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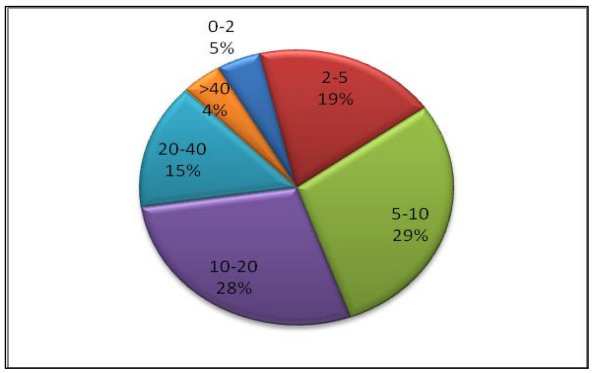
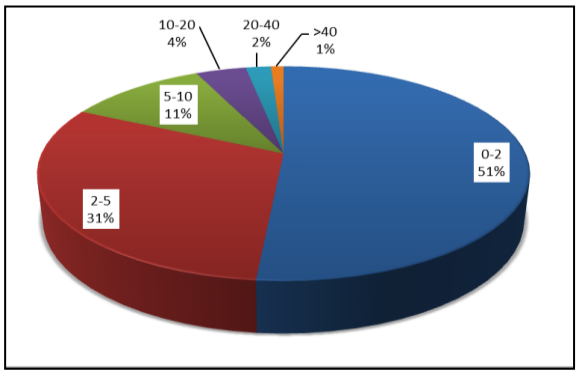
Central Ground Water Board

Ministry of Jal Shakti
Department of Water Resources,
River Development & Ganga Rejuvenation
Govt. of India

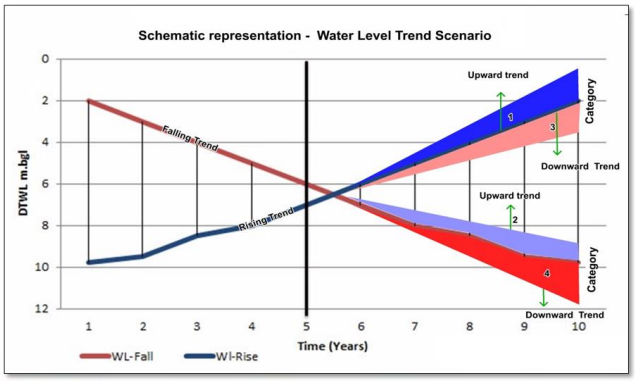
GROUND WATER YEAR BOOK
2020-21
ANDHRA PRADESH



MAY 2020 WATER LEVEL



NOVEMBER 2020 WATER LEVEL



Southern Region, Hyderabad
June, 2021

Central Ground Water Board
Ministry of Jal Shakti
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GROUND WATER YEAR BOOK
2020-2021
ANDHRA PRADESH STATE

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GROUND WATER YEAR BOOK
2020-21
ANDHRA PRADESH STATE

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FOREWORD

The historical ground water level monitoring data is useful in understanding changes in ground water regime in time and space and for preparation of sustainable development plan for the state. Central Ground Water Board has been monitoring ground water regime since 1969. As on 31-3-2021, a total of 867 operational ground water monitoring wells (GWMS) (DW: 674, Pz: 193) are in operation. These stations are being monitored four times a year viz., May, August, November and January to study the seasonal and long term changes.

The ground water level monitoring carried out by Central Ground Water Board, Southern Region, and Hyderabad during 2020-21 is compiled in the form of Ground Water Year Book. It outlines the ground water level behaviour in the current year with reference to the corresponding periods of previous year and also with last decadal mean. It also elaborates the chemical quality of ground water.The water level data of Groundwater and Water Audit Department of Andhra Pradesh state has also been considered to study the water level behavior. It also elaborates the chemical quality of ground water.

The sincere efforts made by **Dr. G.Praveen Kumar Sc-C, Ms. Caroline Louis Sc-B, Ms. Resma S.Pillai Sc-B and Ms T.Sabna Sc-B** in preparation of the report are commendable.

It is hoped that the Ground Water Year Book will be quite useful as baseline information for planners, administrators and researchers involved in ground water development and management in the state of Andhra Pradesh.

Hyderabad **(G KRISHNAMURTHY)**
Dated: 03.06.2021 **Scientist-D & Head of Office**

Executive Summery

Andhra Pradesh State with geographical area of 1.63 lakh sq.km is governed administratively by 13 districts. The total population of the State is 4.96 crores with a decadal growth of 9.2%. It lies between North Latitude 12° 37' and 19° 09' and East Longitude 76° 45'and 84° 47'. The State is mainly drained by Godavari, Krishna, Pennar, Vamsadhara, Nagavalli, Gundlakamma rivers. The major part of the state is underlain by gneissic complex with a structural fill of sedimentary formations and basin-fill of meta-sedimentary formations and meta-sediments. During the year 2020, the state received rainfall which ranges from 880 mm (Anantapur district) to 1552 mm (West Godavari district) with an annual rainfall of 1247 mm.

As part of National Ground Water Monitoring Programme, Central Ground Water Board (CGWB) is carrying out ground water regime monitoring four times a year (January, May (pre monsoon), August and November (post monsoon)) and ground water quality monitoring once in the year (May). Ground Water Year Book is prepared by integrating data generated from CGWB and Ground Water Department, Govt. of Andhra Pradesh. As on 31.03.2021, Central Ground Water Board, Southern Region monitors 674 dug wells and 193 piezometers in order to depict the changes in ground water regime of the state in different seasons.

During premonsoon 2020, 53% area of the state is having depth to water level within 10mbgl and 97% area in the state having depth to water level within 10mbgl during post monsoon 2020. During pre monsoon deeper water levels of more than 10 m are noticed in Rayalaseema region and Prakasam districts, where ground water is the main source for irrigation. In the state about 87% of the area experienced rise in seasonal water levels in post monsoon compared to the pre-monsoon period.

Annual water level fluctuation of premonsoon has shown a rise in water levels for 92 % of the area. During post-monsoon about 71% area of the state experienced rise in annual water level fluctuation because of the excess rainfall in 2020 monsoon in comparision with 2019 monsoon. 79% of the area experienced rise of water level in decadal mean water level fluctuation of 2010-2019 with respect to May 2020, whereas 87% of the area experienced rise in decadal mean water level of 2010-2019 with respect to November 2020.

GROUND WATER YEAR BOOK
(2020-2021)
ANDHRA PRADESH

1. INTRODUCTION

Central Ground Water Board has taken up the task of ground water management, development, augmentation, protection and regime monitoring both in terms of quality and quantity in the state. In order to arrive at proper parametric indices of evaluation and judicious development of ground water resources, the Board is monitoring a National Network of Hydrograph Stations (NHS) on long term basis since 1969 through a network of wells (Dug wells and Piezometers) for studying its long term behaviour due to influence of rainfall and ground water development. A historical database on the ground water levels and water quality has been developed over a period of time since the year 1969.

The monitoring mainly comprises measurement of water levels and temperature, four times in a year viz., in the months of May (pre-monsoon), August (mid-monsoon), November (post-monsoon) and January and collection of water samples during May every year, for chemical analysis. As on 31-03-2020, there were 838 operational Ground Water Monitoring Wells (GWMS) (674 dug wells and 164 piezometers). During the year (2020-21), 29 piezometers were established in Prakasam district. As on March 2021, the status of monitoring stations is 867 wells, out of which, 674 are Dug wells and 193 Piezometers.

The dug wells tapping unconfined aquifers are mostly confined to village limits, which are used for domestic purpose. Some of these are community wells and the rest belong to private individuals. The piezometers tapping unconfined and confined aquifers constructed under various projects and exploration programs by the department are monitored manually four times a year. The location of network of monitoring wells is presented in the **Fig.1.1.**

1.1 Location and Extent

Andhra Pradesh State is the 7th largest state in India covering geographical area of 1,63,000 Km^2. It lies between NL 12° 37’ and 19° 09’ and EL 76° 45’ and 84° 47’. The State is bordered on the east by Bay of Bengal (~970 km), south by Tamilnadu and Karnataka, west by Karnataka and Telangana and north by Telangana, Chattisgarh and Orissa states.

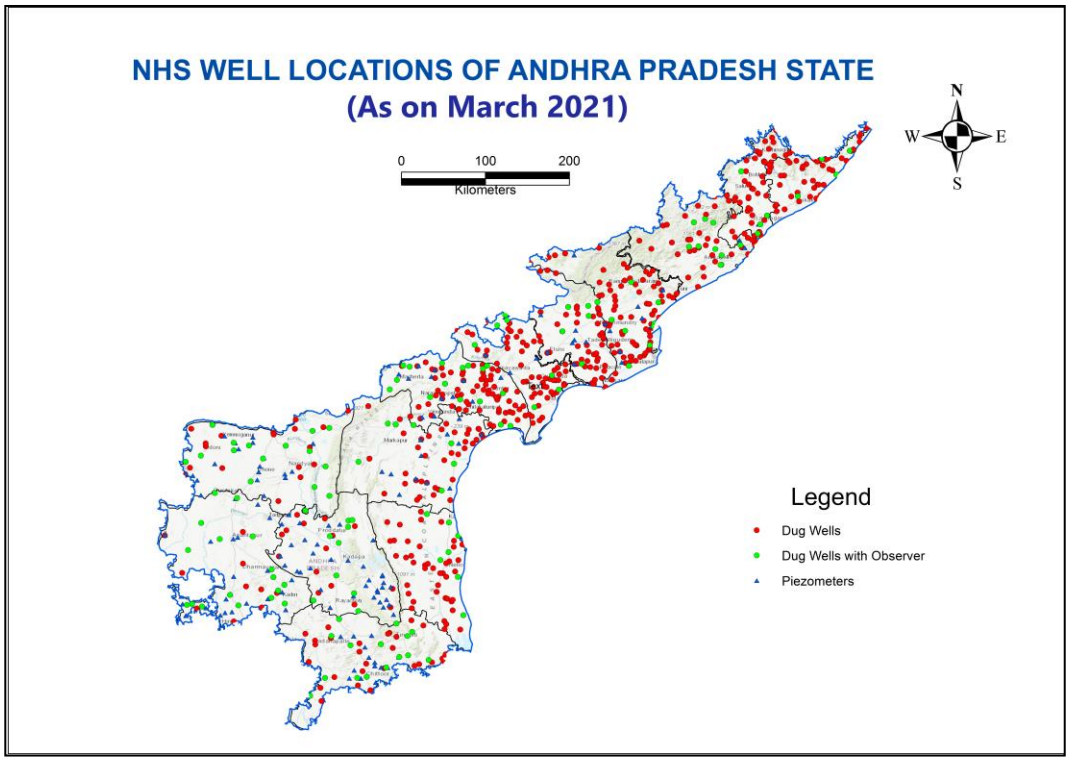


Fig.1.1: Location of GWMS in Andhra Pradesh State (as on 31st March, 2021)

Administratively, the State is divided into 13 districts (Srikakulam, Vizianagaram, Vishakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, SPS Nellore, YSR Kadapa, Kurnool, Anantapur and Chittoor) and governed by 670 revenue mandals (mandals) with 17398 revenue villages. Total population of the state (2011 census) is ~4.96 Crores (with male-female ratio of 997) of which 90 % lives in rural area and 10% in urban area. The density of population varies from 188 persons/km^2 in YSR Kadapa to 518 persons/km^2 in Krishna district (average density: 304 persons/km^2). The overall growth in total population during decade is ~9.2 % (2001 to 2011 census) (**DES, Govt of Andhra Pradesh, 2015**). The present ground water year book (2020-2021) depicts the ground water level scenario in the State and describes the behaviour of water levels during the period. The piezometric data of Ground Water Department, Govt of A.P. is also integrated in order to have realistic water level scenario.

2. PHYSIOGRAPHY, DRAINAGE AND SOIL

2.1 Physiography

Physiographically, Andhra Pradesh State can be divided into three distinct zones, viz., Coastal plains, Eastern Ghats and Western pediplains. The first two zones stretch from north-east to south-west in a narrow strip while 3rd zone occupy rest of the area. The elevation ranges from 0 to > 600 m above mean sea level (a.msl) (**Fig.2.1**).

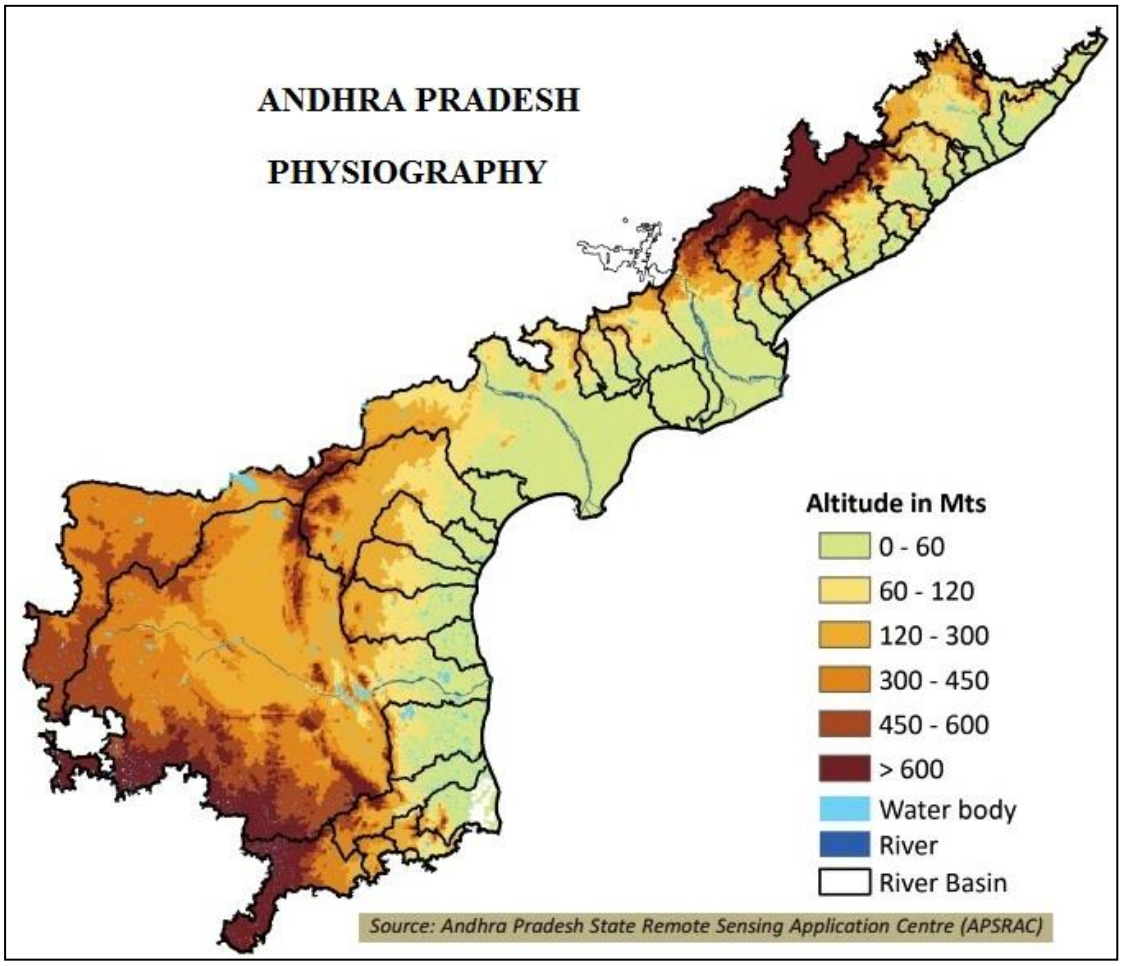


Fig.2.1: Physiography map of Andhra Pradesh (after APRAC-2014)

2.1.1 Coastal Plains

The coastal plains stretch from Kalingapatnam (Srikakulam district) in north to Pulicat (Nellore district) in south along a narrow strip, which broadens in the middle along Godavari-Krishna deltas (up to 80 km^2). The altitude of coastal plains ranges from sea level at the coast to 150-200 m amsl on the west. The area has rich agricultural land owing to two deltas.

2.1.2 Eastern Ghats

The Eastern Ghats follow the Coastal Plains stretching closely from one end to other end except in area between the Godavari and Krishna rivers. The hill ranges trend in NE - SW direction in the north and in N-S direction in the south and attain an elevation of 600 to 1200 m amsl. The Nallamala, Erramala, Seshachalam, Velikonda and Palakonda hills falling in Rayalaseema region, cover southern section of Ghats**.**

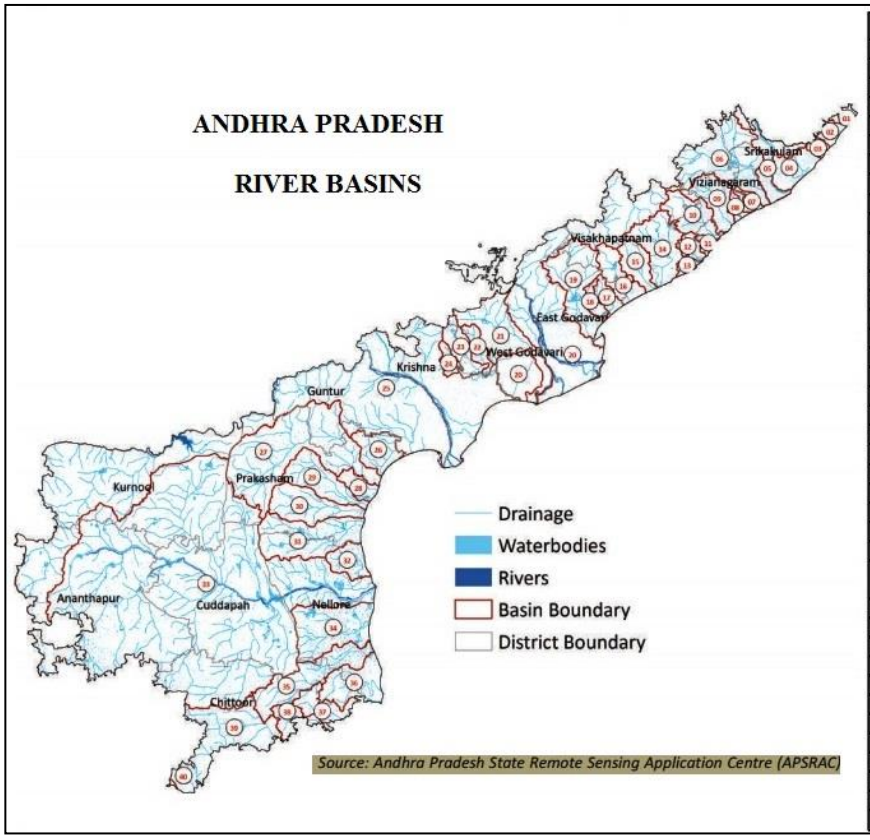
2.1.3 Western Pediplains

A major part of State covering parts of Rayalaseema region (Kurnool and Anantapur districts), fall in this category. The pediplains show rolling topography with flat to undulating tracts. This plateau in the interior of the State extends largely between elevations of 150 to 600 m amsl except at places where the elevation ranges from 600 to 900 m amsl.

2.2 Drainage

Godavari and Krishna rivers and their tributaries drain the northern and central part and Pennar river drains in southern part of state before joining Bay of Bengal (**Fig. 2.2**). There are 3 major basins and 11 medium river basins in the state. The major river basins are Godavari, Krishna and Pennar and medium basins are Vamsadhara, Nagavali, Sarada, Yeleru, Gundlakamma, Paleru (A), Manneru, Uppateru, Swarnamukhi, Palar and minor drainages between Musi and Gundlakamma river. The drainage pattern is generally dendritic with wide valleys in western peniplain. The drainage in Eastern Ghat is coarse and dendritic with steep and narrow valleys. Youthful streams and valleys mark the eastern coastal tract intersected by innumerable feeder and distributary canal system. The mature river courses of Godavari, Krishna and Pennar meanders through the vast areas and are covered by deltas as well as coastal plains. The deltas of rivers are very extensive and characterized by considerable thickness of alluvial material.

Most of the smaller streams feed innumerable tanks. River Penna flows across the southern part of the state with its tributaries Chitravati, Papaghni, Kundu, Sagileru and Cheyyeru and drains major part of Rayalaseema region and Nellore district of coastal region. The drainage basins are characterized by undulating topography comprising a series of ridges and valleys intersperse by hill ranges. Vamsadhara and Nagavalli rivers with their distributaries drain the northeastern part of the state in Srikakulam district. Visakhapatnam district is mostly drained by local rivulets like Sarada. River Yeleru drains most of the East Godavari district while Yerrakalava, Tammileru drain West Godavari district. Nellore district is drained by Pennar, Swarnamukhi and Araniar rivers.



Basin Code	Name of River Basin
01	Bahuda
02	Mahendratanya
03	Pundiminor Basin
04	Noupada Minor Drainages
05	Vamsadara
06	Nagavali
07	Peddagedda
08	Kandivalasagedda
09	Champavathi
10	Gosthani
11	Mathurvada
12	Narvagedda
13	Anakapalli
14	Sarada
15	Varaha
16	Thandava
17	Pampa
18	Suddagedda
19	Yeleru
20	Godavari Basin
21	Yerrakalva
22	Tammileru
23	Ramileru
24	Budameru
25	Krishna Basin
26	Romperu
27	Gundlakamma
28	Minor Drainages between Musi & Gundlakamma
29	Musi (A) - K11
30	Paleru (A)
31	Manneru
32	Kandaleru
33	Pennar Basin
34	Upputeru
35	Swarnamukhi
36	Kalangi Basin
37	Araniar Basin
38	Kushustali
39	Palar
40	Ponnair

Fig.2.2: Drainage and River sub-basin map of Andhra Pradesh State. (After APRAC-2014)

2.3 Soils

The State has a wide variety of soils viz., Red soil, Laterite, Black Cotton soil, Deltaic Alluvium soil, Coastal soil and Saline soil. Red clayey soils occur predominantly in Srikakulam, Visakhapatnam, East Godavari and West Godavari districts in coastal region. Black cotton soil commonly occurs in Krishna and Guntur districts. Red earths with loamy sub-soil and red sandy loamy soil occur in Prakasam and Nellore districts and Laterite soils in Nellore and Prakasam districts. Black cotton soil occurs in part of Kadapa, Kurnool and Anantapur district and red loamy soils occur in parts of Chittoor and Kadapa districts. Red earths are predominant in Anantapur district. Soil map of AP is given in **Fig. 2.3.**

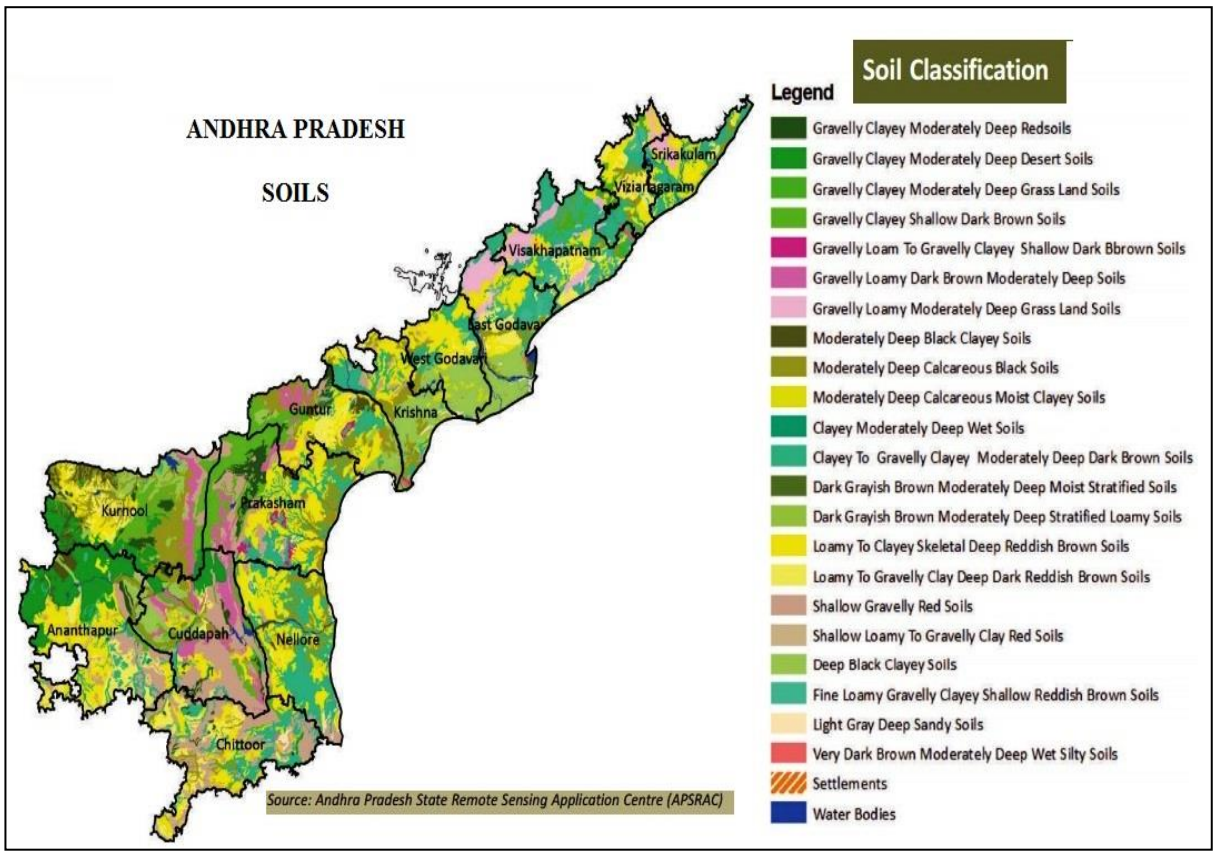


Fig.2.3: Soil Map of Andhra Pradesh (after APSRAC-2014)

3. HYDROMETEOROLOGY

3.1 Climate

The climate of the state is tropical in nature and is influenced by the topographical variations and maritime influence. The Deccan Plateau has more of a temperate climate than the coastal belt. The Eastern Ghats in Vishakhapatnam and its neighborhood play a significant role, which acts as a barrier to easterly winds in association with depression from Bay of Bengal during the southwestern monsoon. The Agro-climatic classification (Agricultural Department) of the state is given below.

Region	Classification
Rayalaseema	Scarce rainfall zone
Plateau	Southern zone
	Krishna – Godavari Zone
Coastal	North Coastal zone
Andhra Pradesh	South Coastal zone
	High Altitude
	Tribal Zone
	Scarce Rainfall Zone

3.2 Rainfall Analysis – 2020

District-wise monthly, seasonal, annual and normal rainfall and departure from normal is given in the **Table-3.1**. The district-wise departure from normal is depicted in **Fig. 3.1**. The salient features of rainfall analysis are given below: The normal annual rainfall of the state is 967 mm. Season-wise normal rainfall is 559 mm, 392 mm, 18 mm and 96 mm in southwest monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively, contributing 58% of annual rainfall in southwest monsoon, 30% of annual rainfall in northeast monsoon and 12% in non-monsoon season. Annual normal rainfall ranges from 596 mm in Anantapur district to 1186 mm in West Godavari district.

The annual rainfall in the year 2020 of the state is 1247 mm. Season-wise rainfall is 750 mm, 392 mm, 23 mm and 82 mm in southwest monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively contributing 60% of annual rainfall in southwest monsoon, 31% of annual rainfall in northeast monsoon and 9 % in non-monsoon season. The state received excess rainfall in 2020 that is 29% above the normal. The annual (2020) rainfall ranges from 880 mm in Anantapar district (48% above normal) to

1552 mm (31 % above normal) in West Godavari district. Monthly mean rainfall ranges from 10.7 mm in February to 232.8 mm in September. The traditional drought prone districts Kadapa, Kurnool, Chittoor and Anantapur of Rayalaseema region received excess rainfall of 100%, 54%, 53% & 48% above normal, respectively in 2020.

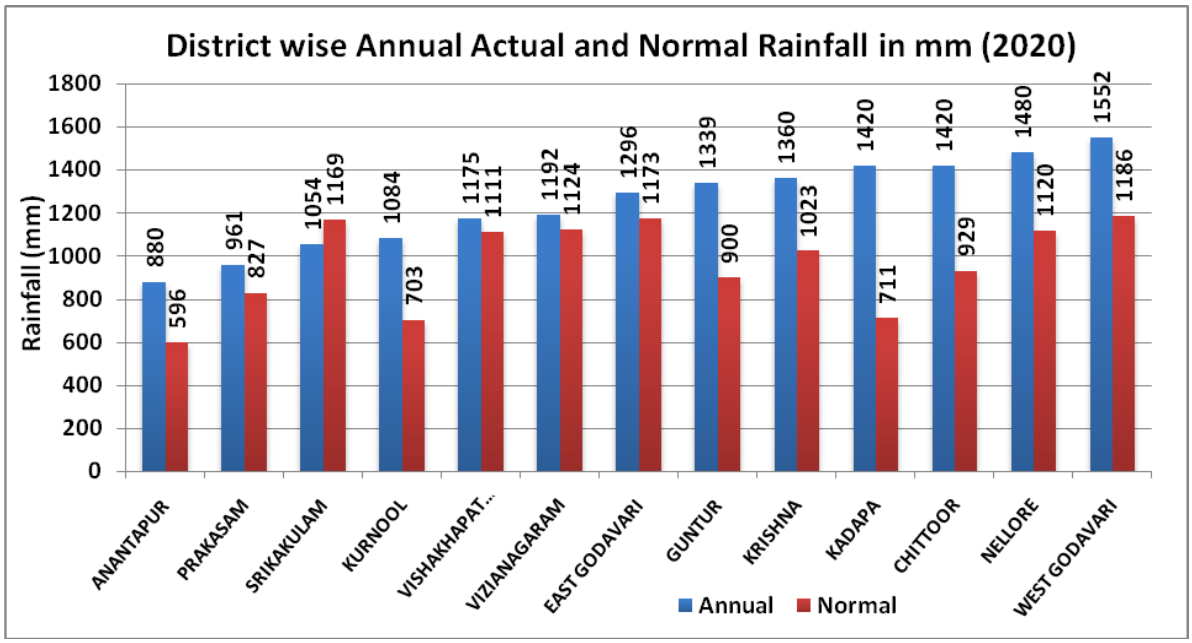


Fig.3.1: District-wise Annual Actual and Normal (2020) rainfall.

Southwest and Northeast monsoon performance:

Southwest monsoon (June-September) was excess in the state (34 % above normal). All the four districts in Rayalaseema region received large excess rainfall (> 60% above normal) during southwest monsoon, with Kadapa having the highest rainfall (843.4 mm, 110% above normal) and Ananthapur the lowest (625.1 mm, 84% above normal). In Coastal Andhra Pradesh, Srikakulam received deficient rainfall (-25 % below normal), Vishakhapatnam & Vizianagaram districts received normal rainfall and all the remaining 6 districts received excess rainfall, with West Godavari having the highest rainfall in Andhra Pradesh (1090.4 mm, 38% above normal). Northeast monsoon (October- December) was excess in the state (37% above normal). Nellore received highest rainfall during the season (802 mm, 25% above normal) and Kadapa received 117% above normal rainfall (519.2).

Significant weather events in 2020:

Number of extreme weather events like Cyclones and depressions were more in 2020 compared to last year in east coast. La Nina conditions were present since September 2020,

which in turn resulted in depressions and cyclones in the region. A Deep Depression developed in Bay of Bengal crossed north Andhra Pradesh coast close to Kakinada on 13th October 2020, resulted in heavy to very heavy rainfall from 12th to 14th October in coastal districts. The very severe Cyclonic storm "Nivar" crossed Andhra Pradesh as deep depression on 26th November 2020, resulted in heavy to very heavy rainfall from 26th to 28th November in coastal districts and south Rayalseema districts.

