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

VIKARABAD DISTRICT, TELANGANA

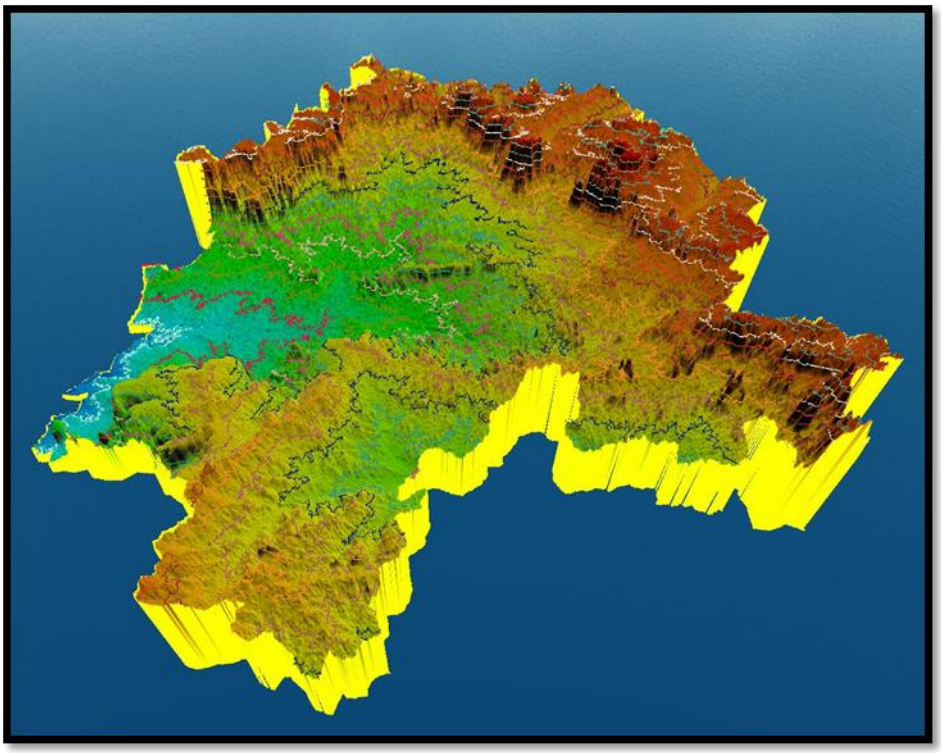
दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल संसाधन नदी विकास एवम् गंगा संरक्षण मंत्रालय
केंद्रीय भूमिजल बोर्ड

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

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



CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD
MARCH 2022

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

CONTRIBUTORS' PAGE

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At a Glance

S.No.	Item		Particulars
1	Districts	:	Vikarabad distrcit
2	Revenue Divisions/ Mandals		2/18
3	Villages	:	501villages
4	Geographical area	:	3386 km^2
5	Population (2011 Census)	:	9.27 lakhs
6	Density of population (2011 Census)	:	274persons/km^2
7	Locations	:	North latitude 16.54°N to 17.38°N East longitude 77.21°E to 78.04°"E
8	Rainfall (Normal)	:	765mm and average annual rainfall of 689 mm
9	Geomorphology	:	Pediplain (32% of the area), Pediment (23%of the area), and remaining area by Denundational hills, Dissected plateaus and Channel fills deposits
10	Major River	:	Kagna a tributary of Bheema River
11	Land Utilization (Ha)	:	Agricultural land occupies nearly 16% of the area, Urban built up area occupies nearly 2% of the area. Forest occupies 13% the area. Remaining area is occupied by water bodies, waste land, etc. Gross cropped area during the year 2019-20 is 53558 ha. Net sown area is 40863 ha
12	Soils	:	The district is covered by red soil is predominant in the district followed by black cotton soil. They are classified into eight types. The 45 % area is occupied by fine mixed soil, Clayey skeletal, mixed in 19 % area, Loamy-skeletal in 7% area
13	Cropping Pattern (2019-20)	:	The gross cropped area (2019-20) during khariff season is 26,712 ha and during rabi season is 26,846 ha (Total 53,558 ha). Main crops grown in Kariff and Rabi seasons are Food Crops 49,609 ha (31%), Cerels and millets 28,363 ha (18 %), Millets 28,004 ha (17%) and Pulses 4,208 ha (4%) Paddy is

			grown in 24,747 ha (16%) and Fruits and Vegetables (10%) in 15484 ha. The other crops grown are Sugarcane, millets and oil seeds 12,169 ha (8%).
14	Irrigation	:	Kotipally Vagu Project is a Medium Irrigation Project constructed across Kagna, a tributary of Bheema River in Vikarabad district. Under this Project irrigation registered ayacut 3710 Ha of ID crops in Rabi season and net area irrigatied 254 Ha in 2019-2020. The project serves 18 villages in Peddemul and Dharur Mandals of Vikarabad.
16	Prevailing Water Conservation/Recharge Practices	:	District there are ~1129 percolation tanks, ~1990 Check dams and ~504 farm ponds with gross storage of 101 MCM. Under Mission Kakatiya (Phase 1 to 4) 1701 tanks have been undertaken under RRR (Repairs, Restoration and Rejuvenation) schemes.
17	Geology	:	Archaean to Proterozoic crystalline banded gneissic complex (50%) and late Cretaceous to early Eocene Deccan trap basalts (37%)
19	Hydrogeological data points		
	Exploratory drilling data points	:	CGWB Exploration: 67
	Water Level data points		67 wells (CGWB:28, SGWD:40)
	Hydro-chemical Points		Total 1155 • Pre-monsoon:66(CGWB: 18, SGWD: 48) • and post-monsoon: 49 (CGWB:0,SGWD: 49)
	Geophysical		VES: 20(CGWB)
20	**DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING**		
20.1	**Ground water Level Scenario**		
	Water Levels Depth to water level (m bgl)	: :	DTW varies during pre-monsoon from 2.3 to 42.6 meter below ground level (m bgl) (average: 13.6 m bgl) and during Post-monsoon varies from 1.5- 32.6 m bgl (average: 9.1) seasons of 2020 respectively During pre and post-monsoon season (May and November) of 2020, the water-table elevation ranges from 421-691and 425-694 meter above mean sea level (m amsl) respectively (m amsl).
	Water Level Fluctuations (May vs. November)	:	The water level fluctuations vary from -0.1 to 15.63 m with average rise of 4.56 m

	Long term water level trends (2010-20) (30 wells)	:	Trend analysis for the last 10 years (2011-2020) is studied from 20 hydrograph stations of SGWD. It is observed that during pre-monsoon season 17 wells shows falling trend (0-1:18 wells) (max fall: 0.87 m/yr) and 01 wells shows rising trend (0-0.05 m/yr). During post-monsoon season 19 wells show falling trend (0-1:15 wells) (maximum fall: 0.96 m/Yr) and 04 wells shows rising trends (0-1 m/yr)			
20.2	**Ground Water Quality**					
	Electrical Conductivity (μ Siemens/cm)	:	Pre: Electrical conductivity varies from 293-2180 (avg: 913)μ Siemens/cm,. Post: Electrical conductivity varies **from 332-2240 (avg: 1131) μ Siemens/cm**..			
	Nitrate mg/l	:	Pre: 0.13-531 mg/L and found 45% of samples are unfit for human consumption Post: **<0.15-254 mg/L** (60%) are unfit for human consumptions.			
28	Fluoride mg/l	:	Pre: 0.25-3.33mg/L, 91% of samples are within permissible limits of BIS and rest is beyond permissible limit of 1.5 mg/L. Post: **0.15-2.54** mg/L. 89 % of sample is within permissible limit of BIS and rest is beyond permissible limit of 1.5 mg/L which is unfit for human consumptions			
20.3	Aquifer Mapping					
	Geology		Archean Crystalline		Deccan Traps	
	Prominent Lithology		Granite, Gneiss,		Basalt	
	Aquifers	:	Aquifer-2 (Fracture Zone)	Aquifer-1 (Weathered Zone)	Aquifer-2 (Fracture Zone)	Aquifer-1 (Weathered Zone)
	Thickness range	:	upto 165m	<10 to 30	upto 165m	<10 to 30
	Depth of range of occurrence of fractures	:	65% fracture encountered between 30 to 100m	35	75% fracture encountered between 30 to 100m	25
	Range of yield potential	:	<1 to 5	<1 to 2	<1 to 5	<1 to 2
	Transmissivity (m2/day)	:	Upto 42		Upto 160	
	Specific Capacity (lpm/mdd)		-		-	

21	Ground Water Resources		
	Ground water Resources (2020) MCM	:	-------
	Net Dynamic groundwater availability	:	291 MCM
	Gross GW Draft	:	**193 MCM**
	Provision for Domestic &Industrial (2025)	:	28 MCM
	Stage of Ground water development (%)		67%
	Net GW Availability for future irrigation	:	97MCM
	Categorization of mandals		66% (Madgul mandal) to 101% (Serilingampally mandal). Seriligampally mandal is over exploited, 7 mandals are Critical, 15 mandals are semi critical and 5 mandals are safe
22	Major Ground Water Issues Identified	:	Four (4) (Yelal, Tandur, Marpelle and Peddamul) mandals are showing fluoride which is geogenic in origin as high as 3.33mg/L during pre-monsoon and 2.52 mg/L during post-monsoon season is found in groundwater. The high fluoride concentration (>1.5 mg/L) occur in 09% and 10 % of the wells during pre-monsoon 2020 and post-monsoon season of 2020. High nitrate (> 45 mg/L) due to anthropogenic activities is observed in 45% and 55% during pre-monsoon 2020 and post-monsoon season of 2020 covering command and urban areas. • 2. No mandals are observed high concentration of EC > 3000 micro-seimens/cm in Pre and post-monsoon season of 2020. • Deep water levels (> 20 m bgl) are observed during pre- as well as post-monsoon season in 14 % and 03 % of the area respectively. Out of 70 wells analysed, 67 wells during pre-monsoon 70 wells during post-monsoon shown rising trend in the last 10 years (@-0.01to -5.6 and -0.01 to -4 m/yr) respectively.

23	Management Strategies	:	**Supply side measures** **Ongoing Projects** • **Mission Kakatiya:** De-silting of existing minor tanks 1701 no. with an area 85050 ha m (storage capacity ~76545 Ha. m considering depth 0.9 m) was taken under state Govt. sponsored Mission Kaktiya, in Phase-1 to Phase-5 removed 765 MCM of silt and this has created additional surface water storage. This will contribute ~ 229 MCM (considered rate of Recharge (30%) increased) to groundwater, which creates additional ~137 ha land can be brought under irrigation of dry (ID) crops in tank ayacut areas. **To be taken up (Artificial Recharge Structure in rural areas)** • 683 artificial recharge structures (345 CD's with 6 filling and 338 mini PT's with 2 fillings) with a total cost of 120 crores can be taken up • **Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).** **Demand side measure** • **Ongoing work:** • In the area till date a total number of 17 no's drip and sprinklers are sanctioned which has irrigated ~11.55 ha under ID crops saving ~0.19 MCM of groundwater from the basin. **Other Recommendations** • ~20040 ha of additional land that can be brought under micro-irrigation (@40ha/village in 501 villages) costing about 120 crores (considering 1 unit/ha @0.6 lakh/ha). With the adoption of Drip and sprinkler we can save additional 30% of ground water by using traditional ancient irrigation practices. With this 36 MCM of ground water can be conserved over the traditional irrigation practices (considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha). • Change in cropping pattern from water intensive paddy/spices (turmeric) to irrigated dry crops like

			pulses and oil seeds are recommended, particularly in water stress/Over-exploited/Critical areas. If necessary some regulatory rules may be framed and implemented. • To avoid the interference of cone of depression between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanism. • Power supply should be regulated by giving power in 4 hour spells two times a day in the morning and evening by the concerned department so that pumping of the bore well is carried out in phased manner to allow recuperations of the aquifer and increase sustainability of the bore wells. As a mandatory measure, every groundwater user should recharge rainwater through artificial recharge structures in proportionate to the extraction.
24	Expected Results and Out come	:	With the above interventions costing Rs:120 crores (excluding the cost involved in Mission Kakatiya and Mission Bhagiratha), the likely benefit recharge additional 19.22 MCM of Ground water and net saving of 36 MCM of ground water through Micro Irrigation (Drip & Sprinkler). This will bring down the stage of ground water development by 11% (from 67 % to 55.22 %)

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
Ha.m	:	Hector meter
ID	:	Irrigated dry
IMD	:	Indian Meteorological Department
Km^2	:	square kilometre
LPS	:	Litres per second
M	:	meter
M^3	:	Cubic meter
m bgl	:	Metres below ground level
MCM	:	Million cubic meter
Mg/l	:	Milligram per litre
MI	:	Micro irrigation
Min	:	Minimum
max	:	Maximum
MPT	:	Mini percolation tank
MSP	:	Minimum Support price
NL	:	North Latitude
NO_3	:	Nitrate
OE	:	Over Exploited
PGWM	:	Participatory ground water management
PT	:	Percolation tank
SGWD	:	State Ground Water Department
S	:	Storativity
Sy	:	Specific Yield
T	:	Transmissivity
WCM	:	Water conservation measures

EXECUTIVE SUMMARY

The Vikarabad district has a geographical area of 3386 km2, with 02 revenue divisions lies between north latitude north latitude 16.54°N to 17.38°N and east longitude 77.21°E to 78.04°"E. Administratively the district is governed by 18 revenue mandals and 501 villages with a population of ~9.27 lakhs (2011 census) having a population density of 274 per Sq.km.

The district is underlain by Archaean to Proterozoic crystalline banded gneissic complex of 49% and late Cretaceous to early Eocene Deccan trap basalts of 47% Pediplains are the major landforms followed by pediment, and structural hills. The district is drained mainly tributaries of Krishna. Agricultural land occupies nearly 16% and Forest occupies 13% of the area and Urban built up area is meagre. Remaining area is occupied by water bodies, waste land, etc. Gross cropped area during the year 2019-20 is 53,558 ha. The district is covered by red soil 32% and Black soil ~21%.

The registered ayacut under the Kotipally Vagu medium irrigation project Scheme is 3710 Ha. Total surface water irrigating area is 94 ha i.e. 0.18% and the total ground water irrigated area is 53,315 ha. i.e 99.5% of Gross irrigation area.

In the district, there are ~1129 percolation tanks, ~1990 Check dams and ~504 farm ponds. Under Mission Kakatiya (Phase 1, 2, 3,4) 1701 minor irrigation tanks have been taken under RRR (Repairs, Restoration and Rejuvenation) schemes.

Water level is monitored through 63 to 68 wells during pre and post-monsoon season. During pre-water-table elevation ranges from 421-691 meter above mean sea level and post-monsoon season 425-694 meter above mean sea level (m amsl). Depth to water level varies from 2.3 to 42.6 m bgl during pre-monsoon and 1.5- 32.6 m bgl during post-monsoon season. In Majority of the water level during this season are in the range of >10m covering 31% of the area, followed by 10-20 m covering 53% of the area, followed by 20-40 m bgl (14 %). Deep water levels in the range of > 40 m bgl occupy about 1 % of the area falling in parts of Peddemul Mandal. Shallow water

levels (< 10 mbgl) occupy about 31% of the area in parts of Nawabpet, Kodangal, Doma, Darur, Moinabad and Yelal mandals.

Most of the wells in the State records water level rise. The seasonal water level fluctuations vary from -0.1 to 15.63 m.

Trend analysis for the last 10 years (2011-2020) is studied from 20 hydrograph stations of SGWD. It is observed that during pre-monsoon season 17 wells shows falling trend (0-1:18 wells) (max fall: 0.87 m/yr) and 01 wells shows rising trend (0-0.05 m/yr). During post-monsoon season 19 wells show falling trend (0-1:15 wells) (maximum fall: 0.96 m/Yr) and 04 wells shows rising trends (0-1 m/yr).

Total 115 ground water samples (Pre-monsoon:66 and Post-monsoon:49) were analysed for knowing the suitability of ground water for drinking purpose. The area is mildly alkaline to alkaline in nature with pH in the range of 6.20-8.84 (Avg: 7.81). Electrical conductivity varies from 293-2180 (avg: 913)µ Siemens/cm. In 88% of area EC is within 1500 µ Siemens/cm, in 12 % area, it is 1500-3000µ Siemens. (Fig.2.8). Average concentration of TDS is 913 mg/L and NO3 ranges from 0.13-531 mg/L. Nitate concentration in 45% of samples is beyond permissible limits of 45 mg/L (Fig.2.9). Fluoride concentration varies from 0.25-3.33 (Fig 2.10) and 91% of samples is within the permissible limits of BIS and 9% is beyond the permissible limit of 1.5 mg/L. High fluoride concentration is observed in the eastern and northern part of the district.

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

Aquifers are conceptualized in to two namely; 1) weathered zone (~30 m) and 2) fractured zone (26- 200 m). The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. Ground water yield varies in weathered granite/gneiss aquifer varies from <0.1 to 9.5 lps and from 0.01 to 1.2 lps (avg: 1.0 lps) in basalt aquifer**.** The fractures in the range of < 60 m depth are more predominant (69 % of the wells), 60-100 and 100-150 fractures occur in 19% and 09%

of area respectively and deep fractures in the range of 150-192 m occur in 3%. Analysis of occurrence of fractures (64 nos from 67 wells) reveal that majority of fractures (~88 %) occur within 100 m depth. Ground water yield in this zone varies from 0.01 to 9.5 lps (avg: 1.9 lps).

As per 2020 GEC report (SGWD), the net dynamic replenishable groundwater availability is 97 MCM, Gross ground water draft for all uses 194 MCM provision for drinking and industrial use for the year 2025 is 28 MCM and net annual ground water potential available for future irrigation needs is 97 MCM. Stage of ground water development varies from 50% to 75 % with average of 67 %. No mandal falls in over-exploited category, No mandal falls in critical category, 08 mandals fall in semi-critical category and remaining 10 mandals fall in safe category. Mandal wise stage of ground water development from 50 %(Kodangal mandal) to 75% (Nawabpet mandal).

The management strategies mainly include both supply side and demand side. The supply side management of ground water resources include artificial recharge of available surplus runoff in check dams and percolation tanks in rural areas and roof top and open space rain water harvesting in urban areas. Construction of 683 artificial recharge structures (345 CD's with 6 filling and 338 mini PT's with 2 fillings) with a total cost of 120 crores can be taken up and is recommended as supply side measures. Roof top and open space rain water harvesting for artificial recharge in urban areas.

De-silting of existing minor tanks 1701 no. with an area 85050 ha m (storage capacity ~76545 Ha. m considering depth 0.9 m) was taken under state Govt. sponsored Mission Kaktiya, in Phase-1 to Phase-5 removed 765 MCM of silt and this has created additional surface water storage. This will contribute ~229 MCM (considered rate of Recharge (30%) increased) to groundwater, which creates additional ~137 ha land can be brought under irrigation of dry (ID) crops in tank ayacut areas.

Demand side measure includes micro irrigation in ~20,040 ha of additional land that can be brought under micro-irrigation (@40ha/village in 501 villages) costing about 120 crores (considering 1 unit/ha @0.6 lakh/ha). With the adoption of Drip and

sprinkler we can save additional 30% of ground water by using traditional ancient irrigation practices. With this 36 MCM of ground water can be conserved over the traditional irrigation practices (considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha).

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

NUMBER OF DATA POINTS USED FOR PREPARATION OF VARIOUS MAPS/FIGS- VIKARABAD DISTRICT

S.No.	Data	Aquifer	Total Data Points	Source	
				CGWB	SGWD
1	Panel Diagram (3-D)	Combine	49	Expl:49	
2	Hydrogeological Sections	1 no	70	Expl:70	VES:20
4	Depth of weathering	1 no	49	Expl:49	
5	Depth of fracturing	1 no	49	Expl:49	
6	Groundwater Yield	combined	49	49	
7	Transmissivity (m^2/day)	combined	10	10	
8	Depth to Water Level Maps	Combine	70		
9	Water Level Fluctuation	Combine	78	37	41
10	Long term water level trends	Combine	20		
11	Water quality Pre Post	Combine	Pre:66 Post:49	18 00	SGWD:48 SGWD:49

1. INTRODUCTION

Aquifer mapping is a multivarient & multidisciplinary scientific approach wherein integration of geologic, geophysical, hydrologic and chemical analysis is applied to characterize the quantity, quality and sustainability of ground water in aquifers. In recent past, there has been a paradigm shift from "groundwater development" to "groundwater management". In the southern parts of India peninusula mostly hard rock aquifers have become water stressed due to rapid growth in irrigation has led to demand for ground water due to population growth, urbanization and changing lifestyle. Therefore, in order to have an accurate and comprehensive micro-level picture of groundwater in India, aquifer mapping in different hydrogeological settings at the appropriate scale is devised and implemented, to enable robust groundwater management plans. This will help in achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural and many parts of urban India. The aquifer mapping program plays vital role for planning suitable development and adaptation of 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.

