized for implementing management strategy.

Ongoing Projects

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

- Under State Govt. sponsored Mission Kakatiya, during Phase-1 to Phase-4, out of 2427 minor irrigation tanks, 976 tanks were desilted. This helped in strengthening of water bodies and created additional surface storage, thereby increased groundwater augmentation in the district.

- There is a need to take remaining tanks in the next phases for de-siltation. This will greatly help in stabilisation of tank ayacut and groundwater augmentation.

6.1.1.2 Mission Bhagiratha

- Under Telangana Drinking Water Supply Project (TDWSP) also known as Mission Bhagiratha, all the villages and towns are proposed to be covered from the water grid with intake from Manjira River at Singur (Segment-8, 9 and 10A) covering entire district to provide protected water from surface reservoirs. The scheme is to enhance the existing drinking water scheme and to provide 100, 135 and 150 lpd/person of water in rural, municipal and Municipal Corporation respectively.

- The total water import will be 62 MCM (drinking and industrial needs) and this imported water from surface sources will reduce the present utilized 33 MCM of groundwater (considering 60 lpcd). This can be effectively utilized to irrigate 5576 ha. of additional land under ID crops.

To be taken up

6.1.1.3 Artificial Recharge Structures

While formulating the village wise groundwater management plan, the unsaturated volume of aquifer is estimated by multiplying the area with specific yield and unsaturated thickness (post-monsoon water levels below 5 m). Initially village wise dynamic groundwater resources of 2017 are considered. Potential surface run off is estimated by following standard procedures. On conservative side 25% run off yield is considered as non-committed yield for recommending artificial recharge structures in intermittent areas 50% of yield is considered and remaining 50% is recommended for implementing water conservation measures in recharge areas.

The pre-monsoon groundwater quality is considered for categorising contaminated area (F >1.5 mg/l & EC >3,000 µ S/cm). Nitrate is not considered here because it is point source pollution and localized. Based on above criteria, the area can be prioritized into Priority-1 (over-exploited) which needs immediate intervention followed by Priority-2. A detailed hydrogeological characteristic along with its category is prepared for the state. Based on this, the district is falling under 7 categories (category-1, category-2, category-3, category-4, category-5, category-7 and category-8) (Table 6.1).

Table 6.1: Hydrogeological characteristics of area.

Category	Hydrogeological characterizations
1	High EC with additional scope for artificial recharge.
2	High EC with no additional scope for artificial recharge.
3	High F with additional scope for artificial recharge.
4	High F with no additional scope for artificial recharge.
5	High EC and F with additional scope for artificial recharge.
6	High EC and F with no additional scope for artificial recharge.
7	Groundwater quality within permissible limits for drinking and irrigation with scope for artificial recharge
8	Groundwater quality within permissible limits for drinking and irrigation with no scope for artificial recharge.

Priority-1 (Area where groundwater development >100%)

- Based on the village wise GEC 2020 estimates an area consisting of 159 villages having 798 km^2 covered under Priority-1, where 87 MCM recharge potential and 34 MCM utilizable yield (uncommitted run-off) is available and immediate intervention is required where the stage of groundwater development is >100%. The management plan for Priority-1 area is given in Fig. 6.1 and Annexure-1.
- About 77 artificial recharge structures were constructed (PTs: 29, CDs: 48) in 25 villages with existing storage capacity of 2.32 MCM.
- About 321 artificial recharge structures (205 mini PT's with 1.5 fillings with a unit cost of Rs. 20 lakhs each and 116 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 58 Crores can be taken up.
- After effective utilization of this yield, there will be 7 MCM of groundwater recharge with 100% recharge efficacy.
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).

