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

NAGARKURNOOL DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

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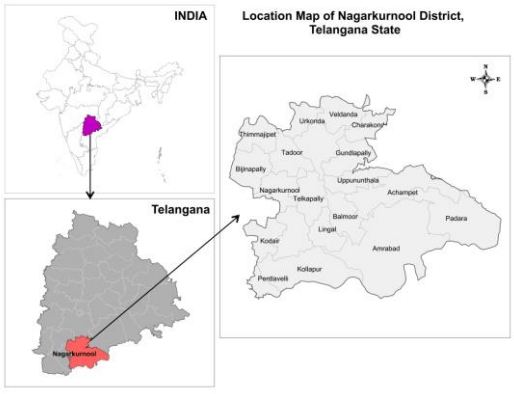
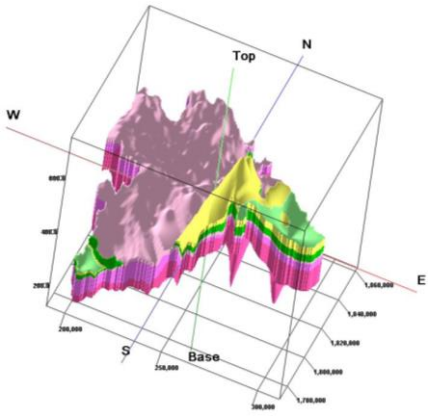
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT &
GANGA REJUVENATION

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





CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD

DECEMBER 2021

REPORT ON
AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN NAGARKURNOOL DISTRICT, TELANGANA STATE
(AAP 2021-22)

CONTRIBUTORS' PAGE

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Supervision & Guidance

1. Sh. J. Siddhardha Kumar, Regional Director

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 for Sustainable Management of Ground Water Resources in Nagarkurnool 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. G. Praveen Kumar, Scientist – C (Hydrogeology) & Dr. S. S. Vittala, Scientist - B (Hydrogeology) and the efforts made by the officers 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 Mahabubnagar district in the year 2017-18, 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

EXECUTIVE SUMMARY

The Nagarkurnool district covering 6,396 km^2 carved from erstwhile Mahabubnagar, district. Administratively the area is governed by 20 revenue mandals, 4 revenue divisions covering 349 revenue villages with a population of ~8.61 lakhs (2011 census) (urban: ~10 %, rural: ~90 %) with average density of 135 persons/km^2. A large patch of hilly and forest area occupying 39% is noticed towards southern and south eastern part of district.

The normal annual rainfall varies between 539 mm (Charakonda) and 757 mm (Padara) with average of 629 mm. SW monsoon contributes 72 % and 18 % is contributed by retreating monsoon (NE) season and rest by winter and summer rainfall. Rainfall increases from south-west to north and south-east direction. The area received average annual rainfall of 1088 mm (69 % large excess rainfall than normal) during the year 2020-21.

The district is contiguous part of Mysore Plateau and characterised by erosional topography with general slope is towards east and south. Pediplain is the major landform followed by pediment and dissected plateau, etc. The drainage is mainly dendritic to sub-dendritic in nature and it is part of the River Krishna basin and Krishna Middle Sub-basin. The major river that drains in the district is Dindi and their tributaries.

The forest occupies about 39% of the total geographical area, barren and uncultivable land occupies 4% of area; land put to non-agricultural use is 2%, cultivable wasteland is 2%. With respect to land utilization, out of total area, 10% of the area is falling under current fallows; 5% is under other fallows. The net area sown is about 37% and area sown more than once is 7% which brings gross cropped area to 43%. During kharif season, out of total gross cropped area, the Cotton is grown in 62% of the area followed by Maize in 15%, Paddy in 11% and other crops in 12% of the area while during rabi season, Groundnut is grown in 53% of the area followed by Paddy in 39% of the area and others crops in 9% of the area. Majority of soils are occupied by fine mixed soils followed by loamy-skeletal & rock lands soils.

The Dindi river alluvium has a maximum thickness of ~10 m and width of 250 m. The major lineaments in the area trend in NS and EW. The courses of Dindi river also follow major lineaments trending NW-SE and NNW-SSE respectively. Another major E-W lineament also runs in the central part of the district form Nagarkurnool to north of Gadwal passing close to Wanaparthy town.

Water level data of 2019 varies from 3.7 to 42 meter below ground level (m bgl) (average: 15.89 m bgl) and 1.4 to 38.5 m bgl (average: 11.80) during pre-monsoon (May) and post-monsoon (November) season respectively. Majority of the water levels during this season are in the range of 10-20 m, covering 38 % of the area, followed by 5-10 m bgl (28% of the area) and >20 m bgl (28% of the area). The Deep water levels > 20 m bgl also occupy about 20 % of the area covering northern and central part of the district. During post-monsoon season too, majority of the water levels during this season are in the range of 10 to 20 m bgl, covering 34 % of the area noticed in central and eastern part of the district. The water levels in the ranges of 5 to 10 m bgl occupy 25 % of the district. The water a level in the range of 2 to 5 m bgl is covering in 25% of the area while the water level >20 m bgl occupy 18 % area. The shallow water levels <2 m bgl is noticed in 2% of area.

The ground water quality reveals that during pre-monsoon, the NO_3 concentration ranges from 1 to 674 mg/l (avg. 113 mg/l) and noticed that in about 36% of the samples it is falling within the permissible limits and in about 64% of the samples the quality is not suitable for agriculture purpose (>45 mg/l). The Fluoride concentration varies from 0.8 to 4.16 mg/l (avg. 1.03 mg/l) and in 87% of the samples, it is within the permissible limit of <1.5 mg/l and in remaining 13% of the samples it is beyond permissible limit of >1.5 mg/l and not suitable for drinking water purpose. During post monsoon season, the NO_3 concentration ranges from 0.44 to 722 mg/l (avg. 159 mg/l) and is noticed that in about 40% of the samples it is within the permissible limit (<45 mg/l) while in 60% of the samples it is beyond the permissible limit (>45 mg/l) and not suitable for agriculture purpose (Fig. 2.12). The Fluoride concentration varies from 0.25 to 2.99 mg/l (avg. 1.19 mg/l) and in about 77% of the samples, it is falling within permissible limit of <1.5 mg/l while in 23% of the samples are having high fluoride concentration beyond permissible limits (>1.5 mg/l) and are not suitable for drinking water purpose (Fig. 2.13).

The results of the GW exploration have shown that, CGWB drilled 100 bore wells (exploratory, observation and piezometers) and SGWD drilled 8 wells (piezometers) in the district. The depth drilled varies from 26 to 200 m bgl and weathering varies from 1 to 31 m bgl. The data analysed from the exploratory wells indicates 12% of the wells are shallow wells that are drilled up to a depth of <30 m bgl, 29% of the wells between the depth of 30 to 60 m bgl, 14% of the wells between the depth of 60 to 100 m bgl, 16% of the wells drilled between the depth range of 100 to 150 m bgl and about 30% of the wells are drilled between the depth range of 150 to 200 m bgl. Further, the study reveal that majority of fractures (86%)

occur within beyond 100 m depth. The Transmissivity varies from 1 to 630 m^2/day. The Storativity varies from 0.00017 to 5.

Conceptualization of 3-D hydrogeological model was carried out by interpreting and integrating 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 3-D map for the district along with panel diagram and hydrogeological sections.

As per 2020 GEC report, the net dynamic replenishable groundwater availability for newly formed district Nagarkurnool district is 444 MCM, gross groundwater draft for all uses 272 MCM, provision for drinking and industrial use for the year 2025 is 53 MCM and net annual groundwater potential available for future irrigation needs is 219 MCM. Out of 20 mandals, 2 fall under Over-exploited, 6 under Semi Critical category and 12 under Safe category. Mandal wise stage of groundwater development varies from 51 % (Achampet) to 129 % (Urkonda) with an average of 61 %.

Based on the village wise GEC 2020 estimates an area consisting of 79 villages having 468 km2 covered under Priority-1, where 63 MCM recharge potential and 4 MCM utilizable yield (uncommitted run-off) is available and immediate intervention is required where the stage of groundwater development is >100%. About 475 artificial recharge structures were constructed (PTs: 200, CDs: 275) in 37 villages with existing storage capacity of 12 MCM. About 60 artificial recharge structures (40 mini PT's with 1.5 fillings with a unit cost of Rs. 20 lakhs each and 20 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 11 Crores can be taken up. After effective utilization of this yield, there will be 1.40 MCM of groundwater recharge with 100% recharge efficacy.

Area consisting of 270 villages having 4450 km2 covered under Priority-2, where 642 MCM recharge potential and 41 MCM utilizable yield (uncommitted run-off) is available and immediate intervention is required. About 1650 artificial recharge structures were constructed (PTs: 711, CDs: 939) in 126 villages with existing storage capacity of 40 MCM. Artificial recharge structures are recommended for 50% of the utilizable yield in the intermittent areas. About 531 artificial recharge structures (265 mini PT's with 1.5 fillings with a unit cost of Rs 20 lakhs each and 266 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 93 Crores can be taken up. After effective utilization of this yield, there will be 15 MCM of groundwater recharge with 100% recharge efficacy.

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 7160 farm ponds are recommended (20 in each village in 358 villages) at Rs 25,000/-each with total cost of 18 Crores, this can create an additional storage of 2.15 MCM.

A total 8068 ha. area is brought under micro-irrigation (Sprinklers: 3161 and drip: 4848) saving 12 MCM of groundwater (considering 25% of saving to traditional practices). Additionally, about 7932 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 47 Crores (considering 1 unit/ha. @0.6 lakhs/ha.). With this, about 12 MCM of groundwater can be conserved over the traditional irrigation practices (considering 25% of net saving for ID crops).

With the above interventions costing Rs 172 crores, the likely benefit would be increases in gross groundwater availability with net saving of 30.33 MCM of groundwater or net reduction of 4 % in stage of groundwater, i.e., from 61 % to 57%. The onetime cost will be 7 paisa/litre.

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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

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 Nagarkurnool district covering 6396 km2 lies between north latitude 15°59'58" - 16°49'58" and east longitude 78°05'55" - 79°14'09" (Fig. 1.1). The district is bounded on the north by Ranga Reddy and Nalgonda district, on the east by Nalgonda and Guntur district (AP), on south by Guntur, Prakasam and Kurnool districts of AP and on west by Wanaparthy district. As per present district set up, it is carved from erstwhile Mahabubnagar district. Administratively, the area is governed by 20 revenue mandals, 4 revenue divisions covering 358 revenuevillages with a population of ~8.61 lakhs (2011 census) (urban: ~10%, rural: 90%) with average populationdensity of 135 persons/km2.A large patch of hilly and forest area occupying 39% towards southern and southeastern part of district.

1.4 Climate and Rainfall

Climate of the district is semi-arid and tropical. The normal mean daily minimum and maximum temperature of 25 ℃ and 40.9 ℃ during summer season and 16 ℃ and 26 ℃ during winter season (December month). The normal annual rainfall varies between 539 mm (Charakonda) and 757 mm (Padara) with average of 629 mm (Fig. 1.2).The SW monsoon contributes 72 % and 18 % is contributed by retreating monsoon (NE) season and rest by winter and summer rainfall. Rainfall increases from south-west to north and south-east direction. The area received annual rainfall of 1088 mm (69% large excess rainfall than normal rainfall) during the year 2020-21.

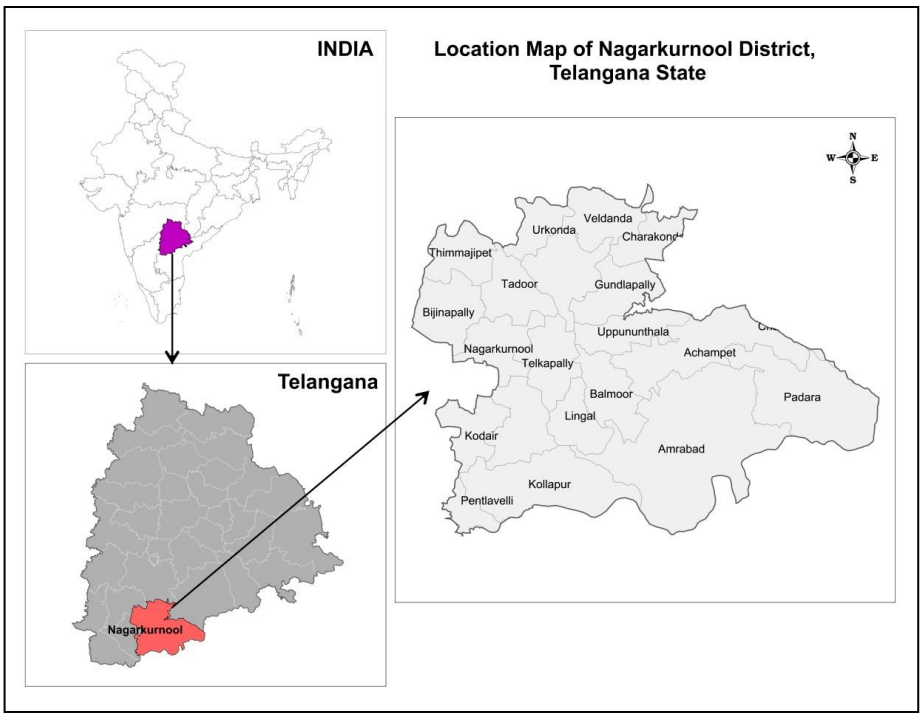

Fig.1.1: Location map.

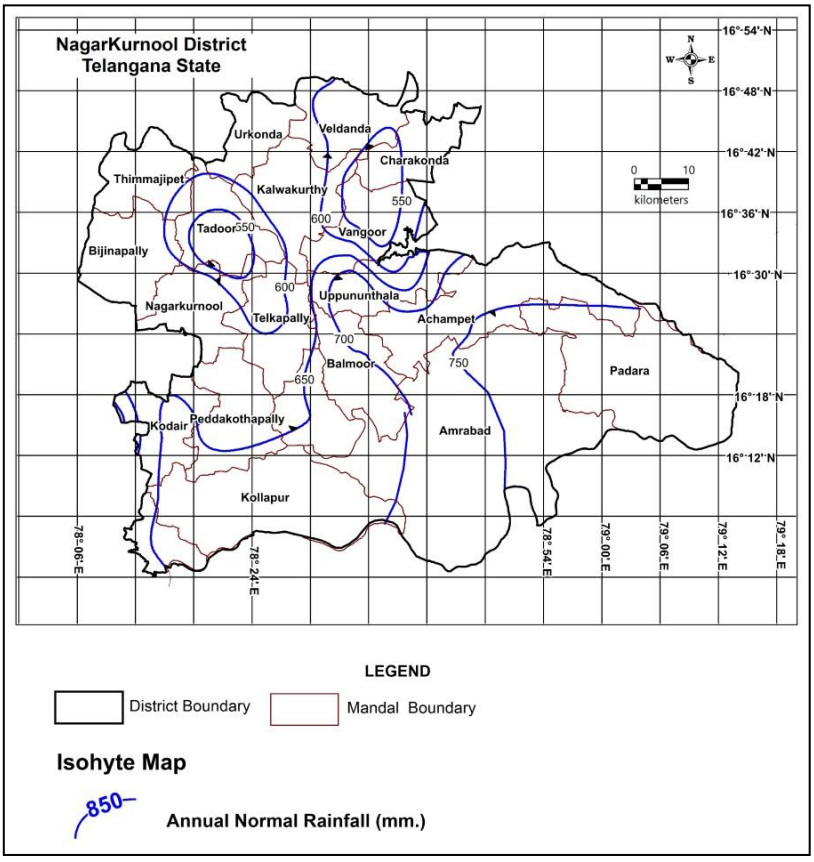

Fig.1.2: Isohyetal map.

Analysis of long term rainfall data of 20 years shows very little change in annual rainfall, with fall of 2 mm/yr. The monthly rainfall trend shows major change in rainfall distribution,

Rise in rainfall trend is observed in monsoon months from June to September, up to 3 mm/yr and fall in rainfall is observed in October and November months (Fig. 1.3a & 1.3b).

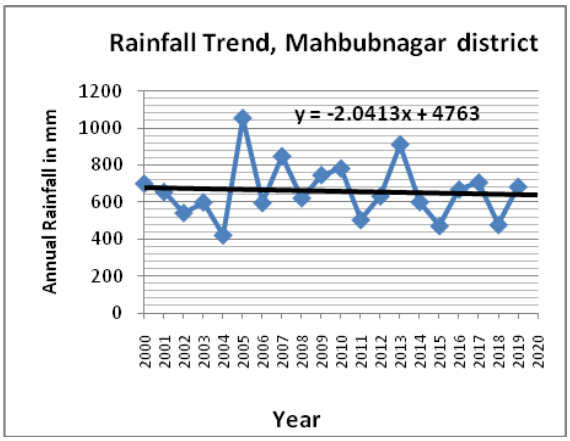

Fig. 1.3a: Annual rainfall trend

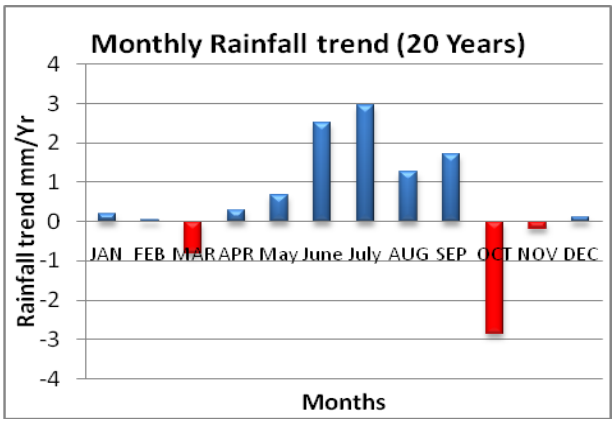

Fig. 1.3b: Monthly rainfall trend

1.5 Geomorphological Set up

Thedistrict is contiguous part of Mysore Plateau and characterised by erosional topography with general slope is towards east and south. Total mappable area is 4622 km^2, forest and hills occupy 1774 km^2 (39%). Pediplain is the major landform followed by pediment and dissected plateau, etc. (Fig.1.4).

1.6 Drainage

The drainage is mainly dendritic to sub-dendritic in nature and it is part of the River Krishna basin and Krishna Middle Sub-basin. The major river that drains in the district is Dindi and their tributaries. Map depicting drainage, hills 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, deciduous open forest, etc. Out of the total area, majority of the area (>50%) falling under kharif category followed by double crop. A significant portion of forest plantaion is also observed. The land use / land cover map is given in Fig. 1.6.

1.8 Soils

The soils from the district are mainly form loamy, fine mixed and clayey soils. Majority of soils are occupied by fine mixed soils followed by loamy-skeletal & rock lands soils. They

are grouped into 8 classes (NBS & LUP) based on geomorphology and landscapes and further sub-divided based on physiography, relief and drainage (Fig.1.7).

