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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

YADADRI BHUVANAGIRI DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल शक्ति मंत्रालय
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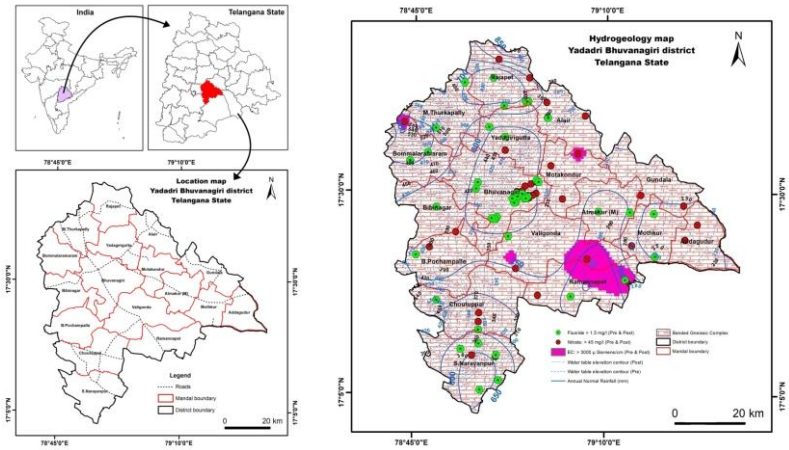
GOVERNMENT OF INDIA

MINISTRY OF JAL SHAKTI

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

INCEPTION REPORT ON
AQUIFER MAPPING AND MANAGEMENT PLANS FOR SUSTAINABLE GROUND WATER RESOURCES IN YADADRI BHUVANAGIRI DISTRICT, TELANGANA STATE



CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD

MAY 2023

REPORT ON
AQUIFER MAPPING AND MANAGEMENT PLANS FOR SUSTAINABLE GROUND WATER RESOURCES IN YADADRI BHUVANAGIRI DISTRICT, TELANGANA STATE (AAP 2022-23)

CONTRIBUTORS' PAGE

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FOREWORD

India is the largest ground water user in the world, with an annual ground water withdrawal of 253 billion cubic meters (BCM). This represents about 25% of the world's ground water withdrawals. India has about 112.3 BCM of water resources, of which 690 BCM is surface water and the remaining 433 BCM is ground water. Out of the total available ground water, 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 ground water, 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 ground water and its management in different hydrogeological environments, and develop effective management methods with the involvement of the community to better manage ground water. 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 ground water resources to delineate and describe aquifers and develop ground water management plans for their sustainable development with stakeholder participation.

The report titled " Report on Aquifer Mapping and Management Plans for Sustainable Ground Water Resources in Yadadri Bhuvanagiri District, Telangana State" prepared from the extensive hydrogeological, geophysical and hydro chemical data generated by CGWB over the years and integrated with the 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 viz., ArcGIS 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 ground water 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), and the efforts made by the officer in preparation of this report are greatly appreciated. Due thanks to (i) Dr. Pandith Madhnure, then Scientist-D, CGWB, SR and presently serving as Director, State Ground Water Department, Telangana State (ii) Dr. G. Praveen Kumar, Scientist-C and (iii) Shri Ravi Kumar Gumma, Scientist-D who had prepared the reports on watershed basis (Phase – I to III) in the year 2015-16 for the erstwhile Nalgonda district during their service at SR, Hyderabad. These reports have helped a lot to prepare the present report by incorporating latest data. Thanks are due to Smt. Rani, V.R, Scientist-D and Sh. Ravi Kumar Gumma, Scientist-D & OIC, CGWB, APSUO, Visakhapatnam 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 ground water resources in the district.

Sh. J. Siddhardha Kumar
Regional Director
CGWB, SR, Hyderabad

EXECUTIVE SUMMARY

The Yadadri Bhuvanagiri district covering 3579 sq.km is carved out from erstwhile Nalgonda district. Administratively, the area is governed by 2 Revenue Divisions, 17 Revenue Mandals and 320 Revenue villages with a population of 7.71 lakhs (2011 census) (Rural: 84%, Urban: 16%) with average density of 225 persons/sq.km.

The annual normal rainfall of the district varies from 600 mm (S.Narayanpur mandal) to 850 mm (Rajapet mandal). The Southwest monsoon contributes 75%; Northeast monsoon contributes by 18% and remaining 7% by January to May months of normal annual rainfall. The average normal rainfall in the district is 744 mm and received large excess rainfall of 1108 mm (64% above normal) during the water year 2020-21.

The district falls under Krishna basin and Krishna Middle Sub-Basin. The major river flowing in the district is Musi from west to east. The tributaries viz., Chinna Musi, Chinnaeru and Aler Rivers are also flows in the district and finally join to River Musi. The major lineaments in the area trend towards N-S, NW-SE directions.

Geologically, major part of the district is underlain by Gneisses. The pediplain is the major landform followed by pediment. The district is one of the agriculturally developed districts in the Telangana state. The land use/land cover in the district indicates that out of the total area, majority of the area (>50%) falling under kharif category followed by double crop. The double cropped area has been noticed on either side of the river courses within the district. The forest occupied in about 3.45% area of the district. During kharif season, out of total gross cropped area, the is Cotton is grown in 48% of the area followed by Paddy in 36% and other crops in 16% of the area while during rabi season, Paddy is grown in 98% of the area followed by others crops in 2% of the area. The majority of the soils are covered with fine mixed, loamy skeletal mixed, and clayey skeletal mixed and course loamy mixed soils.

Ground water exploration carried out up to the depth 200 m bgl and reveals that weathered zone thickness varies from 2.5 to 30 m bgl. The data indicates that 14% of the wells drilled at shallow depth that are drilled up to a depth of <30 m bgl, 8% of the wells between the depth of 30 to 60 m bgl, 14% of the wells drilled between the depth of 60 to 100 m bgl, again 14% of the wells drilled between the depth of 100 to 150 m bgl and the

remaining 48% of the wells drilled between the depth of 150 to 200 m bgl. Further, the study revealed that majority of fracture (87%) occurs within 100 m depth. The yield of the wells varies from <1 to 7.4 lps with an average of 1 lps.

The depth to water level during pre-monsoon season is ranging from 2.8 to 24.23 m bgl with an average of 13.15 m bgl. Majority of the water levels during this season are in the range of 10 to 20 m bgl and distributed in 55% of the area followed by the water levels ranging from 5 to 10 m bgl (28% of the area). The water levels >20 m bgl is noticed in 14% of the area while the water levels between 2 to 5 m bgl is observed in 2% of the area. In none of the samples, the depth to water level is shown <2 m bgl. During post-monsoon season is ranging from 1.39 to 20.55 m bgl with an average of 9.15 m bgl. Majority of the water levels during this season are in the range of 5 to 10 m bgl and noticed in 49% of the area followed by water levels of between 10 to 20 m bgl distributed in 29% of the area. The water levels ranging from 2 to 5 m bgl is observed in 18% of the area. The shallow water levels <2 m bgl is noticed in 2% of the area while the deeper water levels >20 m bgl is also noticed in 2% of the area.

The data analysed from the ground water quality indicates that during pre-monsoon season, the Electrical conductivity varies from 480 to 6228 µ Siemens/cm (avg. 1590 µ Siemens/cm). In about 6% of the samples, the EC is noticed >3000 µ Siemens/cm The concentration of TDS varies from 307 to 3986 mg/l (avg. 1018 mg/l) and found that in 6% of the samples, it is falling >2000 mg/l. The NO3 concentration ranges from 1 to 680 mg/l (avg. 67 mg/l) and noticed that in about 37% of the samples, the quality is not suitable and falling beyond permissible limit of >45 mg/l. The Fluoride concentration varies from 0.36 to 4.42 mg/l (avg. 1.37 mg/l) and 34% of the samples, it is beyond permissible limit of >1.5 mg/l. During post-monsoon season, Electrical conductivity varies from 403 to 3950 µ Siemens/cm (avg. 1187 µ Siemens/cm), the EC >3000 µ Siemens/cm is observed in 2% of the samples. The concentration of TDS varies from 258 to 2528 mg/l (avg. 759 mg/l) and in 2% of the samples, the EC is beyond permissible limit of >2000 mg/l. The NO3 concentration ranges from 0.07 to 433 mg/l (avg. 51 mg/l) and it is noticed that in about 36% of the samples are falling beyond permissible limit of >45 mg/l). The Fluoride concentration varies from 0.28 to 4.14 mg/l (avg. 1.35 mg/l). In about 33% of the samples are having high fluoride concentration beyond permissible limits of >1.5 mg/l.

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 2022 estimation report, the annual extractable ground water resources is is 804 MCM, the gross ground water extraction for all uses 46 MCM, provision for drinking and industrial use for the year 2025 is 35 MCM and net annual ground water potential available for future irrigation needs is 425 MCM. All the 17 mandals are falling under 'Safe' category (Addagudur (63%), Alair (63%), Atmakur_M (67%), Bhongiri (53%), Bibinagar (34%), Bommalaramaram (50%), Choutuppal (41%), Gundala (67%), Mootakondur (50%), Mothkur (56%), Narayanapur (63%), Pochampalle (33%), Rajapet (61%), Ramannapeta (24%), Turkapalle_M (59%), Valigonda (48%) and Yadagirigutta (49%). The overall average stage of ground water extraction in the district is 63% falling under 'Safe' category.

With respect to village wise ground water management plans, out of the total 320 villages, in around 305 villages, the depth to water level of <5 m bgl is noticed during post-monsoon season. Hence, artificial recharge structures for water conservation and management plan have recommended for all these villages. About 14467 MCM of unsaturated volume (below 5 m depth) is available (in both weathered and fractured zones), 289 MCM recharge potential and 46 MCM utilizable yield (uncommitted run-off) is available for immediate intervention. About 115 artificial recharge structures (Percolation Tanks (PTs): 67 & Check Dams (CDs): 48) were already existing in 18 villages with storage capacity of 0.09 MCM. About 1145 artificial recharge structures have further recommended (527 PTs with 2 fillings with a unit cost of Rs. 20 lakhs each and 618 CDs with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 198.10 Crores. After effective implementation of artificial recharge structures, there will be 33.34 MCM of ground water recharge.

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 6400 farm ponds needs to be constructed at a unit cost of Rs. 25,000/- totalling to 16 Crores. This will create an additional storage capacity of 1.92 MCM.

With respect to micro-irrigation practices as per the estimates about 13634 ha. of additional land that can be brought under micro-irrigation (where actual area irrigated though MI is less than 1,000 ha.). By shifting from traditional to micro irrigation practices, 20.45 MCM of ground water can be conserved.

In the entire district, with the above interventions, the likely benefit would be increases in gross ground water availability with net saving of 55.71 MCM of ground water or net reduction of 17% in stage of ground water extraction, i.e., from the existing 63% to 46%. The onetime cost will be 5 paisa/litre and the actual cost of invest will be 0.5 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

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ABBREVATIONS		
2D	:	2 Dimensional
3D	:	3 Dimensional
ARS	:	Artificial Recharge Structures
Avg	:	Average
BDL	:	Below Detection Level
BW	:	Bore Well
CD	:	Check dam
CGWB	:	Central Ground Water Board
Cr	:	Crore
DTW	:	Depth to water
DW	:	Dug well
EC	:	Electrical conductivity
EL	:	East Longitude
F	:	Fluoride
FP	:	Farm Pond
GEC	:	Ground Water Estimation committee
GW	:	Ground Water
ha.	:	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 ground water in aquifers. In recent past, there has been a paradigm shift from “ground water development” to “ground water 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 ground water in India, aquifer mapping in different hydrogeological settings at the appropriate scale is devised and implemented, to enable robust ground water 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 ground water management through community participation.

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

1.3 Area Details

The Yadadri Bhuvanagiri district covering 3579 sq.km lies between north latitude of 78°40'48" - 79°27'35" and east longitude of 17°02'36" - 17°48'50" (Fig. 1.1). The district is bounded on the north by Siddipet and Jangaon, on the east by Jangaon and Suryapet, on the south by Nalgonda and on the west by Medchal Malkajgiri and Rangareddy districts. The present district is carved out from erstwhile Nalgonda district. Administratively, the area is governed by 2 Revenue Divisions, 17 Revenue Mandals and 320 Revenue villages with a population of 7.71 lakhs (2011 census) (Rural: 84%, Urban: 16%) with average density of 225 persons/sq.km. The hilly and forest area occupying 3.45% of the total area located in different parts 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 South Telangana Agro-climatic zone based on the geographical characteristics such as rainfall, temperature and nature of soils. The wet season is oppressive and overcast; the dry season is humid and mostly clear and hot throughout the year. The temperature typically varies from 17°C to 40°C.

The hot season lasts for 3 months from April to June with an average daily high temperature above 38°C. The hottest month of the year in the district is May with an average high of 40°C and low of 28°C.

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. The annual normal rainfall of the district varies from 600 mm (S.Narayanpur mandal) to 850 mm (Rajapet mandal). The Southwest monsoon contributes 75%; Northeast monsoon contributes by 18% and remaining 7% by January to May months of summer showers. The Isohyetal map is prepared using annual normal rainfall in the district collected from DES, Govt. of Telangana is shown in Fig. 1.2. The average normal rainfall in the district is 744 mm and received large excess rainfall of 1108 mm (64% above normal) during the water year 2020-21.

