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

MEDCHAL-MALKAJGIRI DISTRICT, TELANGANA

दक्षिणी क्षेत्र, हैदराबाद

Southern Region, Hyderabad

भारत सरकार
जल संसाधन नदी विकास एवम् गंगा संरक्षण मंत्रालय
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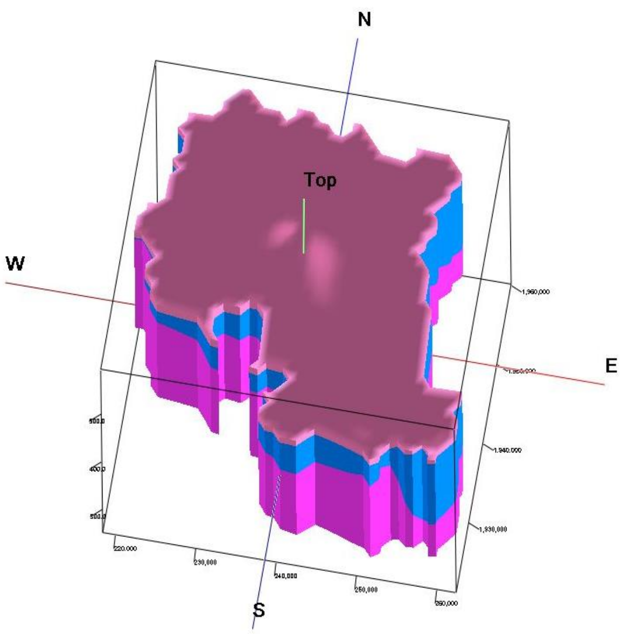
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND
GANGA REJUVENATION

REPORT ON
AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUNDWATER RESOURCES IN MEDCHAL−MALKAJGIRI DISTRICT, TELANGANA STATE



CENTRAL GROUND WATER BOARD
SOUTHERN REGION
HYDERABAD
MARCH 2022

REPORT ON

AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN MEDCHAL−MALKAJGIRI DISTRICT, TELANGANA STATE

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AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN MEDCHAL–MALKAJGIRI DISTRICT TELANGANA STATE

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AQUIFER MAPPING FOR SUSTAINABLE MANAGEMENT OF GROUND WATER RESOURCES IN MEDCHAL−MALKAJGIRI DISTRICT, TELANGANA STATE

AT A GLANCE

S.No.	Item		Particulars
1	Districts	:	Medchal−Malkajgiri district
2	Revenue Divisions/ Mandals	:	15
3	Villages	:	604 villages
4	Geographical area	:	1089.91 km^2
5	Population (2011 Census)	:	24.61 lakhs
6	Density of population (2011 Census)	:	2321 persons/km^2
7	Locations	:	North latitude 17.3614° - 17.7085° N East longitude 78.3479° - 78.7600° E
8	Rainfall (Normal)	:	552 mm to 836 mm with average of 770 mm (SW: 75% & NE: 16%, rest others)
9	Geomorphology	:	Pediplain (59% of the area), Pediment (28%of the area), and remaining area by Denundational hills, Dissected plateaus and Channel fills deposits
10	Major River	:	Krishna
11	Land Utilization (Ha)	:	Agricultural land occupies nearly 58% of the area, Urban built up area occupies nearly 34% of the area. Forest occupies 6% the area. Remaining area is occupied by water bodies, waste land, etc. Gross cropped area during the year 2019-20 is 16552 ha. Net sown area is 12346 ha
12	Soils	:	The district is covered by red soil and based on the texture, type of soil includes: fine mixed soil (31% area), Clayey skeletal mixed (38% area), loamy-skeletal soil (16% area), and Coarse loamy soil (4%).
13	Cropping Pattern (2019-20)	:	The gross area cropped during Khariff season is 10784 ha and the major crops grown during khariff season is Millets (18%), Cereals (6%), Cotton(31%) and Paddy(6%). The gross area cropped during Rabi season is 5768 ha and the major crops grown during the period include Paddy (32%), Cereals (33%), fruits and vegetables (26%).
14	Irrigation	:	Minor Projects: minor irrigation exists and total surface water irrigating area is 14370 ha. irrigation by tube wells is common that covers an area of 6733 ha while area irrigated by dug wells is only 24.50 ha and total ground water irrigated area is 6757.50 ha.
15	Prevailing Water	:	~236 percolation tanks, 254 Check dams and 188 farm ponds.

	Conservation/Recharge Practices		Under Mission Kakatiya (Phase 1, 2, 3,4), 352 tanks have been taken under RRR (Repairs, restoration, and Rejuvenation) schemes.
16	Geology	:	Archaean to Proterozoic crystalline banded gneissic complex (100%)
17	Hydrogeological data points		
	Exploratory drilling data points	:	CGWB Exploration: 23
	Water Level data points		42 wells (CGWB:16, SGWD:26)
	Hydrochemical Points		Total 119 • Pre-monsoon: 58 (CGWB: 27, SGWD: 31) • and post-monsoon: 61 (CGWB:31, SGWD: 30)
	Geophysical		VES: 07 (CGWB)
18	**DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING**		
18.1	Ground water Level Scenario		
	Water Levels Depth to water level(m bgl)	: :	Depth to water level varies from 3.76 to 35.06 m bgl during pre-monsoon and 2.06 to 23.26 m bgl during post-monsoon seasons. Pre-monsoon season: In Majority of the areas, water level during this season are in the range of 10-20 m (70% of the area), followed by >20 m bgl (11%). Post-monsoon: Majority of the water level during this season are in the range of 10-20 m covering 25% of the area, 5-10 m bgl in 65 % of the area. During pre- monsoon water table elevation ranges from 474-588 meter above mean sea level and post-monsoon season 475-589 meter above mean sea level (m amsl).
	Water Level Fluctuations (May vs. November)	:	Water level rise from 0.02 to 26m
	Long term water level trends (2010-20) (25 wells)	:	Pre-monsoon season: 05 wells show falling trend in the range of -0.28 m/yr to – 0.58 m/yr and 20 wells show a rising trend 0.06 to 0.81 m/yr. Post-monsoon season: 01 well show falling trend -0.202 m/yr and 24 wells shows rising trends 0.129 to 1.756 m/yr
18.2	Ground Water Quality		
	Electrical Conductivity (µ Siemens/cm)	:	Pre: 270 to 2580 (Avg: 1247.15) micro Siemens/cm 100% of area EC is within 3000 µ Siemens/cm. Post: 317 to 3470 (Avg: 1392.69) micro Siemens/cm in 98% of area EC is within 3000 µ Siemens/cm.
	Nitrate mg/l	:	Pre: 1.68 to 332.17 mg/L and found 41% of samples are unfit for human consumption. Post: 0.5 to 443 mg/L and found 42% of samples are unfit for human consumption.

	Fluoride mg/l	:	Pre: 0.32 to 2.93 mg/L, 69% of samples are is within permissible limits of BIS and rest is beyond permissible limit of 1.5 mg/L. Post: 0.24 to 4.84 mg/L. 56 % 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	
18.3	Aquifer Mapping			
	Geology		Archean Crystalline	
	Prominent Lithology		Granite, gneiss,	
	Aquifers	:	Aquifer-1 (Weathered Zone)	Aquifer-2 (Fracture Zone)
	Thickness range	:	<10 to 30	upto 196m
	Depth of range of occurrence of fractures	:	-	70% fracture encountered between 30 to 100m
	Range of yield potential	:	<1 to 5	<1 to 9
	Transmissivity (m2/day)	:	Upto 93	
	Specific Capacity (lpm/mdd)		12 to 34	
	Specific yield/Storativity		0.0001 to 2.3 $x10^{-5}$	
19	**Ground Water Resources**			
	Ground water Resources (2020) MCM	:		
	Net Dynamic groundwater availability	:	98.93 MCM	
	Gross GW Draft	:		
	Irrigation (MCM)		34.39 MCM	
	Domestic and Industrial use (MCM)		25.72 MCM	
	Provision for Domestic &Industrial (2025)	:	10.67 MCM	
	Average Stage of Ground water development (%)		67.52 MCM	
	Net GW Availability for future irrigation	:	28.92 MCM	
	Categorization of mandals		55% (Shamirpet mandal) to 95% (mandal). 04 (Bachpalle, Balanagar, Kukatpally and Quthbullapur) mandals are categorised as Critical zone, 03 (Alwal, Dundigal and Medchel)	

			mandals as semi critical and remaining 08 mandals as safe zone.
20	**Major Ground Water Issues Identified**	:	• Few mandals are fluorosis endemic where fluoride (geogenic) as high as 2.93 mg/L during pre-monsoon and 4.84 mg/L during post-monsoon season is found in groundwater especially at Balanagar. The high fluoride concentration (>1.5 mg/L) occurs in 31% and 44 % of the wells during pre-monsoon and post-monsoon season. • High nitrate (> 45 mg/L) due to anthropogenic activities is observed in 41% and 42% of ground water samples collected during pre-monsoon and post-monsoon season in all the mandals. • The high concentration of EC (> 3000 micro Siemens /cm) is noticed in only 2% of ground water samples collected during the post-monsoon season. • Bachpalle, Balanagar, Kukatpally and Quthbullapur mandals are critical with a stage of ground water development of 95%. • Deep water levels (> 20 m bgl) are observed during pre as well as post-monsoon season in 11 % and 07 % of the area respectively. • Out of 25 wells analysed, 05 wells during pre-monsoon 01 well during post-monsoon showed a falling trend in the last 10 years (@ -0.28 m/yr to – 0.58 m/yr and < -0.202 m/yr) respectively. • Low yield (<1 lps) occurs in ~70% of the area.
21	**Management Strategies**	:	**Supply side measures** **Artificial Recharge Structures in rural areas:** 50% of the available surplus runoff is considered for the recommendation of artificial recharge structures, as the remaining 50 % is recommended for implementing water conservation measures in recharge areas through MGNREGS. **To be taken up (Artificial Recharge Structure in rural areas)** 201 artificial recharge structures (100 CD's and 101 mini PT' in 41 villages) with a total cost of **2.51** Cr. **Roof top and open space rain water harvesting for artificial recharge in urban areas.** Number of pits proposed for roof top rainwater harvesting=237754 Number of pits proposed for open space rain water harvesting=**61137** **Water Conservation measures (WCM) Farm Ponds** The size of form ponds can be 10 x 10 x 3 m. Total 2280 farm ponds are recommended (20 in each village in 114 villages)

			with total cost of **5.70** crores **Demand side measure** ● **Ongoing work:** In the district, currently ~**576 ha** area is irrigated through micro-irrigation saving ~1MCM (considering 0.006 MCM/ha for Irrigated Dry crops against 0.008 MCM/ha). **Other Recommendations** ● ~11400 ha of additional land that can be brought under micro-irrigation (@100 ha/village in 114 villages) costing about 68.40 crores (considering 1 unit/ha @0.6 lakh/ha). With this, 19.79 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 between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanisms. ● 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 a 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. ● 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.
24	Expected Results and Out come	:	With the above interventions costing Rs: 76.61 crores (Roof top and open space rain water harvesting for artificial recharge in urban areas.), the likely benefit would be the net saving of 114 MCM of ground water for draft and recharge of 19.75MCM of ground water. This will bring down the stage of ground water development by 38% (from 95 % to 57%).

ABBREVATIONS

1	2D	2 Dimensional
2	3D	3 Dimensional
3	ARS	Artificial Recharge Structures
4	Avg	Average
5	BDL	Below Detection Level
6	BW	Bore Well
7	CD	Check dam
8	CGWB	Central Ground Water Board
9	Cr	Crore
10	DTW	Depth to water
11	DW	Dug well
12	EC	Electrical conductivity
13	EL	East Longitude
14	F	Fluoride
15	FP	Farm Pond
16	GEC	Ground Water Estimation committee
17	GW	Ground Water
18	Ha	Hector
19	Ha.m	Hector meter
20	ID	Irrigated dry
21	IMD	Indian Meteorological Department
22	Km^2	square kilometre
23	LPS	Litres per second
24	M	meter
25	M^3	Cubic meter
26	m bgl	Metres below ground level
27	MCM	Million cubic meter
28	Mg/l	Milligram per litre
29	MI	Micro irrigation
30	Min	Minimum
31	max	Maximum
32	MPT	Mini percolation tank
33	MSP	Minimum Support price
34	NL	North Latitude
35	NO_3	Nitrate
36	OE	Over Exploited
37	PGWM	Participatory ground water management
38	PT	Percolation tank
39	SGWD	State Ground Water Department
40	S	Storativity
41	Sy	Specific Yield
42	T	Transmissivity
43	WCM	Water conservation measures

EXECUTIVE SUMMARY

The Medchal Malkajgiri district having geographical area of 1089.91 sq.km and bounded by Siddipet District at North side, Yadadri District at East side, Hyderabad and Rangareddy District at Southern side and Sangareddy and Rangareddy District at West side. Medchal district lies between north latitudes 17.3614° - 17.7085° and east longitude 78.3479° - 78.7600°. 02 Revenue Divisions (Malkajgiri and Keesara). There are 8 GHMC Circles, 13 Municipalities, 162 Revenue Villages and 61 Grama panchyaths. As per 2011 census of India, the district is the second most populous of the state with a population of 24, 60,095, having density of 2321. This district populous is predominantly Urban, represented by 91.4% (22, 50,267) and rural by 8.6% (2, 09,828) Rural.

The district is underlain by Archaean to Proterozoic crystalline banded gneissic complex. The principal aquifer in the area is granites gneiss (100%). Pediplains are the major landforms followed by pediment, structural hills and channel fill. The major part of the district falls in Krishna basin. 40% area of Medchal-Malkajgiri district falls in Majeera subbasin, 60% of the area in Musi subbasin. Major part of the district is represented by agricultural areas (58%) while forest occupies only 8% of the area. Remaining areas are occupied by built-up land, water bodies and waste land etc. Gross cropped area during the year 2019-20 is 16552 ha. Red soil is predominant in the district followed by black cotton soil.

In the district, only minor irrigation exists and total surface water irrigating area is 14370 ha and total ground water irrigated area is 6757.50 ha. No major and medium irrigation projects exist in this district.

In the district there are ~236 percolation tanks, 254 Check dams and 188 farm ponds with gross storage of 12.24 MCM. Under Mission Kakatiya (Phase 1, 2, 3 & 4) 352 tanks have been undertaken under RRR (Repairs, restoration and Rejuvenation) schemes.

Water level is monitored through 42 wells during pre and post-monsoon season. During pre-monsoon water table elevation ranges from 474 to 588 meter above mean sea level and post-monsoon season 475 to 589 meter above mean sea level (m amsl). Depth to water level varies from 3.76 to 35.06 m bgl during pre-monsoon and 2.06 to 23.26 m bgl during post-monsoon seasons. In majority of the areas, water level during this season are in the range of 10-20 m (70% of the area), followed by >20 m bgl (11%). Deeper water level in the range of > 20 m bgl occupy parts of Dundigal, Kukatpally, Quthbullapur, Balanagar and Medchel mandals. Shallow water level <10 m bgl occupies about 19 % of the areas in Ghatkesar and Bachpalle mandals.

Out of 42 wells, 37 wells in the state record water level rise. The water level fluctuation varies from 0.12 to 14.98 m in all the wells.

Trend analysis for the last 10 years (2011-2020) is studied from 25 hydrograph stations of CGWB and SGWD. It is observed that during pre-monsoon season, 05 wells show falling trend in the range of -0.28 m/yr to – 0.58 m/yr and 20 wells show a rising trend 0.06 to 0.81 m/yr. During post-monsoon season, 01 well show falling trend -0.202 m/yr and 24 wells shows rising trends 0.129 to 1.756 m/yr.

Total 119 ground water samples (Pre-monsoon:58 and Post-monsoon:61) were analysed for knowing the suitability of ground water for drinking purposes. In 100% and 98 % of area EC is in the range of < 3000 µ Siemens/cm during pre and post-monsoon season respectively. During pre-monsoon season, concentration of NO_3 ranges from 1.68 to 332.17 mg/L. Nitrate concentration in 41% of samples is beyond permissible limits of 45 mg/L and rest is within the permissible limit (Fig.3.6a). Fluoride concentration varies from 0.32 to 2.93 mg/L and 69% of samples is within the permissible limits of BIS and rest is beyond the permissible limit of 1.5 mg/L. During post-monsoon season, concentration of NO_3 ranges from 0.5 to 443 mg/L. Nitrate concentration in 42% of samples is beyond permissible limits of 45 mg/L and rest is within the permissible limit of 45 mg/L (Fig.3.6b). Fluoride concentration varies from 0.24 to 4.84 and 56% of area is within permissible limits of BIS and rest is beyond permissible limits of 1.5 mg/L.