The Southern Peninsular Shield of India comprises of consolidated sedimentary rocks, ignous rocks and Deccan basalts. Occurrence and movement of ground water in these formations are restricted to weathered residuum and interconnected fractures at deeper levels have led to limited ground water potential resources. Weathered zone is the potential recharge zone for deeper fractures and excessive withdrawal from these zones leading to desaturation of pheratic aquifer or drying up most places and reducing yield and sustainability of borewell structures. Apart from these, the quantitative aspects, groundwater quality also represents a major challenge, which is threatened by both geogenic and anthropogenic pollution. In search Ground Water at places, the deeper 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.

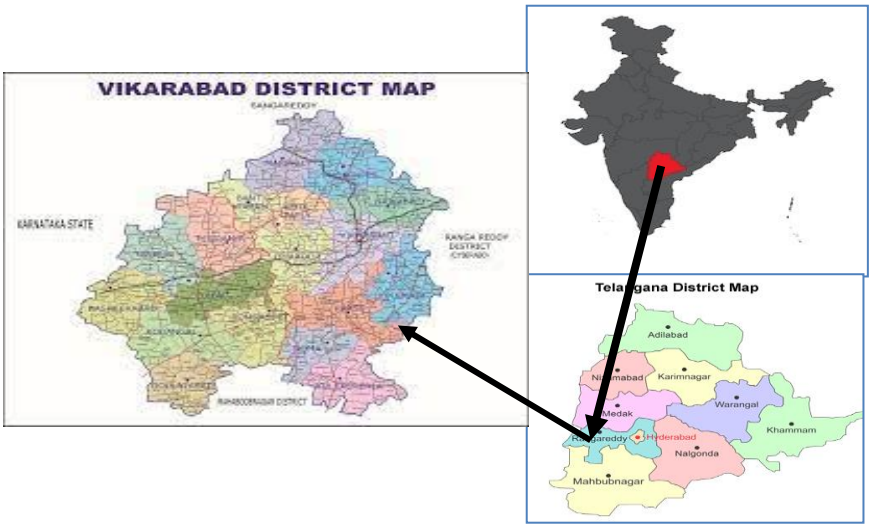
1.1 **Objectives:** In view of the above challenges, an integrated hydrogeological study was taken up to develop a reliable and comprehensive aquifer map and to suggest suitable groundwater management plan on 1: 50,000 scale.

1.2 Scope of study: The main scope of study is summerised below.

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

1.3 Area Details: The Erstwhile Ranga Reddy district (52 mandals) having geographical area of 7,493 Sq. km, (bifurcated into 3 districts with incorporating few mandals from neibouring districts). The district Vikarabad is covering a geographical area about 3386 sq.Km. having 18 mandals with 2 Revenue Disvisons (3 Mandals are included from Mahhabubnagar district erstwhile). The district lies between north latitude 16°54´- 17°38´and east longitude 77°21´- 78°48’ (Fig.1.1). Out of total area, the non-command area is 91 % and command area is 00 % and hilly area is 9 %. Administratively the district is governed by 18 mandals, 501 villages with 565 Gram Panchayats with a population of ~9.27 lakhs (2011 census), having density of 274 with 86.52% Rural population and 13.48% urban population.

Fig.1.1: Location of Vikarabad district



1.4 Climate and Rainfall: The climate of the district is characterised by hot summer and generally dry weather except during S-W monsoon season.The normal mean daily minimum and maximum temperature of 26 °C and 40 °C during May and 13°C and 28.2°C during December. Normal annual rainfall is 765 mm and annual rainfall is 689 mm (**Fig. 1.2**). ~ S-W monsoon contributes 78 % and 22 % is contributed by retreating monsoon (N-E) season and rest by winter and summer rainfall. Rainfall increases from west to central part and from east to central part and then decreases further south-east (750m). As per the IMD rainfall data for 20 years (1999 to 2019), average annual rainfall of 781 mm (21% excess rainfall than normal rainfall) deviation -7.2%. During the year 2011 it received 516 mm of rainfall (-20 % less than normal rainfall).

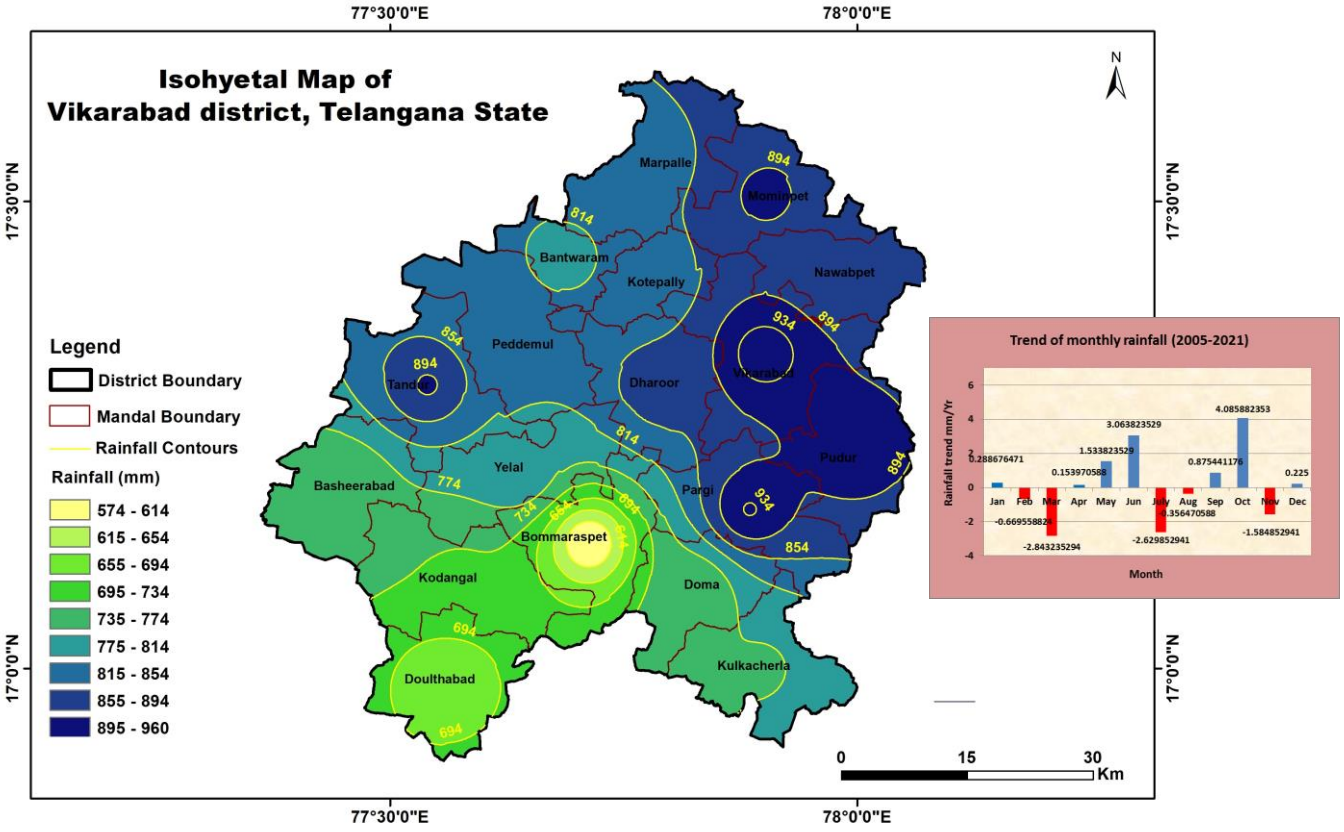


Fig.1.2: Isohyetal map of Vikarabad district.

1.5 Geomorphological Set up: Pediplain is the major landform covering about 3387 km^2 (32%) area. The other landforms observed are pediment (23%), dissected plateau (37%), denudation hills & others (7.5 %). (**Fig.1.3**). Physiographically, the district shows the height between 425 and 718 meters in its Eastern and Southwestern parts intervened by most obviously by the elevated middle part that ranges even up to 1,200 meters. Naturally, slope direction in both the parts is centrifugal

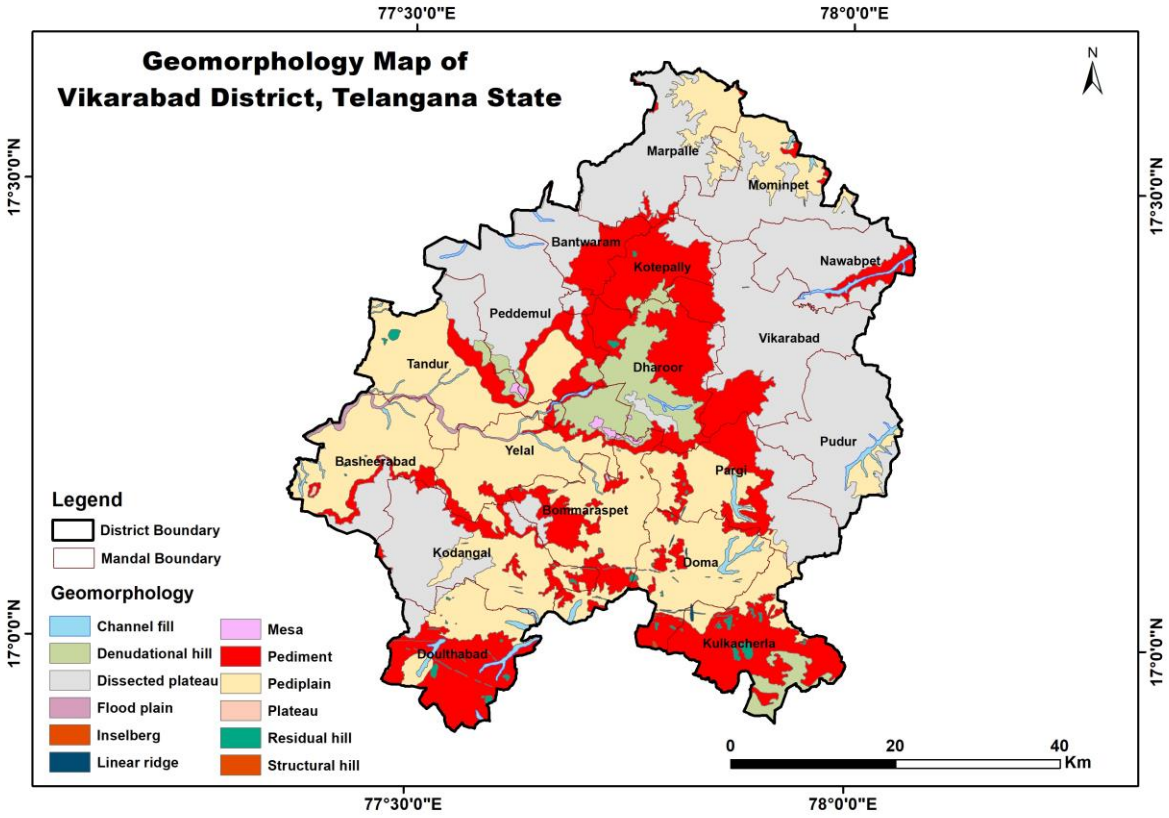


Fig.1.3: Geomorphology of Vikarabad district.

1.6 Drainage and Structures: The district is drained by the river Musi, Kagna, Manjeera and other small rivers like Haldi Vagu and Nalla Vagu. The musi river originates in Anantagiri hills near Vikarabad and flows towards East. It joins the Krishna River at Vadapally in Nalgonda district after covering a distance of about 240 km. Kagna river originates in Vikarabad mandal and drains Vikarabad and Tandur areas. The “Manjeera”, is a tributary of Godavari river, originates in Bidar district and enters in the southeastern of Vikarabad district. It flows for about 96 Km. in the western and northwestern taluks of Narayankhed, Zaheerabad, Sangareddy, Narsapur and Vikarabad. All the streams are ephemeral in nature. The drainage pattern is dendritic and density is coarser in the Kagna catchment areain basaltic formation. Trellis pattern of drainage is observed in the grantic rocks covers 50% of area falls under Musi catchment. Major part of the district falls under Krishna basin.

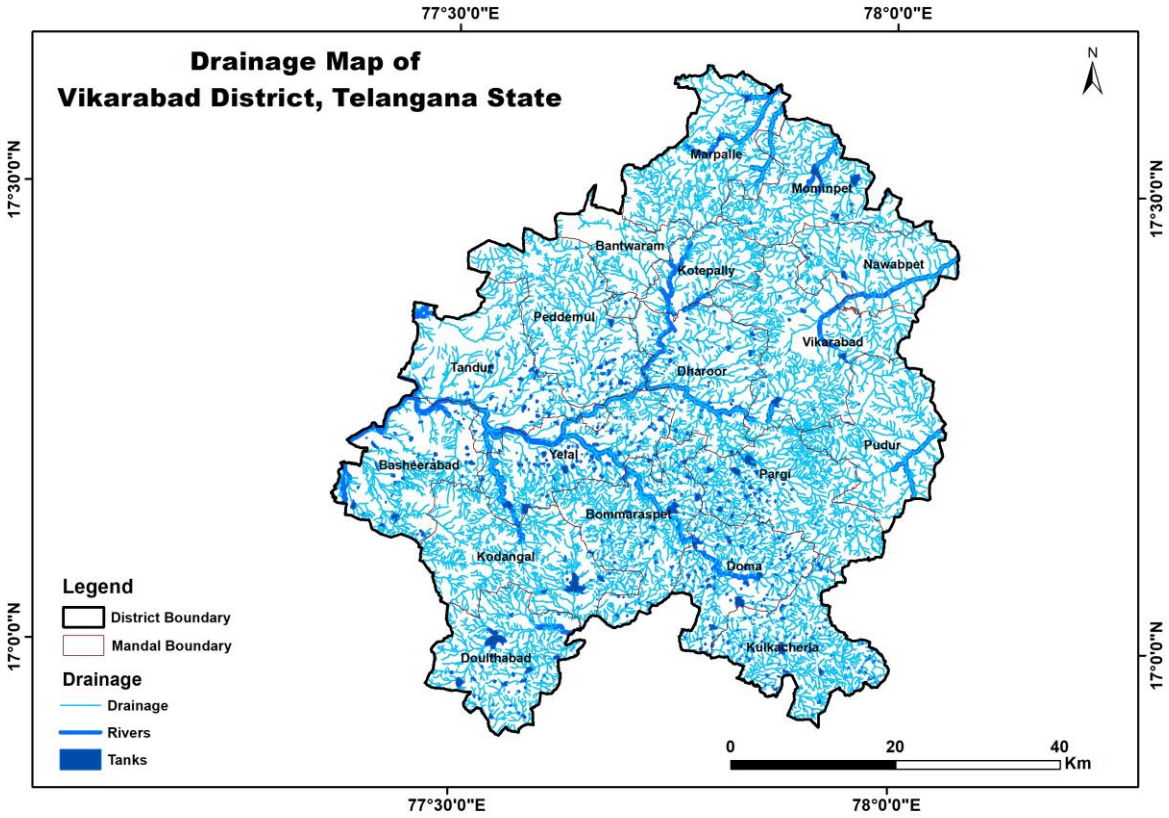


Fig.1.4: Drainage, lineaments and watershed boundaries.

1.7 Land use and cropping pattern (2019-20): In the district, the land use can be grouped into 21 classes (**Fig.1.5**). Land put to agriculture (includes Khariff, Khariff+Rabi, Plantation, Crop-Land-in-Forest) occupies ~16 % (536 sq.km) of the total geographical area (3386 Sq.km), Forest occupy 13% (433 sq.km) of the area, 6% (203 Sq.km) area is waste land (Land-with-scrub, hills, mining, Sheet rocks.). Remaining area is occupied by villages, towns, tanks and reservoir. The gross cropped area (2019-20) during khariff season is 26,712 ha and during rabi season is 26,846 ha (Total 53,558 ha). Main crops grown in Kariff and Rabi seasons are Food Crops 49,609 ha (31%), Cerels and millets 28,363 ha (18 %), Millets 28,004 ha (17%) and Pulses 4,208 ha (4%) Paddy is grown in 24,747 ha (16%) and Fruits and Vegetables (10%) in 15484 ha. The other crops grown are Sugarcane, millets and oil seeds 12,169 ha (8%).

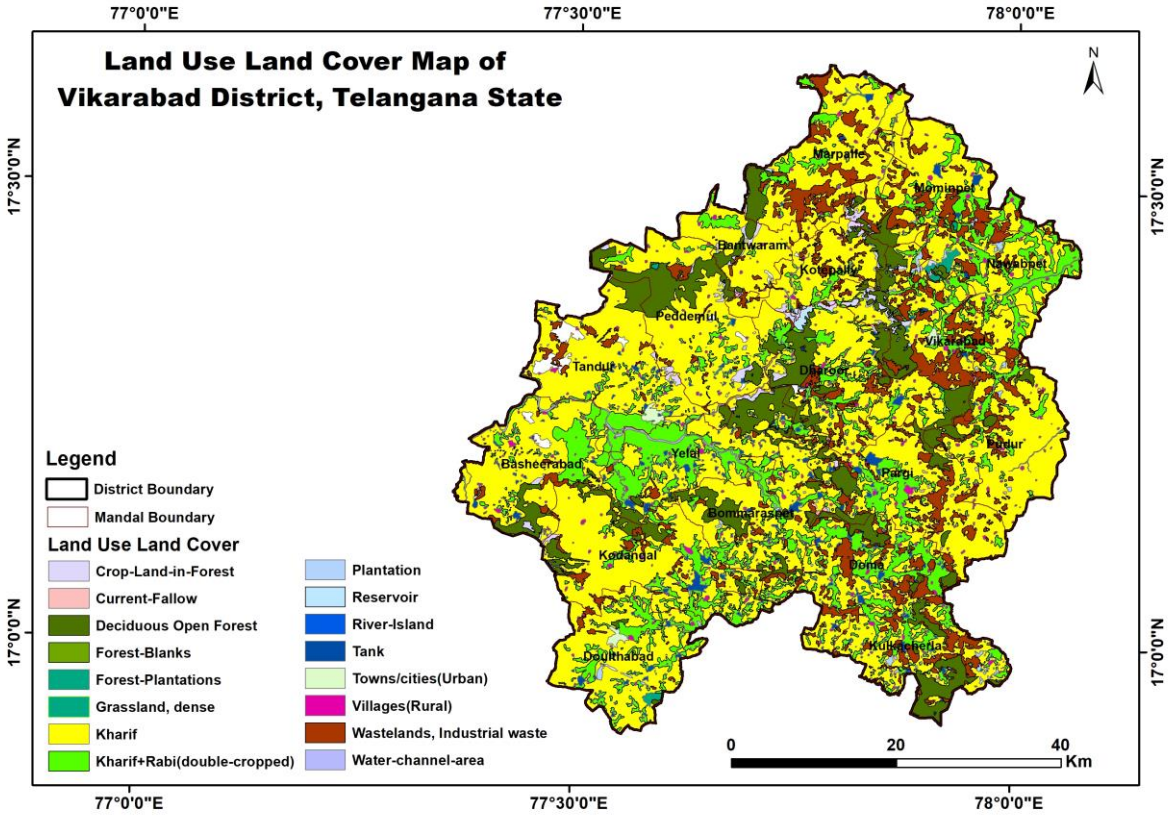


Fig.1.5: Land use and land cover of Vikarabad district.

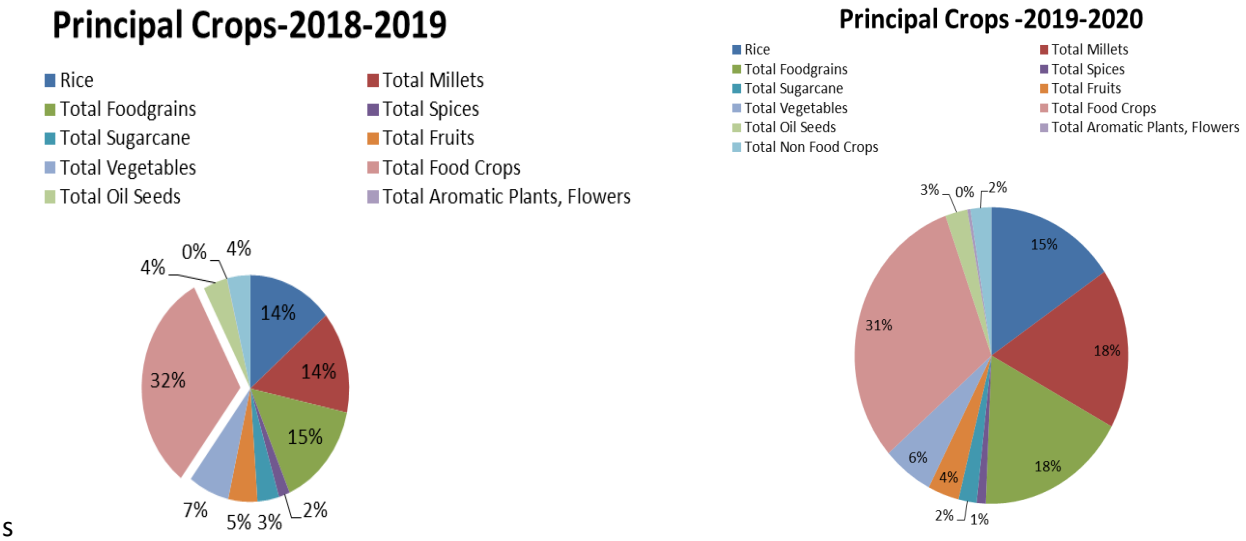


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Fig. 1.6 a, b Season Wise principal Crops 2018 to 2020

1.8 Soils: Red soil is predominant in the district followed by black cotton soil. They are classified ito eight types. The 45 % area is occupied by fine mixed soil, Clayey skeletal, mixed in 19 % area, Loamy-skeletal in 7% area. (**Fig.1.6**).