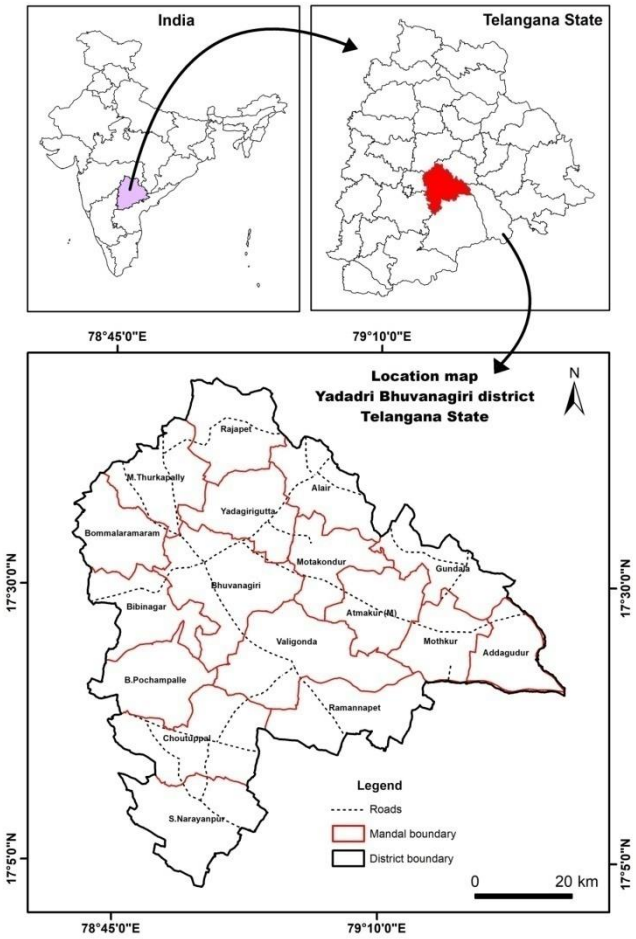

Fig. 1.1: Location map

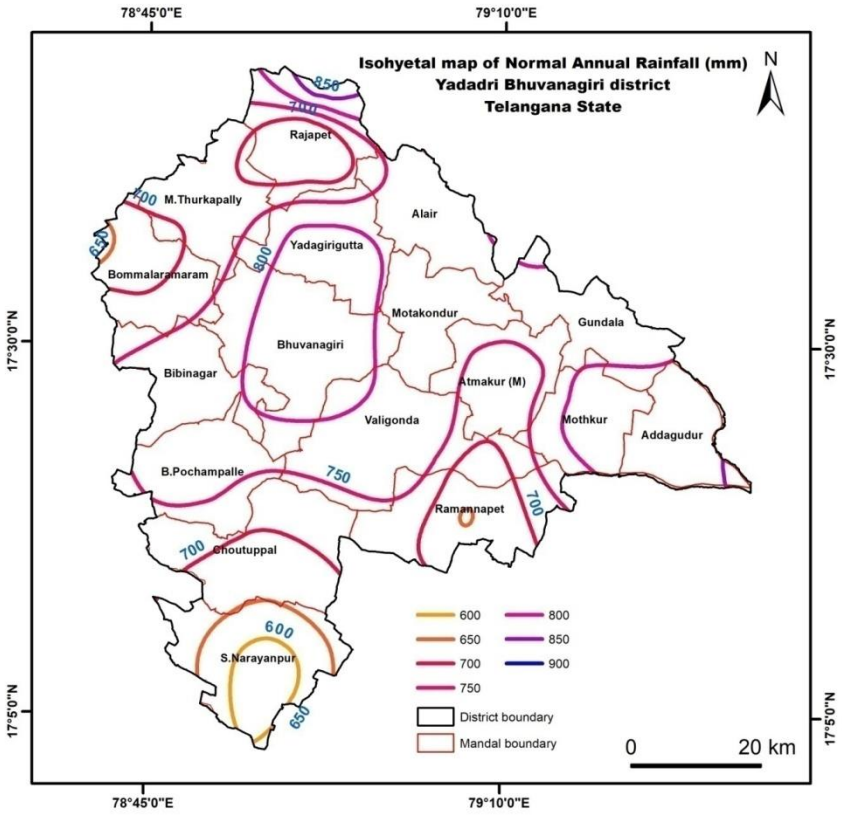

Fig. 1.2: Isohyetal map

1.5 Drainage

The district falls under Krishna basin and Krishna Middle Sub-Basin. The major river flowing in the district is Musi from west to east. The tributaries viz., Chinna Musi, Chinnaeru and Aler Rivers are also flows in the district and finally join to River Musi. The drainage map is presented in Fig. 1.3.

1.6 Geology

Geologically, most of the area is underlain by crystalline rocks viz., Banded gneissic complex (100%) with basic intrusive rocks, dolerite. The major lineaments in the area trend towards N-S, NW-SE directions. The geology map of the district is given in Fig. 1.4.

1.7 Geomorphological Set up

The district is contiguous part of Mysore Plateau and is characterised by erosional topography with general slope from east to west and northwest to southeast. The pediplain (74%) is the major landform followed by denudational hills (10%), pediment (7%), residual hill (5%) and others (4%) geomorphological units (Fig. 1.5).

1.8 Land use/ land cover

Based on the land use study, several major classes have been delineated in the district viz., agricultural land (kharif and rabi), double crop, plantations, deciduous open forest, waste lands and water bodies. Out of the total area, majority of the area (>50%) falling under kharif category followed by double crop. The double cropped area is noticed on either side of the river courses in the district. About 3.45% of forest cover is noticed from the total area of the district. The land use / land cover map is given in Fig. 1.6.

1.9 Soils

The majority of the soils are covered with fine mixed, loamy skeletal mixed, and clayey skeletal mixed and course loamy mixed soils and all these soils constitute about 90% of the district. The remaining 10% of the soils are rock lands and coarse loamy mixed soils. 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).

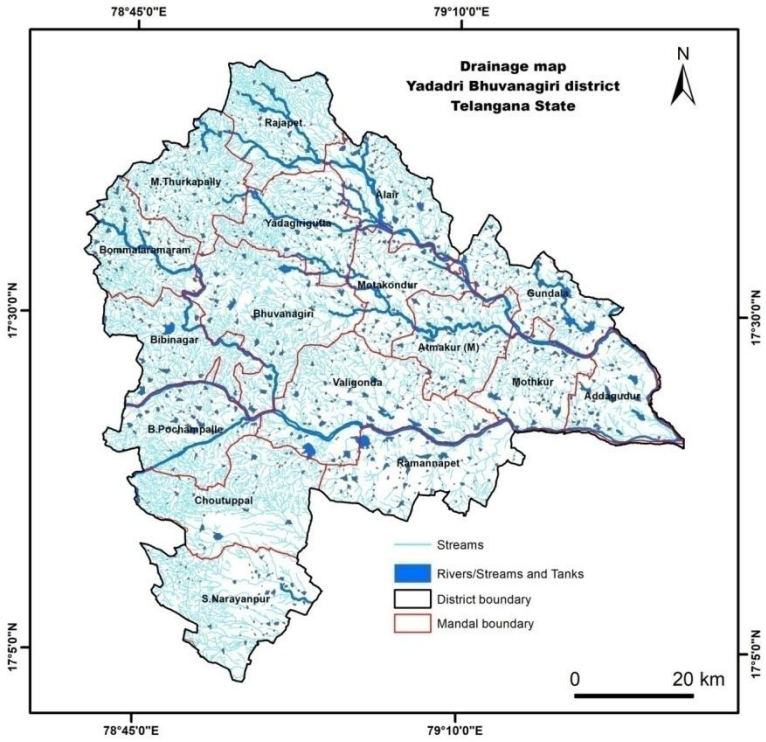

Fig 1.3: Drainage and water bodies map

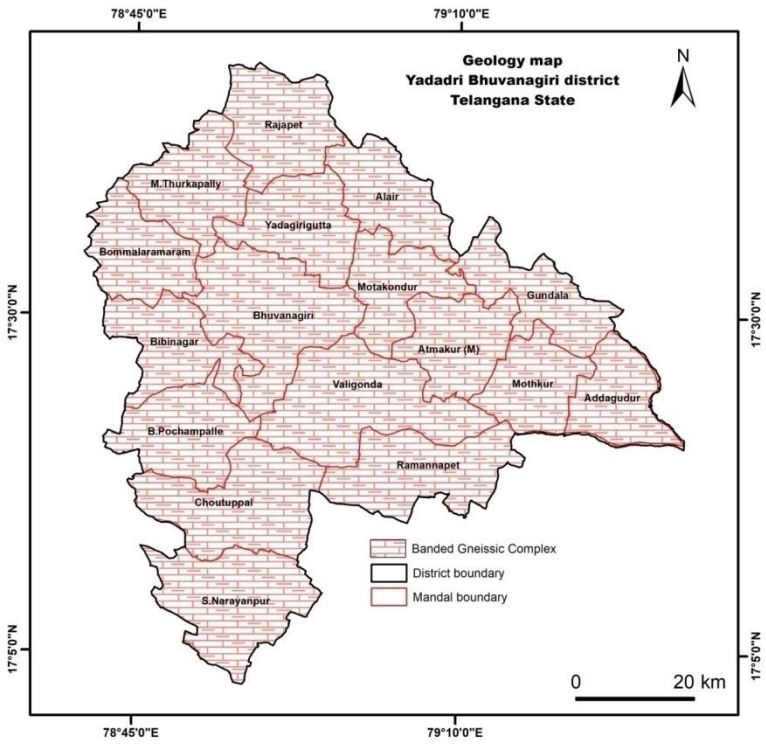

Fig. 1.4: Geology map

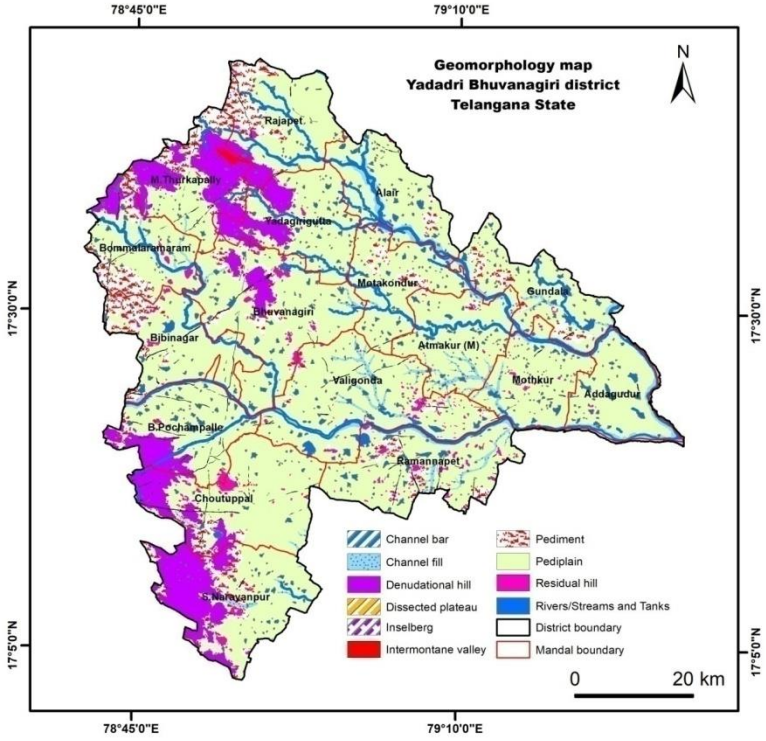

Fig. 1.5: Geomorphology map

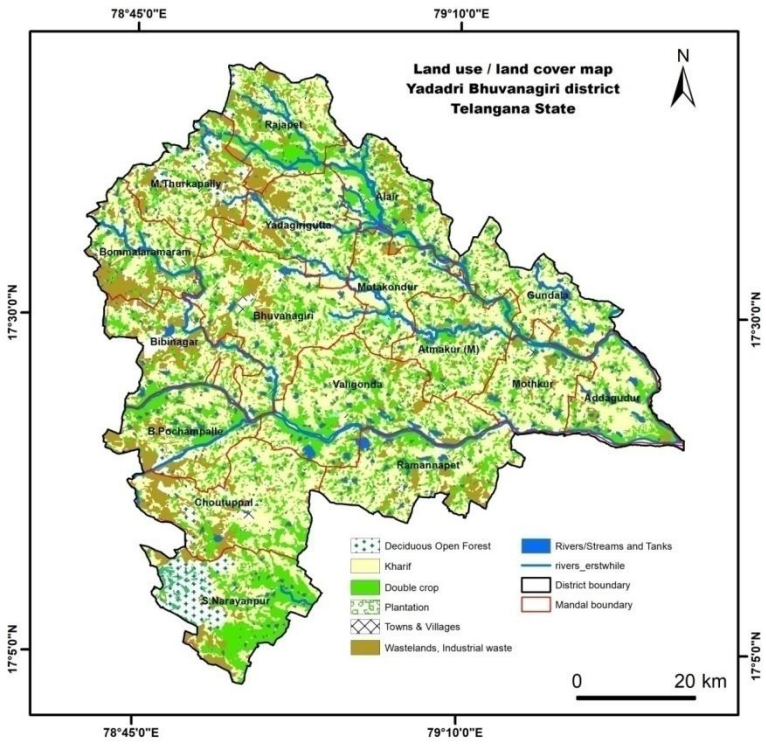

Fig. 1.6: Land use / land cover map

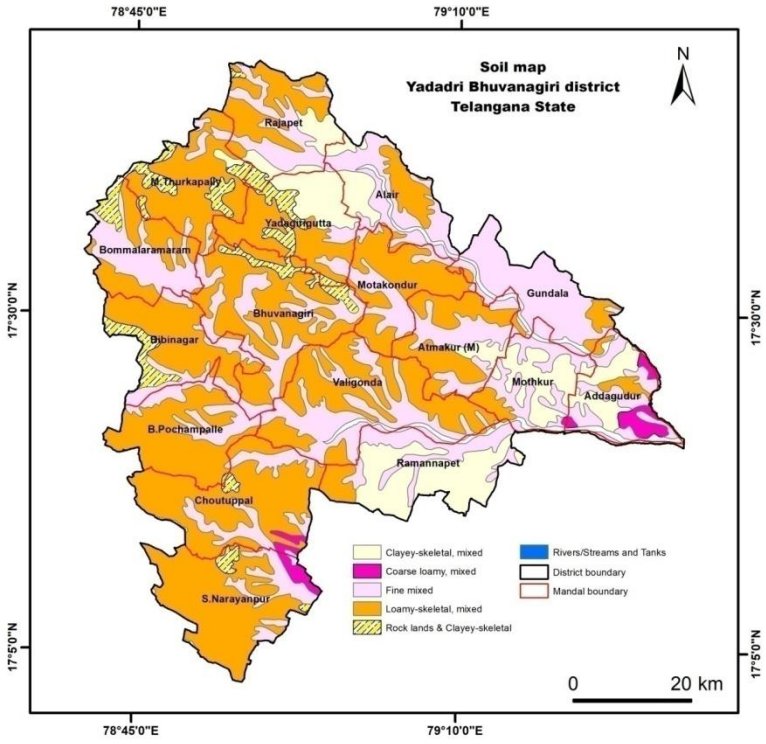

Fig. 1.7: Soil map

1.10 Cropping Pattern

The forest occupies about 3.45% of the total geographical area, barren and uncultivable land occupies 8% of area; land put to non-agricultural use is 7%, cultivable wasteland is 4%. With respect to land utilization, out of total area, 17% of the area is falling under current fallows; 11% is under other fallows category. The net area sown is about 41% and area sown more than once is 12%, which brings gross cropped area to 53%. During kharif season, out of total gross cropped area, the is Cotton is grown in 48% of the area followed by Paddy in 36% and other crops in 16% of the area while during rabi season, Paddy is grown in 98% of the area followed by others crops in 2% of the area (Fig. 1.8).

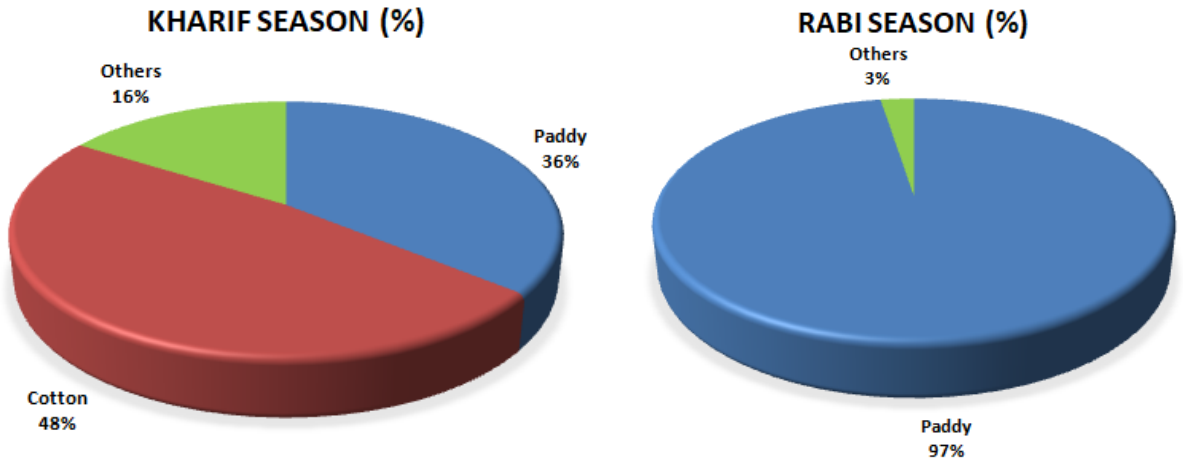

Fig. 1.8: Pie chart showing Cropping pattern trend during kharif and rabi seasons

1.11 Irrigation

In the district, there are 4 contemplated/completed Irrigation Potential (IP) projects viz., Alimineti Madhava Reddy (SLBC) Project (534 Ha.), Asif Nahar Project (4944 Ha.), JCR Godavari Lift Irrigation Scheme (52292 Ha.) and Srirama Sagar Project Stage II (10 Ha.) (Fig. 1.9). In the district, about 1485 number of minor irrigation tanks covering 25440 ha. of ayacut. As per the latest GEC report, there are about more than 55,000 numbers of bore wells (irrigation, domestic and industrial) and about more than nearly 8000 dug wells are being existed in the district.