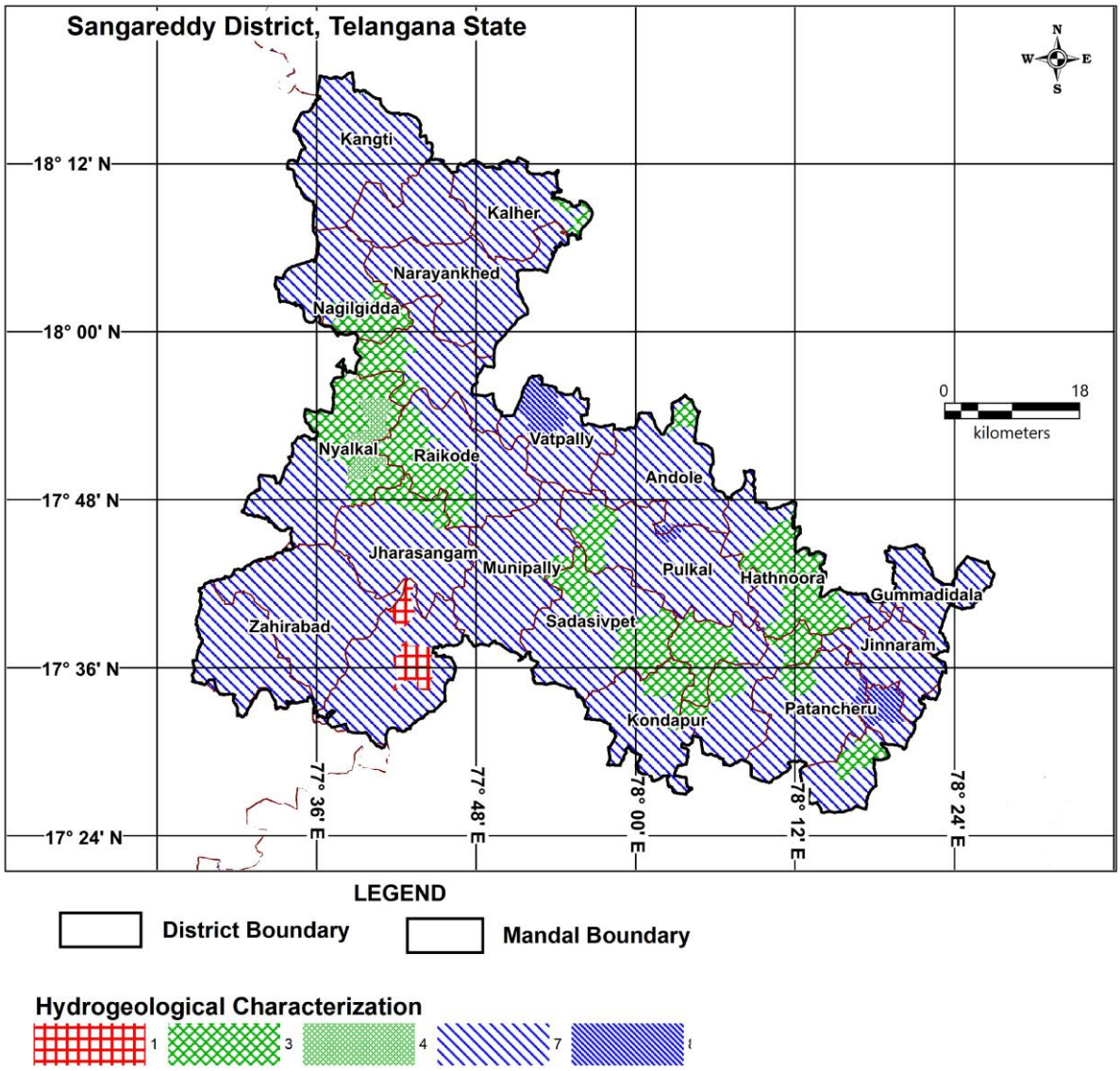

Fig. 6.1: Priority area for sustainable management plan of ground water resources.

Priority-2 (Area where groundwater development <100%)

- Area consisting of 441 villages having 3653 km^2 covered under Priority-2, where 465 MCM recharge potential and 143 MCM utilizable yield (uncommitted run-off) is available and immediate intervention is required. The management plan for Priority-2 area is given in Fig. 6.1 and Annexure-2.
- About 128 artificial recharge structures were constructed (PTs: 51, CDs: 77) in 67 villages with existing storage capacity of 4 MCM.
- Artificial recharge structures are recommended for 50% of the utilizable yield in the intermittent areas.

- About 1255 artificial recharge structures (687 mini PT's with 1.5 fillings with a unit cost of Rs 20 lakhs each and 568 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 223 Crores can be taken up.
- After effective utilization of this yield, there will be 31 MCM of groundwater recharge with 100% recharge efficacy.
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings.

6.1.1.4 Water Conservation Measures (Farm Ponds):

The farm ponds are the ideal water conservation structures, which are constructed in the low lying areas of the farm. The size of form ponds can be 10 x 10 x 3 m. The total 12000 farm ponds are recommended (20 in each village in 600 villages) at Rs 25,000/-each with total cost of 30 Crores, this can create an additional storage of 3.6 MCM.