The rainfall received during the period January to December 2020 is compiled and analysed for correlating with water levels monitored during the period May 2020, August 2020, November 2020 and January 2021. Isohytel map of Andhra Pradesh State (Normal annual rainfall in mm) is depicted in **Fig.3.2.** The data is presented in **Table-3.2** to **3.5** and depicted in Fig. **3.3** to **3.10.**

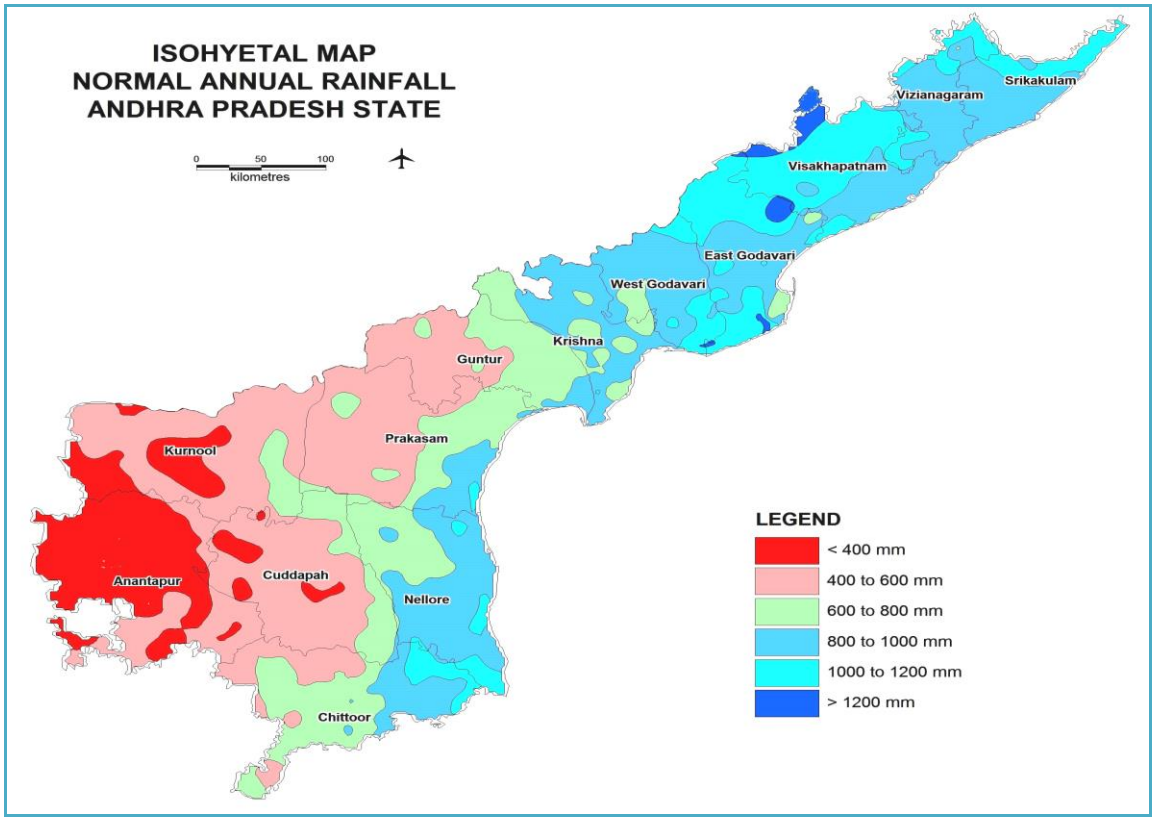


Fig.3.2: Isohytel map of Andhra Pradesh State (Normal annual rainfall in mm).

Table-3.1: Monthly Actual and Normal (2020) rainfall (mm) in Andhra Pradesh State

		JAN		FEB		MAR		APR		MAY		JUNE		JULY	
S No	**DISTRICT**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**
1	ANANTAPUR	0.3	3.9	0	4.3	4.1	9.2	30.5	18.4	26.6	56.5	123.4	59	187.1	62.9
2	CHITTOOR	14.6	6.9	0	8.6	9.5	12.9	54.4	23.8	21.2	68.7	109.8	72.1	311.3	101.7
3	EAST GODAVARI	5.9	7.5	4.8	12	3.4	14.6	43.6	25.3	15.9	68.6	112.5	135.5	309.5	201.4
4	GUNTUR	17.6	6.7	11.9	9	10.4	10.9	6	14.9	11.7	54.9	143.6	91.4	286.5	150.1
5	KADAPA	3.9	2.4	0	3.2	6.9	6.8	30	15	16.4	44	103.3	67.6	189.6	96.3
6	KRISHNA	10.6	5.6	21.8	8.8	8.9	13.7	31.3	16.4	3.8	52.3	126.7	115	302.4	199
7	KURNOOL	0	1.4	0	2.4	6.3	8.3	18.8	18.2	38.1	47.8	140.2	85.8	273.9	113.7
8	NELLORE	50	19.7	0.4	13	5.5	7	60	14.9	6.3	46.9	98.2	51.7	162	91.8
9	PRAKASAM	24.1	8.7	2.8	10.8	20.8	13.6	22.5	16.5	12.1	53.4	83.1	68.8	128.6	98.1
10	SRIKAKULAM	6.6	9.8	35.2	20.3	55.3	19	57.5	26.7	35.5	66.2	137.7	148.9	137	191.3
11	VISHAKHAPATNAM	8.4	9	24.3	15.6	49.4	18.1	84.6	41.1	47.5	93	128.4	133.3	167.4	164.3
12	VIZIANAGARAM	6.8	10.5	33	16.9	47.3	19	82.7	33.8	45.5	86.8	171.5	143.7	191.3	181.6
13	WEST GODAVARI	14.3	7.9	4.5	14.1	0.6	11.4	33.6	21.4	5.4	60.8	139.4	130.2	379.9	233.1
	STATE AVERAGE	12.5	7.7	10.7	10.7	17.6	12.7	42.7	22.0	22.0	61.5	124.4	100.2	232.8	145

		AUG		SEP		OCT		NOV		DEC		ANNUAL		
S No	**DISTRICT**	**ACT**	**NOR**	ACT	NOR	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**ACT**	**NOR**	**DEP(%)**
1	ANANTAPUR	58.7	84.2	255.9	133.4	117.3	113.3	53.5	40.3	22.5	11	879.9	596.4	48%
2	CHITTOOR	135.6	115.1	194.7	152.1	162.7	166.9	299.7	142.4	106.7	57.8	1420.2	929	53%
3	EAST GODAVARI	309.3	200.5	238.9	191.5	143.5	205	108.7	93	0.1	17.7	1296.1	1172.6	11%
4	GUNTUR	168.5	156.9	251.6	157.7	312.1	144.6	118.6	84.7	0.2	17.9	1338.7	899.7	49%
5	KADAPA	178	109	372.5	128.4	185	134.4	268.3	80.4	65.9	23.1	1419.8	710.6	100%
6	KRISHNA	186.8	193.5	231.2	175.5	293.5	156.4	142.5	71.2	0.6	16	1360.1	1023.4	33%
7	KURNOOL	132.5	128.6	279.2	145.4	146.2	111.8	44.9	31.9	3.8	7.3	1083.9	702.6	54%
8	NELLORE	130.3	98.8	164.8	108.6	99.6	265.6	522.3	294.3	180.3	107.5	1479.7	1119.8	32%
9	PRAKASAM	93.4	102.2	249.3	122.1	109.6	172.9	212	129.7	2.3	29.8	960.6	826.6	16%
10	SRIKAKULAM	132.9	197.5	151	204.7	253.2	202.4	51.7	73.9	0.4	8.1	1054	1168.8	-10%
11	VISHAKHAPATNAM	137.5	170.6	163.3	180.4	281.4	202.1	82.3	74.6	0	9.3	1174.5	1111.4	6%
12	VIZIANAGARAM	114.8	189.7	199.4	203.8	246.1	164.1	53.2	64.8	0	9.2	1191.6	1123.9	6%
13	WEST GODAVARI	293.1	238.7	278	185.5	286.6	193.4	117	75.7	0	13.7	1552.4	1185.9	31%
	STATE AVERAGE	159.3	152.7	233.1	160.7	202.8	171.8	159.6	96.7	29.4	25.3	1247.0	967.0	29%

3.2.1 May 2020

The rainfall data collected from India Meteorological Department and compiled from weekly weather reports has been used to analyze the rainfall for the period June 2019 to May 2020. **Table-3.2** gives the district-wise rainfall data for the period June 2018 to May 2019, June 2019 to May 2020 and normal for June to May and the departure of June 2019 to May 2020 rainfall with other periods. The departure values are used to prepare the graphs and presented in **Fig-3.3** and **Fig-3.4.**

Table-3.2: District-wise rainfall (June'19-May'20) and its departure from normal and June'18-May'19

S NO	DISTRICT	Rainfall (mm) (June'19-May'20)	Rainfall (mm) (June'18-May'19)	NORMAL Rainfall (mm) (June-May)	Departure(%) from June'18-May'19	Departure (%) from normal	REMARK
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Anantapur	650.9	362	552	80.1%	17.9%	Normal
2	Chittoor	985	524	934	87.7%	5.4%	Normal
3	Cuddapah	689.1	326	700	111.3%	-1.6%	Normal
4	East Godavari	1211	1052	1218	15.2%	-0.6%	Normal
5	Guntur	944	660	847	43.1%	11.5%	Normal
6	Krishna	999.3	969	1033	3.1%	-3.3%	Normal
7	Kurnool	728	376	670	93.8%	8.6%	Normal
8	Nellore	1078	515	1080	109.2%	-0.2%	Normal
9	Prakasam	744	434	871	71.5%	-14.6%	Normal
10	Srikakulam	1375	1301	1162	5.7%	18.3%	Normal
11	Vishakhapatnam	1187.8	913	1202	30.1%	-1.2%	Normal
12	Vizianagaram	1365	949	1131	43.8%	20.7%	Excess
13	West Godavari	1036	1113	1153	-6.9%	-10.2%	Normal
	STATE MEAN	**999**	**730**	**966**	**36.5%**	**3.5%**	**Normal**

Source: India Meteorological Department, GOI

3.2.1.1 Rainfall Departure of June'19 -May'20 from Normal Rainfall of Same Period:

Fig 3.3 gives departure of June'19 - May'20 rainfall from normal of the same period. During the period June'19 - May' 20, the state has received 3.5 % more rainfall (999 mm) than normal (966 mm). It ranges from –14.6 % in Prakasam district to 20.7% in Vizianagaram district.

The state has received excess rainfall in Vizianagaram district and normal in the remaining districts.

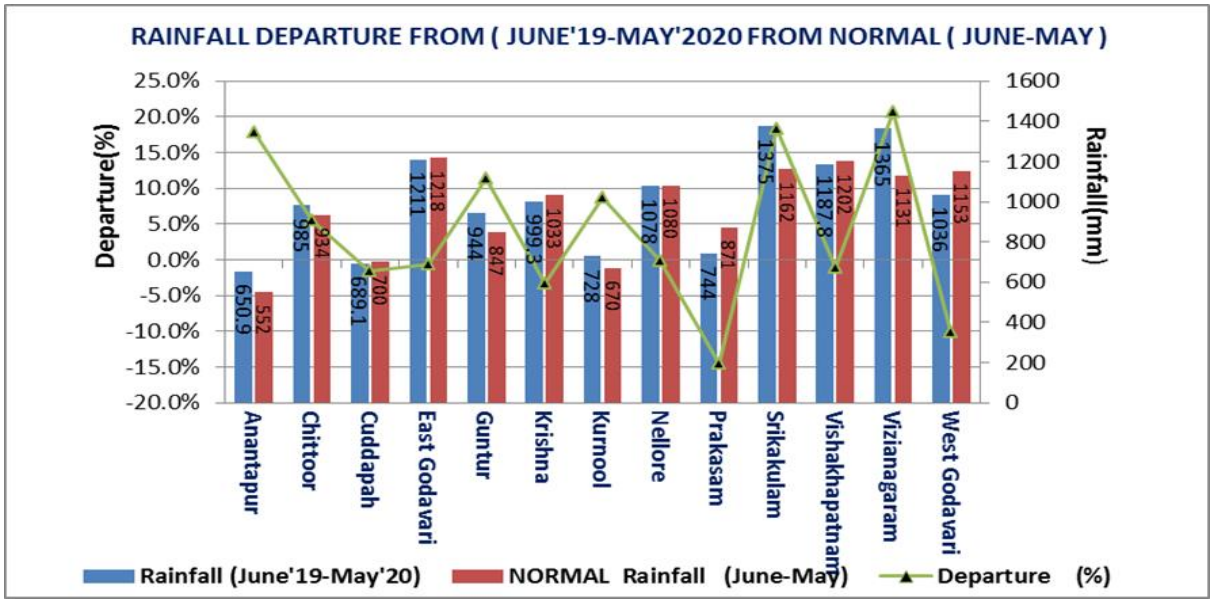


Fig.3.3: Rainfall Departure of June '19- May'20 from Normal of same Period.

3.2.1.2 Rainfall Departure of June'19 -May'20 from June'18 -May'19.

Table 3.2 indicates that state has received 999 mm of rainfall during the period June'19 - May'20**,** which is 36.5% more than the rainfall received during June'18 - May'19. The departure in percentage ranges from -6.9 % in West Godavari district to 111.3 % in Cuddapah district.

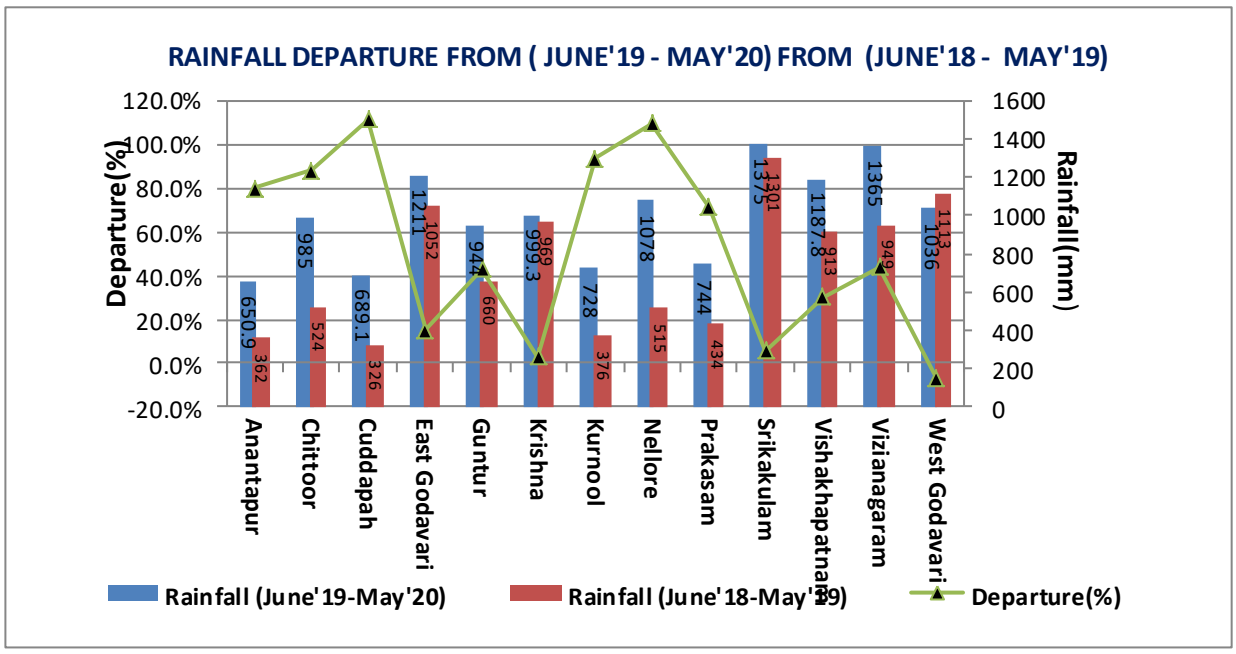


Fig.3.4: Rainfall Departure of June'19 - May'20 rainfall from June'18 - May'19

3.2.2 August 2020

Table.3.3 gives the district-wise rainfall data for the period June-August 2019, June-August 2020 and normal of June-August and the departure of June- August 2020 rainfall with other periods. The departure values are used to prepare the graphs and presented in **Fig.3.5.** & **Fig.3.6.**

Table.3.3: District-wise rainfall (June'20-Aug'20) and its departure from normal and June'19 Aug'19

NO	District	Rainfall (mm) (June'20-August'20)	Rainfall (mm) (June'19-August'19)	Normal Rainfall (mm) (June-August)	Departure from 2019 (%)	Departure from Normal (%)	Remarks
	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Anantapur	360	153	192	135.3%	87.2%	Excess
	Chittoor	536	288	276	86.0%	94.3%	Excess
	Kadapa	426	205	261	107.7%	62.9%	Excess
	East Godavari	722	649	513	11.2%	40.7%	Excess
	Guntur	597	422	379	41.4%	57.3%	Excess
	Krishna	608	468	487	29.9%	24.9%	Excess
	Kurnool	545	281	313	93.8%	73.9%	Excess
	Nellore	378	216	231	75.2%	63.9%	Excess
	Prakasam	303	271	254	11.9%	19.4%	Normal
	Srikakulam	403	498	513	-19.1%	-21.5%	Deficient
	Vishakhapatnam	430	398	447	8.1%	-3.8%	Normal
	Vizianagaram	469	497	494	-5.7%	-5.1%	Normal
	West Godavari	796	555	575	43.5%	38.6%	Excess
	STATE MEAN	**506**	**377**	**380**	**34.1%**	**33.2%**	**Excess**
Source: India Meteorological Department, GOI							

3.2.2.1 Rainfall Departure of June -August 2020 from Normal Rainfall of Same Period

Figure-3.5 gives departure of June – August 2020 rainfall from normal of the same period. During the period June – August 2020, the state has received 33.2% more rainfall (506 mm) than normal. It ranges from -21.5 % in Srikakulam district to 94.3% in Chittoor district. The state has received deficient rainfall in Srikakulam district, normal in Prakasam, Vishakhapatnam and Vizianagaram districts and excess rainfall in the remaining districts.

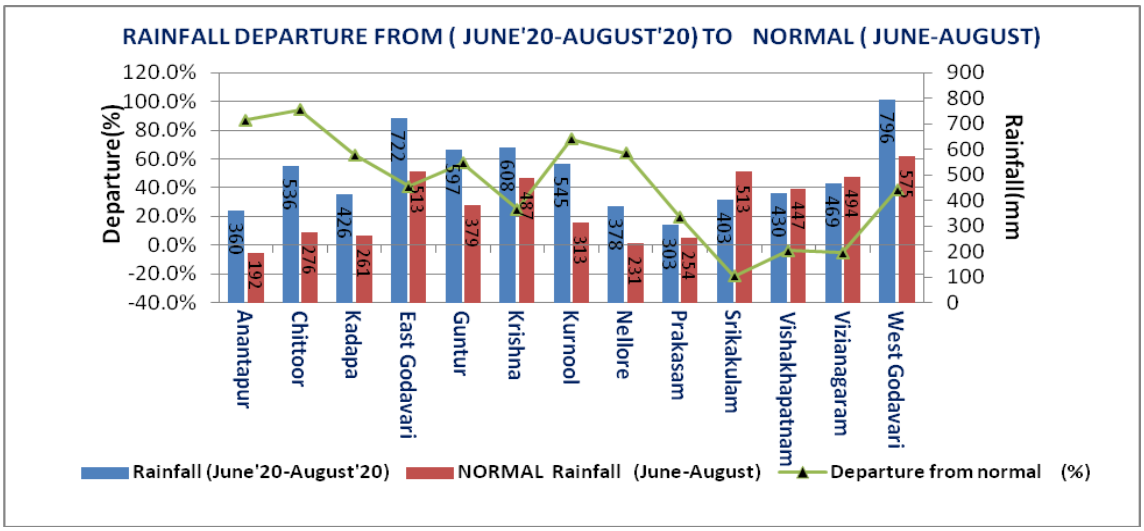


Fig.3.5: Rainfall Departure of June 2020 - August 2020 from Normal of same Period.

3.2.2.2 Rainfall Departure of June 2020- August 2020 from June 2019- August 2019

Figure-3.6 gives departure of June-August'20 rainfall from June to August'19 rainfall. **Table 3.3** indicates that state has received 506 mm of rainfall during the period June –August 2020, which is 34.1 % more than the rainfall received during June to August 2019. The departure in percentage ranges from -19.1% in Srikakulam district to 135.3% in Anantapur district.

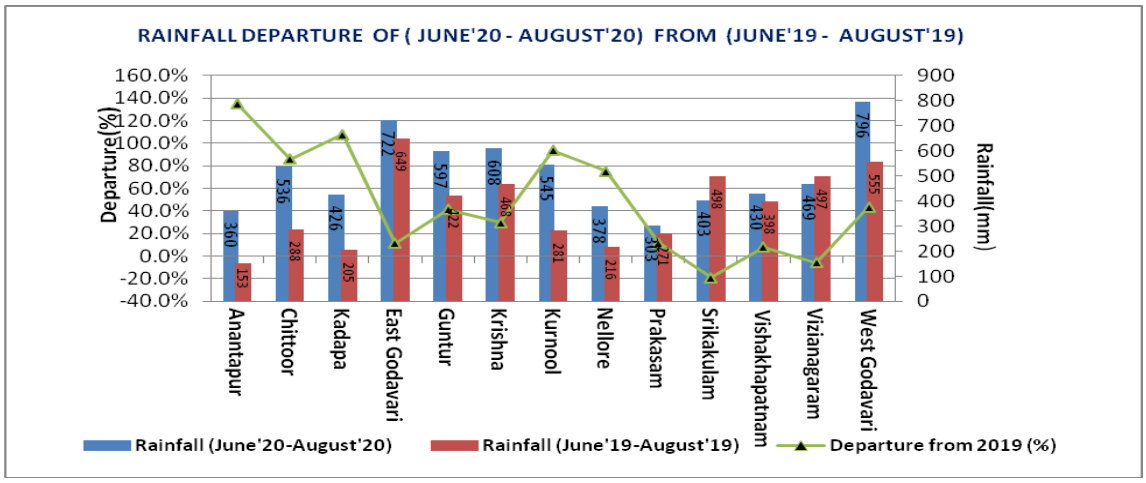


Fig.3.6: Rainfall Departure of June-August 2020 from June-August 2019

3.2.3 November 2020

Table.3.4. gives the district-wise rainfall data for the period June-October 2020, June – October 2019, normal of June-October and the departure of June- October 2020 rainfall from 2019 & normal. The departure values are used to prepare the graphs and presented in **Fig-3.7 and Fig-3.8.**

Table-3.4: District-wise rainfall (June'20-Oct'20) and its departure from normal and June'19-Oct'19

S. No.	District	Rainfall (mm) (June'20-October'20)	Rainfall (mm) (June'19-October'19)	Normal Rainfall (mm) (June-October)	Departure from 2019 (%)	Departure from Normal (%)	Remarks
1	Anantapur	742	562	438	32%	69%	Excess
2	Chittoor	914	743	584	23%	57%	Excess
3	East Godavari	1282	1129	903	14%	42%	Excess
4	Guntur	1035	878	687	18%	51%	Excess
5	Kadapa	987	787	541	25%	82%	Excess
6	Krishna	1141	916	866	25%	32%	Excess
7	Kurnool	972	655	566	48%	72%	Excess
8	Nellore	655	700	601	-6%	9%	Normal
9	Prakasam	664	621	564	7%	18%	Normal
10	Srikakulam	812	1177	957	-31%	-15%	Normal
11	Vishakhapatnam	878	1118	879	-21%	0%	Normal
12	Vizianagaram	923	966	914	-4%	1%	Normal
13	West Godavari	1377	973	982	42%	40%	Excess
	State Mean	**952**	**864**	**729**	**10%**	**31%**	**Excess**

Source: India Meteorological Department, GOI

3.2.3.1 Rainfall Departure of June to October 2020 from Normal Rainfall of Same Period:

During the period June to October 2020, the state has received 31 % more rainfall than normal rainfall. **Fig. 3.7** gives departure of June to October 2020 rainfall from normal of the same period. It ranges from -15% in Srikakulam district to 82% in Kadapa district. The state has received excess rainfall in Anantapur, Chittoor, East Godavari, Guntur, Kadapa, Krishna, Kurnool & West Godavari districts and normal rainfall in the remaining districts. The traditional drought prone districts Anantapur, Chittoor, Kadapa and Kurnool of Rayalaseema region received large excess rainfall of 69%, 57%, 82% & 72% above normal, respectively during the period. During Southwest monsoon season state has received excess rainfall (34% above normal) with 61 % above normal rainfall in the month of July 2020. A Deep Depression developed in Bay of Bengal crossed north Andhra Pradesh coast close to Kakinada on 13th

October 2020, resulted in heavy to very heavy rainfall from 12th to 14th October in coastal districts.

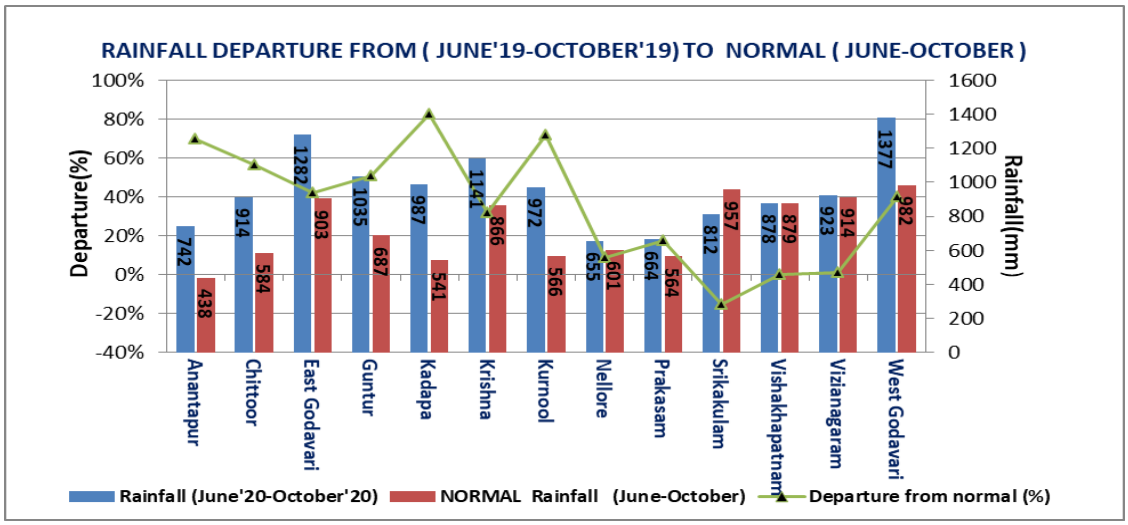


Fig.3.7: Rainfall Departure of June- October'20 from Normal of same Period.

3.2.3.2 Rainfall Departure of June to October 2020 from June to October 2019:

State has received 952 mm of rainfall during the period June to October 2020, which is 10% more than the rainfall (864 mm) received during June to October 2019. **Fig.3.8** gives departure of June to October 2020 rainfall from June to October 2019 rainfall. The departure in percentage ranges from -31% in Srikakulam district to 48% in Kurnool district.

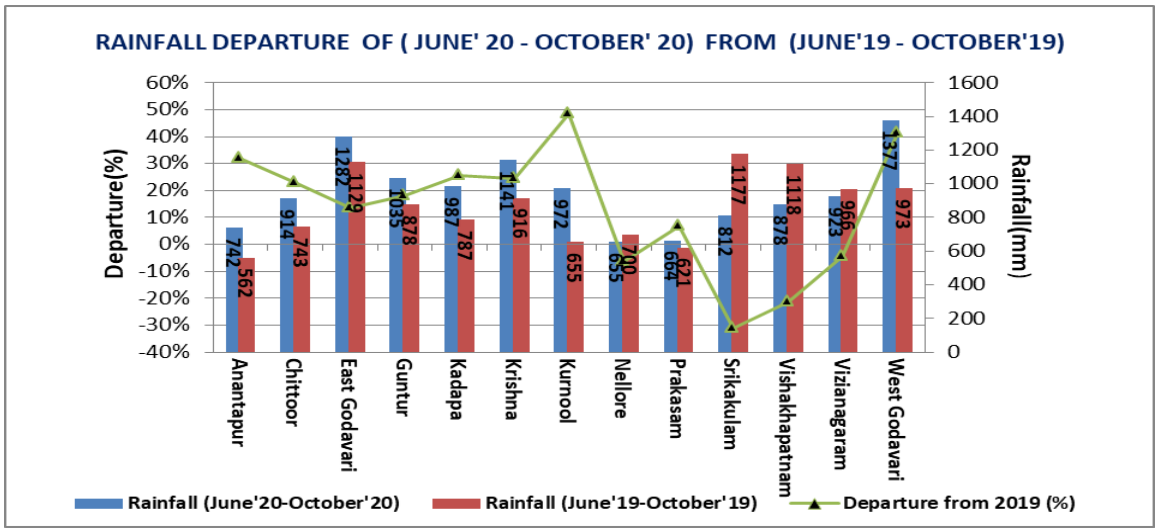


Fig.3.8: Rainfall Departure of June- October'20 from June to October'19

3.2.4 Januray 2021

Table 3.5 gives the district-wise rainfall data for the period June- December 2020, June – December 2019, normal of June- December and the departure of June- December 2020 rainfall from 2019 & normal. The departure values are used to prepare the graphs and presented in **Fig-3.9** and **Fig-3.10.**

Table-3.5: District-wise rainfall (June'20-Dec'20) and its departure from normal and June'19-Dec'19.

District	Rainfall (mm) (June'20-December'20)	Rainfall (mm) (June'19-December'19)	Normal Rainfall (mm) (June-December)	Departure from 2019 (%)	Departure from Normal (%)	Remarks
Anantapur	818	589	485	39%	69%	Large Excess
Chittoor	1321	885	780	49%	69%	Large Excess
East Godavari	1223	632	981	94%	25%	Excess
Guntur	1281	1138	777	13%	65%	Large Excess
Kadapa	1363	887	643	54%	112%	Large Excess
Krishna	1284	923	944	39%	36%	Excess
Kurnool	1021	665	601	54%	70%	Large Excess
Nellore	1358	955	992	42%	37%	Normal
Prakasam	878	662	712	33%	23%	Normal
Srikakulam	864	1185	1032	-27%	-16%	Normal
Vishakhapatnam	960	974	942	-1%	2%	Normal
Vizianagaram	976	1150	977	-15%	0%	Normal
West Godavari	1494	977	1060	53%	41%	Excess
State Mean	**1142**	**894**	**840**	**28%**	**36%**	**Excess**

Legend: Large Excess (+60% or more), Excess (+20% to +59%), Normal (+19% to -19%) *Source: India Meteorological Department, GOI.*

3.2.4.1 Rainfall Departure of June to December 2020 from Normal Rainfall of Same Period:

During the period June to December 2020, the state has received 36% more rainfall (1142 mm) than normal rainfall (840 mm). **Fig.3.9** gives departure of June to December 2020 rainfall from normal of the same period. It ranges from -16% in Srikakulam district to 112% in Kadapa district. The state has received large excess rainfall in Kadapa, Anantapur, Chittoor, Guntur & Kurnool districts, excess rainfall in East Godavari, Krishna & West Godavari districts and normal rainfall in the remaining districts. All the four districts of traditional drought prone Rayalseema region received large excess (> 60% from normal) rainfall during the period. During Southwest monsoon season (June to September) state has received excess rainfall (35% above normal) and 37% above normal rainfall in Northeast monsoon season (October to December). A Deep Depression developed in Bay of Bengal crossed north Andhra Pradesh coast close to

Kakinada on 13th October 2020, resulted in heavy to very heavy rainfall from 12th to 14th October in coastal districts. The very severe Cyclonic storm "Nivar" crossed Andhra Pradesh as deep depression on 26th November 2020, resulted in heavy to very heavy rainfall from 26th to 28th November in coastal districts and south Rayalseema districts.

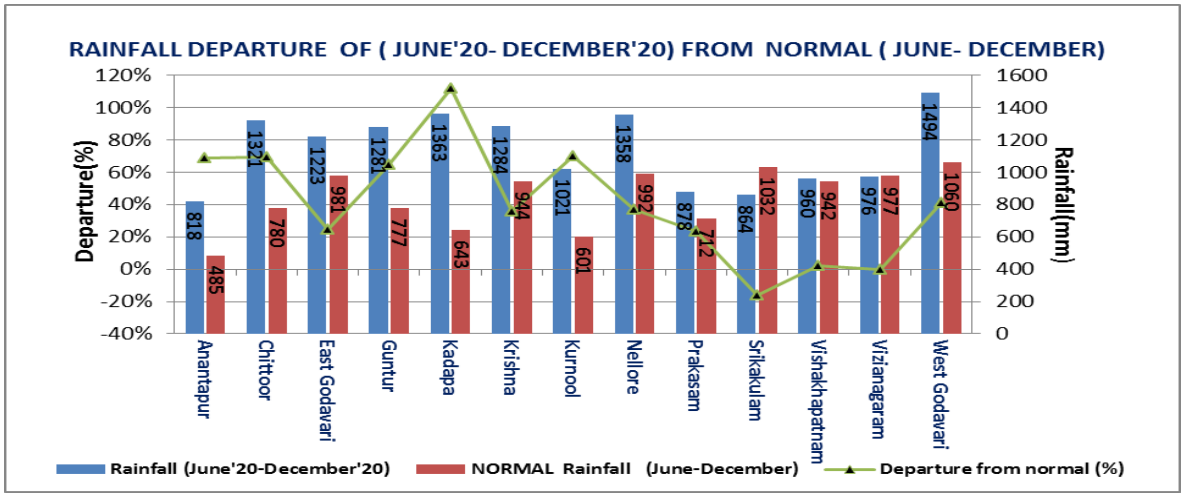


Fig.3.9: Rainfall Departure of June- December'20 from Normal of same Period.