1.12 Prevailing Water Conservation/Recharge Practices

In the district, 115 artificial recharge structures (PT's: 67, CD's: 48 and Farm Ponds: 7) are exists. Under Mission Kakatiya (Phase-1 to 4), out of 1485 minor irrigation tanks, 747 tanks (50%) of tanks are desilted.

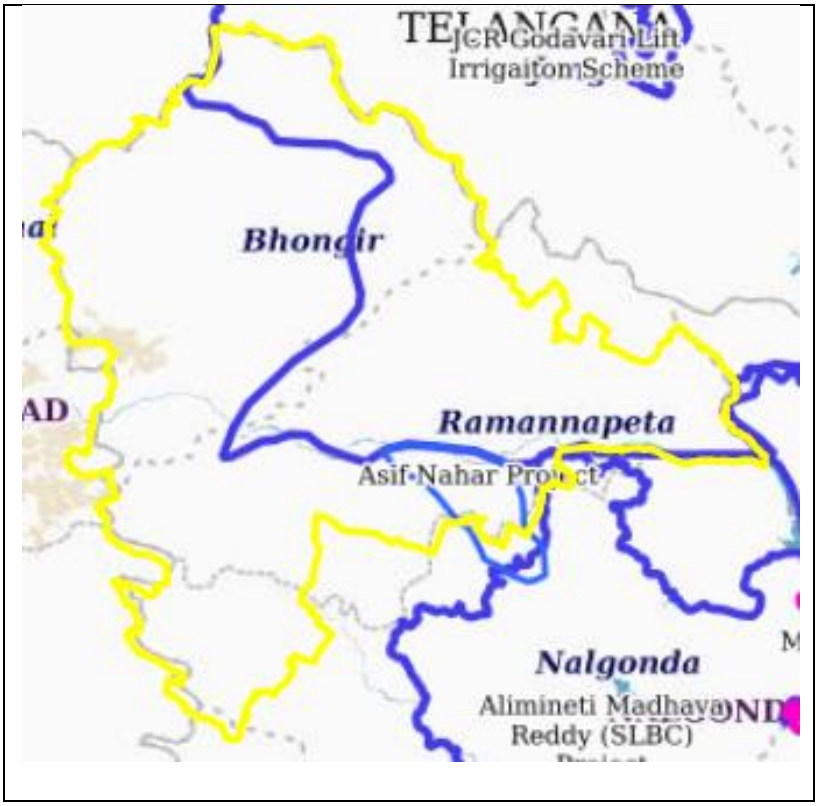

Fig. 1.9: Irrigation Projects and canal command areas in the district
(Source: https://bhuvan-app1.nrsc.gov.in/twris/geoportal/twris.php)

2. DATA COLLECTION AND GENERATION

Collection and compilation of data for aquifer mapping studies is carried out in conformity with Expenditure Finance Committee (EFC) document of XII plan of CGWB encompassing various data generation activities (Table 2.1).

Table 2.1: Brief activities showing data compilation and generations

S. No.	Activity	Sub-activity	Task
1	Compilation of existing data/ Identification of Principal Aquifer Units and Data Gap	Compilation of Existing data on ground water	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 extraction 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 extraction 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 ground water recharge	Soil infiltration studies, rainfall data analysis, canal flow and recharge structures.
		Preparation of Hydrogeological map (1:50, 000 scale)	Water level monitoring, exploratory drilling, pumping tests, preparation of sub-surface hydrogeological sections.
		Generation of additional water quality parameters	Analysis of ground water for general parameters including fluoride.
3.	Aquifer Map 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 ground water 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 gneiss. 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 and presented in Fig. 2.1.

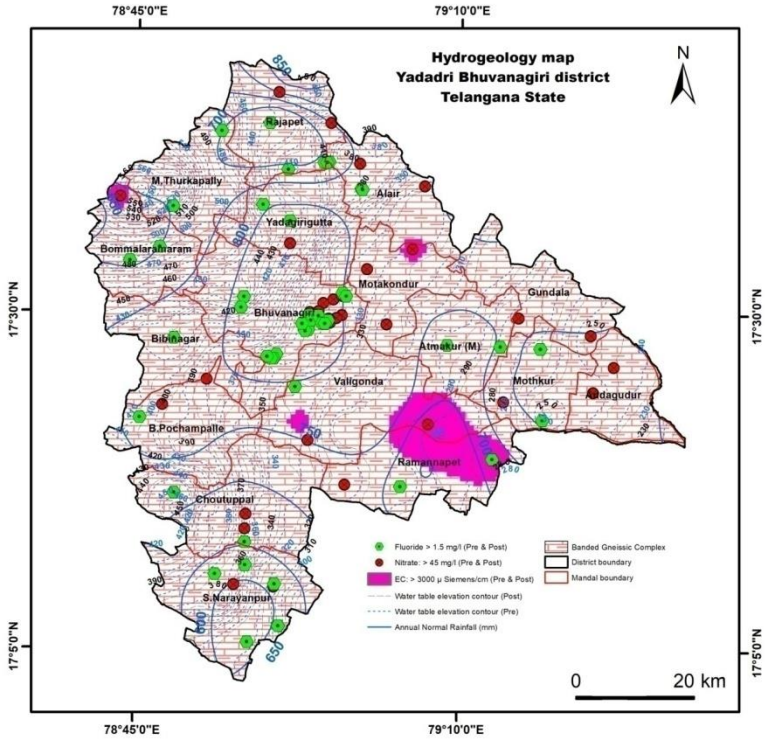

Fig. 2.1: Hydrogeology map

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 are constitute the by 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 the aquifer formations 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 ground water 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

Ground water exploration done under four phases in the district (1971-75, 1989-92, 1999-2004, 2014-16 and till date) to understand the shallow and deep aquifers. As on 31/03/2022, CGWB had drilled 298 bore wells (EW-163, OW-22, PZ-38, HP (PZ)-75 and State Ground Water Department (SGWD) drilled 20 piezometers. The depth of the drilling ranges from 15 to 243 m bgl and weathering ranges from 2.5 to 30 m bgl. The data analysed from the above exploratory wells indicates that 14% of the wells drilled at shallow depth that are drilled up to a depth of <30 m bgl, 8% of the wells between the depth of 30 to 60 m bgl, 14% of the wells drilled between the depth of 60 to 100 m bgl, again 14% of the wells drilled between the depth of 100 to 150 m bgl and the remaining 48% of the wells drilled between the depth of 150 to 200 m bgl. The further deeper bore wells of 1% is drilled beyond >200 m bgl (Fig. 2.2). The deeper wells of >100 m bgl are drilled in all mandals. Further, the study revealed that majority of fracture (87%) occurs within 100 m depth. The deepest fractures of >100 m bgl is occurred in 11 mandals viz., Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bommalaramaram, Choutuppal, M.Thurkapally, Motakondur, Rajapet and Yadagirigutta mandals. The yield of the wells varies from <1 to 7.40 lps with an average of 1 lps.

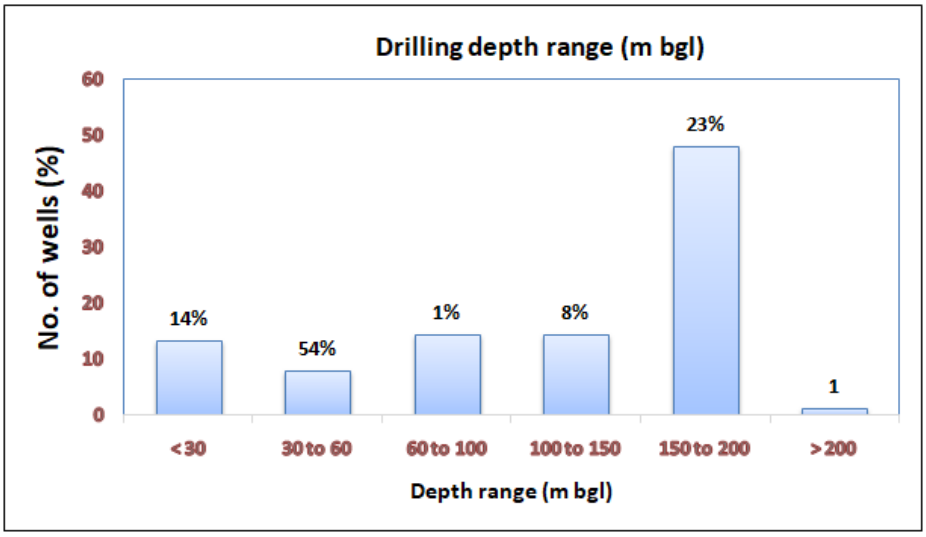

Fig. 2.2: Bar chart showing depth range under exploratory drilling programme

2.2 Depth to Water Levels (DTWL)

To understand the behaviour of ground water in time and space, the wells were established and monitored at different places of the district by CGWB and SGWD. These data were utilized for preparation of depth to water level maps. The average values of water levels measured from the year 2010 to 2019 during pre and post-monsoon season were analysed for better interpretation of the area. From the data, it is revealed that the depth to water level in the district varies from 2.8 to 24.23 m bgl (average: 13.15 m bgl) and 1.39 to 20.55 m bgl (average: 9.15 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 of 2019, water-table elevation ranges from 242 to 572 and 246 to 576 m amsl respectively (Fig. 2.3).

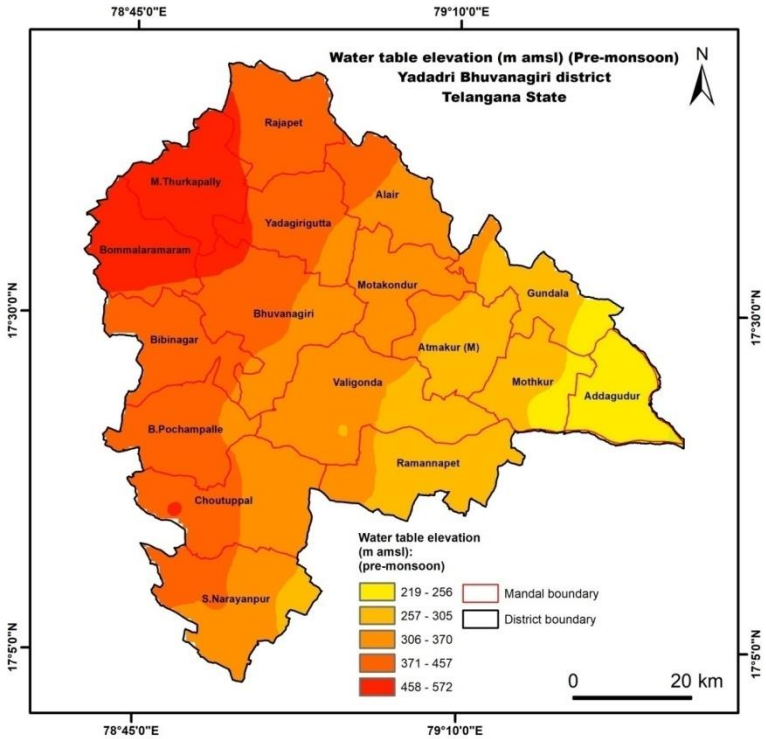

Fig. 2.3: Water table elevation (m amsl) map pre-monsoon

2.2.2 Pre-monsoon depth to water level

The depth to water level during pre-monsoon season is ranges from 2.8 to 24.23 m bgl with an average of 13.15 m bgl. Majority of the water levels during this season are in the range of 10 to 20 m bgl covering in 55% of the area followed by the water levels ranging from 5 to 10

m bgl (28% of the area). The water levels >20 m bgl is noticed in 14% of the area while the water levels between 2 to 5 m bgl is observed in 2% of the area. In none of the samples, the depth to water level is shown <2 m bgl (Fig. 2.4). The mandal wise distribution of depth to water levels during pre-monsoon season is given in Table 2.2.

Table 2.2: Mandal wise distribution of water levels during pre-monsoon season

DTWL Range	% of distribution	Mandals covered
0 to 2	Nil	-
2 to 5	3	B.Pochampalle and Choutuppal
5 to 10	28	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Choutuppal, M.Thurkapally, Motakondur, Mothkur, Ramannapet and Valigonda
10 to 20	55	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
>20	14	Choutuppal, Motakondur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta

2.2.3 Post-monsoon depth to water level

The depth to water level during post-monsoon season is ranges from 1.39 to 20.55 m bgl with an average of 9.15 m bgl. Majority of the water levels during this season are in the range of 5 to 10 m bgl and noticed in 49% of the area followed by water levels of between 10 to 20 m bgl distributed in 29% of the area. The water levels ranging from 2 to 5 m bgl is observed in 18% of the area. The shallow water levels <2 m bgl is noticed in 2% of the area while the deeper water levels >20 m bgl is also noticed in 2% of the area (Fig. 2.5) and mandal-wise distribution of water level is given in Table 2.3.