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

Aquifers are conceptualized in to two namely; 1) weathered zone (~30 m) and 2) fractured zone (30- 199 m). The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. Ground water yield in these unconfined aquifers varies from 0.0003 to 4.30 lps (avg: 2.29 lps). The transmissivity varies from 0.09 to 93m^2/day. The depth of fracturing varies from 11 m to 196m with yield of 0.07 to 9.24 lps. The specific capacity of the consolidated formation ranges between 12 and 34 lpm/mdd; transmissivity (T) between 0.2 and 40m^2/day.

As per 2020 GEC report, the net dynamic replenishable groundwater availability is 98.93 MCM, gross ground water draft for all uses is 60.11 MCM, provision for drinking and industrial use for the year 2025 is 10.67 MCM and net annual ground water potential available for future irrigation needs is 28.92 MCM. Thus, Stage of ground water development varies from 55% (Shamirpet mandal) to 95% (mandal). 04 (Bachpalle, Balanagar, Kukatpally and Quthbullapur) mandals are categorised as Critical zone, 03 (Alwal, Dundigal and Medchel) mandals as semi critical and remaining 08 mandals as safe zone.

Major issues identified are critical (Bachpalle, Balanagar, Kukatpally and Quthbullapur mandals), ground water pollution (both anthropogenic (NO_3) and geo-genic (F), deep water levels are > 20 m bgl in 11% of the area during pre-monsoon season low sustainability of wells (yield less than 1 lps).

The management strategies mainly include both supply side and demand side. The supply side management of ground water resources include artificial recharge of available surplus runoff in check dams and percolation tanks in rural areas and roof top and open space rain water harvesting in urban areas. Construction of 201 artificial recharge structures (100 CD's and 101 mini PT' in 41 villages) with a total cost of **2.51** crores is recommended as supply side measures. Under Water conservation measures include, construction of 2280 numbers of farm ponds with 5.70 crores in all villages. Roof top and open space rain water harvesting for artificial recharge in urban areas.

De-silting of existing minor tanks (352) was taken under state Govt. sponsored Mission Kaktiya-Phase-1, Phase-2, Phase 3 and 4 to remove 4 MCM of silt and this has created additional surface storage. This will augment ~ 1.75 MCM to groundwater and with this additional ~114 ha land can be brought under irrigated dry (ID) crops in tank ayacut.

Demand side measure includes micro irrigation in ~11400 ha of additional land that can be brought under micro-irrigation (@100 ha/village in 114 villages) costing about 68.40 crores (considering 1 unit/ha @0.6 lakh/ha). With this, 19.79 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).

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.

With the above interventions costing Rs: 76.61 crores (Roof top and open space rain water harvesting for artificial recharge in urban areas.), the likely benefit would be the net saving of 114 MCM of ground water for draft and recharge of 19.75MCM of ground water. This will bring down the stage of ground water development by 38% (from 95 % to 57%).

NUMBER OF DATA POINTS USED FOR PREPARATION OF VARIOUS MAPS/FIGS- BHADRADRI KOTHAGUDEM DISTRICT, ANDHRA PRADESH

S.No.	Data	Aquifer	Total Data Points	Source	
				CGWB	SGWD
1	Panel Diagram (3-D)	Combine	30	Expl:23 VES:07	
2	Hydrogeological Sections	2 no	30	Expl:23 VES:07	
4	Depth of weathering	1 no	23	Expl:23 VES:07	
5	Depth of fracturing	1 no	23	Expl:23 VES:07	
6	Groundwater Yield	combined	23	23	
7	Transmissivity (m^2/day)	combined	23	23	
8	Depth to Water Level Maps	Combine	42	16	26
9	Water Level Fluctuation	Combine	42	16	26
10	Long term water level trends	Combine	49	30	19
11	Water quality Pre Post	Combine	Pre:58 Post:61	27 31	SGWD:31 SGWD:30

1. INTRODUCTION

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

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

1.1 Objectives:

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

1.2 Scope of the study: The main scope of the study is summarised below.

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

1.3 Area Details:

The Medchal Malkajgiri district having geographical area of 1089.91 sq.km and bounded by Siddipet District at North side, Yadadri District at East side, Hyderabad and Rangareddy District at Southern side and Sangareddy and Rangareddy District at West side. Medchal district lies between north latitudes 17.3614° - 17.7085° and east longitude 78.3479° - 78.7600° (Fig.1.1). Out of the total area, the non-command area is 95 % and hilly area is 5 %. Administratively this district consists of 15 Mandals (1. Alwal, 2. Bachupally, 3. Balanagar, 4. Dundigal – Gandimmaisamma, 5. Kukatpally, 6. Quthbullapur 7. Malkajgiri, 8. Keesara, 9. Ghatkesar, 10. Medipally, 11. Uppal, 12. Kapra, 13. Shamirpet, 14. Medchal, and 15.Muduchintalapally), 02 Revenue Divisions (Malkajgiri and Keesara). There are 8 GHMC Circles, 13 Municipalities, 162 Revenue Villages and 61 Grama panchyaths. As per 2011 census of India, the district is the second most populous of the state with a population of 24, 60,095, having density of 2321. This district populous is predominantly Urban, represented by 91.4% (22, 50,267) and rural by 8.6% (2, 09,828) Rural.

1.4 Climate and Rainfall:

The climate of the district is characterised by hot summer and generally dry weather except during Southwest monsoon season and October, November months of Northeast monsoon season. This districts maximum temperature is 48.4 °C and minimum temperature is 5.6°C at Ghatkesar in the year 2013 to 2020. The normal annual rainfall for the district is 770.57 mm. Southwest Monsoon (June – September) is 583.10 mm contributes 75%, Northeast monsoon (October-December) is 122.90 mm contributes 16% while the winter and summer rainfall is 10 and 58.7 mm respectively. Monthly normal varies from 3.8 mm in December to 177.4 mm in August. Normal annual rainfall varies between 552 mm in Shamirpet mandal and 836 mm in Alwal mandal (Fig. 1.2). Rainfall decreases towards the North-eastern part of the district. As per the IMD rainfall data, the district received 866 mm of rainfall (-12% less than normal rainfall) during the year 2019. Analysis of time series annual rainfall (January- December) data for 16 years (2005-2020) collected from TSDPS, Govt. of Telangana show slightly increasing trend in annual rainfall of 6.9 mm/y (Fig.1.3). The district received large excess rainfall (>70% departure above normal) in 2020, excess rainfall (+20% to +59%) in 7 years (2005, 2008, 2010, 2013, 2016, 2017 & 2019), deficient rainfall (-20% & below normal) in 3 years (2011, 2014 & 2018) and remaining 5 years received normal rainfall (-19% to +19%).

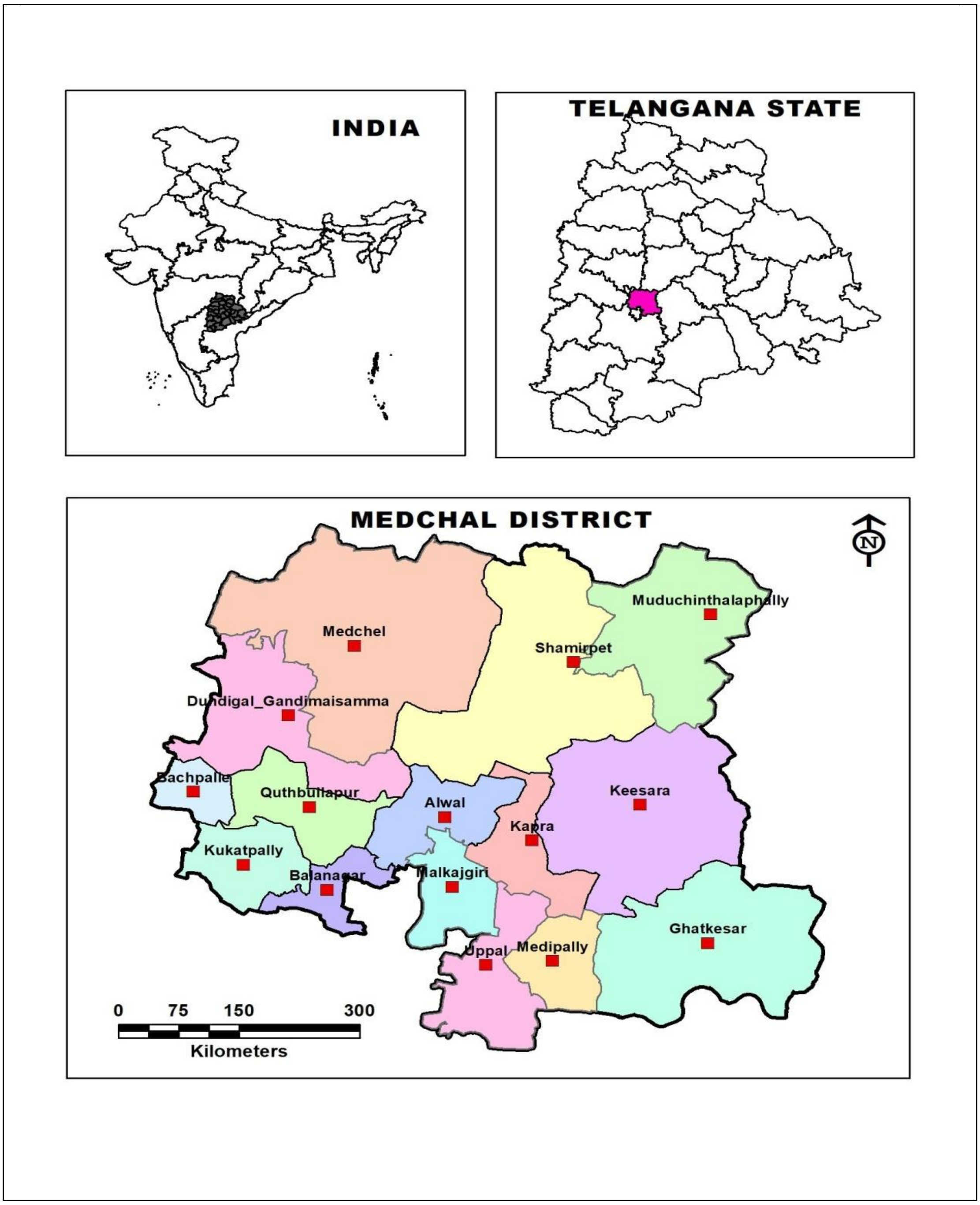


Fig.1.1: Location of Medchal-Malkajgiri district and Telangana State.

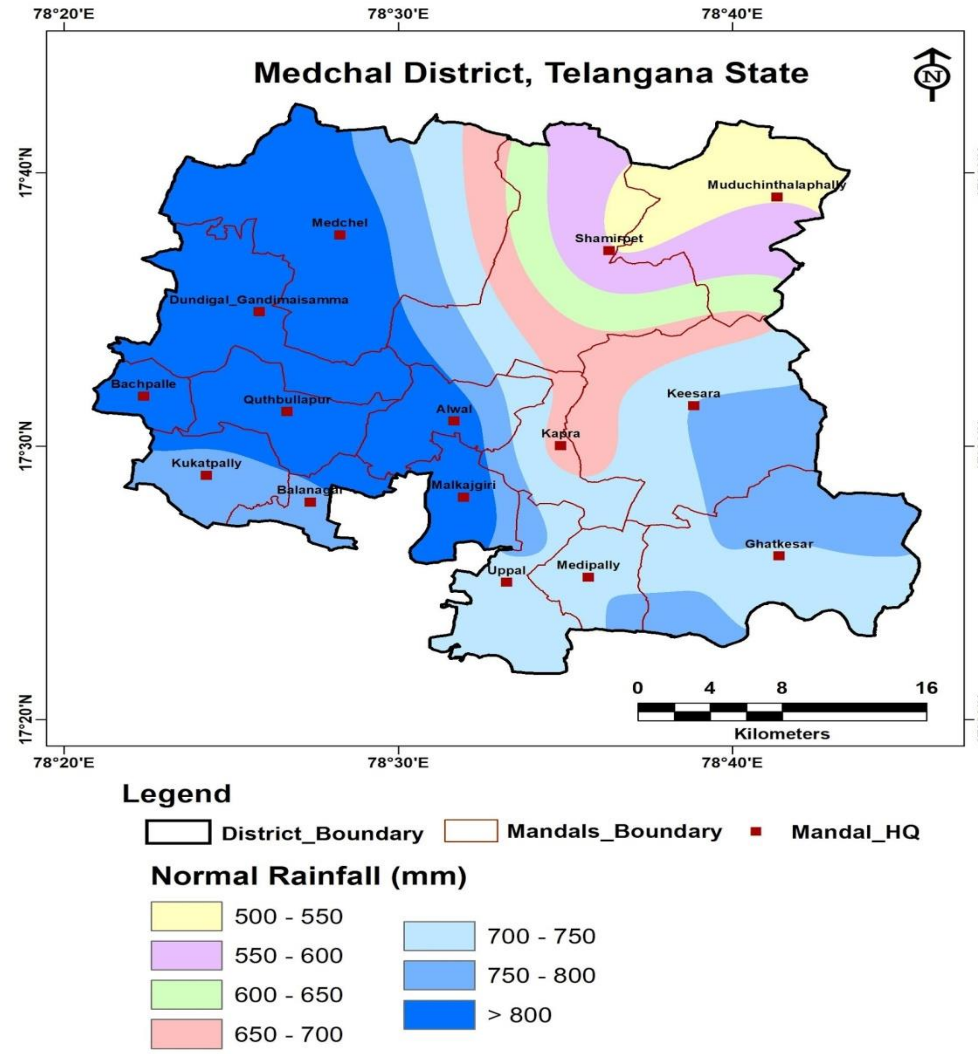


Fig.1.2: Isohyetal map of Medchal-Malkajgiri district.

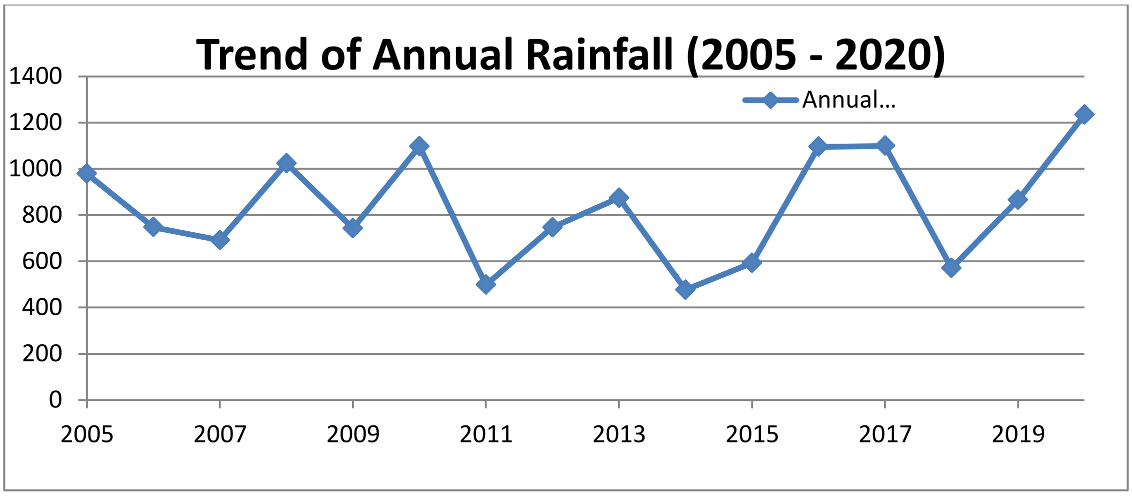


Fig. 1.3: Trend of Annual Rainfall (2005 – 2020).
Source: TSDPS, Govt. of Telangana

1.5 Geomorphological Set up:

Geomorphologically, the study area consists of Pediplain (59% of the area), Pediments (28% of the area), and Denudational hills, Dissected plateaus and Channel fill deposits (Fig.1.4). Physiographically, elevation ranges from 460 m. amsl to 608 m. amsl with a regional slope (NW to SE) towards the south eastern direction.