Soils	Area in Sq.Kms	Area %
Clayey-skeletal, mixed	670.89	18.62
Fine, kaolinitic,	101.95	2.83
Loamy, mixed	16.36	0.45
Loamy-skeletal, mixed	253.99	7.05
Very fine, montmorillonitic	270.5	7.49
Clayey, montmorillonitic	776.45	21.54
Fine, montmorillonitic	359.7	9.99
Fine mixed	1154.28	32.03

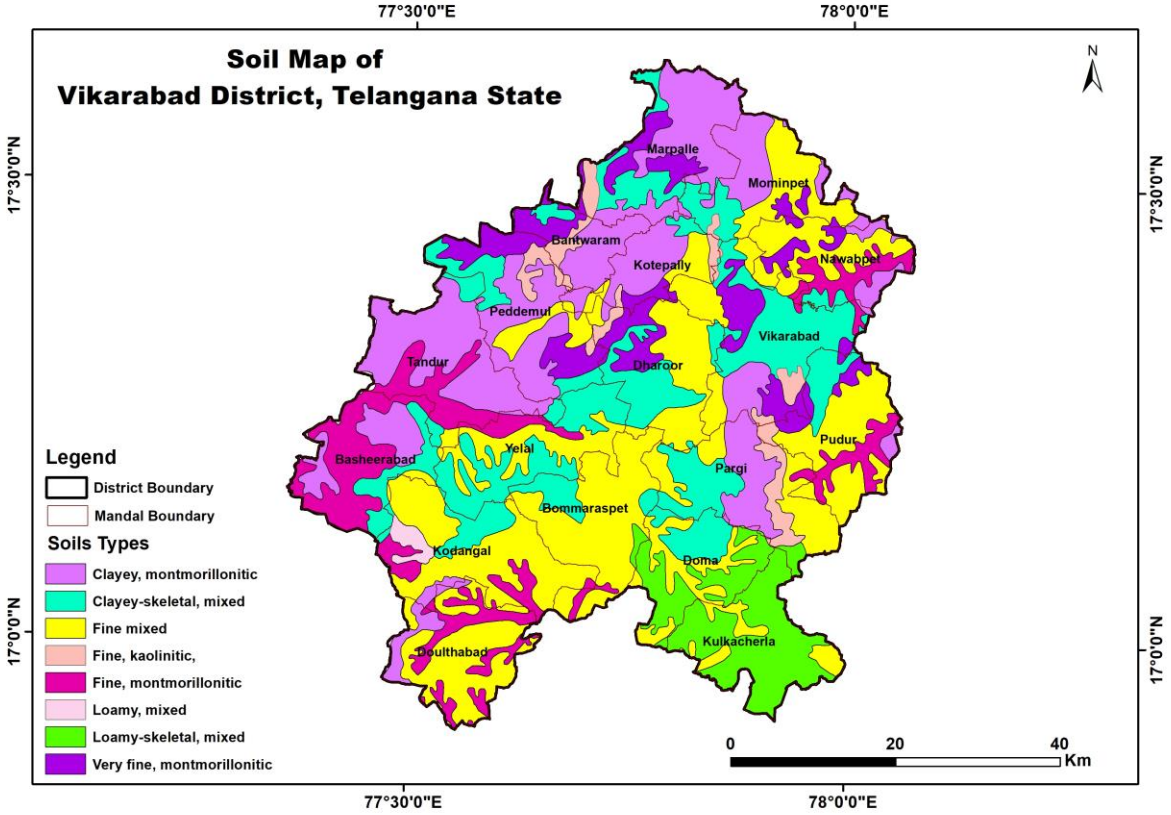


Fig.1.7: Soil map of Vikarabad district.

1.9 Irrigation:

Kotipally Vagu Project is a Medium Irrigation Project constructed across Kagna, a tributary of Bheema River in Vikarabad district. Under this Project irrigation registrered ayacut 3710 Ha of ID crops in Rabi season and net area irrigatied 254 Ha in 2019-2020. The project serves 18 villages in Peddemul and Dharur Mandals of Vikarabad.

The Lakhnapur Project is a Medium Irrigation Project constructed across the Pargi Stream, which is a tributary to Krishna. The Project is located near the Lakhnapur village, Pargi Mandal, Vikarabad District to irrigate a total ayacut of 2647 acres in the District of Vikarabad. The salient features of irrigation during 2019-20 are given in ***Table-1.2***.

Table-1.8 AREA IRRIGATED UNDER DIFFERENT SOURCES FROM 2019-20

(in Hectares)

Sl. No.	Source of Irrigation	2019-20
1	Canals	**0**
2	Tanks	**94**
3	Tube wells	**51861**
4	Dug wells	**1454**
5	Lift irrigation	**149**
6	Other sources	**0**
7	Gross area irrigated	**53558**
8	Area irrigated more than once	**12695**
9	Net area irrigated	**40863**

1.10 Prevailing Water Conservation/Recharge Practices: In the district there are ~1129 percolation tanks, ~1990 Check dams and ~504 farm ponds with gross storage of 101 MCM. Under Mission Kakatiya (Phase 1 to 4) 1701 tanks have been undertaken under RRR (Repairs, Restoration and Rejuvenation) schemes.

Sl. No.	MINOR IRRIGATION SOURCES BY CATEGORY ACCORDING TO 5TH MINIOR IRRIGATION CENSUS	
		(in Nos.)
1	**Dug Wells**	**5482**
2	**Shallow Tube Wells**	**0**
3	**Medium Tube wells**	**0**
4	**Deep Tube Wells**	**26892**
5	**Surface Flow Irrigation Schemes**	**638**
6	**Surface Lift Irrigation Schemes**	**0**
7	**Mission Kakatiya (Total No. of Tanks existing) RRR ph I to IV**	**1701**
	Total:	**34,713**

1.11 Geology: The district is underlain by various geological formations from oldest Archaean granites and gneisses, Proterozoic Bhima series and the younger Deccan traps formations. The Archaean crystalline rocks occupy nearly three fourths of the district comprising older metamorphic rocks, peninsular gneissic complex (migmatites) and younger intrusive rocks. The upper pretoerozoic sediments of Bhima group comprising of limestones and shales occur in the western part of the district. The shale beds show intercalations of limestone. The Mesozoic-lower tertiary (Deccan traps) basaltic flows overlain the Bhima sediments and archeans extend from central to Southern part. The thickness of each flow varies from 15 to 20 m. Intra-trappean beds are thin and comprise conglomerates, chert and sandstone. The thickness of infra-trappeans varies from 0.5 to 8 m and these are fossiliferous. A series of WNW–ESE trending faults are seen in the southeastern part of the area. (**Fig.1.7**).

Geological Formation	Sq.Km	Area %
Basalt	**1345.11**	**37.33**
Limestone	**75.847**	**2.10**
Laterite	**319.1**	**8.85**
Shale	**62.22**	**1.72**
Banded Gneissic Complex (Granites)	**1801.38**	**49.99**

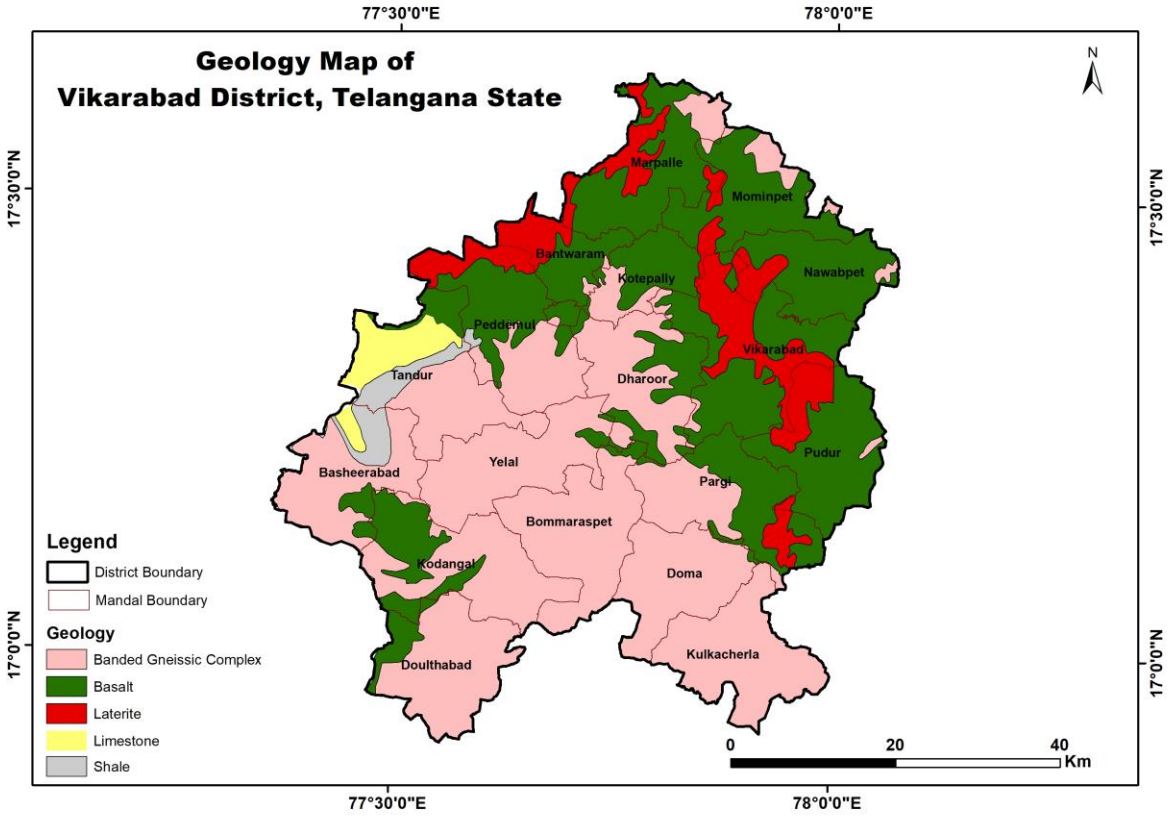


Fig.1.7: Geology of Vikarabad district.

Geological Sucession of Vikarabad District, Telangana State

1. GEOLOGY AND MINERALS

LITHOLOGY			NATURE AND CHARACTERISTICS
Laterite		PLEISTOCENE	Moderately hard, porous
Basalt, Intertrappean	DECCAN TRAP	CRETACEOUS TO PALEOCENE	Parallel layered, step topography
Infratrappean		CRETACEOUS	Bedded & Laminated
Unconformity			
Sandstone, shale, limestone	BHIMA GROUP	PROTEROZOIC	Bedded & Laminated
Unconformity			
Basic dyke(Dolerite,Pyroxenite, Gabbro)	YOUNGER INTRUSIVES		Hard, massive, dense
Quartz reef			Hard, massive, fractured
Granodiorite-adamellite	PENINSULAR GNEISSIC COMPLEX	ARCHAEAN	Hard, foliated
Predominantly granite (ss) and alkali feldspar granite			Hard, compact
Migmatite			Hard, compact
			Moderately hard,

2. DATA COLLECTION and GENERATION

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

Table-2.1: Brief activities showing data compilation and generations.

S. No.	Activity	Sub-activity	Task
1	Compilation of existing data/ Identification of Principal Aquifer Units and Data Gap	Compilation of Existing data on groundwater	Preparation of base map and various thematic layers, compilation of information on Hydrology, Geology, Geophysics, Hydrogeology, 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.

Hydrogeology is concerned primarily with mode of occurrence, distribution, movement and chemistry of ground water occurring in the subsurface in relation to the geological environment. The occurrence and movement of water in the subsurface 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, gneisses and basalts and the occurrence and movement of ground water in these hard rocks is controlled by the degree of interconnection of secondary pores/voids developed by fracturing and weathering. Based on 70 hydrogeological data points (**Fig.2.1)** hydrogeological map is prepared.

2.1.1 Ground water occurrences and movement: Ground water occurs under unconfined and semi-confined conditions and flows downward from the weathered zone (saprolite and Regolith rock) into the fracture zone. The primary aquifers constitute the weathered zone at the top, followed by an anisotropic, discrete fracture/fissured zone at the bottom, generally extending down to 200 m depth. The storage in granite rocks is primarily confined to the weathered zone due to need of ground water for irrigation purpose the weathered zone is over exploited has resulted in desaturation of weathered zone at many places. In Basaltic terrain, vesicular basalt is the main aquifer. 68 borewells were drilled in the area with maximum depth drilled upto 200 m.bgl. At present, extraction is mainly through boreholes of 30-100 m depth, with yield between <0.1 and 10 litres/second (lps). ~ 84 % of fractures occur within 100 m depth and deepest fracture is encountered in granites at the depth of 176.5m (Pallepalli Village) and in basalts at the depth of 85 m depth (Dharmapur village) and contact between grantic and basalt rock unable to trace in Northern region of District. The hydrogeological map of the area is presented in **Fig. 2.2**.

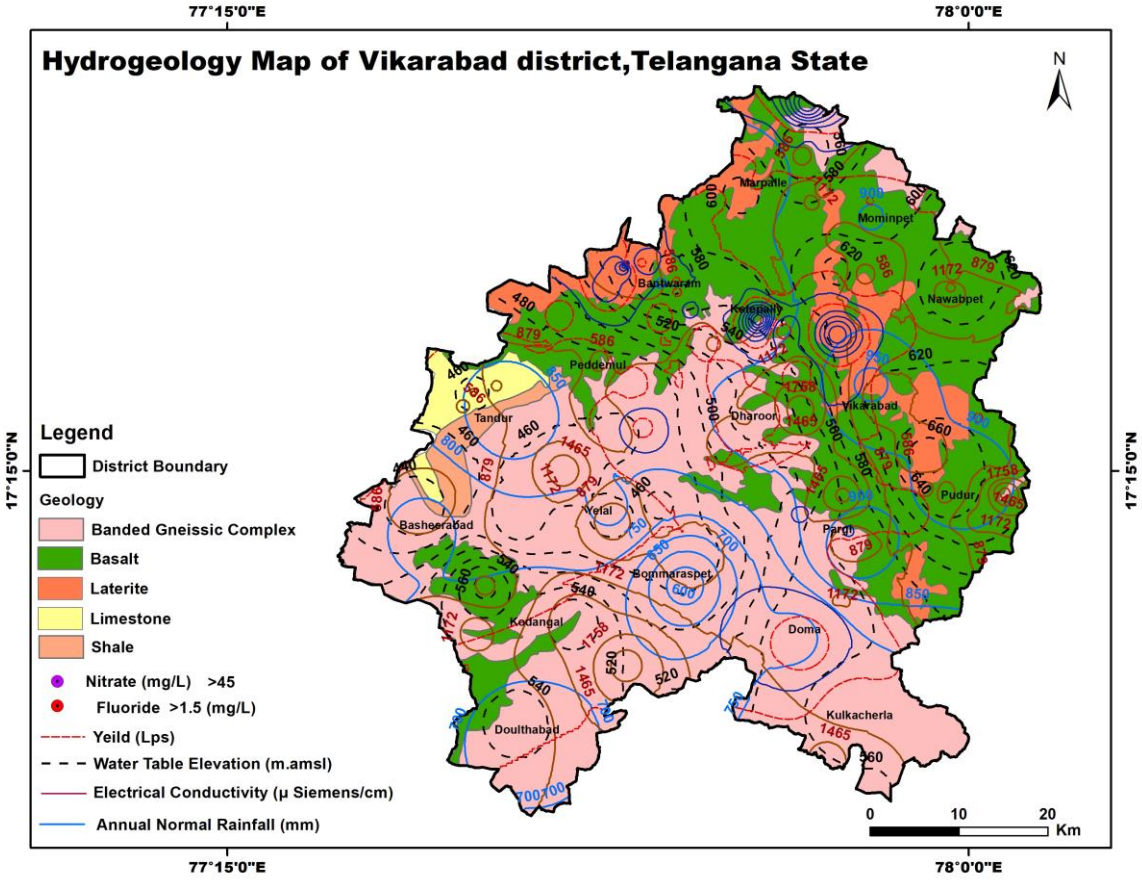


Fig.2.1: Hydrogeological map of Vikarabad district.

2.1.2 Exploratory Drilling: As on 31/03/2020, CGWB drilled 67 bore wells (exploratory, observation and piezometers), 15 wells in basaltic area, 10 nos in laterite and 42 wells in granitic area were drilled. Data analysed from CGWB wells indicates, 01 well of shallow depth (30 m), 22 nos (30-60 m), 24nos (60-100 m) 5 nos (100-150 m) 15 nos (150-200 m) depth respectively**.**

2.1.3 Ground water Yield: Ground water yield of granitic aquifers varies varies from <0.1 to 9.5 lps (avg: 1.19 lps) and basaltic aquifers varies varies from <0.1 to 6.81 lps (avg: 1.08 lps). Wells located in the minor irrigation structures have higher yield (1-3 lps) as compared to without any minor irrigation structures area where yields are relatively low sustainability for 2-3 hrs (**Fig.2.2)** on pumping.

2.2 Water Levels (2020): Ground water levels from 68 piezometers (CGWB: 28 and SGWD: 40) were monitored for pre-monsoon and 63 piezometers (CGWB:28 and SGWD: 35) during post-monsoon season.

2.2.1 Water Table Elevations: During pre and post-monsoon season (May and November) of 2020, the water-table elevation ranges from 421-691and 425-694 meter above mean sea

level (m amsl) respectively. Ground water flow is towards Western direction from North and Western part, North to West direction in central and south-Western part. The groundwater divides, marked by the divergence of flow lines, almost coincide with the path of topographic divides and evelation (**Fig.2.3**).

2.2.2 Depth to Water Levels (DTW): The DTW varies during pre-monsoon from 2.3 to 42.6 meter below ground level (m bgl) (average: 13.6 m bgl) and during Post-monsoon varies from 1.5- 32.6 m bgl (average: 9.1) seasons of 2020 respectively.

Pre-monsoon season: Majority of the water level during this season are in the range of >10m covering 31% of the area, followed by 10-20 m covering 53% of the area, followed by 20-40 m bgl (14 %). Deep water levels in the range of > 40 m bgl occupy about 1 % of the area falling in parts of Peddemul mandal (**Fig.2.4**). Shallow water levels (< 10 mbgl) occupy about 31% of the area in parts of Nawabpet, Kodangal, Doma, Darur, Moinabad and Yelal mandals.

Post-monsoon season: Majority of the water level during this season are in the range of 10-20 m covering 31% of the area, 20-40 m bgl in 03 % of the area. (**Fig.2.4**). Shallow water levels (< 10 mbgl) occupy about 66% of the area in parts of Vikarabad, Marpalle, Dharoor, Bantawaram,Tandur, Nawabpet, Pudur, and Yelal mandals.