Table 2.3: Mandal wise distribution of water levels during pre-monsoon season

DTWL Range	% of distribution	Mandals covered
0 to 2	2	B.Pochampalle
2 to 5	18	Alair, Bhuvanagiri, Bibinagar, Choutuppal, Ramannapet and Valigonda
5 to 10	49	Addagudur, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet and Valigonda
10 to 20	29	Alair, Atmakur (M), Bhuvanagiri, Choutuppal, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
>20	2	S.Narayanpur

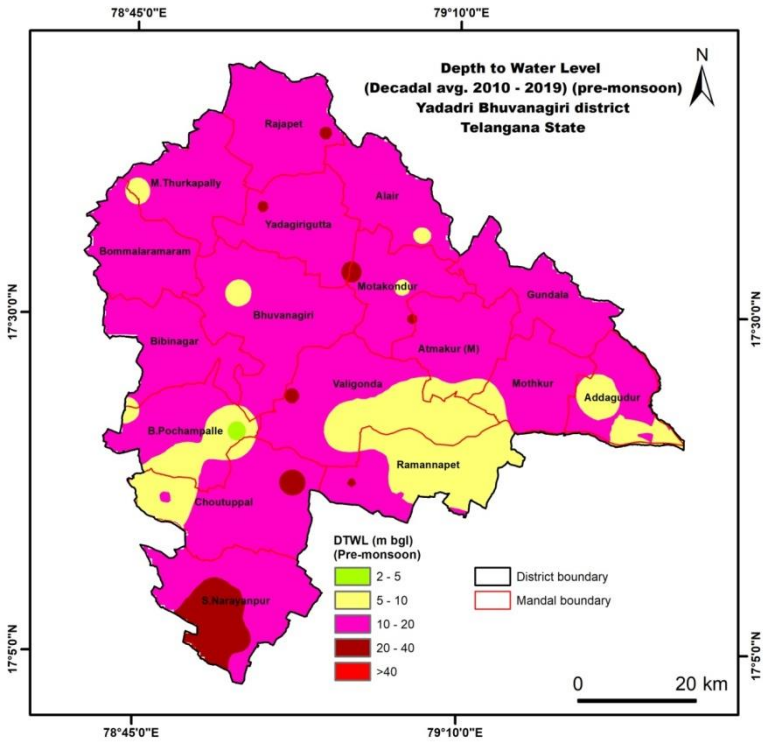

Fig. 2.4: Depth to water levels Pre-monsoon

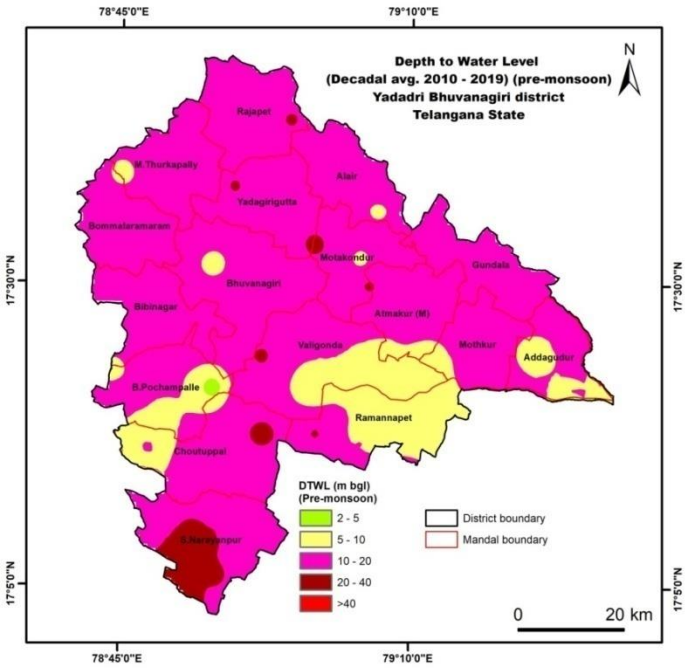

Fig. 2.5: Depth to water levels Post-monsoon

2.2.4 Seasonal Water Level Fluctuations (November vs. May)

The entire district is showing rise in water levels in the range of 0.47 to 10.88 m. Most of the wells (58% of the area) shows water level rise from 2 to 5 m and 20% of the area showing rise in water from 5 to 10 m. The water level rise between 0 to 2 m is noticed in 18% of the area while the water level rise of 10 to 20 m is noticed in 3% of the area (Fig. 2.6, Table 2.4).

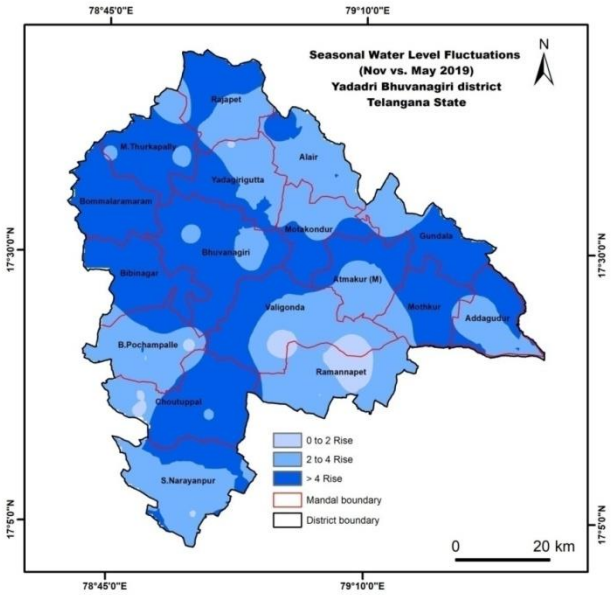

Fig. 2.6: Seasonal Water Level Fluctuations (m)

Table 2.4: Mandal wise distribution of seasonal water level fluctuation (November vs. May)

Seasonal fluctuation	% of distribution	Mandals covered
0 to 2	18	B.Pochampalle, Choutuppal, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
2 to 5	58	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur and Valigonda
5 to 10	20	Bhuvanagiri, Bibinagar, Choutuppal, M.Thurkapally, Motakondur, Mothkur, Rajapet, Valigonda and Yadagirigutta
10 to 20	3	Choutuppal

2.2.5 Long term water level trends

The trend analysis for last 10 years (2010-2019) is studied from the different hydrograph stations of CGWB and SGWD. During pre-monsoon season, 51% of the area shows rising trends ranges from 0.02 to 2.47 m/yr and in remaining 49% of the area, it shows falling trend in the range of -0.009 to -2.58 m/yr (Fig. 2.7). Whereas, during post-monsoon season, 98% of the area is showing rising trend ranges from 0.11 to 3.09 m/yr and in remaining 2% of the area, it is showing the falling trend of -0.005 m/yr (Fig. 2.8 and Table 2.5).

Table 2.5: Mandal wise distribution of seasonal water level fluctuation (November vs. May)

Season		Range	% of Distri-bution	Mandals covered
Pre-mon	Rise	0.02 to 2.47	51	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet and Valigonda
	Fall	-0.009 to -2.58	49	Addagudur, Alair, B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, Gundala, M.Thurkapally, Motakondur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
Post-mon	Rise	0.11 to 3.09	98	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
	Fall	-0.005	2	Valigonda

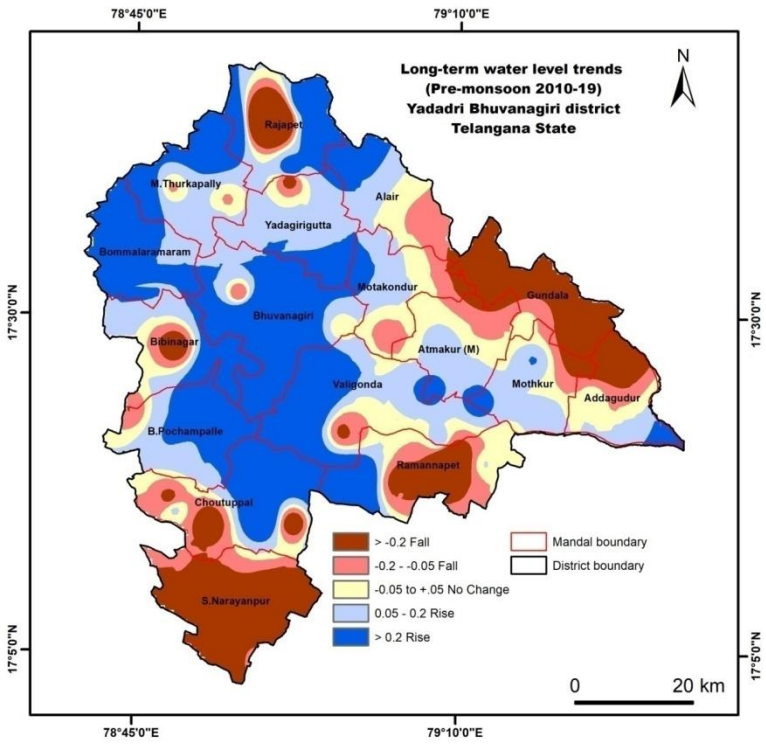

Fig. 2.7: Long-term water level trends (Pre-monsoon 2010-19)

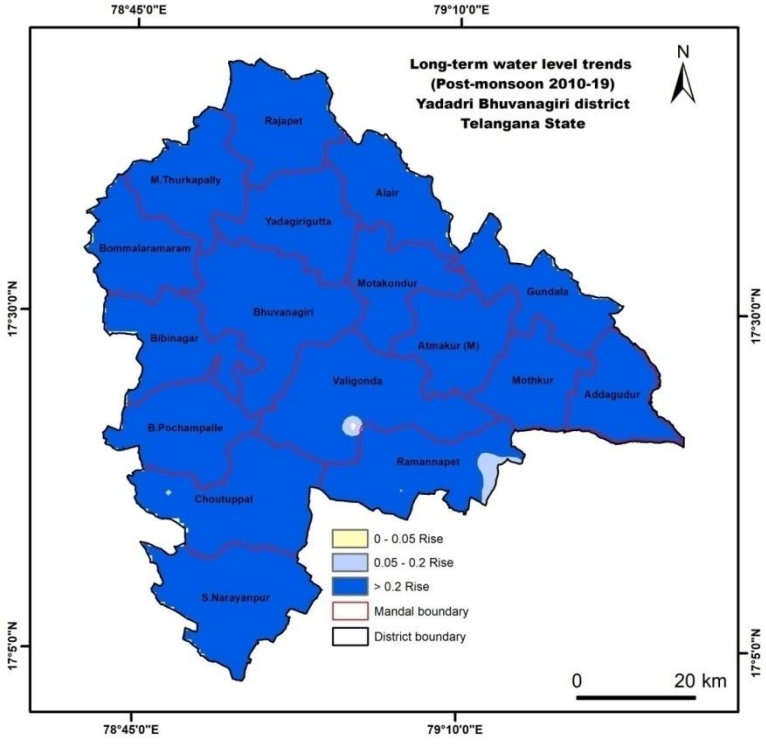

Fig. 2.8: Long-term water level trends (Post-monsoon 2010-19)

2.3 Geophysical Studies

Under aquifer mapping studies, 118 VES were carried out in parts of Yadadri district covering 11 mandals viz., Gundala, Mothkur, Addaguduru, Ramannapet, Narayanpur, Choutuppal, B.Pochampally, Bibinagar, Bhongir, Bommala Ramaram and Thurkapally. The weathered zone is characterized by a resistivity of 10 to 200 Ohm (Ω) m and thickness varies from 3 m to 25 m. The fractured rock exhibits the resistivity between 50 to 350 Ohm (Ω) m. Based on the analysis of geophysical data for Yadadri district the following resistivity ranges for different litho-units were arrived and given in Table 2.6.

Table 2.6: Resistivity ranges for different litho-units

Geological formation	Resistivity range Ohm (Ω) m	Depth range (m)
Top soil	5-150	0-5
Weathered formation	10-200	3-25
Fractured/jointed formation	50-350	30-50
Hard massive formation	More than 400	

2.4 Hydro-chemical Studies

To understand chemical quality of ground water, water samples collected from Aquifer-2 for both pre and post-monsoon seasons from SGWD during the year 2021 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

Ground water from the area is mildly alkaline in nature with pH in the range of 6.82 to 8.28 (avg. 7.46). The Electrical conductivity varies from 480 to 6228 µ Siemens/cm (avg. 1590 µ Siemens/cm). In about 57% of the samples, the EC is within 1500 µ Siemens/cm, while in 38% of the samples it is in the range of 1500-3000 µ Siemens/cm. In about 6% of the samples, the EC is >3000 µ Siemens/cm (Fig. 2.9). The concentration of TDS varies from 307 to 3986 mg/l (avg. 1018 mg/l) and found that in 94% of the samples, it falls within maximum permissible limits of BIS (<2000 mg/l) while in remaining 6% of the samples, it is falling >2000 mg/l. The NO_3 concentration ranges from 1 to 680 mg/l (avg. 67 mg/l) and noticed

that in about 63% of the samples is falling within the permissible limits of <45 mg/l and in about 37% of the samples, the quality is not suitable and falling beyond permissible limit of >45 mg/l (Fig. 2.10). The Fluoride concentration varies from 0.36 to 4.42 mg/l (avg. 1.37 mg/l) and in 66% of the samples, it is within the permissible limit of <1.5 mg/l and in remaining 34% of the samples, it is beyond permissible limit of >1.5 mg/l and not suitable for drinking water purpose (Fig. 2.11). The mandal wise distribution of water quality during pre-monsoon season is given in Table 2.7.

Table 2.7: Mandal wise distribution of water quality during pre-monsoon season

Para-meter	Range	% of distribution	Mandals covered
EC	<1500	57	Addagudur, Alair, Atmakur (M), Bhuvanagiri, Bibinagar, Bommalaramaram, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, S.Narayanpur, Valigonda and Yadagirigutta
	1500 to 3000	38	Alair, B.Pochampalle, Bhuvanagiri, Bibinagar, Choutuppal, Gundala, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda AND Yadagirigutta
	>3000	6	Bommalaramaram, Motakondur, Ramannapet and Valigonda
TDS	<2000	94	All mandals
	>2000	6	Bommalaramaram, Motakondur, Ramannapet and Valigonda
NO_3	<45	63	Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
	>45	37	Addagudur, Alair, B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
Fluoride	<1.5	66	All mandals
	>1.5	34	Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, M.Thurkapally, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta

2.4.2 Post-monsoon

During post-monsoon season, the ground water from the area is mildly alkaline in nature with pH in the range of 6.85 to 8.57 (avg. 7.7). The Electrical conductivity varies from 403 to

3950 µ Siemens/cm (avg. 1187 µ Siemens/cm). In 78% of the samples, the EC is within 1500 µ Siemens/cm while in 20% of the samples, it is in the range of 1500-3000 µ Siemens/cm. The EC >3000 µ Siemens/cm is observed in 2% of the samples (Fig. 2.12). The concentration of TDS varies from 258 to 2528 mg/l (avg. 759 mg/l). In 98% of the samples, it is within the maximum permissible limits of BIS of <2000 mg/l, while in 2% of the samples, the EC is beyond permissible limit of >2000 mg/l. The NO_3 concentration ranges from 0.07 to 433 mg/l (avg. 51 mg/l). It is noticed that in about 64% of the samples, it is within the permissible limit (<45 mg/l) while in 36% of the samples are falling beyond permissible limit (>45 mg/l) and not suitable for drinking water purpose (Fig. 2.13). The Fluoride concentration varies from 0.28 to 4.14 mg/l (avg. 1.35 mg/l). In about 67% of the samples, it is falling within permissible limit of <1.5 mg/l while in 33% of the samples are having high fluoride concentration beyond permissible limits (>1.5 mg/l) and are not suitable for drinking water purpose (Fig. 2.14). The mandal wise distribution of water quality during post-monsoon season is given in Table 2.8.