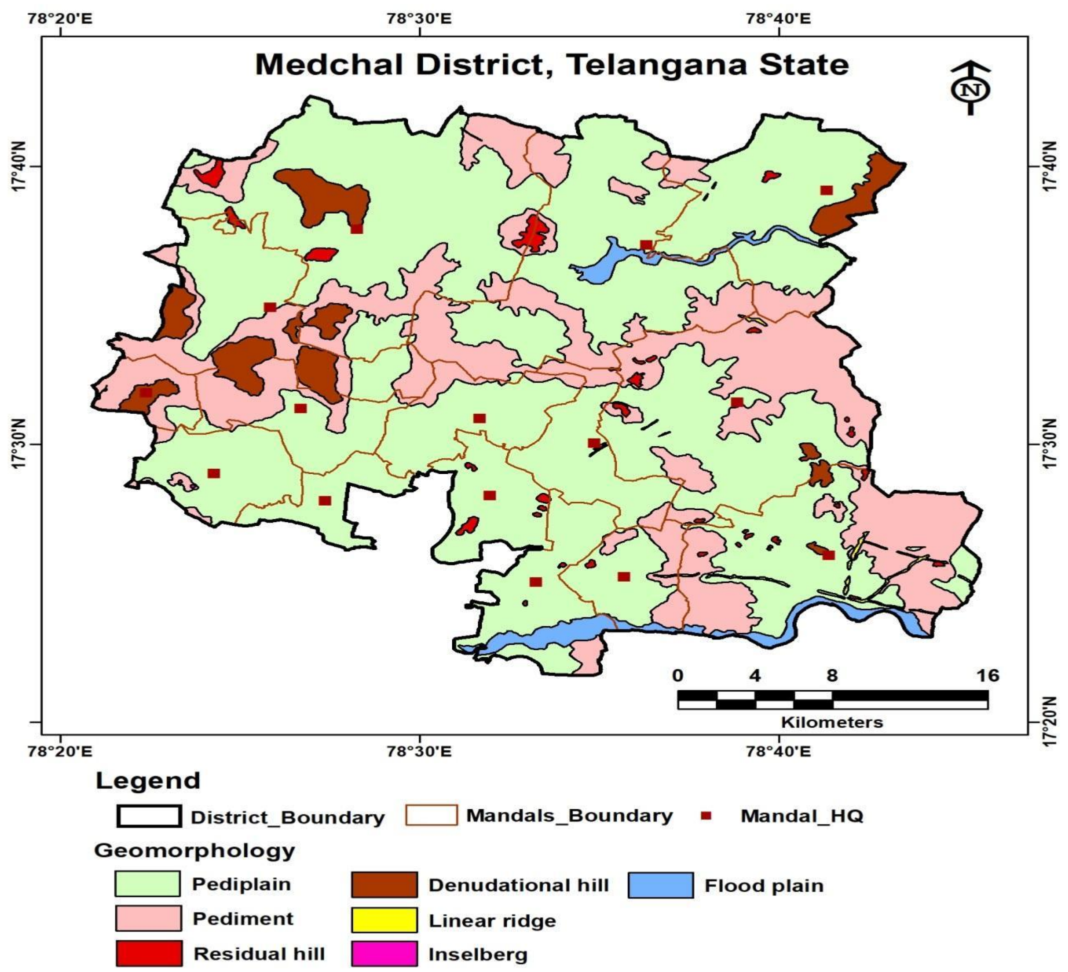


Fig.1.4: Geomorphology of Medchal-Malkajgiri district.

1.6 Drainage:

The major part of the district falls in Krishna basin. 40% area of Medchal-Malkajgiri district falls in Majeera subbasin, 60% of the area in Musi subbasin. The Musi River and its tributaries and flows towards the south eastern direction (Fig. 1.5).

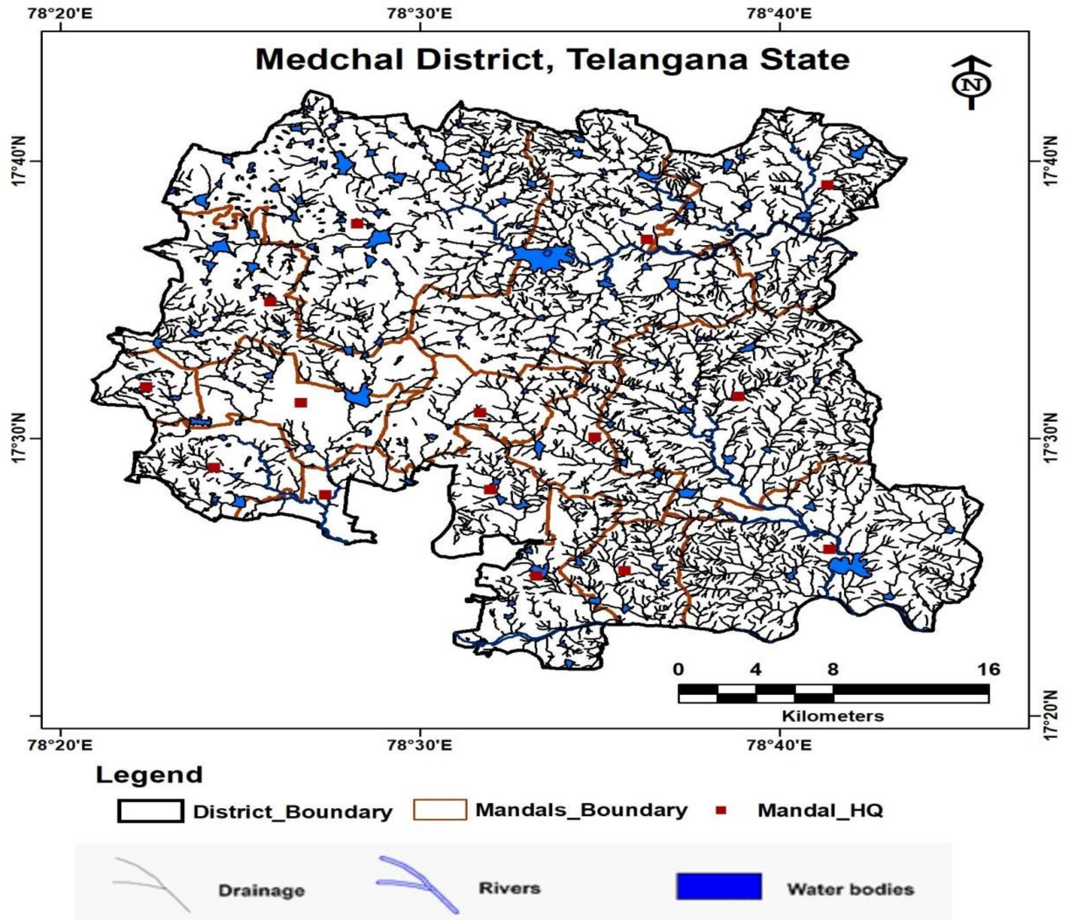


Fig.1.5: Drainage map of Medchal-Malkajgiri district, lineaments and watershed boundaries.

1.7 Land use and cropping pattern (2019-2020):

Major part of the district is represented by agricultural areas (58%) while forest occupies only 8% of the area. Remaining areas are occupied by built-up land, water bodies and waste land (Fig.1.6). The total gross cropped area during the year 2019-20 is 16552 ha and net sown area is 12346 ha, remaining agricultural land was kept fallow. The gross area cropped during Kharif season is 10784ha and the major crops grown during kharif season are Millets (18%), Cereals (06%), Cotton (31%) and Paddy (06%) and fruits and vegetables (08%). The gross area cropped during Rabi season is 5768 ha and the major crops grown during the period include Paddy (32%), Cereals (33%), Millets (02%), fruits and vegetables (26%). Season wise cropping pattern is given in Fig.1.7a and Fig.1.7b.

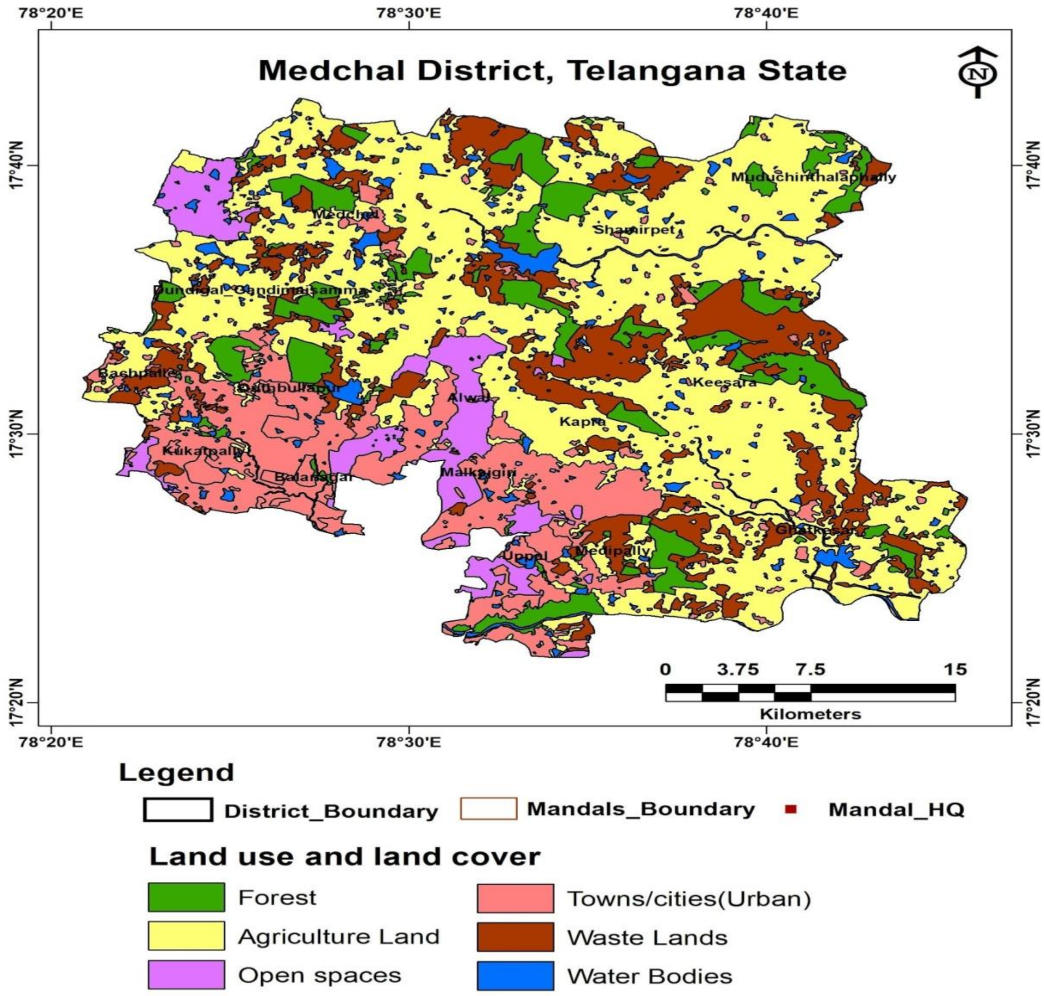


Fig.1.6: Land use and land cover of Medchal−Malkajgiri district.

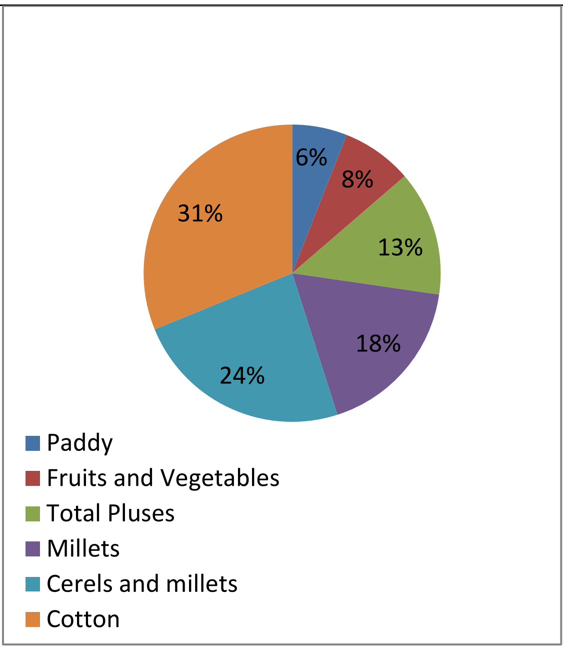


Fig.1.7a: Kharif season.

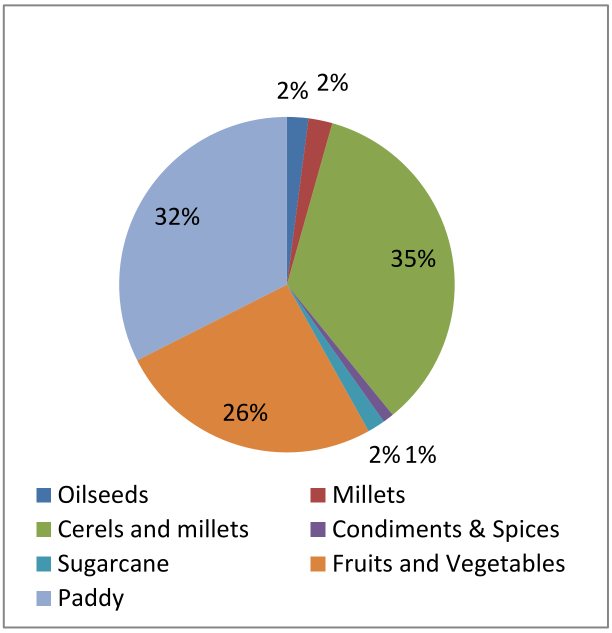


Fig.1.7a: Rabi season.

1.8 Soils:

Red soil is predominant in the district followed by black cotton soil. They are classified into six types. The 31 % area is occupied by fine mixed soil, Clayey skeletal mixed in 38 % area, Loamy-skeletal in 16% area, Coarse loamy in 4% and remaining area is Rock lands (Fig.1.8).

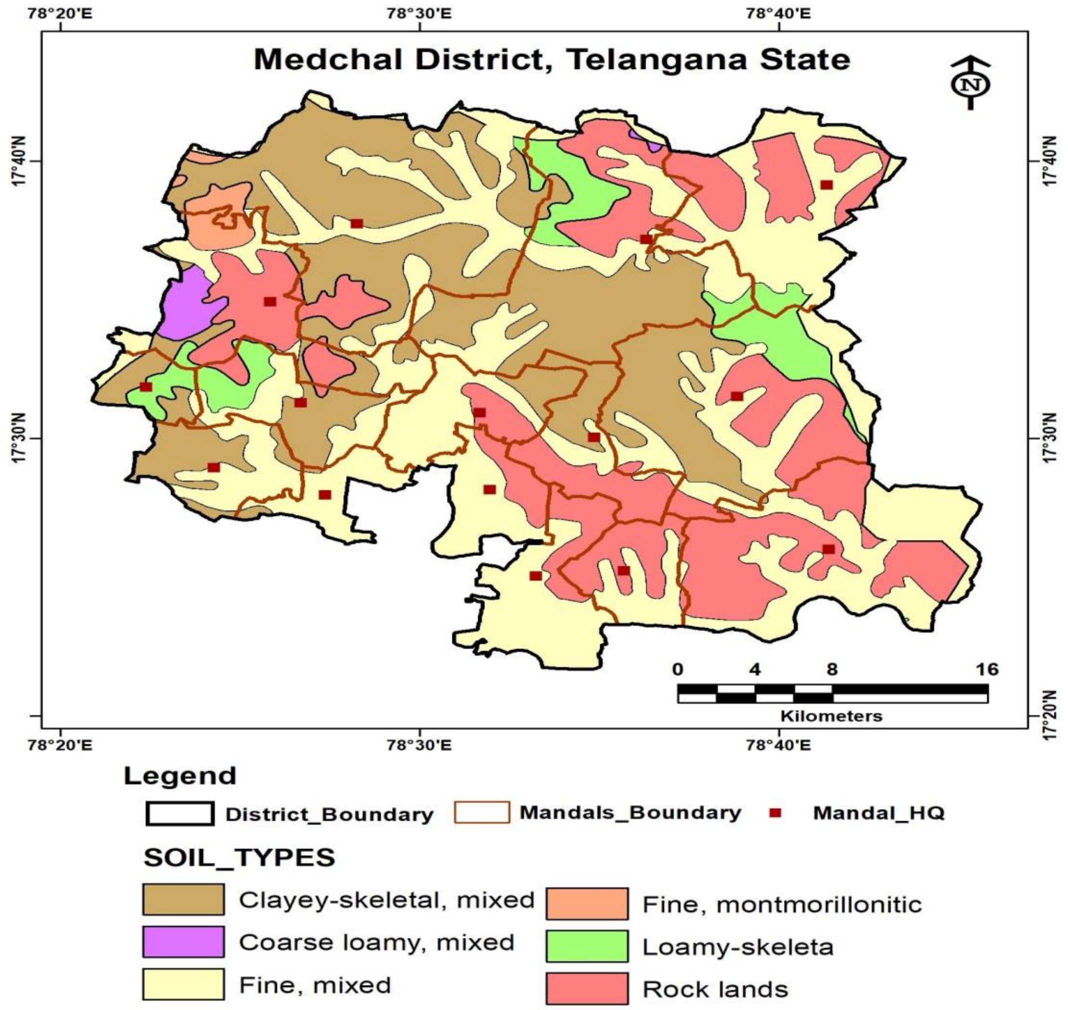


Fig.1.8: Soil map of Medchal–Malkajgiri district

1.9 **Irrigation:**

In the district, only minor irrigation exists and total surface water irrigating area is 14370 ha. No major and medium irrigation projects exist in this district.