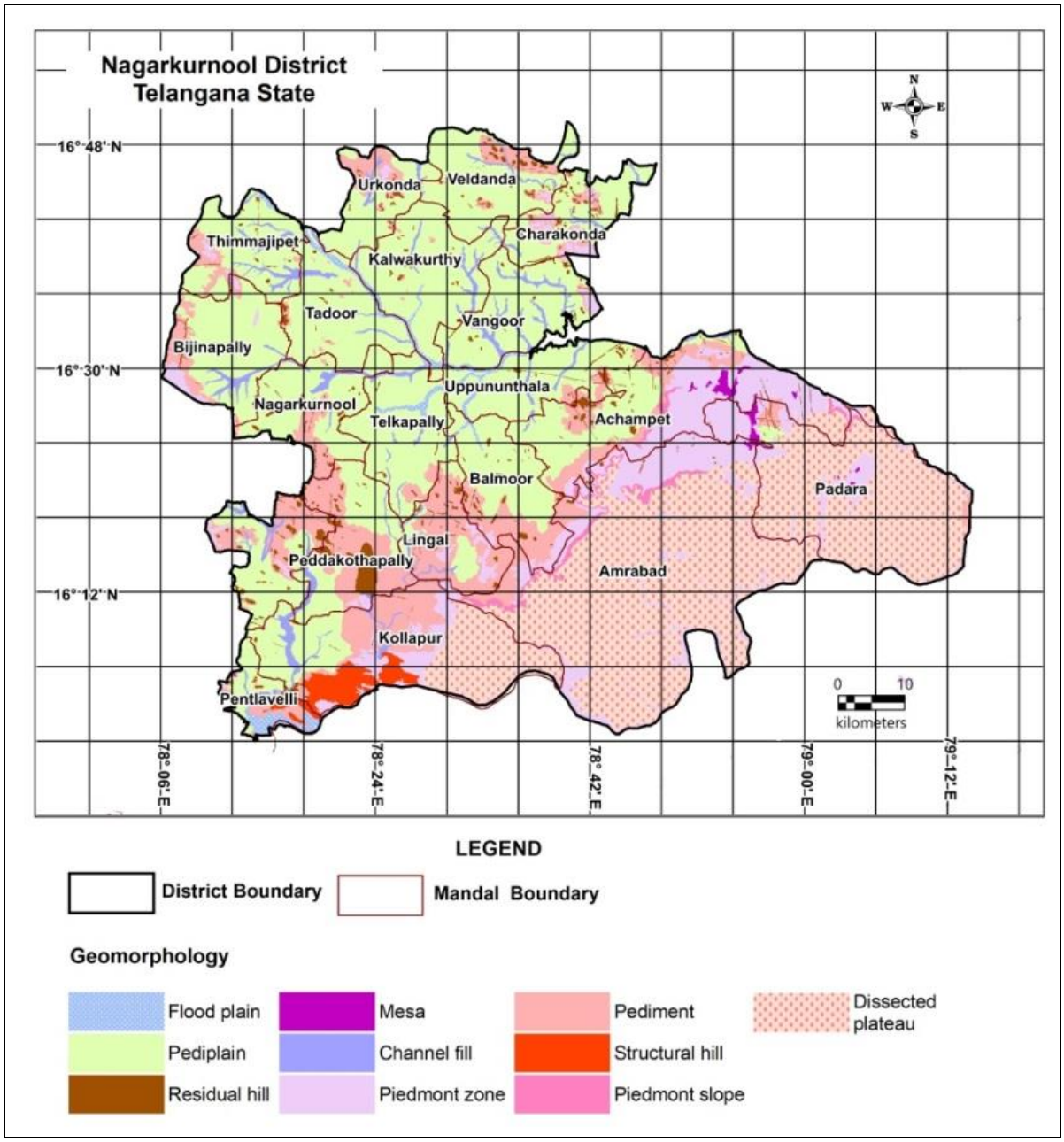

Fig. 1.4: Geomorphology map.

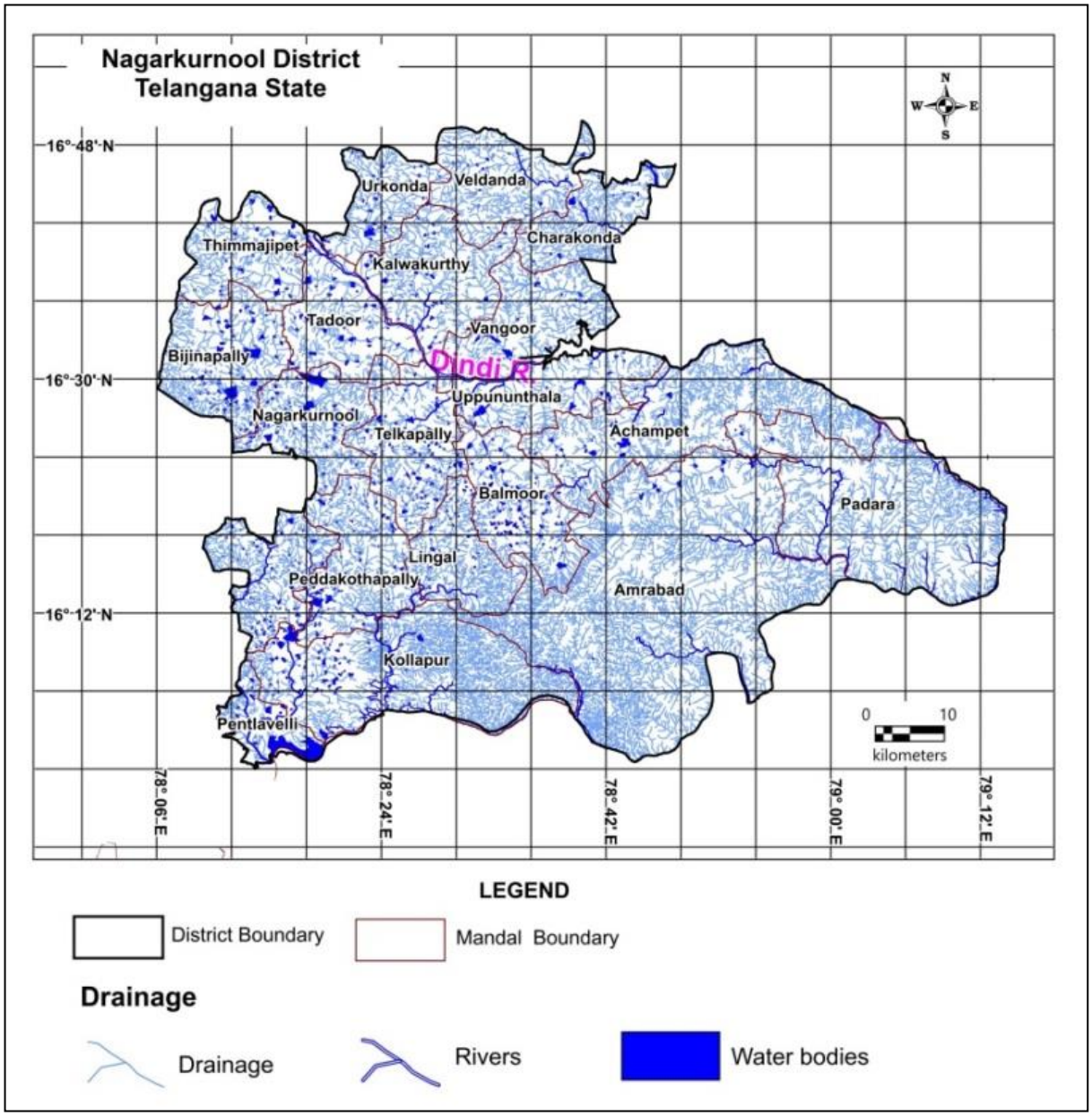

Fig 1.5: Drainage and water bodies map.

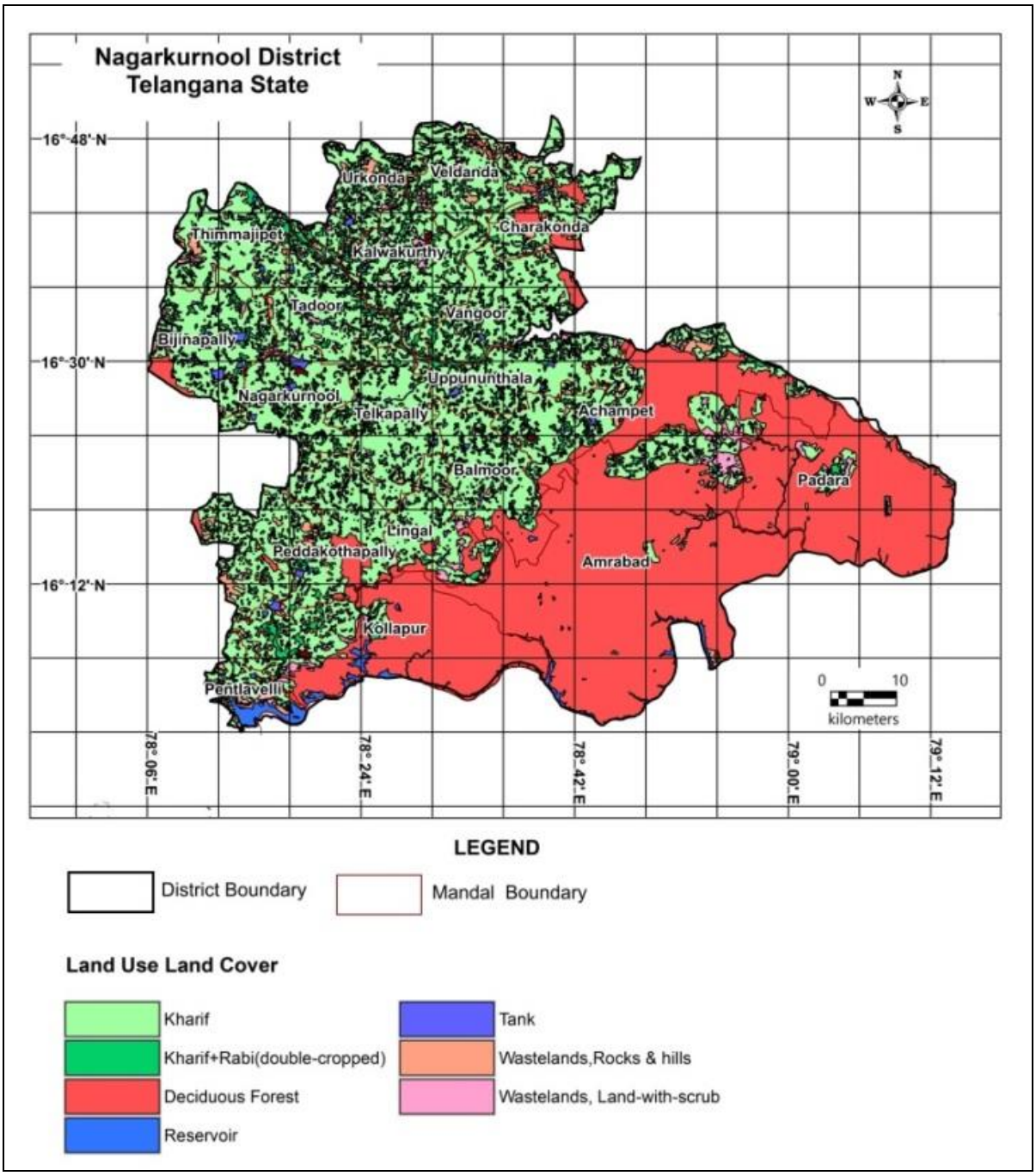

Fig. 1.6: Land use / land cover map

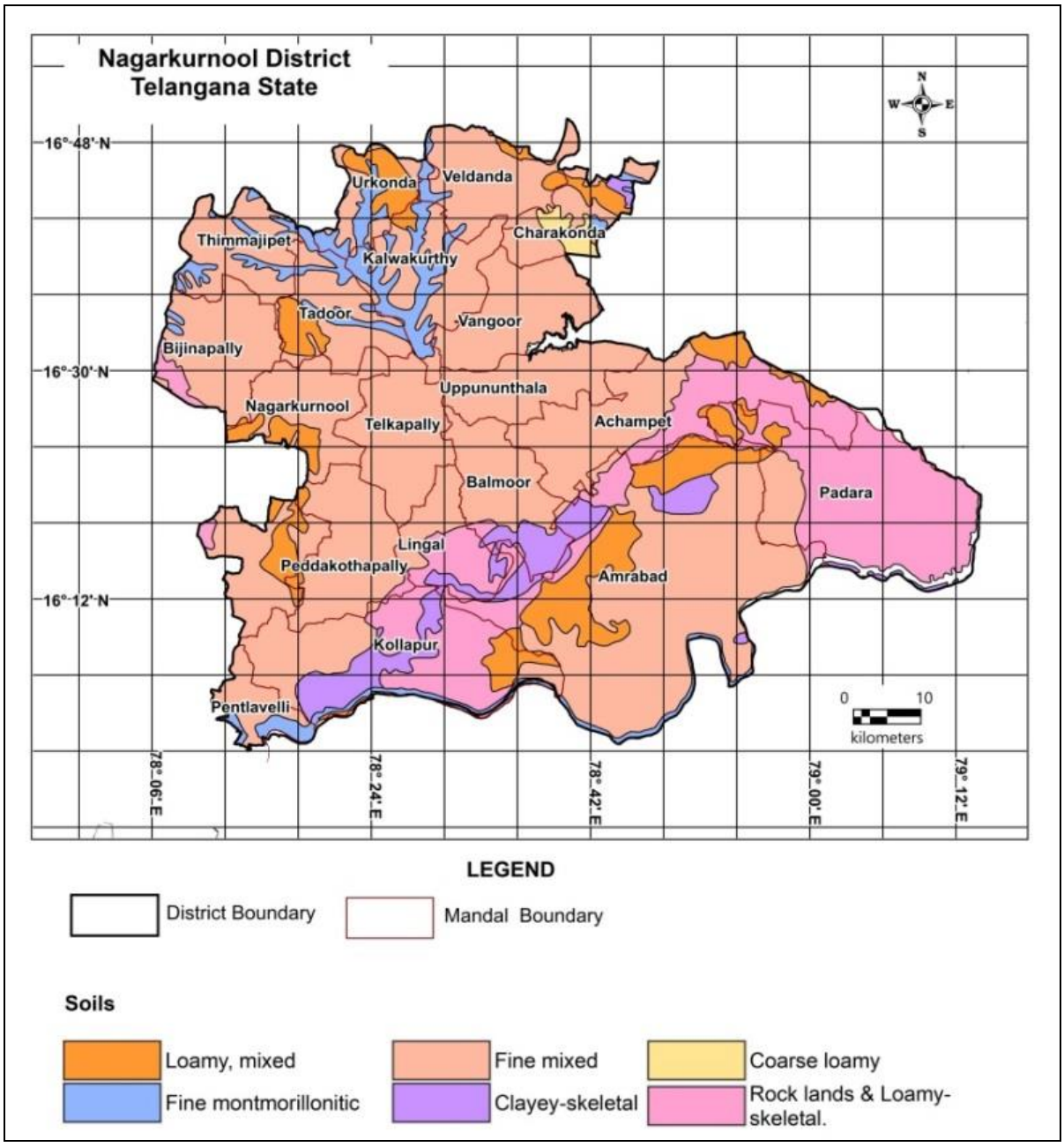

Fig. 1.7: Soil map.

1.9 Cropping Pattern (2019-20 in ha.)

The forest occupies about 39% of the total geographical area, barren and uncultivable land occupies 4% of area; land put to non-agricultural use is 2%, cultivable wasteland is 2%. With respect to land utilization, out of total area, 10% of the area is falling under current fallows; 5% is under other fallows. The net area sown is about 37% and area sown more than once is 7% which brings gross cropped area to 43%. During kharif season, out of total gross cropped area, the Cotton is grown in 62% of the area followed by Maize in 15%, Paddy in 11% and

other crops in 12% of the area while during rabi season, Groundnut is grown in 53% of the area followed by Paddy in 39% of the area and others crops in 9% of the area (Fig. 1.8).

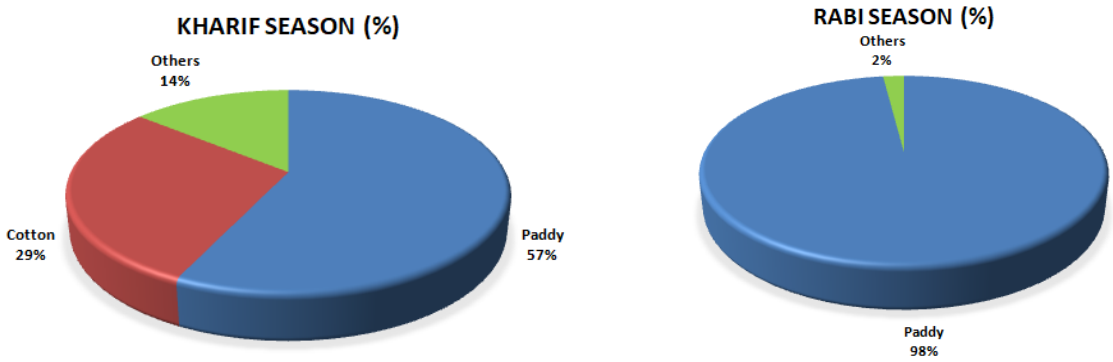

Fig. 1.8: Pie chart showing Cropping pattern trend during kharif and rabi seasons

1.10 Irrigation

In the district, there are 4 contemplated Irrigation Potential (IP) viz., Dindi project (48 ha.), Mahatma Gandhi Kalwakurthy LIS (129147 ha.), Priyadarshini Jurala Project (2414 ha.) and Rajiv Bheema LIS (3718 ha.) providing drinking water needs.Under this scheme there is proposal to lift 25 TMC of water from foreshore of Srisailam Reservoir (Fig. 1.9). In the district, there are 2,069 number of minor irrigation tanks covering 62,823 acres of Ayacut creating an irrigation potential of 2,676 ha. There are 52,652 numbers of borewells and 2,149 dug wells were noticed as per the available existing data. As per the latest GEC 2020 report, there are about ~59000 numbers of bore wells (irrigation, domestic and industrial) and ~3000 dug wells are existing in the district.

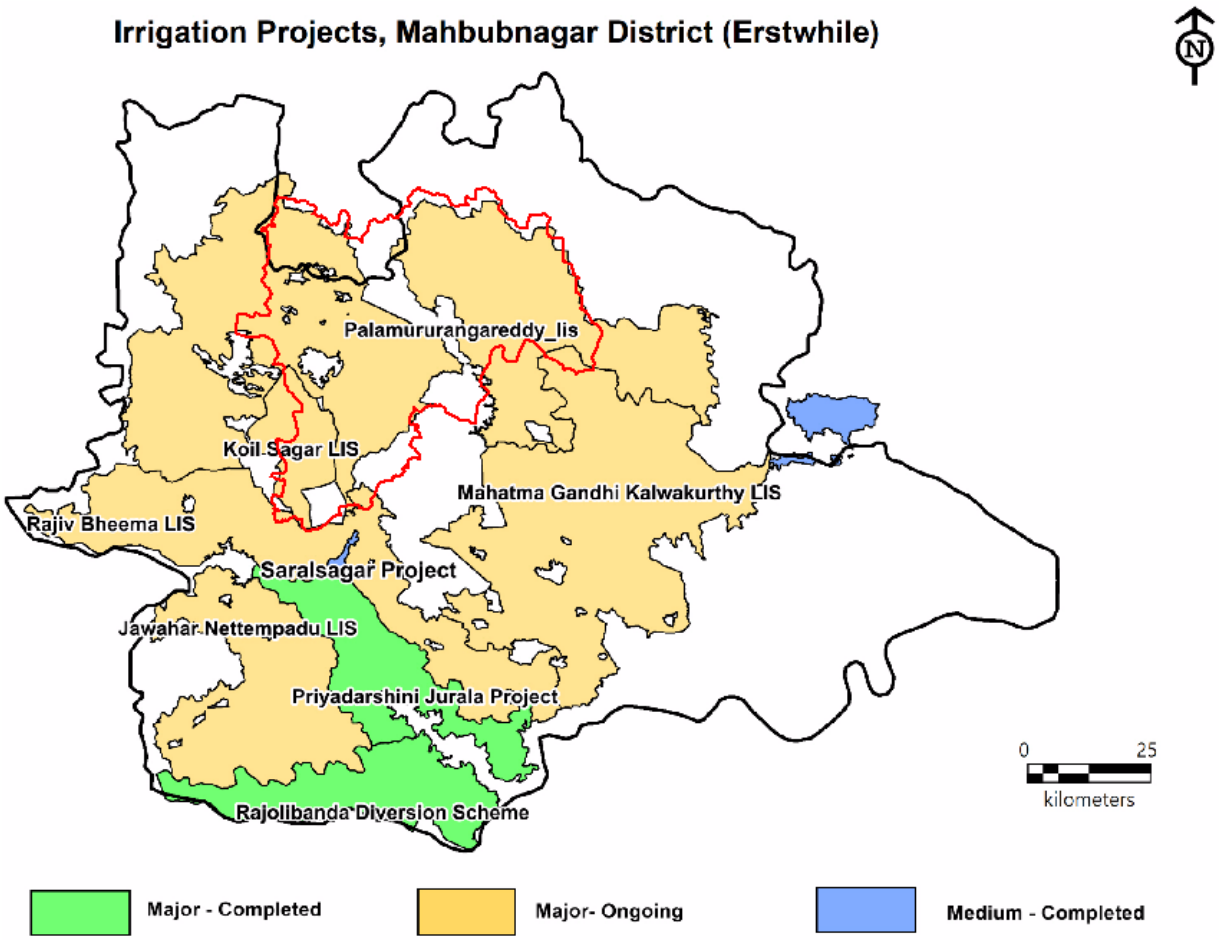

Fig. 1.9: Irrigation Projects, Mahbubnagar District (Erstwhile).