Table 2.8: Mandal wise distribution of water quality during post-monsoon season

Para-meter	Range	% of distribution	Mandals covered
EC	<1500	78	Addagudur, Alair, Atmakur (M), Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
	1500 to 3000	20	B.Pochampalle, Bhuvanagiri, Choutuppal, M.Thurkapally, Mothkur, Rajapet, Ramannapet, S.Narayanpur and Valigonda
	>3000	2	Bommalaramaram and Valigonda
TDS	<2000	98	All mandals
	>2000	2	Bommalaramaram and Valigonda
NO_3	<45	64	Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
	>45	36	Addagudur, Alair, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta

Para-meter	Range	% of distribution	Mandals covered
Fluoride	<1.5	67	Addagudur, Alair, B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta
	>1.5	33	Alair, Atmakur (M), Bhuvanagiri, Bibinagar, Bommalaramaram, M.Thurkapally, Mothkur, Rajapet, S.Narayanpur and Yadagirigutta

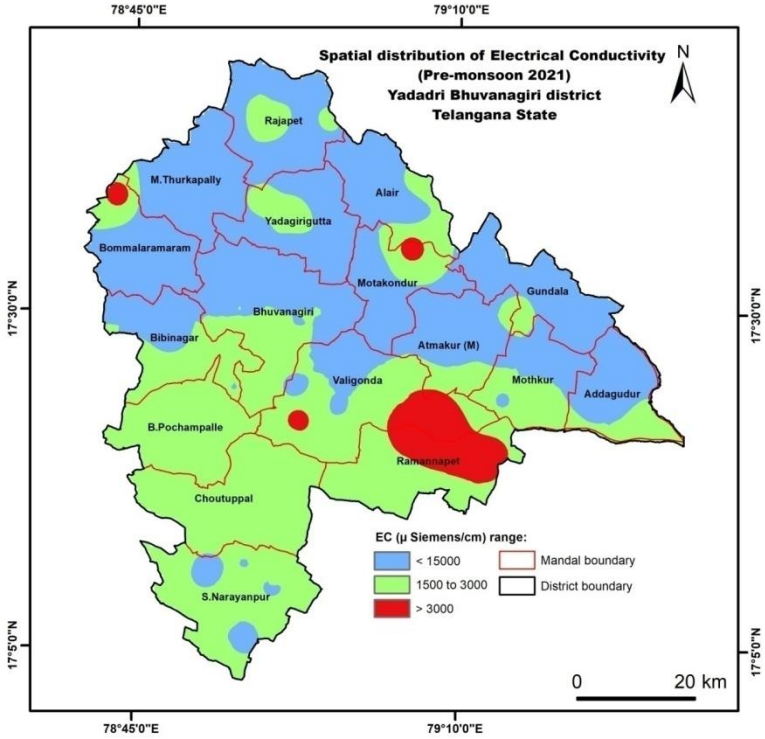

Fig. 2.9: Spatial distribution of Electrical conductivity (Pre-monsoon 2021)

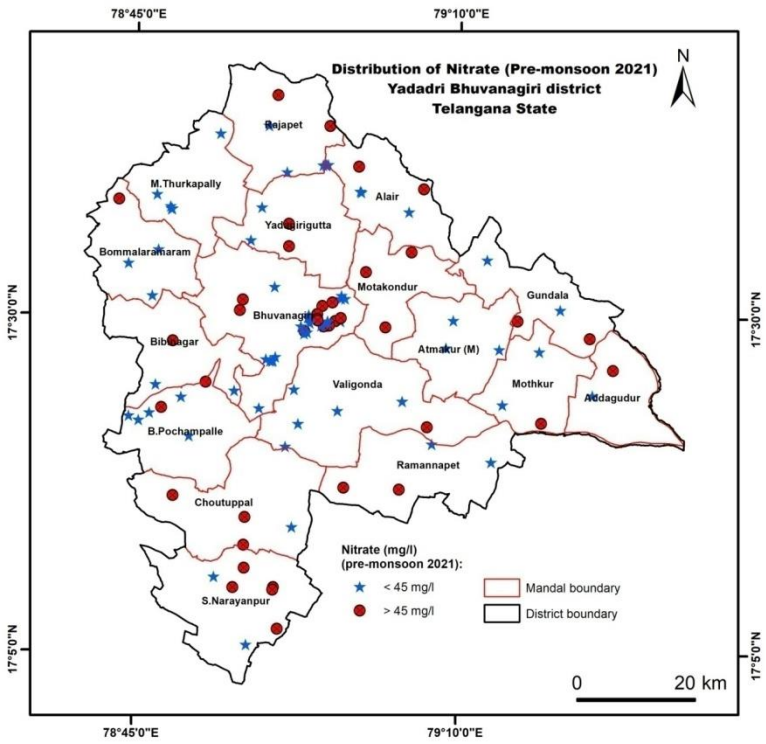

Fig. 2.10: Distribution of Nitrate (Pre-monsoon 2021)

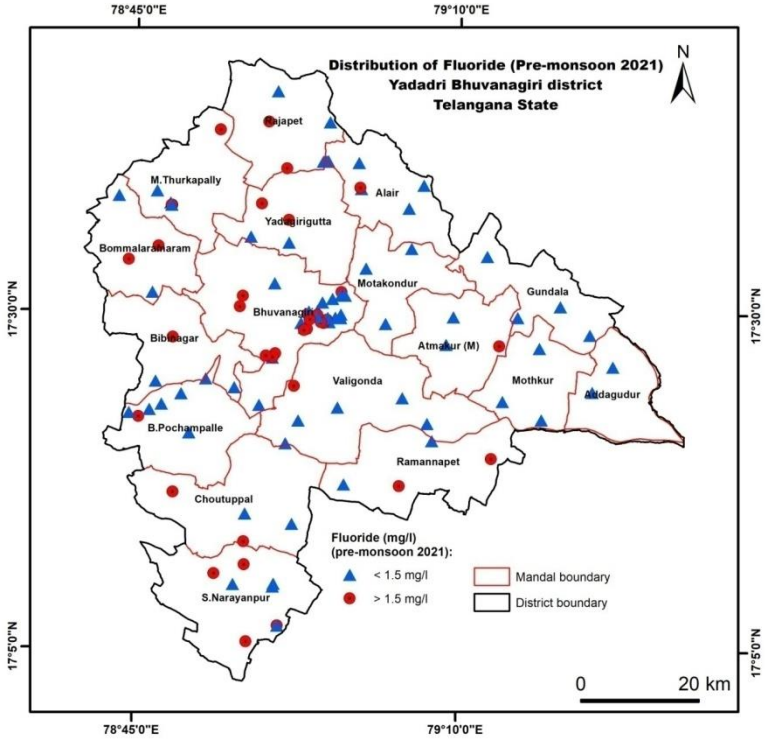

Fig. 2.11: Distribution of Fluoride (Pre-monsoon 2021)

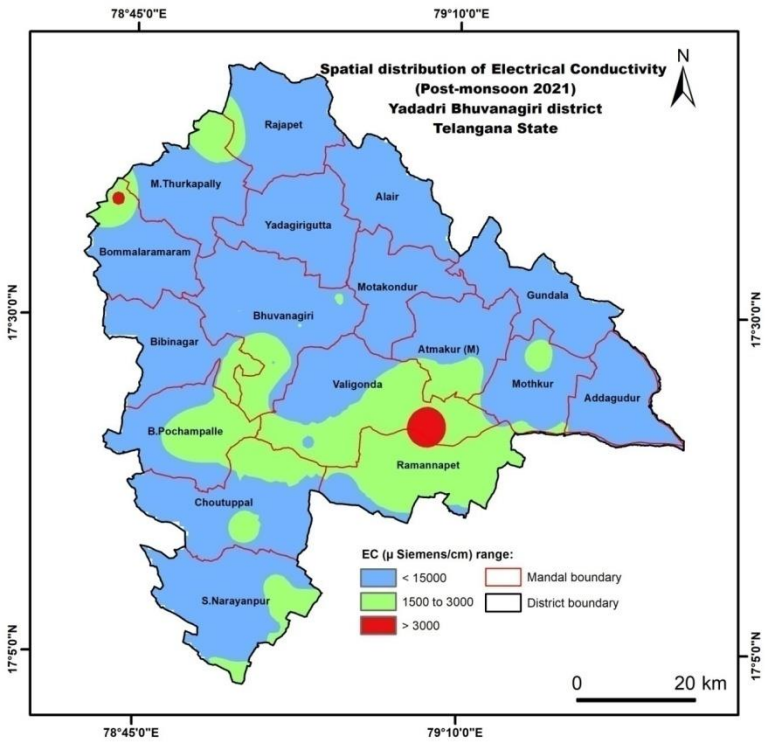

Fig. 2.12: Distribution of Electrical conductivity (Post-monsoon 2021)

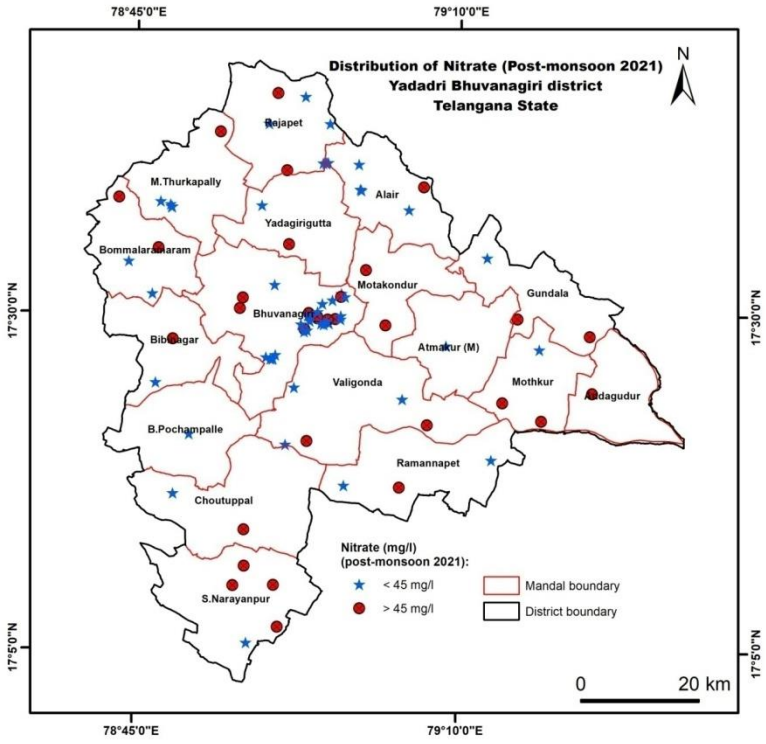

Fig. 2.13: Distribution of Nitrate (Post-monsoon 2021)

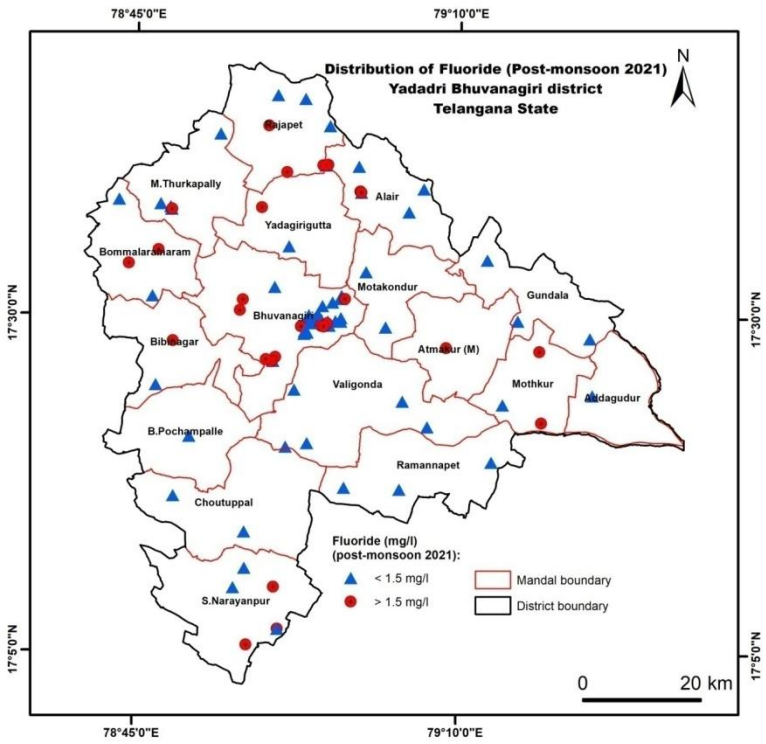

Fig. 2.14: Distribution of Fluoride (Post-monsoon 2021)

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.

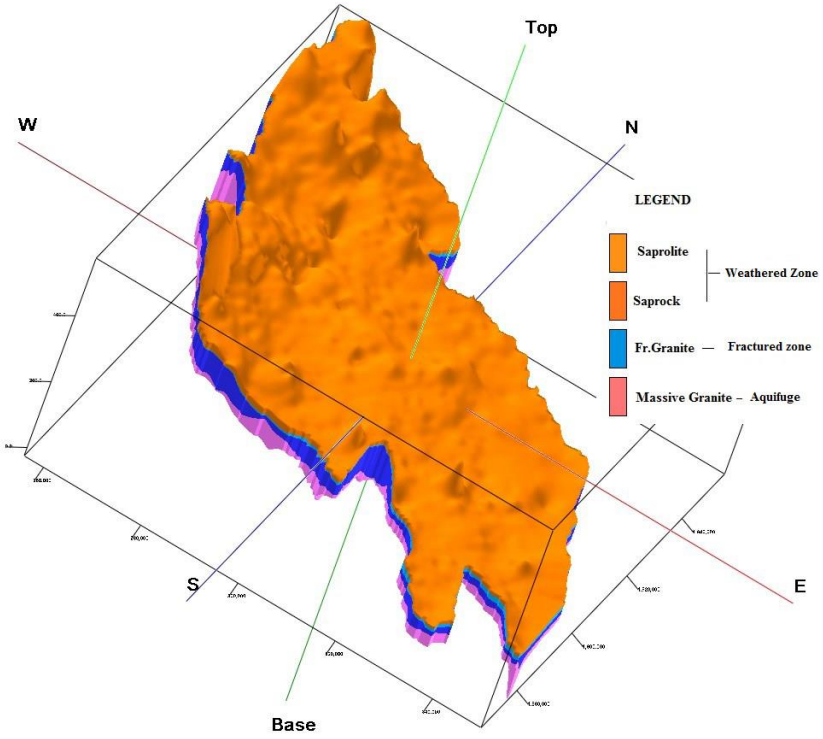

Fig. 3.1: 3D Model

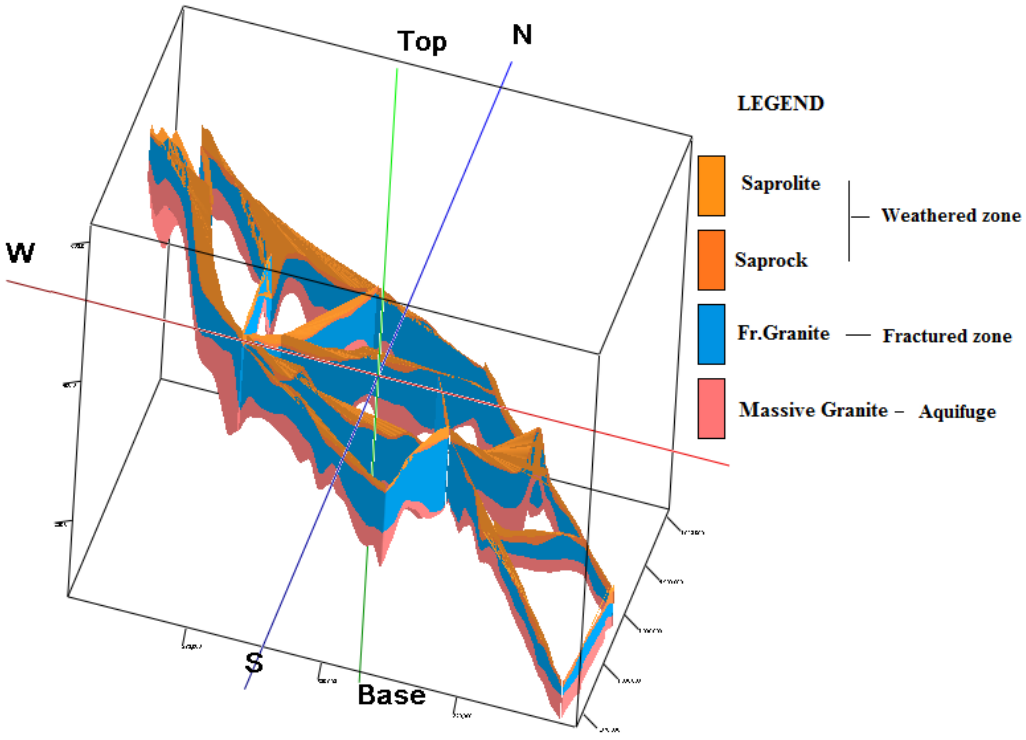

Fig. 3.2: Panel Diagram

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 243 m bgl. The weathered zone varies from 2.5 to 30 m bgl. The weathering thickness >20 m bgl is observed in Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur and Yadagirigutta mandals. The fractured zone varies from 3 to 200 m bgl with the yield ranging from <1 to 7.40 lps with an average of 1 lps. About 87% of the fractures were encountered within 100 m bgl depth in all mandals. The deeper fractures beyond 100 m bgl (13%) are encountered in Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bommalaramaram, Choutuppal, M.Thurkapally, Motakondur, Rajapet and Yadagirigutta mandals.