	Number	Ayacut in ha
Minor Irrigation tanks	456	14370

Table-1.1: Salient features of Groundwater Irrigation in Medchal−Malkajgiri district.

Irrigation	Numbers irrigated	Area irrigated ha
Ground water(2019-2020)		
Tube wells	6733	6733
Dug wells	49	24.5
Total		**6757.5**

In the district, irrigation by tube wells is common that covers an area of 6733 ha while area irrigated by dug wells is only 24.50 ha and total ground water irrigated area is 6757.50 ha.

1.10 Prevailing Water Conservation/Recharge Practices:

In the district there are ~236 percolation tanks, 254 Check dams and 188 farm ponds with gross storage of 12.24 MCM. Under Mission Kakatiya (Phase 1, 2, 3 & 4) 352 tanks have been undertaken under RRR (Repairs, restoration and Rejuvenation) schemes.

1.11 Geology and Hydrogeology:

The district is underlain by Archaean to Proterozoic crystalline banded gneissic complex (Fig1.9). The Archaean crystalline rocks comprises older metamorphic rocks, peninsular gneissic complex (Granite dominated) and younger intrusive rocks. The principal aquifer in the area is granites gneiss (100%).

Table-1.2: Stratigraphic Succession of Geological Formations, Medchal−Malkajgiri District.

AGE	GROUP	Stratigraphic
Archaean	Peninsular gneissic complex	Granite gneisses (Granite dominated)

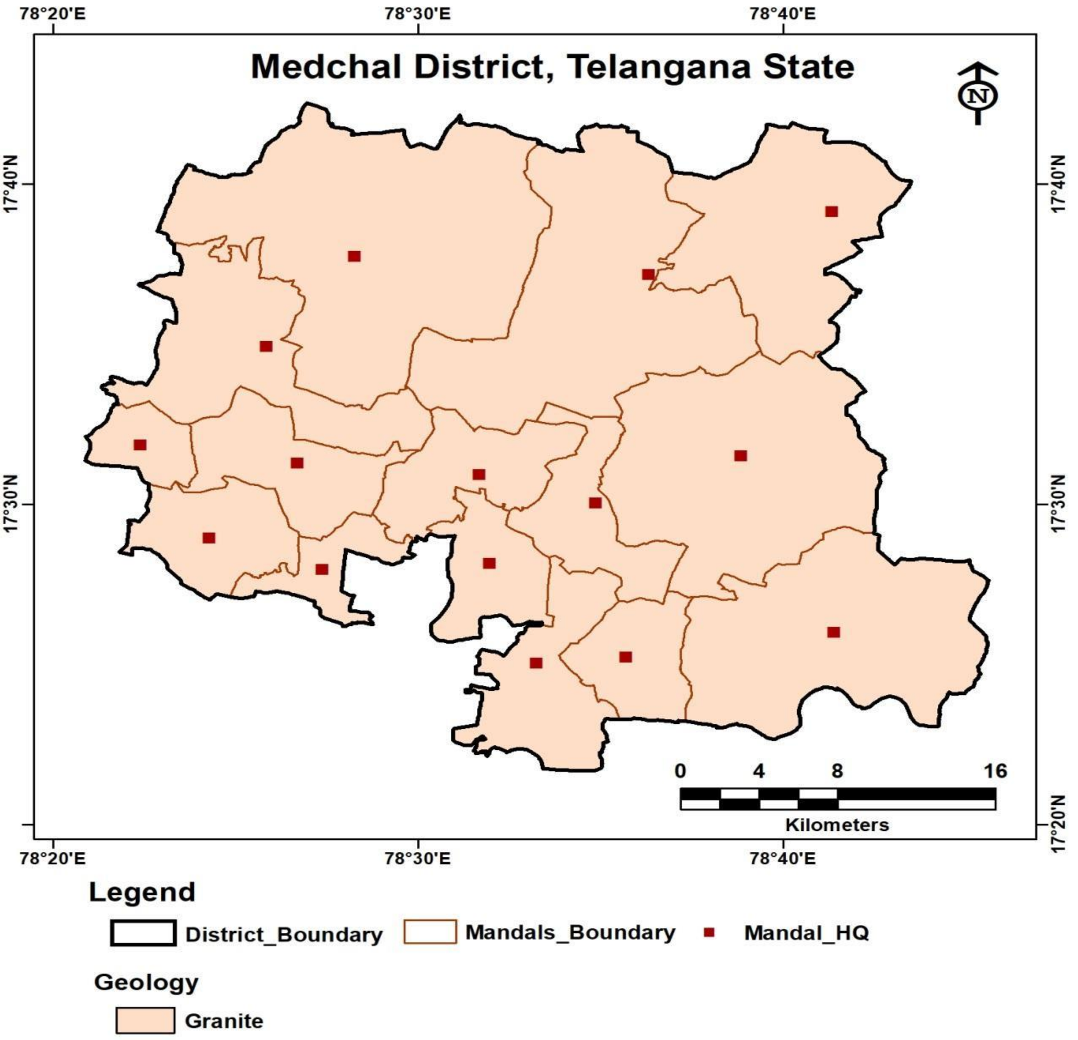


Fig.1.9: Geology of Medchal−Malkajgiri district.

2. DATA COLLECTION AND GENERATION

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

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

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

The aquifer geometry for shallow and deeper aquifers has been established through hydro geological studies, exploration, surface and subsurface geophysical studies in the district. The data used for the integration and interpretation includes:

2.1 Exploratory drilling:

Information on aquifer geometry, groundwater potential of various formations, fracture systems, their characterization is primarily inferred from the exploratory drilling data. CGWB has a total of 23 wells in the district. Out of these, 14 wells were drilled during the period 2013-14 and 2020-21 based on the data gap analysis carried out in the study area as part of NAQUIM. A total of 23 exploratory bore well data of CGWB have been used for the hydrogeological studies and all the wells tapped aquifers in Archean crystalline banded gneissic complex.

2.2 Water Level:

Water level monitoring wells of CGWB and SGWD have been utilized for the Aquifer Mapping studies. 05 dug wells and 11 Piezometers are presently monitored by CGWB and 26 piezometers by SGWD. CGWB wells are being monitored four times (January, April, August and November) in a year whereas the monitoring wells of State Ground Water Department (SGWD) are being monitored every month. These groundwater monitoring wells were used in order to understand the spatial-temporal behaviour of the groundwater regime.

2.3 Hydro chemical Studies:

Water quality data of CGWB and SGWD have been utilized for understanding the spatial variation of quality in the district. A total of 119 (Pre-monsoon:58 (CGWB: 27, SGWD: 31) and post-monsoon: 61 (CGWB:31, SGWD: 30) ground water monitoring well data of Central Ground Water Board, Telangana State Ground Water Department and Telangana Rural Water Supply (mostly tapping combined aquifers Aq-1 and Aq-2) is utilized to understand the chemical characteristics of groundwater. Parameters namely pH, EC (in µS/cm at 25 ° C), TH, Ca, Mg, Na, K, CO_3, HCO_3, Cl, SO_4, NO_3 and F were analysed.

2.4 Geophysical Studies:

Geophysical data on VES and profiling are used to extract information on the weathered thickness, fracture depth, thickness of fracture etc… of hard rock area. For the interpretation of the aquifer geometry, geophysical data in conjunction with the available groundwater exploration data is utilised. The data from 07 Vertical Electrical Soundings (VES) employing the Schlumberger electrode configuration with the maximum electrode separation (AB) of 400 meters is used for the aquifer mapping studies. The data was processed and interpreted by IPI2Win software developed by Moscow State University, after marginally modifying the manually interpreted results in corroboration with geology and hydrogeology.

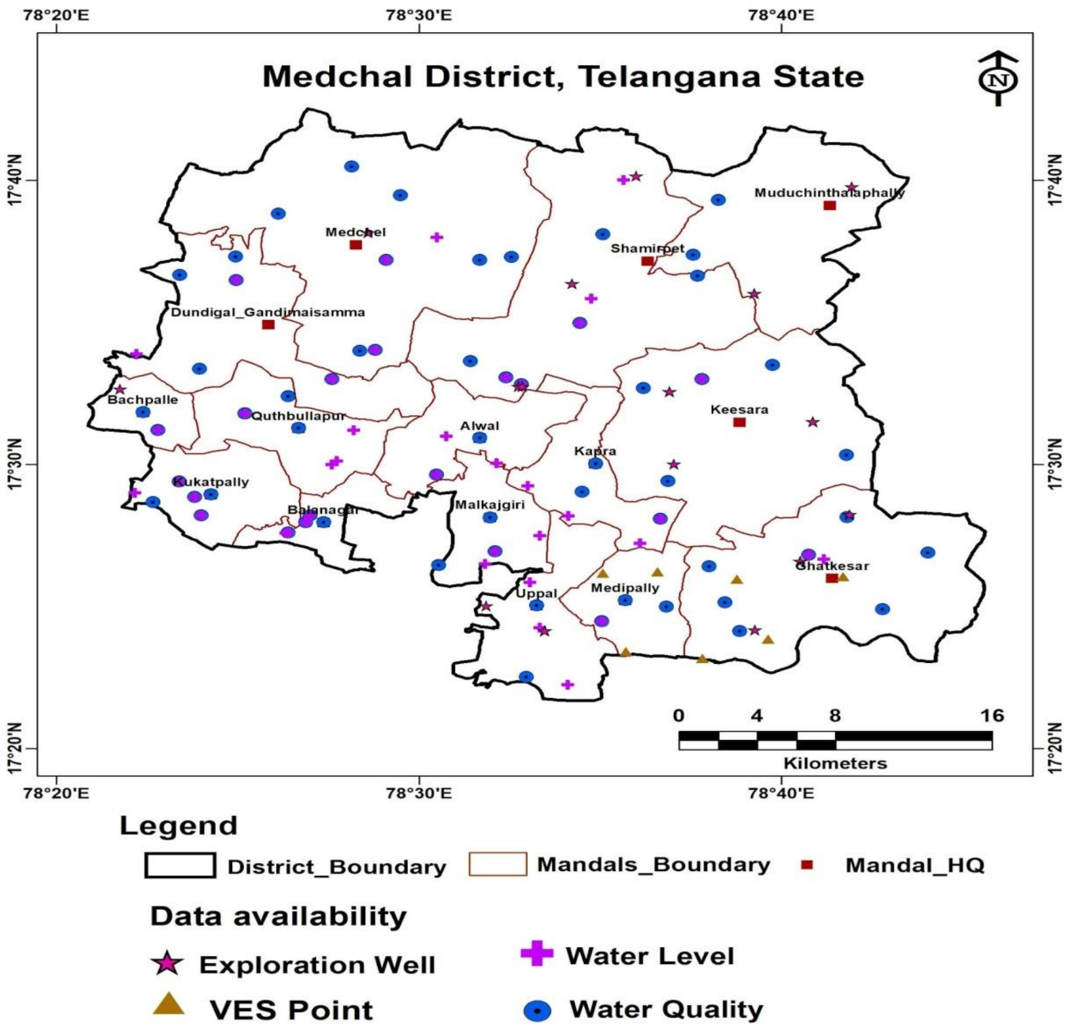


Fig. 2.1: Data availability in Medchal−Malkajgiri district.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 Ground water Level Scenario:

3.1.1 Depth to ground water level:

Analysis of the pre monsoon and post monsoon water level data from 42 (CGWB:16, SGWD:26) groundwater monitoring wells shows that depth to water level varies from 3.76 to 35.06 m bgl during pre-monsoon and 2.06 to 23.26 m bgl during post-monsoon seasons.

A) Pre-monsoon season:

In majority of the areas, water level during this season are in the range of 10-20 m (70% of the area), followed by >20 m bgl (11%). Deeper water level in the range of > 20 m bgl occupy parts of Dundigal, Kukatpally, Quthbullapur, Balanagar and Medchel mandals. Shallow water level <10 m bgl occupies about 19 % of the areas in Ghatkesar and Bachpalle mandals (Fig.3.1a).

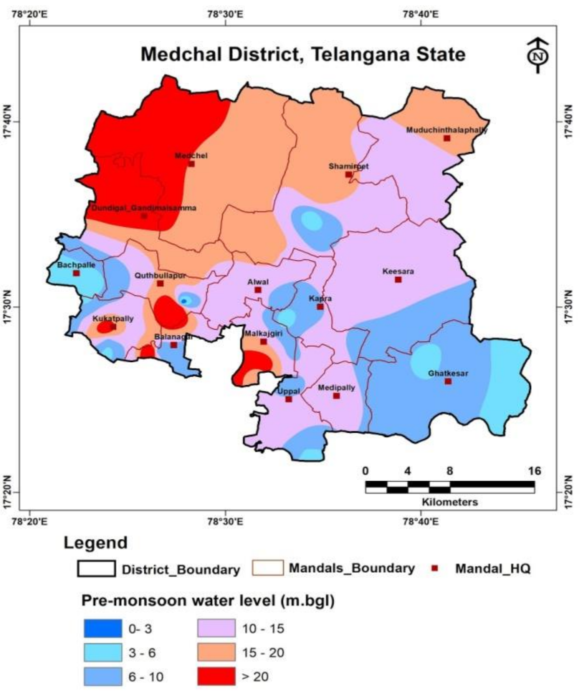


Fig.3.1a: Depth to water levels Pre-monsoon.

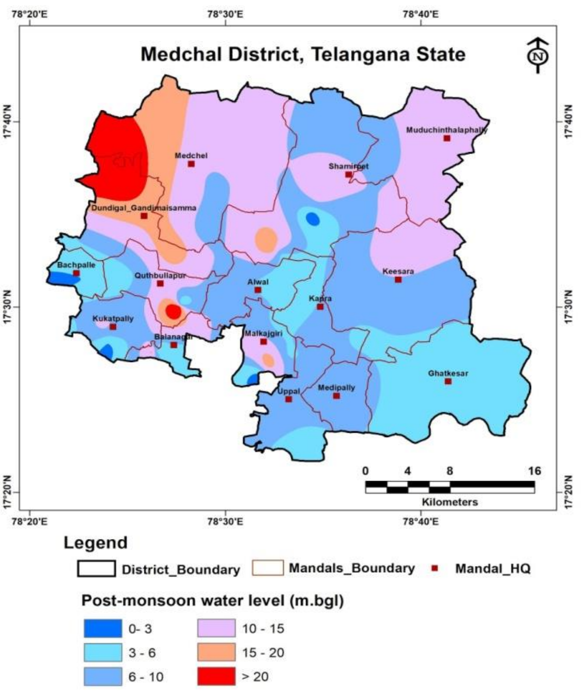


Fig.3.1b: Depth to water levels Post-monsoon.

B) Post-monsoon season:

Majority of the water level during this season are in the range of 10-20 m covering 25 % of the area, 5-10 m bgl in 65 % of the area. Shallow water level < 5 m bgl occupies about 3 % of the area in parts of Bachpalle, Kukatpaly and Shamirpet mandals. Deep water level in the range of > 20 m bgl occupies about 07 % of the area falling in parts of Dundigal, Quthbullapur and Medchel mandals (Fig.3.1b).

3.1.2 Seasonal Water Level Fluctuations (May vs. November):

Out of 42 wells, 37 wells in the state record water level rise. The water level fluctuation varies from 0.12 to 14.98 m in all the wells. 46% of the area have >5m rise in water level and 54% of the area have 0 to 5 m rise. Fall in water level has been recorded in five (05) wells (Fig.3.2).