Fig.2.2: **Depth to water levels Pre-monsoon (May-2020)**

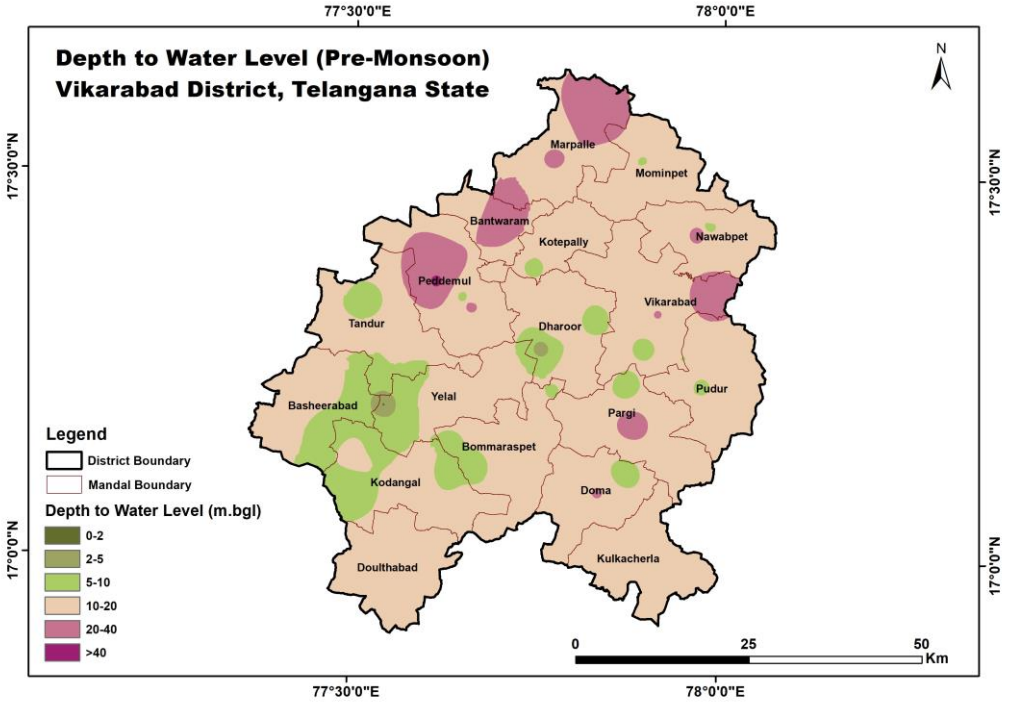


Fig.2.3: Depth to water levels Post-monsoon (Nov-2020)

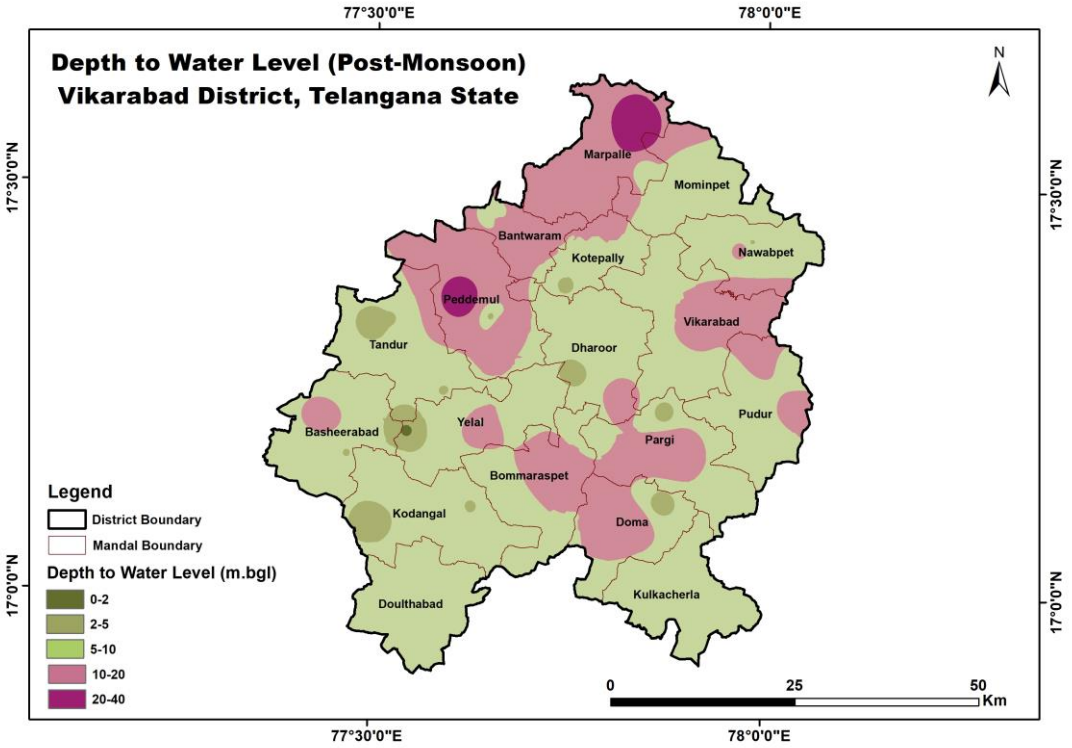


Fig.2.4: Water table elevations (m amsl) during pre-monsoon season

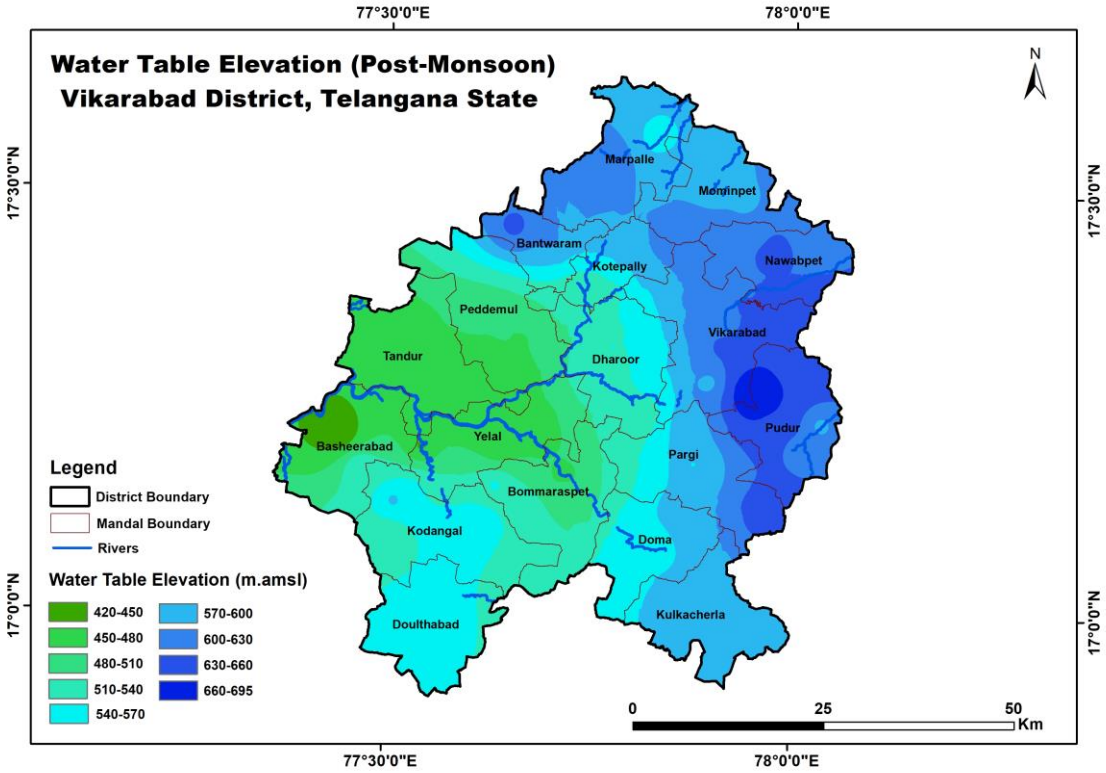
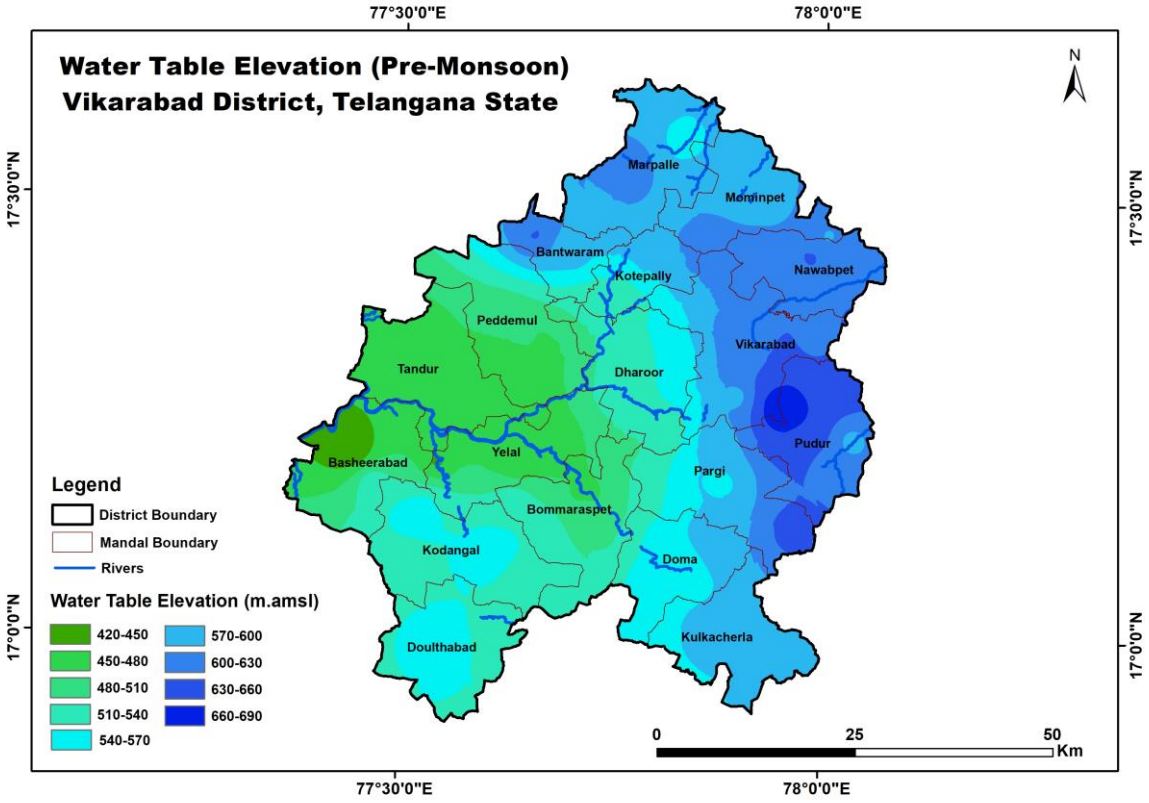
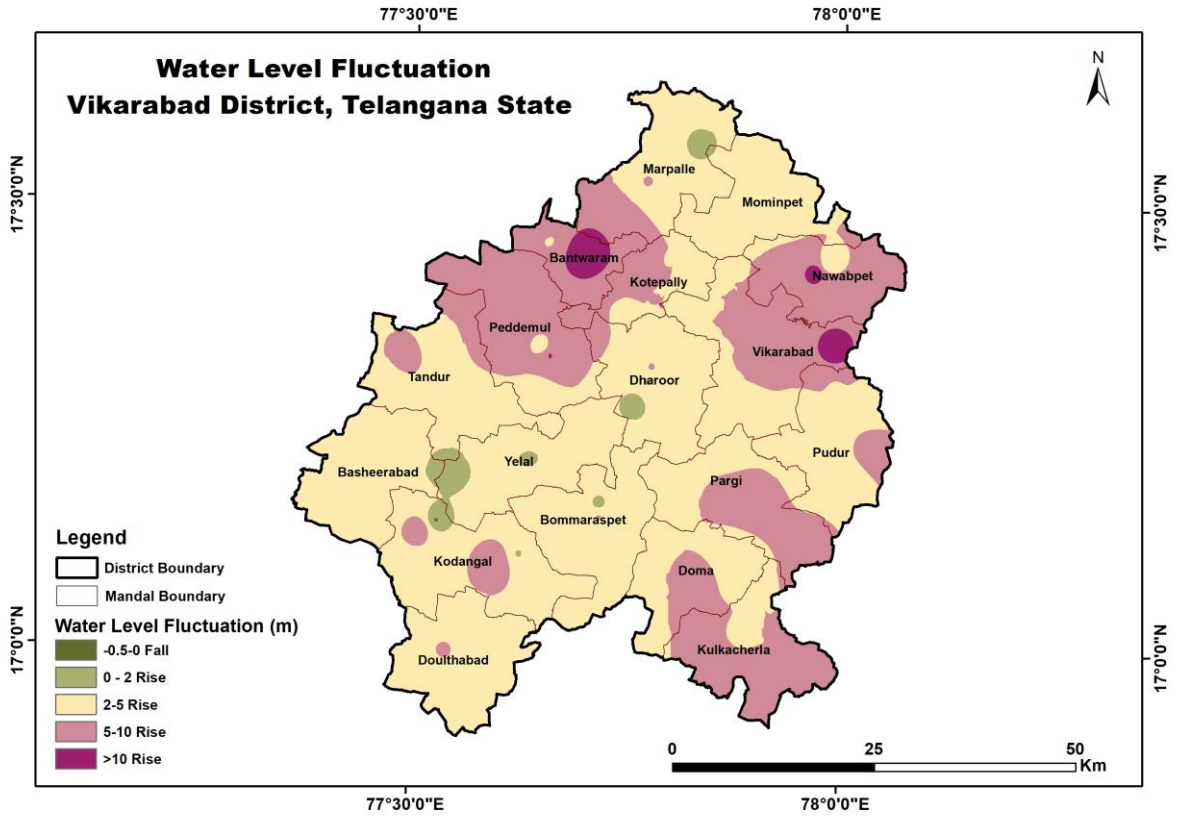


Fig.2.5: Water table elevations (m amsl) during post-monsoon season



2.2.3 Water Level Fluctuations (May vs. November): The water level fluctuations vary from -0.1 to 15.63 m with average rise of 4.56 m (**Fig.2.6**). Only one well at Juntupalli village (Kodangal) registered fall in water level and remaining all wells show rise in water levels. Rise in water level range of 5-10 m cover majority of area with 24% followed by 2 to 5m covering 67% of area. Water level rise of > 10 m with 7% is observed Peddemul, Nawabpet, Vikarabad and Bantwaram mandals. Water level rise of < 5 m. is observed in Dharur and Yelal, mandals.

Fig.2.6: Water Level Fluctuations (m) (Nov with respect to May-2020).



2.2.4 Long term water level trends: Trend analysis for the last 10 years (2011-2020) is studied from 20 hydrograph stations of SGWD. It is observed that during pre-monsoon season 17 wells shows falling trend (0-1:18 wells) (max fall: 0.87 m/yr) and 01 wells shows rising trend (0-0.05 m/yr). During post-monsoon season 19 wells show falling trend (0-1:15 wells) (maximum fall: 0.96 m/Yr) and 04 wells shows rising trends (0-1 m/yr). The graphical representation of fall and rise is shown in **Fig 2.7** and area wise shown in **Fig 2.8**.

Fig. 2.7 a-b: Long-term water level trends (2011-2020).

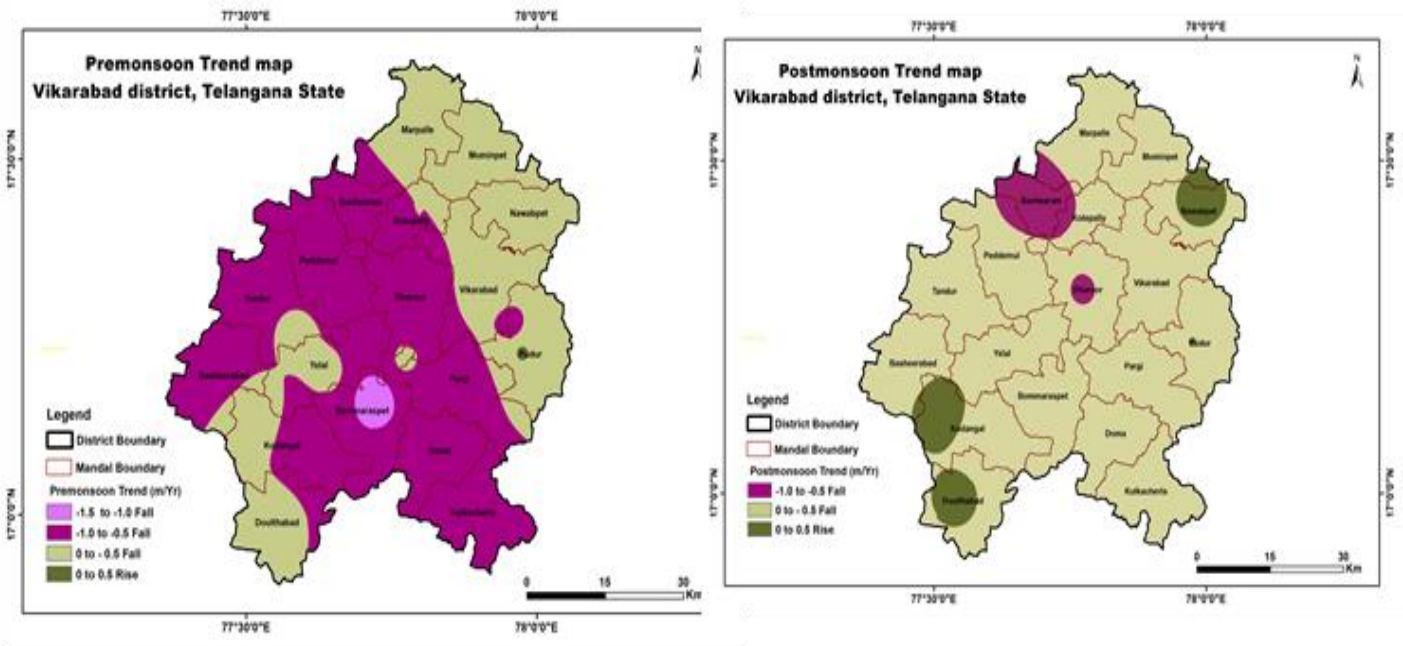
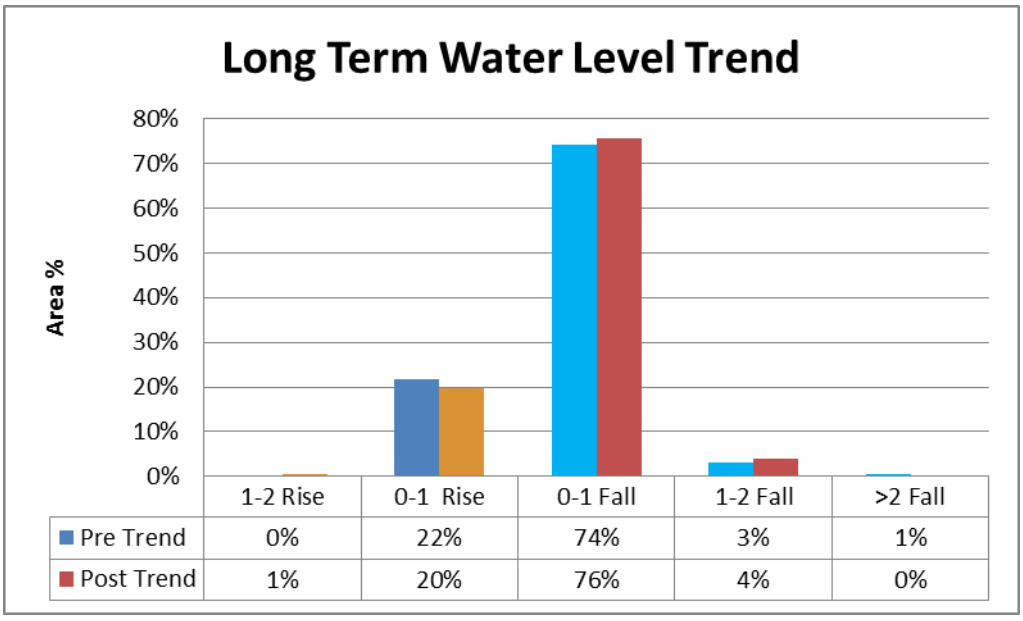


Fig. 2.8: Graphical representation of water level trends (2011-2020).



2.3 Geophysical Studies

A total of 20 VES data (SGWD:20) is interpreted, which reveals resistivity < 100 ohm (Ω) m for the weathered granite (1-23 m), 60-350 Ω m for underlying fractured granite with maximum thickness of 90 m (Utnur) and > 350 Ω m for massive granite.

2.4 Hydro chemical Studies

To understand chemical nature of groundwater, total 66 data is utilized from ground water monitoring wells of CGWB, SGWD and RWS wells (Pre-monsoon:66 and post-monsoon:49) (mostly tapping combined aquifers Aq-1 and aq-2) during the pre-monsoon season of 2020 and post-monsoon season of 2020. 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.

Pre-monsoon (May-2020) (Total 66 samples were analyzed (CGWB: 18, SGWD: 48) :
Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 6.20-8.84 (Avg: 7.81). Electrical conductivity varies from 293-2180 (avg: 913)µ Siemens/cm**.** In 88% of area EC is within 1500 µ Siemens/cm, in 12 % area, it is 1500-3000µ Siemens. (**Fig.2.8).** Average concentration of TDS is 913 mg/L and NO_3 ranges from 0.13-531 mg/L. Nitate concentration in 45% of samples is beyond permissible limits of 45 mg/L (**Fig.2.9**). Fluoride concentration varies from 0.25-3.33 mg/L (**Fig 2.10**) and 91% of samples are within the permissible limits of BIS and 9% is beyond the permissible limit of 1.5 mg/L. High fluoride concentration is observed in the eastern and northern part of the district.

Post-monsoon (Nov-2020) (Total 49 samples were analyzed).
Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 6.12-8.25 (Avg: 7.77). Electrical conductivity varies from 332-2240 (avg: 1131) µ Siemens/cm. In 77 % of area EC is within 1500 µ Siemens/cm, in 23% of area EC is 1500 to 3000 µ Siemens/cm **(**Fig.2.11). Average concentration of TDS is 724 mg/L and NO_3 ranges from <0.15-254 mg/L. Nitate concentration in 60% of samples is beyond permissible limits of 45 mg/L (Fig.2.12). Fluoride concentration varies from 0.15-2.54 mg/L (Fig 2.13) and 89 % of area is within permissible limits of BIS and 11% is beyond permissible limits of 1.5 mg/L. High fluoride concentration is observed mainly in the eastern and Northern part of the district (Yelal and Marpelle mandals).