1.11 Cropping Pattern trend (Erstwhile Mahabubnagar District)

To understand the long term cropping pattern changes, 20 years data of cropping pattern were analysed. It is observed from the cropping area trend (Table 1.1) that the cropping areas of Paddy, Cotton and Pulses are increasing and the cropping areas of Millets and Oil seeds are decreasing. Over all the cropping area of the district is increasing at a rate of 8,404 ha./yr. The plots for cropping area trends are given in Fig. 1.10.

Table 1.1: Cropping area trend.

Crop	Trend ha./yr	Crop	Trend ha./yr
Paddy	2,307	Oil seeds	-8,880
Cotton	13,686	Pulses	3,494
Millets	-4,814	Total	8,404

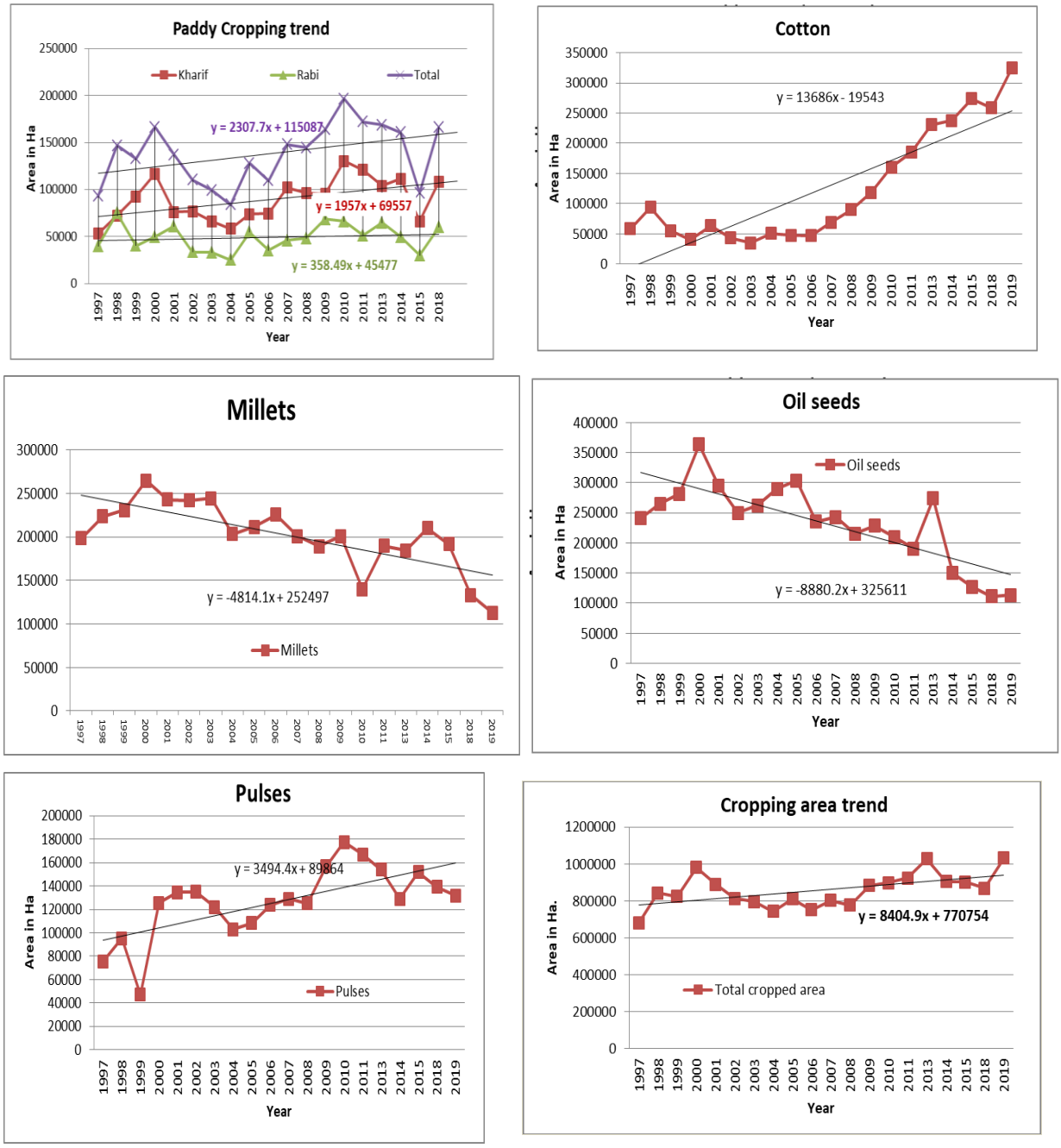

Fig. 1.10: Cropping area trend plots

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) compared to 1998-2008.

1.12 Prevailing Water Conservation/Recharge Practices

In the area, there are 2125 artificial recharge structures (PT's: 911 and CD's: 1214) are existing with combine storage capacity of 52 MCM. Under Mission Kakatiya (Phase-1 to 4), out of 2109 minor irrigation tanks, 961 tanks are desilted.

1.13 Geology

Major part of the district is underlain by Archaean rocks namely peninsular gneissic complex (PGC) (granite/gneisses) intruded by pegmatite veins/reefs and dolerite dykes at places. Kurnool group of rocks are represented by limestone and shales and occurred as patches in southern and south western part of the district. A significant part of Quartize formation is also noticed in the district and is occurred in southern and south eastern part of the district. The Dindi river alluvium has a maximum thickness of ~10 m and width of 250m. The major lineaments in the area trend in NS and EW. The courses of Dindi river also follow major lineaments trending NW-SE and NNW-SSE respectively. Another major E-W lineament also runs in the central part of the district form Nagarkurnool to north of Gadwal passing close to Wanaparthy town(Fig.1.11).

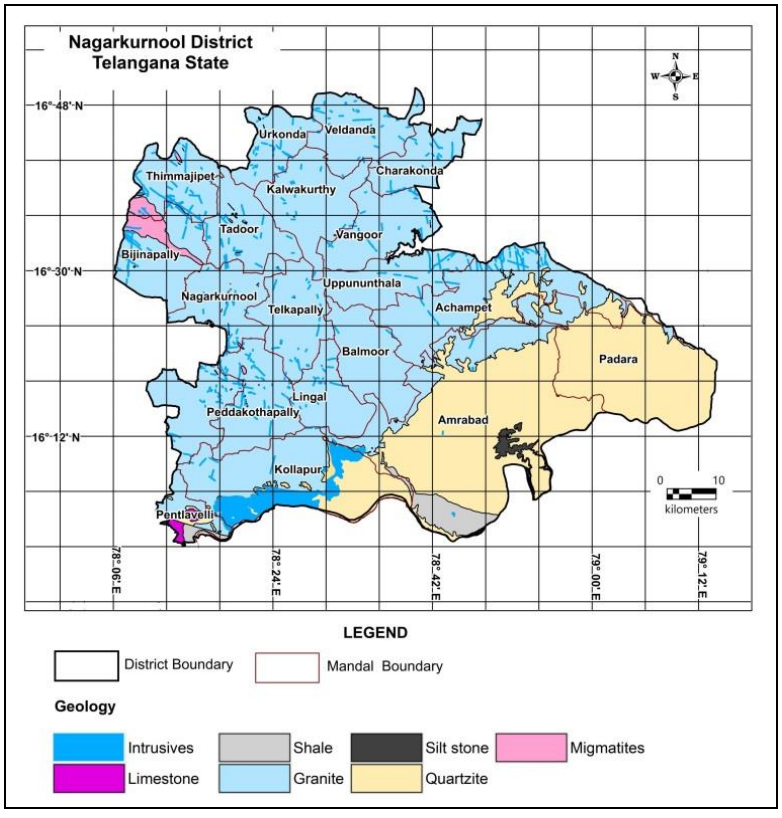

Fig. 1.11: Geology map.

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 granites 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).

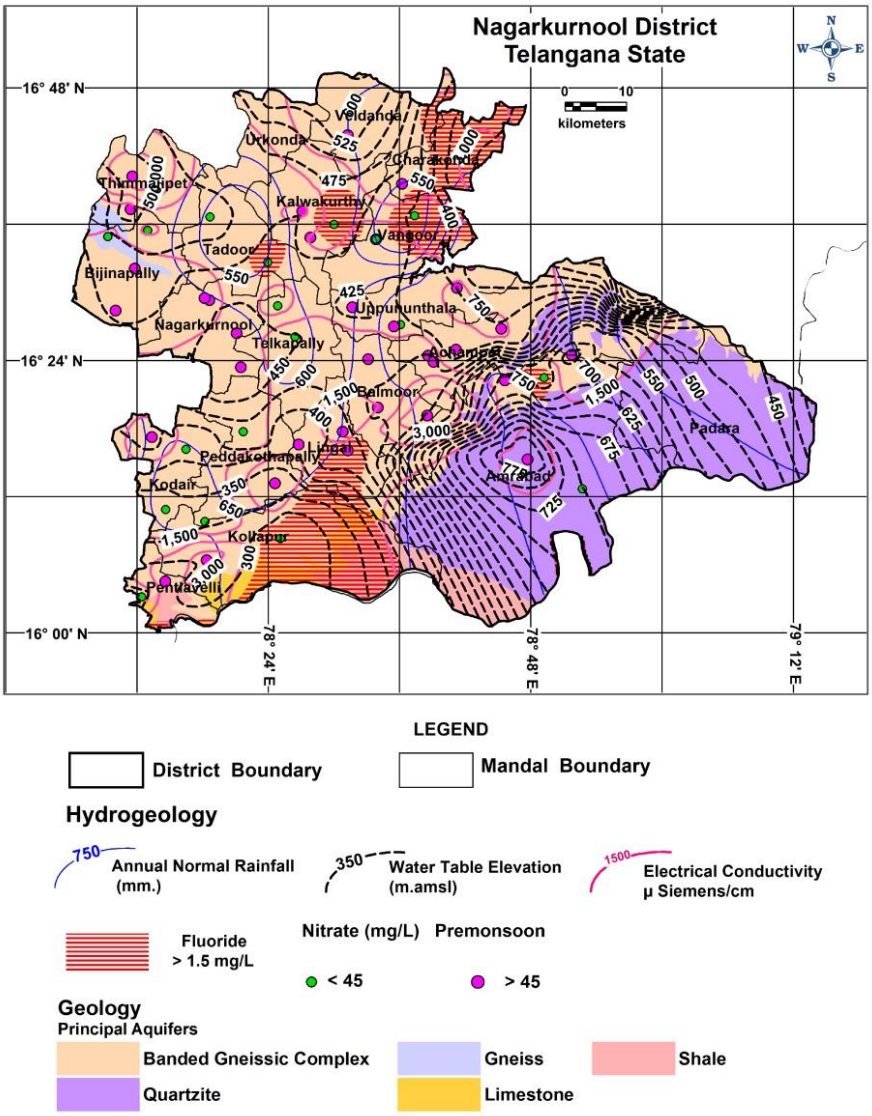

Fig. 2.1: Hydrogeology map.

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 100 bore wells (exploratory, observation and piezometers) and SGWD drilled 8 wells (piezometers) in the district. The depth drilled varies from 26 to 200 m bgl and weathering varies from 1 to 31 m bgl. The data analysed from the exploratory wells indicates 12% of the wells are shallow wells that are drilled up to a depth of <30 m bgl, 29% of the wells between the depth of 30 to 60 m bgl, 14% of the wells between the depth of 60 to 100 m bgl, 16% of the wells drilled between the depth range of 100 to 150 m bgl and about 30% of the wells are drilled between the depth range of 150 to 200 m bgl. The deeper wells of >150 m bgl are drilled in Achampet, Balmoor, Bijinapally, Kalwakurthy, Kodair, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Tadoor, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals. Further, the study reveal that majority of fractures (86%) occur within beyond 100 m depth. The deepest fractures >100 m bgl is noticed in Balmoor, Kalwakurthy, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Telkapally, Uppununthala and Urkonda 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 3.72 to 42 m bgl (average: 15.89 m bgl) and 1.4 to 38.51 m bgl (average: 11.8 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 272 to 796 and 277 to 799 m amsl respectively. The general ground water flow is towards NW-SE, E-W and N-S and ultimately joins River Dindi and River Krishna (Fig.2.2).

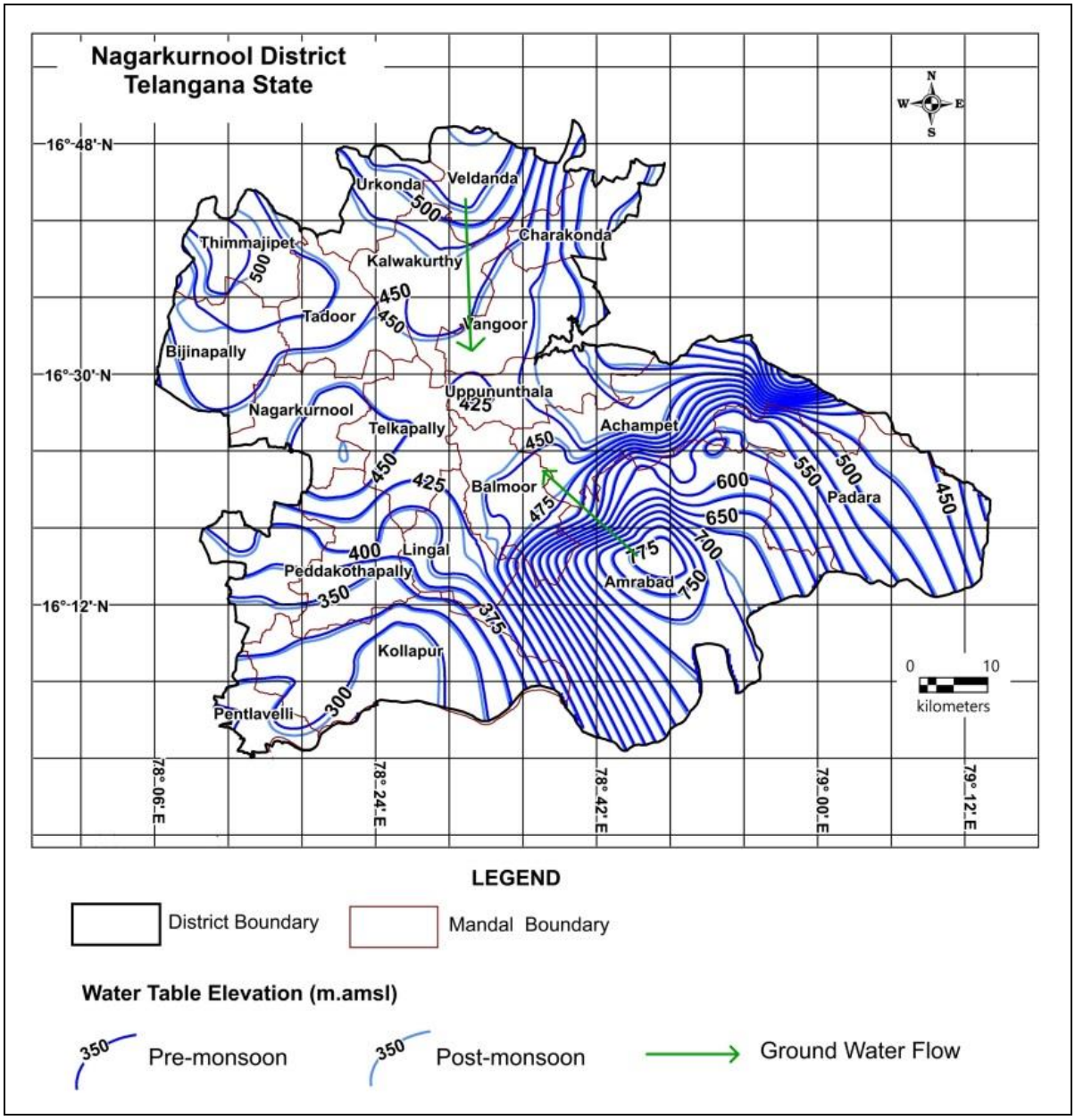

Fig.2.2: Water table elevation (m amsl) map (pre and post-monsoon).

2.2.2 Pre-monsoon depth to water level (Decadal average 2010 to 2019)

Majority of the water levels during this season are in the range of 10 to 20 m bgl and distributed in 38% of the area located in Achampet, Amrabad, Balmoor, Charakonda, Kalwakurthy, Lingal, Nagarkurnool, Peddakothapally, Telkapally, Thimmajipet,

Uppununthala, Urkonda and Vangoor mandals followed by the deeper water levels >20 m bgl (28% of the area) noticed from Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Nagarkurnool, Thimmajipet, Urkonda and Veldanda mandals and 5 to 10 m bgl in 28% of the area Amrabad, Kalwakurthy, Kodair, Kollapur, Lingal, Padara, Peddakothapally, Pentlavelli, Tadoor, Uppununthala and Vangoor mandals). There are shallow water levels of <5 m bgl is also noticed in 7% of the area Kollapur and Telkapally mandals) during this season (Fig. 2.3).

2.2.3 Post-monsoon depth to water level (Decadal average 2010 to 2019)

Majority of the water levels during this season are in the range of 10 to 20 m bgl and noticed in 34% of the area located in Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Lingal, Nagarkurnool, Peddakothapally, Thimmajipet, Uppununthala, Urkonda and Vangoor mandals followed by water levels from 5 to 10 m bgl distributed in 25% of the area falling in Achampet, Balmoor, Charakonda, Kalwakurthy, Lingal, Nagarkurnool, Peddakothapally, Tadoor, Telkapally, Uppununthala and Vangoor mandals. The water levels between 2 to 5 m bgl is noticed in 25% of the area in Amrabad, Kodair, Kollapur, Padara, Peddakothapally, Pentlavelli and Telkapally mandals. The deeper water levels of >20 m bgl (18% of the area) is observed in Amrabad, Balmoor, Bijinapally, Kalwakurthy, Urkonda and Veldanda mandals. The shallow water levels <2 m bgl is noticed in 2% of area (Kollapur mandal) (Fig. 2.4).