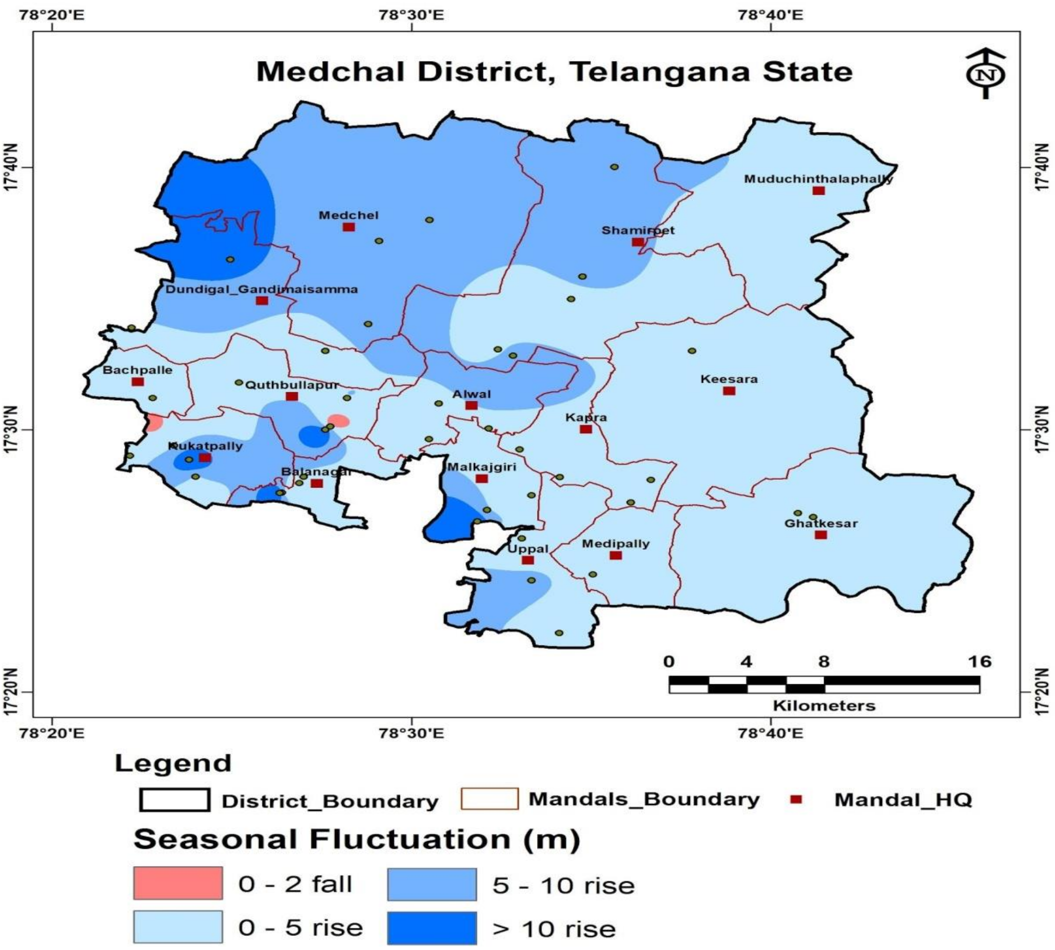


Fig.3.2: Water Level Fluctuation (m) (November with respect to May).

3.1.3 Long term water level trends:

Trend analysis for the last 10 years (2011-2020) is studied from 25 hydrograph stations of CGWB and SGWD. It is observed that during pre-monsoon season, 05 wells show falling trend in the range of -0.28 m/yr to – 0.58 m/yr and 20 wells show a rising trend 0.06 to 0.81 m/yr. During post-monsoon season, 01 well show falling trend -0.202 m/yr and 24 wells shows rising trends 0.129 to 1.756 m/yr (Fig.3.3a & b).

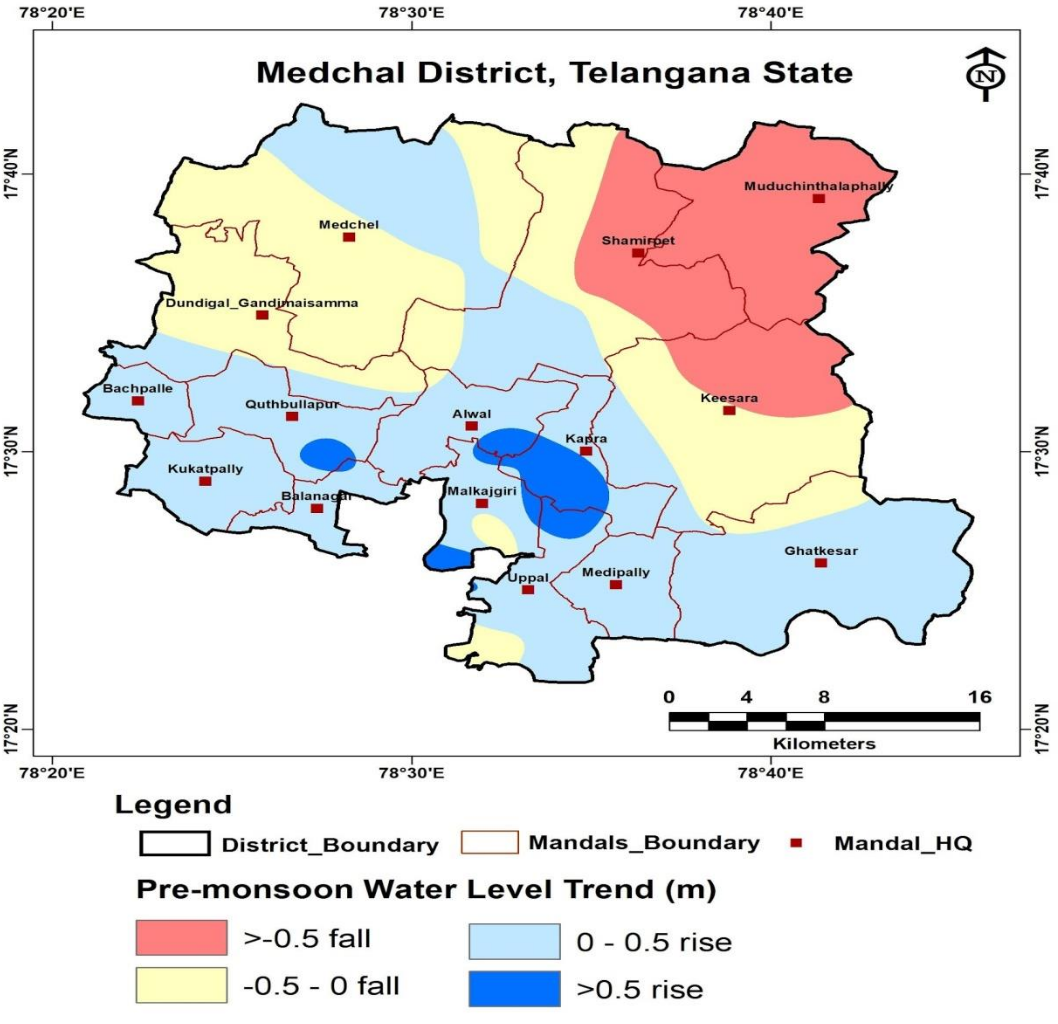


Fig. 3.3a: Decadal Pre-monsoon water level trends (2011-2020)

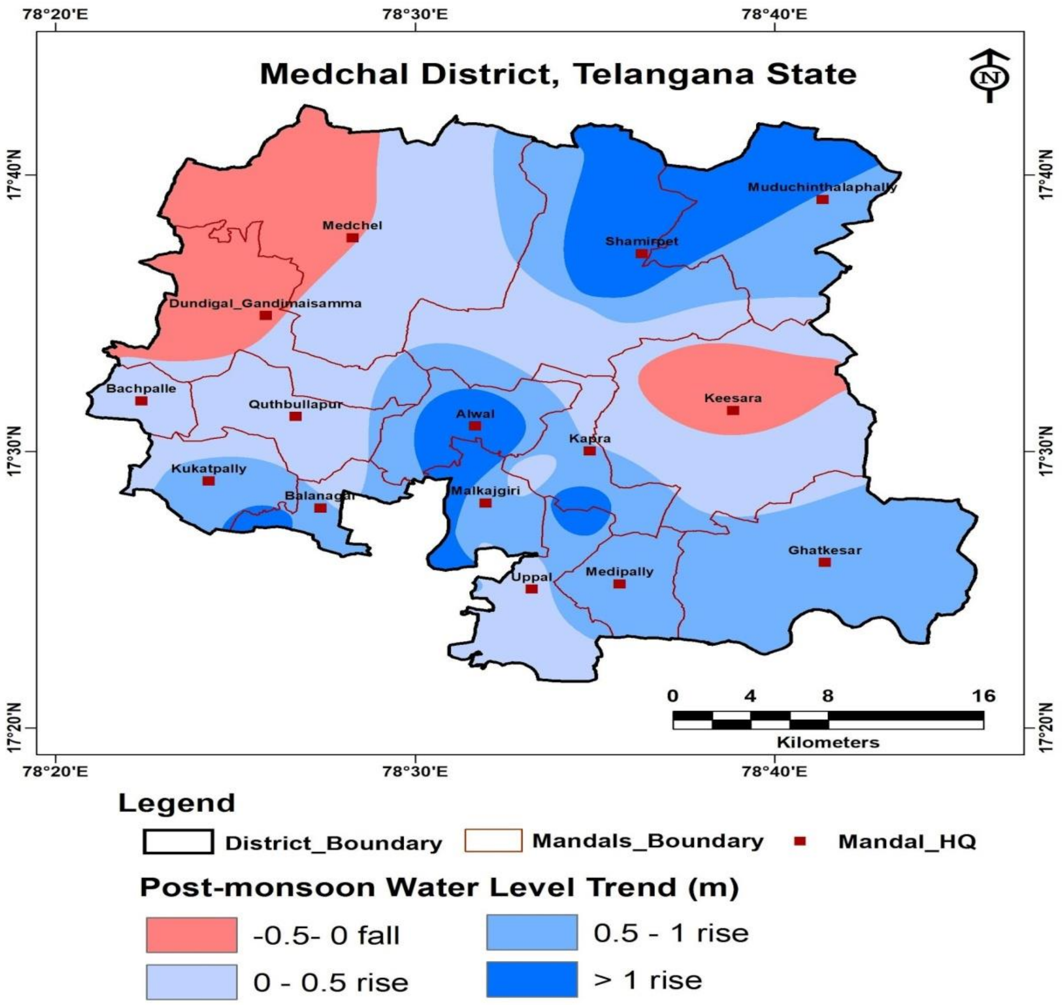


Fig. 3.3b: Decadal Post-monsoon water level trend (2011-2020)

3.1.4 Water Table Elevation:

During pre-monsoon, water-table elevation ranges from 474 to 588 meter above mean sea level and post-monsoon season 475 to 589 meter above mean sea level (m amsl). The ground water flow follows the drainage flow direction. In the lower subbasin the groundwater flow is towards the south eastern direction while in the top subbasin the groundwater flows is from South to North direction (Fig.3.4).

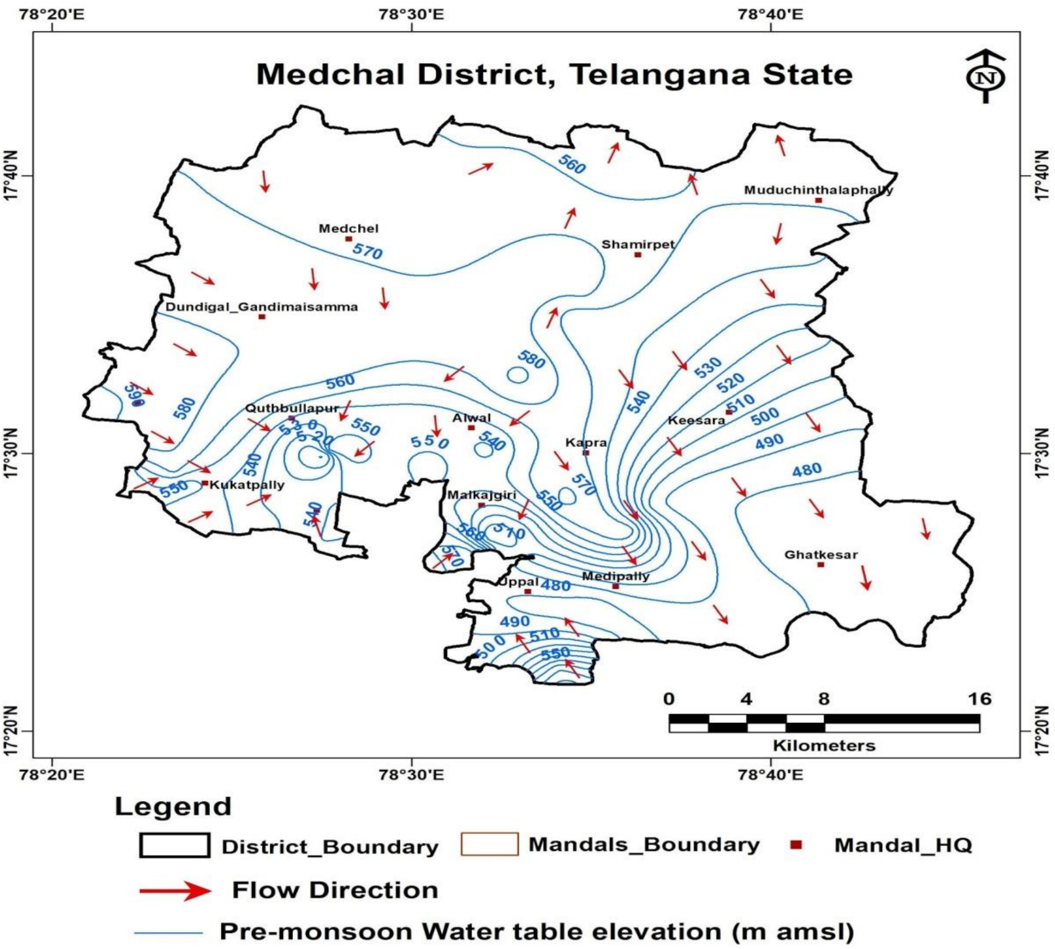


Fig.3.4: Water table elevations (m amsl) during Pre-monsoon season.

3.2 Ground Water Quality:

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

A) Pre-monsoon:

Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 6.96 to 10.59 (Avg: 7.70). Electrical conductivity varies from 270 to 2580 (Avg: 1247.15) µ Siemens/cm and is within 3000 µS/cm in the entire district (Fig.3.5a). Average concentration of TDS is 796.28 mg/L and NO_3 ranges from 1.68 to 332.17 mg/L. Nitrate concentration in 41% of samples is beyond permissible limits of 45 mg/L and rest is within the permissible limit (Fig.3.6a). Fluoride concentration varies from 0.32 to 2.93 mg/L and 69% of samples is within the permissible limits of BIS and rest is beyond the permissible limit of 1.5 mg/L (Fig.3.7a).