3.2 Hydrogeological Sections

Two hydrogeological sections were prepared along N-S (a) and E-W (b) directions.

3.2.1 N-S Section

The section covering distance of ~65 kms depicts uniform weathered zone thickness in most part except in central part (at Musi river inter section) where it is less (Fig.3.3a). The thickness of fractured zone is also uniform except in northern part where it is less. The water table elevations are behaving differently from weathered and fractured zone except at the intersection with Musi River during pre-monsoon season. The water table elevations from weathered zone is at higher elevations in most part and water table from fractured zone is at lower elevations.

3.2.2 E-W Section

The section covering distance of ~62 kms depicts uniform weathered zone thickness in most part except in central part and in western part (Fig.3.3b). The thickness of fractured zone is also uniform except in western part. The water table elevations in weathered zone are at higher elevations in western part, and water table in fractured zone are at higher elevations in eastern part during pre-monsoon season.

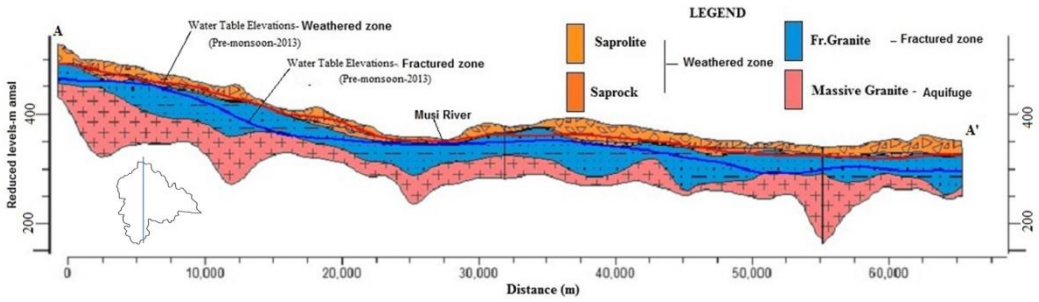

Fig. 3.3(a): N-S Section

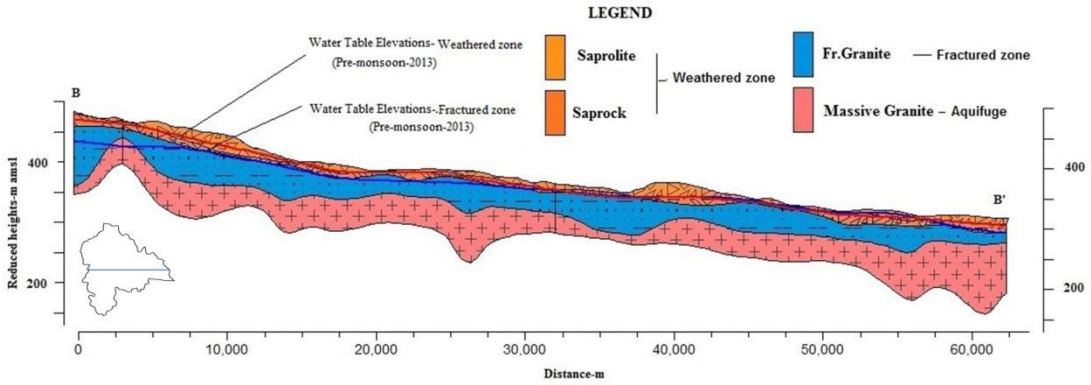

Fig. 3.3(b): E-W Section

Fig. 3.3: Hydrogeological sections along different directions

3.3 Aquifer Characterization

3.3.1 Weathered zone

The depth of weathering ranging from 2.5 to 30 m bgl. In most part of the district (47% of the area), the depth of weathering ranges from 0 to 10 m bgl, while the depth of weathering ranging from 10 to 20 m bgl (37% of the area). The weathering depth >20 m bgl is noticed in 16% of the area (Fig. 3.4 and Fig. 3.5). Generally, the yield of weathered zone varies from up to 2 lps with average of <1 lps. The Transmissivity varies from 8 to 633 m^2/day. The Specific yield varies from 0.001 to 0.01.

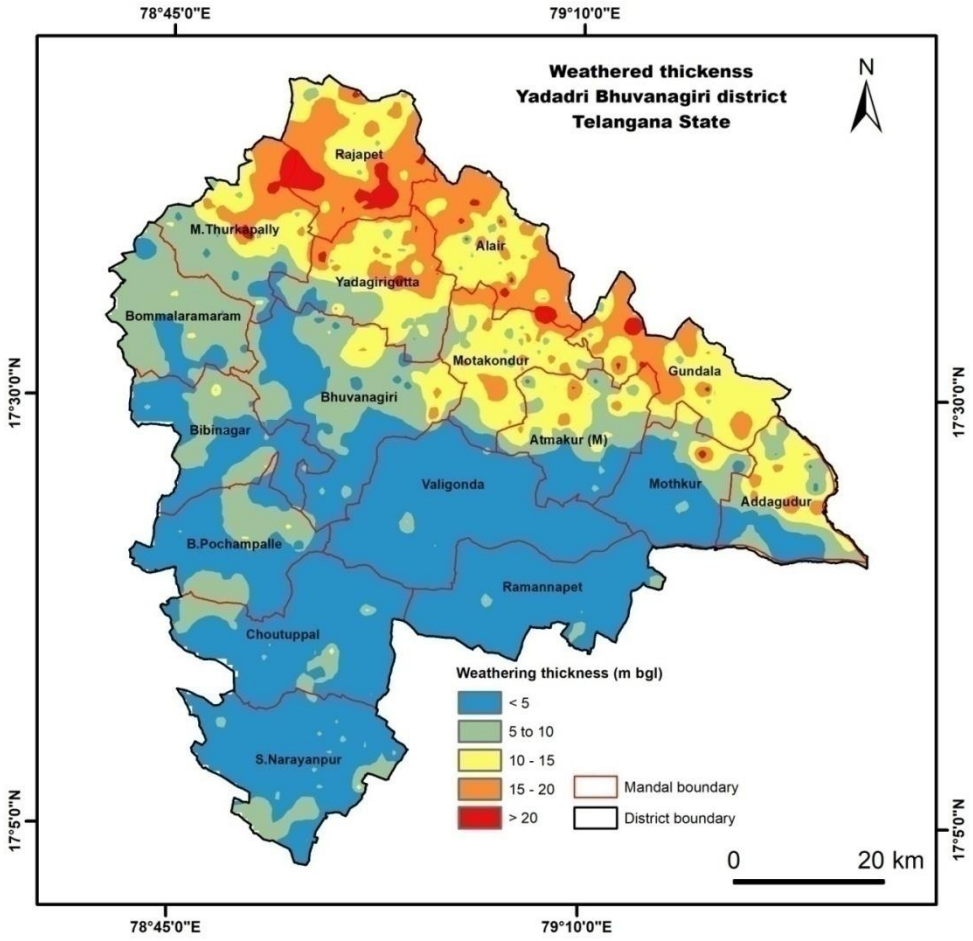

Fig. 3.4: Thickness of Weathered zone

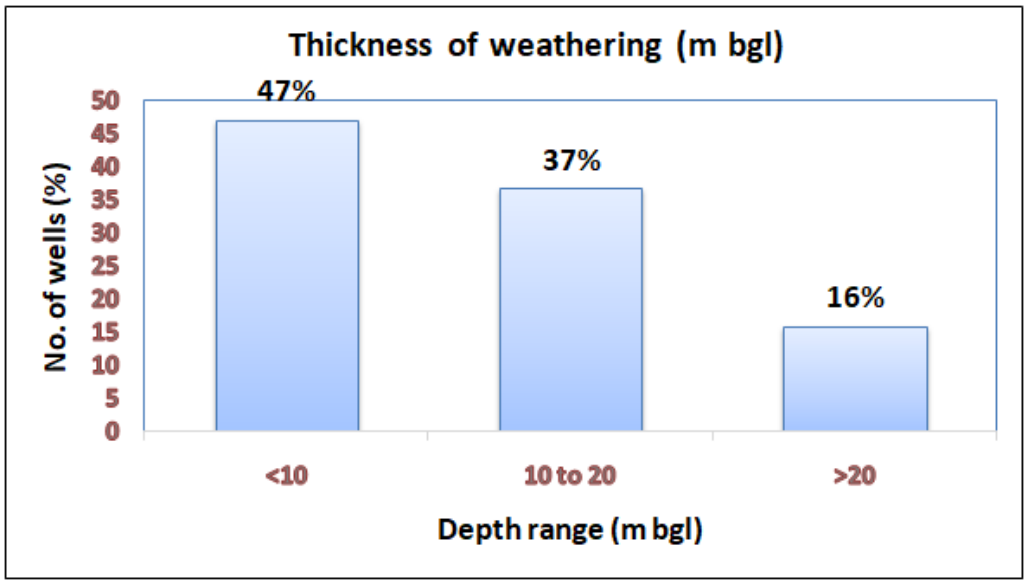

Fig. 3.5: Bar chart showing depth wise distribution of weathering zone

3.3.2 Fractured zone

Ground water is extracted mainly through bore wells tapping fractured zone till to the depth 200 m bgl. The detailed analysis based on exploratory well data, the fractures and yield corresponding with drilling and weathering depth have been analysed and given in Table 3.1. Based on this, it is inferred that 53% of the fractures occur within 30 m bgl with yield ranging from 0.02 to 6.00 lps. About 18% of the fractures occur within depth range of 30 to 60 m bgl with yields varying from 0.02 to 6 lps. About 13% of the fractures occurring within the depth range of 60 to 100 m bgl with yield varying from 0.08 to 6 lps (Fig. 3.6 and 3.7). About 15% of the fractures have occurred beyond 100 m bgl with yield varying 0.02 to 7.4 lps. The deepest fracture tapped at the depth of 190 m bgl is encountered in the exploratory well drilled at Mehar Nagar village of Yadagirigutta mandal. Over all, the yield varies from 0.02 to 7.4 lps in the terrain with an average of 1 lps. The Transmissivity varies from 0.11 to 215 m^2/day. The Storativity varies from 0.000005 to 1.05. From the fracture analysis, it is observed that in about 87% of fractures are encountered within the depth of 100 m bgl. Further exploitation is continued beyond 100 m bgl also in many parts of the district.

The yield wise data analysis shows that in about 85% of the wells, the yield is <1 lps while in 6% of the wells, the yield is ranges from 1 to 2 lps. In about 3% of the wells, the yield is 2 to 3 lps. The yield >3 lps is observed in 7% of the wells (Fig. 3.8).

Table 3.1: Analysis of fractures and yield corresponding with drilling and weathering depths

Fracture depth range (m bgl)	% of fractures	Yield range (lps)	Transmissivity (m2/day)	Storativity	Drilling Depth Range (m bgl)	Weathering Depth Range (m bgl)
<30	53	0.02 to 6	0.11 to 215	0.000005 to 0.015	15.6 to 243	2.5 to 30
30 to 60	18	0.02 to 6	3.76 to 70	0.00034 to 0.001	36 to 200	4.5 to 40
60 to 100	13	0.08 to 6	0.08 to 57.11	0.0001 to 0.49	74 to 200.30	5.6 to 36.60
>100	15	0.02 to 7.4	1.79 to 146.30	0.0001 to 0.01	101.90 to 200	2.5 to 28.50

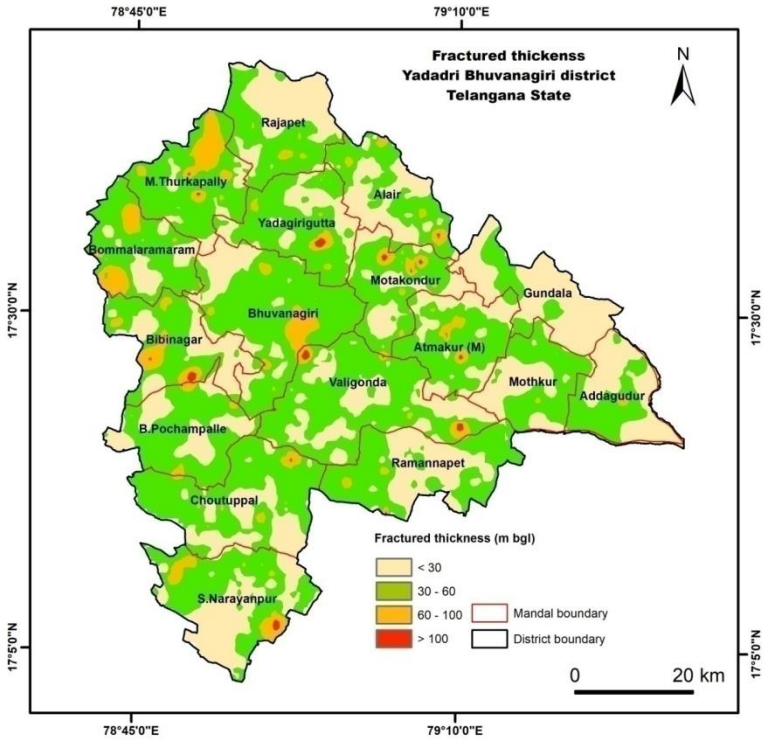

Fig. 3.6: Depth of fracture zone

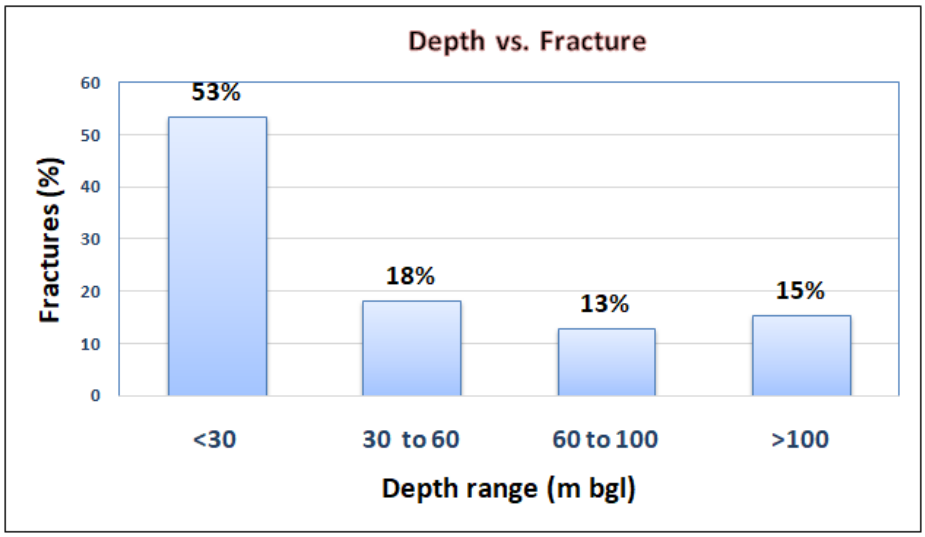

Fig. 3.7: Bar chart showing Depth vs. Fracture

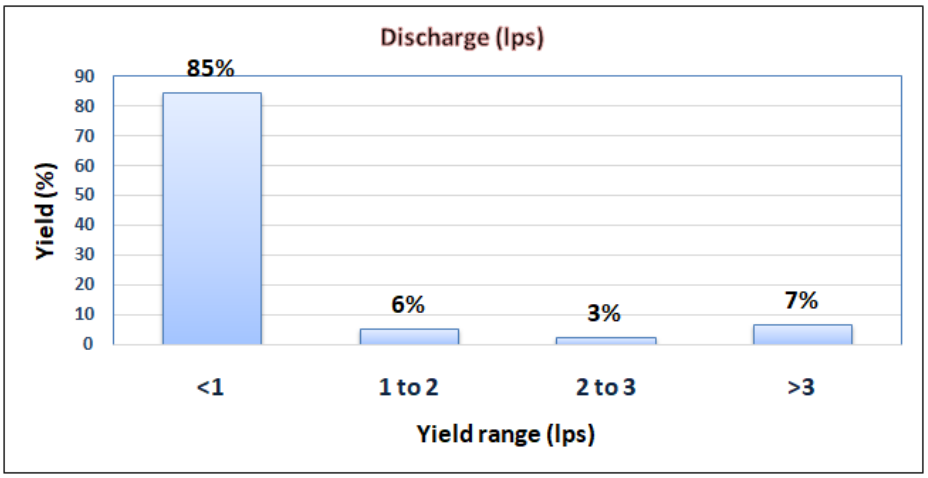

Fig. 3.8: Bar chart showing yield range

4. GROUND WATER RESOURCES (GEC 2022)

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. The mandal wise dynamic and in-storage ground water resources are computed as per the guidelines laid down in GEC-2015 methodology and the highlights of the district is given in Table 4.1.