3.2.4.2 Rainfall Departure of June to December 2020 from June to December 2019:

State has received 1142 mm of rainfall during the period June to December 2020, which is 28% more than the rainfall (894 mm) received during June to December 2019. **Fig.3.10** gives departure of June to December 2020 rainfall from June to December 2019 rainfall. The departure in percentage ranges from -27% in Srikakulam district to 94% in East Godavari district**.**

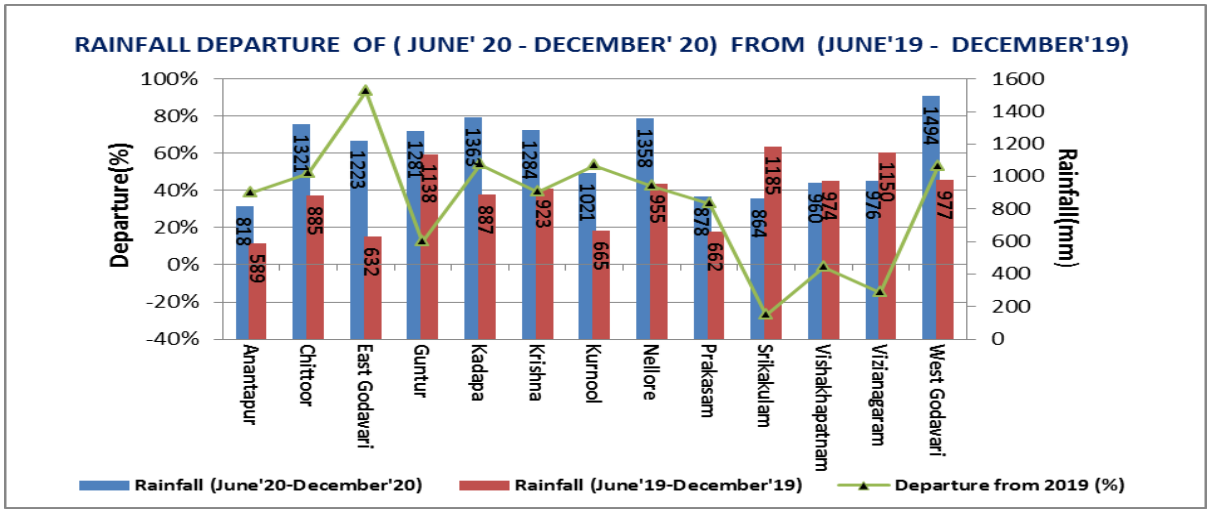


Fig.3.10: Rainfall Departure of June- December'20 from June to December'19

4. GEOLOGY

A wide variety of geological formations occur in Andhra Pradesh State, ranging from the oldest Archaean crystalline formations to recent alluvium. The geological set up and hydrogeological map is presented in the **Fig.4.1** and **4.2** respectively. A major part of the area is underlain by gneissic complex with a structural fill of sedimentary formations and basin-fill of meta-sedimentary formations. The gneissic complex is overlain by basaltic lava flows in the northwestern part and is intruded by several younger rocks namely granites, dolerites, pegmatites and quartzite etc.

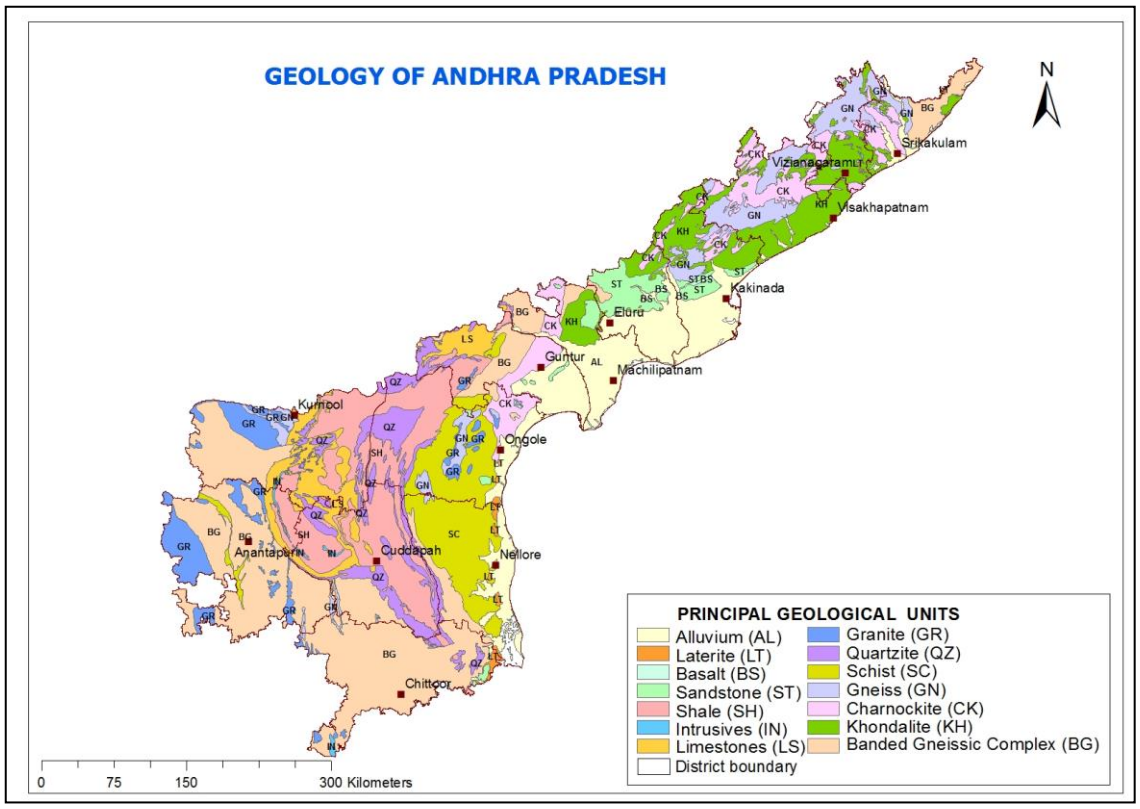


Fig.4.1: Geology of Andhra Pradesh State

4.1 Archaeans and Lower Pre-Cambrians

Peninsular gneisses of Archaean age are dominant rock types in Rayalaseema region of the State. Dharwars, comprising amphibolites, gneisses, schists, and quartzites occur as narrow isolated bands within granites in Chittoor, Anantapur, Kurnool, Kadapa, Nellore and Prakasam districts. The Charnockites and Khondalites occur in an extensive belt in Srikakulam, Vizianagaram, and Visakhapatnam districts and in upland areas of East Godavari

and West Godavari districts. The Charnockite bands also occur as narrow patches adjoining Coastal alluvium in Krishna, Guntur and Prakasam districts.

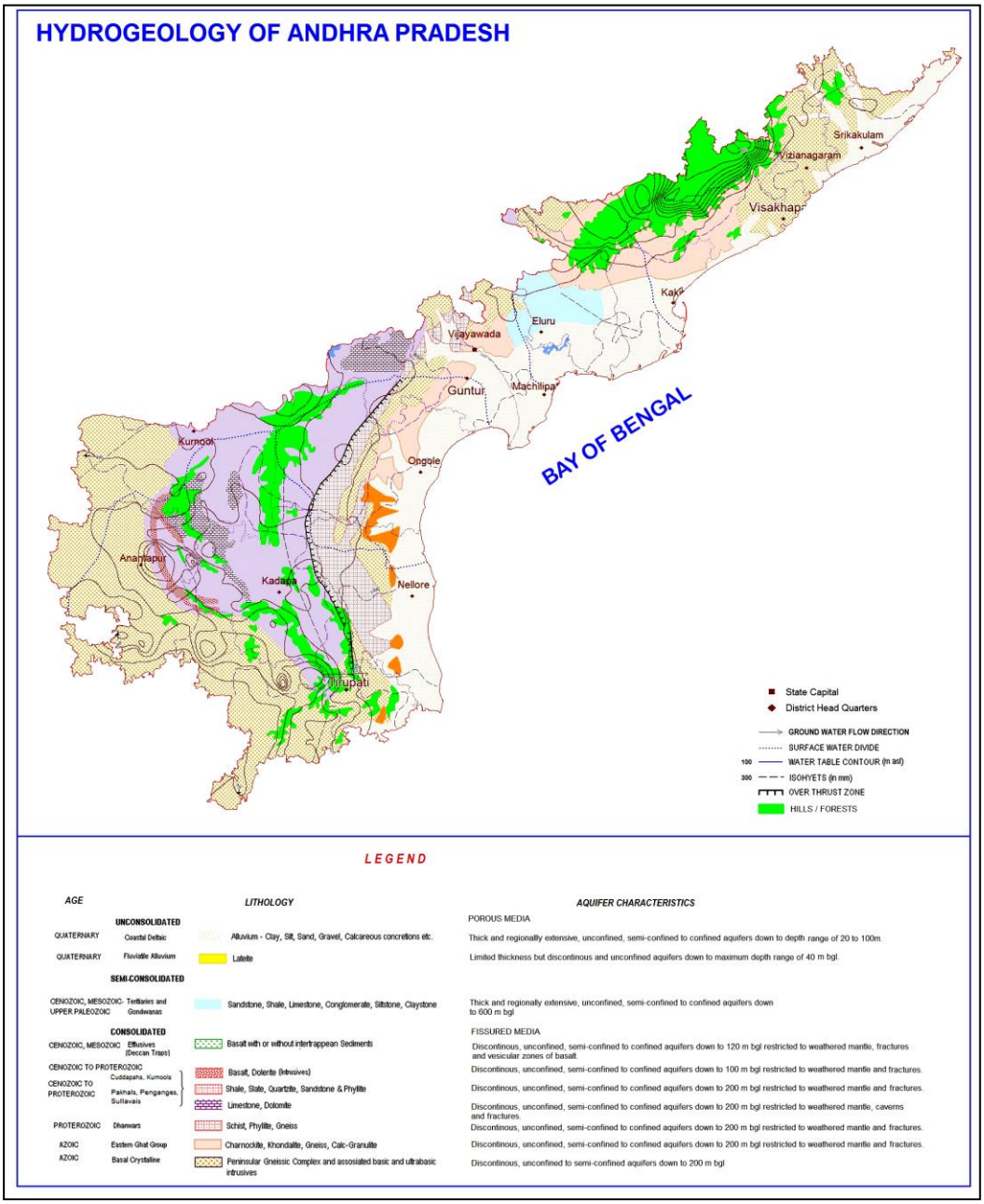


Fig.4.2: Hydrogeology map of Andhra Pradesh State.

4.2 Upper Pre-Cambrian to Early Pre-Cambrian

The group includes Kadapas and Kurnools comprising shales, limestones, dolomites, sandstones and conglomerates. The crescent shaped Kadapa Super Group covering ~42,100 Km^2 occur in parts of Krishna, Kurnool, Prakasam, Guntur, Nellore, Kadapa, Chittoor and

Anantapur districts. Kurnools occur in Kundair valley and Palnad tract. Gondwanas also occur as disconnected outcrops along the coast from Tuni in East Godavari district to Satyavedu in Chittoor district.

4.3 Deccan Traps (Basalt) and Associated Rocks

Deccan traps, the horizontally disposed lava flows are confined to Minor outcrops near Rajahmundry on either banks of the river Godavari. The thickness of individual flow varies between few meters to as much as 30 m. Inter-trappean beds comprising limestones, cherts and sandstones occur between trap flows near Rajahmundry. Infra-trappean beds, comprising deposits of limestones and sandstones, underlie the trap flows. These are exposed in an area covering a stretch of 6 km from Pangidi in West Godavari district to Kateru in East Godavari district.

4.4 Tertiary Formations (Miocene-Pliocene)

The formation of this group is locally known as Rajahmundry formation. It constitutes mainly Sandstones occurring from Eluru to Rajahmundry as isolated out crops dipping gently towards the coast. Sandstones of equivalent age occur along the southern coast in Chittoor, Prakasam and Nellore districts. They are highly potential from ground water point of view.

4.5 Quaternary Formations

Alluvium, beach sands, Laterite soils etc. belong to this group.Beds of clay, sand, gravel and boulders stretch along the coast except near Visakhapatnam. This distribution is not only confined to deltas but also extends deep inland in narrow patches along river courses of Godavari, Krishna, Pennar and Vamsadhara.The alluvial deposits attain a thickness of more than 600 m in East and West Godavari districts sloping towards the coast. In Srikakulam and Visakhapatnam districts, the thickness varies up to 20 m.

5. GROUND WATER RESOURCES (2016-2017)

The dynamic ground water resource potential of the state has been estimated as per the methodology given by the Ground Water Estimation Committee 1997 (GEC 1997).

As per the latest estimates (March 2017), The net ground water availability in the state is 20.15 BCM out of which the total draft for all uses (Domestic, Industrial and Irrigation) is 8.9 BCM. Net ground water available for future use is 11.25 BCM. The stage of development is 44.15%. Out of 670 mandals, over-exploited (OE) mandals are 45, critical mandals are 24, semi-critical mandals are 60 and safe mandals are 541 (including saline mandals 81). Comparatively high ground water development is observed in Anantapur (88.9%) and Kadapa (68.7%) districts. Ground water development is low in Vizianagaram and East Godavari districts (21%). More mandals from Rayalaseema regions falls under OE, Critical and Semi Critical category than Coastal region mandals. The categorization of mandals is depicted in **Fig.5.1**.

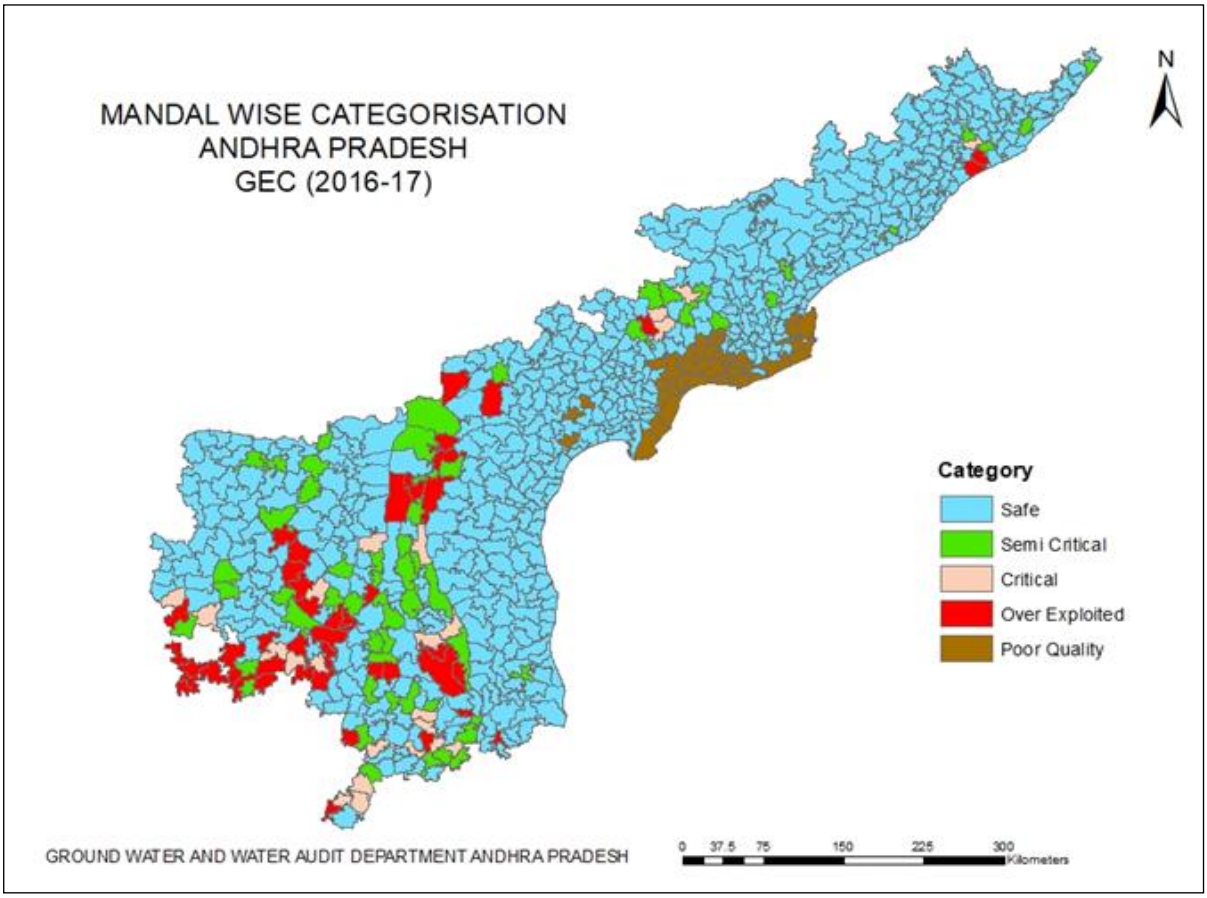


Fig.5.1: Categorization of Mandals (as on March,2017), Andhra Pradesh State.

6. GROUND WATER REGIME MONITORING

Ground water level monitoring is a scientific surveillance system to establish the periodic and long-term changes in ground water regime. The water level data over a period of time provides information on changes in ground water levels with progressive ground water development by natural and artificial recharge/surface water irrigation system.

Monitoring of a network of ground water monitoring wells provides periodical information on ground water regime scenario with a fair degree of accuracy in different hydrogeological environments in the area.

Ground water occurrence point of view State litho units are grouped into following 3 groups.

i) Consolidated Formations
ii) Semi-consolidated Formations
iii) Unconsolidated Formations

6.1 Consolidated formations: Crystalline rocks of Archaean age, metasedimentary rocks of Kadapa and Kurnools and basalts lava flows of Deccan traps are included in these formations occupying ~83% of the area. These rocks generally lack primary porosity and secondary porosity is developed due to weathering, fracturing, development of solution cavities and channels and interconnection of vesicles. In these rocks depth of weathering varies from 5 to 10 m bgl (occasionally up to 20 m) and majority of fractures occur within 100 m depth. In these rocks dug wells/ dug cum bore wells and bore wells are the most prevalent abstraction structures. Ground water yield from these rocks varies from 0.1 lps to 3 lps.

In Khondalite formations, depth of weathering varies from 10-40 mbgl with yields of 0.5-2 lps. Consolidated meta-sedimentary formations (Kadapa and Kurnool rocks and equivalents) have undergone great deal of compaction, metamorphism, thereby reducing primary porosity. Occurrence of ground water in these formations is restricted to structural features like folds, faults, lineaments, fractures, fissures, solution cavities and channels etc. Depth of weathering in these formation ranges from 5-10 m bgl and yield varies from 0.01-19 lps (general 1-5 lps). Relatively Kurnool group of rocks are more potential than other Kadapas (general yield 5-10 lps).

6.2 Semi-consolidated formations: Semi-consolidated formations are represented by rocks belonging to Gondwana formations (sandstones) and Rajahmundry sandstones. The yield of these formations ranges from 10-70 lps.

6.3 Unconsolidated formations: Un-consolidated formations are represented by coastal alluvium, deltaic alluvium and inland river alluvium. Ground water occurs under water table and confined conditions. Water quality in deeper aquifers is of poor quality. In deltaic areas of Godavari, Krishna and Pennar, yield varies from 0.7-30 lps and Godavari deltas. Ground water quality is of potable nature in paleo channels.

6.4 Monitoring Methodology

Ground water regime is monitored through a network of dug wells and piezometers known as Ground Water Monitoring Station (GWMS). The dug wells, which are owned by government, non-government agencies and individual users, are tapped in the shallow aquifer system. Piezometers (basically bore wells/tube wells) are constructed exclusively for ground water regime monitoring under Hydrology Projected. Some of the exploratory wells/ observatory wells drilled under and exploratory drilling programme of Central Ground Water Board are converted to piezometers for regular monitoring.

The network of observation wells are monitored 4 times a year by the officials of Central Ground Water Board during the following periods.

Period	**Date**
January	1st to 10th of the month
May (Pre-monsoon)	20th to 30th of the month
August (Mid-monsoon)	20th to 30th of the month
November (Post-monsoon)	1st to 10th of the month

6.4.1 Participatory Ground water Monitoring

Weekly water level measurements are initiated in phases involving local people as observers under participatory ground water monitoring programme, to observe micro-level changes in ground water regime. Participatory observers from the local area where GWMS is there are engaged since May, 2005 and as on 31st March, 2021, 122 no's of GWMS are monitored though participatory approach (**Table-6.1**).

6.4.2 Chemical Quality Monitoring

The chemical quality of ground water is monitored (dug wells/Piezometers) once in the month of May (pre-monsoon season) to observe the effect of geogenic, anthropogenic contamination of ground water in different hydrogeological environments over a period of time.

6.5 Maintenance of Database on Ground Water Monitoring Wells

The database on water levels and chemical quality is entered in the GEMS, developed over a period of time since 1969. The database is maintained in Oracle using GEMS (Ground water Estimation and Management System) software, which is adopted by all ground water agencies in the country.

6.6 Distribution of Ground Water Monitoring Wells

The distribution and density of monitoring wells in the State; distribution in river basins, aquifer systems and canal command areas are summarized in the following session.

6.6.1 District-Wise Distribution of Ground Water Monitoring Wells`

Total 867 GWMS are monitored in the state (DW: 674 (78 %) and Pz: 193 (22%) and density varies from 113 Km^2/well (East Godavari) to 321 Km^2/well in Kurnool district (**Table-6.1**).

6.6.2 Aquifer-Wise Distribution of Ground Water Monitoring Wells

Out of 867 GWMS, 652 wells are located in hard rocks, 215 wells in soft rocks. District wise and aquifer wise distribution of GWMS is given in **Table-6.2.** About 23.7% of

GWMS are located in Banded Gneissic complex, followed by Alluvium formations (21.7%), followed by Shale (8%).

Table-6.1: District-wise Distribution of GWMS, Andhra Pradesh State (As on March, 2021).

S.No.	District	Area (Km2)	No of GWMS			No of Participatory observers	Density of Network stations (sq. km. per well)		
			DW	Pz	Total	Nos	Dug wells	Piezo meters	combined stations
1	Anantapur	19130	27	33	60	16	709	580	319
2	Chittoor	15152	44	15	59	15	344	1010	257
3	Kadapa	15359	24	39	63	9	640	394	244
4	East Godavari	10807	84	12	96	6	129	901	113
5	Guntur	11391	84	13	97	12	136	876	117
6	Krishna	8727	65	7	72	8	134	1247	121
7	Kurnool	17658	35	20	55	17	505	883	321
8	Nellore	13076	57	0	57	7	229	0	229
9	Prakasam	17626	49	42	91	7	360	420	194
10	Srikakulam	5837	51	0	51	4	114	0	114
11	Vishakhapatnam	11161	55	3	58	12	203	3720	192
12	Vizianagaram	6539	48	0	48	3	136	0	136
13	West Godavari	7742	51	9	60	6	152	860	129
	Total	**160205**	**674**	**193**	**867**	**122**	**238**	**830**	**185**

Table 6.2: Aquifer-Wise Distribution of Ground Water Monitoring Wells, Andhra Pradesh State (As on March, 2021).

	Alluvium		BGC		Basalt		Charnokite		Gneiss		Granite		Khondalite		Lime stone		Laterite		Quartzite		Schist		Shale	Sand stone		Total	
District	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**Pz**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	**Dw**	**PZ**	
Anantapur			15	27							12	4												2			60
Chittoor	2		38	15													4										59
Kadapa			6	3		1									1	5			2	1	1		14	29			63
East Godavari	40	6	12	1	1		7		6		1		15	1											1	5	96
Guntur	26		14	3			19	1			1				11	4			2	1	5	2	3	1	3	1	97
Krishna	37	2	14	1			6	1					6	2		1									2		72
Kurnool			10	8					1	3	4	4			8	4			3				9	1			55
Nellore	16		6				1										6		1		25				2		57
Prakasam	10	2	2	1			9	3	5	3			1							1	9	15	13	17			91
Srikakulam	11		26				5		6				3														51
Vizianagaram							11		19				18														48
Visakhapatnam	1						21		16				16	3	1												58
West Godavari	32	4	4		1								4												10	5	60
Grand Total	**175**	**14**	**147**	**59**	**5**	**3**	**79**	**5**	**53**	**6**	**18**	**8**	**63**	**6**	**21**	**14**	**10**	**0**	**8**	**3**	**39**	**17**	**37**	**48**	**18**	**11**	**867**

7. ANALYSIS OF WATER LEVELS

The ground water levels observed over a period of time provide valuable information on behaviour of the ground water regime, which is constantly subjected to changes due to recharge and discharge phenomena. A balance between these two factors results in the decline or rise in the ground water storage. When the recharge exceeds discharge there will be a rise in the ground water storage and vice versa. The decline in water level may be due to increase in draft (for different purposes) or decrease in precipitation (less recharge to ground water). On the other hand a rise in water level may be due to an increase in rainfall and/or due to changes in irrigation practices. The dug wells tap the phreatic aquifer mostly limited to a depth of 20 m. The depth of piezometers which are tapping both the phreatic and deeper aquifers varies from 20 to 100 m. Hence the water level recorded in the piezometers may not be the same as that of dug wells for a particular period though both the structures are in the same place. In this report the water level data collected from un-confined aquifers (shallow depth) is presented. An attempt is also made to interpret the piezometric data generated by SGWD and CGWB and piezometric maps of May and Nov 2020 are prepared. The data from GWMS for the year 2020-21 was analyzed and for every set of measurements, write up and maps were prepared and are presented here under various paragraphs. The purpose of water level data analysis is

i) Four measurements of depth to water level give an overall idea regarding the ground water level in the state during the year of measurement.

ii) The fluctuation in comparison to the same month in the previous year gives an idea about the change in the ground water level for a particular period with respect to that of the level during the same month in the previous year. This gives an idea about the change in the amount of draft and rainfall between the two years.

iii) The water level fluctuation during the pre-monsoon period in comparison to last year gives an idea about the seasonal fluctuation, which ultimately reflects the change in dynamic ground water resources.

iv) The water level fluctuation during a particular month of measurement with reference to the decadal mean for the same months gives an idea of the behaviour of the ground water level on long-term basis.

Note : *Water level monitoring and sampling was not done during May 2020 and August 2020 because of COVID-19 conditions. However NHS observer data and NHS data of Hyderabad and Rangareddy districts along with State monitoring data were utilized for preparing May and August 2020 reports.*

7.1 Depth to Water Levels

7.1.1 Depth to Water Levels (May, 2020)

The depth to water level during May, 2020 based on analysis of water level data of 1348 wells (83- CGWB, 1265-SGWD) is generalized and given below. Distribution of wells in different depth ranges is depicted in pie diagram **Fig.7.1** and depth to water level map is given in **Fig 7.2**.

An analysis of depth to water level data of 1348 wells **(Annexure-III**) shows water levels vary from less than 2m and 91.28 m.bgl (Chitoor district). Water level of less than 2 m bgl is recorded in 10% of wells, between 2-5 m bgl in 15% of wells, between 5-10 m bgl in 26% of wells, between 10-20 m bgl in 21% of wells, between 20-40 m bgl in 12% of wells and > 40 m bgl in 16% of wells. Depth to water level map of May, 2020 (**Fig. 7.2**) shows that, Shallow water levels of less than 2 m bgl are noticed as small scattered patches in Srikakulam, Nellore, Kurnool, Ananthpur, Prakasam, Krishna, West Godavar i, East Godavari, Guntur and Visakhapatnam covering an area of 5% (134 wells). Water level 2 to 5 m bgl is covered in 19% of the area (352 wells), mainly in Srikakulam, Krishna, East Godavari and Guntur, Nellore. Area-wise 29% of the state is covered by depth to water level of 5 to 10 m bgl (267 wells), as small patches. Water level 10 to 20 m bgl is covered in 28% of the area (287 wells). Water level 20 to 40 m covers about 15% of the state (162 wells) noticed mostly in Anathpur, Cuddapah, Prakasam and West Godavari districts. Deeper water levels of more than 40 m cover about 4% of the state (216 wells) in Anathpur, Cuddapah, Prakasam and Chitoor districts.

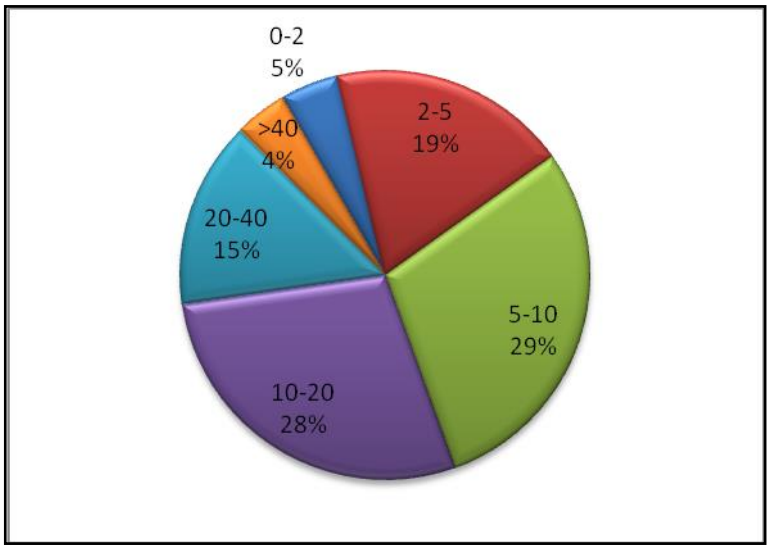


Fig.7.1: Percentage of wells in different depth ranges of DTW-May 2020

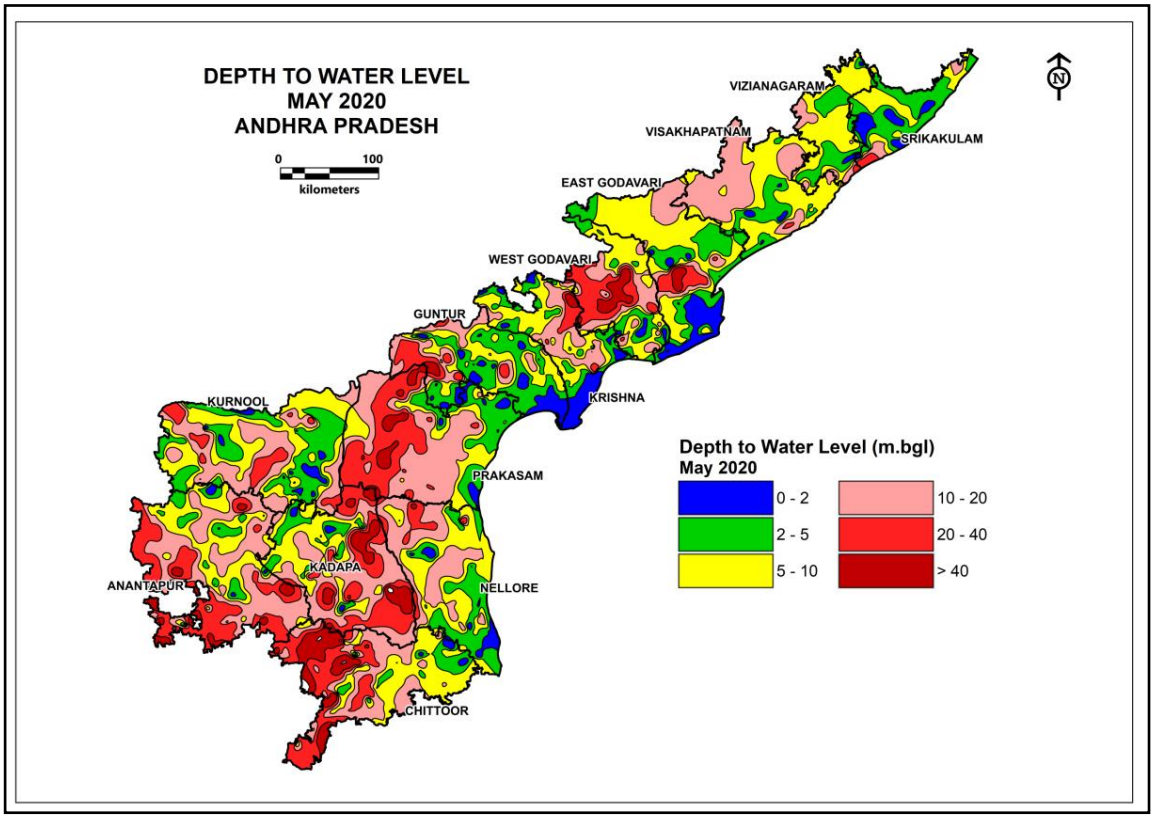


Fig-7.2: Depth to water level, May, 2020 in Andhra Pradesh State

7.1.2 Depth to Water Levels –August, 2020 (Mid-monsoon Season)

The depth to water level data of 1334 wells is used for the analysis. Distribution of wells in different depth ranges is depicted in pie diagram **Fig.7.3** and depth to water level map is given in **Fig.7.4**.

Analysis of depth to water level data **(Annexure - IV**) shows that water levels range between < 1 m bgl (Kurnool district) and 80.12 m bgl (West Godavari district). Water level of less than 2 m bgl is recorded in 15% of wells, between 2-5 m bgl in 25% of wells, between 5-10 m bgl in 25% of wells, between 10-20 m bgl in 19% of wells, between 20-40 m bgl in 11% of wells and > 40 m bgl in 5% of wells. Depth to water level map of August 2020 (**Fig.7.4**) shows that, Shallow water levels of less than 2 m bgl are noticed in small scattered parts in all the districts covering 5% of the area (200 wells). Water levels between 2 to 5 m bgl is covered in 23% of the area (336 wells) mainly in Srikakulam, Vishakapatnam, Vizianagaram, Krishna, East Godavari, Kurnool, Nellore and Guntur districts. Area-wise 29% of the state is covered by depth to water level of 5 to 10 m bgl (328 wells), as small parts. Water levels of 10 to 20 m bgl are covered in 25% of the area (254 wells). Water levels of 20 to 40 m covers about 14% of the state (144 wells) noticed mostly in Anantapur, Kadapa, Chittoor, Prakasam and West

Godavari districts. Deeper water levels of more than 40 m cover about 4% of the state (67 wells) in Anantapur, Kadapa, Prakasam and Chittoor districts.