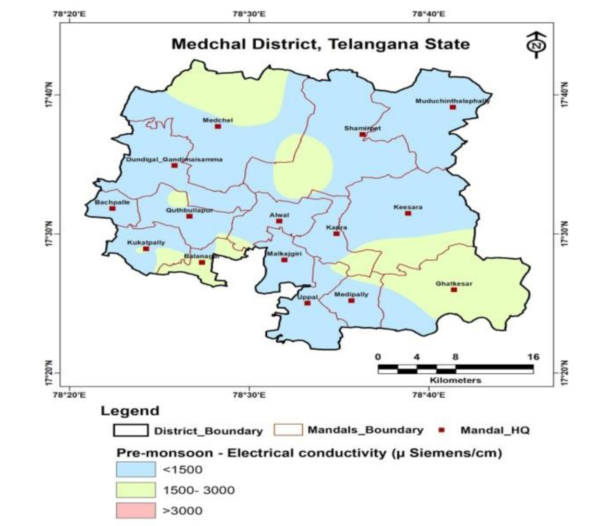


Fig.3.5a: Pre-monsoon EC distribution

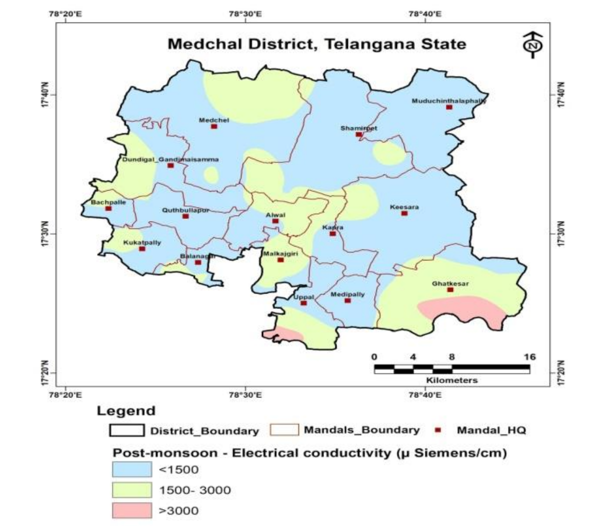
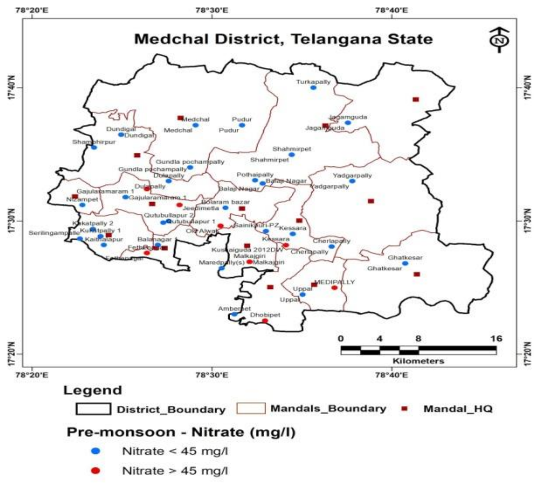


Fig.3.5b: Post-monsoon EC distribution

B) Post-monsoon:

Groundwater from the area is mildly alkaline to alkaline in nature with pH in the range of 6.5 to 8.74 (Avg: 7.40). Electrical conductivity varies from 317 to 3470 (Avg: 1392.69) µ Siemens/cm. In 98% of area EC is within 3000 µ Siemens/cm and in 02% of the area EC>3000 µ Siemens/cm (Fig.3.5b). Average concentration of TDS is 851.12 mg/L and NO_3 ranges from 0.5 to 443 mg/L. Nitrate concentration in 42% of samples is beyond permissible limits of 45 mg/L and rest is within the permissible limit of 45 mg/L (Fig.3.6b). Fluoride concentration varies from 0.24 to 4.84 and 56% of area is within permissible limits of BIS and rest is beyond permissible limits of 1.5 mg/L (Fig.3.7b).



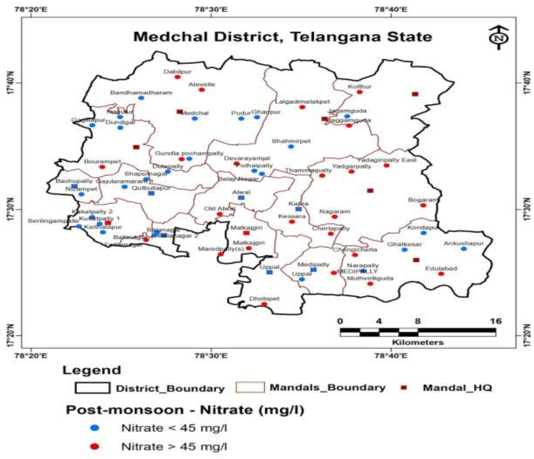
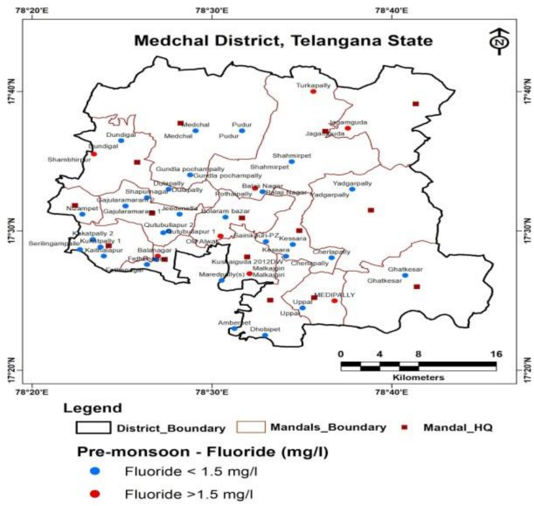


Fig.3.6a: Pre-monsoon Nitrate distribution.	Fig.3.6b: Post-monsoon Nitrate distribution.



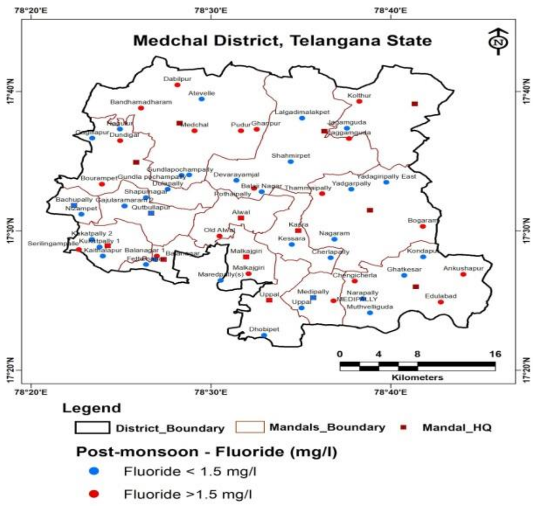


Fig.3.7a:Pre-monsoon Fluoride distribution.	Fig.3.7b: Post-monsoon Fluoride distribution.

3.3 Aquifer Mapping:

3.3.1 Hydrogeology:

The aquifer geometry for shallow and deeper aquifers has been established through hydro geological studies, exploration, surface and subsurface geophysical studies in the district.

Aquifers were characterized based on the terms of potential and quality. The principal aquifer in the area is granite gneiss and the occurrence and movement of ground water is controlled by the degree of interconnection of secondary pores/voids developed by fracturing and weathering. Hydrogeology map is depicted in the Figure.3.8.

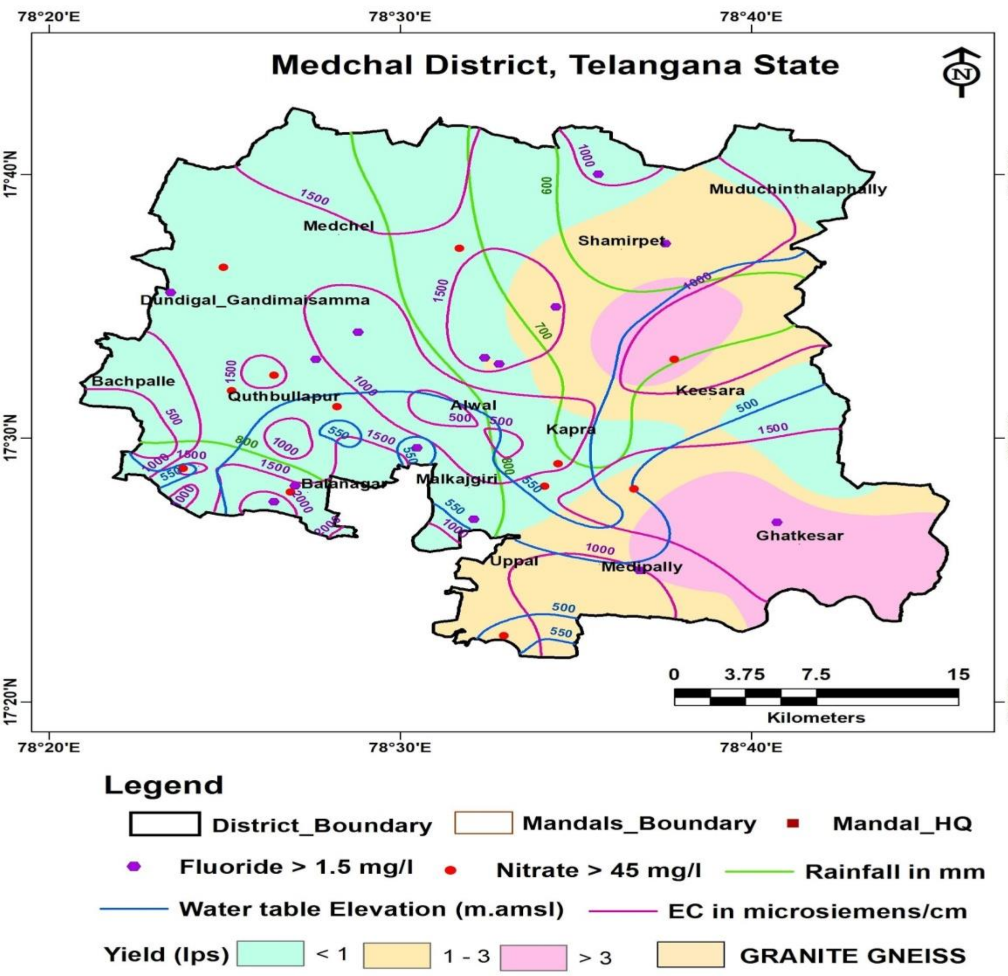


Fig.3.8: Hydrogeology map of Medchal−Malkajgiri district.

3.3.1a Thickness of weathering:

Thickness of weathering ranges from 10-20 m in 67 % of area, shallow weathering (< 10 m) in 12% of the area and deep weathering (> 20 m) in remaining part of Medchal−Malkajgiri district (Fig.3.9).

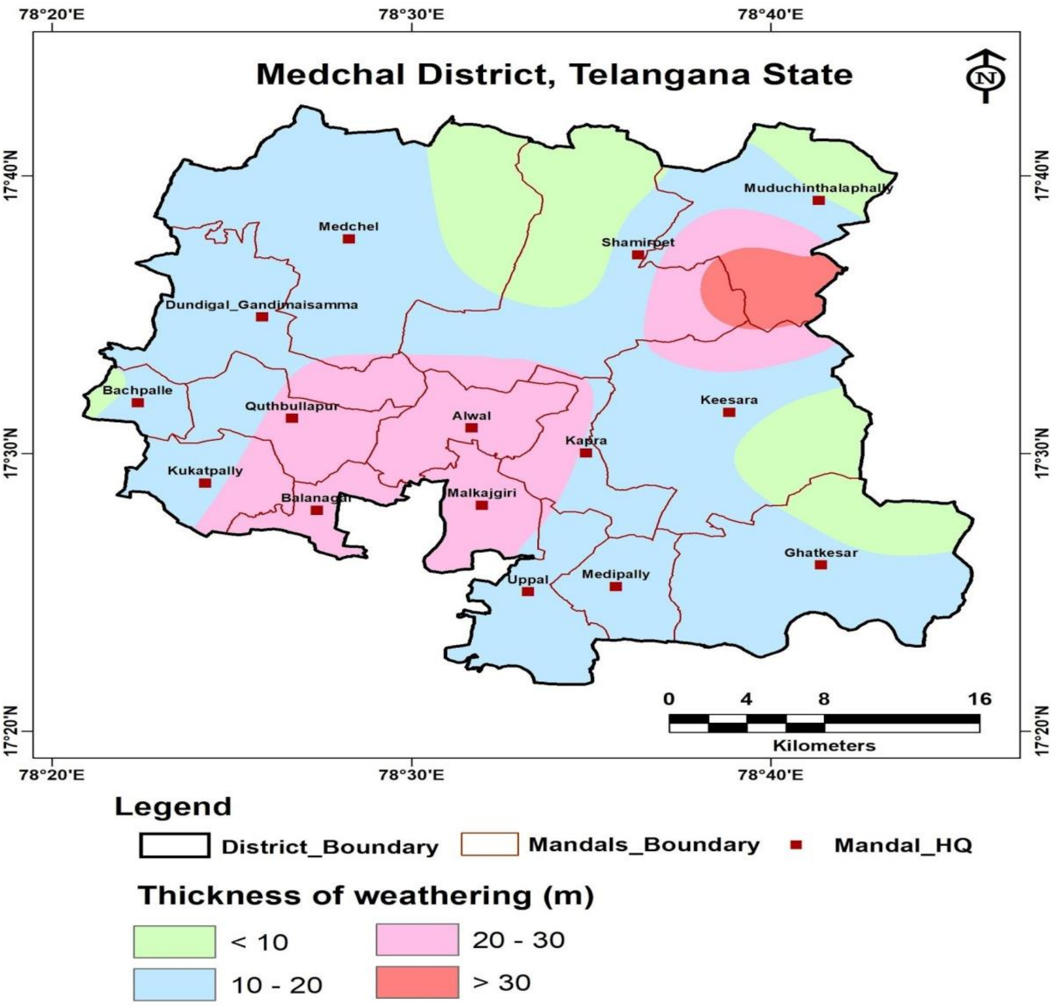


Fig.3.9: Thickness of weathering in Medchal−Malkajgiri district.

3.3.1b Depth of occurrence of Fractures:

Groundwater is extracted mainly through bore wells of 10 to 200m depth from fractured zone (~10 to 180 m). The fractures are more predominant upto the depth of 60 m in 73 % of the area, 60-100 and 100-150 fractures occur in 8% and 19% of area respectively and deep fractures in the range of above 150m (~ 150 to 199 m) occur in between Keesara and Shamirpet mandal HQ and Northeast part of Ghatkesar, Muduchinthalapally mandals. Analysis of occurrence of fractures (32 no's from 23 wells) reveals that the majority of fractures (~70 %) occur within 100 m depth (Fig. 3.10).

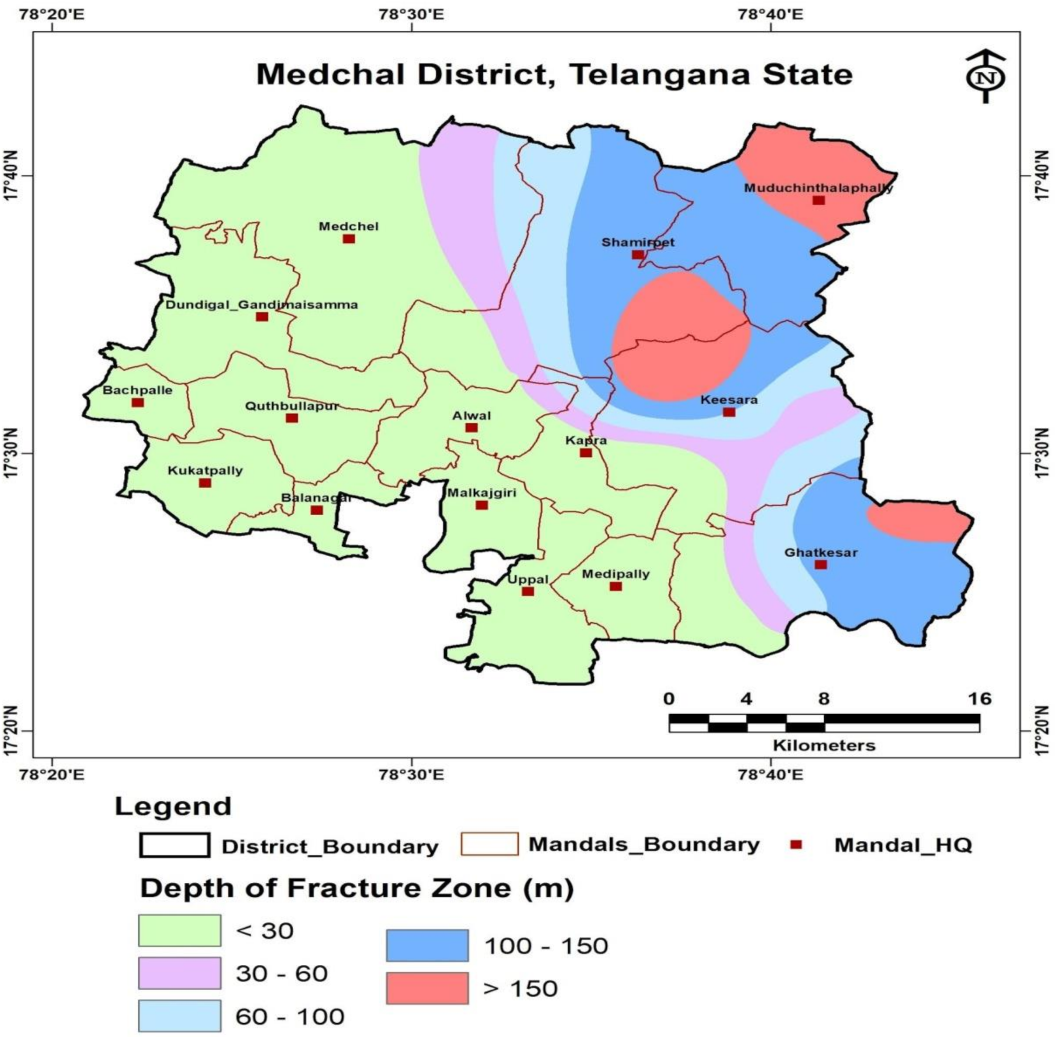


Fig.3.10: Depth of occurrence of fracture zone in Medchal−Malkajgiri district.