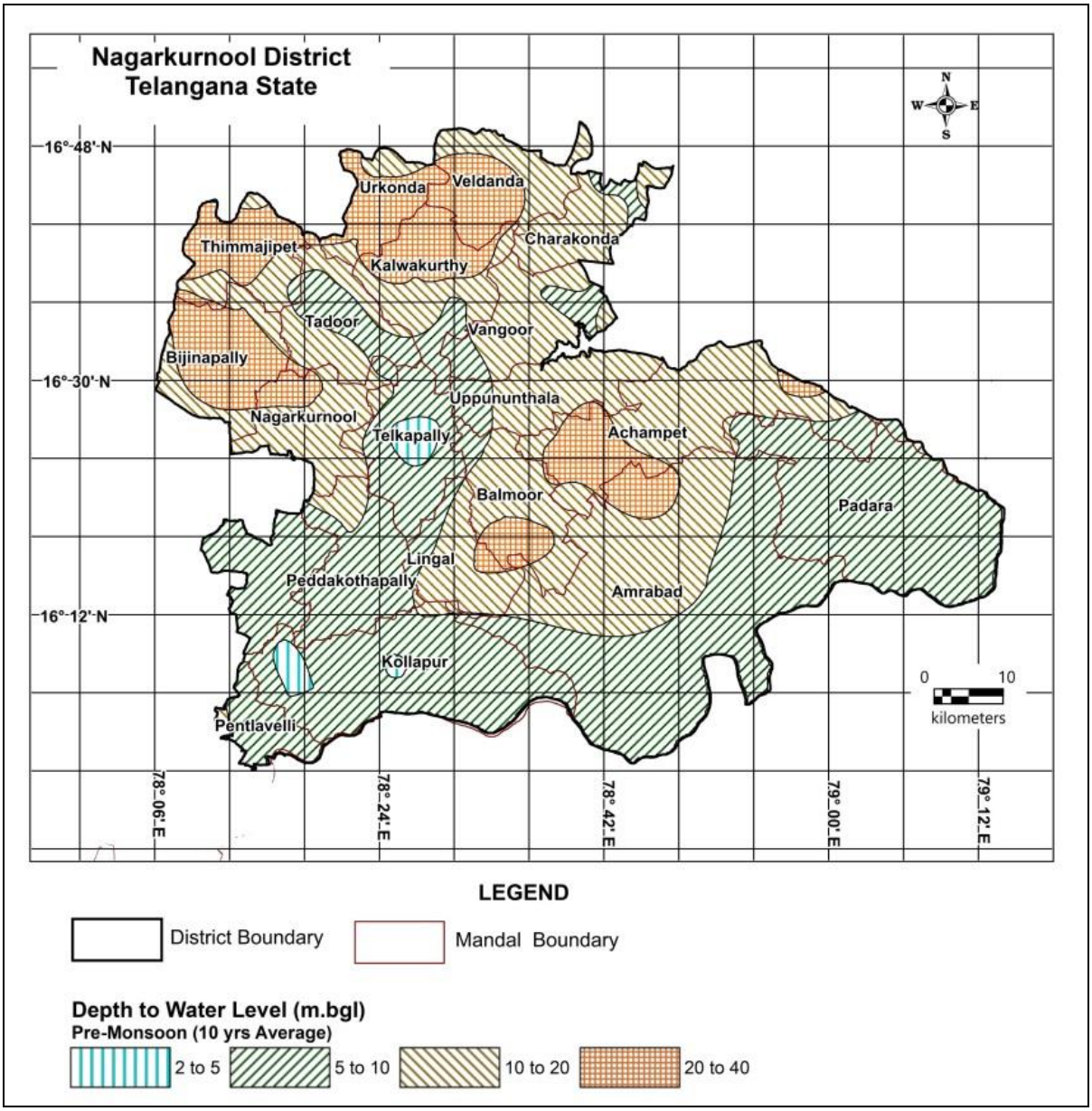

Fig.2.3: Depth to water levels Pre-monsoon (avg. of 10 years: 2010 to 2019).

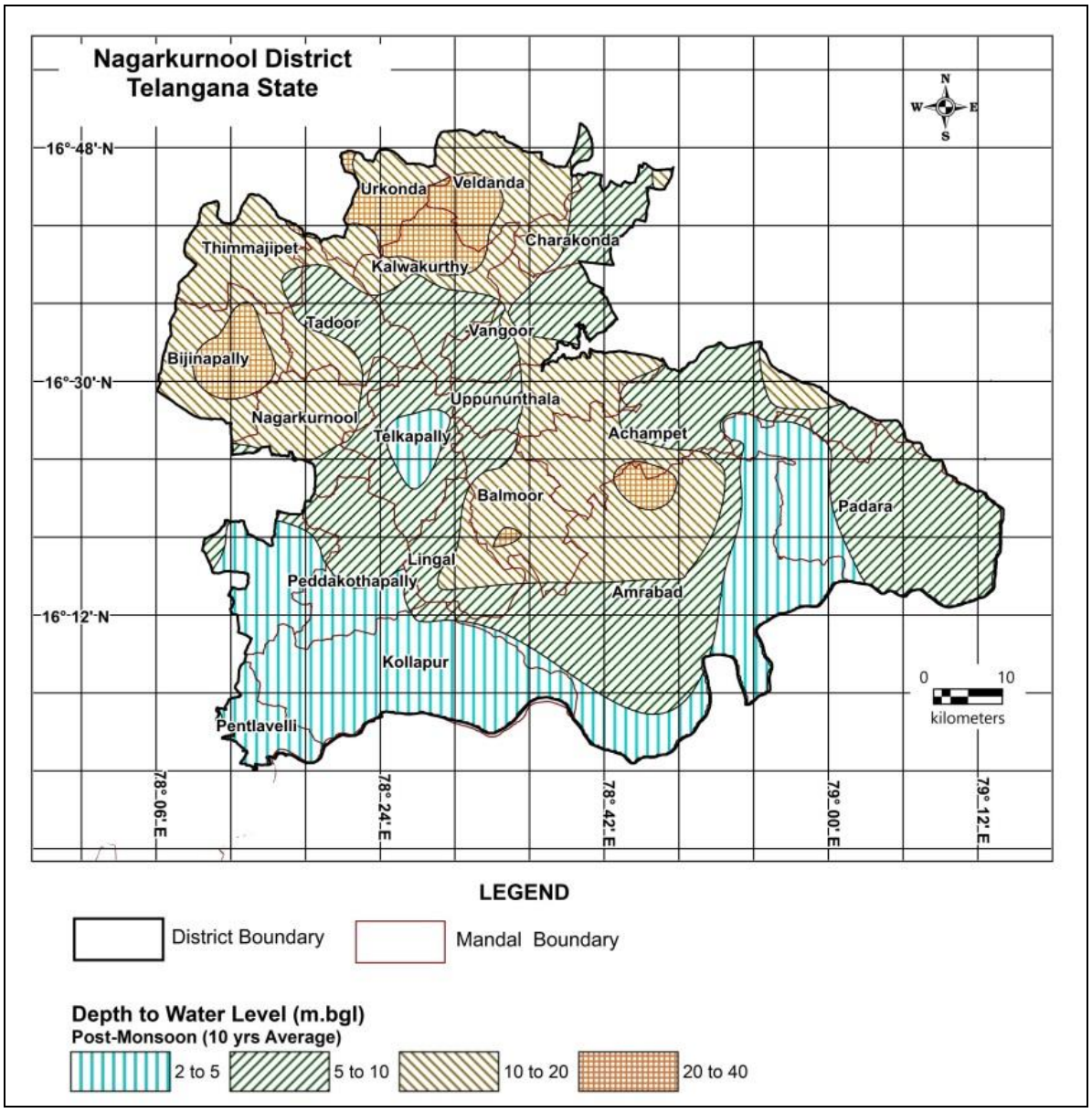

Fig.2.4: Depth to water levels Post-monsoon (avg. of 10 years: 2010 to 2019).

2.2.4 Seasonal Water Level Fluctuations (November vs. May)

About 98% wells show Rise in water levels in the range of 0.08 to 14.54 m and remaining 2% of the wells show Falling in the range of -1.06 m. With respect to the rising in water levels, most of the wells (52% of the area) shows water level rise from 2 to 5 m located in Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Telkapally, Thimmajipet, Uppununthala and Urkonda mandals, followed by 0 to 2 m in 23% of the area located in Amrabad, Balmoor, Kollapur, Nagarkurnool, Peddakothapally, Tadoor, Telkapally, Uppununthala and Vangoor mandals. The water level rise between 5 to 10 m (17% of the

area) is noticed in Achampet, Kalwakurthy, Lingal, Padara, Uppununthala, Urkonda, Vangoor and Veldanda mandal. In Balmoor, Bijinapally, Kalwakurthy, Thimmajipet and Urkonda mandals, the water level rise of 10 to 20 m is noticed (Fig. 2.5).

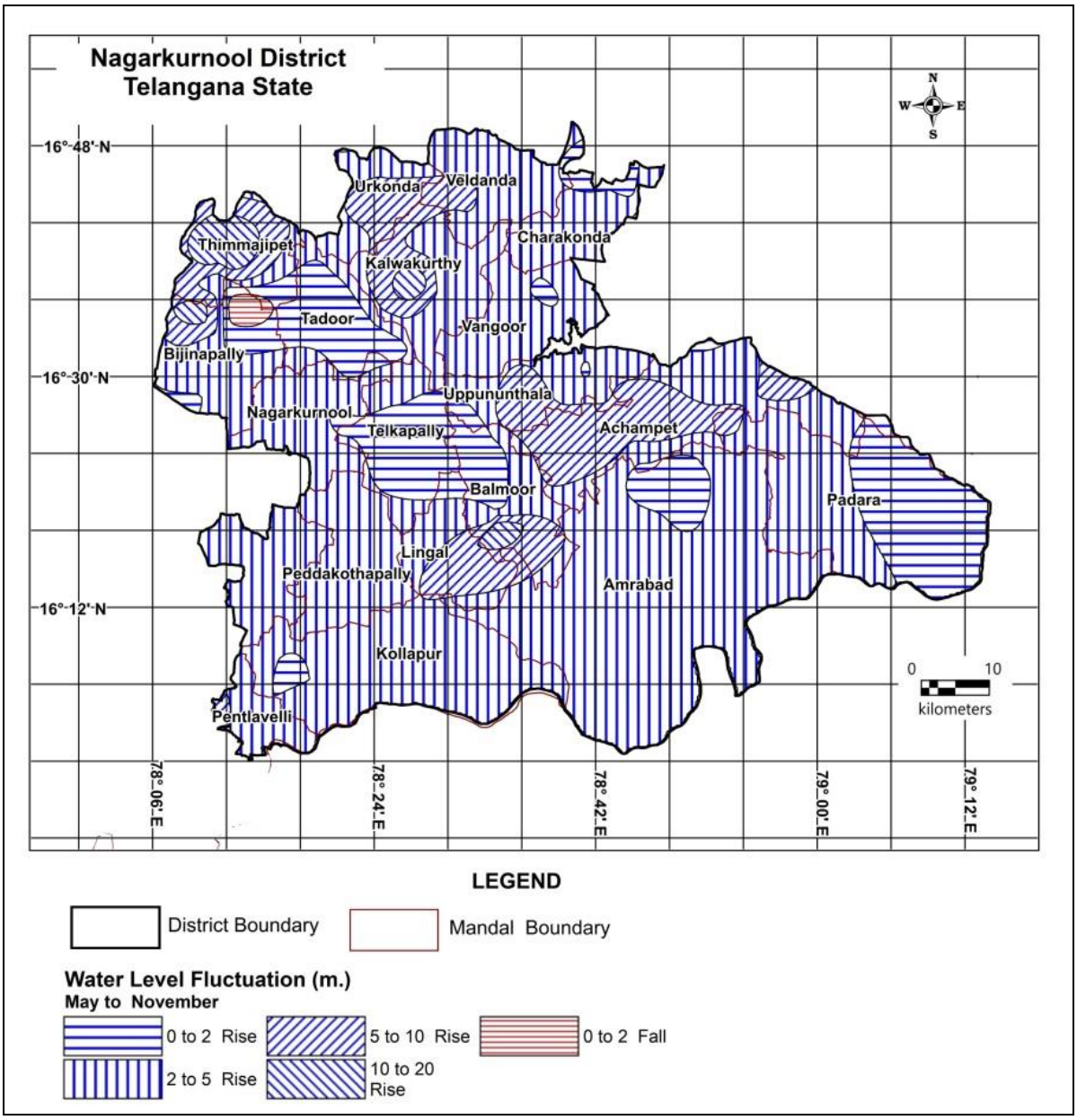

Fig. 2.5: Seasonal Water Level Fluctuations (m) (Nov vs. May2019)

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, 48% of the area shows rising trends ranging from 0.06 to 2.91 m/yr (Achampet, Balmoor, Bijinapally, Kodair, Kollapur, Nagarkurnool, Peddakothapally, Tadoor, Telkapally, Thimmajipet, Uppununthala and

Urkonda mandals) and in remaining 52% of the area, it shows falling trend in the range of -0.009 to -1.38 m/yr (Amrabad, Balmoor, Kalwakurthy, Kollapur, Nagarkurnool, Peddakothapally, Thimmajipet, Urkonda, Vangoor and Veldanda mandals) (Fig. 2.6). Whereas, during post-monsoon season, 79% of the area is showing rising trend ranging from 0.01 to 3.37 m/yr which is noticed in Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Kodair, Kollapur, Nagarkurnool, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals and in remaining 21% of the area, it is showing the falling trend of (-0.03 to -1.83 m/yr) observed in Amrabad, Balmoor, Kalwakurthy, Nagarkurnool and Peddakothapally mandal (Fig. 2.7).

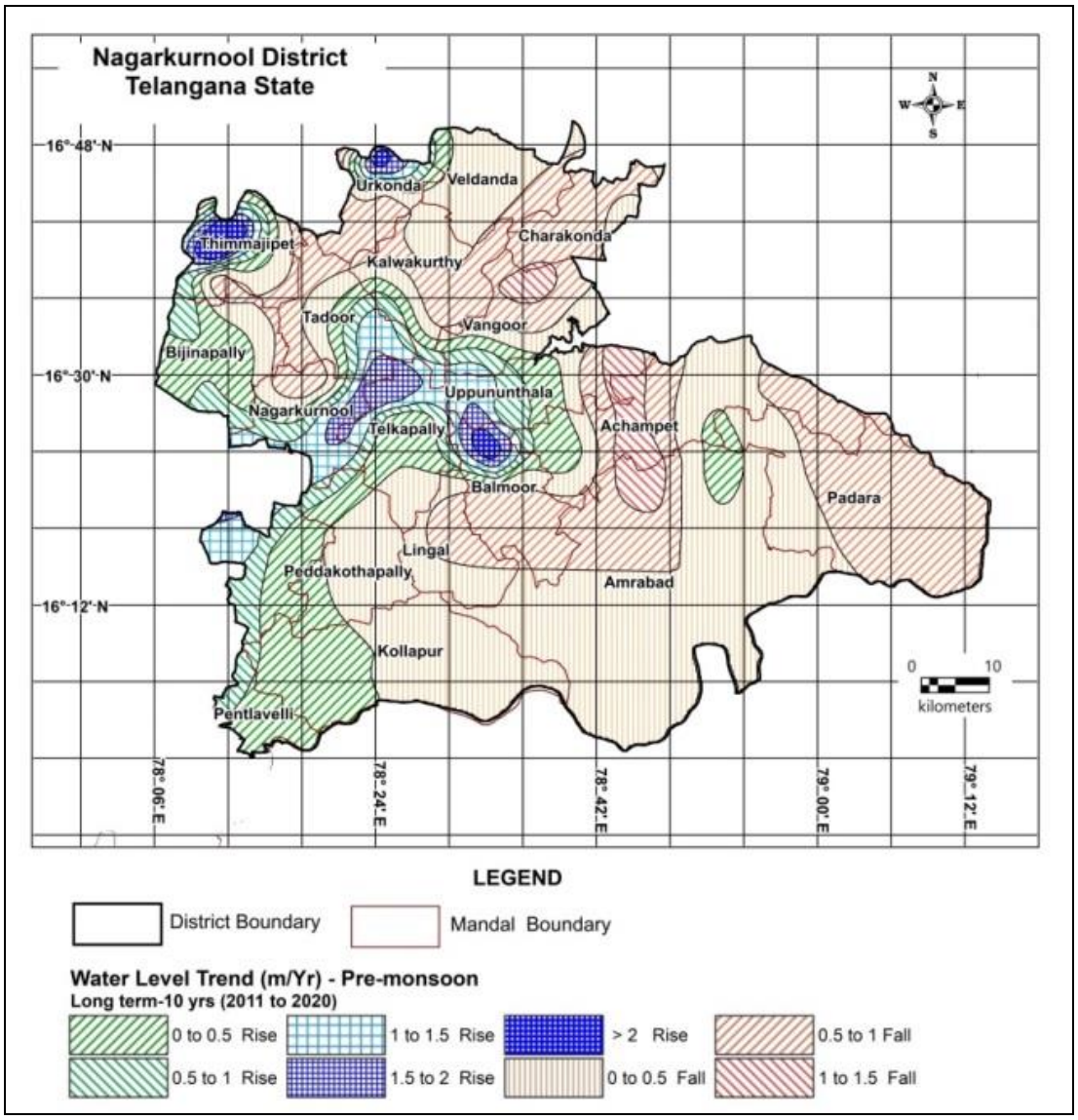

Fig. 2.6: Long-term water level trends (Pre-monsoon-2011-20).

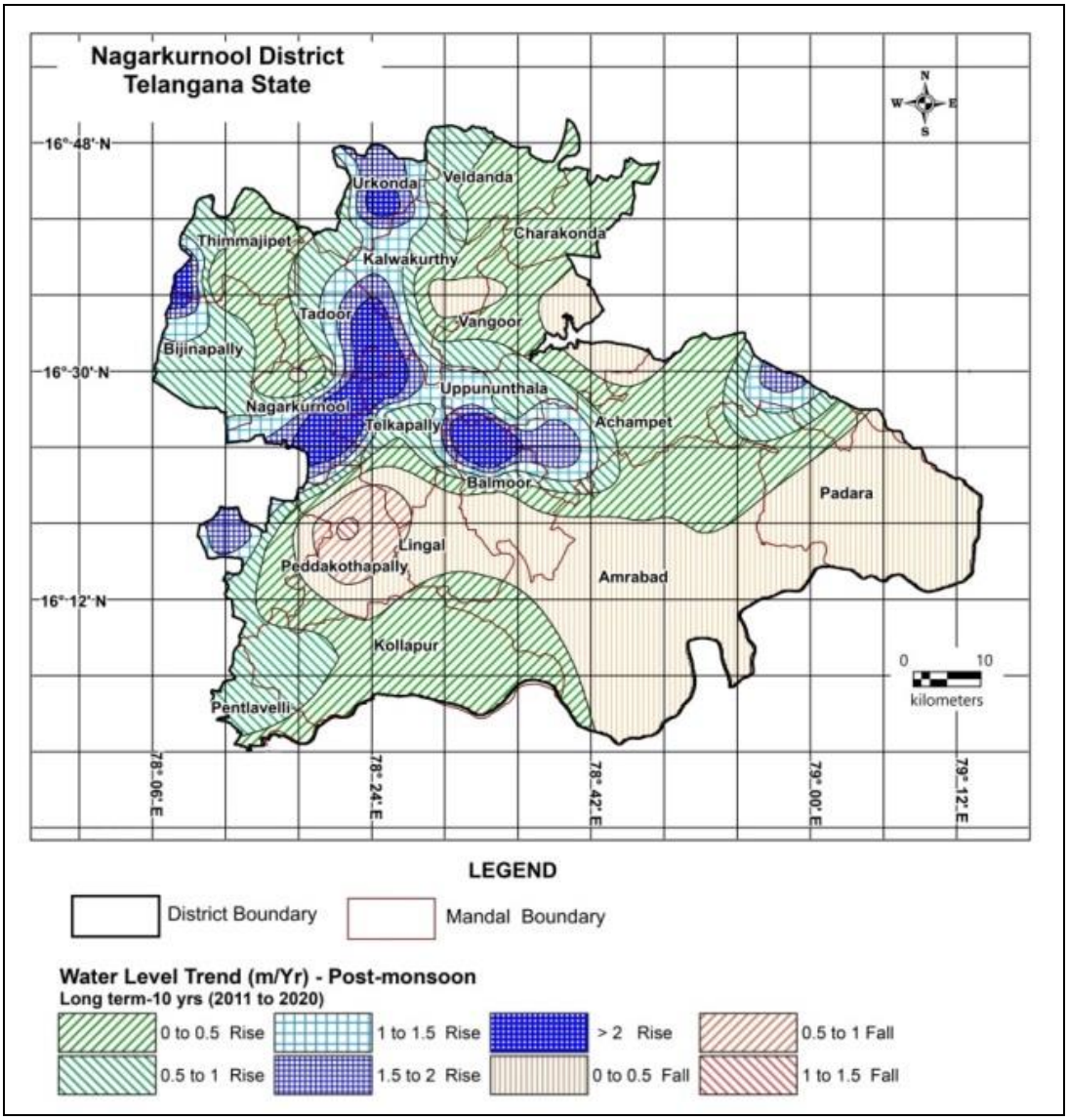

Fig. 2.7: Long-term water level trends (Post-monsoon-2011-20).