Other Supply Side Measures

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

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

6.1.2.1 Ongoing Micro-irrigation

- In the area till date, a total 15598 ha. area is brought under micro-irrigation (Sprinklers: 2338 and drip: 10499) saving 23 MCM of groundwater (considering 25% of saving to traditional practices).

6.1.2.2 Proposed Micro-irrigation (MI)

- About 10716 ha. of additional land that can be brought under micro-irrigation (where actual area irrigated though MI is less than 1,000 ha.) costing about 64 Crores (considering 1 unit/ha. @0.6 lakhs/ha.). With this, about 16 MCM of groundwater can be conserved over the traditional irrigation practices (considering 25% of net saving for ID crops).

6.1.3 Other Recommendations

- Declaration of MSP in advance (before start of season) and improved facilities at procurement centres.
- As a mandatory measure, every groundwater user should recharge rainwater through artificial recharge structures in proportionate to the extraction.
- Roof top rainwater harvesting structures should be made mandatory to all Government/industrial buildings (new and existing).
- Capacity building in power supply regulation (4 hour each in morning and evening) will increase the sustainability of wells.
- Participatory Ground Water Management (PGWM) approach in sharing of groundwater and monitoring resources on a continuous basis along with effective implementation of the existing 'Water, Land and Trees Act' of 2002 (WALTA-2002).
- Subsidy/incentives on cost involved in sharing of groundwater may be given to the concerned farmers
- 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. 375 Crores, the likely benefit would be increases in gross groundwater availability with net saving of 58 MCM of groundwater or net reduction of 10% in stage of groundwater extraction, i.e., from the existing 63 to 53%. The onetime cost will be 6 paisa/litre and the actual cost of invest will be 0.6 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

Acknowledgments

The author thanks Sh. Sunil Kumar, Chairman, Sh. Anoop Nagar, Member (HQ) of the Central Ground Water Board, Govt. of India, Sh. Sh. J. Siddardha Kumar, Regional Director, Sh. Ravi Kumar Gumma, Sc-C and Dr.G.Praveen Kumar, Sc-C for their encouragement and guidance. The author acknowledges State Ground Water Department and Rural Water Supply department, Govt. of Telangana for making available of field data. Author also thanks the Executive Engineer and his drilling crew of CGWB, for carrying out the exploration activity.

Annexure – I

Proposed interventions in Priority-1 areas (Area where ground water development >100 %), Sangareddy district.

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Ameenapur	Ilapur			1	1
Andhole	Brahampally				3
Andhole	Kansanpally			1	2
Andhole	Kondareddypally				
Andhole	Rollapahad			1	
Andhole	S.R.M.Pally				3
Gummadidala	Anantharam			1	1
Gummadidala	Dharmaram		4		
Hathanoora	Akwancheguda	7			
Hathanoora	Chanadapur		2	1	
Hathanoora	Cheekmaddur			1	2
Hathanoora	Devulapalli			1	
Hathanoora	Doulathabad	3	3		
Hathanoora	Gundlamachanur	11			3
Hathanoora	Kodapak	8			2
Hathanoora	Konyal			2	2
Hathanoora	Lingapur			1	2
Hathanoora	Madhura			1	
Hathanoora	Malkapur				2
Hathanoora	Nasthipur			1	
Hathanoora	Reddykhanapur			2	1
Hathanoora	Royyapalli	3			2
Hathanoora	Sadullanagar	3			
Hathanoora	Seri Sirpura				
Hathanoora	Shairkhanpalli	3			
Hathanoora	Taherkhanpet				1
Jharasangam	Bardipur			1	
Jharasangam	Bopanpalle			1	
Jharasangam	Boregaon			1	2
Jharasangam	Islampur				3
Jharasangam	Jharsangam			1	2
Jharasangam	Krishnapur				3
Jharasangam	Kuppanagar			2	2
Jharasangam	Medpalle			1	2
Jharasangam	Potpalle				
Jharasangam	Pyarawaram				2