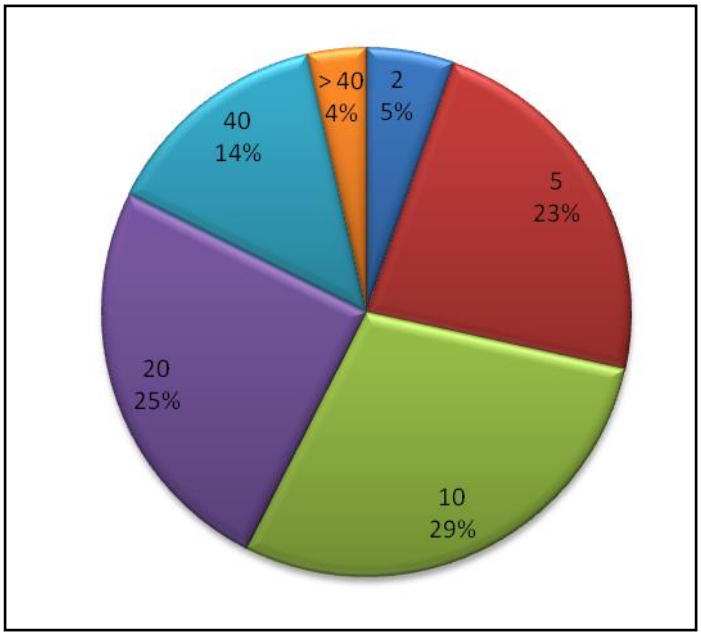


Fig.7.3: Percentage of wells in different depth ranges of DTW-August 2020

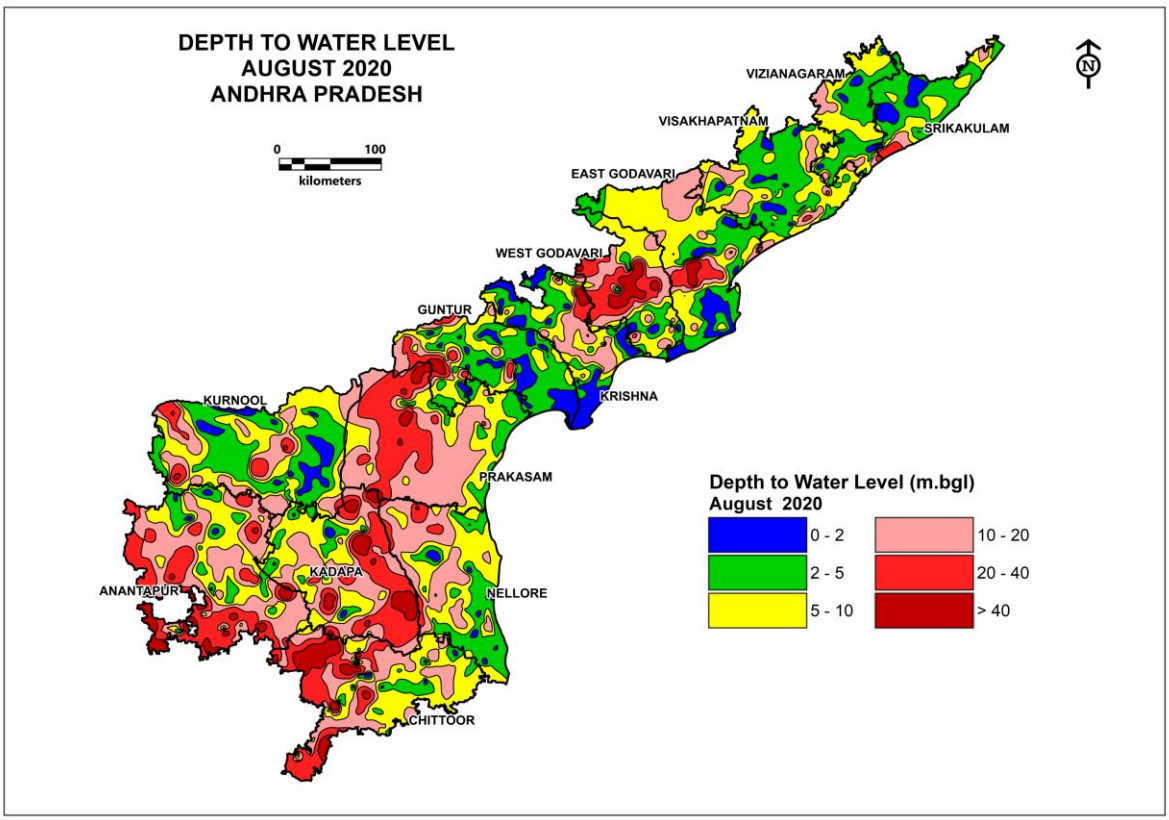


Fig.7.4: Depth to water level August, 2020 in Andhra Pradesh State

7.1.3 Depth to Water Levels - Post-Monsoon Season (November, 2020)

The depth to water level during November, 2020 based on water level data of 722 wells is generalized **(Annexure-I)**. Distribution of wells in different depth ranges is depicted in pie diagram **Fig.7.5** and depth to water level map is given in **Fig 7.6**.

An analysis of depth to water level data of 722 wells **(Annexure - V)** shows water levels vary between ground level and 52.16 mbgl (Kadapa district). The average water level of the state is 3.7 m bgl. Water level of less than 2 m.bgl is recorded in 52 % of wells, between 2 - 5 m bgl in 31% of wells, between 5-10 m bgl in 11% of wells, between 10-20 m bgl in 4 % of wells, between 20-40 m bgl in 2% of wells and water level more than 40 m bgl is registered in 1% of wells. Depth to water level map of November, 2020 (**Fig.7.6**) shows that shallow water levels of less than 2 m bgl are noticed mainly northern districts covering an area of 36 %. Water level 2 to 5 m bgl is covered in 47% of the area. Area-wise 14 % of the state is covered by depth to water level of 5 to 10 m bgl. Water level 10 to 20 m bgl is covered in 2% of the area. Deeper water levels of more than 20 m cover about 1% of the state area which pertains to Kadapa and Prakasam districts.

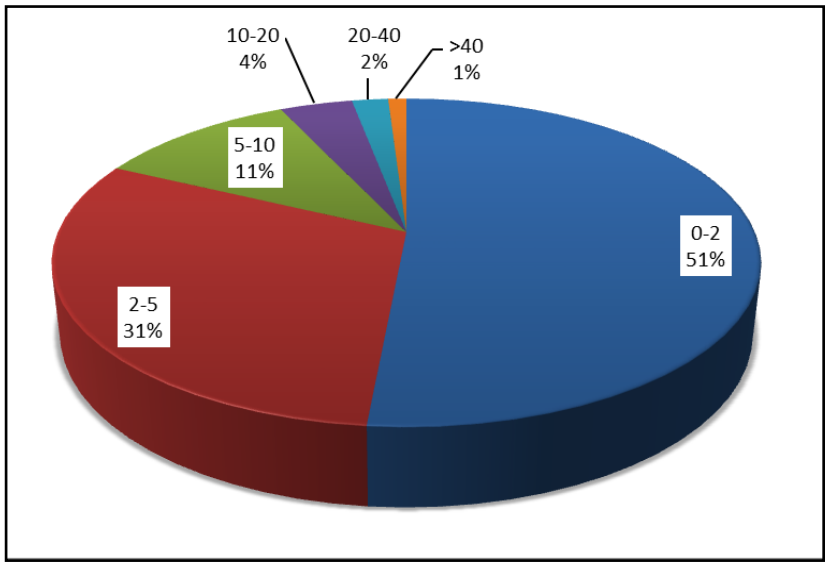


Fig.7.5: Percentage of wells in different depth ranges of DTW-November 2020

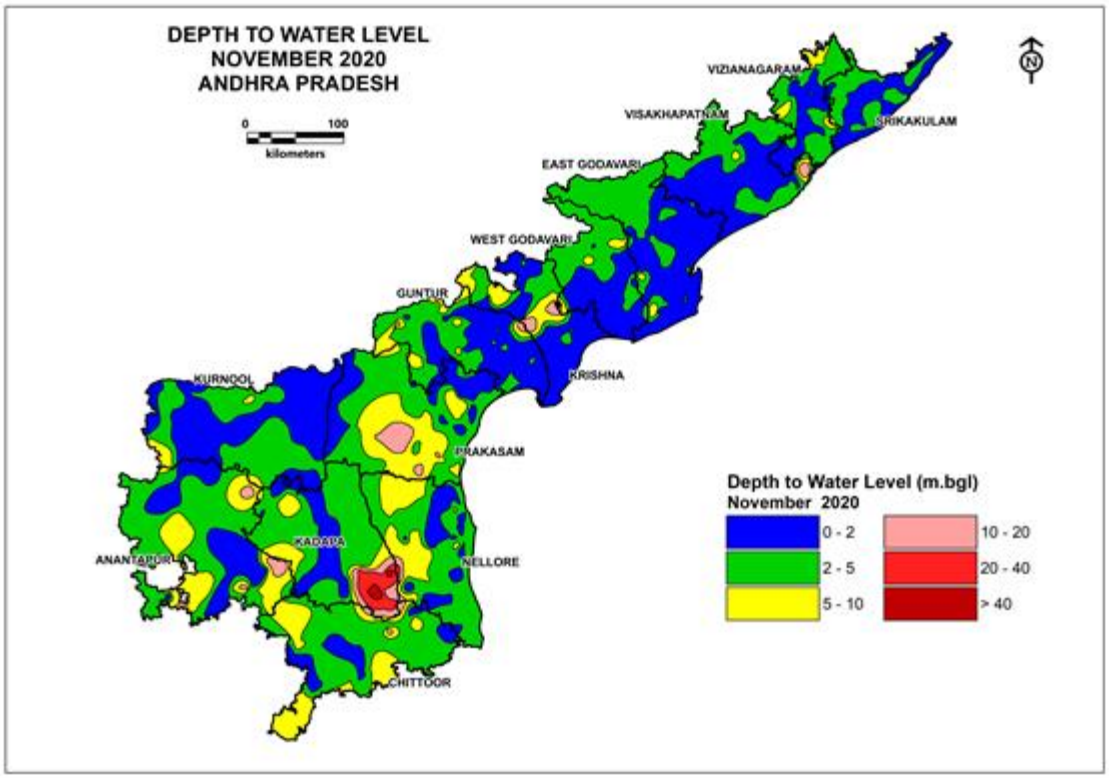


Fig.7.6: Depth to water level November, 2020 in Andhra Pradesh State

7.1.4 Depth to Water Levels (January, 2021)

The water level data collected from 745 ground water monitoring wells during January 2021 is used for the analysis **(Annexure-II**). Distribution of wells in different depth ranges is depicted in pie diagram **Fig.7.7** and depth to water level map is given in **Fig 7.8**.

Analysis of 745 water level data **(Annexure - VI**) shows that water level varies from ground level to 62.34 m bgl (Prakasam district) in the entire state. Water level less than 2 m bgl is recorded in 42% of wells, between 2-5 m bgl in 40% of wells, 5-10 m bgl in 14% of wells, 10-20 m bgl in 3% of wells, >20 m bgl in 2% of wells. Depth to water level map of January 2021(**Fig.7.8**) shows that, shallow water level of less than 2m bgl is covered in 30% area (311wells) of the state mainly in West Godavari, East Godavari, Nellore and Krishna districts. Water level between 2 to 5 m bgl is recorded in all the districts, covering an area of 49 % (297 wells). Area wise 16% of the state is covered by depth to water level of 5 to 10 m bgl (102 wells). Water level between 10 to 20 m bgl is covered in 3% of the area (26 wells). Deeper

water level of more than 20 m covers about 2% of the state (9 wells) noticed mostly in southern part of Kadapa, and eastern part of Prakasam districts.

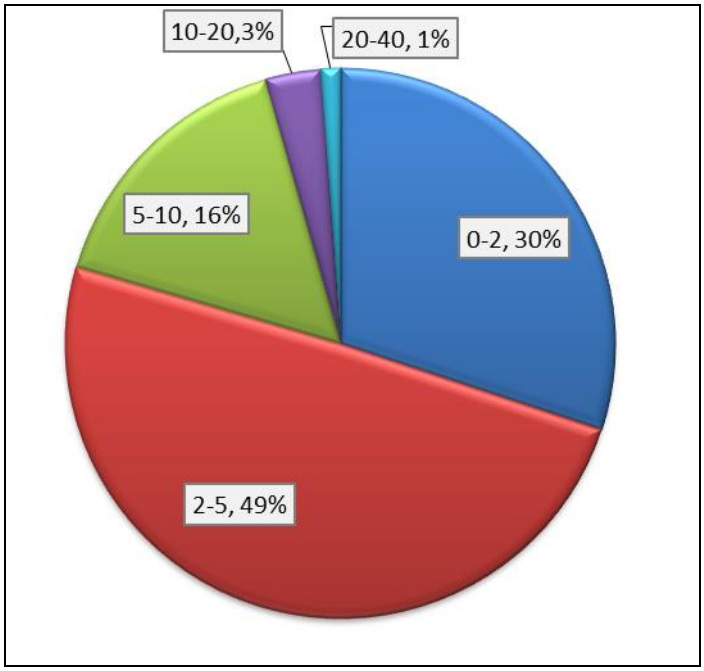


Fig.7.7: Percentage of wells in different depth ranges of DTW-January 2021

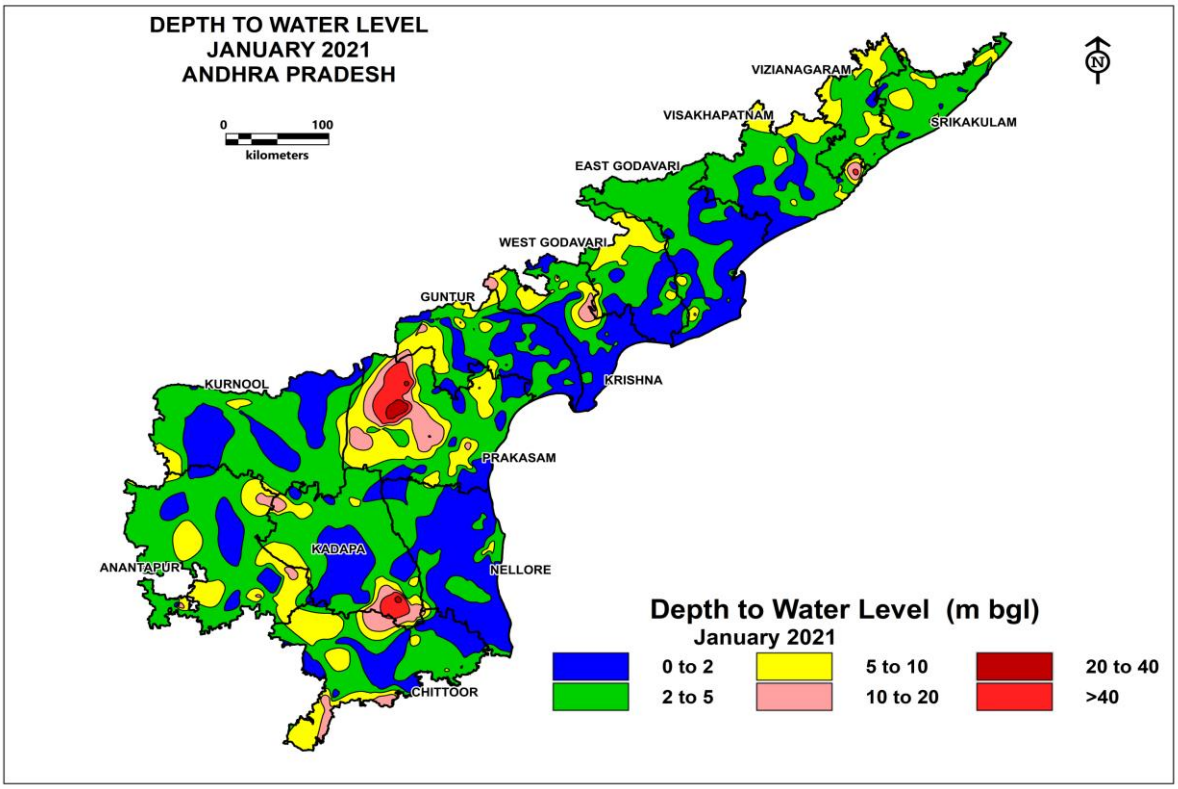


Fig.7.8: Depth to water level January, 2021 in Andhra Pradesh State

7.2 Integrated Depth to Water Level (SGWD and CGWB)

The water level data of monitoring stations (Piezometers only) of Central Ground Water Board and Groundwater and Water Audit Department of Andhra Pradesh state are considered together to analyze the water level data of the monitoring stations in the state.

7.2.1 Integrated Depth To Water Level Maps (SGWD and CGWB) in May 2020

Water level data from a total of 1348 station (Piezometers), out of which, 1265 stations of State GWD and 83 of CGWB are utilized for preparing the depth to water level map **(Fig 7.9)** and the depth to water levels and percentage of wells in different depth ranges in May 2020. Based on the tabulated **(Table 7.1)** results, it is inferred that, water level of less than 2 m bgl is recorded in 10% of wells, between 2-5 m bgl in 15% of wells, between 5-10 m bgl in 26% of wells, between 10-20 m bgl in 21% of wells, between 20-40 m bgl in 12% of wells and > 40 m bgl in 16% of wells. Area-wise 57% of the state is covered by depth to water level of <20 m bgl. and deeper water levels of more than 40 m covers about 4% of the state.

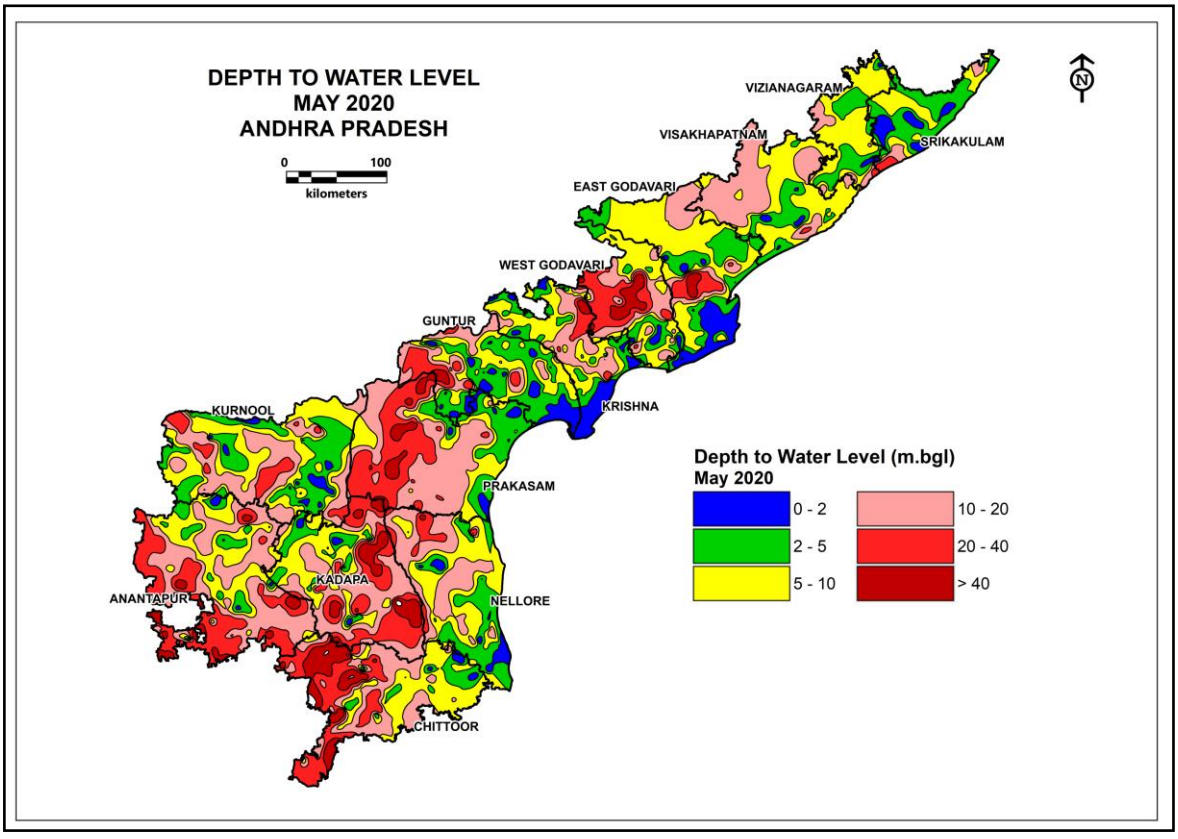


Fig 7.9 Depth To Water Level Map of May 2020 (Integrated data)

TABLE 7.1: Depth to water levels and percentage of wells in different depth ranges in May-2020																
S NO	**DISTRICT**	**NO OF WELLS**	**MIN**	**MAX**	**0 TO 2**	**% OF WELLS**	**2 TO 5**	**% OF WELLS**	**5 TO 10**	**% OF WELLS**	**10 TO 20**	**% OF WELLS**	**20 TO 40**	**% OF WELLS**	**> 40**	**% OF WELLS**
1	Anantapur	163	0.21	69.48	7	4.29	11	6.75	32	19.6	47	28.83	39	23.93	27	16.56
2	Chittoor	128	0.56	91.28	6	4.69	9	7.03	31	24.2	28	21.88	23	17.97	31	24.22
3	YSR Kadapa	115	0.09	89.12	5	4.35	10	8.70	26	22.6	29	25.22	21	18.26	24	20.87
4	East Godavari	99	0.44	73.21	19	19.19	19	19.19	32	32.3	5	5.05	12	12.12	12	12.12
5	Guntur	130	0.05	55.43	21	16.15	33	25.38	31	23.8	21	16.15	7	5.38	17	13.08
6	Krishna	115	0.2	71.06	14	12.17	16	13.91	33	28.7	27	23.48	10	8.70	15	13.04
7	Kurnool	160	0.18	40.00	21	13.13	34	21.25	43	26.9	27	16.88	12	7.50	23	14.38
8	Nellore	97	0.181	43.35	10	10.31	14	14.43	28	28.9	26	26.80	2	2.06	17	17.53
9	Prakasam	101	1.094	61.06	6	5.94	12	11.88	16	15.8	30	29.70	17	16.83	20	19.80
10	Srikakulam	42	0.17	26.51	12	28.57	8	19.05	11	26.2	4	9.52	1	2.38	6	14.29
11	Visakhapatnam	75	0.402	22.57	6	8.00	12	16.00	30	40.0	18	24.00	2	2.67	7	9.33
12	Vizianagaram	46	0.91	17.14	2	4.35	11	23.91	24	52.2	7	15.22	0	0.00	2	4.35
13	West Godavari	77	0.38	80.44	5	6.49	8	10.39	15	19.5	18	23.38	16	20.78	15	19.48
14	**State Figures**	**1348**	**0.05**	**91.28**	**134**	**10 %**	**197**	**15%**	**352**	**26%**	**287**	**21%**	**162**	**12%**	**216**	**16%**

7.2.2 Integrated Depth To Water Level Maps (SGWD and CGWB) in Nov 2020

The water level data of monitoring stations of Central Ground Water Board and State Ground Water Board are considered together to analyse the water level data of the monitoring stations in the state. Water level data from a total of 1274 station, out of which, 1210stations of State GWD and 64 wells of CGWB are utilized for preparing the depth to water level map **(Fig 7.10)** and the depth to water levels and percentage of wells in different depth ranges in Nov 2020. Based on the tabulated results **(Table 7.2),** it is inferred that, out of 1274 stations, depth to water level of 354 stations (28%) are in the range of 0 to 2 m bgl, 368 stations (29%) are in the range of 2 to 5 m bgl, 258 stations (20%) are in the range of 5 to 10 m bgl, 193 stations (15%) are in the range of 10 to 20 m bgl, 75 stations (6%) are in the range of 20 to 40 m bgl. Deeper water level of more than 20 m bgl are observed in 2% of wells . Area-wise, 6% of the state have deeper water levels(>20 m bgl) and 17% of the area has shallow water levels. Medium range 5-20 m bgl is observed in 43 % of the area.

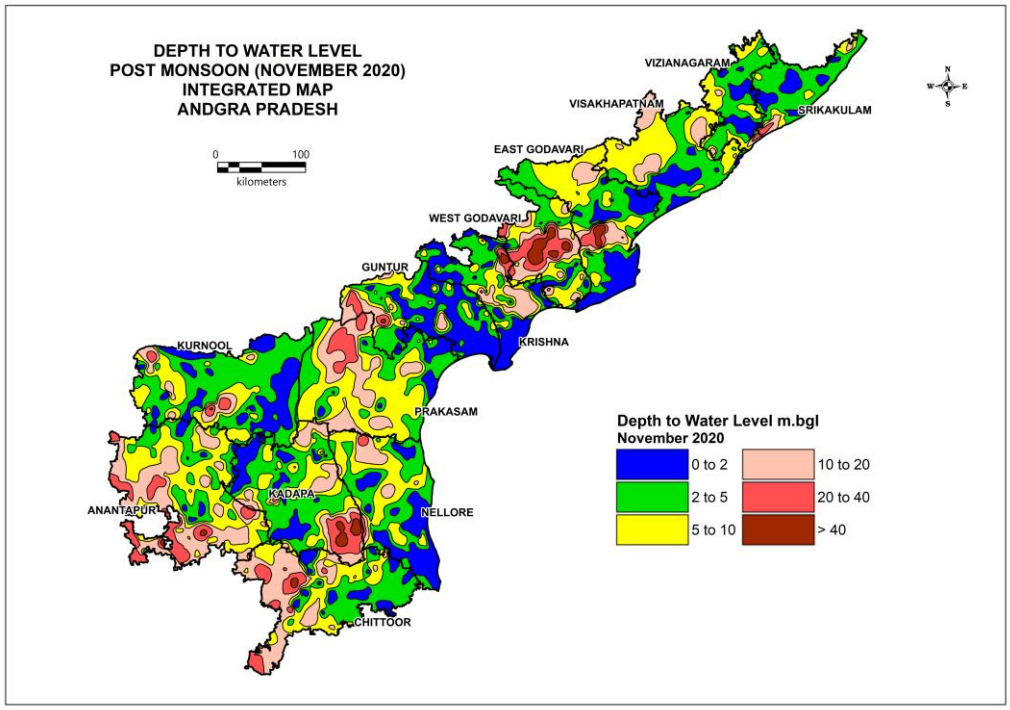


Fig 7.10 Depth To Water Level Map of Nov – 2020 (Integrated data)

TABLE 7.2: Depth to water levels and percentage of wells in different depth ranges in November-2020

S NO	DISTRICT	NO OF WELLS	MIN	0 TO 2	% OF WELLS	2 TO 5	% OF WELLS	5 TO 10	% OF WELLS	10 TO 20	% OF WELLS	20 TO 40	% OF WELLS	> 40	% OF WELLS
1	Anantapur	152	0.1	12	8%	31	20%	47	31%	37	24%	22	14%	3	2%
2	Chittoor	110	0.32	28	25%	17	15%	20	18%	35	32%	9	8%	1	1%
3	East Godavari	13	3.86		0%	2	15%	1	8%	1	8%	6	46%	3	23%
4	Guntur	96	0.27	39	41%	26	27%	16	17%	10	10%	3	3%	2	2%
5	Kadapa	126	0.1	56	44%	34	27%	19	15%	14	11%	1	1%	2	2%
6	Krishna	110	0.03	39	35%	30	27%	14	13%	21	19%	4	4%	2	2%
7	Kurnool	143	0.15	45	31%	66	46%	22	15%	6	4%	3	2%	1	1%
8	Nellore	91	0.14	36	40%	30	33%	19	21%	5	5%	1	1%		0%
9	Prakasam	101	0.07	17	17%	19	19%	37	37%	19	19%	8	8%	1	1%
10	Srikakulam	39	0.59	12	31%	19	49%	4	10%	3	8%	1	3%		0%
11	Visakhapatnam	75	0.12	19	25%	30	40%	15	20%	10	13%	1	1%		0%
12	Vizianagaram	45	0.28	13	29%	18	40%	11	24%	3	7%		0%		0%
13	West Godavari	69	0.63	11	16%	15	22%	11	16%	16	23%	10	14%	6	9%
14	**State Figures**	**1294**	**0.1**	354	28%	368	29%	258	20%	193	15%	75	6%	24	2%

7.3 Fluctuations with Pre-Monsoon Water Levels

7.3.1 Water Level Fluctuation- From May, 2020 to Aug 2020

Water level fluctuation during August 2020 from May 2020 is presented in **Annexure-VII.** An analysis of 1334 wells shows that water level rise is recorded in 74% wells (985) and fall is recorded in 25% wells (337). Spatial distribution of fluctuation of water level given in **Fig.7.11**.

Rise in water levels

In the state about 79% of the area (985wells) experienced rise in water levels compared to the pre-monsoon period (May 2020). Out of the 985 wells, 66 % of wells have recorded less than 2m rise, 17% of wells in the range of 2 to 4 m while 16% of wells recorded water level rise of more than 4 m. Rise in water level of less than 2 m is observed in all districts, mainly in the coastal parts of the state. Water level rise of 2-4 m is observed mainly in Anantapur, Kadapa, Kurnool and Chittoor districts. Rise of water level more than 4 m is significant and predominant in Anantapur, Kadapa, Chittoor and Kurnool districts.

Fall in water levels

In the state about 21% of the area (337 wells) experienced fall in water levels compared to the pre-monsoon period (May 2020). Out of the 337 wells that have registered fall in water levels, 65% of wells have recorded less than 2 m fall, 19% of wells in the range of 2-4 m and the rest 16% wells registered water level fall of more than 4 m. Fall of more than 4 m is observed significantly in parts of Vishakapatnam, Chittoor, Srikakulam, Kurnool, and Kadapa districts. Fall of 0 to 2 m observed in small parts in all the districts of the state.

The rainfall received during June 2020 to August 2020 is 33.2% more than the normal rainfall for the same period. The significant seasonal water level rise in Anantapur, Chittoor, and Kadapa and Kurnool districts can be attributed to excess rainfall received during the period.

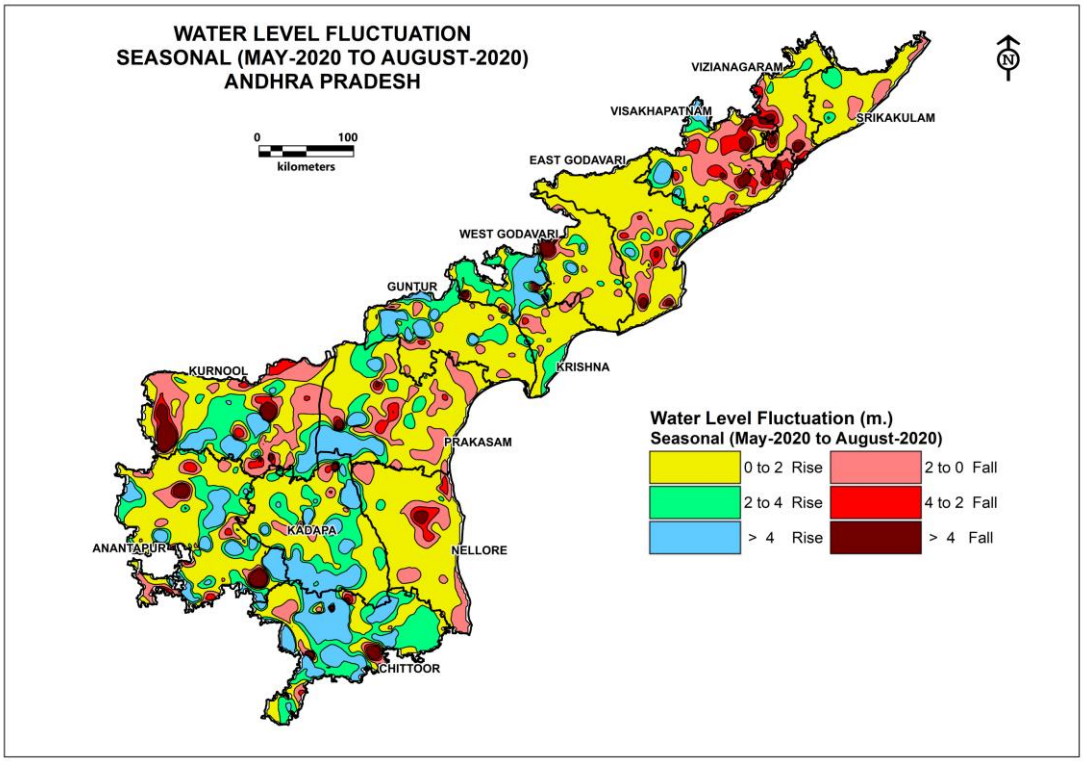


Fig 7.11: Water Level Fluctuation (From May 2020 to August 2020)

7.3.2 Water Level Fluctuation - from May, 2020 to Nov, 2020

For seasonal water level fluctuations, 10 years (2010-2019) average of May Water level has been considered. Fluctuations during November 2020 from May 2020 (10 Years Average) are presented in **Annexure-VIII.** An analysis of 669 wells shows that water level rise is recorded in 87% wells (584 nos) and fall is recorded in 13% wells (85 nos). Spatial distribution is given in **Fig 7.12**.