As per GEC 2022 estimation report, the annual extractable ground water resources is is 804 MCM, the gross ground water extraction for all uses 46 MCM, provision for drinking and industrial use for the year 2025 is 35 MCM and net annual ground water potential available for future irrigation needs is 425 MCM.

All the 17 mandals are falling under 'Safe' category (Addagudur (63%), Alair (63%), Atmakur_M (67%), Bhongiri (53%), Bibinagar (34%), Bommalaramaram (50%), Choutuppal (41%), Gundala (67%), Mootakondur (50%), Mothkur (56%), Narayanapur (63%), Pochampalle (33%), Rajapet (61%), Ramannapeta (24%), Turkapalle_M (59%), Valigonda (48%) and Yadagirigutta (49%). The overall average stage of ground water extraction in the district is 63% falling under 'Safe' category.

Table 4.1: Computed dynamic ground water resources (GEC 2022)

Parameters	Resources (GEC 2022) in MCM
Annual Extractable GW Resources (Dynamic GWR Availability)	804
• Monsoon recharge from rainfall	204
• Monsoon recharge from other sources	312
• Non-Monsoon recharge from rainfall	45
• Non-monsoon recharge from other sources	331
• Natural Discharge	87
Gross Recharge	891
Gross GW Extraction	392
• Irrigation	346
• Domestic and Industrial use	46
Provision for Drinking and Industrial use for the year 2025	35
Net GW availability for future irrigation	425
Stage of GW extraction (%)	63% (Safe)
Categorization of mandals	**Safe: 17 mandals** **<u>Safe:</u>** Addagudur (63%), Alair (63%), Atmakur_M (67%), Bhongiri (53%), Bibinagar (34%), Bommalaramaram (50%), Choutuppal (41%), Gundala (67%), Mootakondur (50%), Mothkur (56%), Narayanapur (63%), Pochampalle (33%), Rajapet (61%), Ramannapeta (24%), Turkapalle_M (59%), Valigonda (48%) and Yadagirigutta (49%).

5. GROUND WATER RELATED ISSUES

5.1 Issues

5.1.1 Inferior ground water Quality (Geogenic and Anthropogenic)

- **EC:** High Electrical Conductance (EC) (>3000 µ Siemens/cm) is noticed in 6% of the samples during pre-monsoon season (Bommalaramaram, Motakondur, Ramannapet and Valigonda mandals), while it is noticed in 2% of the samples during post-monsoon season (Bommalaramaram and Valigonda mandal). This is due to geogenic contamination.
- **Nitrate:** High nitrate contamination (>45 mg/l) due to anthropogenic activities is also observed in 63% of the samples during pre-monsoon season (Addagudur, Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta mandals) and 36% during post-monsoon season (Addagudur, Alair, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, Gundala, M.Thurkapally, Motakondur, Mothkur, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta mandals). The higher concentration is due to unscientific sewage disposal of treated and untreated effluents in rural areas. Use of fertilizers and nitrogen fixation by leguminous crops.
- **Fluoride:** The fluoride contamination (geogenic) in ground water is as high as 4.42 mg/l during pre-monsoon and 4.14 mg/l during post-monsoon season. The high fluoride concentration (>1.5 mg/l) occurred in 34% of samples during pre-monsoon (Alair, Atmakur (M), B.Pochampalle, Bhuvanagiri, Bibinagar, Bommalaramaram, Choutuppal, M.Thurkapally, Rajapet, Ramannapet, S.Narayanpur, Valigonda and Yadagirigutta mandals) and 33% of the samples during post-monsoon season (Atmakur (S), Giridepalli, Huzurnagar, Kodad, Munagala, Nuthankal, Suryapet and Thirumalagiri mandals). 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. More fluoride is released when residence time of ground water in deeper aquifer become more.

5.1.2 Deeper water levels (>20 m bgl)

- The deeper water levels (>20 m bgl) are observed in 14% of the area during pre-monsoon season (Chinthalapalem mandals) and 2% of the area during post-monsoon season. The

Paddy cultivation during rabi season leads to more ground water extraction. The limited artificial measures might also be the main causes of deeper water levels in the area.

5.1.3 Ground water Sustainability

- The yield information from exploratory wells indicates that the low yield of <1 lps occurred in 18% of the wells observed in almost all the mandals and shown low ground water potential.

- The yield from many bore wells have reduced over a period of time and some bore wells which used to yield sufficient quantity of water have gone dry. This is due to limited availability or absence of primary porosity, negligible development of secondary porosity, low rainfall and desaturation of weathered zone.

5.1.4 Shallow water levels (<2 m bgl)

- The shallow water levels (<2 m bgl) are observed in 2% of the area observed in B.Pochampalle mandal during post-monsoon season.

5.1.5 Water Marketing and other Issues

- Water marketing is observed in almost all mandals and people are buying water can/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 (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.

6. MANAGEMENT STRATEGY

The high dependence on ground water 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 ground water 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. In this district also, the most of the fractures encountered within 100 m bgl and further exploitation is happening till to the depth 200 m bgl. The higher NO_3 concentrations (>45 mg/l) is due to over use of fertilizers in agriculture lands and other anthropogenic activities. The higher concentration of Fluoride (>1.5 mg/l) in weathered zone and fractured zone is due to local geology, high weathering, longer residence time and alkaline nature of ground water.

The uneven distribution of ground water 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 ground water management, which involves a combination of 1) Supply side measures and 2) Demand side measures.

6.1 Supply side management

The supply-side management of ground water resources can be done through the artificial recharge by computing surplus runoff available within river sub-basins and also by repairing, renovation and restoration of existing tanks.

6.1.1 Implementation of Artificial Recharge Structures

The areas feasible for construction of recharge structures has been demarcated based on the analysis of post-monsoon depth to water level data and existing data on artificial recharge structures constructed under various schemes of MGNREGA and IWMP by Rural Development department, Govt. of Telangana. The availability of unsaturated volume of aquifer was computed by multiplying the area feasible for recharge and unsaturated depth below 5 m bgl. The recharge potential of aquifer is calculated by multiplying the unsaturated volume with specific yield of the aquifers (0.02 for hard rock).

The source water availability is estimated from the rainfall and run-off correlations. The runoff was calculated by taking into account of normal monsoon rainfall of the mandal and corresponding runoff yield from Strangers table for average catchment type. Out of the total run-off available in the mandal, only 20% is considered for recommending artificial recharge structures in intermittent areas. The storage required for existing artificial recharge structures by State Govt. departments under different IWMP and MNREGS schemes is deducted to find the available surplus run-off for recommending the additional feasible artificial recharge structures. About 50% of the available surplus run-off is considered for the recommendation of artificial recharge structures and the remaining 50% needs to be recommended for implementing water conservation measures in recharge areas through MGNREGS by State Government.

As per the GEC 2022 estimation, all the 17 mandals are falling under Safe category. The artificial recharge structures are proposed for entire district as per requirement. The villages which are having unsaturated thickness to the depth below 5 m bgl during post-monsoon season water levels were considered and recommended suitable artificial recharge structures.

The existing water conservation structures were also considered during formulation of water conservation management plan. The villages which are already having sufficient water conservation structures were not considered for recommending artificial recharge structures. The more importance is given to villages where there are no artificial recharge structures and also villages with less number of existing structures. The artificial recharge structures have not been recommended for those villages where the depth to water level is <5 m bgl during post-monsoon season. The highlights of the existing and proposed management plans for the district is given in Table 6.1. The village wise artificial recharge intervention structures proposed is given in Annexure - I.

- Out of the total 320 villages, in around 305 villages, the depth to water level of <5 m bgl is noticed during post-monsoon season. Hence, artificial recharge structures for water conservation and management plan have recommended for all these villages.

- About 14467 MCM of unsaturated volume (below 5 m depth) is available (in both weathered and fractured zones), 289 MCM recharge potential and 46 MCM utilizable yield (uncommitted run-off) is available for immediate intervention.
- 115 artificial recharge structures (Percolation Tanks (PTs): 67 & Check Dams (CDs): 48) were already existing in 18 villages with storage capacity of 0.09 MCM.
- 1145 artificial recharge structures have further recommended (527 PTs with 2 fillings with a unit cost of Rs. 20 lakhs each and 618 CDs with recharge shafts with 6 fillings with a unit cost of Rs. 15 lakhs each) with a total cost of 198.10 Crores.
- After effective implementation of artificial recharge structures, there will be 33.34 MCM of ground water recharge.

6.1.2 Water conservation measures through 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 6400 farm ponds are recommended (20 in each village in 320 villages for the entire district) at Rs 25,000/-each with total cost of 16 Crores. This can create an additional storage of 1.92 MCM. This may help the farmers for early sowing and to meet the needs for intermediate irrigation.

6.1.3 Other Supply Side Measures

- Existing artificial recharge structures viz., percolation tanks, check dams and dried natural water bodies can be de-silted involving people's participation through the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) (NREGA 2005). This will also help in sustainable management of ground water resources.

6.1.4 State Government Projects

6.1.4.1 Mission Kakatiya (Repair, Renovation and Restoration of existing water bodies)

- Under Mission Kakatiya Programme taken up by State Government, out of 1485 minor irrigation tanks, 747 tanks were desilted during Phase-1 to Phase-4 and excavated 9 MCM quantity of silt. This helped in strengthening of water bodies and created additional surface storage thereby increased ground water augmentation in the district. This has indirectly saved 2.25 MCM of ground water (considering 25% of

ground water savings) and with this about 375 ha. of additional land that can be brought under ID crops under irrigation.

- 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 further ground water augmentation.

6.1.4.2 Mission Bhagiratha

- Under Telangana Drinking Water Supply Project (TDWSP) also known as 'Mission Bhagiratha', all the villages are proposed to be covered (the schemes are at various stages of completion). The scheme is to enhance the existing drinking water scheme and to provide 100 lpd/persons in rural areas and 135 lpd/person in urban areas. Thus all habitations (including fluoride affected) will be covered with the implementation of this project.
- The water required to be imported to the tune of 29.71 MCM per annum from surface sources into the basins will reduce stress on ground water. Considering 60 lpcd at present utilization, there will be net saving of 17 MCM of ground water, which can be effectively utilized to irrigate 2814 ha of additional land under ID crops.

6.2 Demand side management

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

6.2.1 Ongoing Micro-irrigation

- Till date, a total 3366 ha. area is brought under micro-irrigation (Sprinklers: 259 ha. & Drip: 3118 ha.) saving 5 MCM of ground water (considering 25% of saving to traditional practices).

6.2.2 Proposed Micro-irrigation

- Additionally, about 13634 ha. of additional land that can be brought under micro-irrigation (where actual area irrigated though micro-irrigation is less than 1,000 ha in one mandal) costing about 81.80 Crores (considering 1 unit/ha. @0.6 lakhs/ha.). With this, about 20.45 MCM of ground water can be conserved over the traditional irrigation practices (considering 25% of net saving for ID crops).

Table 6.1 Highlights of the existing and proposed management plans in the district

Existing	
Total geographical area of district (Sq.km)	3426
No. of mandals covered	17
No. of villages covered	320
Unsaturated Volume (MCM) (below 5 m depth)	14467
Recharge Potential (MCM)	289
Uncommitted Run-off (MCM) available	48
No. of villages where water levels above 5 m bgl during post-monsoon season	15 (98 sq.km)
No. of villages where water levels below 5 m bgl during post-monsoon season	305 (3328 kms)
Existing artificial recharge structures	CDs: 48, PTs: 67, Storage Capacity (MCM): 0.09
	Farm ponds: 6, Storage Capacity (MCM): 0.04
	Micro Irrigation: Sprinkler: No. 259, Ha: 248 Drip: No. 2433, Ha: 3118
Proposed	
Villages considered to propose artificial recharge structures where unsaturated thickness below 5 m bgl	305 (3328 kms)
Unsaturated Volume (MCM) (below 5 m depth)	14467
Recharge Potential (MCM) (in both Weathered & Fractured)	289
Uncommitted Run-off (MCM) available	46
Proposed artificial recharge structures	CDs: 618, PTs: 527, Storage Capacity (MCM): 33.34
	Farm ponds: 20*320 villages=6400, Storage Capacity (MCM): 3.17
	Micro Irrigation: Area to be covered: 13634 ha, Expected GW conservation (25% of net saving): 20.45 MCM
Cost estimation (Cr)	CDs: 92.70 Cr, PTs: 105.40 Cr
	Farm ponds: 26.45 Cr
	Micro Irrigation: 81.80 Cr
Gross GW draft (MCM)	252
Annual Extractable GW Resources (Dynamic GWR Availability) (MCM)	804
Expected GW recharge (MCM)	55.71
Present stage of GW extraction (%)	63%
Change in stage of GW extraction (%)	46%
Change stage of GW extraction (%)	**17%**

6.3 Other Recommendations

- Declaration of MSP in advance (before start of season) and improved facilities at procurement centres.
- As a mandatory measure, every ground water user should recharge rainwater through artificial recharge structures in proportionate to the extraction.
- 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 ground water 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 ground water may be given to the concerned farmers
- In urban and rural areas, the sewerage line should be constructed to arrest leaching of nitrate.
- Demand side measures include adaptation of micro irrigation practices which saves ~25 % water as compared to traditional flooding irrigation.
- Change in cropping pattern from water intensive paddy to other irrigated dry and drought resistant crops that have a short growing season is recommended, particularly in semi-critical mandals. If necessary, some regulatory rules may be framed and implemented.
- To avoid the interference of cone of depression between two productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism.
- Complete ban on paddy cultivation during rabi season under ground water irrigation in non-command areas and semi-critical mandals.
- Power supply should be regulated by giving power in 4 hour spells (two times a day, in the morning and evening)to increase the sustainability of structures.
- As mandatory measures power connection may be given to only those farmers who are adopting micro irrigation for all new bore well to be constructed.
- Compulsory rain water harvesting in proportionate to withdrawal.
- Roof top rainwater harvesting structures should be made mandatory to all Government/industrial buildings (new and existing).