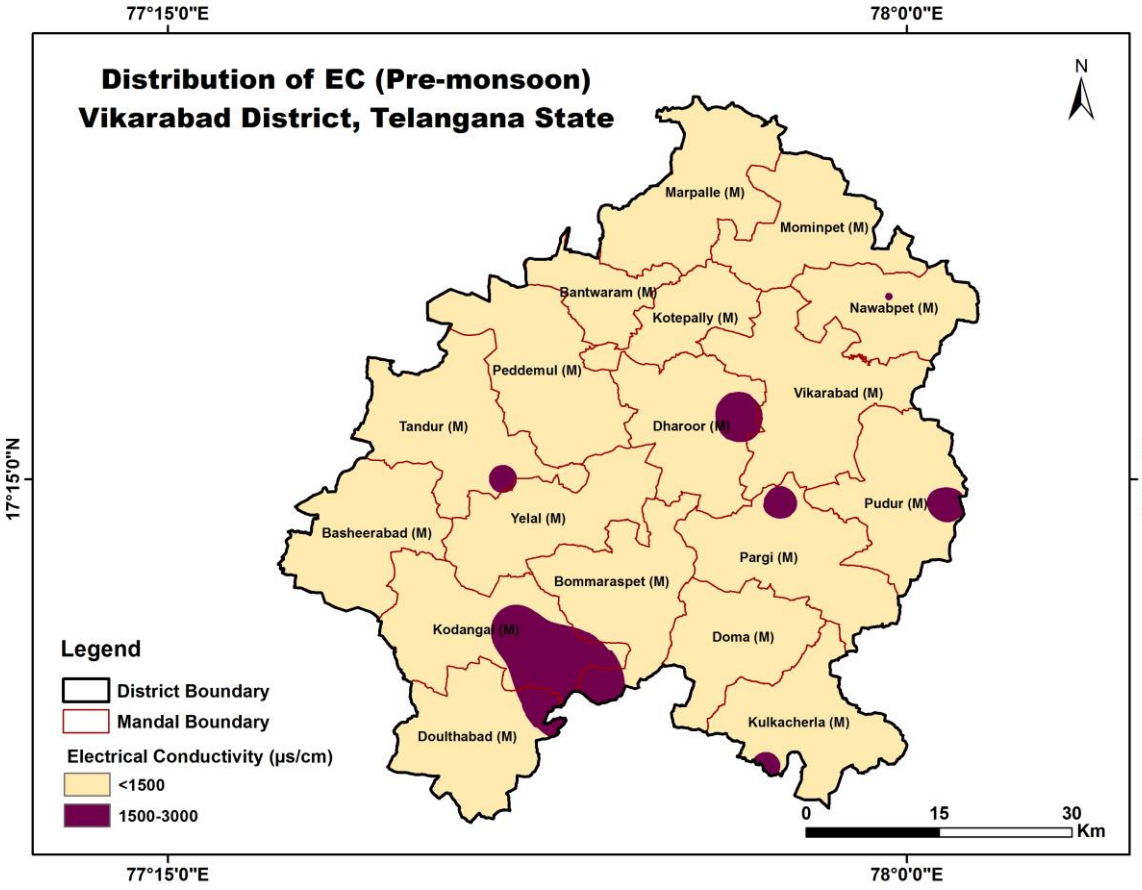


Fig.2.9: Distribution of Electrical conductivity (Pre-monsoon-2019).

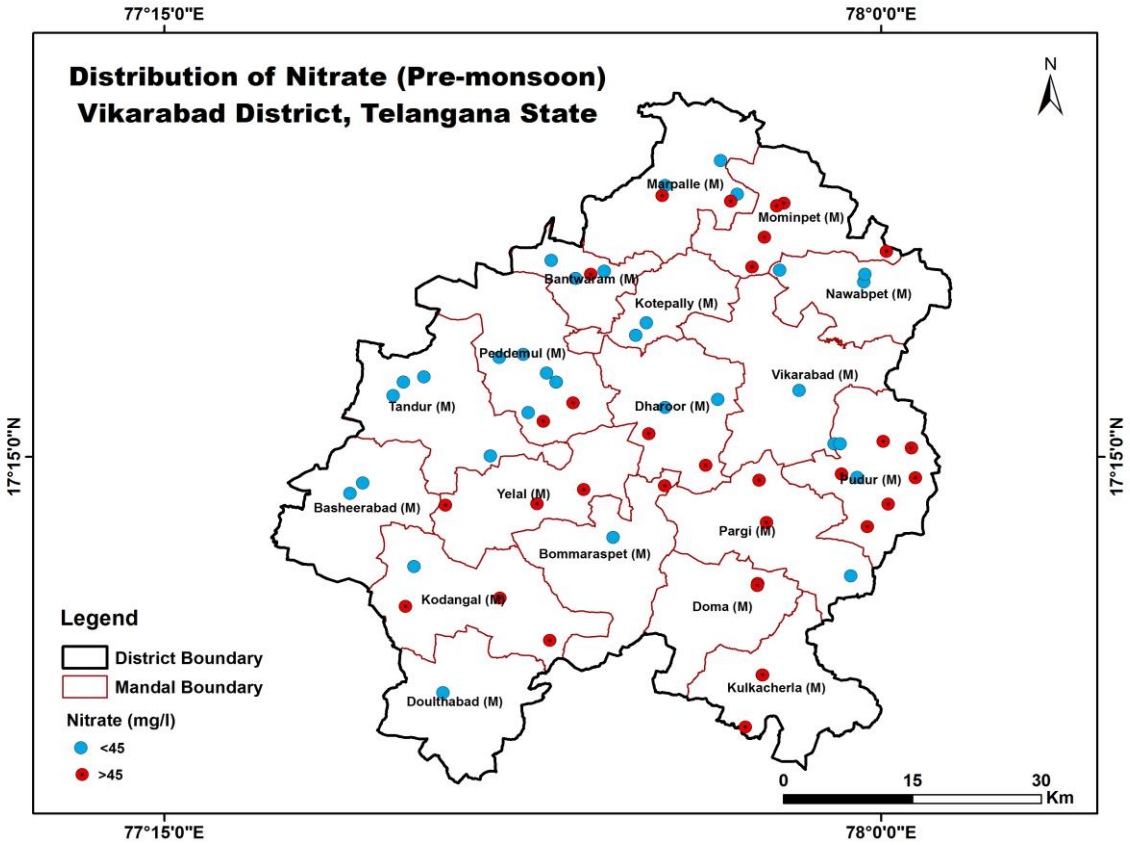
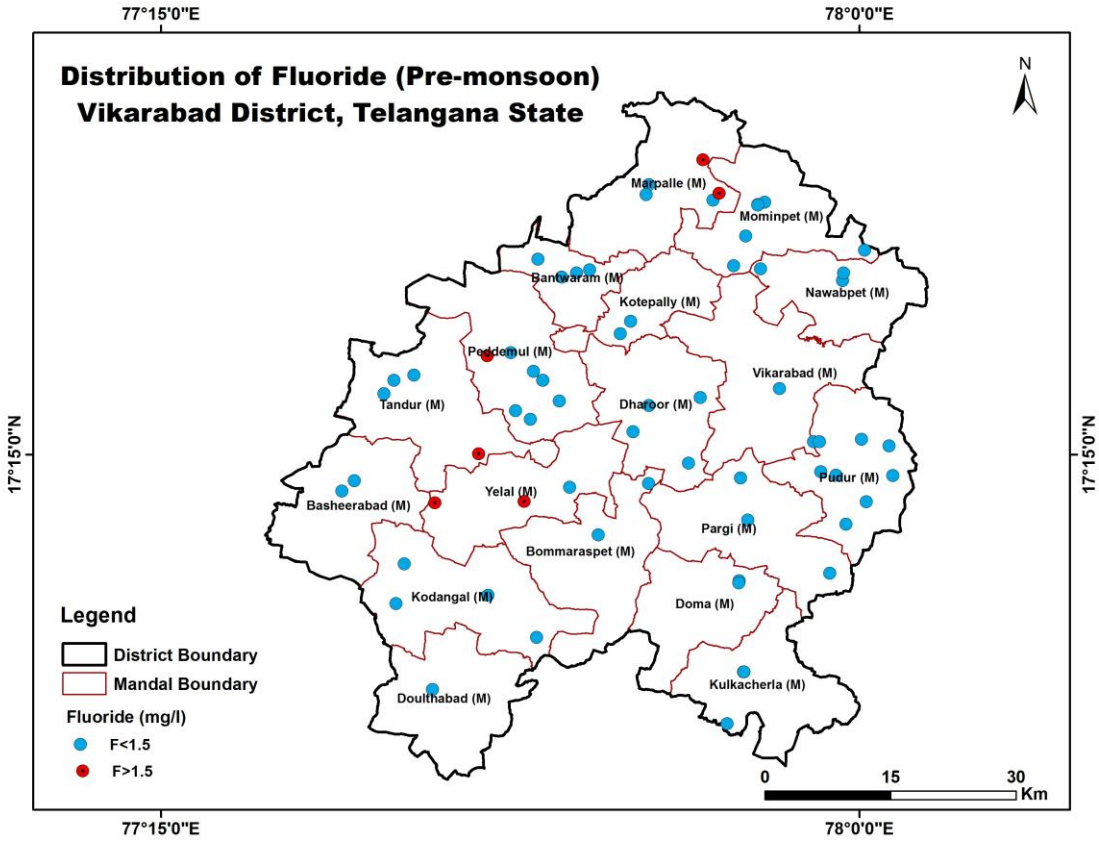


Fig.2.10: Distribution of Nitrate (Pre-monsoon-2019).

Fig.2.11: Distribution of Fluoride (Pre-monsoon-2019).



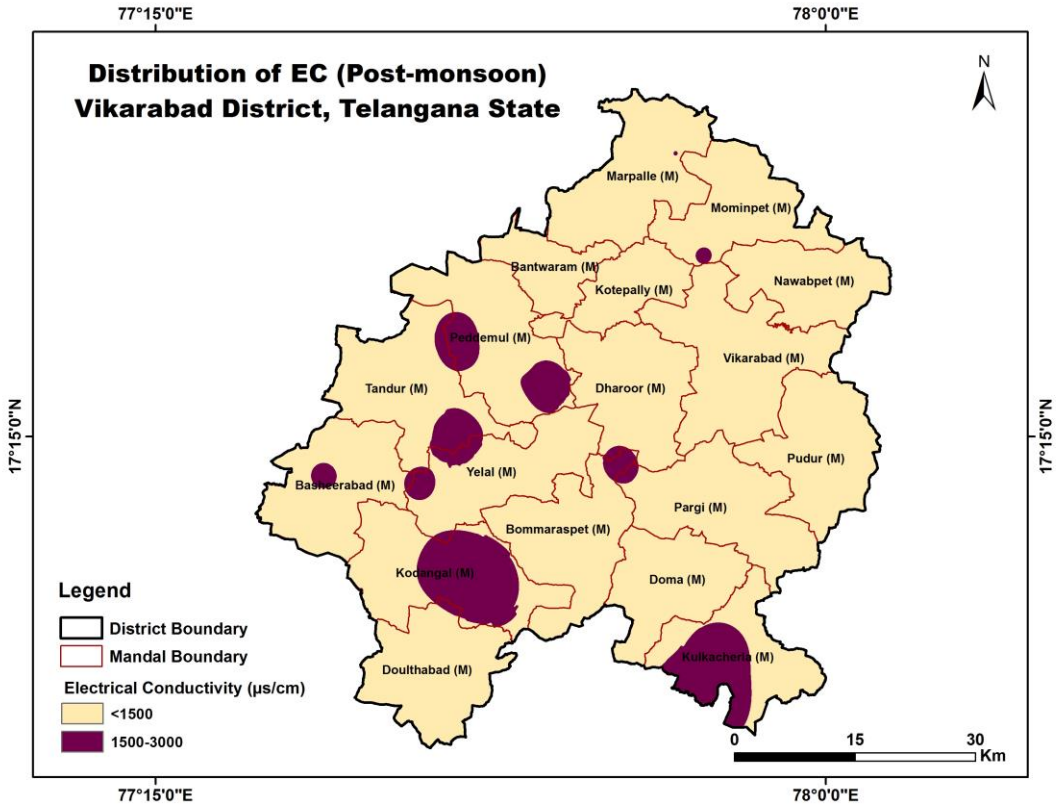
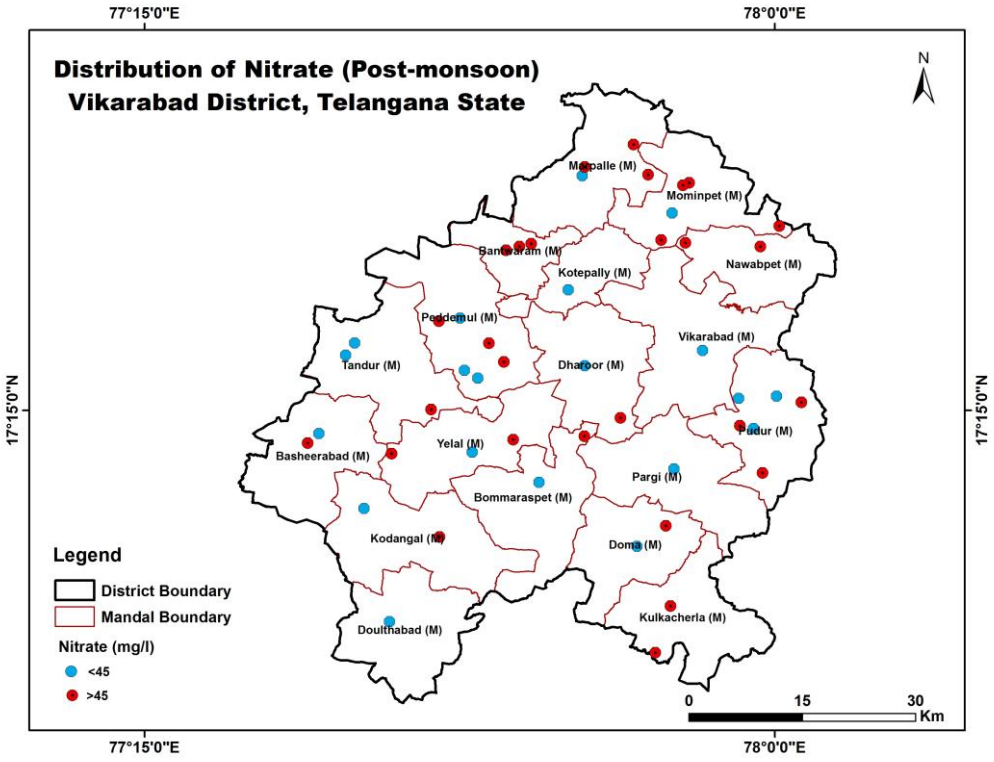


Fig.2.12: Distribution of Electrical conductivity (Post-monsoon-2020).

Fig.2.13: Distribution of Nitrate (Post-monsoon-2020).



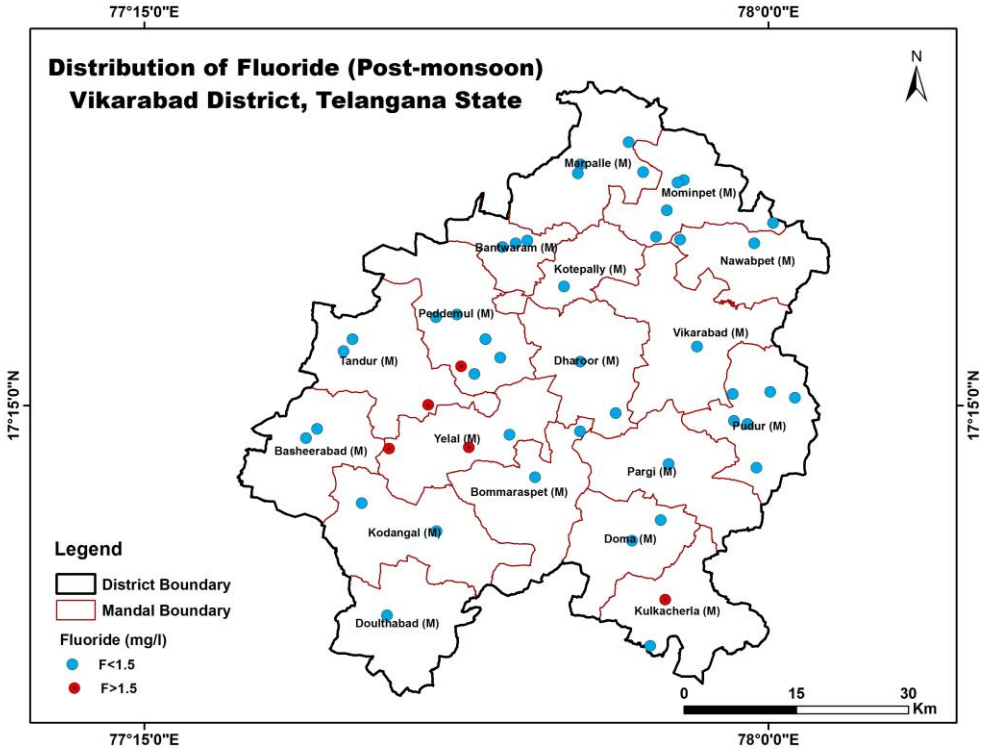


Fig.2.14: Distribution of Fluoride (Post-monsoon-2020).

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

Conceptualization of 3-D hydrogeological model was carried out by interpreting and integrating representative 67 data points (both hydrogeological and geophysical down to 200 m) for preparation of 3-D map, panel diagram and hydrogeological sections. The data (**Fig.2.1**) is calibrated with acquiring elevations from Shuttle Radar Topography Mission (SRTM) data. The lithological information was generated by using the RockWorks-16 software and generated 3-D map for Vikarabad district (**Fig.3.1)** along with panel diagram (**Fig. 3.2a-b**) and hydrogeological sections.

Fig. 3.1a. ELEVATIONS OF SHUTTLE RADAR TOPOGRAPHY MISSION (SRTM)

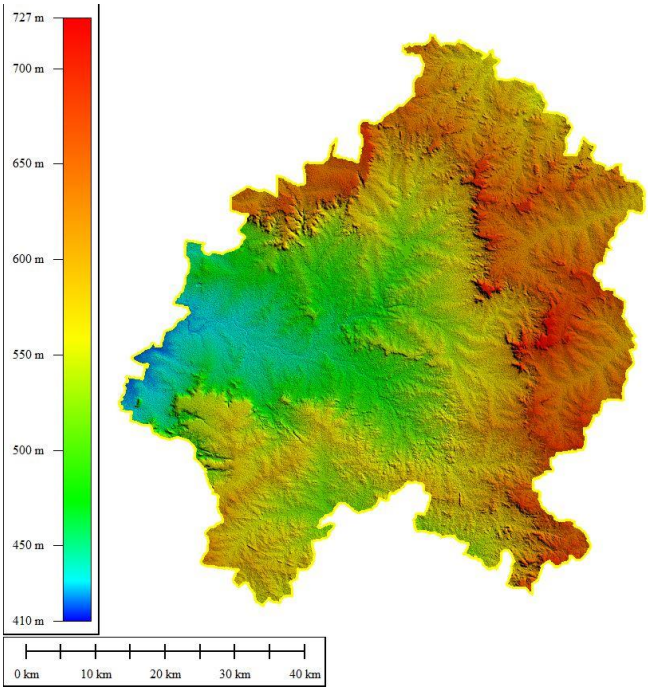


Fig. 3.1b 3 D MODEL ELEVATIONS OF SHUTTLE RADAR TOPOGRAPHY MISSION (SRTM)

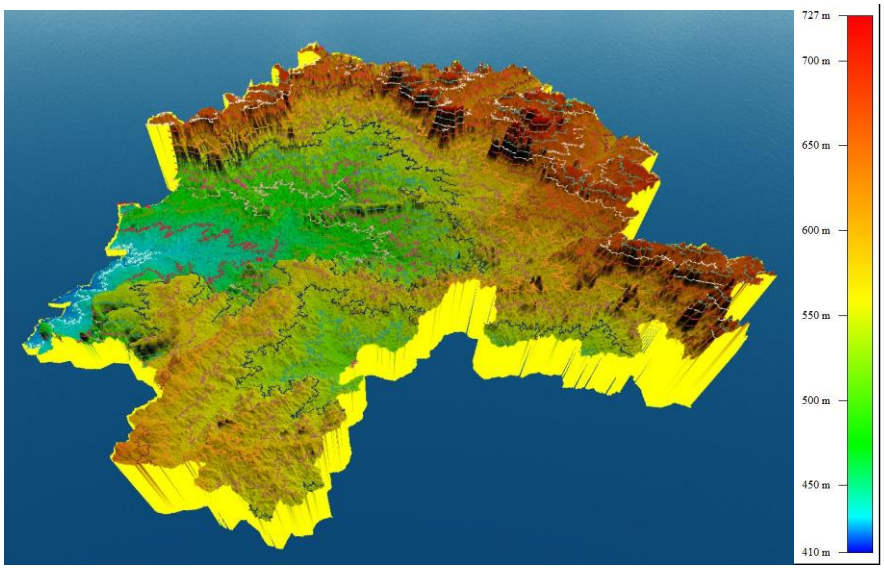


Fig.-3.2 a: 3-D Model for study area.