Rise in water levels:

In the state about 87% of the area (584 wells) experienced rise in water levels compared to the pre-monsoon period May 2020 (10 Years Average). Out of the 584 wells, 21% of wells have recorded water level less than 2m and is observed in all districts especially in Guntur, Vishakhapatnam, West Godavari, East Godavari, Nellore and Prakasam districts. Water level rise of 2-4 m is observed in all the districts especially in Vizianagaram, Srikakulam, East Godavari, Krishna, Kurnool, Vishakhapatnam and Kadapa districts. 58% of wells have

recorded rise of water level more than 4 m and observed in all districts especially in southern districts Anantapur, Kurnool, Kadapa, Prakasam, Nellore & Chittoor and West Godavari district.

Fall in water levels:

In the state about 13% of the area (85 wells) experienced fall in water levels compared to pre-monsoon period (May'20). Out of the 85 wells that have registered fall in water levels, 69% of wells have recorded less than 2 m fall and observed in small parts of Nellore, Prakasam and Krishna districts. 21 % of wells recorded fall of 2-4 m and is observed mainly in small parts of Kadapa and Prakasam districts and remaining 10 % of wells recorded fall of more than 4 m, observed mainly in small parts of Kadapa district.

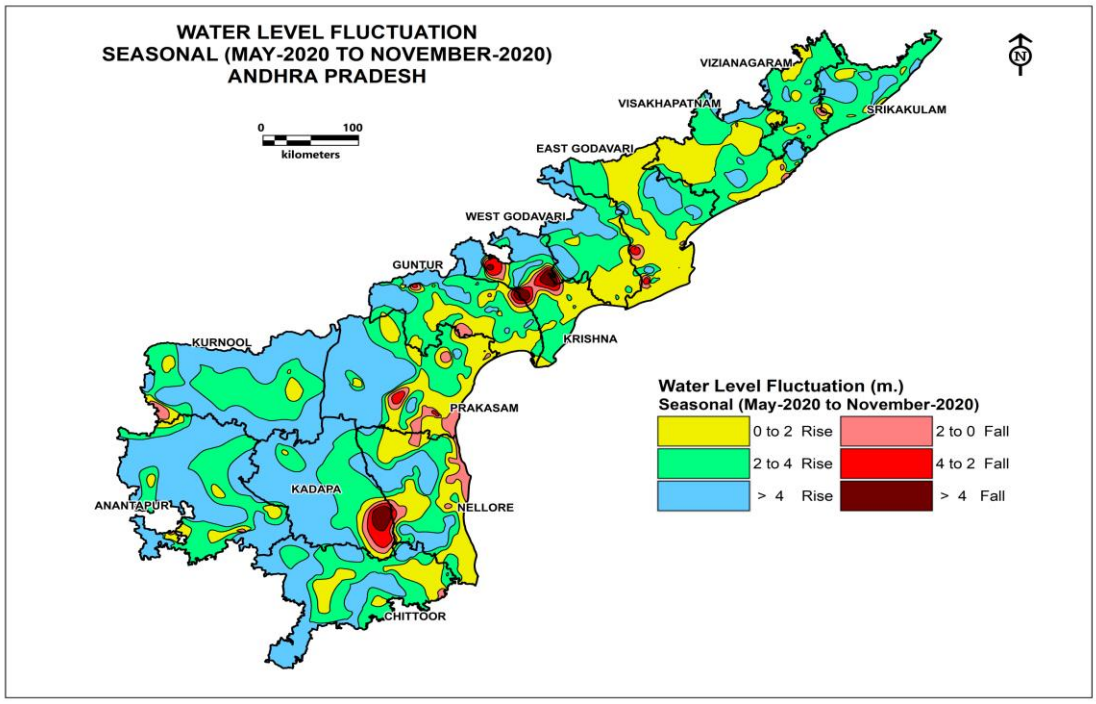


Fig 7.12 Water Level Fluctuation (From May 2020 to November 2020)

7.3.3 Water Level Fluctuation - from May, 2020 to January 2021

For seasonal water level fluctuation, 10 years (2010-2019) average of May water level has been considered. Water level fluctuation of May 2020 (10 Years Average) with January 2021 is presented in **Annexure - IX.** Analysis of 690 wells shows that water level rise is recorded in 90% (621 wells) and fall is recorded in 5% (33 wells). Spatial distribution of fluctuation of water level given in **Fig 7.13**.

Rise in water levels:

In the state about 98% of the area (621 wells) experienced rise in water levels compared to the pre-monsoon period May 2020 (10 years Average). Out of the 621 wells, 63% of wells have recorded water level rise less than 2m and is observed in all districts. Water level rise of 2-4 m is observed in all the districts as patches. Rise of water level more than 4 m is significant in southern part of the state in Anantapur, Kurnool, Chittoor, Nellore, Kadapa, Prakasam districts and as patches in Srikakulam and all the remaining districts.

Fall in water levels:

In the state about 2% of the area (33 wells) experienced fall in water levels compared to pre-monsoon period May 2020 (10 years Average). Out of the 33 wells that have registered fall in water levels, 91% of wells have recorded less than 2m fall and 3% of wells shows fall more than 4 m. Fall of water level less than 2 m observed as small patches in Kadapa, Nellore, Kurnool, Guntur, Srikakulam and Chittoor districts.

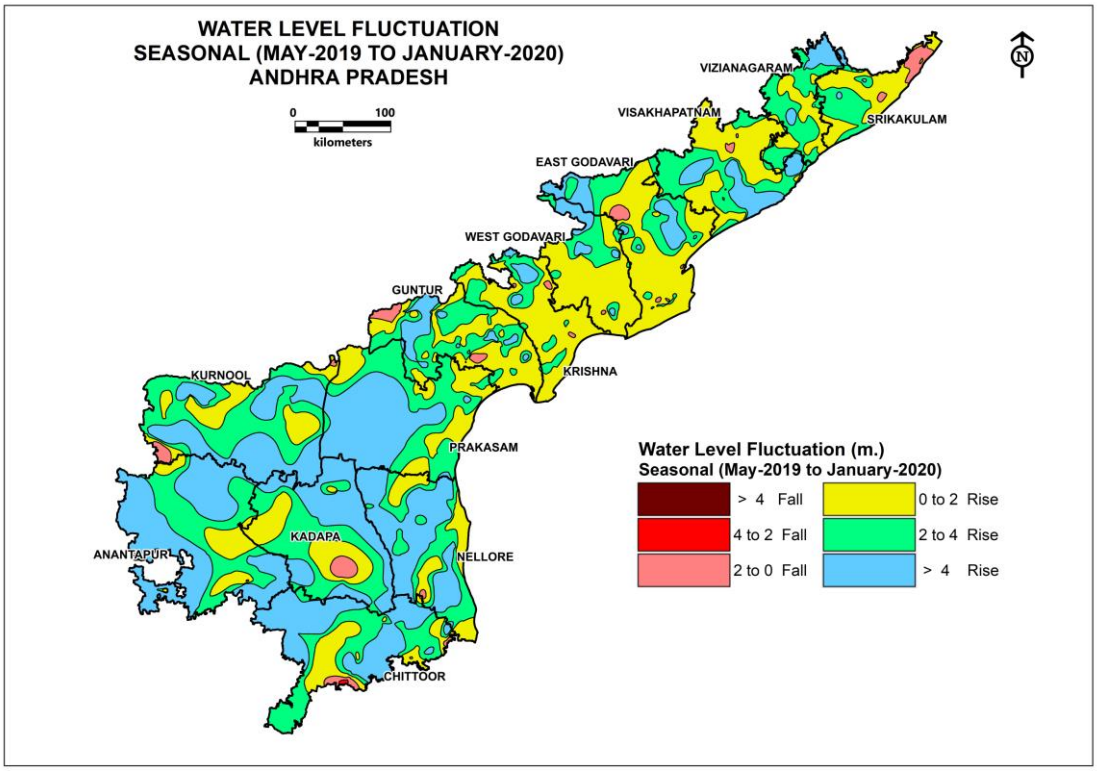


Fig 7.13: Water Level Fluctuation (From May 2020 to January 2021)

7.4 Annual Water Level Fluctuation

7.4.1 Water Level Fluctuation (From May 2019 to May, 2020)

Water level fluctuation of May 2020 with May 2019 is presented in **Annexure –X.** An analysis of data of 1249 wells shows that water level rise is recorded in 85% of wells (1062), water level fall is recorded in 15 % of wells (187). The state has experienced fluctuation in the range of -2 to 4m in about 64% of the wells.Spatial distribution of fluctuation is shown in **Fig 7.14.**

Rise in water levels:

In the state about 92% of the area (1062 wells) experienced rise in water levels compared with last year same period. Out of the 1062 wells that have registered rise in water level, 39% of wells have recorded less than 2m. 24% of wells in the range of 2 to 4 m while the rest 37% of wells recorded water level rise of more than 4 m. Rise in water level less than 2 m and 2-4 m are observed in small parts in all districts. Rise of Water level more than 4 m is predominantly observed Kadapa, Prakasam, Chittoor, Kurnool, Nellore and Anantapur districts.

Fall in water levels:

In the state about 8% of the area (187 wells) experienced fall in water levels compared with last year same period (May 2019). Out of the 187 wells that have registered fall in water levels, 69% of wells have recorded less than 2 m, 14% of wells in the range of 2-4 m and the rest 17% wells registered more than 4 m. Fall of 2 to 4 m and more than 4 m is observed as small patches in Kadapa, Prakasam, Chittoor, Krishna, Ananthpur and West Godavari. Fall of 0 to 2 m is observed mainly in Guntur, Kadapa, Prakasam, Chittoor, Kurnool, Nellore, Anantapur, Visakhapatnam, Srikakulam, and small areas in all other districts.

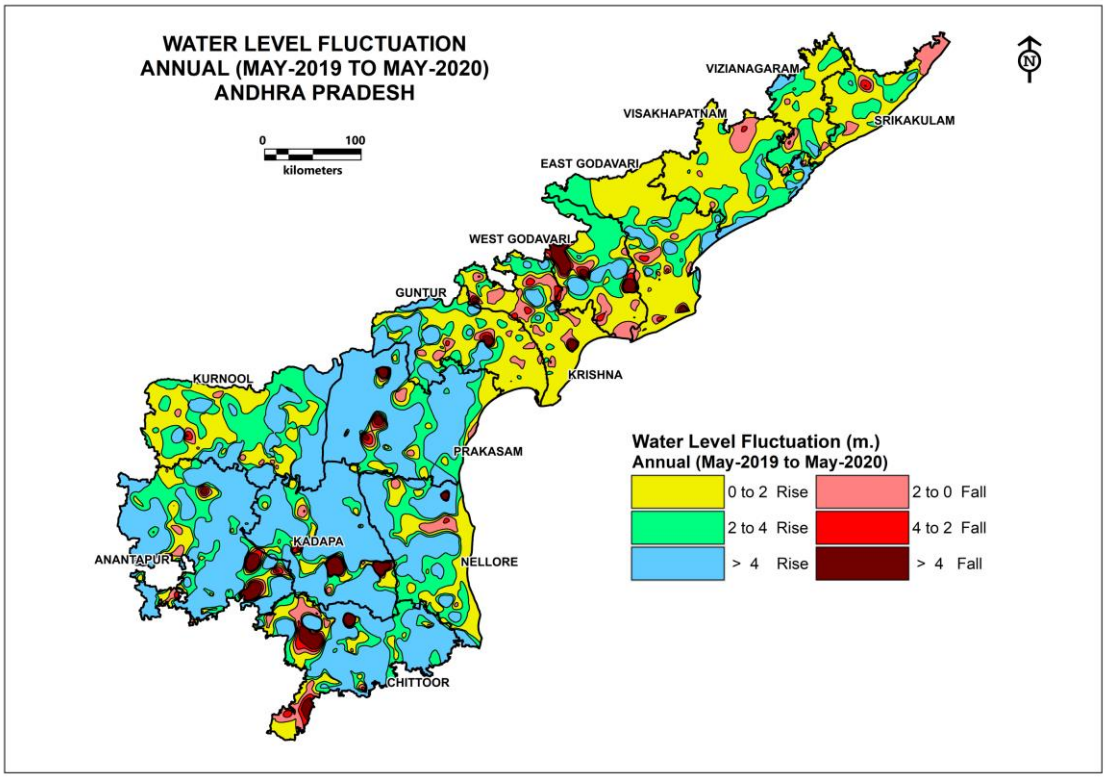


Fig.7.14: Water Level Fluctuations from May-2019 to May-2020

7.4.2 Water Level Fluctuation (August-2020 from August-2019)

Water level fluctuation of August 2020 with August 2019 is presented in **Annexure –XI.** Analysis of data of 1334 wells shows that water level rise is recorded in 78% of wells (1047), water level fall is recorded in 20% of wells (268). Spatial distribution of fluctuation is shown in **Fig 7.15.**

Rise in water levels:

In the state about 84% of the area (1047 wells) experienced rise in water levels compared with August'19. Out of the 1047 wells, 38 % of wells have recorded less than 2m rise, 23% of wells in the range of 2 to 4 m. while the rest 39% of wells recorded water level rise of more than 4 m. Rise in water level less than 2 m is observed in all districts, mainly in Visakhapatnam, East Godavari, West Godavari, Srikakulam and Vizianagaram districts. Water level rise of 2-4 m is observed as small patches in Nellore, Krishna, East Godavari, Kurnool and Vizianagaram

districts. Rise of Water level more than 4 m is observed mainly in Rayalaseema Region covering Anantapur, Chittoor, Kadapa, Kurnool and Prakasam districts.

Fall in water levels:

In the state about 16% of the area (268 wells) experienced fall in water levels compared with August'19. Out of the 268 wells, 62% of wells have recorded less than 2 m, 18% of wells in the range of 2-4 m. and the rest 20% wells registered more than 4 m. Fall of more than 4 m and 2 to 4 m is observed in small isolated parts in Anantapur, Chittoor, Kadapa, Kurnool and Prakasam districts. Fall of 0 to 2 m is observed as small parts in all districts mainly in Kurnool, East Godavari, West Godavari, Srikakulam and Vizianagaram districts.

Annual rainfall of 2019-20 is ~34% more than the preceding year annual rainfall (2018-19), thus 84 % area of the state recorded a rise in water level.

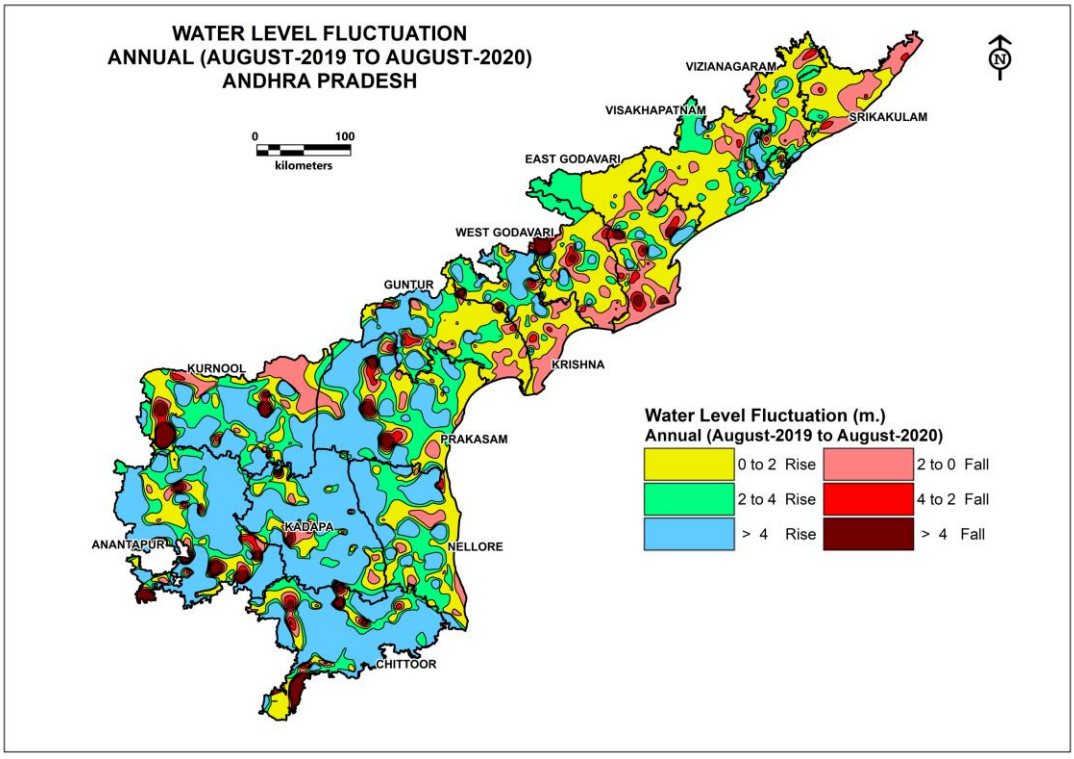


Fig. 7.15: Water Level Fluctuations (August 2020 from August 2019)

7.4.3 Water Level Fluctuations (November 2020 from November 2019)

Water level fluctuation of November 2020 with November 2019 is presented in **Annexure –XII.** An analysis of data of 672 wells shows that water level rise is recorded in 58% of wells (389), water level fall is recorded in 42% of wells (281). Spatial distribution of water level fluctuations is presented in **Fig 7.16.**

Rise in water levels:

In the state about 71% of the area (389 wells) experienced rise in water levels compared with last year same period. Out of the 389 wells that have registered rise in water level, 72 % of wells have recorded water level less than 2 while 14% of wells in the range of 2 to 4 m. 14 % of wells recorded water level rise of more than 4 m. Rise in water level less than 2 m is observed predominantly in all the districts. Water level rise of 2-4 m is observed mainly in southern districts such as Kadapa, Anantapur, Kurnool, Nellore, Prakasam and Chittoor. Rise of water level more than 4 m is observed mainly in Kadapa, Prakasam, Kurnool, Krishna, Chittoor and Guntur districts. Majority of the districts predominantly shows rise in water level due to good rainfall.

Fall in water levels:

In the state about 29% of the area (281 wells) experienced fall in water levels compared with last year same period (November -2020). Out of the 281 wells that have registered fall in water levels, 93% of wells have recorded less than 2 m, 5% of wells in the range of 2-4 m and the rest 2% wells registered more than 4 m. Fall of more than 4 m is observed significantly in small parts of Kadapa Prakasam, Chittoor, Anantapur, Vizianagaram and Visakhapatnam districts. Fall of 2 to 4 m is observed mainly in Srikakulam, West Godavari, Vizianagaram, Visakhapatnam, Nellore and Prakasam districts. Fall of 0 to 2 m is observed in all the districts, significantly in Srikakulam, Vizianagaram, Visakhapatnam, West Godavari and East Godavari districts.

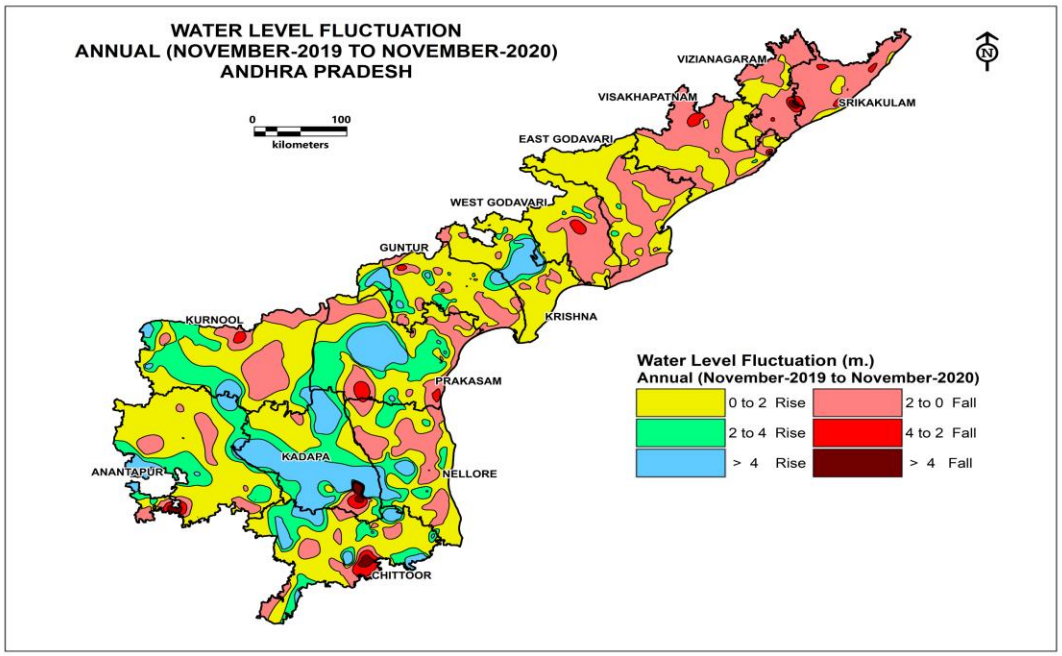


Fig.7.16 : Water Level Fluctuations (November 2020 from November 2019)

7.4.4 Water Level Fluctuations (January-2021 from January-2020)

Water level fluctuation of January 2020 with January 2021 is presented in **Annexure – XIII.** Analysis of data of 690 wells shows that water level rise is recorded in 72% (498 wells) and water level fall is recorded in 28% (182 wells). Spatial distribution of water level fluctuations is given in **Fig 7.17.**

In the state about 80% of the area (498 wells) experienced rise in water levels compared with last year same period. Out of the 498 wells that have registered rise in water level, 73% of wells have recorded water level less than 2 m. 15% of wells in the range of 2 to 4 m. while 12% of wells recorded water level rise of more than 4 m. Rise in water level less than 2 m is observed predominantly in all the districts. Water level rise of 2-4 and >4 m is observed in southern districts; Anantapur, Kurnool, Nellore, Kadapa, Prakasam and Chittoor districts, as these districts received excess rainfall during June to December 2020 compared to the same period in 2019 .

Fall in water levels:

In the state about 20% of the area (182 wells) experienced fall in water levels compared with last year same period (January 2020). Out of the 196 wells that have registered fall in water levels, 92% of wells have recorded less than 2 m, 4% of wells in the range of 2-4 m and the rest 4%

wells registered more than 4 m. Fall of more than 4 m is observed significantly as small patches in parts of Nellore, Anantapur, Chittoor and Kurnool districts. Fall of 2 to 4 m is observed mainly in Kadapa, Chittoor, Anantapur and Nellore districts. Fall of 0 to 2 m is observed as very small scattered patches in all districts.

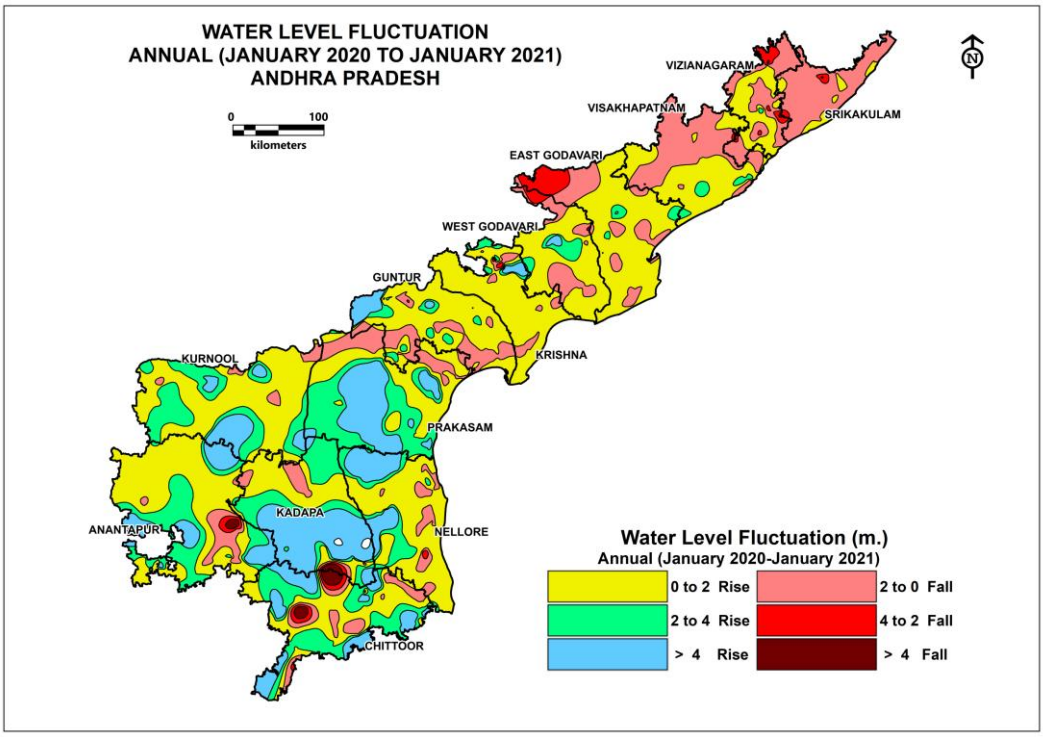


Fig. 7.17: Water Level Fluctuations (January, 2021 from January, 2020).

7.5 Decadal Water Level Fluctuations

7.5.1 Water Level Fluctuations-Decadal mean of May (2010-19) to May 2020

Water level fluctuation of May 2020 from Decadal Mean of May (2010-2019) is presented in **Annexure – XIV**. Water level fluctuation map of May-2020 from Decadal Mean of May (2010-2019) is depicted in **Fig. 7.18**.

Analysis of data of 402 wells shows that water level rise is recorded in 56% wells (226 wells), water level fall is recorded in 44% wells (176 wells).

Rise in water levels:

Area-wise,79% of the state experienced water levels rise compared with the decadal mean of May (2010-19). Out of 226 wells, water level rise of less than 2 m is recorded in 40% wells, in

the range of 2-4 m in 26% wells. Rise of water level more than 4 m is observed in 34% of the wells, covering 16% of the area and observed in Krishna, Kadapa, Chitoor and Srikakulam. Rise in water level of less than 2 m and 2-4m observed in parts of all the districts.

Fall in water levels:

In the state about 21% of the area experienced fall in water levels compared with decadal mean (2010-2019). Out of the 176 wells that have registered fall in water levels, 42% have recorded less than 2 m, 24% in the range of 2-4 m and 34% wells registered water level fall of more than 4 m. Fall of less than 2 m and 2-4m is observed as patches in all districts. Fall of more than 4 m is observed in all districts except Vishakhapatnam and Vijayanagaram districts.

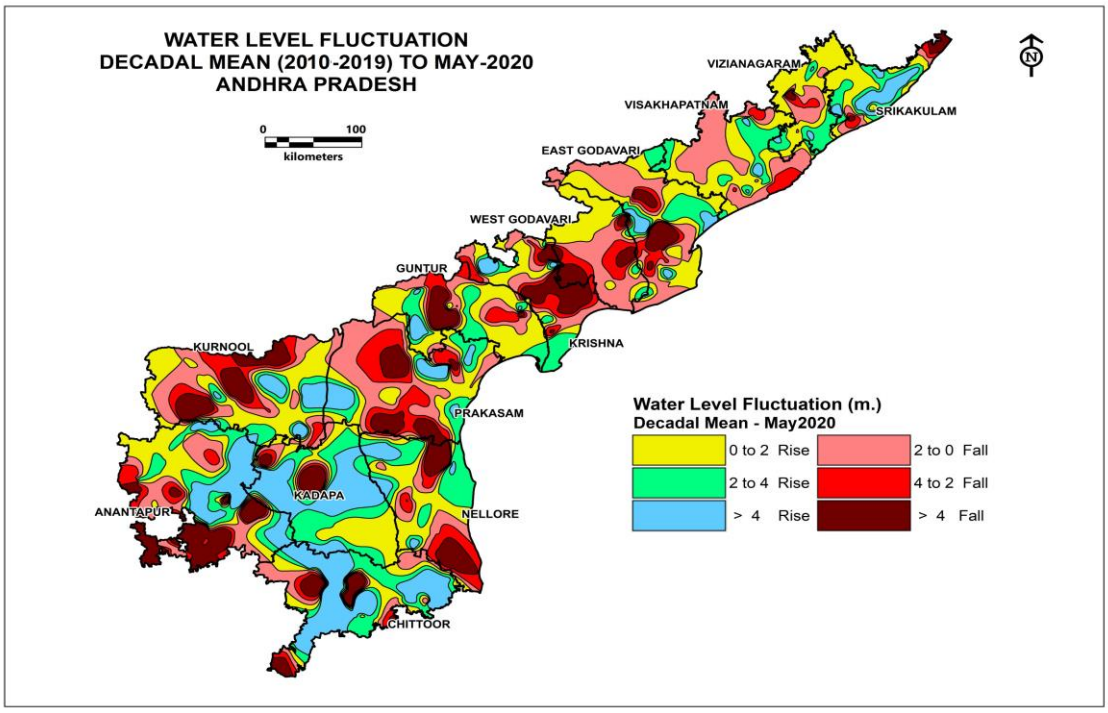


Fig.7.18: Water Level Fluctuations - Decadal Mean of May (2010-2019) to May-2020

7.5.2 Water Level Fluctuation-Decadal Mean of Nov (2010-2019) to Nov, 2020

Water level fluctuation of November 2020 from Decadal Mean of November (2010-2019) is presented in **Annexure-XV.** Spatial distribution of fluctuations shown as **Fig 7.19**. Analysis of data of 691 wells shows that water level rise is recorded in 77 % wells (529 wells), water level fall is recorded in 23% wells (162 wells).

Rise in water levels:

Area-wise, 87% of the state experienced water level rise compared with the decadal mean of November (2010-19). Out of 529 wells, water level rise of less than 2 m is recorded in 75% wells, in the range of 2-4 m in 18% wells. Rise of water level more than 4 m is observed in 7 % of the wells, covering small parts in Anantapur, Kadapa, Krishna, Prakasam, West Godavari, and Nellore, Kurnool and districts. Rise in water level of less than 2 m is observed in all the districts. Water level rise of 2-4 m is observed significantly in southern districts such as Anantapur, Cuddapah, Kurnool, Nellore, Prakasam, Chittoor, West Godavari and Guntur districts.

Fall in water levels:

In the state about 13% of the area experienced fall in water levels compared with decadal mean (2010-2018). Out of the 162 wells that have registered fall in water levels, 90% have recorded less than 2 m, 7% in the range of 2-4 m. and 3% wells registered water level fall of more than 4 m. Fall of less than 2 m is observed predominantly Srikakulam and as small patches in all districts. Fall of 2 to 4 m is observed mainly in Anantapur, Prakasam and Vizianagaram districts. Fall of more than 4 m is observed significantly in parts of Kadapa, Krishna and Prakasam districts.

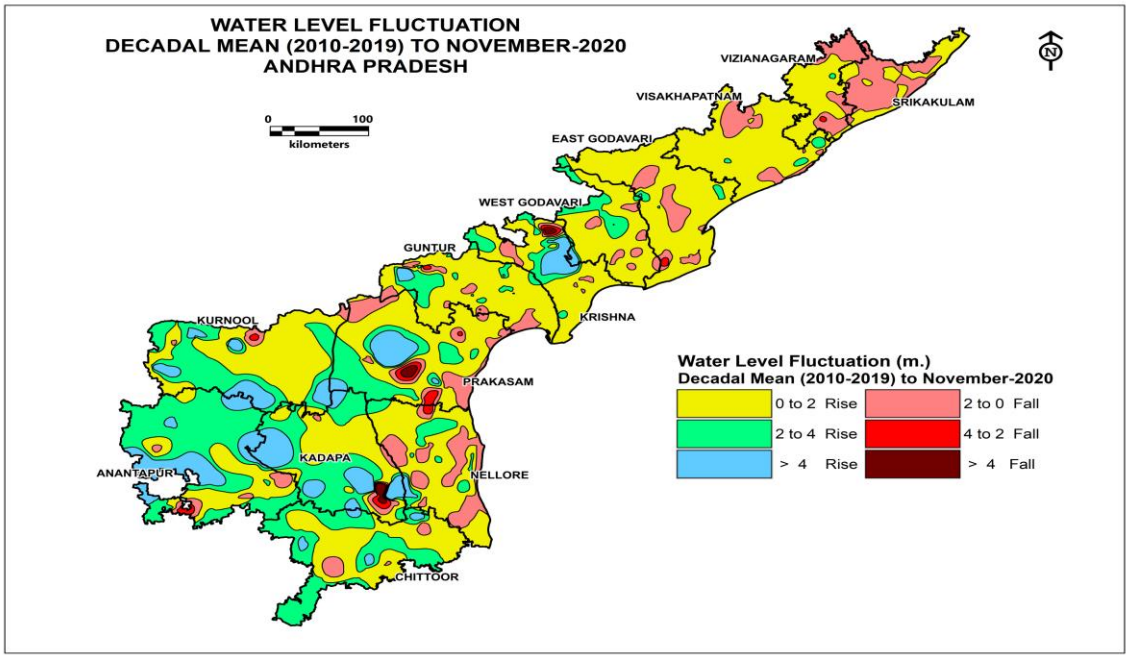


Fig. 7.19: Water Level Fluctuation - Decadal Mean (2010-2019) to November-2020

7.5.3 Water Level Fluctuation- Decadal Mean (2011-2020) to January 2021

Water level fluctuation of January 2021 from Decadal Mean (2011-2020) is presented in **Annexure-XVI.** Spatial distribution of water level fluctuations is presented in **Fig 7.20.**

Analysis of data of 712 wells shows that water level rise is recorded in 80% (573 wells), water level fall is recorded in 20% (139 wells).