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Jinnaram	Amdoor	1		1	2
Jinnaram	Madhavaram			1	1
Jinnaram	Palem				1
Jinnaram	Puttuguda				3
Jinnaram	Shivanagar				
Kalher	Bachepally			4	1
Kalher	Kalher			3	1
Kalher	Khanapur.B	3	1		
Kalher	Mahadevpally				
Kalher	Mardi			2	4
Kalher	Masanpally			1	1
Kalher	Meerkhanpet			1	1
Kalher	Nagdhar			5	4
Kalher	Raparthy			3	1
Kandi	Chiduruppa			1	
Kandi	Erdanoor				
Kandi	Kashipur		1		1
Kandi	Koulampet				
Kandi	Mamidipally			1	1
Kangti	Banswada		2	1	
Kangti	Ghanpur	1	2		
Kangti	Jumgi.B.		3	1	
Kangti	Jumgi.K			1	
Kangti	Murkunjal	1	4		
Kangti	Tadkal,			2	3
Kangti	Valmoor	1			3
Kondapur	Garakurthy				3
Kondapur	Girmapur				1
Kondapur	Gopularam				1
Kondapur	Haridaspur				2
Kondapur	Mallepally			1	
Kondapur	Saidapur				
Manoor	Dawoor			1	2
Manoor	Dosapally			1	
Manoor	Maqudumpur			1	1
Manoor	Thumnoor				3
Mogdampalle	Asadgunj				
Mogdampalle	Auranganagar		1	1	
Mogdampalle	Dhanasiri		1		
Mogdampalle	Godegarpalle				

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
	(Pattidhanasiri)				
Mogdampalle	Gousabad		1	1	1
Mogdampalle	Khanjamalapur				
Munipalli	Magdempally				1
Munipalli	Takkadpally				2
Nagalgidda	Keshwar			1	1
Nagalgidda	Pusalpad			1	2
Nagalgidda	Shapoor				
Narayankhed	Allapur				2
Narayankhed	Anthwar				2
Narayankhed	Bhanapur				1
Narayankhed	Gangapur			2	3
Narayankhed	Jagannathpur				2
Narayankhed	Jujalpur				1
Narayankhed	Kondapur			1	1
Narayankhed	Malharpur				1
Narayankhed	Mansurpur				2
Narayankhed	Narsapur			1	
Narayankhed	Paidipally				3
Narayankhed	Ryakal				1
Narayankhed	Sanjeevanraopet			3	1
Narayankhed	Venkatapur				2
Naykal	Ameerabad			1	
Naykal	Atnur			1	1
Naykal	Basanthpur				3
Naykal	Chalki			2	
Naykal	Cheekurthi			2	
Naykal	Chingepally			1	2
Naykal	Dappur			2	3
Naykal	Gangwar				3
Naykal	Ganjoti			1	2
Naykal	Humnapur				3
Naykal	Hussain nagar			2	
Naykal	Kakaijanwada			1	1
Naykal	Khaleelpur.M				3
Naykal	Malgi			1	3
Naykal	Malkanpahad.				1
Naykal	Mamidgi			2	2
Naykal	Mariampur			1	3
Naykal	Metalkunta			1	3

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Naykal	Mirzapur.B.				3
Naykal	Mirzapur-N				3
Naykal	Mungi			2	
Naykal	Murthuzapur			1	
Naykal	Naimatabad			1	2
Naykal	Nyalkal			3	2
Naykal	Raghapur			1	1
Naykal	Rajola			1	
Naykal	Ramtirth			1	1
Naykal	Ratnapur			2	1
Naykal	Rukmapur				3
Naykal	Shamshallapur			1	1
Patancheruvu	Bachaguda				2
Patancheruvu	Bandalguda				1
Patancheruvu	Chitkul			2	
Patancheruvu	Chitkul			2	
Patancheruvu	Kardanur				3
Patancheruvu	Pocharam			1	1
Pulkal	Gangojipet				3
Pulkal	Kudur			1	2
Pulkal	Pulkal			2	2
Ramachandrapuram	E.N.pally			1	
Ramachandrapuram	Osman Nagar				2
Ramachandrapuram	Tellapur			2	3
Regode	M.Venkatapur	3			2
Regode	Sinddole				1
Sadasivpet	Enkepally				3
Sadasivpet	Istritabad				1
Sadasivpet	Kambalpally		1		1
Sadasivpet	Meligirpet		1		
Sadasivpet	Rejintal				3
Sadasivpet	Siddapur		1	1	
Sangareddy	Irrigipally				2
Sirgapoor	Gosaipally				1
Watpalle	Shadnagar				
Watpalle	Watpally				
Zahirabad	Burdipahad				

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Zahirabad	Hothi - K			3	4
Zahirabad	Huggelli			4	1
Zahirabad	Hyderabad			1	1
Zahirabad	Kothur -B				
Zahirabad	Raipalle (PD)		1	1	
Zahirabad	Tamadpalle				3
Zahirabad	Tumkunta				

Annexure – II

Proposed interventions in Priority-2 areas (Area where ground water development <100 %), Sangareddy district.