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 6.66 to 8.32 (avg. 7.53). The Electrical conductivity varies from 576 to 3800 µ Siemens/cm (avg. 1598 µ Siemens/cm). In about 53% of the samples from Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Kodair, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala and Vangoor mandals the EC is within 1500 µ Siemens/cm, while in 42% of the samples from Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Telkapally, Uppununthala, Vangoor and Veldanda mandals it is in the range of 1500-3000 µ Siemens/cm. In about 5% of the samples in Balmoor, Kollapur and Thimmajipet mandals, the EC of >3000 µ Siemens/cm is observed (Fig. 2.8). The concentration of TDS varies from 347to 2432 mg/l (avg. 1008 mg/l) and found that in 95% of samples, it falls within maximum permissible limits of BIS (<2000 mg/l) (Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Vangoor and Veldanda mandals) whereas in the remaining 5% of the samples, it is exceeding the permissible limit (>2000 mg/l) (Balmoor, Kollapur and Thimmajipet mandals). The NO_3 concentration ranges from 1 to 674 mg/l (avg. 113 mg/l) and noticed that in about 36% of the samples from Amrabad, Bijinapally, Kalwakurthy, Kodair, Kollapur, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Uppununthala and Vangoor mandals is falling within the permissible limits of <45 mg/l and in about 64% of the samples from Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Thimmajipet, Uppununthala, Vangoor and Veldanda mandals, the quality is not suitable for agriculture purpose (>45 mg/l) (Fig. 2.9). The Fluoride concentration varies from 0.8 to 4.16 mg/l (avg. 1.03 mg/l) and in 87% of the samples, it is within the permissible limit of <1.5 mg/l (Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Vangoor and Veldanda mandals) and in remaining 13% of the samples it is beyond permissible limit of >1.5 mg/l (Amrabad, Kalwakurthy, Kollapur, Lingal, Tadoor and Vangoor 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 6.56 to 8.76 (avg. 7.51). The Electrical conductivity varies from 696 to 4800 µ Siemens/cm (avg. 2010 µ Siemens/cm). In 37% of the samples from Achampet, Amrabad, Balmoor, Kalwakurthy, Kodair, Nagarkurnool, Peddakothapally, Tadoor, Telkapally and Thimmajipet mandals, the EC is within 1500 µ Siemens/cm while in 50% of the samples from Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Pentlavelli, Uppununthala and Vangoor mandals, it is in the range of 1500-3000 µ Siemens/cm. The EC >3000 µ Siemens/cm is observed only in 13% of the samples from Peddakothapally, Telkapally, Uppununthala and Veldanda mandal (Fig. 2.11). The concentration of TDS varies from 445 to 3072 mg/l (avg. 1287 mg/l). In about 90% of the samples from Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala and Vangoor mandals it is within the maximum permissible limits of BIS (<2000 mg/l) whereas in remaining 10% of the samples from Telkapally, Uppununthala and Veldanda mandal it is exceeding the permissible limit>2000 mg/l. The NO_3 concentration ranges from 0.44 to 722 mg/l (avg. 159 mg/l). It is noticed that in about 40% of the samples from Achampet, Balmoor, Kodair, Kollapur, Peddakothapally, Pentlavelli, Tadoor, Telkapally and Vangoor mandals it is within the permissible limit (<45 mg/l) while in 60% of the samples from Achampet, Amrabad, Bijinapally, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Telkapally, Thimmajipet, Uppununthala and Veldanda mandals, it is beyond the permissible limit (>45 mg/l) and not suitable for agruculture purpose (Fig. 2.12). The Fluoride concentration varies from 0.25 to 2.99 mg/l (avg. 1.19 mg/l). In about 77% of the samples, it is falling within permissible limit of <1.5 mg/l (Achampet, Amrabad, Balmoor, Bijinapally, Kodair, Kollapur, Lingal, Nagarkurnool, Peddakothapally, Pentlavelli, Telkapally, Thimmajipet, Uppununthala and Veldanda mandals) while in 23% of the samples from Balmoor, Kalwakurthy, Kodair, Lingal, Tadoor and Vangoor mandals are having high fluoride concentration beyond permissible limits (>1.5 mg/l) and are not suitable for drinking water purpose (Fig. 2.13).

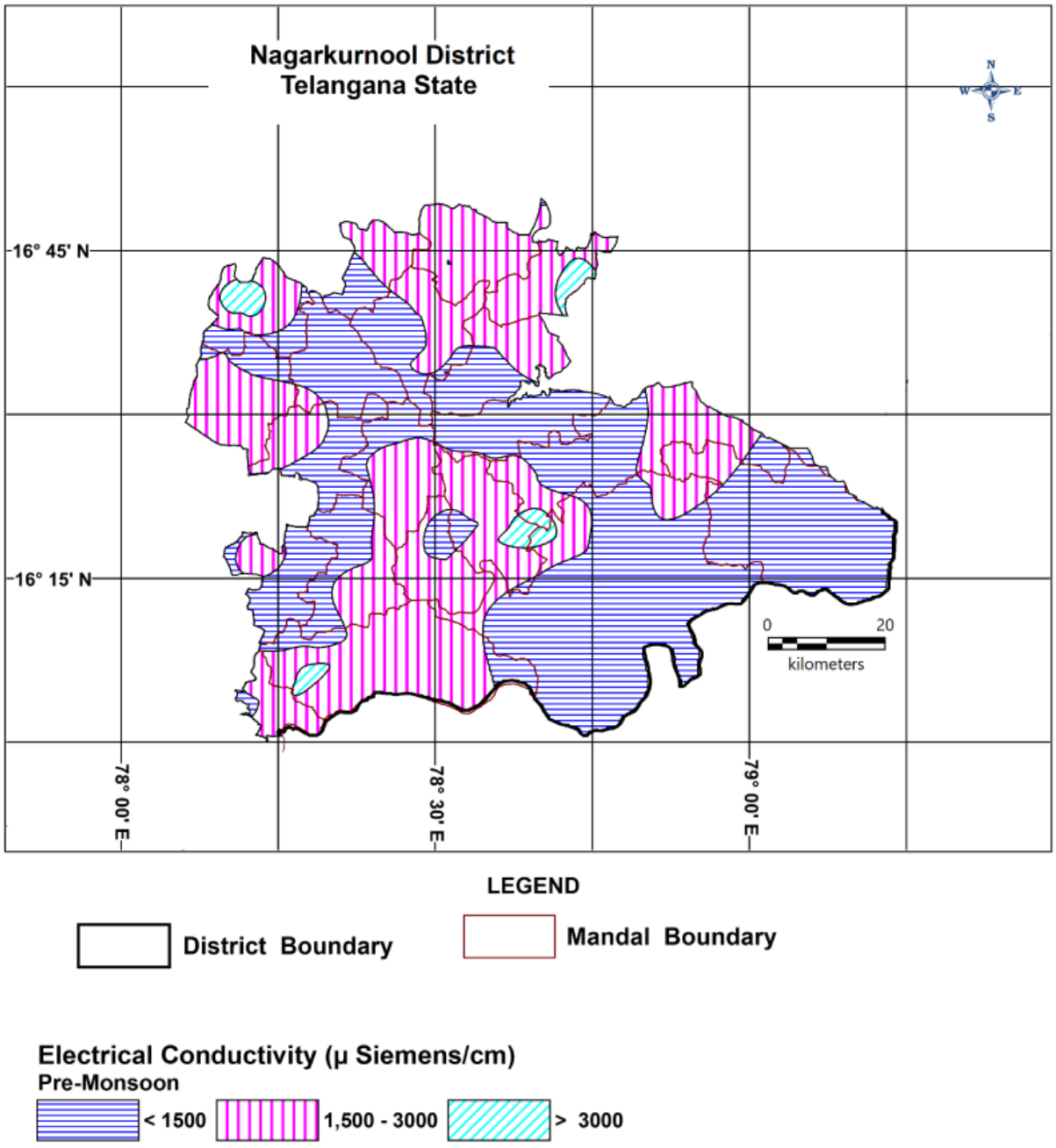

Fig.2.8: Distribution of Electrical conductivity (Pre-monsoon 2019).

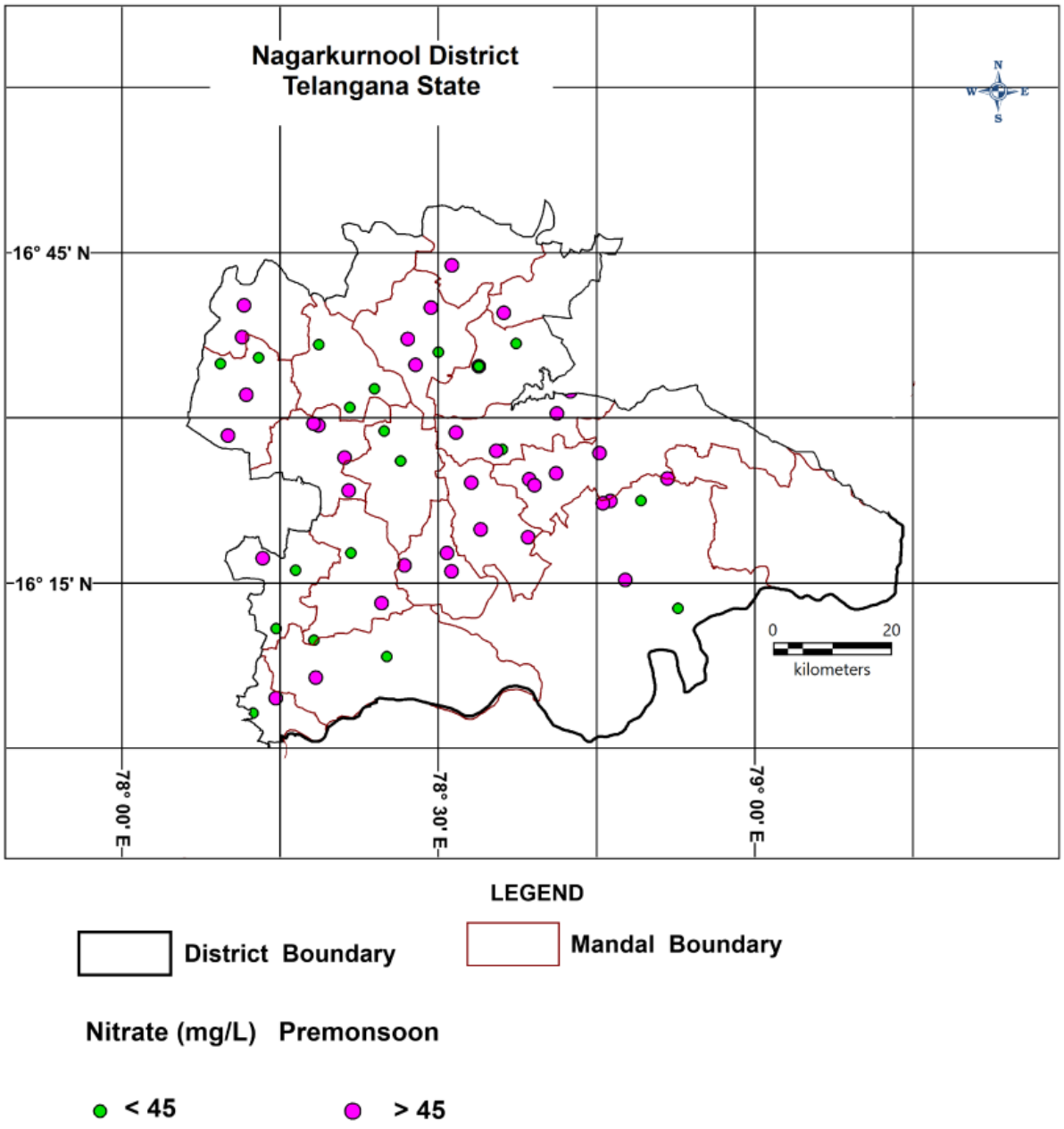

Fig.2.9: Distribution of Nitrate (Pre-monsoon 2019).

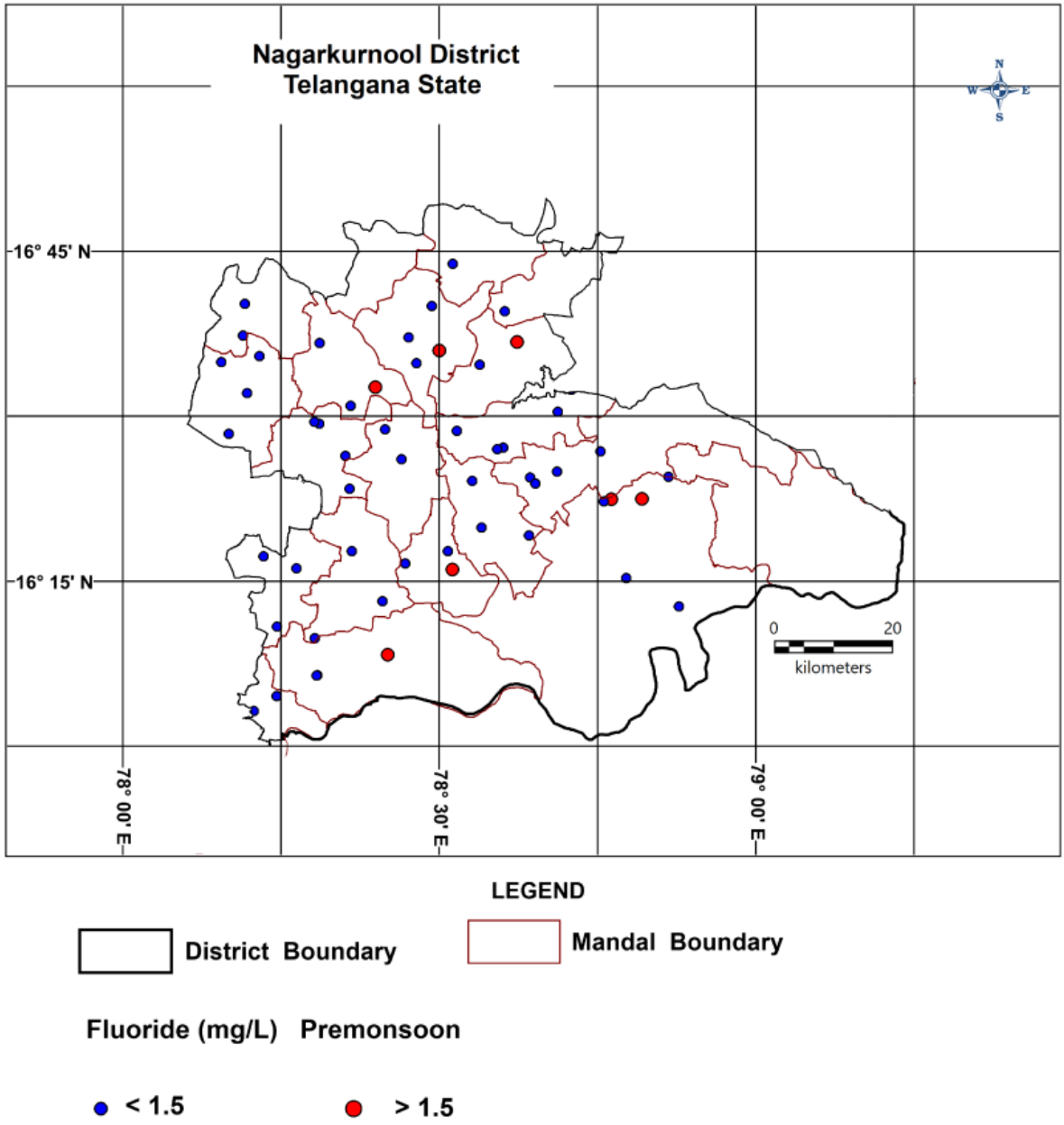

Fig. 2.10: Distribution of Fluoride (Pre-monsoon 2019).

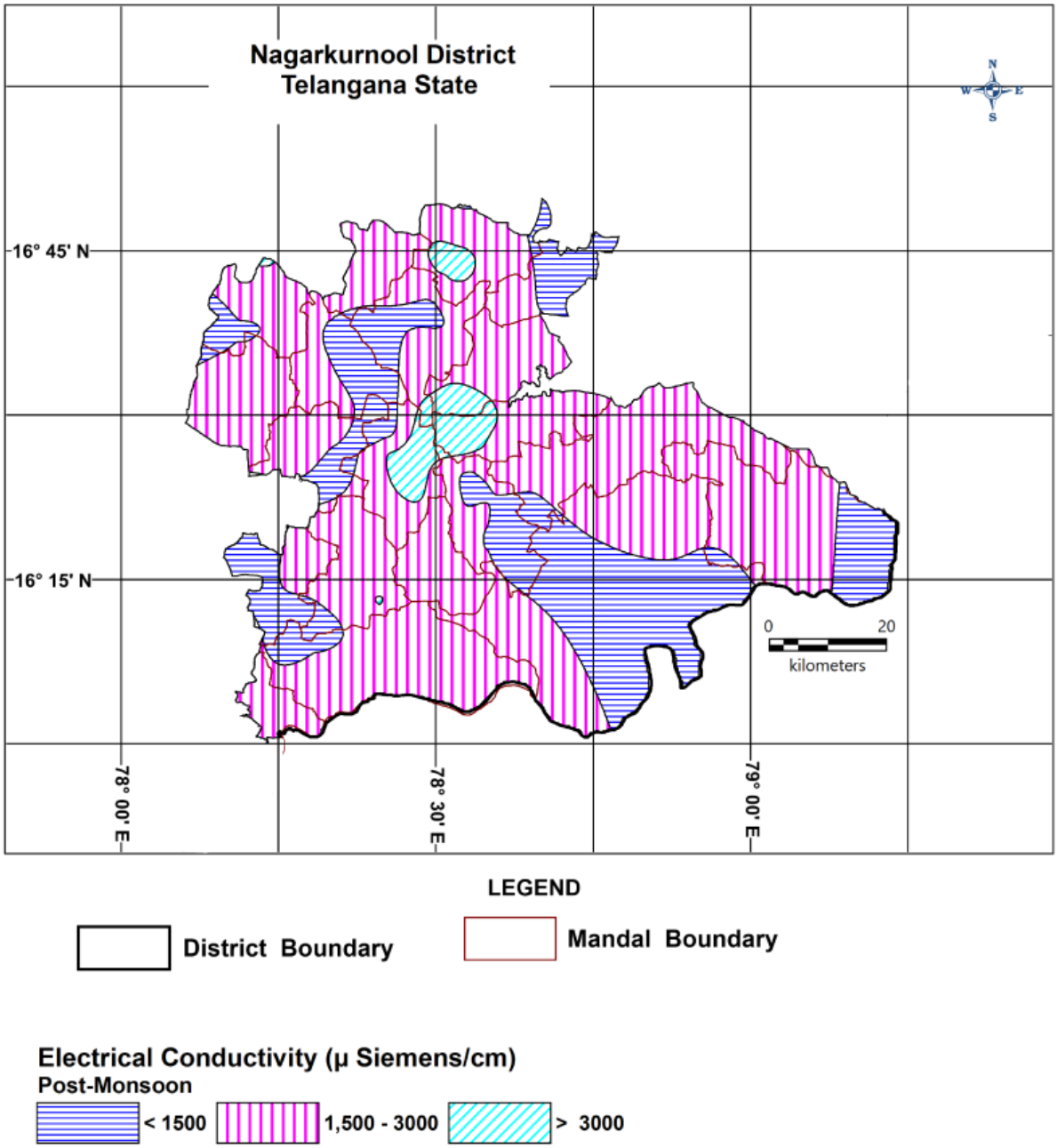

Fig. 2.11: Distribution of Electrical conductivity (Post-monsoon 2019).