Rise in water levels:

Area-wise, 83 % of the state experienced water level rise compared with the decadal mean of January (2011-20). Out of 573 wells, water level rise of less than 2 m is recorded in 69% wells, 2-4 m in 18% wells and rise of water level more than 4 m is recorded in 13% of the wells. Rise in water level less than 2 m is observed in all the districts and predominantly in Guntur, East Godavari, Krishna, Visakhapatnam and West Godavari districts. Water level rise of 2-4 m is observed significantly in southern parts of the state in Anantapur, Kurnool, Prakasam, and Chittoor districts. Rise of water level more than 4 m is observed in parts of Kadapa, Prakasam, Kurnool, Chittoor and Anantapur districts.

Fall in water levels:

In the state about 17 % of the area experienced fall in water level compared with decadal mean (2011-2020). Out of the 139 wells that have registered fall in water level, 87% have recorded less than 2 m fall, 9% recorded 2-4 m fall and 4% registered water level fall of more than 4 m. Northern districts prominently recorded fall in water levels .Fall of more than 4 m is observed in isolated parts of Anantapur, Prakasam and Chittoor districts. Fall in water level range of 2 to 4 m is observed in small parts of Vizianagaram, Chittoor, Kadapa and East Godavari districts. Fall in water level range of 0 to 2 m is observed mainly in Srikakulam, Visakhapatnam, Vizianagaram and East Godavari districts.

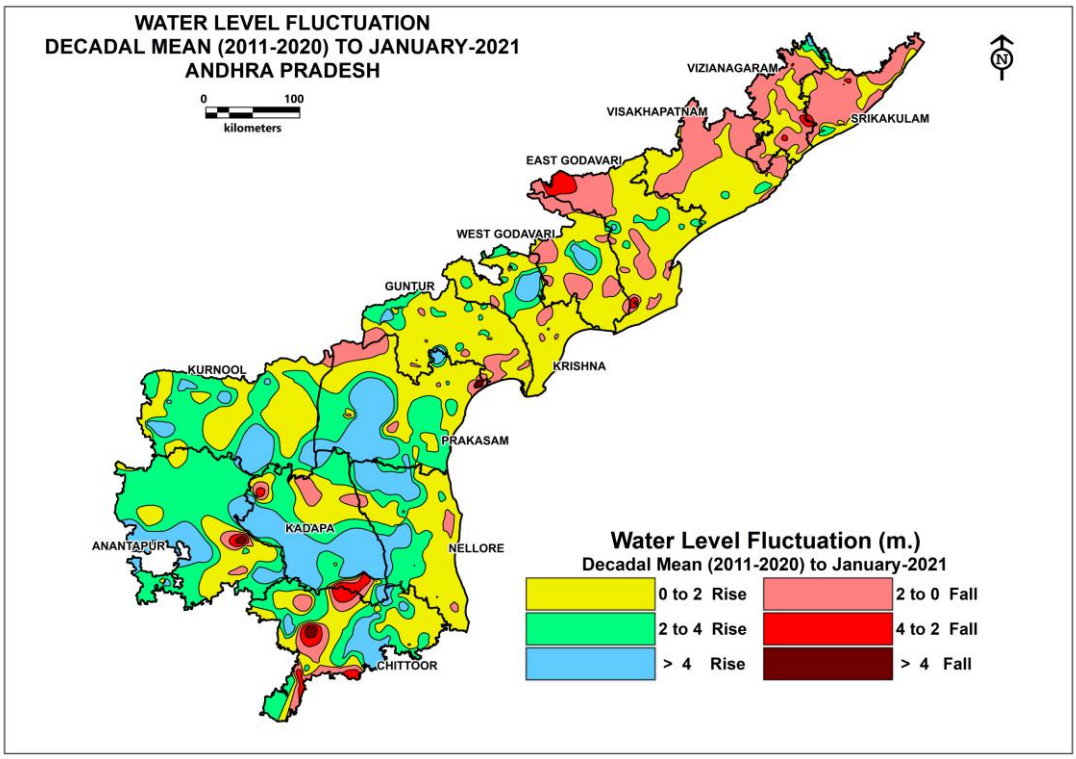


Fig. 7.20: Water Level Fluctuation - Decadal Mean (2011-2020) to January-2021

7.6 Aquifer wise water levels

Aquifer wise water level analysis shows that during pre-monsoon season shallowest water levels are observed in all the formations except in intrusives. In pre-monsoon, deepest water levels are observed banded gneissic complex, shale, sandstone, limestone and granite. During post-monsoon season, shallowest water levels are observed in all formations except in intrusives. Deepest water levels are observed in banded gneissic complex, gneiss, limestone, shale and sandstone. Aquifer wise water level scenario is presented in **Table-7.3.**

Table-7.3: Aquifer wise Minimum, Maximum and Average values of water levels, Andhra Pradesh State.

Principle Aquifer	Pre-monsoon May 2020			Post-monsoon Nov 2020		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Alluvium	0.19	38.02	7.44	0.02	30.26	2.95
Branded gneissic complex	0.43	91.28	15.84	0.4	72.49	5.69
Chanrockite	0.44	30.77	6.40	0.7	19.68	3.17
Gneiss	0.17	21.07	7.54	1.19	10.9	3.58
Granite	0.21	59.61	14.45	0.8	17.97	4.58
Khondalite	0.49	49.96	8.56	0.85	17.46	3.56
Limestone	0.05	56.98	8.74	0.87	55.24	6.45
Laterite	2.27	9.41	6.12	1.32	9.6	3.65
Quartzite	0.09	30.49	10.22	1.4	8.72	4.03
Schist	0.18	43.35	10.19	1.1	26.39	6.47
Shales	0.94	89.12	19.29	0.71	79.8	14.03
Sandstone	1.76	80.44	28.64	0.85	39.12	6.86

7.7 Long-term Water Level trends:

7.7.1 Pre-monsoon trend map:

It is inferred from the pre-monsoon water level trend map that the falling trend in water level of 0-2.6 m/yr. is observed in 90% of the area and rising trend of 0-1.4 m / yr. in water level is observed in 10% of the area in the state. Falling trend is recorded at 721 locations and rising trend in 219 locations during May. Falling trend of 0 to 1 m/yr is more prevalent all the districts. The falling trend of 1 to 2 m/yr is observed in parts of Anantapur, Kadapa, Prakasam, Krishna, Nellore and West Godavari districts. Falling trend of more than 2 m/yr. is restricted to few locations in Prakasam and Nellore districts. Rising trend of 0 to 1 m/yr is observed in parts of all the districts except Prakasam, Nellore, Guntur and Krishna districts

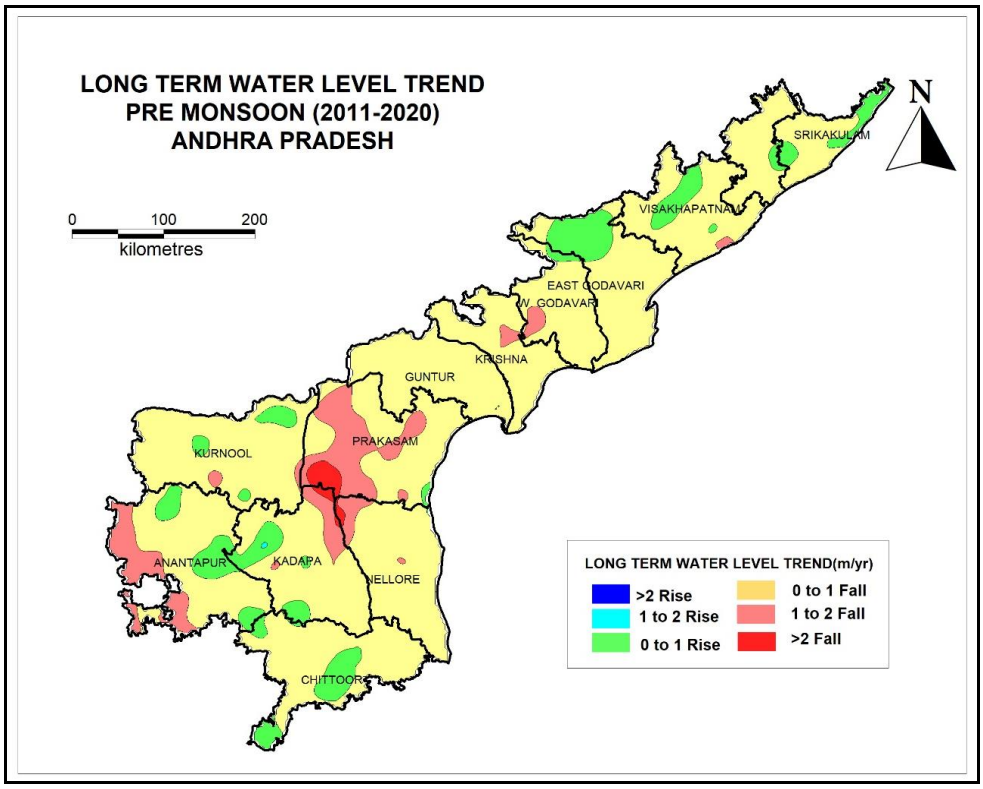


Fig-7.21 Long term water level trend – Pre-monsoon period (2011-2020)

7.7.2 Post-monsoon trend map:

It is inferred from the post-monsoon water level trend map that the falling trend in water level of 0-1.98 m/yr. is observed in 35% of the area and rising trend of 0-2 m / yr. in water level is observed in 65% of the area in the state. Falling trend is recorded at 462 locations and rising trend is recorded in 680 locations. Falling trend of 0 to 1 m/yr. is more prevalent in all the districts except Chittoor and Visakhapatnam, where relatively less areas area seen. The falling trend of 1 to 2 m/yr is observed in parts of all the districts. Falling trend of more than 2 m/yr is identified in few locations of Prakasham, Nellore, Kadapa, Krishna and Godavari districts. Rising trend of 0 to 1 m/yr. is predominant in the districts. Season wise area under Fall and Rise with percentages is given below.

Criteria	Fall	Rise	Fall in % of area	Rise in % of area
	Area (sq.km.)		(%)	
Pre-monsoon	147591	16399	90%	10%
Post-monsoon	57396	106594	35%	65%

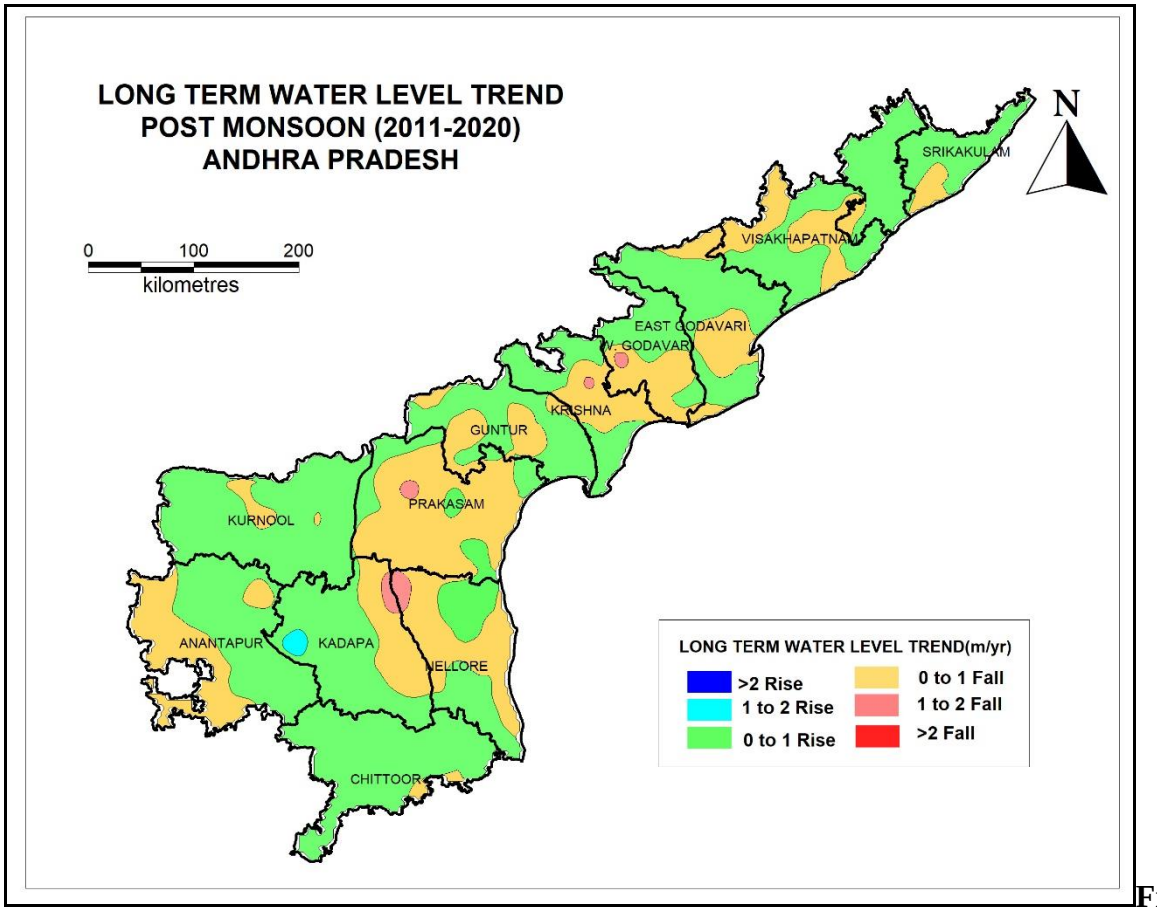


Fig - 7.22 Long term water level trend Post-monsoon period (2011-2020)

7.8 Long term water level scenario

To study the change in Ground water scenario, the pre and post monsoon long term water level trend data of 10 years (2011 – 2020) is compared with pre and post monsoon water level trend data of last five years (2016-2020). The change in water level trends in last five years is categorized into 4 categories, represented in **Table-7.4** and **Fig:7.23.**

Table-7.4 Categorization of Water Level Scenario

Water level Trend	Category	Description
Rising	**1**	Areas with rising trend showing further improvement (increase in rising rate) in water level trends in last five years
	2	Areas with falling trend, showing improvement (fall in declining rate) in water level trends in last five years
Declining	**3**	Areas with rising trends, showing decline (fall in rising rate) in water level trends in last five years.
	4	Areas with falling trend showing further decline (increase in falling rate) in water level trends in last five years

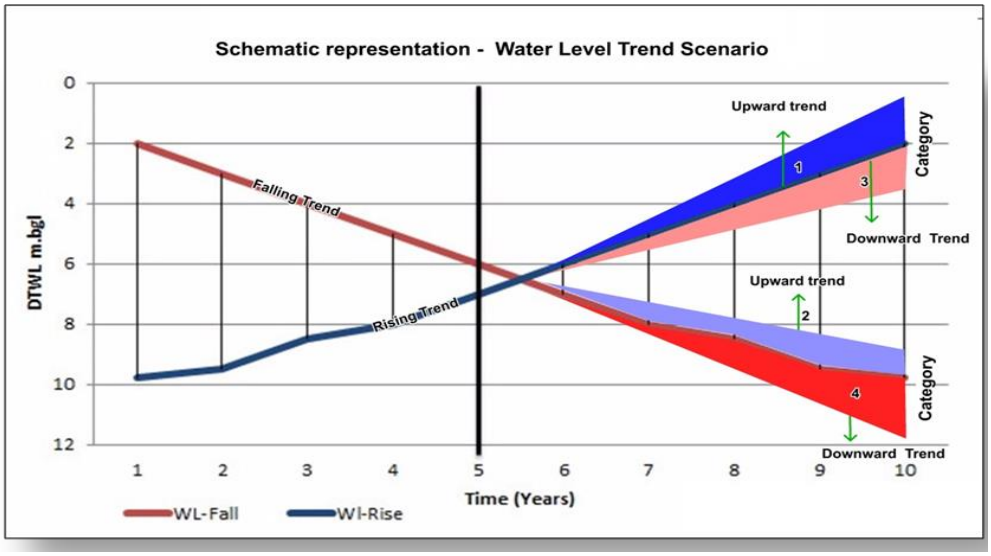


Fig.7:23 Schematic representation of water level trend scenario

During pre-monsoon 43% area of the state shows improvement in water levels (Category -1 & 2) and 57 % of the area shows decline in water level trends (Category - 3 & 4) in **Fig:7.24.** Major improvement in last five years is observed in Prakasam (62%) and Kurnool (59%), Krishna (53%), Srikakulam (86%) and West Godavari (50%), major decline in water level trend is observed in Ananthpur(68%), Chitoor(81%), Nellore(79%) and Vishakapatnam(73%). It is further observed that long term 10 years falling trend further declined in last 5 years in 57% area of the state ranging from 81% in Chittoor to 14% in Srikakulam.

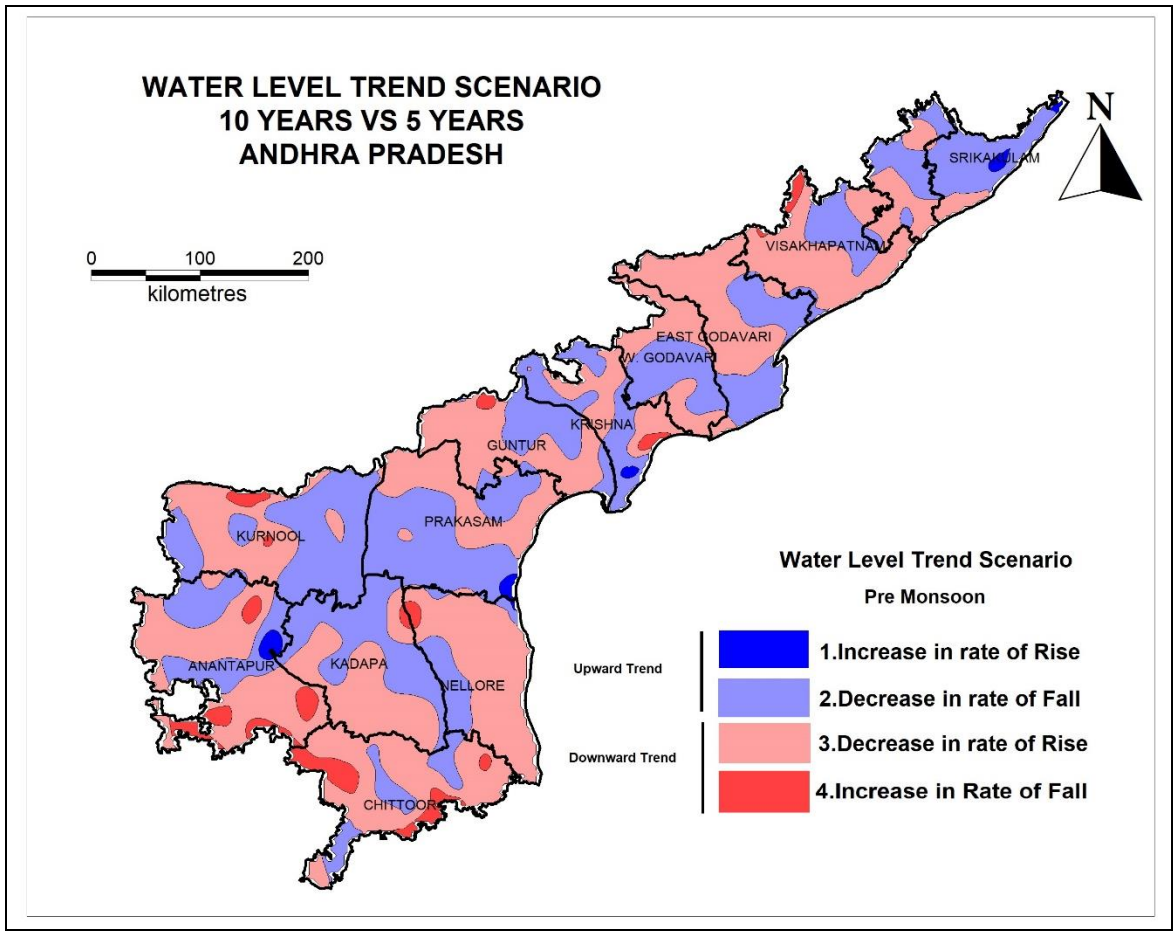


Fig-7.24 Pre monsoon Water Level Trend Scenario

Table-7.5 District wise Water Level Trend Scenario

District	Category-1		Category-2		Category-3		Category-4		Rise		Fall	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
ANANTAPUR	2%	18%	30%	61%	57%	21%	10%	0%	32%	79%	68%	21%
CHITTOOR	0%	8%	19%	67%	67%	25%	14%	0%	19%	75%	81%	25%
EAST GODAVARI	0%	16%	38%	81%	62%	3%	0%	0%	38%	97%	62%	3%
GUNTUR	0%	20%	37%	79%	62%	1%	2%	0%	37%	99%	63%	1%
KRISHNA	2%	35%	51%	64%	44%	1%	3%	0%	53%	99%	47%	1%
KURNOOL	0%	36%	59%	56%	38%	7%	3%	0%	59%	93%	41%	7%
NELLORE	0%	13%	20%	82%	77%	4%	2%	1%	21%	95%	79%	5%
PRAKASAM	1%	23%	60%	68%	38%	9%	0%	0%	62%	91%	38%	9%
SRIKAKULAM	6%	35%	80%	65%	14%	0%	0%	0%	86%	100%	14%	0%
VISAKHAPATNAM	0%	17%	27%	64%	70%	16%	3%	2%	27%	81%	73%	19%
VIZIANAGARAM	0%	48%	48%	52%	52%	0%	0%	0%	48%	100%	52%	0%
W. GODAVARI	0%	13%	50%	78%	50%	8%	0%	0%	50%	92%	50%	8%
KADAPA	0%	15%	48%	70%	51%	14%	1%	1%	48%	85%	52%	15%
Total	**1%**	**21%**	**42%**	**68%**	**54%**	**10%**	**3%**	**0%**	**43%**	**57%**	**90%**	**10%**

During post-monsoon 90% area of the state shows improvement in water levels and 10% of the area shows decline in water level trends in **Fig:7.25.** Improvement in water level trends in last five years is observed in all the districts whereas declining trend is observed in parts of Vishakhapatnam (19%), Chittoor (25%) and Anantapur district (21%). It is further observed that long term 10 years falling trend is improved in last 5 years in 68% area of the state ranging from 52% in Vizianagaram to 82% in Nellore district.

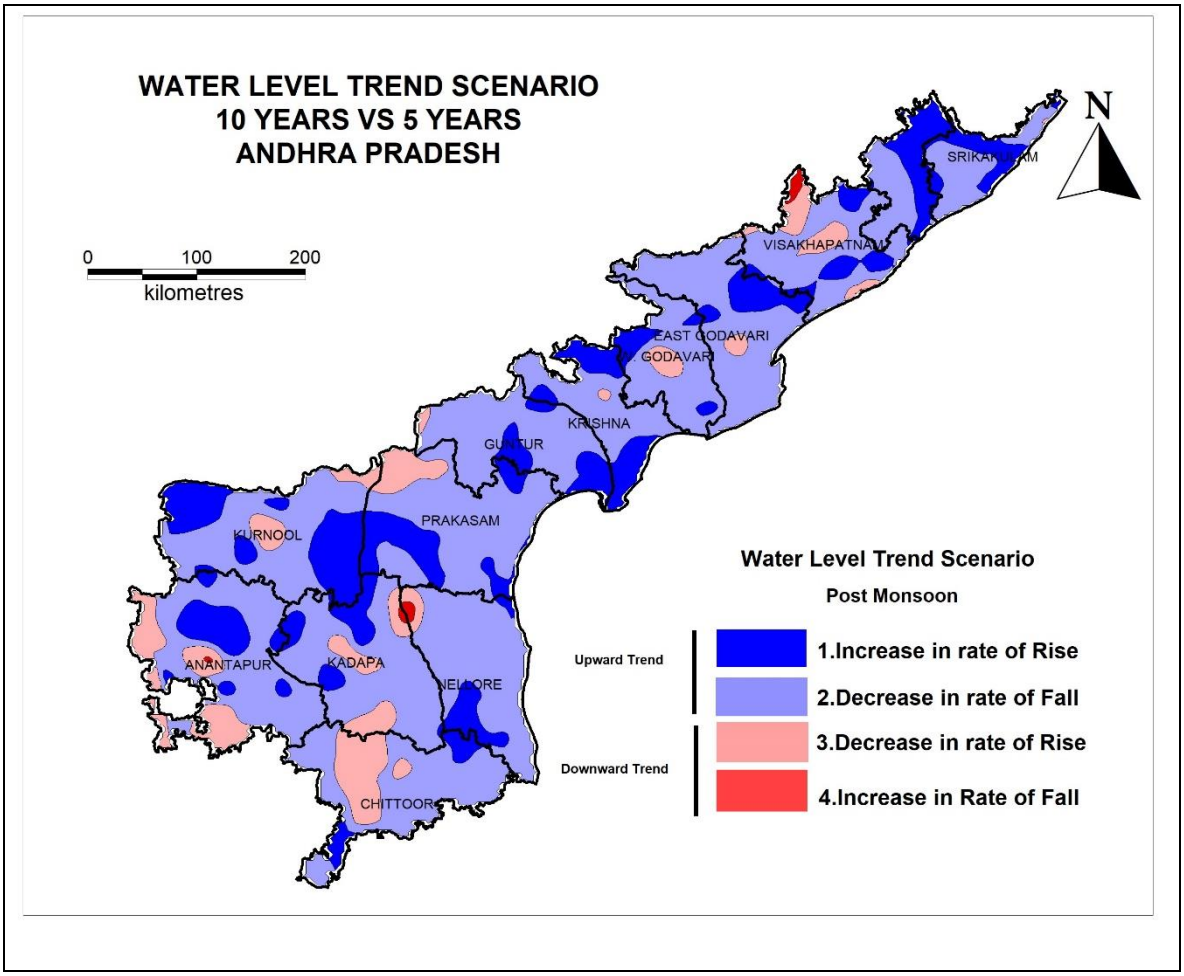


Fig.7.25: Post monsoon Water Level Trend Scenario

Rise in water levels in last five years can be attributed to improvement in medium and minor irrigation projects. Under rehabilitation of minor irrigation tanks, ~ 40.2 MCM of desiltation works completed under Neeru-Chettu program of Govt. of AP which facilitated accelerated ground water recharge. The Govt. of Andhra Pradesh had taken several initiatives in improving the surface water availability in various irrigation projects like Sir Arthur Cotton Barrage (GDS) in East Godavari, Tadipudi LI Scheme in West Godavari, Thotapalli Barrage Project in Vijayanagaram district and KC Canal modernisation project in Cuddapah district etc. These initiatives had sustained command area, which in turn reduced the stress on ground water system and resulted in rise in ground water levels in the State.

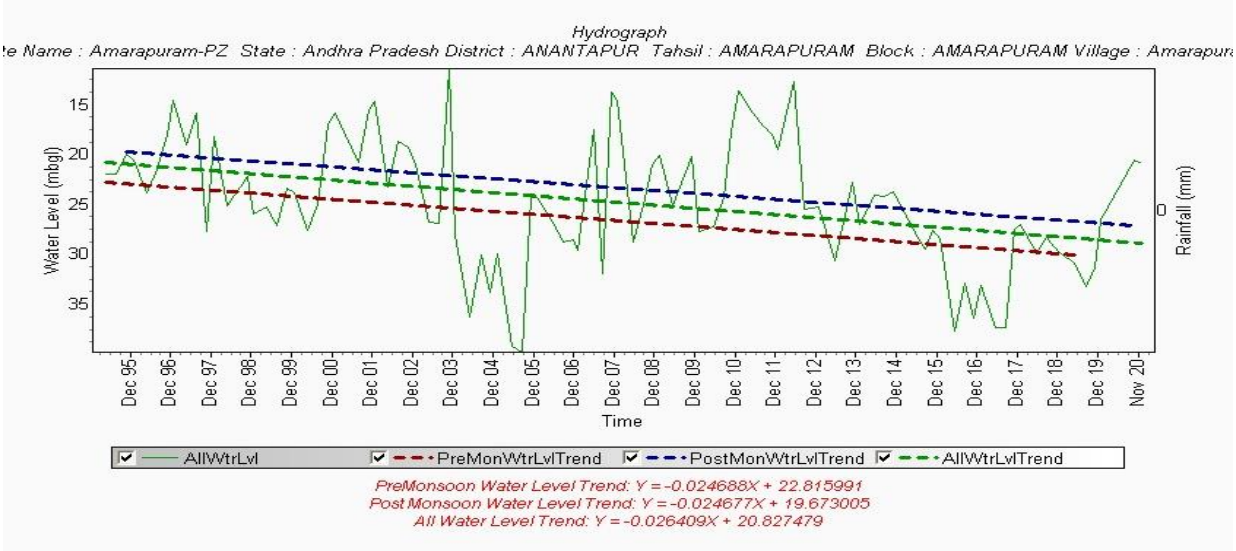
7.9 Hydrographs of water level

Total 26 hydrographs are generated (2 from each district) (**Fig. 7.26**). Out of 26, 12 wells show rising trends in both seasons, 10 shows falling trend in both season and rest shows mixed trend (**Table-7.6**).

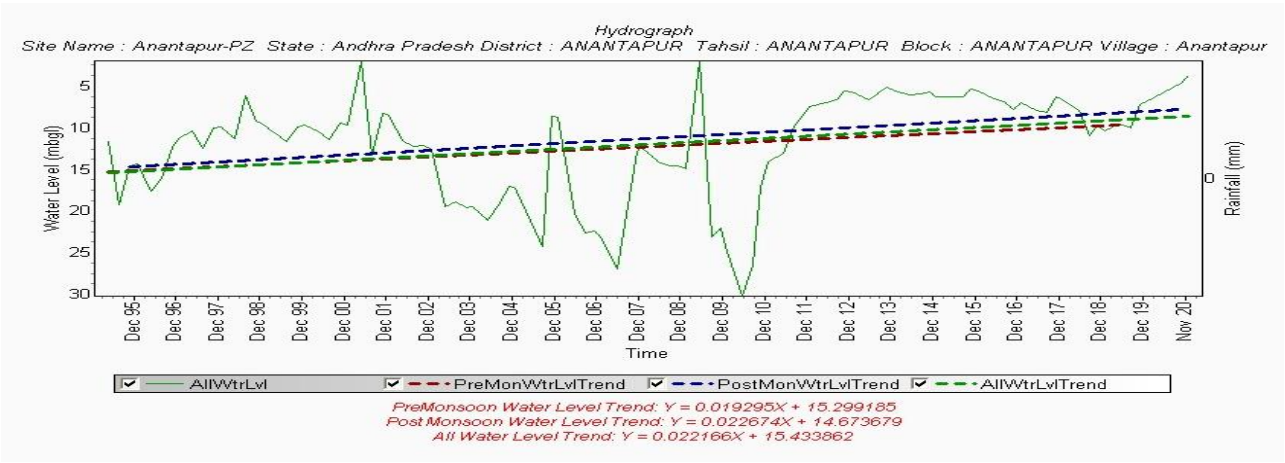
Table-7.6: Representative Hydrographs showing rising and falling trends in Andhra Pradesh State.