3.3.2 Aquifer systems of Medchal−Malkajgiri District:

The aquifers are the weathered zone at the top, followed by a discrete anisotropic fractured zone at the bottom, generally extending down to 200m depth. Weathered and fractured granites and gneisses form the major aquifer system. Ground water occurs under unconfined and semi-confined conditions and these zones are interconnected with the deep fracture zones. The primary storage available in the weathered zone is over-exploited for irrigation purposes which has resulted in desaturation of the weathered zone at many places. Broadly, two aquifer units have been identified that include Shallow Aquifer and Deeper Aquifer.

A) Shallow Aquifer (Aquifer-I):

Shallow aquifer mainly consists of weathered residuum where ground water occurs under water table condition and is mainly developed by construction of dug wells or shallow bore wells fitted with hand pump. The shallow aquifer is considered up to the maximum depth of weathering and first fracture encountered (below weathered depth) generally down to ~30 m depth. Ground water yield in these unconfined aquifers varies from 0.0003 to 4.30 lps (avg: 2.29 lps). The transmissivity varies from 0.09 to 93m^2/day in weathered granite/gneiss aquifer and details of aquifer characteristics are given in Table 3.1.

B) Deep Aquifer (Aquifer II):

The second aquifer is the deeper aquifer which tapped the fractured zone. Ground water occurs under semi-confined to confined conditions in the fractures upto the maximum depth of 199 m bgl (Deepest fracture encountered). The depth of fracturing varies from 11 m to 196m with yield of 0.07 to 9.24 lps. The specific capacity of the consolidated formation ranges between 12 and 34 lpm/mdd; transmissivity (T) between 0.2 and 40m^2/day. The aquifer characteristics given in Table 3.1.

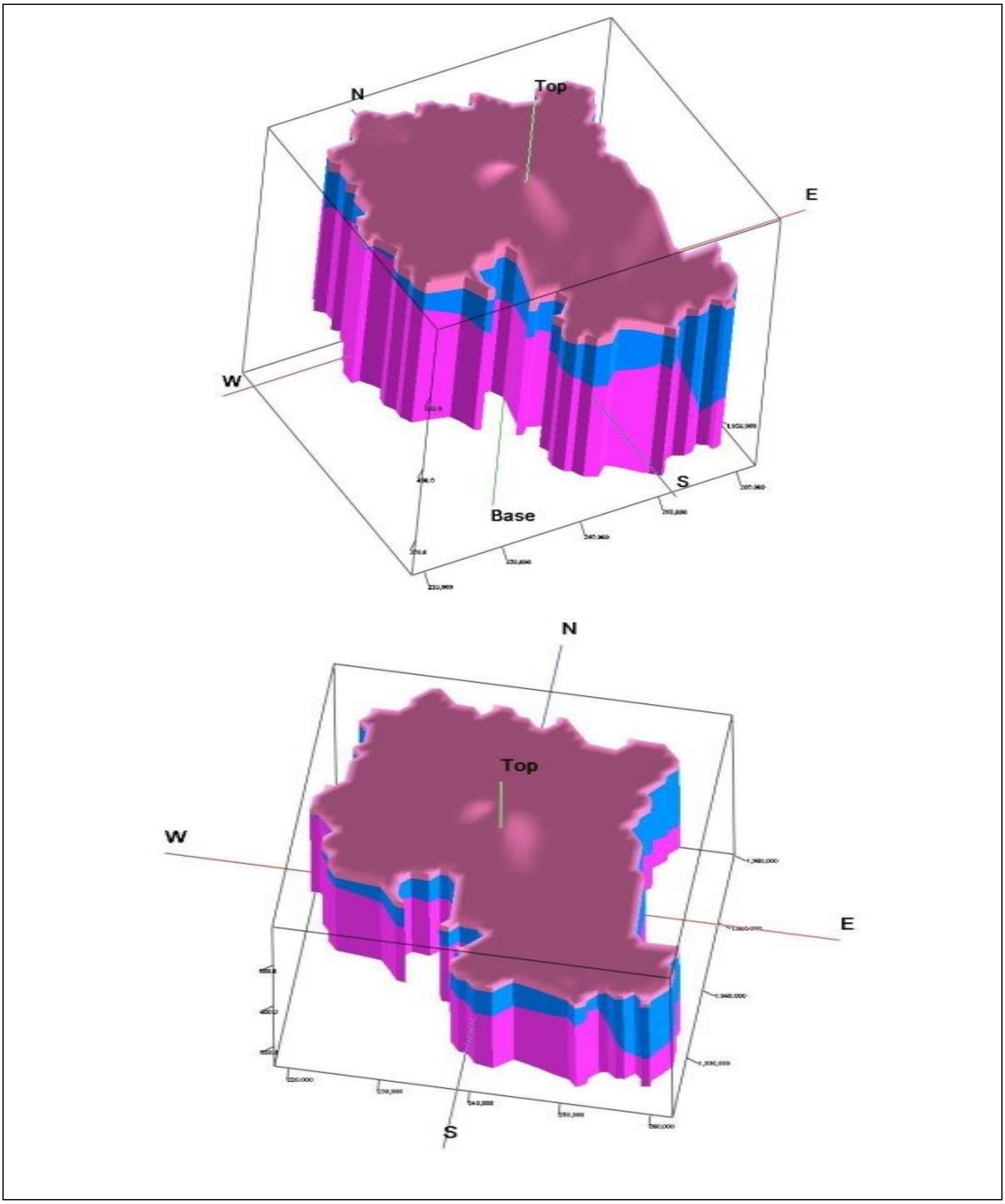
Table 3.1: Aquifer Characteristics

	Archean Crystalline	
Prominent Lithology	Granite, gneiss,	
Aquifers	Aquifer-1 (Weathered Zone)	Aquifer-2 (Fracture Zone)
Thickness range	<10-30m	upto 196m
Depth range of occurrence of fractures	-	70% fracture encountered between 30 to 100m

Range of yield potential	<1 to 5	<1 to 9
Transmissivity (m2/day)	Upto 93	
Specific Capacity (lpm/mdd)	12 to 34	
Specific yield/Storativity	0.0001 to 2.3 $x10^{-5}$	
Suitability of domestic purposes	Yes	

3.3.3 Aquifer Disposition 3D and 2D:

a) Aquifer Disposition 3D: Conceptualization of 3-D hydrogeological model was carried out by interpreting and integrating representative 30 data points (both hydrogeological and geophysical down to 200 m) for preparation of 3-D map, panel diagram and hydrogeological sections. The collated lithological information has been utilized to generate 3D maps (Fig.3.14) along with panel diagram (Fig. 3.11) for Medchal−Malkajgiri district using the RockWorks-16 software.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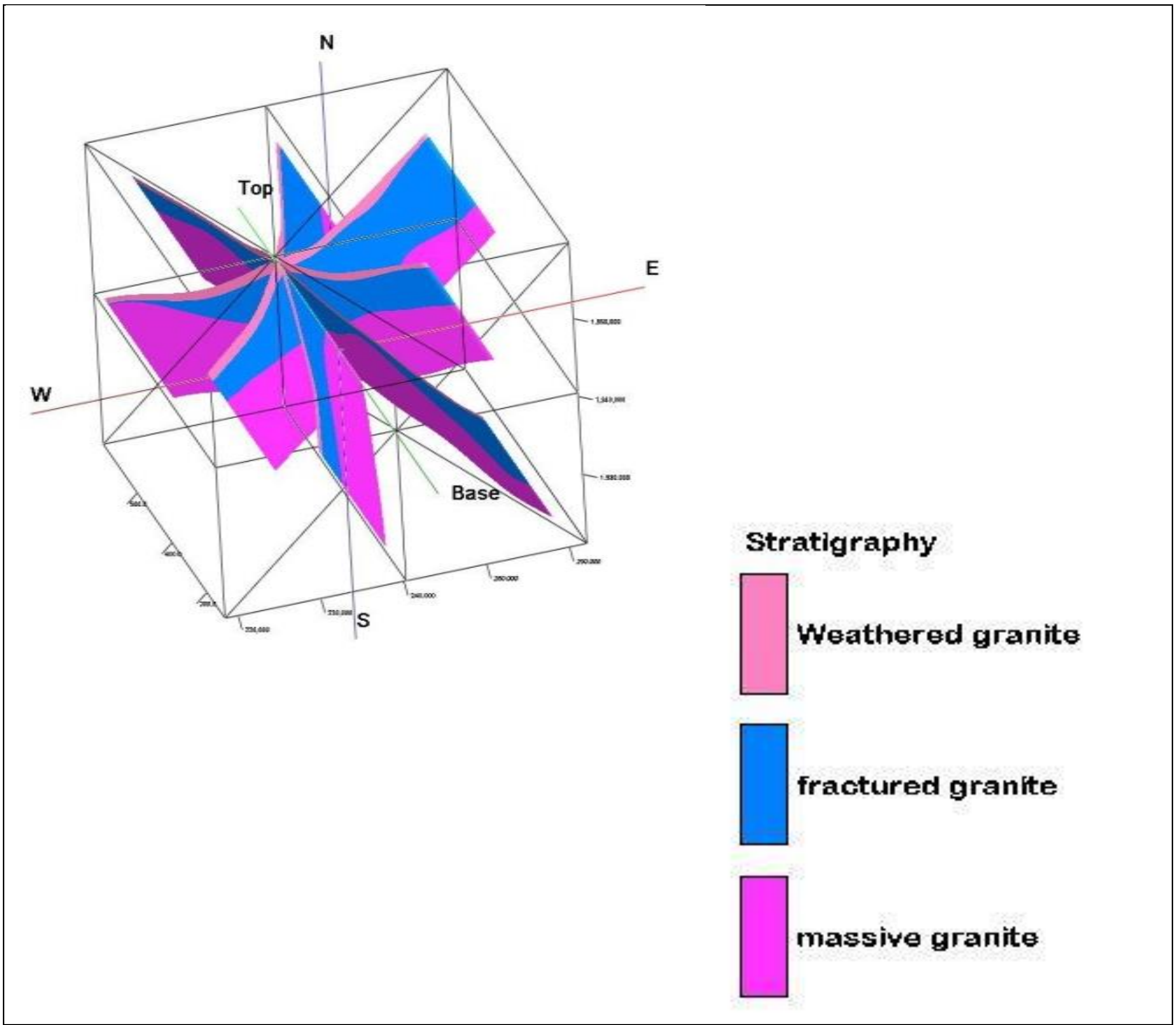

Fig.3.11: 3D Model for study area

b) Aquifer Disposition 2D:

Two hydrogeological sections are prepared in NE-SW and NW-SE directions (Fig.3.12 a & b).

i) North East and South West Section:

The section from Laxampur to Qutubullapur covering 45 kms shows a variation in thickness of Aquifer I (Fig.3.12a). The thickness of fracture decreases towards (NE to SW) North East to South Western part and the least thickness of the fracture zones encountered at Qutubullapur area.

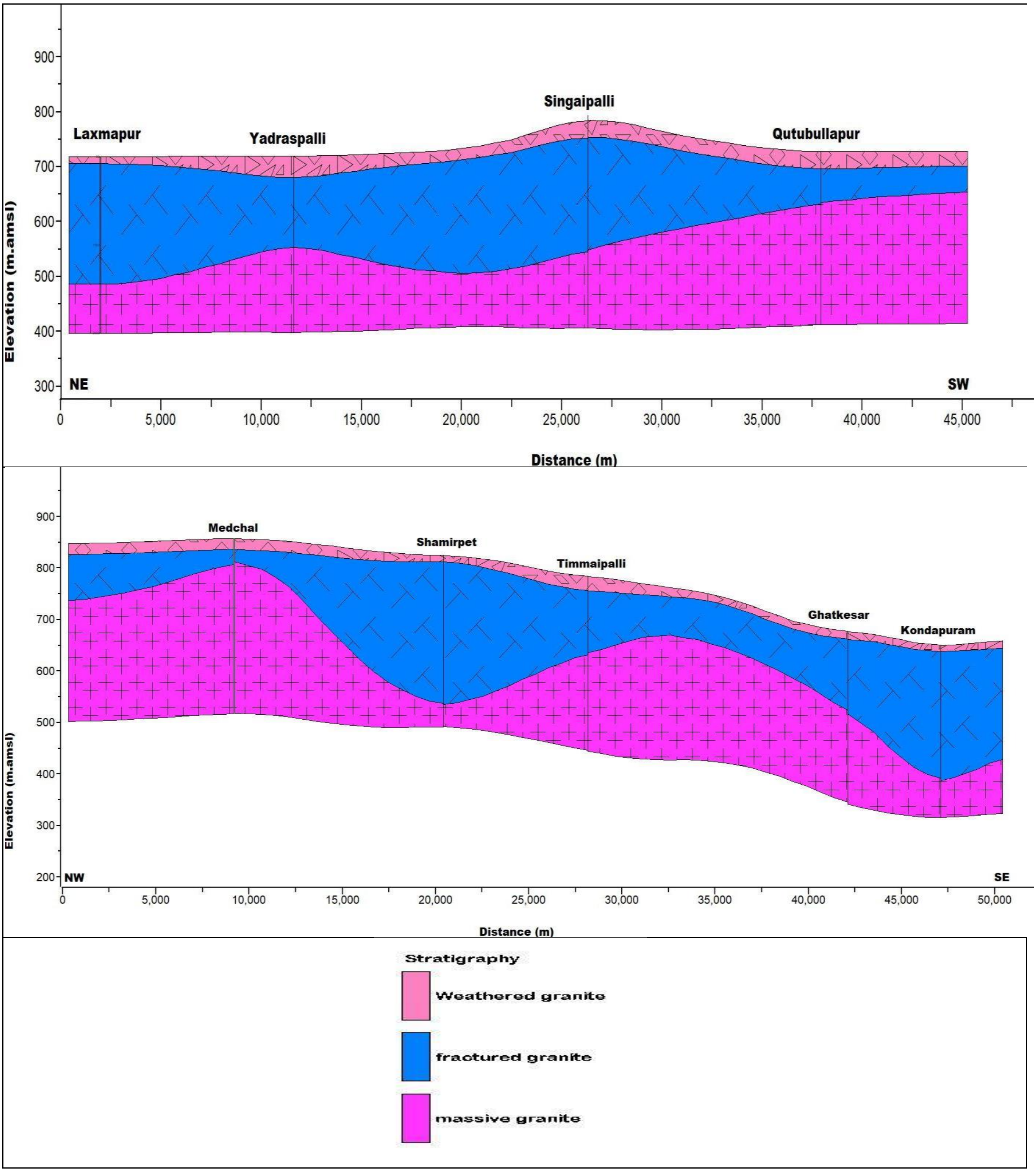

Fig.3.12: 2D - Hydrogeological profile in different directions.

ii) North West and South East Section:

The section along Medchal to Kondapuram in North West - South East direction covers~50 kms (Fig.3.12b) shows a high variation in the thickness of fracture zone. The maximum thickness was encountered at Shamirpet and Kondapuram locations.

4. GROUND WATER RESOURCES

Mandal-wise dynamic and in-storage ground water resources are computed based on GEC-2015 methodology. Summarized mandal-wise resources are given in Table-4.1.

As per 2020 GEC report, the net dynamic replenishable groundwater availability is 98.93 MCM, gross ground water draft for all uses is 60.11 MCM, provision for drinking and industrial use for the year 2025 is 10.67 MCM and net annual ground water potential available for future irrigation needs is 28.92 MCM. Thus, Stage of ground water development varies from 55% (Shamirpet mandal) to 95% (mandal). 04 (Bachpalle, Balanagar, Kukatpally and Quthbullapur) mandals are categorised as Critical zone, 03 (Alwal, Dundigal and Medchel) mandals as semi critical and remaining 08 mandals as safe zone (Fig. 4.1).

Table-4.1: Computed Dynamic, In-storage ground water resources, Medchal−Malkajgiri district.