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Ameenapur	Ameenpur			3	3
Ameenapur	Kistareddypet				2
Ameenapur	Patelguda				2
Ameenapur	Sultanpur			2	2
Ameenapur	Wadakpally				3
Andhole	Aksanpally			2	3
Andhole	Almaipet			3	3
Andhole	Ananthasagar			2	
Andhole	Andole			4	4
Andhole	Chinthakunta			2	3
Andhole	Dakoor			6	4
Andhole	Danampally				3
Andhole	Jogipet			2	2
Andhole	Kichannapally				2
Andhole	Kodikal			2	1
Andhole	Mansanpally			1	2
Andhole	Mansanpally			2	1
Andhole	Nadlapur			1	
Andhole	Neradigunta			2	2
Andhole	Pasanipet			2	
Andhole	Podthireddypally				
Andhole	Ramsanipally	4			1
Andhole	Saibanpet			1	3
Andhole	Sangupet			2	
Andhole	Talelama			3	2
Andhole	Thadmanoor			2	4
Andhole	Yerraram			3	2
Gummadidala	Annaram			2	2
Gummadidala	Bonthapally			2	3
Gummadidala	Dacharam				3
Gummadidala	Domadugu			1	2
Gummadidala	Gummadidala			3	4
Gummadidala	Kanukunta			6	2
Gummadidala	Kothapally	1			2
Gummadidala	Laxmapur			1	1
Gummadidala	Mambapur			3	2
Gummadidala	Nallapally			2	3
Gummadidala	Pyaranagar				3
Hathanoora	Borpatla			3	1

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Hathanoora	Chintalcheru	1		3	4
Hathanoora	Govindarajpalli			1	3
Hathanoora	Hathnoora	2	2	3	
Hathanoora	Kasala			4	2
Hathanoora	Mangapur			2	4
Hathanoora	Nagaram		1		
Hathanoora	Naguladevpalli			2	3
Hathanoora	Palpanoor			1	1
Hathanoora	Panyal			3	1
Hathanoora	Sikindarpur			3	1
Hathanoora	Sirpuram			5	4
Hathanoora	Turkalakhanapur	1		1	1
Hathanoora	Yellammaguda		2	2	
Jharasangam	Ananthasagar				2
Jharasangam	Bidekanna			2	4
Jharasangam	Chilemamidi			1	3
Jharasangam	Chilkepalle			1	3
Jharasangam	Chillepalle			1	3
Jharasangam	Devarampalle				3
Jharasangam	Edakulapalle			4	1
Jharasangam	Edulapalle			2	2
Jharasangam	Gangapur				2
Jharasangam	Giniarpally			1	
Jharasangam	Guntamarpalle			1	1
Jharasangam	Jeerlapalle			1	3
Jharasangam	junegaon				3
Jharasangam	Kakkerwada			1	2
Jharasangam	Kamalpalle				3
Jharasangam	Kappad			1	
Jharasangam	Kollur			1	2
Jharasangam	Machnoor			2	4
Jharasangam	Narsapur				2
Jharasangam	Sangam-K				2
Jharasangam	Siddapur			1	
Jharasangam	Tummanpalle			1	
Jharasangam	Vanampalle			1	1
Jharasangam	Yelgoi			3	2
Jinnaram	Bollaram	2			3
Jinnaram	Ch.Potharam	2			3
Jinnaram	Gaddapotharam				3
Jinnaram	Jinnaram			4	1
Jinnaram	Khajipally			1	2
Jinnaram	Kistaipally			1	1
Jinnaram	Kodakanchi			2	2