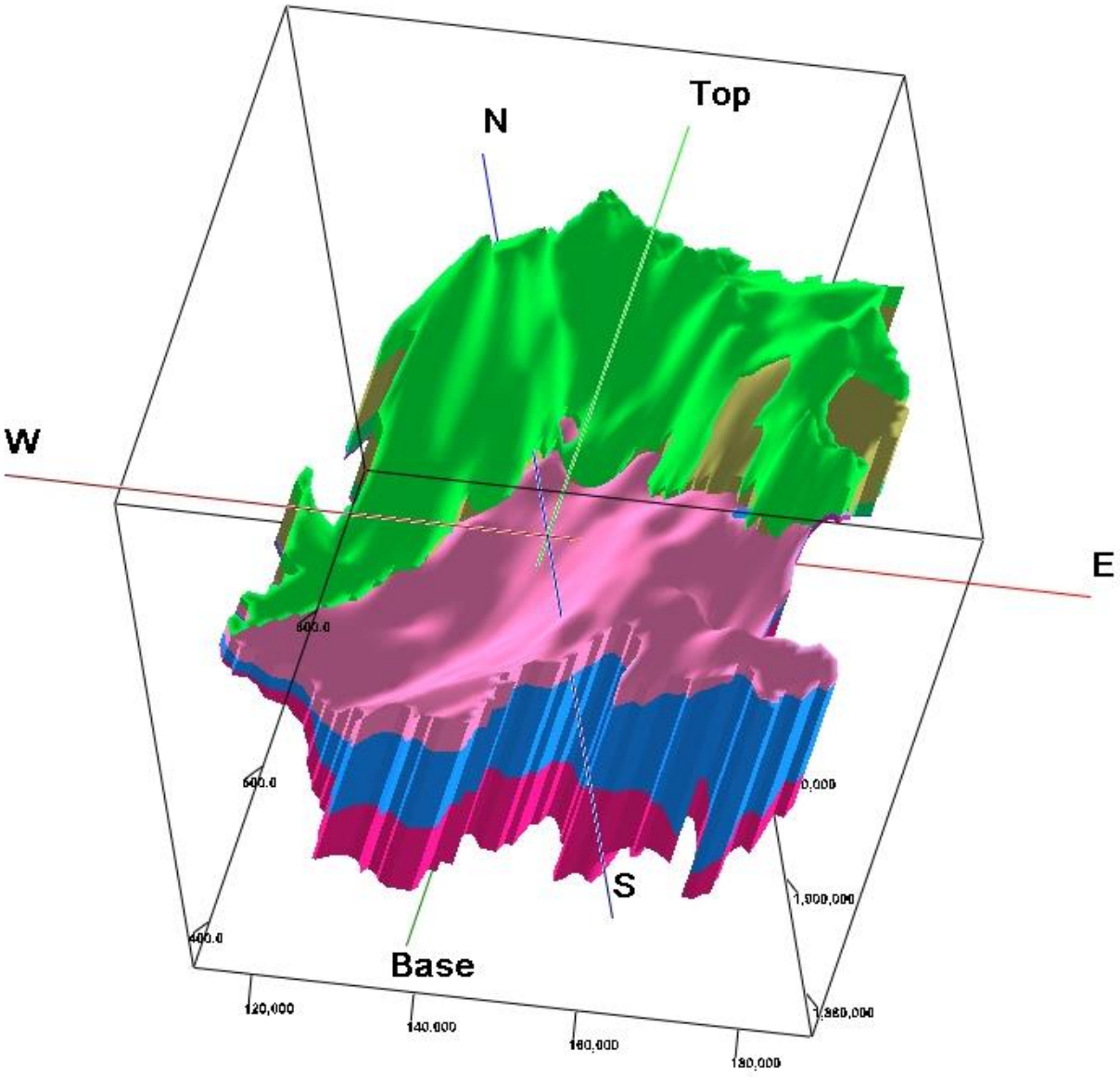


Fig.-3.3 c: 3-D Vertical and Lateral Model of aquifer for study area.

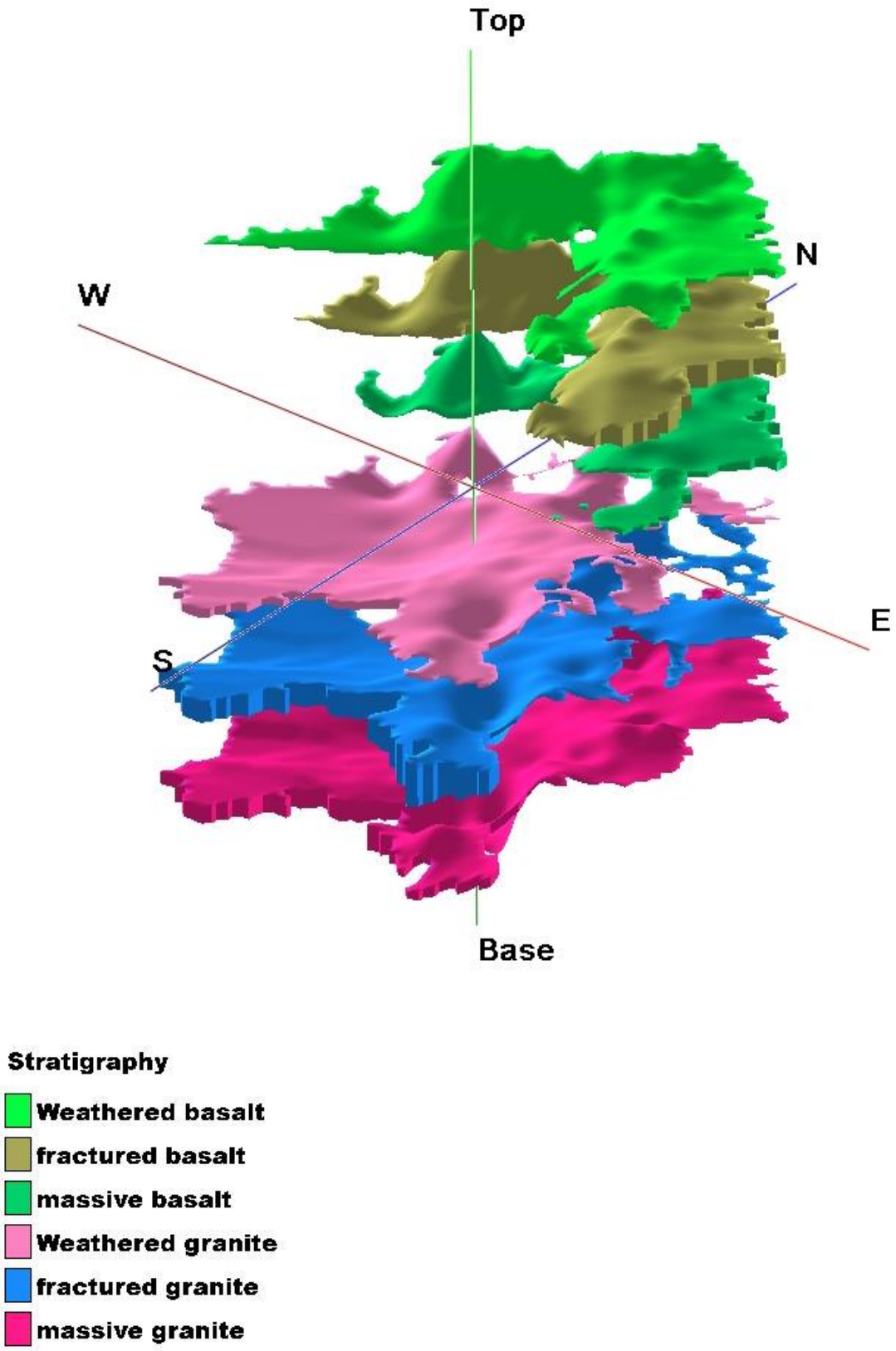
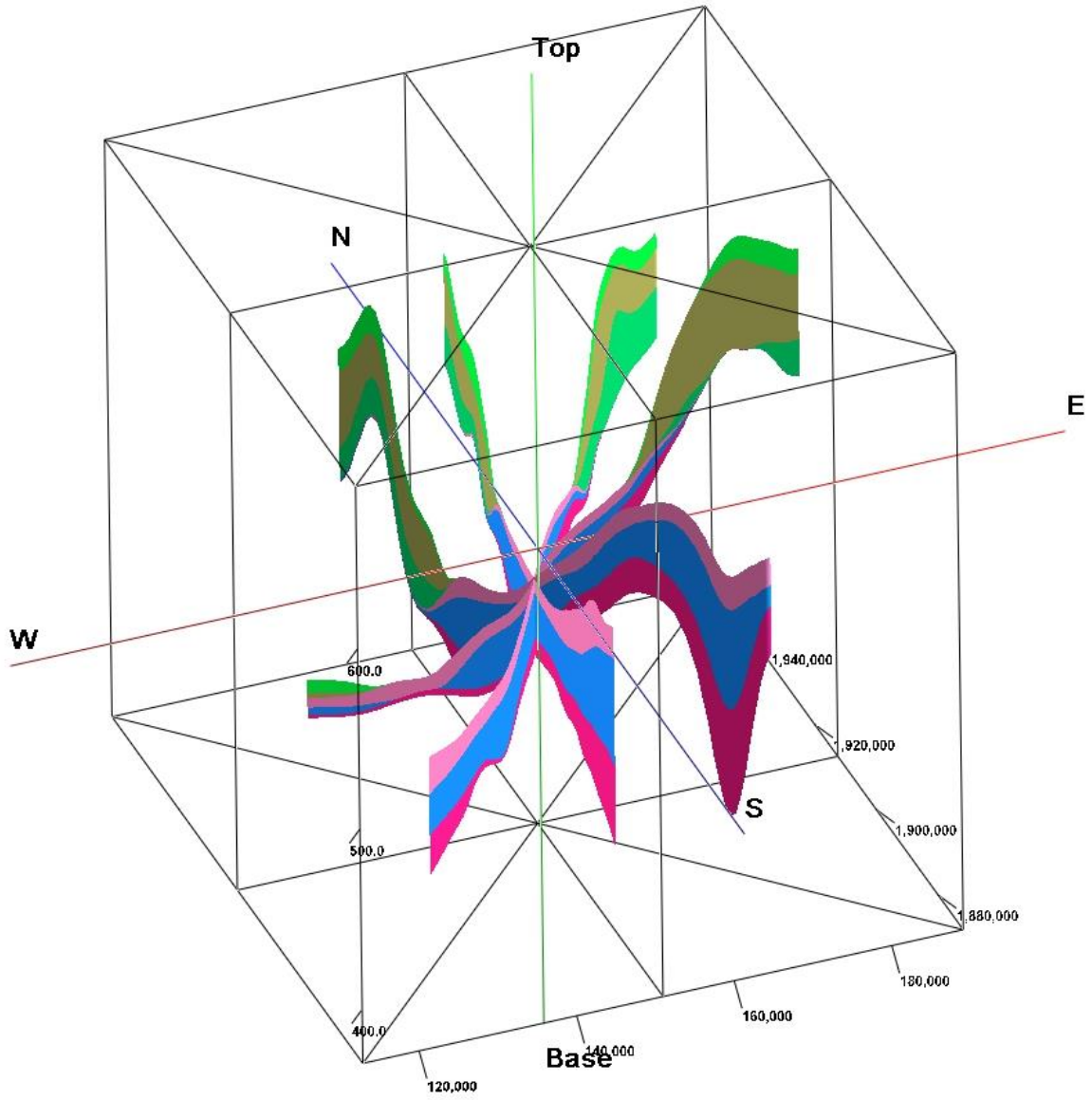


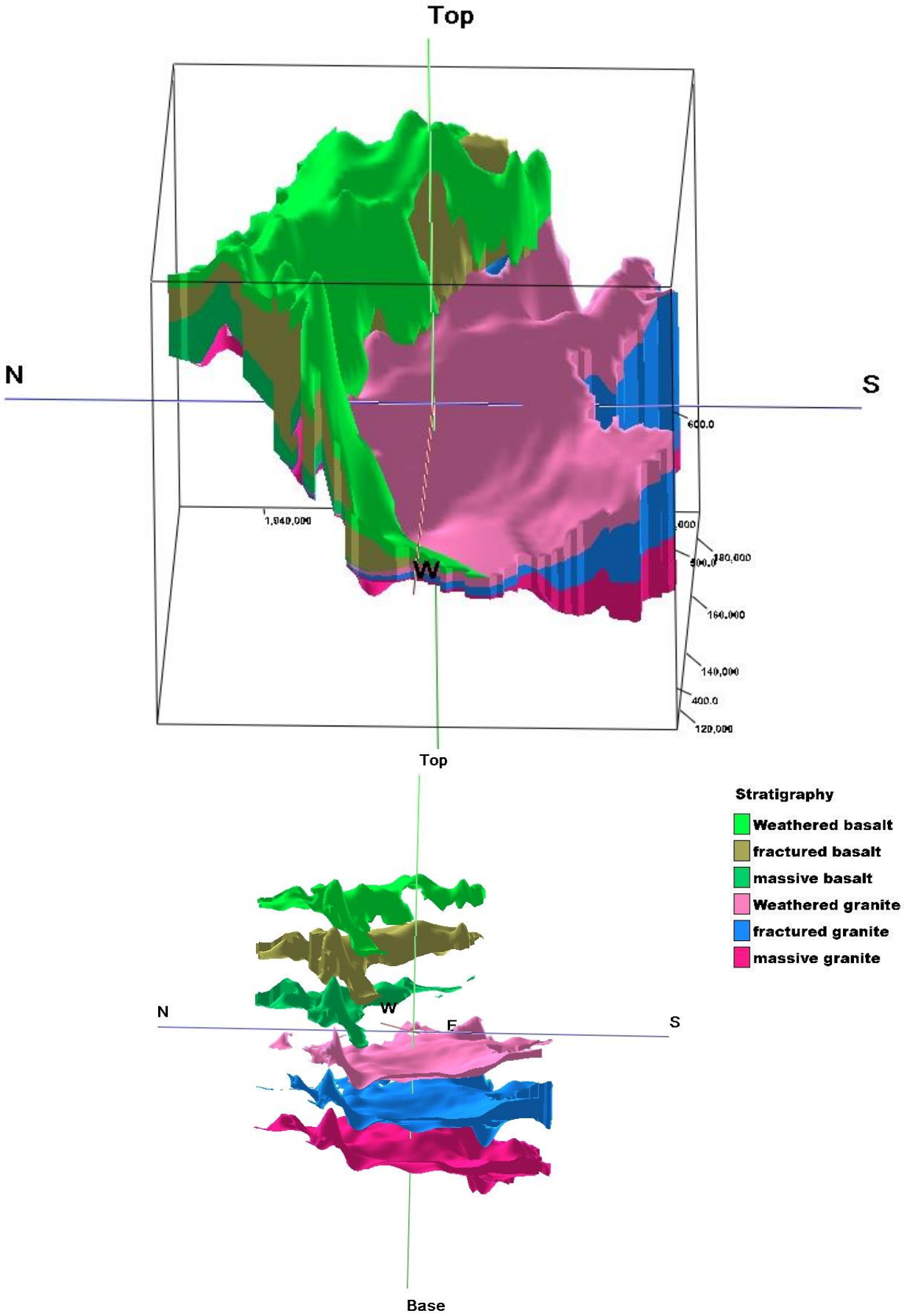
Fig.-3.3 a-c: Panel Diagram-Vikarabad district.



Stratigraphy

- Weathered basalt
- fractured basalt
- massive basalt
- Weathered granite
- fractured granite
- massive granite

Fig.-3.3 a-c: Panel Diagram-Vikarabad district



3.1 Conceptualization of aquifer system in 3D

Aquifers were characterized in terms of potential and quality, based on integrated hydrogeological data and various thematic maps. Weathered zone is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~20 m depth and the fractured zone (fractured granite) is considered up to the depth of deepest fracture below weathered zone (~20-180 m).

3.4. Hydrogeological Sections

The 4 Hydrogeological sections are prepared in NW-SE, SW-NE and W-E directions.

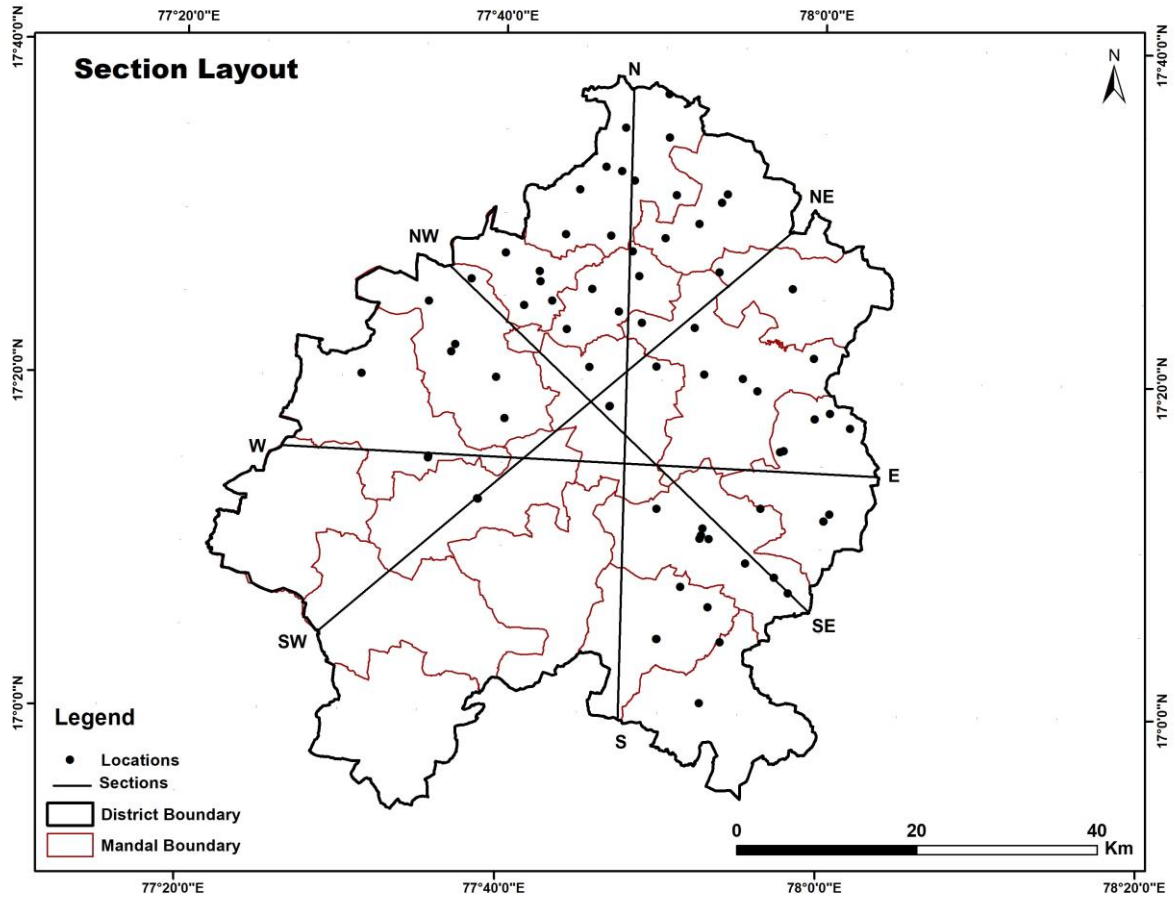


Fig.-3.4: Map showing orientation of various sections.