As per GEC 2020	
Parameters	**Total**
Dynamic (Net GWR Availability)	
• Monsoon recharge from rainfall (MCM)	63.46
• Monsoon recharge from other sources (MCM)	8.15
• Non-Monsoon recharge from rainfall (MCM)	13.49
• Non-monsoon recharge from other sources (MCM)	13.83
• Total Natural Discharges (Ham)	989.28
Gross GW Draft	
• Irrigation (MCM)	34.39
• Domestic and Industrial use (MCM)	25.72

Provision for Drinking and Industrial use for the year 2025 (MCM)	10.67
Net GW availability for future irrigation (MCM)	28.92
Stage of GW development (%)	67.52

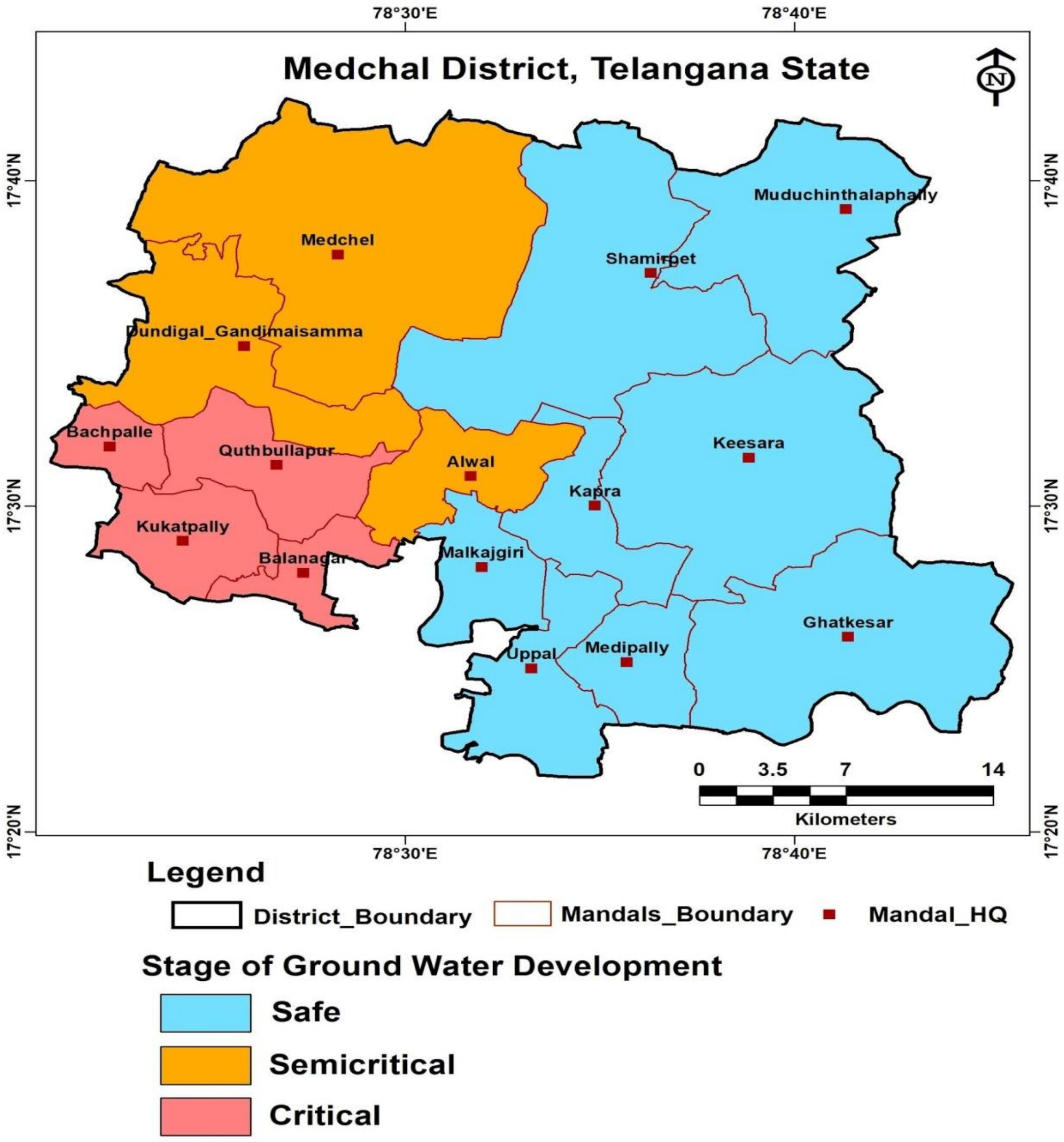

Fig.4.1: Mandal wise stage of ground water development.

5. GROUND WATER RELATED ISSUES AND REASONS

5.1 Issues:

- Few mandals are fluorosis endemic where fluoride (geogenic) as high as 2.93 mg/L during pre-monsoon and 4.84 mg/L during post-monsoon season is found in groundwater especially at Balanagar. The high fluoride concentration (>1.5 mg/L) occurs in 31% and 44 % of the wells during pre-monsoon and post-monsoon season.

- High nitrate (> 45 mg/L) due to anthropogenic activities is observed in 41% and 42% of ground water samples collected during pre-monsoon and post-monsoon season in all the mandals.

- The high concentration of EC (> 3000 micro Siemens /cm) is noticed in only 2% of ground water samples collected during the post-monsoon season.

Critical

- Bachpalle, Balanagar, Kukatpally and Quthbullapur mandals are critical with a stage of ground water development of 95%.

Deep water levels

- Deep water levels (> 20 m bgl) are observed during pre as well as post-monsoon season in 11 % and 07 % of the area respectively.

- Out of 25 wells analysed, 05 wells during pre-monsoon 01 well during post-monsoon showed a falling trend in the last 10 years (@ -0.28 m/yr to – 0.58 m/yr and < -0.202 m/yr) respectively.

Sustainability

- Low yield (<1 lps) occurs in ~70% of the area. The yield from bore wells have reduced over a period of time and some bore wells which used to yield sufficient quantities of water have gone dry due to low rainfall in the last two years.

Water Marketing and other Issues

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

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

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

5.2 Reasons for Issues:

Geo-genic pollution (Fluoride)

- Fluoride bearing minerals such as fluorite and Fluor apatite in the country rock forms the major source of fluoride in ground water. The situation is exacerbated by rock water interaction where acid-soluble fluoride bearing minerals get dissolved under alkaline conditions.

- Higher residence time of ground water in deeper aquifer.

Anthropogenic pollution (Nitrate)

- Higher concentration is due to unscientific sewage disposal of treated and untreated effluents in urban and rural areas. Use of NPK fertilizers and nitrogen fixation by leguminous crops.

Anthropogenic activity in **Critical areas and Deep water levels**

- In Critical areas, paddy cultivation during Rabi season (32 % to total crops of rabi) demands a high dependence on ground water resulted in deep water level and the situation is worsened by limited artificial measures.

Geogenic Factors - Sustainability

- Absence of primary porosity and negligible development of secondary porosity along with low rainfall, desaturation of weathered zone and urbanization reduced the sustainability of aquifers..

6. MANAGEMENT STRATEGIES

High dependence on groundwater coupled with absence of augmentation measures has led to a fall in water level and desaturation of weathered zones in some parts of the district. Apart from this ground water quality problems due to geogenic and anthropogenic factors as well as sustainability of existing groundwater structures, food and drinking water security are challenging tasks in the preparation of management plans. The uneven distribution of groundwater availability and its utilization indicates that a single management strategy cannot be adopted and requires integrated hydrogeological aspects along with socio-economic conditions to develop appropriate management strategies.

6.1 Management plan:

The management plan comprises two components namely supply side management and demand side management. The supply side management is proposed, based on surplus surface water availability and the unsaturated thickness of aquifer whereas the demand side management is proposed by use of micro irrigation techniques. Supply side management has been prepared separately for urban mandals namely, Alwal, Bachupally, Balanagar, Kapra, Kukatpally, Malkajgiri, Medipally, Quthbullapur and Uppal.

6.1a. Supply side management

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

- The area suitable for ground water augmentation through artificial recharge has been demarcated based on the analysis of average post-monsoon depth to water level data of the observation wells for the period of 2012-2021 and the existing data on artificial recharge structures constructed under various schemes of Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and Integrated Watershed Management Programs (IWMP) by Rural Development department, Govt. of Telangana.

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

- The source water availability is estimated from the 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, 20 % run- off yield is considered as un-committed yield and for recommending artificial recharge structures in intermittent areas.

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

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

Table-6.1: Recharge and Run-off available in the district

Total geographical area of district (Sq.km)	1089.91 Sq.km
Area feasible for recharge (Sq.km)	729.17 Sq.km
Unsaturated Volume (MCM)	3854.97 MCM
Recharge Potential (MCM)	77.09 MCM
Runoff available (MCM)	48.87 MCM
Surplus runoff available for recharge (MCM)(20% of runoff)	9.77 MCM

6.1.1 Supply side measures:

6.1.1a. Artificial Recharge Structures in rural areas

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

Table-6.2: Proposed artificial recharge structures

Percolation Tanks (@ Rs.15 lakh Capacity of the tank: 0.007MCM, Av. Gross storage in an year =0.007 MCM*2 fillings = 0.014 MCM Volume of Water expected to be recharged (in MCM) Estimated Expenditure (in Crores)	101 1.41 MCM 1.51 Cr
Check Dams (@ Rs.10 lakh, Av. Gross storage in an year = 0.007 MCM * 5 fillings = 0.035 MCM Volume of Water expected to be recharged (in MCM) Estimated Expenditure (in Crores)	100 3.5 MCM 1.0 Cr
Total volume of water expected to be recharged (in MCM)	4.91 MCM
Total Estimated Expenditure for Artificial Recharge (Rs. in Cr.)	2.51 Cr

201 artificial recharge structures (100 check dams and 101 mini Percolation tanks 'in 41 villages) with a total cost of **2.51** crores can be taken up. (Considering CDS with recharge shafts with 5 fillings with a unit cost of Rs 10 lakhs each and mini PT's with 2 fillings with a unit cost of Rs 15 lakhs each)

- After effective utilization of this yield, there will be 4.91 MCM of ground water recharge (50 % of total utilizable yield).
- Roof top rainwater harvesting structures should be made mandatory to all Government buildings (new and existing).

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

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

Around 206.6 sq.km of the land in the Alwal, Bachupally, Balanagar, Kapra, Kukatpally, Malkajgiri, Medipally, Quthbullapur and Uppal urban mandals are developed by built-up and 33.3 Sq.km of the land as open land. The thickness of weathering varies from 10 - 30 m and the depth of occurrence of shallow fractures is less than < 30 m. The rain water from the built-up and open spaces can be harvested by the construction of open pits and trenches. The recharge pits (Fig: 6.2) of dimensions 3.0*3.0*4.0 m length*width*depth is proposed to harvest rain water from the roof top and the recharge pits of dimensions 3.0*5.0*4.0 m

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

Table-6.3: Proposed structures for roof top and open space harvesting

Recharge potential available:12 MCM Run off considered from built-up area= 90.4 MCM Run off considered from open space= 5.0 MCM Recharge pits recommended for individual buildings					
Pit/Trench for AR	**Width (m)**	**Length (m)**	**Depth (m)**	**No. of Pits/trenches Feasible**	**Total Pit volume (Cu.m)**
No. of pits for roof top@36 cu.m (Avg. 5 fillings/yr for 1800 sq. m)	**3**	**3**	**4**	**237754**	**8559135**
No. of pits for Open area@60 cu.m (Avg. 5 fillings/yr)	**3**	**5**	**4**	**61137**	**3668201**

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

Fig 6.1:Trench

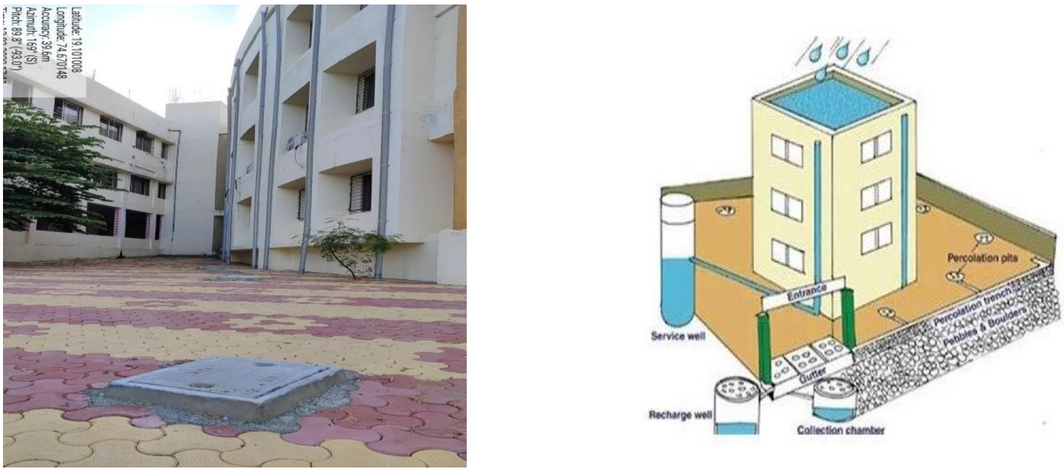

Fig:6.2: Recharge Pit

Storm Water Management in Open areas

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

Source Control & Prevention Techniques:

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

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

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

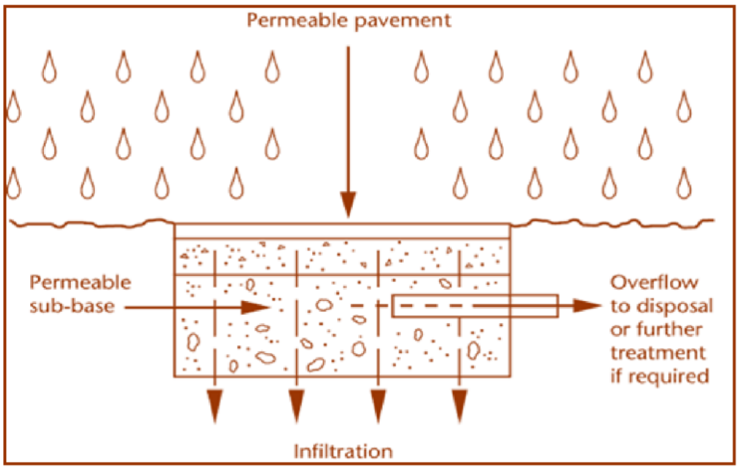

Fig 6.3. Permeable pavement

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

Fig 6.4: Paved Pervious Surfaces

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

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

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

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

Ongoing projects

6.1.1.2 Repair Renovation and Restoration of existing tanks:

- Desilting of existing minor tanks (352) was taken under state Govt. sponsored Mission Kaktiya-Phase-1, Phase-2, Phase 3 and 4 to remove 4 MCM of silt and this has created additional surface storage. This will augment ~ 1.75 MCM to groundwater and with this additional ~114 ha land can be brought under irrigated dry (ID) crops in tank ayacut.

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

6.1.1.3 Water Conservation Measures (WCM) (Farm Ponds)

The farm ponds are the ideal water conservation structures, which are usually constructed in the low lying areas of the farm. The size of form ponds can be 10 x 10 x 3 m. In the district, 190 farm ponds exist in 19 villages and additional **2280** farm ponds are recommended (20 in each village in 114 villages) with a total cost of **5.70** crores.

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

6.1.2.1 Rain Water Harvesting for Storage & Reuse in City areas

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

Fig-6.4: Runoff from built-up & open area

Runoff	**Quantity (???units)**
Runoff generated from the roof top area	90.4
Runoff generated from the open area	5.0
Runoff utilized from roof top area for ground water recharge	9.0
Runoff utilized from open area for ground water recharge	4.0
Available surplus runoff from built up area for storage and domestic purposes	83

Fig 6.5 Storage Tank (for direct use)

6.1.3 Other supply side measures:

Existing ARS like percolation tanks and check dams and dried dug wells can be de-ilted 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.

On-going Work:

- In the district, currently ~**576 ha** area is irrigated through micro-irrigation saving ~1MCM (considering 0.006 MCM/ha for Irrigated Dry crops against 0.008 MCM/ha).

Proposed Work:

- ~11400 ha of additional land that can be brought under micro-irrigation (@100 ha/village in 114 villages) costing about 68.40 crores (considering 1 unit/ha @0.6 lakh/ha). With this, 19.79 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 between the productive wells, intermittent pumping of bore wells is recommended through regulatory mechanisms.
- 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 a 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.

6.1.4 Other measures

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

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

6.2 Expected Outcomes

With the above interventions costing Rs: 76.61 crores (Roof top and open space rain water harvesting for artificial recharge in urban areas.), the likely benefit would be the net saving of 114 MCM of ground water for draft and recharge of 19.75MCM of ground water. This will bring down the stage of ground water development by 38% (from 95 % to 57%).

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