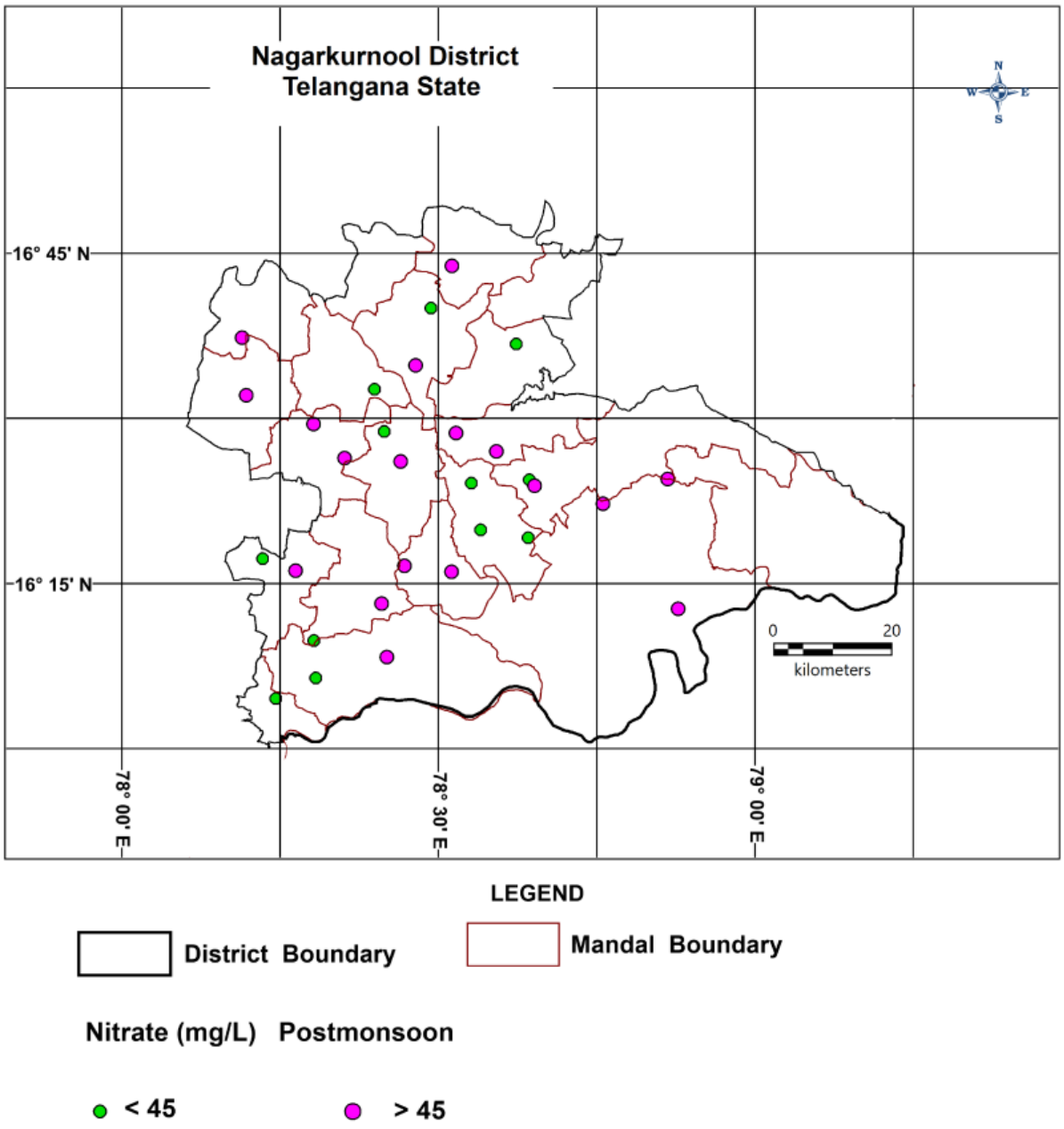

Fig.2.12: Distribution of Nitrate (Post-monsoon 2019).

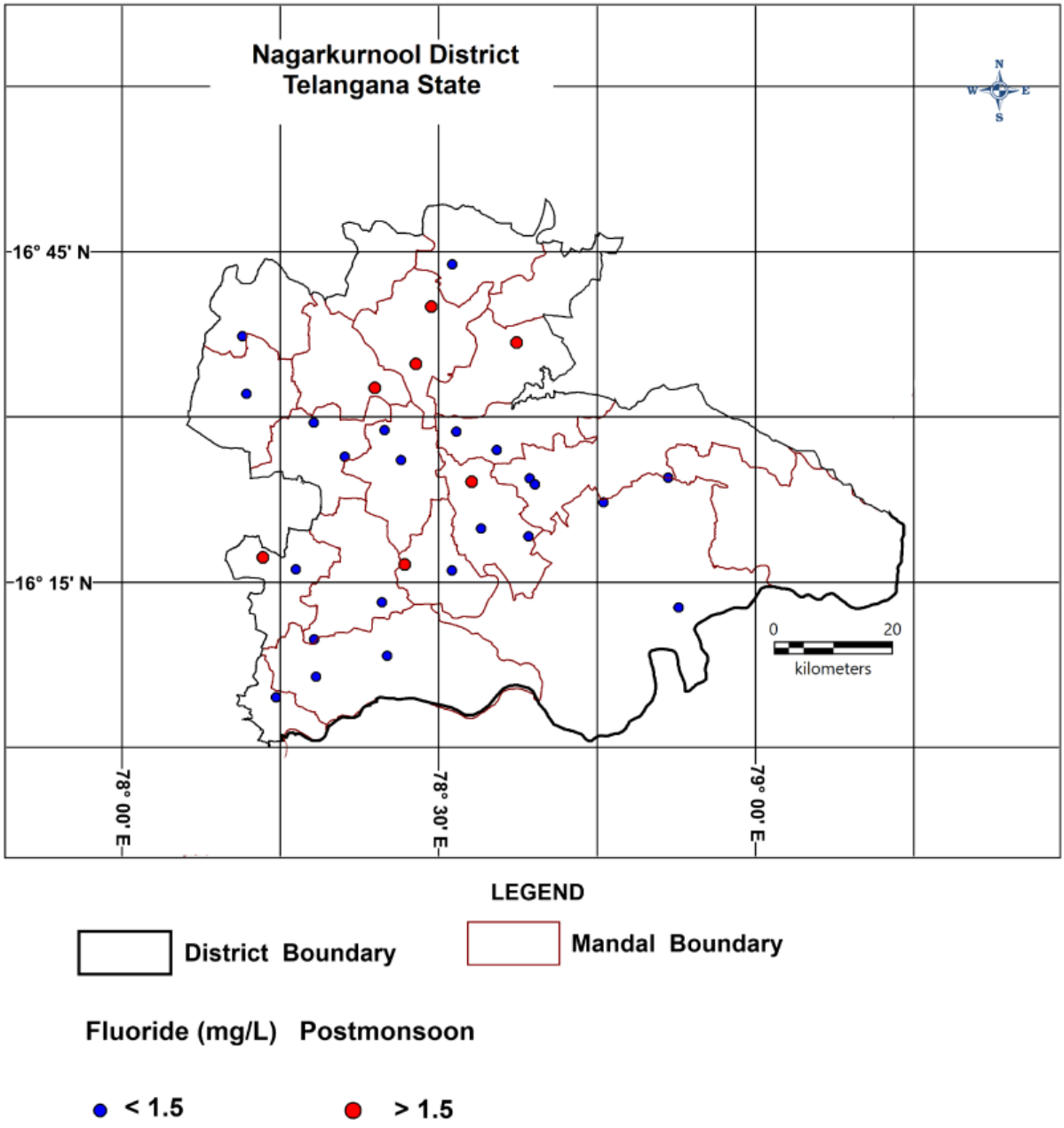

Fig. 2.13: Distribution of Fluoride (Post-monsoon 2019).

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.

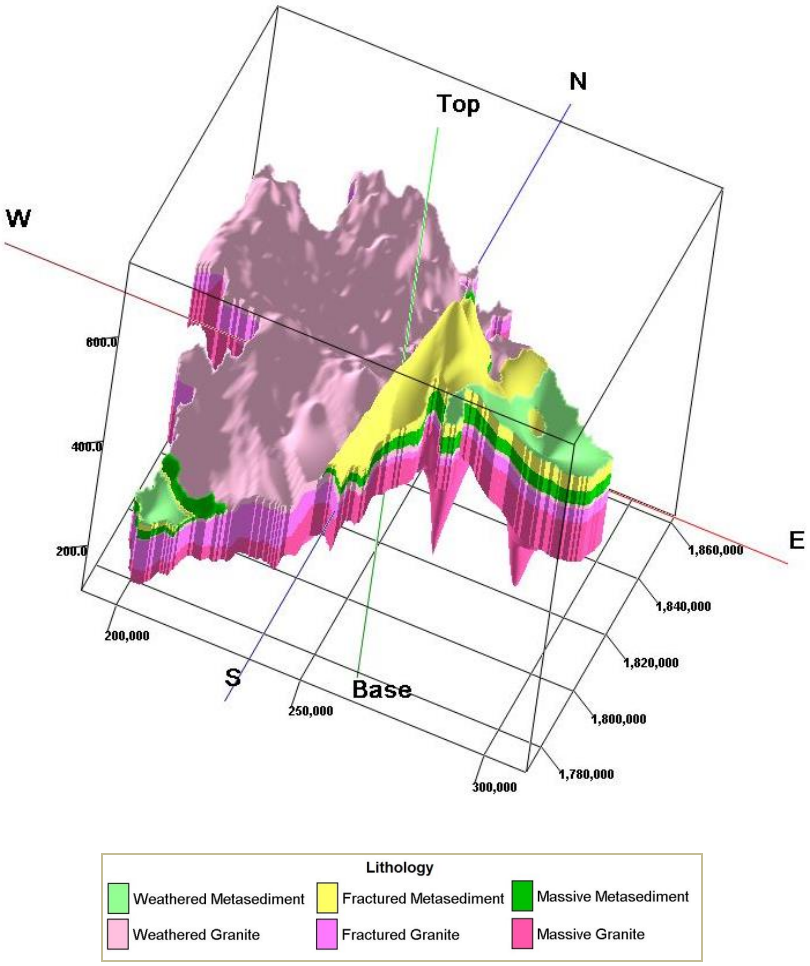

Fig. 3.1: 3D Model.

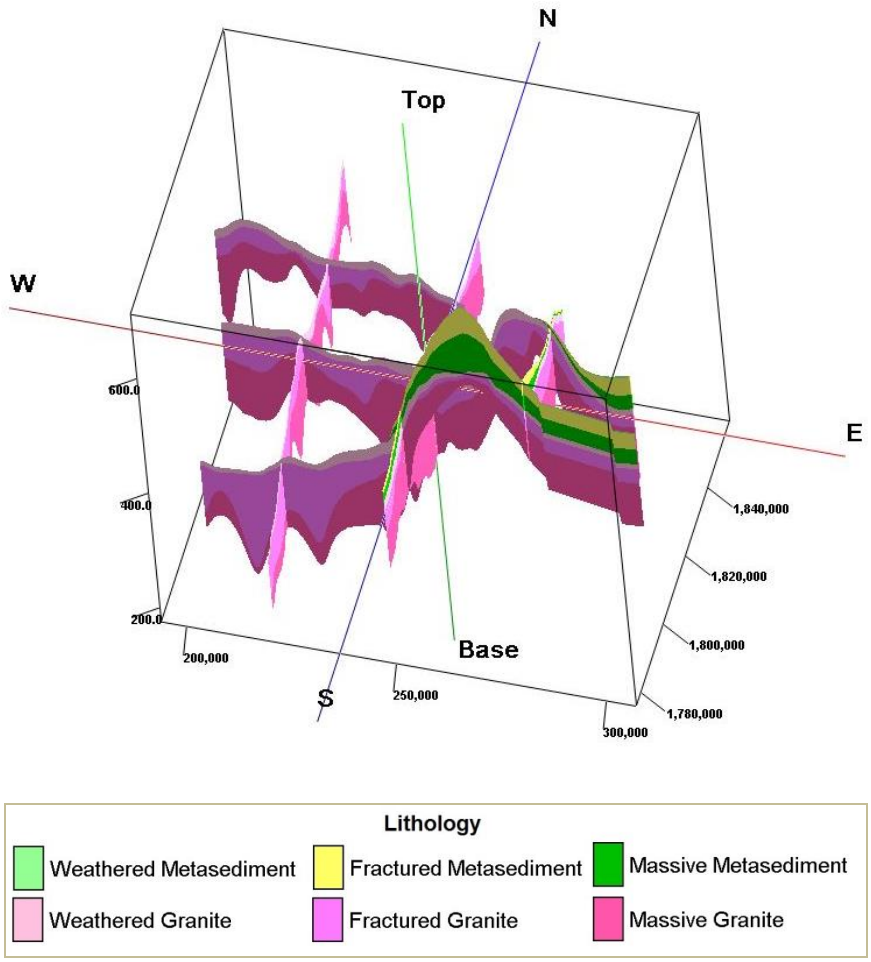

Fig. 3.2: Panel Diagram.

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 1 to 31 m bgl. The weathering >20 m bgl is observed in Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Nagarkurnool, Uppununthala and Urkonda mandals. The fractured zone is ranging from 5 to 195 m bgl with the yield ranging from 0.001 to 12 lps with an average of 1.25 lps. About 86% of the fractures were encountered within 100 m bgl depth. The deeper fractures beyond 100 m bgl (14%) are encountered in Balmoor, Kalwakurthy, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Telkapally, Uppununthala and Urkonda 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 ~110 kms. It depicts uniform weathered zone throughout the section. The thickness of fractured zone is more between 5 and 20 km and 45 to 70 and 80 t0 100 kms stretch of the section (Fig. 3.3a).

3.2.2 NE-SW Section (b)

The section drawn along the NW-SE direction covered a distance of ~11 kms. It depicts a uniform weathered zone. The thick fractured zone is noticed between the distance of 7 to 25 kms and 55 to 65 kms (Fig. 3.3b).

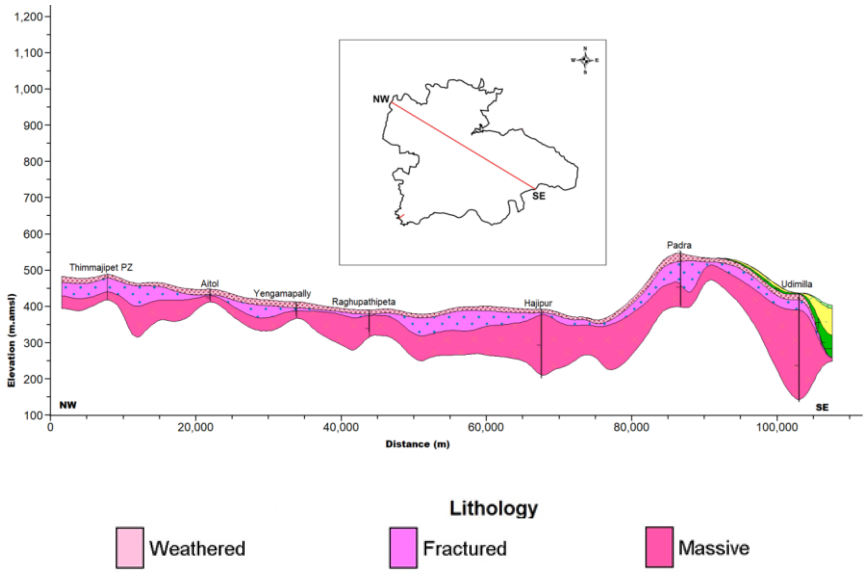

Fig.3.3a: Hydrogeological section through NW-SE direction.

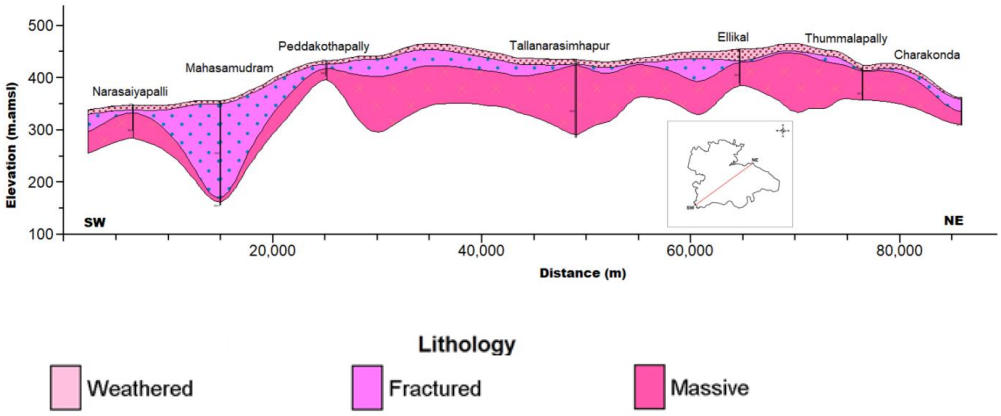

Fig.3.3b: Hydrogeological section through NW-SE direction.

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 in some of the patches. The depth of weathering ranging from 1 to 31 m bgl. In most part of the district (44% of the area), the depth of weathering ranges from 10 to 20 m bgl is mostly observed in Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Lingal, Nagarkurnool, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda and Vangoor mandals, while the depth of weathering ranging from 0 to 10 m bgl (39% of the area) is observed in Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kodair, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Vangoor and Veldanda mandals. The weathering depth >20 m bgl (17% of the area) is seen in Achampet, Amrabad, Balmoor, Bijinapally, Kalwakurthy, Nagarkurnool, Uppununthala and Urkonda mandals (Fig.3.4 and Fig.3.5). Generally, the yield of weathered zone varies from <1 to 3 lps with average of 1 lps. The Transmissivity varies from 1 to 30 m^2/day with average of 7 m^2/day. Specific yield varies from 1 to 3 with average of 2.