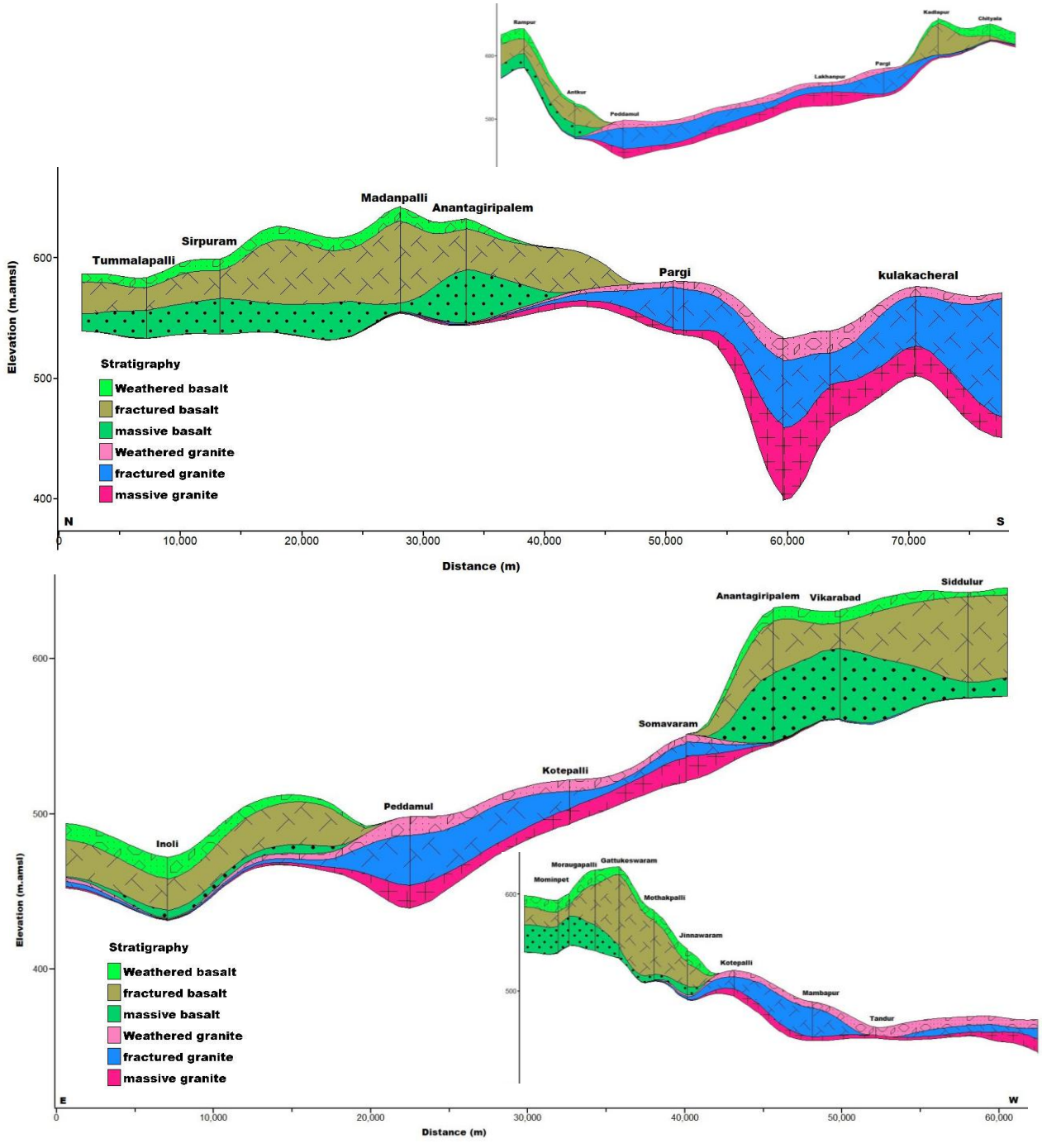
North and South Section: The section drawn along the N-S direction covering distance of ~70 kms (**Fig.3.4a**). It depicts thin weathered zone and fractured zone in north part and thick fractured zone in south. Basalts extend upto 43 km in the district from N boundary and the depth of basalt occurance gradually decrease from N–S direction.

East-West Section: The section drawn horizontally along the East to West direction covering distance of ~64 kms (**Fig.3.4b**). It depicts thin weathered and fractured zone in the western part and thick fractured zone in the Eastern part. Basalts extend upto ~45 km into the district from W boundary.Granites are in the central part shows deeper fracture than the basalt of Western part.

North-East and South-West Section: The section drawn along the NE-SWparts covering distance of ~58 kms (**Fig.3.4c**). It depicts thin fracture zones in the central part with thick fractured zone in form of cris-cross, on either sides shows basalts having poor fractures zone in the deeper zones. On the either sides of section shows Basalts overlying on granitic formation.

North-West and South-East Section: The section drawn along the NW-SE direction covering distance of ~75 kms in that 45 kms granitic formation and 30 km basaltic formation (**Fig.3.4d**). It depicts thin fracture zones in the central part with thick fractured zone extending in the SE direction. Basalts overlying granitic formation in the NW part.

Fig.3.5 (a-d): Hydrogeological profile in different directions in Vikarabad district



3.3 Aquifer Characterization

3.3.1 Weathered zone: The Weathered zone (~30 m) consisting of upper saprolite (~10 m) and lower sap rock (1-30m.) varies from 1 (Paddamul, Vikarabad) to 66 m.bgl (Nawabpet) in basaltic formation and varies from 0.5 to 30 mbgl in granitic formation. At few places, the pheratic aquifer has been desatured /dry. Dug wells, which are in existence, have become defunct/dried up. Thickness of weathered zone is in the range of 10-20 m is covering ~60 % of area, shallow weathering (< 10 m) occurs in 36% of the area and deep weathering (> 20 m) occurs in rest of the area (**Fig.3.5**).

Ground water yield from weathered granite/gneiss aquifer varies from <0.1 (Doulthabad) to 9.5 lps (Kodangal) an avg: 1.0 lps and from 0.01 to 1.2 lps (avg: 1.0 lps) in basalt aquifer. The transmissivity varies from 1-160.7 m^2/day (Mominpet) in basalts and upto 40 m^2/day (Basheerabad) in weathered granite/gneiss aquifer.

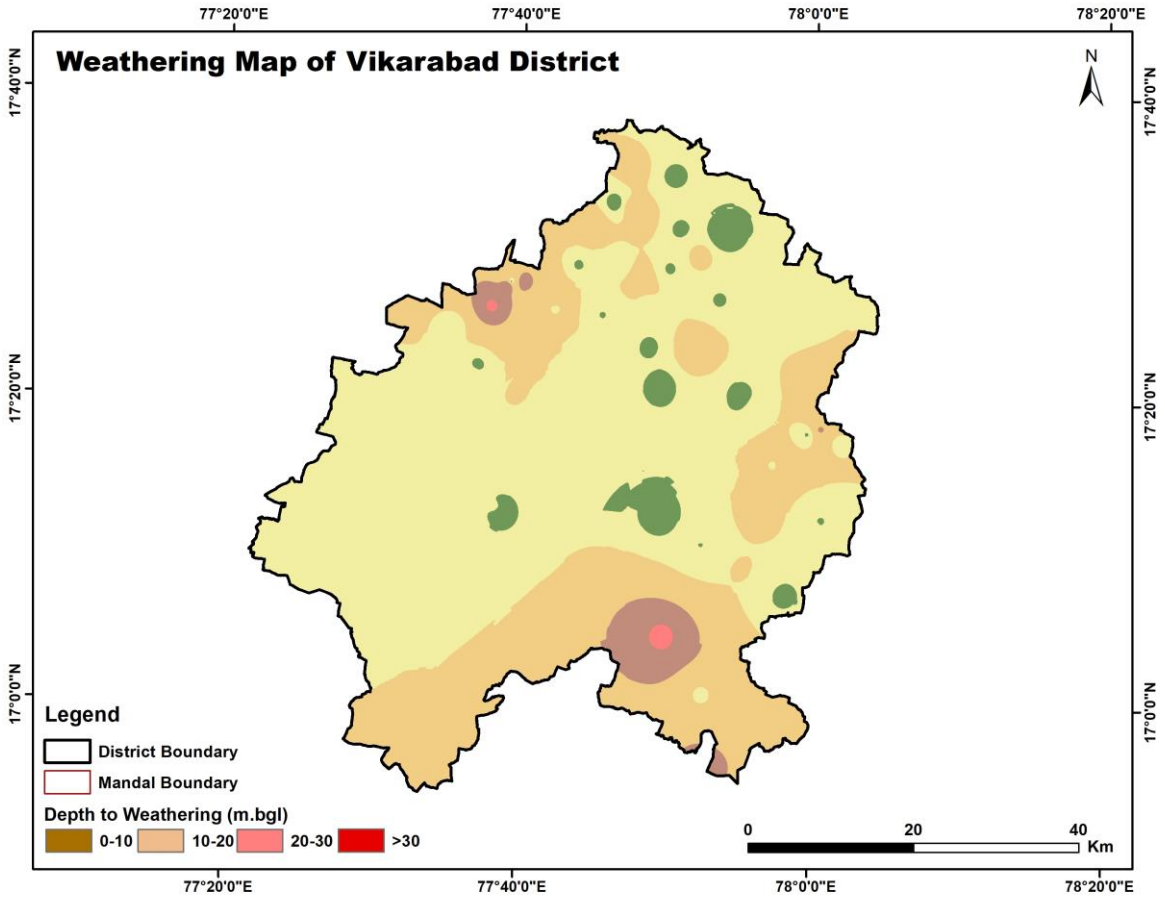


Fig.3.6: Thickness of Weathered zone-Vikarabad district.

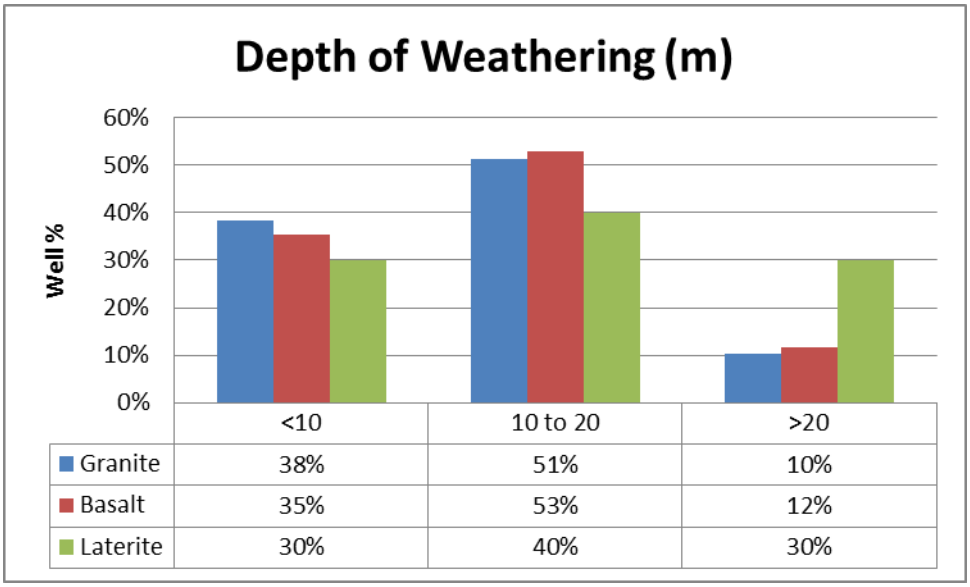


Fig.3.7: Depth wise weathered zone distribution

Fractured zone: Ground water is extracted mainly through bore wells of 26 to 200m depth from fractured zone (~10 to 176 m). Based on CGWB data, it is inferred that fractures in the range of < 60 m depth are more predominant (69 % of the wells), 60-100 and 100-150 fractures occur in 19% and 09% of area respectively and deep fractures in the range of 150-192 m occur in 3% of pudur and Doma mandals (**Fig.3.6**). Analysis of occurence of fractures (64 nos from 67wells) reveal that majority of fractures (~88 %) occur within 100 m depth (**Fig. 3.7**). Ground water yield in this zone varies from 0.01 to 9.5 lps (avg: 1.9 lps). The transmissivity (T) varies from <1 to 160 m^2/day, in most of the wells it is < 50 m^2/day in granite/gneiss aquifers and in basaltic area T varies from < 0.1 to 160.70m^2/day.

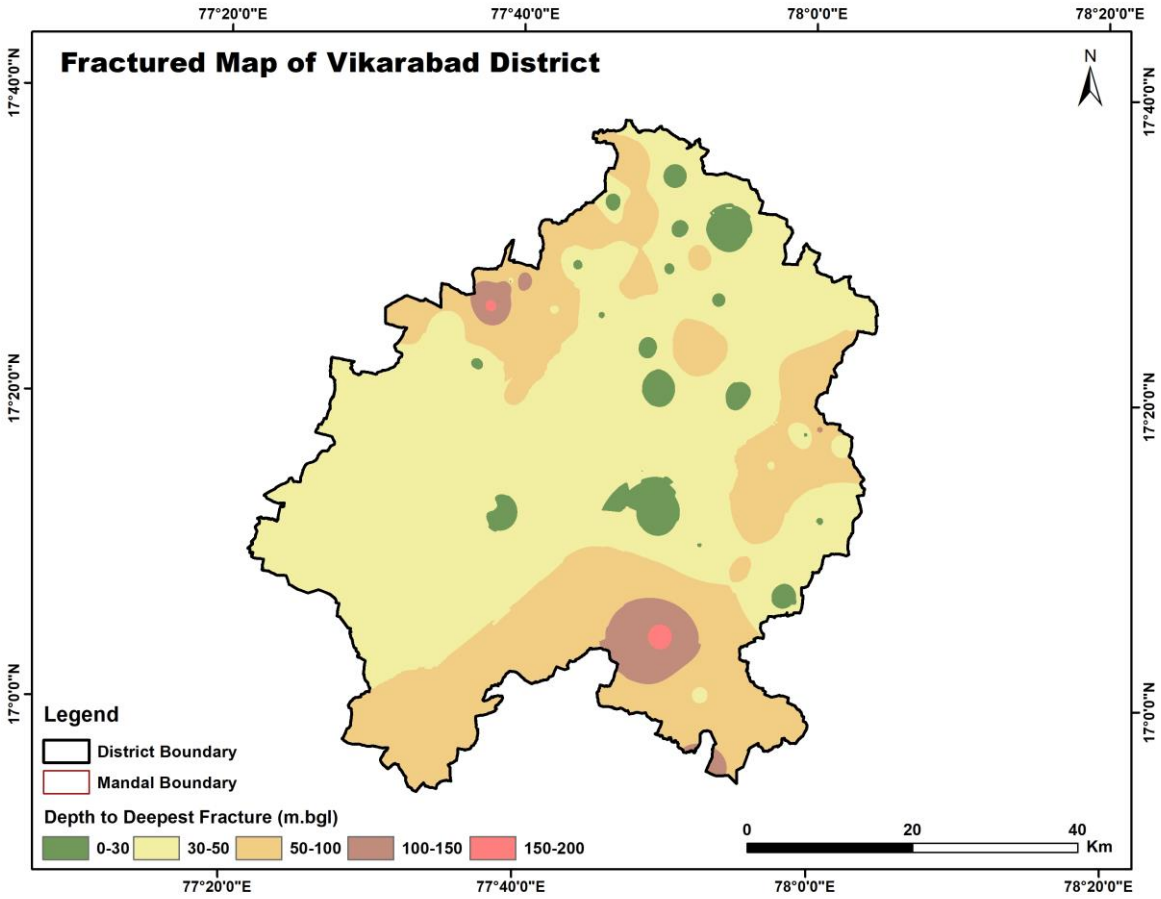
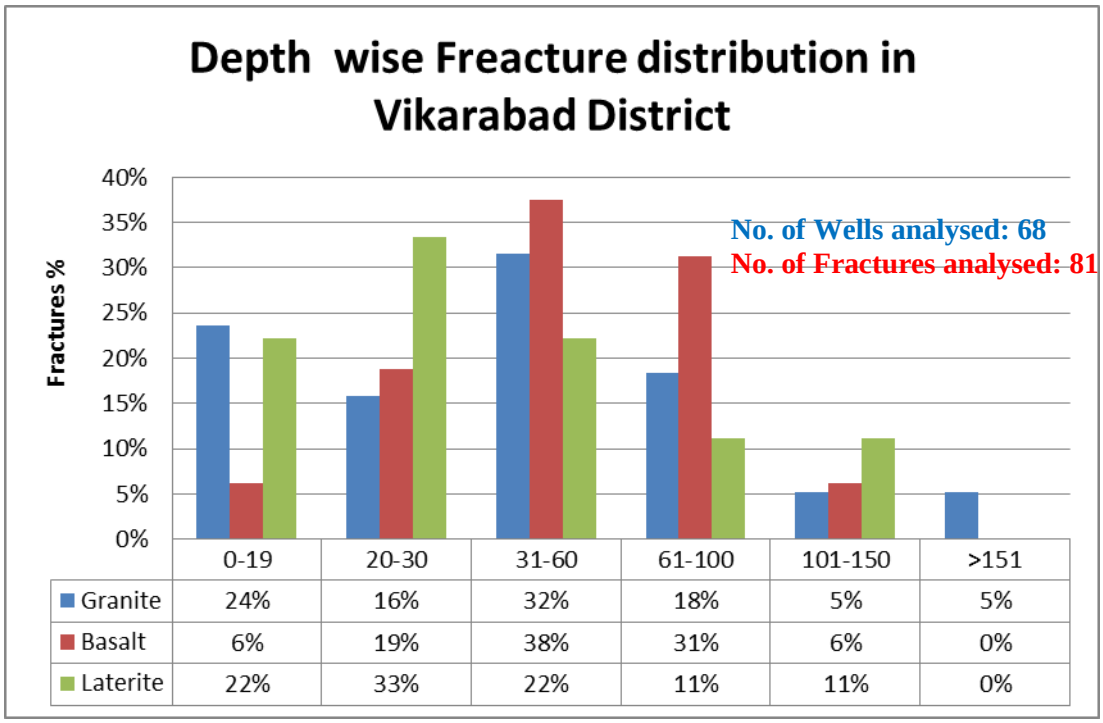


Fig.-3.8: Depth of Fractured zone (Maximum depth) (m bgl).



	0-19	20-30	31-60	61-100	101-150	>151
Granite	24%	16%	32%	18%	5%	5%
Basalt	6%	19%	38%	31%	6%	0%
Laterite	22%	33%	22%	11%	11%	0%

Fig.-3.9: Depth wise distribution of fractures.

4. GROUND WATER RESOURCES (2020)

The hard rocks are very complex in nature (anisotrope and Heterogeneity), in practical it is very difficult to compute zone wise (aquifer wise) ground water resources, because the weathered zone (WZ) followed/below by fractured zone (FZ) is mostly inter-connected with fractures and joints, these fractures and joints are 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 unit system. Village wise dynamic ground water resources are computed as per the guidelines laid down in GEC-2017 methodology.

Pre-monsoon water levels and 2 % of granular zone (depth below pre-monsoon water level and down to deepest fracture depth in the village) were considered. Summarized command/non-command area and mandal wise resources are given in **Table-4.1 and Annexure-1** respectively.

As per 2020 GEC report (SGWD), the net dynamic replenishable groundwater availability is 97 MCM, Gross ground water draft for all uses 194 MCM provision for drinking and industrial use for the year 2025 is 28 MCM and net annual ground water potential available for future irrigation needs is 97 MCM. Stage of ground water development varies from 50% to 75 % with average of 67 %. No mandal falls in over-exploited category, No mandal falls in critical category, 08 mandals fall in semi-critical category and remaining 10 mandals fall in safe category. Mandal wise stage of ground water development from 50 % (Kodangal mandal) to 75% (Nawabpet mandal).

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

Parameters	Total
As per GEC 2020	MCM
Dynamic (Net GWR Availability)	**291**
• Monsoon recharge from rainfall	214
• Monsoon recharge from other sources	21
• Non-Monsoon recharge from rainfall	31
• Non-monsoon recharge from other sources	55
Gross GW Draft	**193**
• Irrigation	166
• Domestic and Industrial use	28
Provision for Drinking and Industrial use for the year 2025	28
Net GW availability for future irrigation	97
Stage of GW development (%)	67%

Fig.4.1: Utilizable ground water resources (2020).

5. GROUND WATER RELATED ISSUES AND REASONS FOR ISSUES

5.1 Issues

Four (4) (Yelal, Tandur, Marpelle and Peddamul) mandals are showing fluoride which is geogenic in origin as high as 3.33mg/L during pre-monsoon and 2.52 mg/L during post-monsoon season is found in groundwater. The high fluoride concentration (>1.5 mg/L) occur in 09% and 10 % of the wells during pre-monsoon 2020 and post-monsoon season of 2020.

1. High nitrate (> 45 mg/L) due to anthropogenic activities is observed in 45% and 55% during pre-monsoon 2020 and post-monsoon season of 2020 covering command and urban areas.

2. No mandal are observed high concentration of EC > 3000 micro-seimens/cm in Pre and post-monsoon season of 2020.

Over-exploitation

1. No villages are categorized as over-exploited.

Deep water levels

2. Deep water levels (> 20 m bgl) are observed during pre- as well as post-monsoon season in 14 % and 03 % of the area respectively.

3. Out of 70 wells analysed, 67 wells during pre-monsoon 70 wells during post-monsoon shown rising trend in the last 10 years (@-0.01to -5.6 and -0.01 to -4 m/yr) respectively.

Sustainability

4. Low yield (<1 lps) occurs in ~56 % of area and yields covering entire district. 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 excess rainfall in the last two years as well as increased construction of borewells simultaneously high draft for paddy cultivation.

Water Marketing and other Issues

5. Water marketing is present in almost all over the area and people are buying bottled water from the market for drinking purposes as there is presumption of piped water supply of surface water is in poor quality.

6. Change in land use from agricultural land to residential purposes and cropping pattern from traditional crops to cash crops (spices, cotton) is observed at places due to Government scheme encouraged as per market value and successfully bring the facts of un-in-dated rainfall and fall in ground water levels drastically.