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Jinnaram	Mangampet			1	1
Jinnaram	Nalthur			2	3
Jinnaram	Ootla	1		1	3
Jinnaram	Solakpally				
Jinnaram	Wailal			2	4
Kalher	Bibipet			2	3
Kalher	Fathepur				3
Kalher	Khanapur.K.				3
Kalher	Krishnapur			2	2
Kalher	Mungepally	11			3
Kalher	Ramreddypet			5	2
Kandi	Arutla			1	3
Kandi	Byathole			1	
Kandi	Cheriyal			2	1
Kandi	Eddumailaram			1	1
Kandi	Indrakaran			2	4
Kandi	Julkal		1	2	
Kandi	Kalivemula		1	2	
Kandi	Kandi		1	3	
Kandi	Maktha Alloor		1		2
Kandi	Topugonda		1		
Kandi	Uttarpally		1	2	1
Kangti	Bheemra	1		1	
Kangti	Borgi.A			3	2
Kangti	Chapta.B			2	
Kangti	Chapta.K.		2	2	1
Kangti	Chowkanpally			3	2
Kangti	Damargidda P.M.			2	
Kangti	Degulwadi			3	3
Kangti	Enkenmori			2	2
Kangti	Gajulpad	1	2	1	
Kangti	Kangti			3	4
Kangti	Naganpally			1	3
Kangti	Nagoor.B.			2	2
Kangti	Nagoor.K.			1	2
Kangti	Ramtirth			1	
Kangti	Rasole				3
Kangti	Sidhangarga			2	2
Kangti	Sukkaltirth			2	1
Kangti	Turkwadgaon		2	4	
Kohir	Badampet			2	3
Kohir	Bilalpur			3	2
Kohir	Chinthalghat			1	3
Kohir	Digwal			2	3

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Kohir	Godgarpally Pattiiko			1	
Kohir	Gurujwada			1	3
Kohir	Kaveli			2	3
Kohir	Khanapur			1	
Kohir	Kohir			5	3
Kohir	Kothur D			1	
Kohir	Kothur K.			1	
Kohir	Machireddypally			1	2
Kohir	Madri			1	3
Kohir	Maniyarpally			2	3
Kohir	Nagireddypally			1	2
Kohir	Paidigammail			3	3
Kohir	Parsapally			2	
Kohir	Pitcharagadi			2	3
Kohir	Pothireddypally				
Kohir	Rajnelli				3
Kohir	Sajjapur			1	1
Kohir	Siddapur Pattikohir				
Kohir	Venkatapur			2	
Kondapur	Aliabad				3
Kondapur	Anathasagar			2	
Kondapur	Ch. Konapur			1	
Kondapur	Gadi Malkapur				2
Kondapur	Gangaram			1	2
Kondapur	Gollapally			1	2
Kondapur	Gunthapally			1	
Kondapur	Kondapur			1	3
Kondapur	Machapally				
Kondapur	Malkapur			2	1
Kondapur	Mansanpally			1	
Kondapur	Marepally			2	
Kondapur	Mohamdpur			1	1
Kondapur	Munidevunipally			1	3
Kondapur	Qutubshapet				1
Kondapur	Terpole			2	
Kondapur	Togarpally			1	3
Manoor	Athmial			2	
Manoor	Badalgaon			1	1
Manoor	Bellapur			2	2
Manoor	Borancha			3	3
Manoor	Dhanwar			1	2
Manoor	Doodgonda			1	1
Manoor	Islampur				2
Manoor	Kamalapur				2

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Manoor	Maikode			1	3
Manoor	Manoor			2	
Manoor	Nadigadda Hurkrana			1	1
Manoor	Pulkurthy			2	
Manoor	Raipally			1	1
Manoor	Ranapur			1	1
Manoor	Shaligira			1	2
Manoor	Thimmapur				3
Manoor	Thornal			1	3
Manoor	Usrikpally			1	2
Manoor	Yelgoi			5	1
Mogdampalle	Gopanpalle				
Mogdampalle	Gudpalle		1	8	2
Mogdampalle	Ippepalle		1		
Mogdampalle	Madgi				
Mogdampalle	Malkapur (JADI)			2	3
Mogdampalle	Mannnapur		1		
Mogdampalle	Mogdampalle		1	11	9
Mogdampalle	Parvathapur			1	3
Mogdampalle	Raipally				
Mogdampalle	Sarjaraopet			2	2
Munipalli	Allapur				2
Munipalli	Antharam				3
Munipalli	Beloor			1	2
Munipalli	Bodepally			1	
Munipalli	Bodishettipally				3
Munipalli	Budera				
Munipalli	Busareddypally			2	4
Munipalli	Chellapally			1	3
Munipalli	Chelmedakurd			2	
Munipalli	Chinnachelmada			2	3
Munipalli	Garilapally			2	
Munipalli	Goplaram Kalan				
Munipalli	Goreghat				
Munipalli	Hydlapur				2
Munipalli	Kallepally			1	2
Munipalli	Kamkole			2	3
Munipalli	Khamampally			2	2
Munipalli	Lingampally		1	2	
Munipalli	Lonikalan			1	3
Munipalli	Lonikud			2	
Munipalli	Maktyakysaram			1	3
Munipalli	Mallikarjunpally			1	3
Munipalli	Mansanpally			1	1