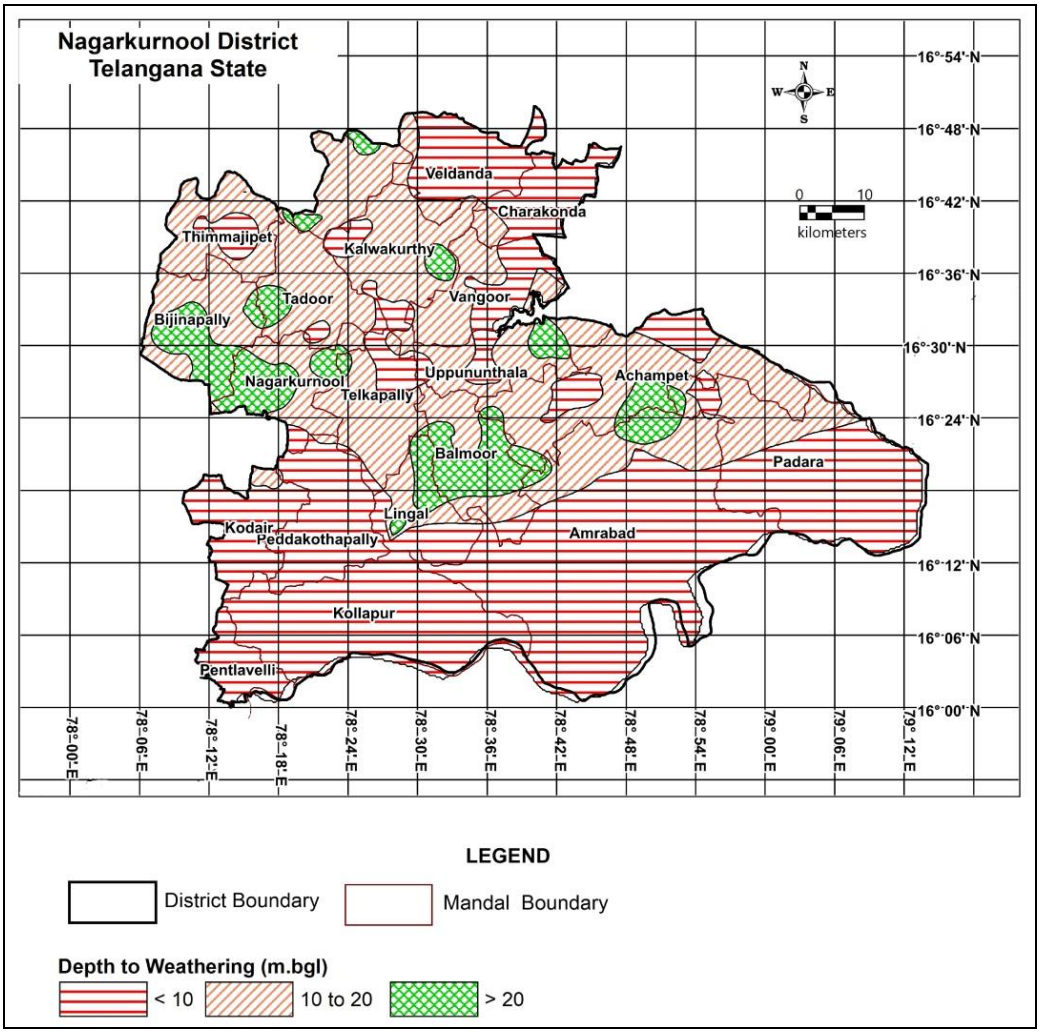

Fig. 3.4: Thickness of Weathered zone.

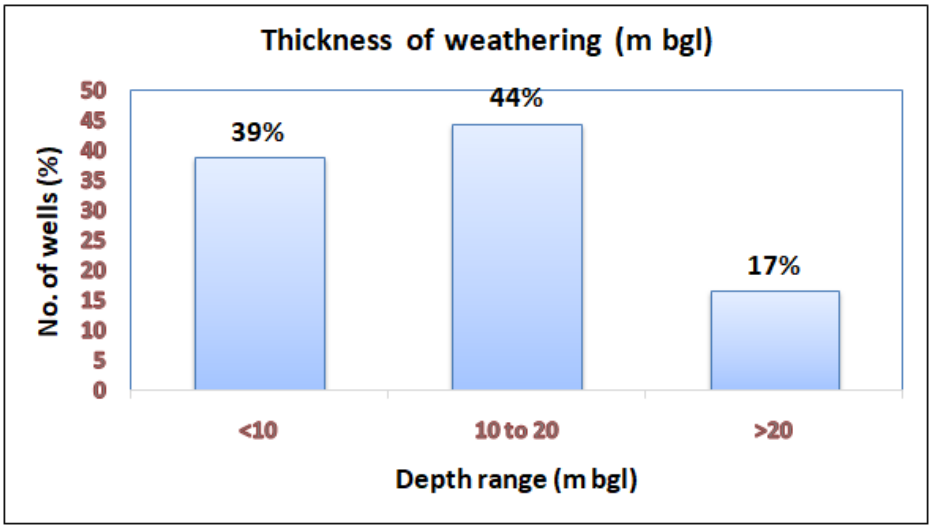

Fig.3.5: Bar chart showing depth wise distribution of weathered zone.

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 38% of the fractures occur within 30 m bgl with yield ranging from 0.02 to 4.5 lps observed at Achampet, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals. About 31% of the fractures occur within depth range of 30 to 60 m bgl with yields varying from 0.14 to 5.54 lps and are observed at Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kollapur, Nagarkurnool, Peddakothapally, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals. About 17% of the fractures occurring within the depth range of 60 to 100 m bgl with yield varying from 0.077 to 12 lps (Achampet, Balmoor, Bijinapally, Kodair, Nagarkurnool, Padara, Tadoor, Telkapally, Thimmajipet, Urkonda and Vangoor mandals). About 14% of the fractures have occurred beyond 100 m bgl with yield varying 0.01 to 12.2 lps (Balmoor, Kalwakurthy, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Telkapally, Uppununthala and Urkonda mandals) (Fig. 3.6 and Fig. 3.7). The deepest fracture tapped at the depth of 194.7 m bgl is observed in Mahasamudram village in Peddakothapally mandal. Over all, the yield varies from 0.001 to 12.2 lps in the terrain with an average of 1.25 lps. The Transmissivity varies from 1 to 630 m^2/day. The Storativity varies from 0.00017 to 5.

The yield wise data representation shows that in about 59% of the wells, the yield is <1 lps (Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals) while in 18% each of the wells, the yield is ranging from 1 to 2 lps (Achampet, Amrabad, Bijinapally, Kalwakurthy, Kodair, Lingal, Nagarkurnool, Padara, Tadoor, Telkapally, Uppununthala, Urkonda and Vangoor mandals). About 6% of the wells, the yield is ranging from 2 to 3 lps (Kalwakurthy, Lingal, Nagarkurnool, Tadoor, Urkonda and Vangoor mandal). In about 17% of the wells, the yield is >3 lps (up to 12.2 lps) noticed in Achampet, Balmoor, Bijinapally, Nagarkurnool, Peddakothapally, Tadoor, Telkapally, Uppununthala and Urkonda mandals (Fig. 3.8).

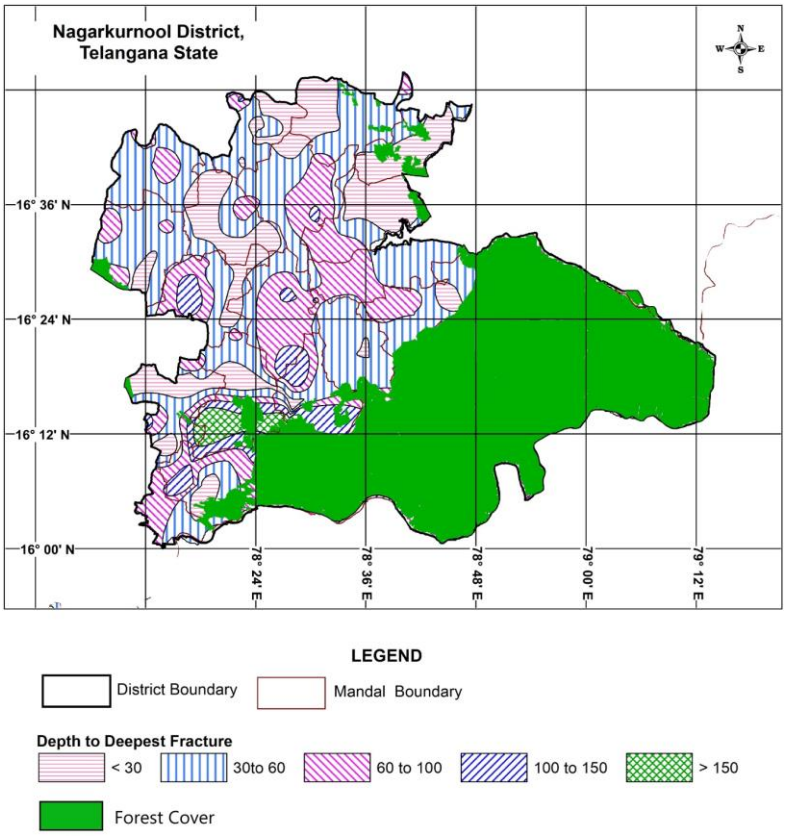

Fig.3.6: Depth of Fractured zone.

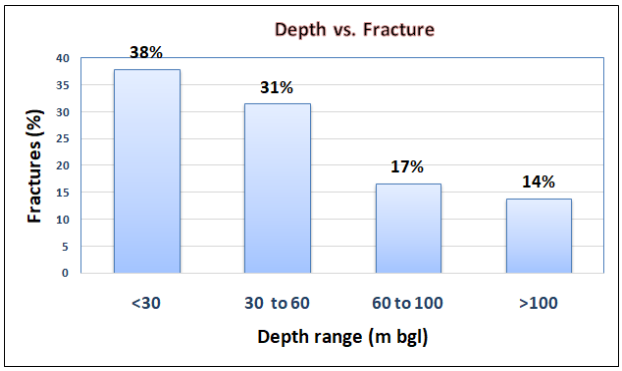

Fig. 3.7: Bar chart showing depth vs. fracture.

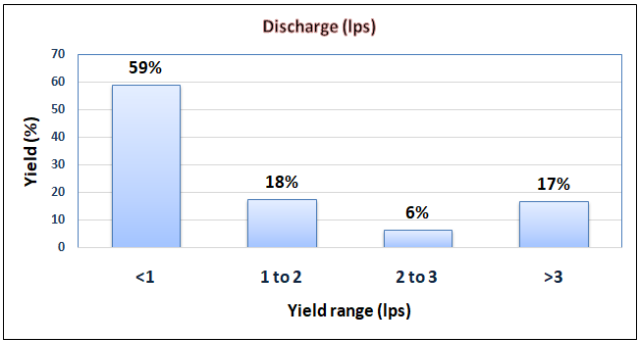

Fig. 3.8: Bar chart showing discharge vs. yield.

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 2020 GEC report, the net dynamic replenishable ground water availability for newly formed district Nagarkurnool district is 444 MCM, gross ground water draft for all uses 272 MCM, provision for drinking and industrial use for the year 2025 is 53 MCM and net annual ground water potential available for future irrigation needs is 175 MCM.

Out of 20 mandals, 12 mandals are falling under Safe ((Achampet (55%), Amrabad (31%), Bijinepally (47%), Charakonda (57%), Kalwakurthy (59%), Kollapur (32%), Padara (29%), Pentlavelly (38%), Tadoor (68%), Telkapally (70%),Thimmajipet (65%) and Uppunuthala (67%)), 6 mandels falling under Semi Critical ((Balmoor (73%), Kodair (73%), Lingal (80%), Nagarkurnool (82%), Peddakothapally (79%) and Vangoor (87%)) and remaining 2 mandals are falling under Over-exploited category ((Urkonda (129%) and Veldanda (112%)) with overall average stage of groundwater development of 61% in the district and falling under Safe category.

Table 4.1: Computed dynamic ground water resources (GEC 2020)

Parameters	Resources (GEC 2020) in MCM
Dynamic (Net GWR Availability)	444
• Monsoon recharge from rainfall	263
• Monsoon recharge from other sources	46
• Non-Monsoon recharge from rainfall	70
• Non-monsoon recharge from other sources	87
• Natural Discharge	23
Gross Recharge	467
Gross GW Draft	272
• Irrigation	219
• Domestic and Industrial use	52.61
Provision for Drinking and Industrial use for the year 2025	53.27
Net GW availability for future irrigation	175
Average Stage of GW extraction (%)	61
Categorization of district	Safe
Categorization of mandals	**Safe: 12, Semi-Critical: 6, Over-exploited: 2** **Safe:** Achampet (55%), Amrabad (31%), Bijinepally (47%), Charakonda (57%), Kalwakurthy (59%), Kollapur (32%), Padara (29%), Pentlavelly (38%), Tadoor (68%), Telkapally (70%),Thimmajipet (65%) and Uppunuthala (67%) **Semi-Critical:** Balmoor (73%), Kodair (73%), Lingal (80%), Nagarkurnool (82%), Peddakothapally (79%) and Vangoor (87%) **Over-exploited:** Urkonda (129%) and Veldanda (112%)

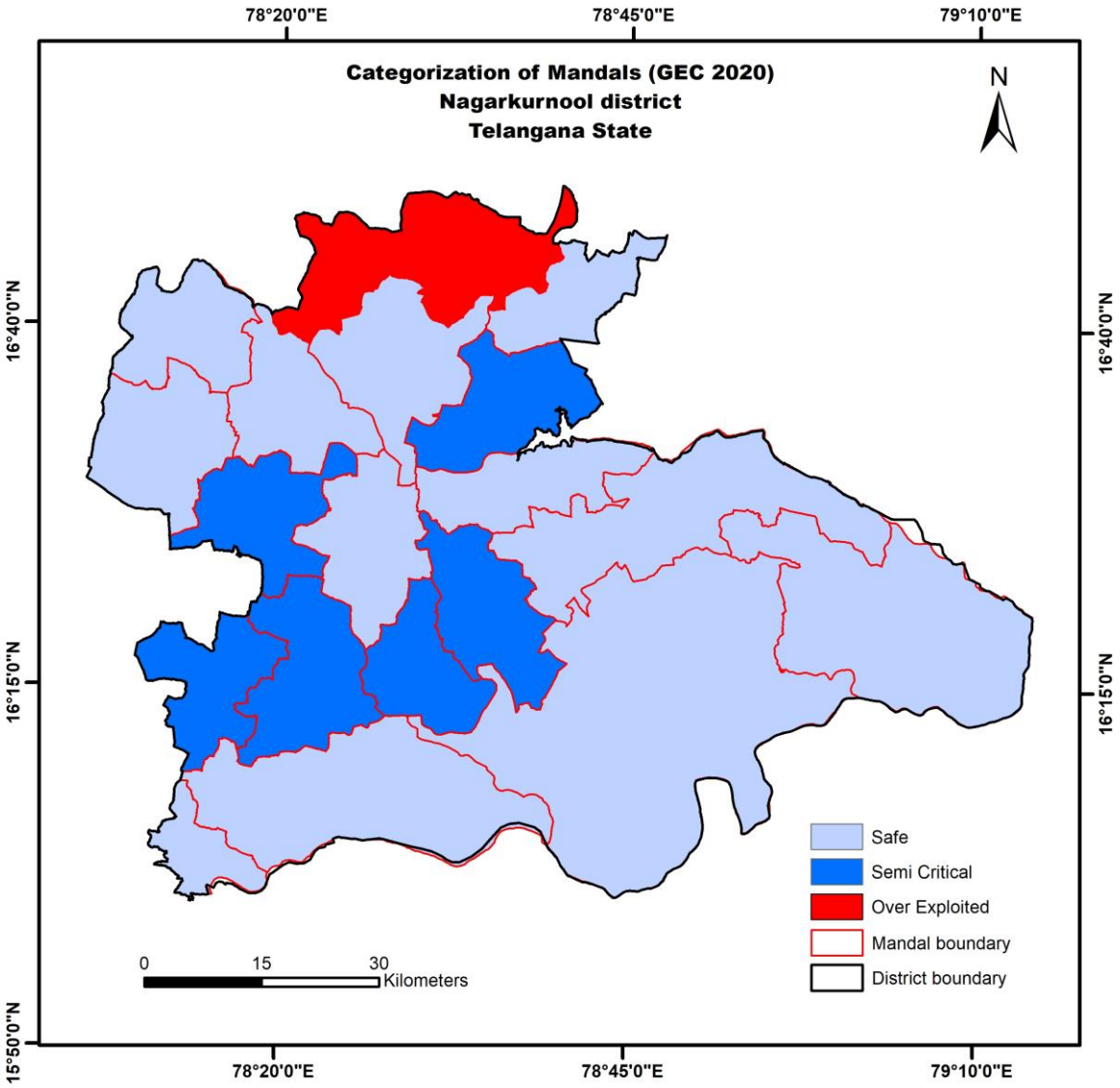

Fig. 6.1: Categorisation of mandals based on GEC 2020

5. GROUND WATER RELATED ISSUES AND REASONS FOR ISSUES

5.1 Issues

Over-exploitation

- 468 km^2 area covering 79 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 4.16 mg/l during pre-monsoon and 2.99 mg/l during post-monsoon season. The high fluoride concentration (>1.5 mg/l) occur in 13% of samples and 23% 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 64% of the samples and 60% 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 28% of the area.

Sustainability

- Low yield (<1 lps) occurs in 59% of the exploratory wells covering in Achampet, Amrabad, Balmoor, Bijinapally, Charakonda, Kalwakurthy, Kodair, Kollapur, Lingal, Nagarkurnool, Padara, Peddakothapally, Pentlavelli, Tadoor, Telkapally, Thimmajipet, Uppununthala, Urkonda, Vangoor and Veldanda mandals 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 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 occur within 100 m depth. The higher NO_3concentrations (>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, 35268 MCM of unsaturated volume (below the depth of 3 m) is available during post-monsoon, having 706 MCM of recharge potential. 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 2109 minor irrigation tanks, 961 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 scheme, all the villages and towns are proposed to be covered from the water grid with intake from Yellore reservoir, Kalvakurthy lift irrigation. This scheme is to enhance the existing drinking water schemes and to provide 100, 135 and 150 lpcd of water in rural, municipal and Municipal Corporation respectively.

- The total water import will be 33 MCM (drinking and industrial needs) and this imported water from surface sources will reduce the present utilized 19 MCM of groundwater (considering 60 lpcd). This can be effectively utilized to irrigate 3135 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 3 m bgl). Initially, village wise dynamic groundwater resources of 2020 are considered. Potential surface run off is estimated by following standard procedures. Initially, 20% run off yield is considered as non-committed yield and for recommending artificial recharge structures in intermittent 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 79 villages having 468 km^2 covered under Priority-1, where 63 MCM recharge potential and 4 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 475 artificial recharge structures were constructed (PTs: 200, CDs: 275) in 37 villages with existing storage capacity of 12 MCM.
- About 60 artificial recharge structures (40 mini PT's with 1.5 fillings with a unit cost of Rs. 20 lakhs each and 20 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 11 Crores can be taken up.
- After effective utilization of this yield, there will be 1.40 MCM of groundwater recharge with 100% recharge efficacy.
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).