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

5.2 Reasons for Issues

Geo-genic pollution (Fluoride)

1. Higher concentration of fluoride in ground water is attributed due to source rock, rock water interaction where acid-soluble fluoride bearing minerals (fluorite, fluoro-apatite) gets dissolved under alkaline conditions.
2. Deeper aquifers water levels found in urban dewelling.

Anthropogenic pollution (Nitrate)

3. Higher concentration of Nitrate is due to un-scientific sewage disposal and untreated effluents in urban and rural areas. Excess useage of NPK fertilizers and nitrogen fixation by leguminous crops.

Over-exploitation and Deep water levels

4. Over-extraction, paddy cultivation during rabi season (32 % to total crops of rabi) un-scientific ground water mining, un-even rainfall, rapid development, limited resources of artificial measures etc.,.

Sustainability

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

6. MANAGEMENT STRATEGIES

In the area, 96% 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 of the district. The sustainability of existing groundwater structures, food and drinking water security are challenging tasks in the preparation of management plan. The occurrence of fractures in is very limited in extent, as the gradual increase in overburden stress with depth results in the closure of fracture in the rock with depth. The majority of fractures occur within 100 m depth (84 %) (**Fig.3.7**). Higher NO_3^- concentrations (> 45 mg/L) in weathered zone is due to sewage contamination and higher concentration of F^- (>1.5 mg/L) in weathered zone and fractured zone is due to local geology (granite/gneiss rock), high weathering, longer residence time and alkaline nature of groundwater.

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 be develop appropriate management strategy.

In the district 309 MCM of unstaturated volume (below the depth of 5 m) is avaialable during post-monsoon season of 2020 having 304 MCM of recharge potential (2%). This can be utilized for implementing management strategy.

The study suggests notable measures for sustainable groundwater management, which involves a combination of various measures given below.

1. Supply side measures
2. Demand side measures
3. Regulatory measures
4. Institutional measures

6.1.1 Supply side measures:

Completed Project:

Repair Renovation and Restoration of existing tanks:

- De-silting of existing minor tanks 1701 no. with an area 85050 ha m (storage capacity ~76545 Ha. m considering depth 0.9 m) was taken under state Govt. sponsored Mission Kaktiya, in Phase-1 to Phase-5 removed 765 MCM of silt and this has created additional surface water storage. This will contribute ~ 229 MCM (considered rate of

Recharge (30%) increased) to groundwater, which creates additional ~137 ha land can be brought under irrigation of dry (ID) crops in tank ayacut areas.

Mission Bhagiratha:

- Under Telangana Drinking Water Supply Project (TDWSP) also known as Mission Bhagiratha, all the villages and towns are proposed to be covered from the two water grids with intake from Godavari river at SRSP (Segment-12 & Date of completion 19/10/2017), covering 1 municipal corporation (Vikarabad) to provide protected water from surface reservoirs. The scheme is to enhance the existing drinking water scheme and to provide 100, 135 and 150 lpd/person of water in rural, municipal and Municipal Corporation respectively.

- The total water requirement as per 2011 census is 556 MCM and this imported water from surface sources will reduce the present utilized ~278 MCM of ground water (considering 60 lpcd). This can be effectively utilized to irrigate ~168 ha of additional land under ID crops.

To be taken up

6.1.1 Artificial Recharge structures:

Construction of 683 artificial recharges structures (ARS) are suggested by following standard methodology.

While formulating the village wise groundwater management plan, the unsaturated volume of aquifer is estimated by multiplying the area with specific yield and unsaturated thickness (post-monsoon water levels below 5 m). Village wise dynamic groundwater resources of 2020 are considered for the calculation feasible artificial recharges structures (**Fig.4.1**). Potential surface run off is estimated by following standard procedures. On conservative side 20 % run off yield is considered as non-committed yield for recommending artificial recharge structures in intermittent areas 25 % of yield is considered and remaining 75 % is recommended for implementing water conservation measures in recharge areas through MGNREGS.

The pre-monsoon groundwater quality is considered for categorising contaminated area (F >1.5 mg/l & EC >3000 µ S/cm). Nitrate is not considered here because it is point source pollution and localized. Based on hydrogeological characteristics, the area is further sub-divided into following 8 categories (**Table-6.1**).

The 3386 Km^2 area of 501 villages **Fig.6.1**) have recharge potential of 304 MCM and immediate intervention is required. The area is again sub-divided into 8 categories based on hydrogeological conditions as mentioned above. For sustainable development and management of the groundwater resources the following recommendations are made and summarised in **Annexure-2**.

- 683 artificial recharge structures (345 CD's with 6 filling and 338 mini PT's with 2 fillings) with a total cost of **120** crores can be taken up.
- After effective utilization of this yield, there will be 19.22 MCM of ground water recharge (25 % of total utilizable yield).
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).

Other supply side measures:

- Existing ARS like percolation tanks and check dams and dried dug wells can be de-silted involving people's participation through the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) (NREGA 2005). This will also help in sustainable management of groundwater resources.
- Along the Kagna tributary and Pargi Stream the tanks which are dried up are to be desilted in the lean period.

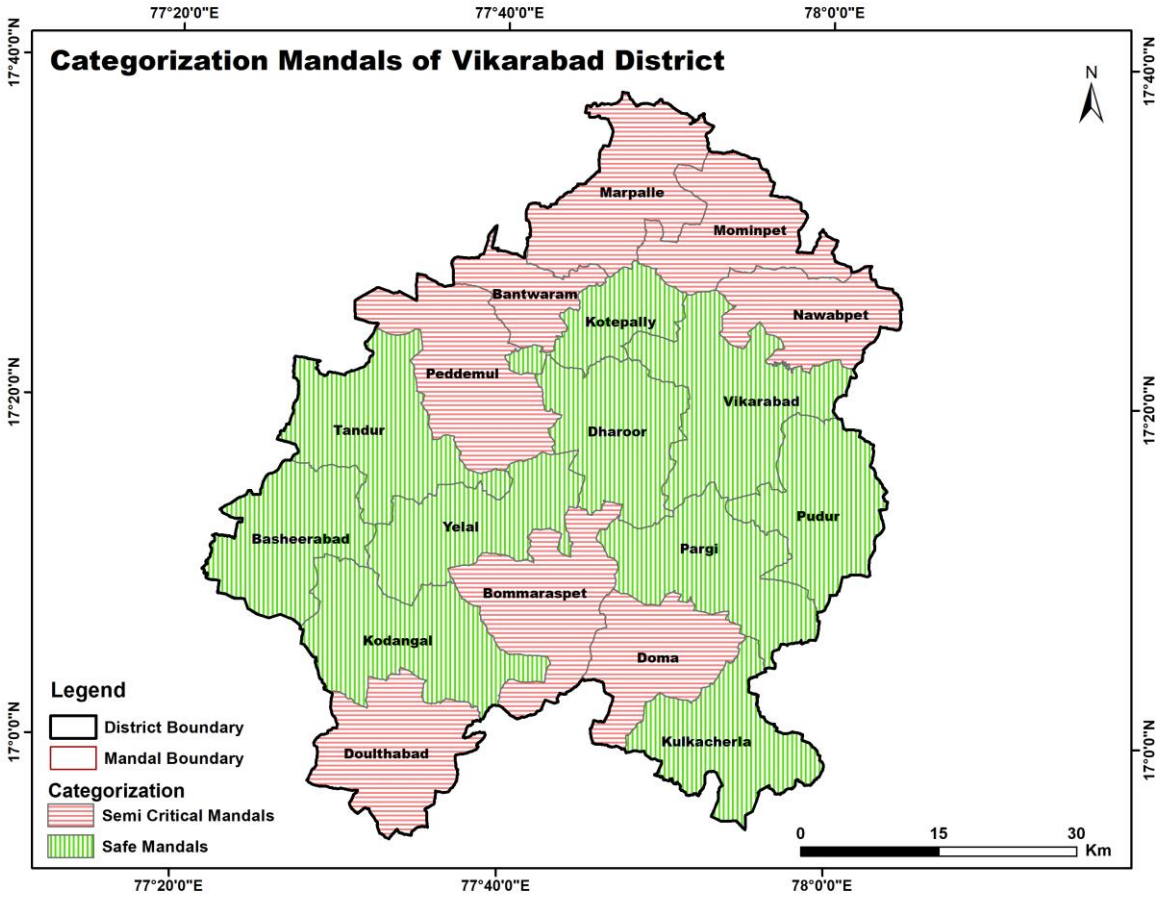


Fig.6.0: Hydrogeological Characterization

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

Ongoing Work

- In the area till date a total number of 17 no's drip and sprinklers are sanctioned which has irrigated ~11.55 ha under ID crops saving ~0.19 MCM of groundwater from the basin.

Proposed Work

- ~20040 ha of additional land that can be brought under micro-irrigation (@40ha/village in 501 villages) costing about 120 crores (considering 1 unit/ha @0.6 lakh/ha). With the adoption of Drip and sprinkler we can save additional 30% of ground water by using traditional ancient irrigation practices. With this 36 MCM of ground water can be conserved over the traditional irrigation practices (considering 0.006 MCM/ha for ID crops against 0.008 MCM/ha).

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

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

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

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

6.1.3 Other measures

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

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

- The other measure includes supplementary calcium and phosphorous rich food to the children in fluoride endemic mandals. Creating awareness about safe drinking water habits, side effects of high fluoride and nitrate rich groundwater, improving oral hygiene conditions are recommended.

6.2 Expected Results and Out come

With the above interventions costing Rs:120 crores (excluding the cost involved in Mission Kakatiya and Mission Bhagiratha), the likely benefit recharge additional 19.22 MCM of Ground water and net saving of 36 MCM of ground water through Micro Irrigation (Drip & Sprinkler). This will bring down the stage of ground water development by 15 % (from 67 % to 52 %).

Acknowledgment

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Table. 6.1. Proposed Artificial Recharge Structures for 8 Semi-Critical Mandals

Sl.No	Mandal	Village	Proposed PTs	Proposed CDs	Cost of PTs @ 20 lakhs (100 % sources)	Cost of Cds @ 15 lakhs (100 % sources)
1	Bantwaram	Madhvapur (H)	0	0	0	0
2	Bantwaram	Mangraspally (H)	1	0	20	0
3	Bantwaram	Pommapur	0	0	0	0
4	Bantwaram	Noorullapur (H)	0	1	0	15
5	Bantwaram	Nagaram (H)	1	1	20	15
6	Bantwaram	Yacharam	2	1	40	15
7	Bantwaram	Salbathapur	1	1	20	15
8	Bantwaram	Rompalle	5	1	100	15
9	Bantwaram	Sultanpur (H)	1	1	20	15
10	Bantwaram	Malasomaram	2	2	40	30
11	Bantwaram	Bopparam	0	3	0	45
12	Bantwaram	Turmamidi	6	5	120	75
13	Bantwaram	Bantwaram	7	8	140	120
14	Bomaraspet	Salimdapur	0	0	0	0
15	Bomraspet	Machanpally	0	0	0	0
16	Bomraspet	Regadmailwar	0	0	0	0
17	Bomraspet	NazKhanpalle	0	0	0	0
18	Bomraspet	Madanpalle	0	0	0	0
19	Bomraspet	Amsanpalle	0	0	0	0
20	Bomraspet	Lingampallye	0	0	0	0
21	Bomraspet	Nagireddipallei	0	0	0	0
22	Bomraspet	Thirumalapur	0	0	0	0
23	Bomraspet	Namdarpur	1	1	20	15
24	Bomraspet	Chowdarpalle	0	1	0	15
25	Bomraspet	Dupcherla	1	1	20	15
26	Bomraspet	Dudyal	0	1	0	15
27	Bomraspet	Erlapalle	0	1	0	15
28	Bomraspet	Gouraram	0	1	0	15
29	Bomraspet	Yenkepalle	1	1	20	15
30	Bomraspet	Burhanpoor	2	2	40	30
31	Bomraspet	Chilmalmailwar	0	2	0	30
32	Bomraspet	Thunkimetla	2	2	40	30
33	Bomraspet	Erupumalla	1	2	20	30
34	Bomraspet	Wadicherla	2	2	40	30
35	Bomraspet	Lagcherla	2	2	40	30
36	Bomraspet	Kothur	2	3	40	45
37	Bomraspet	Metlakunta	2	3	40	45
38	Bomraspet	Bomraspet	2	3	40	45
39	Doma	Badampalle	0	0	0	0

40	Doma	Sivareddipalle	0	0	0	0
41	Doma	Rakonda(H)	0	0	0	0
42	Doma	Bachpalle	0	0	0	0
43	Doma	Dongayankepalle	0	0	0	0
19.22	Doma	Dornalpalle	0	0	0	0
45	Doma	Bompalle	2	1	40	15
46	Doma	Batlachandraram(H)	1	1	20	15
47	Doma	Timmaipalle	1	1	20	15
48	Doma	Kammam nacharam	1	1	20	15
49	Doma	Linganpalle	1	1	20	15
50	Doma	Budlapur	1	1	20	15
51	Doma	Pothreddypalle	1	1	20	15
52	Doma	Anantharedipalle	1	1	20	15
53	Doma	Gudur	1	1	20	15
54	Doma	Palepalle	1	1	20	15
55	Doma	Dirsampally	0	1	0	15
56	Doma	Ganjipalle	1	1	20	15
57	Doma	Mallepalle	0	2	0	30
58	Doma	Doma	2	2	40	30
59	Doma	Kondaipalle	1	2	20	30
60	Doma	Kishtapur	1	2	20	30
61	Doma	Brahmanpally	2	2	40	30
62	Doma	Gumdal	3	3	60	45
63	Doma	Ainapur	0	3	0	45
64	Doma	Dadapur	1	3	20	45
65	Doma	Ootpally	2	3	40	45
66	Doma	Mothkur	0	6	0	90
67	Doulathabad	Neetur	1	0	20	0
68	Doulathabad	Allapur	0	0	0	0
69	Doulathabad	Nandaram	0	0	0	0
70	Doulathabad	Kuppagiri	0	0	0	0
71	Doulathabad	Matoor	0	0	0	0
72	Doulathabad	Sulthanpur	1	0	20	0
73	Doulathabad	Devarfaslawad	2	0	40	0
74	Doulathabad	Erlapalle	1	0	20	0
75	Doulathabad	Gundepalle	1	0	20	0
76	Doulathabad	Saleempur	0	0	0	0
77	Doulathabad	Thirumalapur	0	0	0	0
78	Doulathabad	Chandrakal	1	0	20	0
79	Doulathabad	Anthwar	0	0	0	0
80	Doulathabad	Kowdeed	0	0	0	0
81	Doulathabad	Balampeta	0	0	0	0
82	Doulathabad	Polkampalle	0	0	0	0
83	Doulathabad	Nagasar	1	1	20	15
84	Doulathabad	Suraipalle	1	1	20	15
85	Doulathabad	Doulatabad	3	1	60	15

86	Doulathabad	challapur	0	1	0	15
87	Doulathabad	Yamki	1	1	20	15
88	Doulathabad	Imdapur	1	1	20	15
89	Doulathabad	Timmareddipalle	1	1	20	15
90	Doulathabad	Kudrimalla	2	2	40	30
91	Doulathabad	Bichal	3	3	60	45
92	Doulathabad	Gokafaslwad	4	3	80	45
93	Marpally	Siripuram	4	0	80	0
94	Marpally	Ghanapur	4	0	80	0
95	Marpally	Patloor	3	0	60	0
96	Marpally	Dargulapally	1	0	20	0
97	Marpally	Panchalingala	2	0	40	0
98	Marpally	Mogiligundla	2	0	40	0
99	Marpally	Komshettypally	2	0	40	0
100	Marpally	Jamshedpur	1	1	20	15
101	Marpally	Piligundla	1	1	20	15
102	Marpally	Narsapur	2	1	40	15
103	Marpally	Ravalapalle	0	1	0	15
104	Marpally	Rampur(H)	1	1	20	15
105	Marpally	Mallikarjunagiri(H)	1	1	20	15
106	Marpally	Thummalapally	3	1	60	15
107	Marpally	Shapur (H)	1	1	20	15
108	Marpally	Bilkal	2	1	40	15
109	Marpally	Allapur	1	1	20	15
110	Marpally	Gundlamarpally(H)	1	1	20	15
111	Marpally	Virlapally	1	1	20	15
112	Marpally	Peddapur	1	1	20	15
113	Marpally	Thimmapur (H)	2	2	40	30
114	Marpally	Kudgunta (H)	2	2	40	30
115	Marpally	Marpally Kalan	7	3	140	45
116	Marpally	Kothlapur	4	4	80	60
117	Marpally	Kotmarpalle	5	4	100	60
118	Marpally	Damasthapur	5	5	100	75
119	Marpally	Buchanpalle	0	6	0	90
120	Marpally	Kalkoda	4	7	80	105
121	Mominpet	Amrad khurd	3	0	60	0
122	Mominpet	Yenkapally	1	0	20	0
123	Mominpet	Kolkonda	3	0	60	0
124	Mominpet	Izra Chettempalle	0	1	0	15
125	Mominpet	Devarampally	1	1	20	15
126	Mominpet	Chakrampally	1	1	20	15
127	Mominpet	Rallagudpally	1	1	20	15
128	Mominpet	Kasulabad(H)	1	1	20	15
129	Mominpet	Ravalpalli	1	1	20	15
130	Mominpet	Ramnathpallygudpally	1	1	20	15
131	Mominpet	Cheemaldari	1	2	20	30

132	Mominpet	Govindapur	1	2	20	30
133	Mominpet	Durgamchervu	2	2	40	30
134	Mominpet	Morangupally	1	2	20	30
135	Mominpet	Saidalipur H/o P.V.Y. Palli	2	2	40	30
136	Mominpet	Burgupally	2	2	40	30
137	Mominpet	Amradikalan	3	2	60	30
138	Mominpet	Mekavanampally	3	3	60	45
139	Mominpet	Velchala	3	3	60	45
140	Mominpet	Yenkathala	5	4	100	60
141	Mominpet	Tekulapally	4	4	80	60
142	Mominpet	Mominpet	6	5	120	75
143	Mominpet	Kesaram	6	6	120	90
119.22	Nawabpet	Nawabpet	0	0	0	0
145	Nawabpet	Vattiminapalle H/o Nawabpet	0	0	0	0
146	Nawabpet	Kadcherla	1	1	20	15
147	Nawabpet	Dathapur	1	1	20	15
148	Nawabpet	Madireddipalle	0	1	0	15
149	Nawabpet	Yavapur(H)	1	1	20	15
150	Nawabpet	Mubarakpur	1	1	20	15
151	Nawabpet	Attapur	1	1	20	15
152	Nawabpet	Madaram	1	1	20	15
153	Nawabpet	Lingampalle	1	1	20	15
154	Nawabpet	Gubbad Fathepur	1	1	20	15
155	Nawabpet	Arkathala	2	2	40	30
156	Nawabpet	Kojjavanampally	2	2	40	30
157	Nawabpet	Aknapur	2	2	40	30
158	Nawabpet	Gangeda	2	2	40	30
159	Nawabpet	Meenapallykalan	2	2	40	30
160	Nawabpet	Poolapalle	3	3	60	45
161	Nawabpet	Chinchelpet	4	4	80	60
162	Nawabpet	Pulumamidi	4	4	80	60
163	Nawabpet	Yellakonda	6	6	120	90
164	Nawabpet	Ekmamidi	6	6	120	90
165	Nawabpet	Chittigidda	9	10	180	150
166	Peddamul	Khanapur (H)	0	0	0	0
167	Peddamul	Madananthapur	0	0	0	0
168	Peddamul	Kondapur	0	0	0	0
169	Peddamul	Girmapur(H)	1	1	20	15
170	Peddamul	Rampur	1	1	20	15
171	Peddamul	Rudraram (H)	1	1	20	15
172	Peddamul	Rukmapur	1	1	20	15
173	Peddamul	Mansanpalle	1	1	20	15
174	Peddamul	Hanmapur (H)	1	1	20	15
175	Peddamul	Adkicherla	2	1	40	15
176	Peddamul	Duggapur (H)	1	1	20	15

177	Peddamul	Regondi	2	2	40	30
178	Peddamul	Gopalpur	2	2	40	30
179	Peddamul	Thimsanpally (H)	2	2	40	30
180	Peddamul	Mambapur	3	3	60	45
181	Peddamul	Athkur (H)	3	3	60	45
182	Peddamul	Gazipur	3	3	60	45
183	Peddamul	Bairampally H/o Pashapur	3	3	60	45
184	Peddamul	Kandanelly	5	3	100	45
185	Peddamul	Buddaram (H)	3	3	60	45
186	Peddamul	Gotlapally	3	4	60	60
187	Peddamul	Ramachandrapur	4	4	80	60
188	Peddamul	Marpally	4	4	80	60
189	Peddamul	Jangaon	4	5	80	75
190	Peddamul	Pashapur	6	6	120	90
191	Peddamul	Peddamul	5	7	100	105
192	Peddamul	Nagulapally	8	9	160	135
193	Peddamul	Indur	12	11	240	165
194	Peddamul	Tattepally	0	12	0	180