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Munipalli	Melasangam			1	2
Munipalli	Munipally			3	3
Munipalli	Polkampally				3
Munipalli	Ramchandrapur(UT)			1	
Munipalli	Rekulpahad UT				2
Munipalli	Thatpally			1	2
Nagalgidda	Audathpur			1	3
Nagalgidda	Enakpally			2	
Nagalgidda	Erakpally			3	3
Nagalgidda	Gondegam			1	
Nagalgidda	Goudgaon Janwada				
Nagalgidda	Gudoor			1	1
Nagalgidda	Karamungi			3	3
Nagalgidda	Karasguthi			3	1
Nagalgidda	Mavinhally			2	2
Nagalgidda	Morgi			2	
Nagalgidda	Mukthapur			1	2
Nagalgidda	Nagalgidda			1	3
Nagalgidda	Ootpally			1	2
Nagalgidda	Sharidamargidda			2	2
Nagalgidda	Shikarkhana			1	2
Nagalgidda	Vallor			1	1
Nagalgidda	Yerraboguda				3
Nagalgidda	Yesgi			1	2
Narayankhed	Gatlingampally			1	
Narayankhed	Abbenda			3	3
Narayankhed	Ananthasagar			3	2
Narayankhed	Chand Kanpally				2
Narayankhed	Chandapur	7			2
Narayankhed	Chaptka-K			1	3
Narayankhed	G.Hukarana			1	
Narayankhed	Hangarga-B			1	1
Narayankhed	Hangarga-K			2	2
Narayankhed	Hanmathraopet	8			1
Narayankhed	Jukal	3			2
Narayankhed	Kamjipur			1	3
Narayankhed	Lingapur	3			2
Narayankhed	Madhwar		1	3	1
Narayankhed	Nagapur			1	
Narayankhed	Namalimet		2	1	
Narayankhed	Narayankhed			2	
Narayankhed	Nizamapet	1		4	2
Narayankhed	Panchagoan			1	
Narayankhed	Pipri			1	

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Narayankhed	Rudrar	1			1
Narayankhed	Ryalamadugu	3			
Narayankhed	Sathagoan		4	1	
Naykal	Ganeshpur			1	1
Naykal	Handnoor			3	2
Naykal	Husselli			1	1
Naykal	Ibrahimpur			1	3
Naykal	Kalbemula			2	1
Naykal	Rejintal			3	3
Naykal	Tatpally				3
Naykal	Tekur			1	
Naykal	Waddi			1	3
Patancheruvu	Bhanoor			2	4
Patancheruvu	Chinnakanjarla	3			2
Patancheruvu	Indresham	3			3
Patancheruvu	Inole			1	1
Patancheruvu	Isnapur			2	
Patancheruvu	Kyasaram			1	3
Patancheruvu	Lakdaram	3			3
Patancheruvu	Muthangi			1	3
Patancheruvu	Nandigoun			2	4
Patancheruvu	Part Ghanpur			2	3
Patancheruvu	Pashamailaram			1	3
Patancheruvu	Patancheru			3	2
Patancheruvu	PeddaKanjarla	1		1	2
Patancheruvu	Rameshwaranmbanda			1	2
Patancheruvu	Rudraram			3	3
Pulkal	Baswapur			2	3
Pulkal	Chekriyal			1	3
Pulkal	Chowtkur			5	4
Pulkal	Gongloor			4	2
Pulkal	Hunnapur			1	1
Pulkal	Isojipet			1	3
Pulkal	Korpole			4	2
Pulkal	Laxmasagar				
Pulkal	Lingampally				3
Pulkal	Manthoor			2	2
Pulkal	Minpoor			3	3
Pulkal	Muddaipet			1	1
Pulkal	Mudimanik			3	2
Pulkal	Peddareddypet				
Pulkal	Pocharam			1	3
Pulkal	Posanpally				