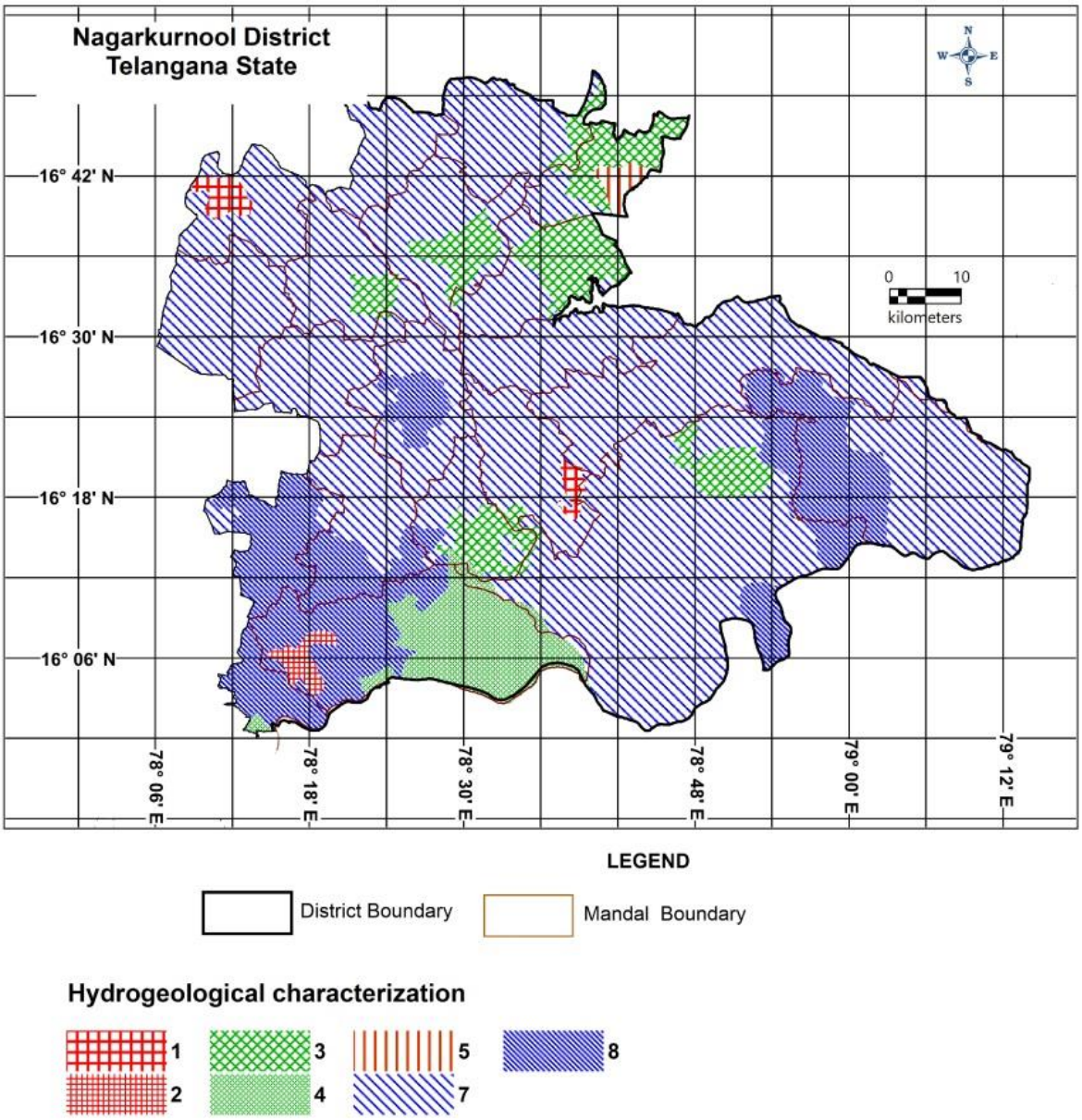

Fig. 6.1: Priority area for sustainable management plan of ground water resources.

Priority-2 (A**rea where groundwater development <100%)**

- Area consisting of 270 villages having 4450 km^2 covered under Priority-2, where 642 MCM recharge potential and 41 MCM utilizable yield (uncommitted run-off) is available and immediate intervention is required (Annexure-2). The management plan for Priority-2 area is given in Fig. 6.1 and Annexure-2.
- About 1650 artificial recharge structures were constructed (PTs: 711, CDs: 939) in 126 villages with existing storage capacity of 40 MCM.

- Artificial recharge structures are recommended for 50% of the utilizable yield in the intermittent areas.
- About 531 artificial recharge structures (265 mini PT's with 1.5 fillings with a unit cost of Rs 20 lakhs each and 266 CD's with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 93 Crores can be taken up.
- After effective utilization of this yield, there will be 15 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 7160 farm ponds are recommended (20 in each village in 358 villages) at Rs 25,000/-each with total cost of 18 Crores, this can create an additional storage of 2.15 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 8068 ha. area is brought under micro-irrigation (Sprinklers: 3161 and drip: 4848) saving 12 MCM of groundwater (considering 25% of saving to traditional practices).

6.1.2.2 Proposed Micro-irrigation (MI)

- About 7932 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 47 Crores (considering 1 unit/ha. @0.6 lakhs/ha.). With this, about 12 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 Outcome

With the above interventions costing Rs. 172 Crores, the likely benefit would be increases in gross groundwater availability with net saving of 30.33 MCM of groundwater or net reduction of 4% in stage of groundwater extraction, i.e., from the existing 61 to 57%. The onetime cost will be 7 paisa/litre and the actual cost of invest will be 0.7 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

Annexure – I

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

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Achampet	Achampet			2	2
Achampet	Brahmanpally			1	1
Achampet	Chandapur	2	27		
Achampet	Chennaram				1
Achampet	Choutapally	7	2		
Amrabad	Macharam			1	
Amrabad	Mannanur	3	29		
Balmoor	Chennaram	4	3		
Balmoor	Mahadevpur			1	1
Balmoor	Manajipet				1
Balmoor	Polepally	4			
Balmoor	Veeramrajupally	3	1		
Bijinapally	Allipur				1
Bijinapally	Anekhanpally				1
Bijinapally	Gouraram				1
Charakonda	seriAppareddyaplly		10		
Kalwakurthy	Bekkera				1
Kalwakurthy	Gundur			1	1
Kalwakurthy	Jeedipally			1	1
Kalwakurthy	Lingasanipally		9		
Kalwakurthy	Raghupathipeta		1	1	1
Kalwakurthy	Suddakal	3	5		
Kalwakurthy	Venkatapur			1	
Kollapur	Chennampalli			1	1
Kollapur	Choutabetla				
Kollapur	Jawaipally				
Kollapur	Narsinghapuram		3		
Kollapur	Narsingharaopally				
Lingal	Dattaram				1
Lingal	Jeedugupally	19	6		
Lingal	Jillelapally				
Lingal	Kothakuntapally	20	4		
Lingal	Madapur				1
Lingal	Mogudumpur	10	2		
Lingal	Vallabhapur	6	4		
Nagarkurnool	Chandubatla	9	5		
Nagarkurnool	Ganyagula	2	12		
Nagarkurnool	Narsaipally	1	3		
Nagarkurnool	Venkatapur				1

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Peddakothapally	Dedinenipally	17	19		
Peddakothapally	Mahasamudram				1
Peddakothapally	Maredammandinne			1	1
Peddakothapally	Narayanraopally	2	7		
Peddakothapally	pochapuram				1
Peddakothapally	Tirumalampally		2		
Peddakothapally	Tirumalapur		1		1
Tadoor	Aitol	14	7		
Tadoor	Akunellikudur		4		
Tadoor	Allapur				1
Tadoor	Antharam		1		
Tadoor	Govindaipally	2	2		
Tadoor	Medipur				1
Tadoor	Nainapally				1
Tadoor	Vengampally	3	9		
Telkapally	Parvathapuram				1
Thimmajipet	Allampally	14	2		
Thimmajipet	Appajipally			1	1
Thimmajipet	Bavajipally	4	6		
Thimmajipet	Buddasamdram			1	1
Thimmajipet	Gummakonda	8	23		
Thimmajipet	Nerallapally			1	1
Thimmajipet	Thimmajipet	10	2		
Uppununthala	Ayyavarpally			1	1
Uppununthala	Egneshpur				1
Uppununthala	latheifpur				1
Uppununthala	Molgara		1		1
Uppununthala	Pertanvanipally			1	1
Uppununthala	Raiched			1	1
Uppununthala	Tippapur				1
Uppununthala	Uppununthala	5	17		
Uppununthala	Zapthisathgode	6	18		
Urkonda	Gudiganpally	4	9		
Urkonda	Ippapad		17		
Urkonda	Jagboinpally			1	1
Urkonda	Jaknalpally			1	1
Urkonda	Narsimhapally				1
Urkonda	Ramreddypally			1	1
Vangoor	Mittasadgode				1
Vangoor	Thirumalgiri	18	2		

Annexure – II

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

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Achampet	Ainole	12	9		
Achampet	Akkavaram	1	5	5	5
Achampet	Bolghatpally			1	1
Achampet	Bommenpally	23	7		
Achampet	Ghanpur			1	1
Achampet	Gumpanpally			1	1
Achampet	Hajipur	7	14		
Achampet	Lakshmapur	4	6		
Achampet	Lingotam			1	1
Achampet	Mannevaripally	1	6		
Achampet	Nadimpally			2	2
Achampet	Palkapally			1	1
Achampet	Puljal			2	2
Achampet	Rangapur		11		
Achampet	Siddapur			9	9
Achampet	Singavaram			1	1
Achampet	Tangapur			1	1
Amrabad	Amrabad			45	45
Amrabad	Lakshmapur	1	11		
Amrabad	Turkpally	2	12		
Balmoor	Ambagiri				1
Balmoor	Ananthavaram	19	1		
Balmoor	Balmur			3	3
Balmoor	Banal			1	1
Balmoor	Billakal			5	5
Balmoor	Gattuthummen	1	10		
Balmoor	Godal	4	3	1	1
Balmoor	Jinkunta	1	2		1
Balmoor	kondanagul			3	3
Balmoor	Kondareddypally			2	2
Balmoor	Mailaram	2	4	5	5
Balmoor	Narsaipally				1
Balmoor	Polsettipally			3	3
Balmoor	Ramgiri			1	
Balmoor	Ramojipally			1	1
Balmoor	Tummanpet	11	5		
Bijinapally	Bajipur			1	1
Bijinapally	Bijinepally	1	3	1	1

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Bijinapally	Boyapur				1
Bijinapally	Gangaram		2	2	2
Bijinapally	Gudlanarva		13		
Bijinapally	Karukonda			1	1
Bijinapally	Khanapur	2	23		
Bijinapally	latpally	9	4		
Bijinapally	Lingasanipally		3		
Bijinapally	Mahadevnpet	4	16		
Bijinapally	Mammaipally	12	1		
Bijinapally	Manganur	10	25		
Bijinapally	Palem	1	1		
Bijinapally	polepally	1	4		
Bijinapally	Salkarpet			1	1
Bijinapally	Shainpally	15	14		
Bijinapally	Vaasanthapur			1	1
Bijinapally	Vaddeman	2	28		
Bijinapally	Vattem	4	3	1	1
Bijinapally	velgonda		7		
Bijinapally	Venkatapur	2	8		
Charakonda	Andugul			1	1
Charakonda	Chrakonda			2	2
Charakonda	Gokavaram	1	6		
Charakonda	Kamalapur	2	10		
Charakonda	Sirisangandla	1	4		
Charakonda	Timmaipally			1	1
Charakonda	Zupally			2	2
Kalwakurthy	Elikal			3	3
Kalwakurthy	Elikatta			1	1
Kalwakurthy	Jillella			1	1
Kalwakurthy	Kalwakurthy		4	2	2
Kalwakurthy	Kurmidda	7	17		
Kalwakurthy	Marchala		4		1
Kalwakurthy	Mukral		18		
Kalwakurthy	Panjugul			2	2
Kalwakurthy	Polmuru				1
Kalwakurthy	Tandra	3	10		
Kalwakurthy	Tarnikal		15		
Kalwakurthy	Totapally		8		
Kalwakurthy	Vepur			1	1
Kodair	Badugadinne	1	1		
Kodair	Baswaipally	1	8		

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Kodair	Janumpally			1	1
Kodair	Khanapuram				1
Kodair	Kodair	3	3		
Kodair	Kondraopally	1	1		
Kodair	Machupally			1	1
Kodair	Mailaram				
Kodair	Muthireddypally	5			1
Kodair	Nagulapally	4	1		
Kodair	Narsaipally	4	8		
Kodair	Paspula	6	7		
Kodair	Rajapuram	7	8		
Kodair	Rekulapally			1	1
Kodair	Singaipally			1	1
Kodair	Teegalpally			1	1
Kodair	Turkadinne			1	1
Kodair	Yettam				
Kollapur	Amaragiri			2	2
Kollapur	Ankiraopally			1	1
Kollapur	Asadpur				
Kollapur	Bollaram				
Kollapur	Chukkaiapally			1	1
Kollapur	Ellur			5	5
Kollapur	Kollapur			1	1
Kollapur	Kudikilla			1	1
Kollapur	Machinenipally				
Kollapur	Malabaswapur				1
Kollapur	Malachintapally	15			
Kollapur	Narlapuram			1	1
Kollapur	Ramapur			1	1
Kollapur	Singawataon				
Kollapur	somasil	12	13		
Kollapur	Wardyal			1	1
Kollapur	Yenmanbetla				
Lingal	Ambatpally			3	3
Lingal	Ausulkunta	21	1		
Lingal	Bakaram	10			
Lingal	chandapuram	11		5	5
Lingal	Goremadugu			17	16
Lingal	Komatikunta	19	3		
Lingal	Lingal	9		6	6
Lingal	Rampur	6	1		

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Lingal	Rangaipally			1	1
Lingal	Rayavaram			1	1
Lingal	sayanpet	5	4		
Lingal	Surapur	22	5		
Nagarkurnool	Auraspally	19	14		
Nagarkurnool	Bheemaram		1		
Nagarkurnool	Bondalpally			1	
Nagarkurnool	Chandayapally		1		
Nagarkurnool	Desiitikyal			1	1
Nagarkurnool	Gaggalpally	1	5		
Nagarkurnool	Gudipally			1	1
Nagarkurnool	Lakshmapuram	8	5		
Nagarkurnool	Malkapur				1
Nagarkurnool	Manthati	6	15		
Nagarkurnool	Naganul	4	9		
Nagarkurnool	Nagarkurnul	1	11		
Nagarkurnool	Nallavelli			1	1
Nagarkurnool	Peddamudunur			1	1
Nagarkurnool	Peddapuram	7	6		
Nagarkurnool	Puljal		6		
Nagarkurnool	Sripuram			1	1
Nagarkurnool	Tadukurthy		1	2	2
Nagarkurnool	Uyyalwada	6	13		
Nagarkurnool	Vallabhampally	5	6		
Nagarkurnool	Vallabraopally				1
Nagarkurnool	Vanapatla			1	1
Nagarkurnool	Yendabetla	2	6		
Padara	Padra	1	9		
Padara	Vankeshwaram				
Peddakothapally	Adiral				1
Peddakothapally	Bacharam			1	1
Peddakothapally	Bhavanampally		5		
Peddakothapally	c.Karpamula	5			1
Peddakothapally	Chandrakal			2	2
Peddakothapally	Chennapuranpally	9	10		
Peddakothapally	Gantraopally			1	1
Peddakothapally	Jonnalaboguda			1	1
Peddakothapally	Kalwakole			1	1
Peddakothapally	Kothapet		1	1	1
Peddakothapally	Marikal			2	2
Peddakothapally	Mustipally			2	1

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Peddakothapally	p.Karpamula			2	1
Peddakothapally	Pedakothapally			2	2
Peddakothapally	Satapuram			2	2
Peddakothapally	Vedukaraopally				1
Peddakothapally	Vennacherla			2	2
Peddakothapally	Yapatla			2	2
Pentlavelli	Gopalapuram				
Pentlavelli	Jatprole			2	2
Pentlavelli	Konduru			1	1
Pentlavelli	Malleshwaram	10	2		
Pentlavelli	Manchalakatta	25	28		
Pentlavelli	Pentlavelly			2	2
Pentlavelli	singavaram			1	
Pentlavelli	Vemkal	7	8		
Tadoor	Ballonipally			1	1
Tadoor	Cherlaitikyal	1	3		
Tadoor	GuntaKodur	6	7		
Tadoor	Indrakal	16	14		
Tadoor	Kummera	4	7		
Tadoor	Papagal			1	1
Tadoor	Parvathyapalli				1
Tadoor	Siriswada		1		1
Tadoor	Tadur	4	11		
Tadoor	Thummalasugur				1
Tadoor	Tirumalapuram	4	10		
Tadoor	Yadireddypally			1	1
Tadoor	Yatmatapur	4	11		
Tadoor	Yetdaripally				1
Telkapally	Aleru			2	2
Telkapally	Ananthasagar				1
Telkapally	Bandapally				1
Telkapally	Boppally			1	1
Telkapally	Chinamudunur	10	6		
Telkapally	Gaddampally			1	1
Telkapally	GattunelliKonduru			1	1
Telkapally	Gouraram	4	3		
Telkapally	Goutampally	1	15		
Telkapally	Jamistapur			1	
Telkapally	karvvanga	4	9		
Telkapally	Laknavaram	11	12		
Telkapally	Nadigadda		12		

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Telkapally	Peddapally			2	2
Telkapally	Pedduru		20		
Telkapally	Raipakuala			1	
Telkapally	Rakonda			1	1
Telkapally	Telkapally	10	10		
Telkapally	Vattipally	1	10		
Thimmajipet	Avancha	11	12		
Thimmajipet	Chegunta			1	1
Thimmajipet	Gorita	15	6		
Thimmajipet	Ippalapally	2		2	2
Thimmajipet	Koduparthy			1	1
Thimmajipet	Marepally	8	2		
Thimmajipet	Marikal			1	1
Thimmajipet	Potrhredypally			2	2
Thimmajipet	Pullagiri	5	6		
Thimmajipet	Tirmalgiri				1
Thimmajipet	Yedirepally	9	4		
Uppununthala	Dasarlapally			1	1
Uppununthala	kamsanipally			1	1
Uppununthala	Koratkal	2	4		1
Uppununthala	Lakhmapur	2	16		
Uppununthala	Mamidipally			1	1
Uppununthala	Marripally			1	1
Uppununthala	Peddapur	7	16		
Uppununthala	Penimmilla	6	5	3	3
Uppununthala	Rajanagar				1
Uppununthala	Tadoor			2	2
Uppununthala	Tirumalapur			1	
Uppununthala	Upparipally			1	1
Uppununthala	Veltur			3	3
Urkonda	Bomraspally	27	4		
Urkonda	Madaram	5	5		
Urkonda	Rachalapally			1	1
Urkonda	Revally		9		
Urkonda	Urakonda			1	1
Urkonda	Urakondapet			2	2
Vangoor	Annaram				1
Vangoor	Dindichintalapally	2	15		
Vangoor	Gajra				1
Vangoor	Jajala	8	5		
Vangoor	Kondareddypally			1	1

New Mandal	Village	Existing No. of Percolation Tanks	Existing No. of Check Dams	Proposed Check Dams	Proposed Percolation Tanks
Vangoor	Konetipuram	18	2		
Vangoor	Nizamabad			1	1
Vangoor	Polkampally			1	1
Vangoor	Pothreddypally				1
Vangoor	Rangapur	14	2		
Vangoor	Sarvareddypally			1	1
Vangoor	Thippareddypally	2	12		
Vangoor	Ulpera	9	14		
Vangoor	Ummapur				1
Vangoor	Uppalapahad				1
Vangoor	Vangur			2	2
Vangoor	Venkatapuram				1
Veldanda	Baherapuram	1	14		
Veldanda	Bollampally		3		
Veldanda	chedurvally			1	1
Veldanda	Cherkur			3	3
Veldanda	Gundala	2	6		
Veldanda	Karrevanipally	1			
Veldanda	Konduduvada				1
Veldanda	Kotra			2	2
Veldanda	Kuppagandla	7	15		
Veldanda	Lingareddypally				1
Veldanda	Peddapuram			1	1
Veldanda	Potepally			1	1
Veldanda	Rachur	1	15		
Veldanda	Veldanda	22	3		
Veldanda	Yerapally	1			1