S. No.	Fig No.	Location	District	Pre (m/yr.)		Post (m/yr.)	
				Rise	Fall	Rise	Fall
1	7.26a	Amarapuram	Anantapur		0.288		0.288
2	7.26b	Anantapur	Anantapur	0.228		0.264	
3	7.26c	Damalcheruvu	Chittoor	0.048		0.0024	
4	7.26d	Battuvaripalli	Chittoor	0.048		0.0072	
5	7.26e	Muddireddipalli	Kadapa		0.096		0.204
6	7.26f	Anjaneyapuram	Kadapa	0.012			0.048
7	7.26g	Jaggampet	East Godavari	0.144		0.06	
8	7.26h	Gollaprolu	East Godavari	0.0228		0.00192	
9	7.26i	Ipur	Guntur		0.0336		0.0288
10	7.26j	Gudur	Kurnool	0.156		0.0996	
11	7.26k	Nuziveedu	Krishna	0.0576		0.0312	
12	7.26l	Gudivada	Krishna		0.01176		0.0204
13	7.26m	Gonegandla	Kurnool	0.114		0.0276	
14	7.26n	Ahobilam	Kurnool		0.372		0.246
15	7.26o	Kadanothola	Nellore		0.084		0.012
16	7.26p	Bata	Nellore		0.0516		0.1032
17	7.26q	Chirala	Prakasam		0.0252		0.024
18	7.26r	Chandalur	Prakasam		0.1116	0.0108	
19	7.26s	Ichapuram	Srikakulam	0.0084		0.0444	
20	7.26t	Barua	Srikakulam	0.0864		0.1224	
21	7.26u	Narsipattanam	Vishakhapattanam	0.0012			0.0036
22	7.26v	Araku	Vishakhapattanam		0.0372		0.0108
23	7.26w	Agraharam	Vizianagaram	0.1056		0.0996	
24	7.26x	Garbham	Vizianagaram	0.0084			0.012
25	7.26y	Kovvur	West Godavari	0.0408		0.0276	
26	7.26z	Eluru	West Godavari		0.984		0.804

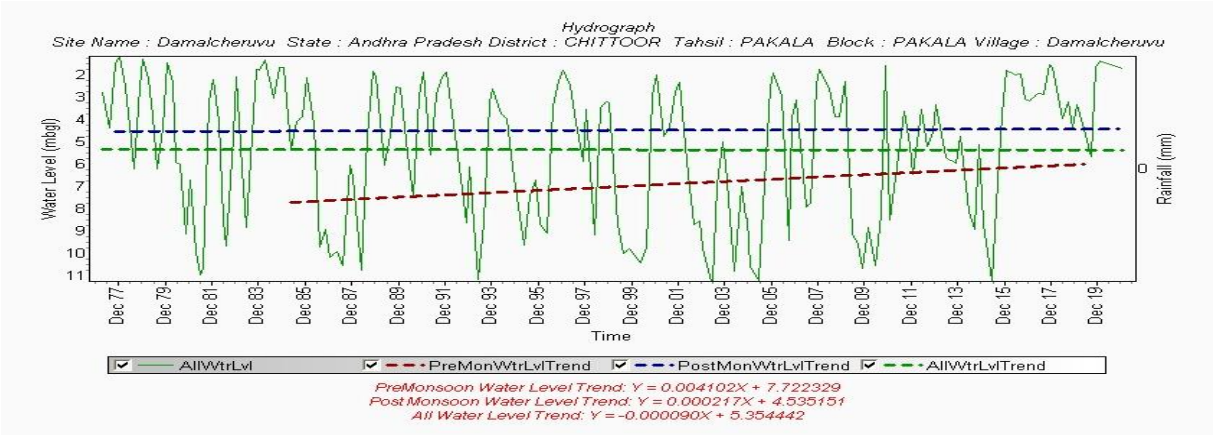
7.26a



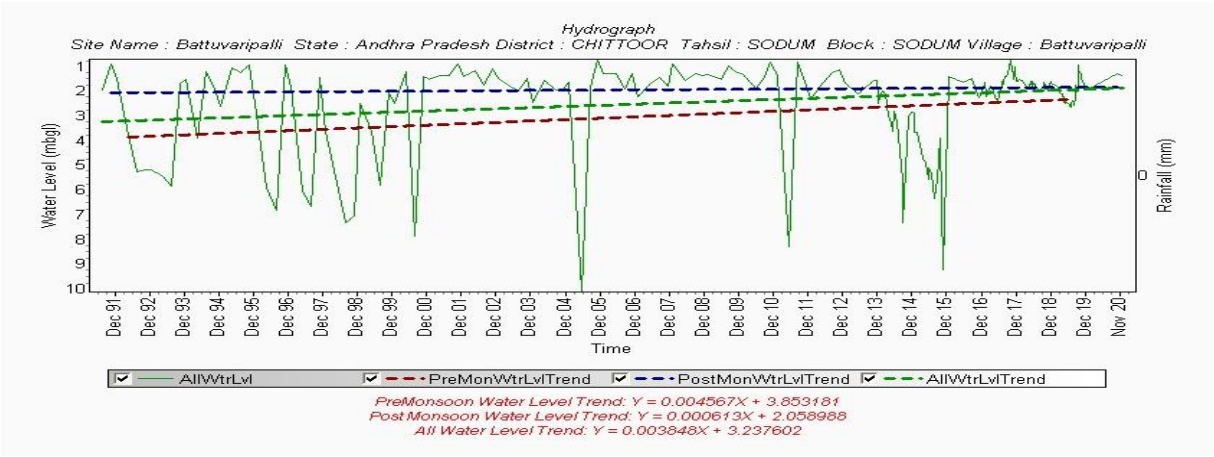
7.26b



7.26c



7.26d



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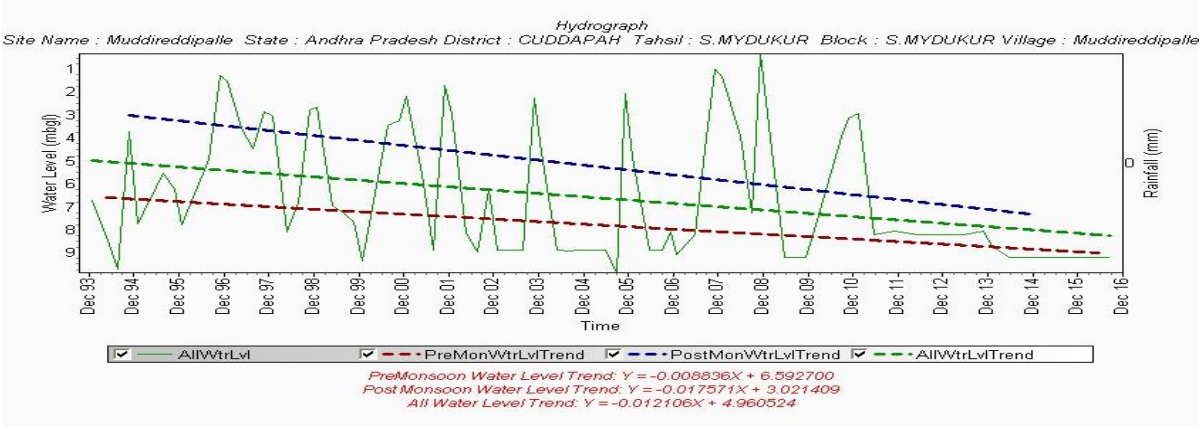

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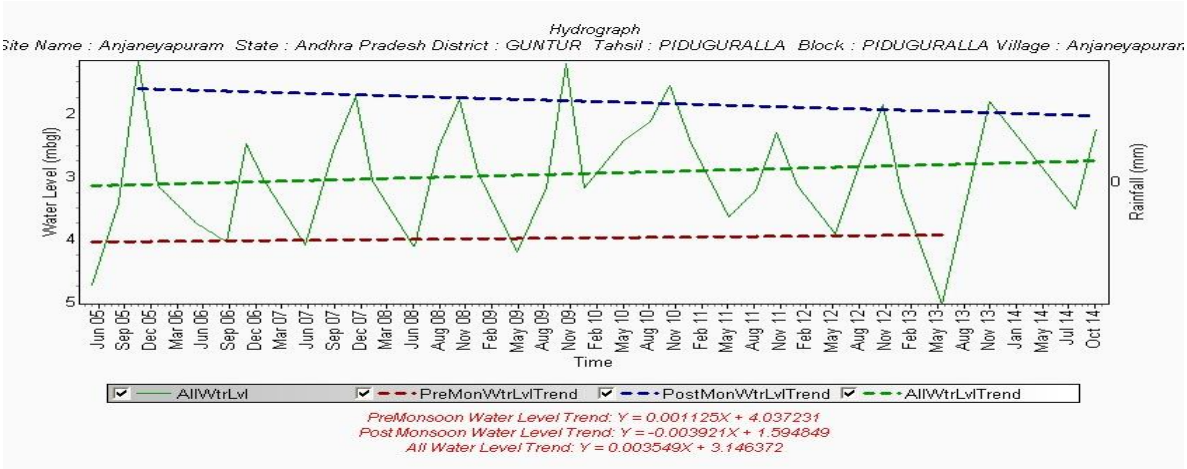
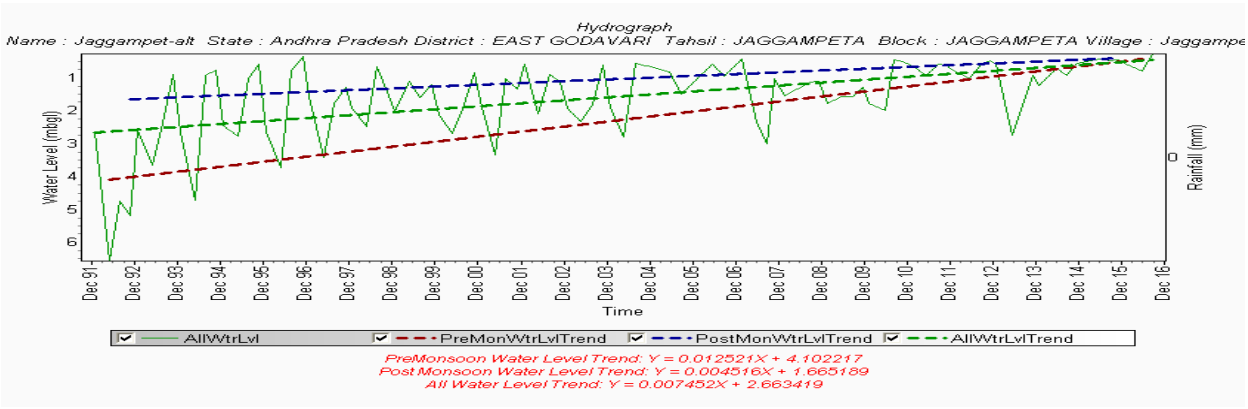
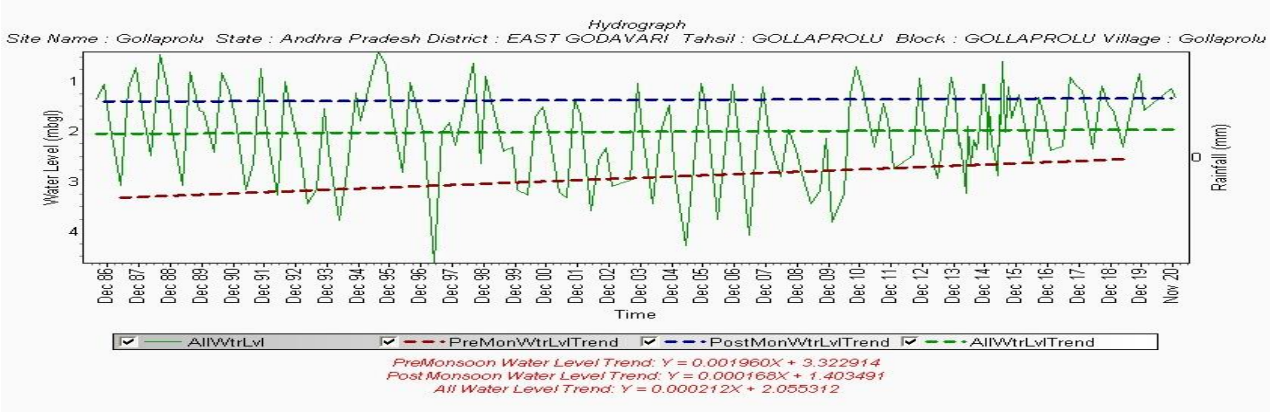


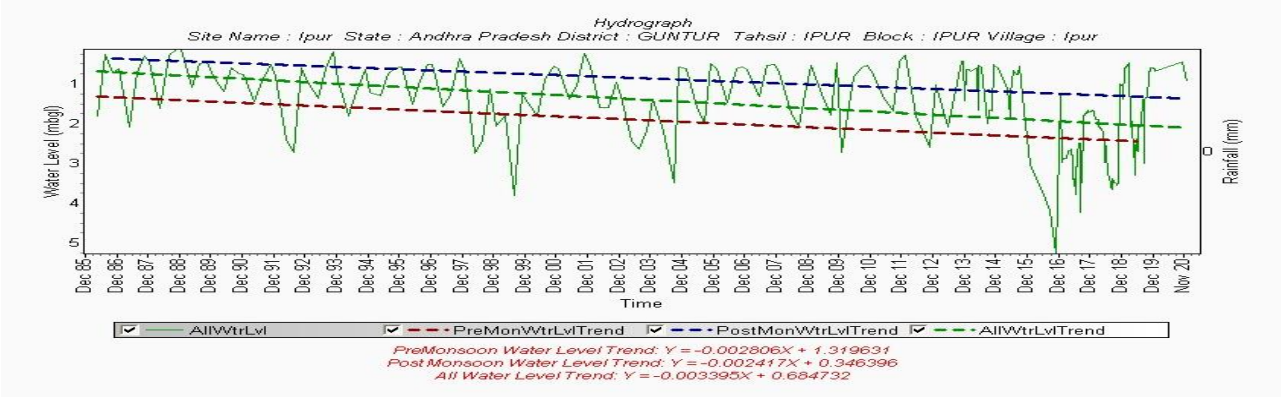
7.26g



7.26h



7.26i



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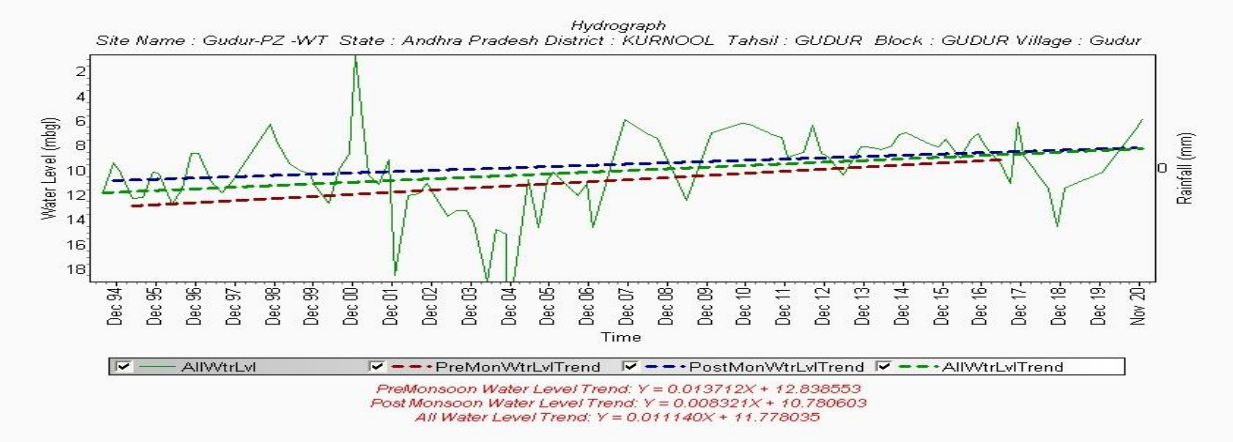

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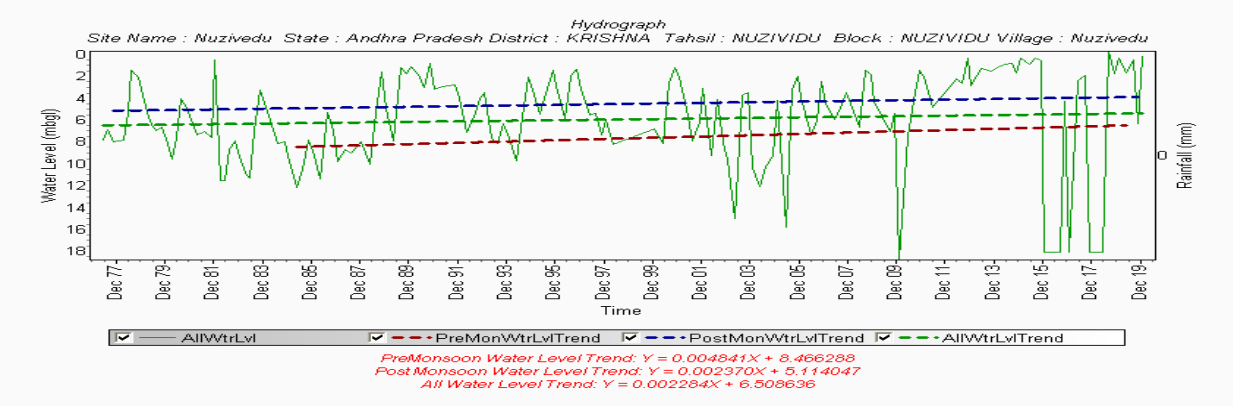

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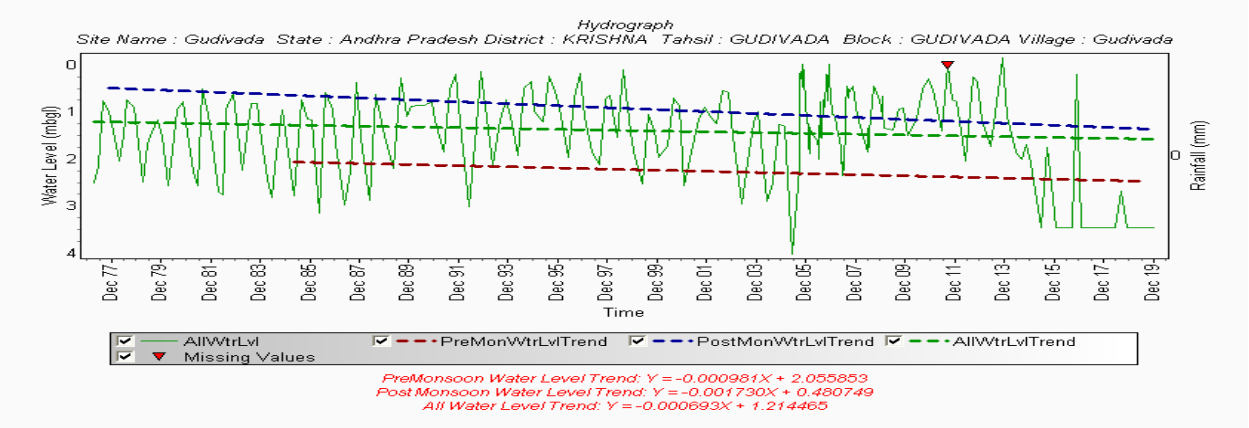

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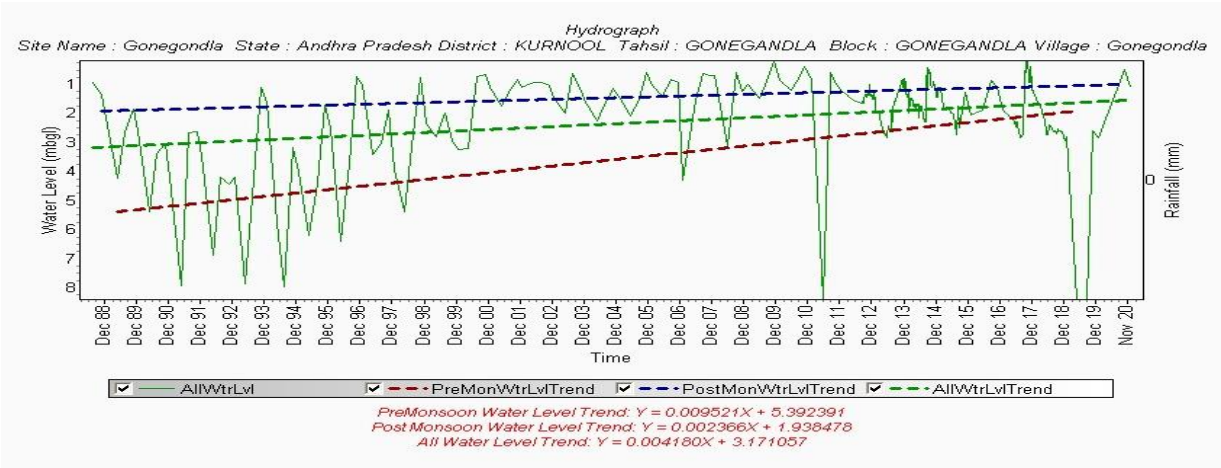
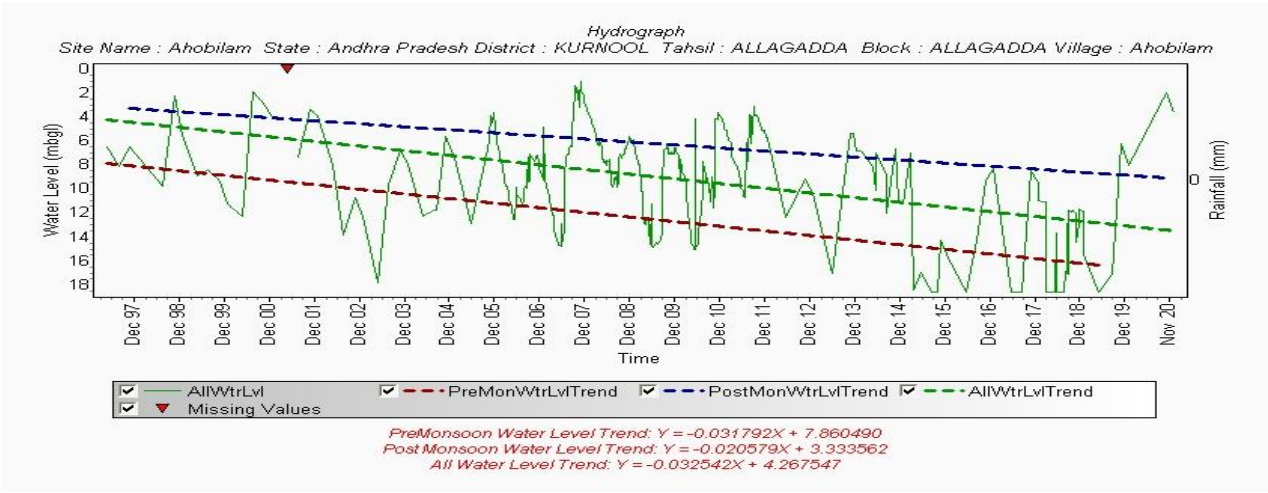
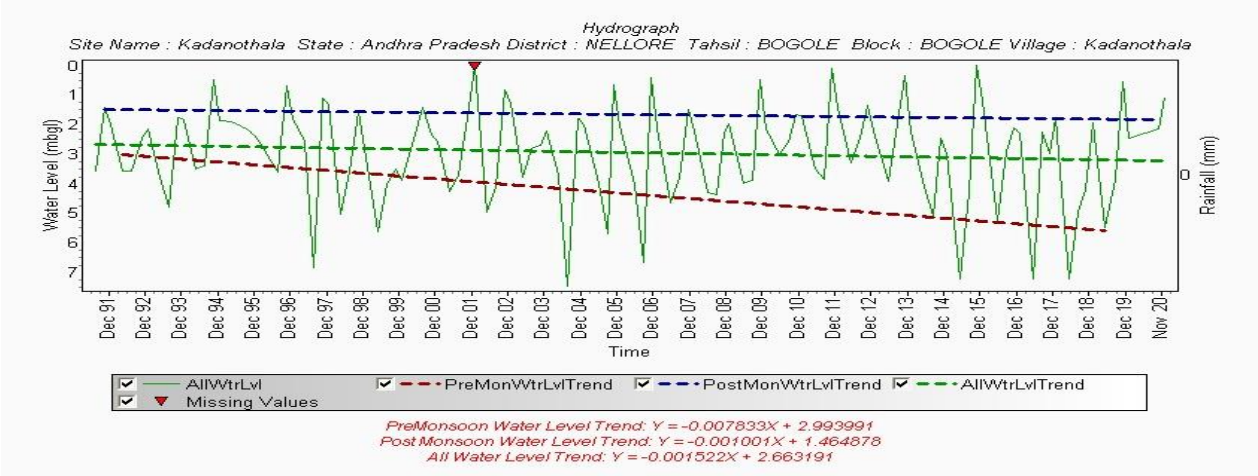


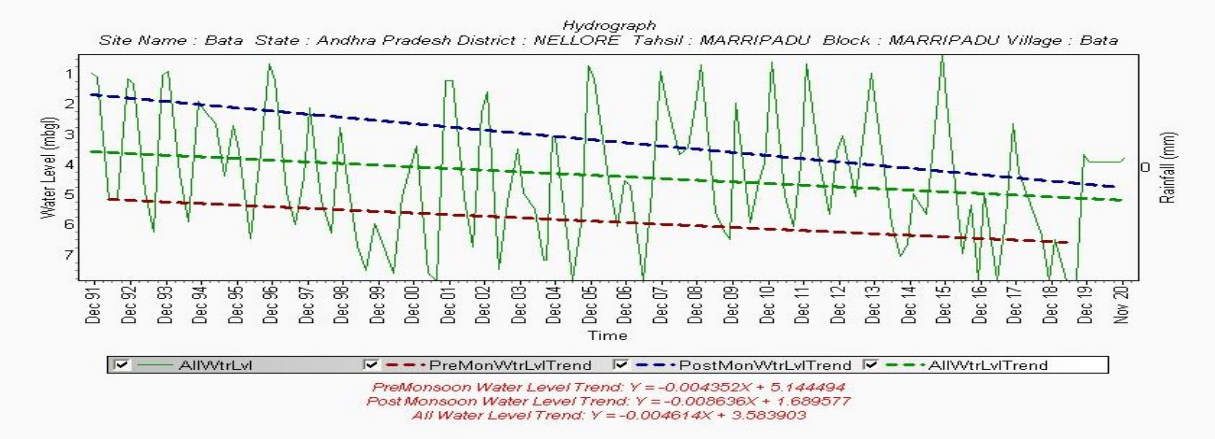
7.26 n



7.26o



7.26p



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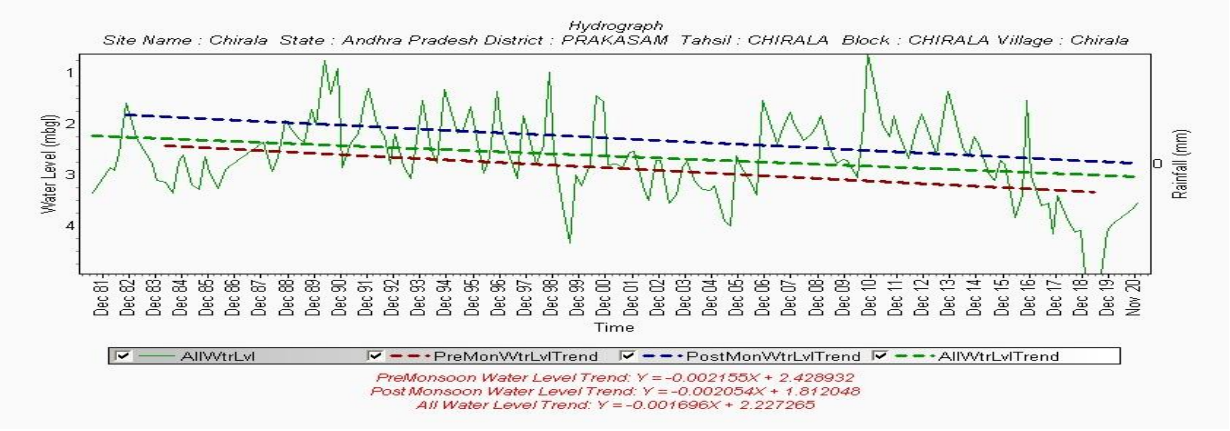
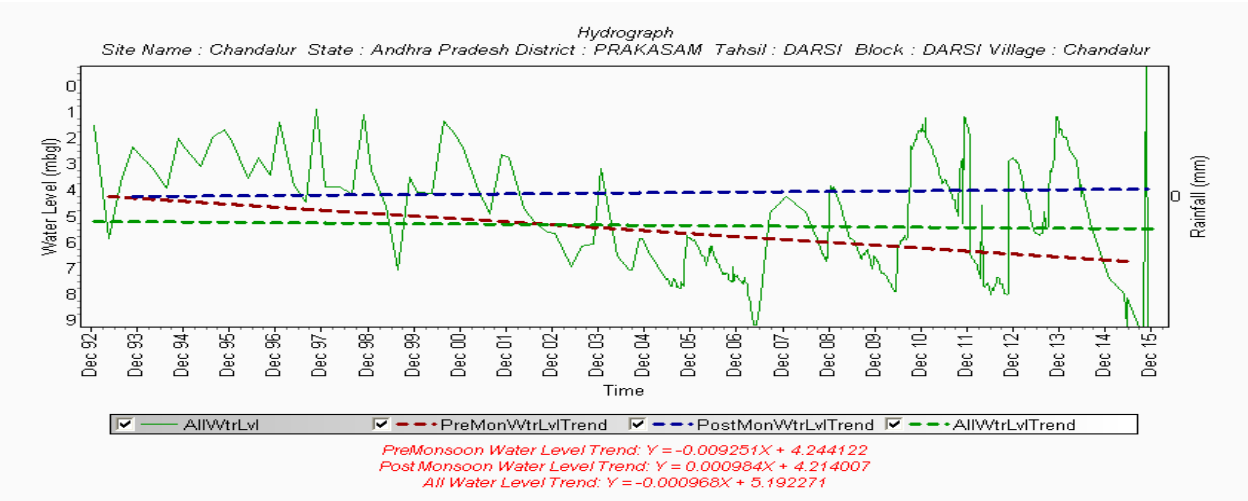
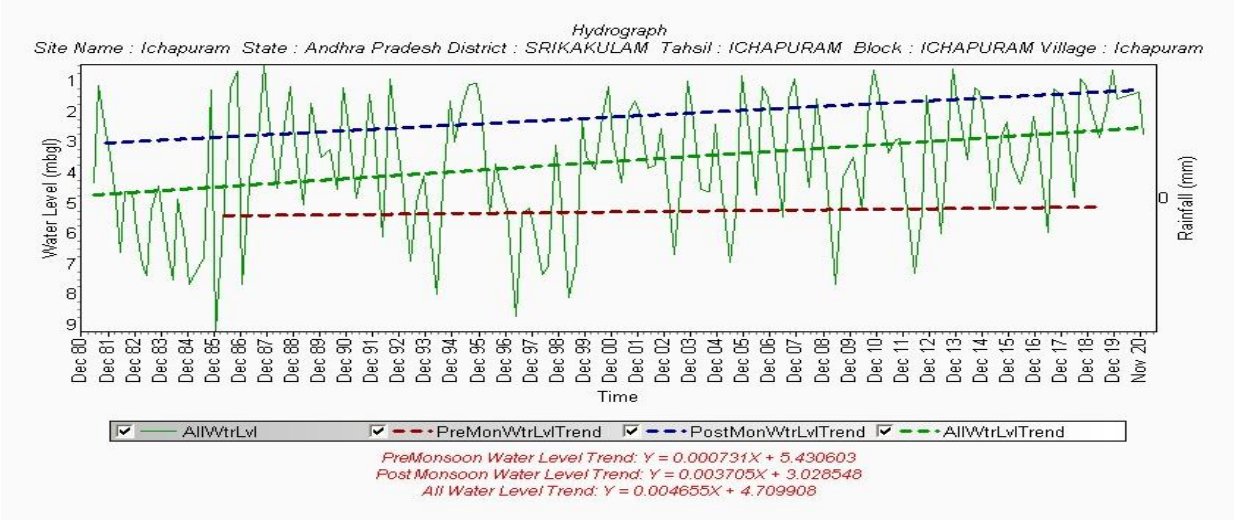