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Pulkal	Raipahad				3
Pulkal	S.Itikyal			1	2
Pulkal	S.R.Guda				1
Pulkal	Sarefpally				2
Pulkal	Seripeddareddypet				
Pulkal	Shivampet			2	3
Pulkal	Singoor				
Pulkal	Sulthanpur			1	1
Pulkal	Taddanpally				3
Pulkal	Vendikole			2	
Pulkal	Venkata kistapur				3
Ramachandrapuram	Kachireddypally.				2
Ramachandrapuram	Kolluru			2	2
Ramachandrapuram	Manmole			2	3
Ramachandrapuram	R.C.puram			1	2
Ramachandrapuram	Velmela			2	2
Regode	Buranwadi				1
Regode	Chowdarpally			1	1
Regode	Dosapally				
Regode	Gajwada				
Regode	Jangiryal	1			3
Regode	Kondapur				3
Regode	Kothwalpally			1	1
Regode	Marpally	1			1
Regode	Pocharam				2
Regode	Pyararam			1	
Regode	R.Itikyal	3			
Regode	Regode	3			3
Regode	T.Lingampally			1	1
Regode	Tatpally				3
Regode	Thimmapur			1	1
Sadasivpet	Ibrahimpur				
Sadasivpet	Ankenpally		1	1	
Sadasivpet	Aroor		1		
Sadasivpet	Atmakur			2	3
Sadasivpet	Babilgoan		1	1	2
Sadasivpet	Chandapur		1		2
Sadasivpet	Ettigaddasangam			1	1
Sadasivpet	Kolkur			2	
Sadasivpet	Konapur		1		
Sadasivpet	Machireddipally			1	3
Sadasivpet	Maddikunta		1	3	
Sadasivpet	Malaphad				2
Sadasivpet	Mubarakpur			2	

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Sadasivpet	Nagulapally		1	1	1
Sadasivpet	Nandikandi			2	3
Sadasivpet	Nizampur		1	3	1
Sadasivpet	Peddapur		1	2	2
Sadasivpet	Pottipally			1	1
Sadasivpet	Sadasivpet			3	3
Sadasivpet	Suraram		1		
Sadasivpet	Tangadpally				
Sadasivpet	Veltoor		1	3	2
Sadasivpet	Venkatapur		1	1	2
Sadasivpet	Yawapur				1
Sadasivpet	Yellaram			1	
Sangareddy	Chinthalpally				2
Sangareddy	Fasalwadi			2	
Sangareddy	Ismailkhanpet			2	2
Sangareddy	Kalabgur			2	
Sangareddy	Kalwakunta		1	1	
Sangareddy	Kothulapur		1	1	2
Sangareddy	Kulabgur		1	1	
Sangareddy	Md.Shapur		1		
Sangareddy	Nagapur				2
Sangareddy	Pothireddypally		1	1	
Sangareddy	Sangareddy		1	1	1
Sangareddy	Tadlapally		1		2
Sirgapoor	Antergaon			2	
Sirgapoor	Bokkasagaon			1	
Sirgapoor	Kadpal			4	4
Sirgapoor	Khajapur			1	2
Sirgapoor	Murbarakpur			1	1
Sirgapoor	Pochapur			1	1
Sirgapoor	Sirgapur			5	2
Sirgapoor	Sultanabad				3
Sirgapoor	Cheemalpad				3
Sirgapoor	Garidegaon				3
Sirgapoor	Goudgaon.K.			1	1
Sirgapoor	Potpally			1	2
Sirgapoor	Sangam.				2
Sirgapoor	Wangdhal			2	1
Sirgapoor	Wasar			3	2
Sirgapoor	Ujalampad			1	2
Watpalle	Bijilipur	3			1
Watpalle	Buddaipally		1		1
Watpalle	Gorrekal				
Watpalle	Gowthapur			1	

New-Mandal	Village	Existing No. of Check Dams	Existing No. of Percolation Tanks	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for intermittent areas
Watpalle	Keroor	3			1
Watpalle	Marvelli			2	
Watpalle	Nagulpally				
Watpalle	Palwatla			1	1
Watpalle	Pothulabaguda		2		
Watpalle	Bhootkur				
Watpalle	Devnoor				
Watpalle	Dudyal				
Watpalle	Khadirabad			5	4
Watpalle	Medikunda				
Watpalle	Nirjipla			2	
Watpalle	Paladgu			1	1
Watpalle	Usrikapally				
Zahirabad	Algole				
Zahirabad	Allipur			1	1
Zahirabad	Anegunta			2	4
Zahirabad	Buchnelli				
Zahirabad	Chiragpalle				
Zahirabad	Didigi				
Zahirabad	Hothi - B			7	3
Zahirabad	Kasimpur				
Zahirabad	Malchelma			3	3
Zahirabad	Pastapur			1	2
Zahirabad	Ranjole			4	3
Zahirabad	Satwar				
Zahirabad	Shaikapur			5	3
Zahirabad	Zahirabad - R			6	1

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