6.4 Expected results and out come

In the entire district, with the interventions, the likely benefit would be increases in gross ground water availability with net saving of 55.71 MCM of ground water or net reduction of 17% in stage of ground water extraction, i.e., from the existing 63% to 46%. The onetime cost will be 5 paisa/litre and the actual cost of invest will be 0.5 paisa/litre if considered the life of the artificial recharge structures and micro irrigation equipment as 10 year.

Acknowledgments

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Annexure – I

Proposed interventions for the villages in Yadadri Bhuvanagiri district

Mandal	Village	Proposed Check Dams for intermittent areas	Proposed Percolation Tanks for Intermittent areas
Addagudur	Adda Gudur	5	4
Addagudur	Chinnapadishala	2	2
Addagudur	Chirra Gudur	1	1
Addagudur	Choulla Ramaram	2	2
Addagudur	Dharmaram	2	1
Addagudur	Janakipur	2	1
Addagudur	Kanchan Palle	1	1
Addagudur	Kotamarthi	4	3
Addagudur	Repaka (P)	3	3
Addagudur	Singaram (P)	4	4
Addagudur	Veldevi	4	3
Alair	Alair	6	5
Alair	Golankonda	3	3
Alair	Kolanupaka	5	4
Alair	Kollur	4	4
Alair	Manthapuri	1	1
Alair	Patelguda	2	2
Alair	Sharajpet	3	3
Alair	Srinivasa Puram	2	2
Alair	Tangutoor	3	2
Atmakur (M)	Atmakur	3	3
Atmakur (M)	Brahman Palle	3	2
Atmakur (M)	Dharmapur	1	1
Atmakur (M)	Kalwapalle	1	1
Atmakur (M)	Khaprai Palle	6	5
Atmakur (M)	Koratikal	4	3
Atmakur (M)	Kurella	2	2
Atmakur (M)	Lingaraj Palle	1	1
Atmakur (M)	Moripirala	2	2
Atmakur (M)	Palle Pahad	1	1
Atmakur (M)	Pallerla	2	1
Atmakur (M)	Raghavapur	1	1
Atmakur (M)	Rahimkhanpet	3	3
Atmakur (M)	Raipalle	1	1
Atmakur (M)	Sarvepalle	2	2
Atmakur (M)	Singaram	1	1
Atmakur (M)	Thukkapur	2	1

B.Pochampalle	Abdullanagar	1	1
B.Pochampalle	Alinagar	1	1
B.Pochampalle	Bheeman Palle	1	1
B.Pochampalle	Danthur	-	-
B.Pochampalle	Deshmukhi	4	4
B.Pochampalle	Dharma Reddi Palle	3	2
B.Pochampalle	Gouse Konda	2	1
B.Pochampalle	Hyderpur	1	1
B.Pochampalle	Indriyala	2	1
B.Pochampalle	Jagatth Palle	2	2
B.Pochampalle	Jalal Pur	1	1
B.Pochampalle	Jiblak Palle	2	2
B.Pochampalle	Julur	1	1
B.Pochampalle	Kanumukla	3	2
B.Pochampalle	Khaprai Palle	2	2
B.Pochampalle	Mehar Nagar	2	2
B.Pochampalle	Mukthapur	2	2
B.Pochampalle	Pedda Ravula Palle	2	2
B.Pochampalle	Pillai Palle	2	2
B.Pochampalle	Pochampalle	3	3
B.Pochampalle	Ramalingam Palle	1	1
B.Pochampalle	Revan Palle	1	1
B.Pochampalle	Vanka Mamidi	-	-
Bhuvanagiri	Anajipur	2	2
Bhuvanagiri	Anantharam	2	2
Bhuvanagiri	Bagath Bhuvanagiri	1	1
Bhuvanagiri	Banda Somaram	2	2
Bhuvanagiri	Baswapur	2	2
Bhuvanagiri	Bhuvanagiri	3	2
Bhuvanagiri	Bhuvanagiri (M)	1	1
Bhuvanagiri	Bolle Palle	3	3
Bhuvanagiri	Bommai Palle	2	1
Bhuvanagiri	Chandupatla	1	1
Bhuvanagiri	Cheemala Kondur	2	2
Bhuvanagiri	Gouse Nagar	2	1
Bhuvanagiri	Hanmapur	2	1
Bhuvanagiri	Hussainabad(Rural)	2	2
Bhuvanagiri	Kesaram	2	1
Bhuvanagiri	Kunoor	1	1
Bhuvanagiri	Mustyalapalli	2	1
Bhuvanagiri	Nagireddipally	1	1
Bhuvanagiri	Nandanam	3	2
Bhuvanagiri	Pagidi Palle	2	2
Bhuvanagiri	Penchikla Pahad	2	2
Bhuvanagiri	Ramachandrapur	2	1
Bhuvanagiri	Rayagiri	5	5

Bhuvanagiri	Sure Palle	2	1
Bhuvanagiri	Tajpur	1	1
Bhuvanagiri	Timmapur	2	2
Bhuvanagiri	Tukkapur	2	2
Bhuvanagiri	Veera Vally	2	2
Bhuvanagiri	Wadaparthy	1	1
Bhuvanagiri	Yerram Balle	1	1
Bibinagar	Annampatla	1	1
Bibinagar	Bagdayara	1	1
Bibinagar	Bibinagar	3	3
Bibinagar	Brahmana Palle	2	2
Bibinagar	Chinaravula Palle	2	2
Bibinagar	Gudur	3	2
Bibinagar	Gurrala Dandi	1	1
Bibinagar	Jainepally	2	2
Bibinagar	Jam Palle	1	1
Bibinagar	Jameelapet	1	1
Bibinagar	Jiya Palle	1	1
Bibinagar	Kondamadugu	2	2
Bibinagar	Madharam	1	1
Bibinagar	Mahadevpur	1	1
Bibinagar	Maktha Anantharam	1	1
Bibinagar	Maqdoom Palle	2	2
Bibinagar	Nemarugomula	1	1
Bibinagar	Padamati Somaram	2	2
Bibinagar	Raghavapur	2	2
Bibinagar	Raheem Khan Guda	2	2
Bibinagar	Rangapur	1	1
Bibinagar	Ravi Pahad	1	1
Bibinagar	Rayarao Pet	5	4
Bibinagar	Rudra Velly	1	1
Bibinagar	Venkiryal	1	1
Bommalaramaram	Bandakadi Palle	1	1
Bommalaramaram	Boin Palle	1	1
Bommalaramaram	Bommalaramaram	1	1
Bommalaramaram	Cheekati Mamidi	2	2
Bommalaramaram	Chinaparvatha Pur	1	1
Bommalaramaram	Hazipur	2	2
Bommalaramaram	Jalalpur	1	1
Bommalaramaram	Mailaram	2	1
Bommalaramaram	Maisi Reddy Palle	2	2
Bommalaramaram	Malyala	2	2
Bommalaramaram	Maryala	4	3
Bommalaramaram	Medi Palle	1	1
Bommalaramaram	Muneerabad	1	1
Bommalaramaram	Nageneni Palle	1	1

Bommalaramaram	Pedda Parvathapur	2	2
Bommalaramaram	Pyararam	1	1
Bommalaramaram	Ramga Puram	1	1
Bommalaramaram	Ramlingam Palle	1	1
Bommalaramaram	Solipeta	1	1
Bommalaramaram	Somaji Palle	1	1
Bommalaramaram	Thimma Puram	1	1
Bommalaramaram	Thumkunta	1	1
Bommalaramaram	Tirumalagiri	1	1
Bommalaramaram	Yavapur	1	1
Choutuppal	Allapur	1	1
Choutuppal	Chinna Kondur	4	4
Choutuppal	Choutuppal	2	2
Choutuppal	Devalamma Nagaram	2	2
Choutuppal	Jai Kesaram	3	2
Choutuppal	Khairathpur	1	1
Choutuppal	Lakkaram	2	1
Choutuppal	Lingoji Guda	3	3
Choutuppal	Malkapur	5	4
Choutuppal	Nelapatla	2	2
Choutuppal	Panthangi	3	2
Choutuppal	Peepal Pahad	2	2
Choutuppal	Swamulavari Lingotam	2	1
Choutuppal	Tallasingaram	2	1
Choutuppal	Tangad Palle	3	3
Choutuppal	Tupranpet	4	3
Choutuppal	Yellagiri	1	1
Gundala	Ambala	3	3
Gundala	Anantaram	4	3
Gundala	Bandakotha Palle	2	1
Gundala	Gangapur	2	1
Gundala	Gundala	4	3
Gundala	Marpadaga	2	2
Gundala	Masan Palle	1	1
Gundala	Paru Palle	1	1
Gundala	Pedda Padishala	2	2
Gundala	Ramaram	3	2
Gundala	Seetarampur	2	2
Gundala	Suddala	2	2
Gundala	Turkala Shapur	2	2
Gundala	Vangala	3	3
Gundala	Vastha Kondur	1	1
Gundala	Velmajala	3	3
M.Thurkapally	China Laxma Puram	1	1
M.Thurkapally	Dattai Palle	2	2
M.Thurkapally	Dharmaram	2	2

M.Thurkapally	Gandamalla	3	2
M.Thurkapally	Gopal Puram	2	2
M.Thurkapally	Ibrahimpur	1	1
M.Thurkapally	Komatikunta	1	1
M.Thurkapally	Konapur	2	2
M.Thurkapally	Kondapur	2	2
M.Thurkapally	Madha Puram	2	2
M.Thurkapally	Malka Puram	2	2
M.Thurkapally	Mannevari Turkapalle	1	1
M.Thurkapally	Mulakala Palle	2	2
M.Thurkapally	Nagai Palle	1	1
M.Thurkapally	Palle Pahad	2	2
M.Thurkapally	Rusta Puram	3	2
M.Thurkapally	Srinivasapur	2	1
M.Thurkapally	Tirumalapur	1	1
M.Thurkapally	Vasala Marri	3	2
M.Thurkapally	Veerareddi Palle	3	3
M.Thurkapally	Velpupalle	2	1
M.Thurkapally	Venkatapur	2	2
Motakondur	Amman Bole	2	2
Motakondur	Chada	7	6
Motakondur	Chamapur	2	2
Motakondur	Chande Palle	2	2
Motakondur	Dilawarpur	2	1
Motakondur	Dursagani Palle	1	1
Motakondur	Ikkurthi	3	3
Motakondur	Kommaipally	1	1
Motakondur	Matoor	2	2
Motakondur	Moota Kondur	6	5
Motakondur	Teryala	2	2
Motakondur	Vartoor	3	3
Mothkur	Anajipur	3	2
Mothkur	Bijilapur	2	2
Mothkur	Dacharam	3	3
Mothkur	Dattappaguda	5	4
Mothkur	Konda Gadapa	3	2
Mothkur	Mothkur	2	2
Mothkur	Musitpatla	2	2
Mothkur	Paladugu	2	1
Mothkur	Panaka Banda	4	3
Mothkur	Patimatla	2	1
Mothkur	Podichedu	4	3
Mothkur	Sadarshapur	3	2
Rajapet	Basanthapur	1	1
Rajapet	Begumpet	2	2
Rajapet	Bondugula	2	2

Rajapet	Burugu Palle	1	1
Rajapet	Challur	2	2
Rajapet	Doodi Venkatapur	2	1
Rajapet	Jala	1	1
Rajapet	Kalapalle	1	1
Rajapet	Kurraram	1	1
Rajapet	Lakshmakka Palle	1	1
Rajapet	Narsapur	2	1
Rajapet	Nemla	2	2
Rajapet	Pamukunta	3	2
Rajapet	Paru Palle	2	1
Rajapet	Raghunathpur	1	1
Rajapet	Rajapet	1	1
Rajapet	Renikunta	2	1
Rajapet	Singaram	2	1
Rajapet	Somaram	1	1
Ramannapet	B.Thurka Palle	1	1
Ramannapet	Bachuppala	-	-
Ramannapet	Bogaram	1	1
Ramannapet	Dubbaka	1	1
Ramannapet	Iskilla	1	1
Ramannapet	Janam Palle	1	1
Ramannapet	Kakkireni	-	-
Ramannapet	Kunkudu Pamula	-	-
Ramannapet	Laxma Puram	1	1
Ramannapet	Muni Panpula	2	1
Ramannapet	Neernemula	1	1
Ramannapet	Nidhanapalle	1	1
Ramannapet	Palliwada	1	1
Ramannapet	Ramannapet	2	2
Ramannapet	Shobanadripuram	1	1
Ramannapet	Siripuram	2	1
Ramannapet	Suraram	1	1
Ramannapet	Thummalaguda	2	2
Ramannapet	Uthatoor	1	1
Ramannapet	Yellanki	3	2
Ramannapet	Yennaram	-	-
S.Narayanpur	Chillapuram	2	2
S.Narayanpur	Chimiriyala	2	1
S.Narayanpur	Guddi Malkapuram	1	1
S.Narayanpur	Gujja	1	1
S.Narayanpur	Jangam	3	2
S.Narayanpur	Kankanal Gudem	1	1
S.Narayanpur	Kothagudem	1	1
S.Narayanpur	Kothulapuram	1	1
S.Narayanpur	Mahammednagar	2	2

S.Narayanpur	Narayanapur	2	2
S.Narayanpur	Puttapaka	2	1
S.Narayanpur	Rachakonda	6	5
S.Narayanpur	Sarvail	4	4
S.Narayanpur	Vaila Palle	2	2
Valigonda	Arrur	-	-
Valigonda	Chittapur	1	1
Valigonda	Duppelli	2	2
Valigonda	Gangapur	-	-
Valigonda	Gokaram	2	2
Valigonda	Golle Palle	2	2
Valigonda	Goparaj Palle	1	1
Valigonda	Gurnath Palli	-	-
Valigonda	Kanchan Palle	3	2
Valigonda	Kashamma Bkunta	2	2
Valigonda	Lothukunta	1	1
Valigonda	Malle Palle	1	1
Valigonda	Mogilipaka	3	3
Valigonda	Muddapur	1	1
Valigonda	Munagala Turkapally	2	2
Valigonda	Nagaram	-	-
Valigonda	Narsapur	1	1
Valigonda	Nemili Kalawa	1	1
Valigonda	Pahilwanpur	3	3
Valigonda	Poddatur	5	4
Valigonda	Puligilla	5	4
Valigonda	Redla Repaka	4	3
Valigonda	Sangam	2	2
Valigonda	Sunki Shala	2	2
Valigonda	Tekula Somaram	2	2
Valigonda	Valigonda	-	-
Valigonda	Velverthy	2	2
Valigonda	Vemalkonda	-	-
Valigonda	Venkatapur	-	-
Valigonda	Verkat Palle	2	2
Yadagirigutta	Bahadurpet	2	1
Yadagirigutta	Chinnakandukur	2	2
Yadagirigutta	Choller	4	3
Yadagirigutta	Dathar Palle	3	3
Yadagirigutta	Gowrai Palle	2	2
Yadagirigutta	Gundla Palle	3	3
Yadagirigutta	Jangam Palle	3	2
Yadagirigutta	Kacharam	6	5
Yadagirigutta	Mallapur	4	3
Yadagirigutta	Masaipet	5	4
Yadagirigutta	Peddakandukur	3	2

Yadagirigutta	Ramojipet	2	2
Yadagirigutta	Sadu Velle	2	1
Yadagirigutta	Saidapur	3	3
Yadagirigutta	Vanga Palle	3	3
Yadagirigutta	Yadagiri Palle (P)U	2	2