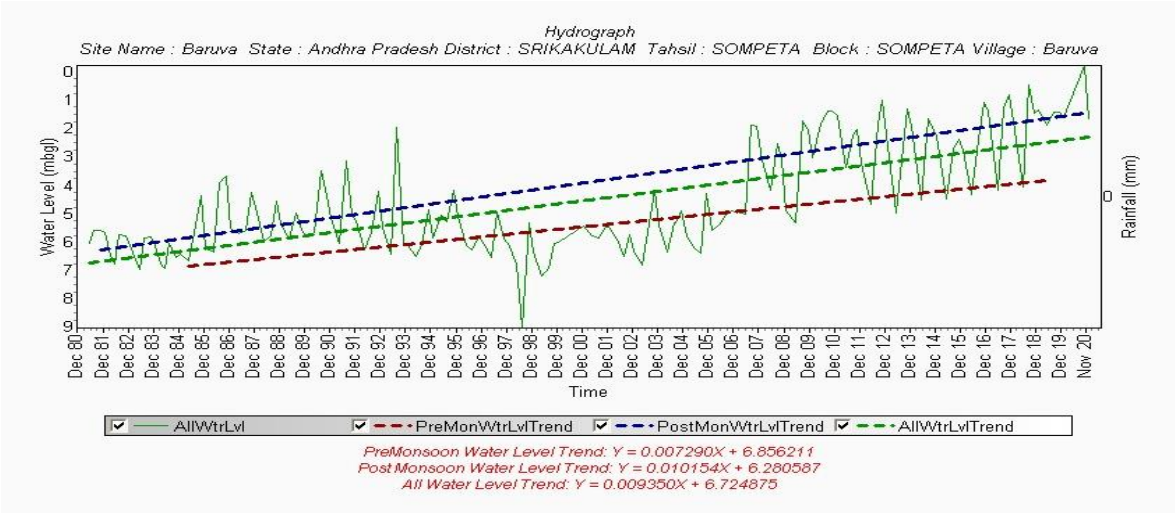
7.26r



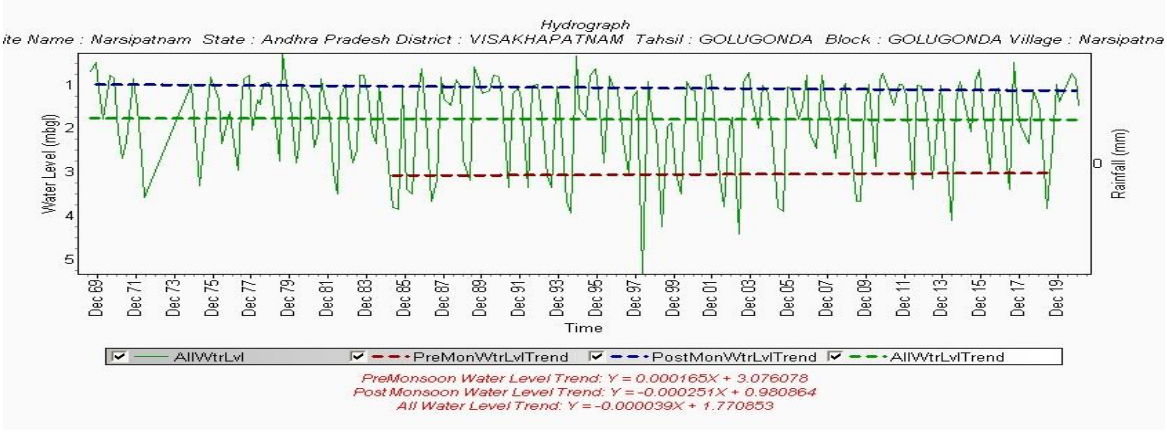
7.26s



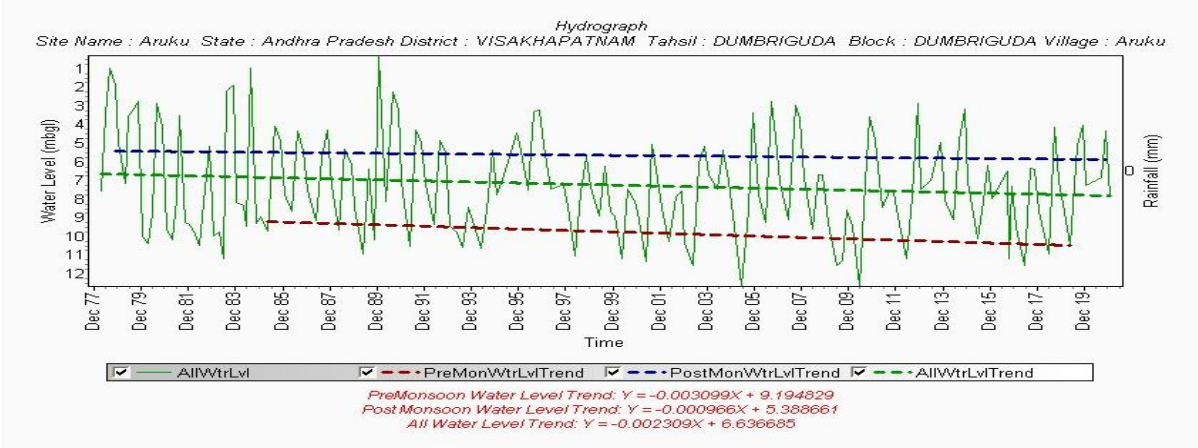
7.26t



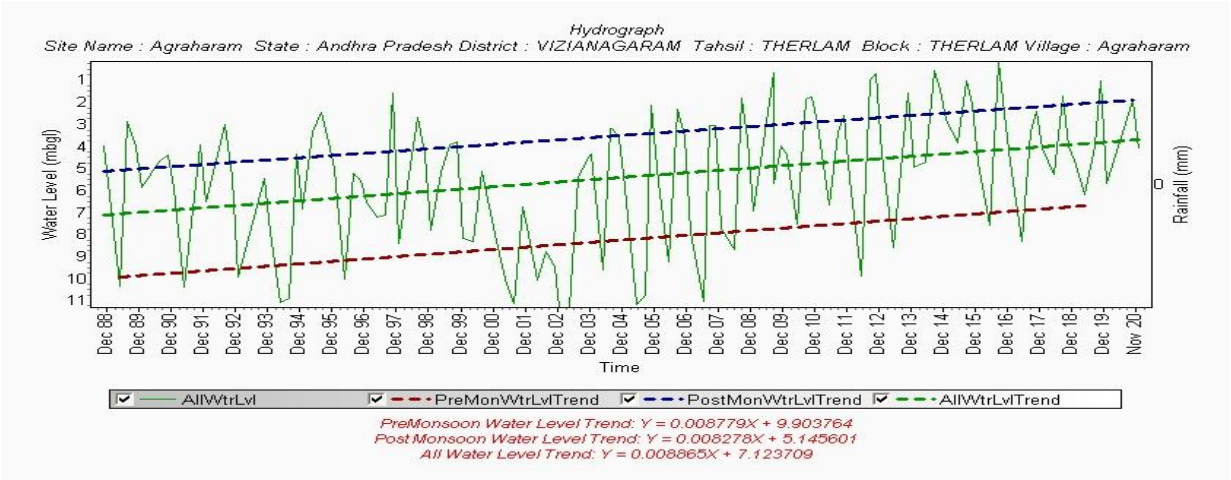
7.26u



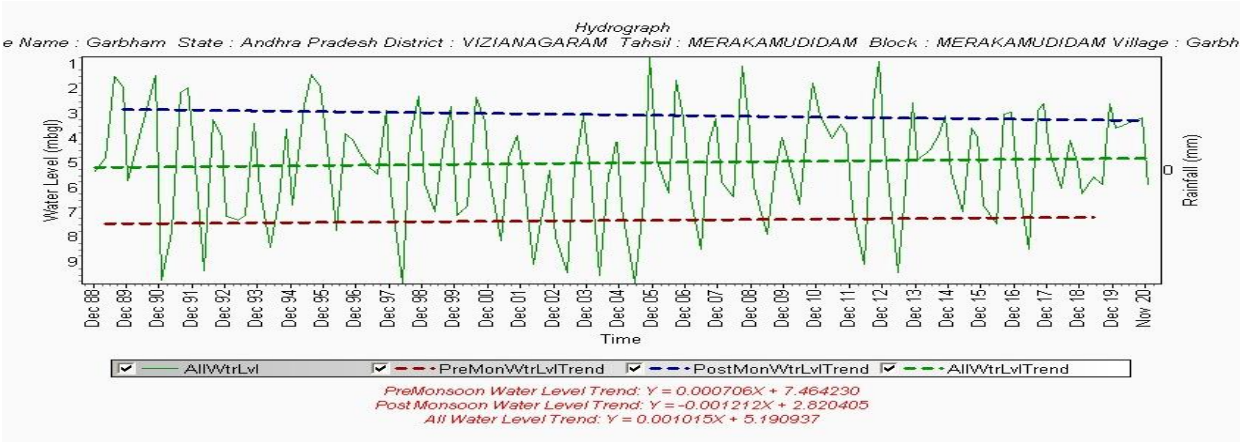
7.26v



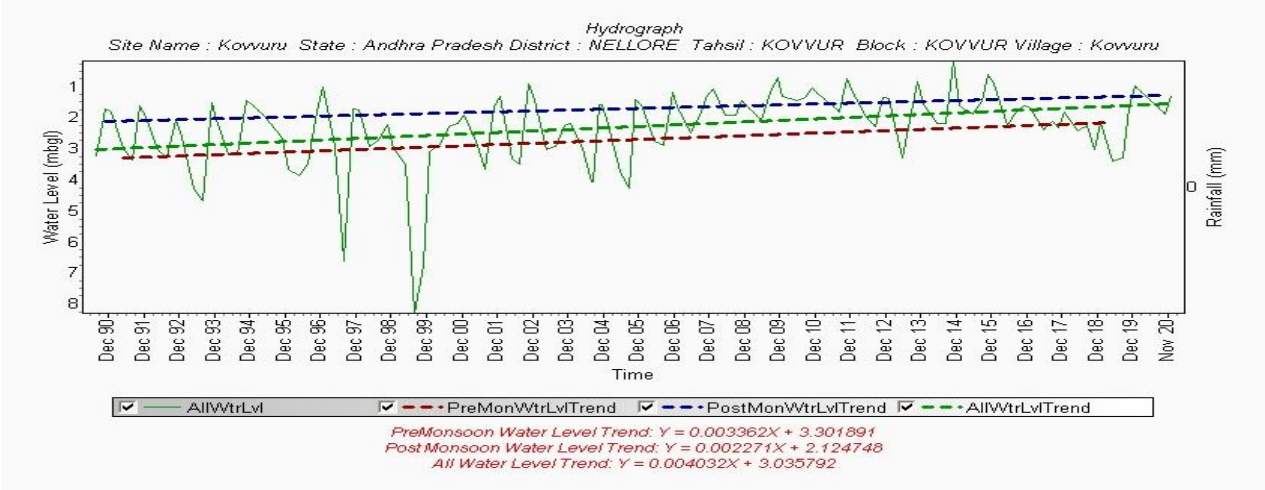
7.26w



7.26x



7.26y



7.26z

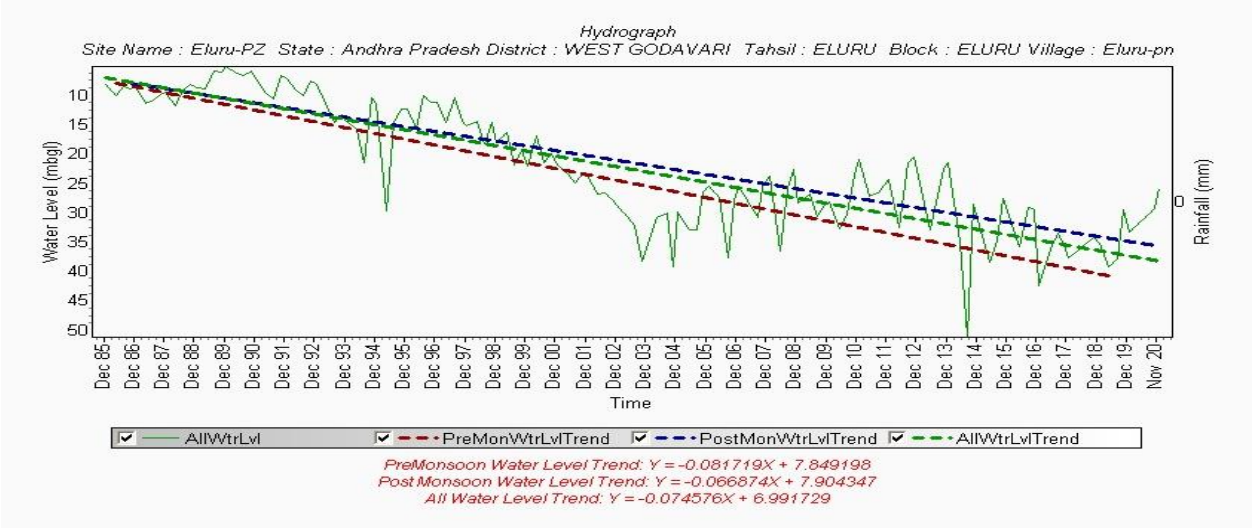


Fig.7.6 (7.26a to 7.26z): Representative Hydrographs of Andhra Pradesh State.

9. SUM-UP

Central Ground Water Board, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India, has been carrying out ground water regime studies all over the country for generating historical data base in order to establish dynamics of ground water regime which plays a crucial role for estimation of ground water resource.

Andhra Pradesh state covering ~1.63 lakh Km^2 lies between NL 12° 37' and 19° 09' and EL 76° 45' and 84° 47' and governed administratively by 13 districts. The total population of the state is ~4.96 crores and shown a decadal growth of 9.2 %. Drainage of the state can be divided into 3 major and 11 medium and ~60% of the soils are red in colour.

The mean annual rainfall in the year 2020 of the state is 1186 mm. Season-wise rainfall is 750 mm, 392 mm, 23 mm and 82 mm in southwest monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively contributing 60% of annual rainfall in southwest monsoon, 31% of annual rainfall in northeast monsoon and 9 % in non-monsoon season. The annual (2020) rainfall ranges from 880 mm in Anantapar district (48% above normal) to 1552 mm (31% above normal) in West Godavari district.

A major part of the state is underlain by gneissic complex with a structural fill of sedimentary formations and basin-fill of meta-sedimentary formations. The gneissic complex is overlain by basaltic lava flows in the northwestern part and is intruded by several younger rocks namely granites, dolerites, pegmatite's and quartzite etc.

The net ground water availability in the state is 20.15 BCM out of which the total draft for all uses (Domestic, Industrial and Irrigation) is 8.9 BCM. Net ground water available for future use is 11.25 BCM. The stage of development is 44.15%. Out of 670 mandals, over-exploited mandals are 45, critical mandals are 24, semi-critical mandals are 60 and safe mandals are 541 (including saline mandals 81).

Ground water monitoring is carried out as part of National ground water monitoring programme 4 times a year (January, May, August and November) and ground water quality once in a year (May). As on 31/03/2021, total of 867 (DW: 674 and Pz: 193) Ground Water Monitoring Wells (GWMS) are in existence. There are 122 observers appointed to monitor GWMS on participatory mode (all dug wells).

Density of wells varies from 113 Km^2/well (East Godavari district) to 321 Km^2/well in Kurnool district with average of 185 Km^2/well. In the state, Soft rocks have 215 monitoring stations and hardocks have 652 monitoring stations.

In general, the water levels are deep during May and shallow during November months. During May (pre-monsoon season) water levels are in the range of 0.05 m bgl to 91 m bgl and water levels in the range of less than 10 mbgl are more predominant and occupying ~53% of the area. Shallow water levels (0 to 2 m bgl) and deep water levels (>20 mbgl) occupy ~5 % and 19% of the area respectively.

During August (mid-monsoon season) water levels are in the range of 0.02 m bgl to 80.19 m bgl. Water levels in the range of 2-5 m bgl and 5-10 m bgl are more predominant, each range covering an area of ~25% followed by 10-20 mbgl (19% area). Shallow water levels less than 2 m occupy about 5% of the area. Water level 10 to 20 m bgl is covered in 25% of the area Deep water levels (>20 mbgl) occupy ~18% of the area.

During November (post-monsoon season) water levels levels vary between ground level and 52.16 mbgl. Shallow water level range 0 to 2 m bgl is observed in 36% of the total area. Water levels in the range of 2-5 m bgl are occupying ~47 % of the area followed by 5-10 m bgl (14 % area). Deep water levels (>20 mbgl) occupy ~1 % of the area. Water levels are within 10 mbgl (97%) range in most of the area.

Area with deep water levels has changed from 18% in August to 1% in November. Area under shallow water levels changed from 5% in May to 36% in November.

During January-21, water levels vary between ground level to 62.34 m bgl and water levels in the range of 2-5 m bgl are more predominant occupying 49 % of the area followed by >2 mbgl (30 % area). Water levels in the range 10-20 mbgl occupy 3 % and deep-water levels (>20 mbgl) occupy ~2 % of the area.

Integrated water level data from CGWB and SGWD (Ground Water Department, Govt of Andhra Pradesh) has been considered to analyze water level scenario based on more dense data. Water level data from GWD is based on real-time monitoring of water level from DWLR of telemetry. Majority of water levels are in the ranges of 5 -20 and 0-5 m bgl in pre-monsoon and post-monsoon seasons respectively. Deep water levels > 20 m bgl 16% has changed to 2% in post monsoon.

Water level fluctuation of August 2020 with pre-monsoon water level of May 2020 have shown fall in 21% of the area and rise in 79% of the area. Maximum rise of 69.05 m in Krishna district and maximum fall of 42.78 m is in Guntur district.

Water level fluctuation of Nov-2020 with pre-monsoon water level of May, 2020 have shown fall in 13% of the area and rise in 87% of the area. Maximum rise of 85.04 m is in Chitoor district and maximum fall is 23.76 m in YSR Kadapa district.

Water level fluctuation of Jan, 2020 with pre-monsoon water level of May, 2020 have shown fall in 2% of the area and rise in 98% of the area. Maximum rise of 37.33 m in Prakasam district and maximum fall of 4.59 is Chitoor district.

Annual water level fluctuation during May, 2020 from May, 2019 has shown fall in water levels in 8% of the area and rise in 92% of the area. Maximum rise of 63.69 is observed in Chitoor district and maximum fall is noticed in Guntur district (30.12 m).

Annual water level fluctuation during Aug, 2020 from Aug, 2019 has shown fall in water levels in 16% of the area and rise in 84% of the area. Maximum fall is noticed in Guntur district (42.78 m) and maximum rise of 69.05 m is observed in Krishna districts.

Annual water level fluctuation during Nov-2020 from Nov, 2019 has shown fall in water levels in 29% of the area and rise in 71% of the area. The maximum rise of 36.9 m is recorded in YSR Kadapa district and maximum fall of 11.03 m is recorded in YSR Kadapa district.

Annual water level fluctuation during January-2021 from January-20 has shown fall in water levels in 20 % of the area and rise in 80% of the area. The maximum rise of 51.76 m recorded in YSR Kadapa district and the maximum fall of 8.18 m is recorded in YSR Kadapa district.

Water levels during May-20,November-20and January-21 as compared to decadal mean water levels, have shown rise in most of the wells in May'20, Nov'20and Jan'21 in comparison with decadal mean of corresponding water levels. The percentage of wells with rise in water levels in comparison with decadal mean of the respective months is 79%, 87%, and 83% in May-19, November-19 and January-20 respectively.

Aquifer wise water level analysis shows that during pre-monsoon season shallowest water levels are observed in all the formations except in Intrusives In pre-monsoon, deepest water levels are observed banded gneissic complex, shale, sandstone, limestone and granite. During post-monsoon season, shallowest water levels are observed in all formations except in intrusives.

Deepest water levels are observed in banded gneissic complex, gneiss, limestone, shale and sandstone.

Based on long term water level trend maps, it is inferred that, during pre-monsoon season, rise in water level trend is observed in 10% of the area, fall in trend is observed in 90% of the area. During post-monsoon season, rise in water level trend is observed in 65% of the area, fall in trend is observed in 35% of the area.

Annexure- I: District wise status of Ground water monitoring wells- November 2020 (m bgl)

S. No.	District	No of Stations to be monitored			No of Stations where WL data Recorded			No of Stations Monitored as Dry			No of Stations not Monitored due to Various Reasons			No of Stations Abandoned			No of Stations Established			No of Stations as on November 2019		
		DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total
1	Anantapur	27	33	60	26	32	58	0	0	0	1	1	2	0	0	0	0	0	0	27	33	60
2	Chittoor	44	15	59	40	14	54	4	0	4	0	1	1	0	0	0	0	0	0	44	15	59
3	Cuddapah	24	39	63	21	34	55	1	3	4	2	2	4	0	0	0	0	0	0	24	39	63
4	East Godavari	84	12	96	79	12	91	0	0	0	5	0	5	0	0	0	0	0	0	84	12	96
5	Guntur	84	13	97	79	9	88	0	0	0	4	5	9	0	0	0	0	0	0	84	13	97
6	Krishna	65	7	72	59	5	64	2	0	2	4	2	6	0	0	0	0	0	0	65	7	72
7	Kurnool	35	20	55	35	16	51	0	0	0	0	4	4	0	0	0	0	0	0	35	20	55
8	Nellore	57	0	57	55	0	55	2	0	2	0	0	0	0	0	0	0	0	0	57	0	57
9	Prakasam	49	13	62	48	36	84	1	0	1	1	5	6	0	0	0	0	29	29	49	42	91
10	Srikakulam	51	0	51	48	0	48	0	0	0	3	0	3	0	0	0	0	0	0	51	0	51
11	Visakhapatnam	55	3	58	53	3	56	0	0	0	2	0	2	0	0	0	0	0	0	55	3	58
12	Vizianagaram	48	0	48	45	0	45	1	0	1	2	0	2	0	0	0	0	0	0	48	0	48
13	West Godavari	51	9	60	50	8	58	0	0	0	1	1	2	0	0	0	0	0	0	51	9	60
	Total	**674**	**164**	**838**	**638**	**169**	**807**	**11**	**3**	**14**	**25**	**21**	**46**	**0**	**0**	**0**	**0**	**29**	**29**	**674**	**193**	**867**

Annexure- II: District wise status of Ground water monitoring wells- January 2021(m bgl)

S. No.	District	No of Stations to be monitored			No of Stations where WL data Recorded			No of Stations Monitored as Dry			No of Stations not Monitored due to Various Reasons			No of Stations Abandoned			No of Stations Established			No of Stations as on January 2020		
		DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total	DW	Pz	Total
1	Anantapur	27	33	60	27	33	60	0	0	0	0	0	0	0	0	0	0	0	0	27	33	60
2	Chittoor	44	15	59	40	14	54	4	0	4	0	1	1	0	0	0	0	0	0	44	15	59
3	Kadapa	24	39	63	22	38	60	2	0	2	0	1	1	0	0	0	0	0	0	24	39	63
4	East Godavari	84	12	96	82	10	92	1	2	3	1	0	1	0	0	0	0	0	0	84	12	96
5	Guntur	84	13	97	82	10	92	0	0	0	2	3	5	0	0	0	0	0	0	84	13	97
6	Krishna	65	7	72	61	6	67	3	0	3	1	1	2	0	0	0	0	0	0	65	7	72
7	Kurnool	35	20	55	33	20	53	0	0	0	2	0	2	0	0	0	0	0	0	35	20	55
8	Nellore	57	0	57	54	0	54	1	0	1	2	0	2	0	0	0	0	0	0	57	0	57
9	Prakasam	49	42	91	46	39	85	0	1	1	3	2	5	0	0	0	0	0	0	49	42	91
10	Srikakulam	51	0	51	51	0	51	0	0	0	0	0	0	0	0	0	0	0	0	51	0	51
11	Visakhapatnam	55	3	58	54	3	57	0	0	0	1	0	1	0	0	0	0	0	0	55	3	58
12	Vizianagaram	48	0	48	46	0	46	0	0	0	2	0	2	0	0	0	0	0	0	48	0	48
13	West Godavari	51	9	60	48	9	57	2	0	2	1	0	1	0	0	0	0	0	0	51	9	60
Total		**674**	**193**	**867**	**646**	**182**	**828**	**13**	**3**	**16**	**15**	**8**	**23**	**0**	**0**	**0**	**0**	**0**	**0**	**674**	**193**	**867**

Annexure- III: Distribution of percentage of wells-May 2020 (m bgl)

Sl. No	District	No of Wells Analysed	Depth to Water Table (m bgl)		No and Percentage of Wells Showing Depth to Water Table (m bgl) in Ranga of											
					0.0 - 2.0		2.0 - 5.0		5.0- 10.0		10.0 - 20.0		20.0 - 40.0		> 40.0	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
1	Anantapur	163	0.21	69.48	7	4.29	11	6.75	32	19.6	47	28.83	39	23.93	27	16.56
2	Chittoor	128	0.56	91.28	6	4.69	9	7.03	31	24.2	28	21.88	23	17.97	31	24.22
3	YSR Kadapa	115	0.09	89.12	5	4.35	10	8.70	26	22.6	29	25.22	21	18.26	24	20.87
4	East Godavari	99	0.44	73.21	19	19.19	19	19.19	32	32.3	5	5.05	12	12.12	12	12.12
5	Guntur	130	0.05	55.43	21	16.15	33	25.38	31	23.8	21	16.15	7	5.38	17	13.08
6	Krishna	115	0.2	71.06	14	12.17	16	13.91	33	28.7	27	23.48	10	8.70	15	13.04
7	Kurnool	160	0.18	40.00	21	13.13	34	21.25	43	26.9	27	16.88	12	7.50	23	14.38
8	Nellore	97	0.181	43.35	10	10.31	14	14.43	28	28.9	26	26.80	2	2.06	17	17.53
9	Prakasam	101	1.094	61.06	6	5.94	12	11.88	16	15.8	30	29.70	17	16.83	20	19.80
10	Srikakulam	42	0.17	26.51	12	28.57	8	19.05	11	26.2	4	9.52	1	2.38	6	14.29
11	Visakhapatnam	75	0.402	22.57	6	8.00	12	16.00	30	40.0	18	24.00	2	2.67	7	9.33
12	Vizianagaram	46	0.91	17.14	2	4.35	11	23.91	24	52.2	7	15.22	0	0.00	2	4.35
13	West Godavari	77	0.38	80.44	5	6.49	8	10.39	15	19.5	18	23.38	16	20.78	15	19.48
Total State		1348	**0.05**	**91.28**	**134**	**10 %**	**197**	**15%**	**352**	**26%**	**287**	**21%**	**162**	**12%**	**216**	**16%**

Annexure- IV: Distribution of percentage of wells- Aug 2020 (m bgl)

Sl. No	District	No of Wells Analysed	Depth to Water Table (m bgl)		No and Percentage of Wells Showing Depth to Water Table (m bgl) Range											
					0.0 - 2.0		2.0 - 5.0		5.0- 10.0		10.0 - 20.0		20.0 - 40.0		> 40.0	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
1	Anantapur	151	0.96	72.73	7	5%	18	30.56	31	25	40	26%	39	26%	14	9%
2	Chittoor	113	0.166	77.93	10	9%	18	28.57	26	21.43	31	27%	17	15%	11	10%
3	YSR Kadapa	97	0.208	72.948	20	21%	27	16.67	29	27.78	7	7%	12	12%	2	2%
4	East Godavari	134	0.2	57.32	35	26%	51	44.05	29	4.76	8	6%	7	5%	4	3%
5	Guntur	109	0.26	77.91	6	6%	13	44.94	35	14.61	25	23%	17	16%	13	12%
6	Krishna	114	0.21	71.59	31	27%	24	43.94	25	9.09	24	21%	7	6%	3	3%
7	Kurnool	143	0.02	46.151	32	22%	52	53.33	34	22.22	19	13%	3	2%	3	2%
8	Nellore	94	0.55	41.31	12	13%	28	28.07	25	19.3	26	28%	1	1%	2	2%
9	Prakasham	94	1.47	59.113	2	2%	17	27.59	17	32.76	33	35%	20	21%	5	5%
10	Srikakulam	41	0.83	27.2	7	17%	20	64.44	9	15.56	3	7%	2	5%	0	0%
11	Visakhapatnam	116	0.04	25.074	24	21%	35	42.86	34	25	19	16%	4	3%	0	0%
12	Vizianagaram	53	0.11	28.67	8	15%	19	64.58	19	16.67	4	8%	1	2%	0	0%
13	West Godavari	75	0.5	80.189	6	8%	14	26.92	15	21.15	15	20%	14	19%	10	13%
Total State		**1334**	**0.02**	**80.189**	**200**	**15%**	**336**	**25%**	**328**	**25%**	**254**	**19%**	**144**	**11%**	**67**	**5%**

Annexure-V: Distribution of percentage of wells - November 2020

Sl. No	District	No of Wells Analysed	Depth to Water Table (m bgl)		No and Percentage of Wells Showing Depth to Water Table (m bgl) in Ranga of											
					0.0 - 2.0		2.0 - 5.0		5.0- 10.0		10.0 - 20.0		20.0 - 40.0		> 40.0	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
1	Anantapur	37	0.04	16.97	15	40.54	12	32.43	5	13.51	5	13.51	0	0	0	0
2	Chittoor	40	0.02	12.34	13	32.5	16	40	10	25	1	2.5	0	0	0	0
3	YSR Kadapa	34	0.7	52.16	10	29.41	10	29.41	3	8.82	2	5.88	6	17.65	3	8.82
4	East Godavari	84	-0.17	10.3	64	76.19	17	20.24	2	2.38	1	1.19	0	0	0	0
5	Guntur	88	-0.83	11.7	50	56.82	31	35.23	6	6.82	1	1.14	0	0	0	0
6	Krishna	62	0.05	16.47	46	74.19	11	17.74	3	4.84	2	3.23	0	0	0	0
7	Kurnool	45	-0.05	9.17	24	53.33	17	37.78	4	8.89	0	0	0	0	0	0
8	Nellore	55	0.34	8.4	16	29.09	26	47.27	13	23.64	0	0	0	0	0	0
9	Prakasham	84	-0.3	20.62	19	22.62	20	23.81	24	28.57	13	15.48	6	7.14	2	2.38
10	Srikakulam	43	-0.23	5.45	27	62.79	14	32.56	2	4.65	0	0	0	0	0	0
11	Visakhapatnam	56	0.37	16.96	33	58.93	19	33.93	2	3.57	2	3.57	0	0	0	0
12	Vizianagaram	44	-0.07	7.1	25	56.82	16	36.36	3	6.82	0	0	0	0	0	0
13	West Godavari	50	0.22	7.19	35	70	12	24	3	6	0	0	0	0	0	0
Total State		**722**	**0**	**52.16**	**377**	**52%**	**221**	**31%**	**80**	**11%**	**27**	**4%**	**12**	**2%**	**5**	**1%**

Annexure-VI: Distribution of percentage of wells- January 2021

Sl. No	District	No of Wells Analysed	Depth to Water Table (m bgl)		No and Percentage of Wells Showing Depth to Water Table (m bgl) in Range of											
					0.0 - 2.0		2.0 - 5.0		5.0- 10.0		10.0-20.0		20.0 - 40.0		> 40.0	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
1	Anantapur	37	0.3	13.67	9	24%	18	49%	6	16%	4	11%	0	0	0	0
2	Chittoor	44	0.02	15.12	18	41%	15	34%	8	18%	3	7%	0	0	0	0
3	YSR Kadapa	35	0.41	42.65	12	34%	10	29%	8	23%	4	11%	0	0	1	3%
4	East Godavari	84	0	10.35	54	64%	26	31%	2	2%	2	2%	0	0	0	0%
5	Guntur	92	0	15.68	40	43%	43	47%	8	9%	1	1%	0	0	0	0%
6	Krishna	67	0.01	14.16	35	52%	24	36%	5	7%	3	4%	0	0	0	0%
7	Kurnool	45	0.13	9.45	16	36%	26	58%	3	7%	0	0%	0	0	0	0%
8	Nellore	55	0	5.75	39	71%	14	25%	2	4%	0	0%	0	0	0	0%
9	Prakasham	86	0	62.34	24	28%	28	33%	19	22%	8	9%	4	5%	3	3%
10	Srikakulam	47	1.4	8.5	11	23%	25	53%	11	23%	0	0%	0	0%	0	0%
11	Visakhapatnam	57	0.57	22	19	33%	25	44%	11	19%	1	2%	1	2%	0	0%
12	Vizianagaram	46	0.8	8.9	4	9%	30	65%	12	26%	0	0%	0	0%	0	0%
13	West Godavari	50	0.04	9.4	30	60%	13	26%	7	14%	0	0%	0	0%	0	0%
Total State		**745**	**0**	**62.34**	**311**	**42%**	**297**	**40%**	**102**	**14%**	**26**	**3%**	**5**	**1%**	**4**	**1%**

Annexure- VII: Fluctuation and Frequency distribution from different ranges from one period to other August 2020 from May 2020

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	151	0.01	32.3	0.044	15.79	74	61%	22	18	25	21%	19	63%	6	20%	5	17%	121	30
2	Chittoor	113	0.026	40.781	0.02	11.15	31	32%	24	24	43	44%	9	60%	2	13%	4	27%	98	15
3	YSR Kadapa	97	0.06	14.545	0.04	7.69	63	86%	8	11	2	3%	17	71%	3	13%	4	17%	73	24
4	East Godavari	134	0.01	50.43	0.059	42.78	76	69%	19	17	15	14%	14	70%	4	20%	2	10%	110	20
5	Guntur	109	0.07	31.99	0.42	11.55	53	54%	24	24	22	22%	7	64%	2	18%	2	18%	99	11
6	Krishna	114	0.06	69.05	0.09	6.110	49	53%	28	30	16	17%	16	76%	3	14%	2	10%	93	21
7	Kurnool	143	0.01	17.313	0.04	42.50	49	63%	10	13	19	24%	43	69%	11	18%	8	13%	78	62
8	Nellore	94	0.008	2.545	0.02	5.66	77	97%	2	3	0	0%	8	57%	5	36%	1	7%	79	14
9	Prakasam	94	0.01	18.546	0.008	11.25	36	63%	13	23	8	14%	27	79%	4	12%	3	9%	57	34
10	Srikakulam	41	0.05	6.714	0.05	5.368	29	91%	1	3	2	6%	8	89%	0	0%	1	11%	32	9
11	Visakhapatnam	116	0.01	10.611	0.04	15.94	44	80%	6	11	5	9%	25	42%	19	32%	16	27%	55	60
12	Vizianagaram	53	0.045	2.87	0.018	28.67	28	88%	4	13	0	0%	12	60%	4	20%	4	20%	32	20
13	West Godavari	75	0.02	10.32	0.04	14.48	45	78%	8	14	5	9%	15	88%	1	6%	1	6%	58	17
Total State		**1334**	**0.008**	**69.05**	**0.008**	**42.78**	**654**	**66%**	**169**	**17%**	**162**	**16%**	**220**	**65%**	**64**	**19%**	**53**	**16%**	**985**	**337**

Annexure- VIII: Fluctuation and Frequency distribution from different ranges from one period to other November 2020 from May 2020

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	36	46.55	1.79	0.06	4.91	1	3%	4	11%	29	81%	1	3%	0	0%	1	3%	34	2
2	Chittoor	40	85.04	0.06	2.78	3.25	5	13%	5	13%	28	70%	0	0%	2	5%	0	0%	38	2
3	YSR Kadapa	32	55.90	0.61	0.84	23.76	4	13%	5	16%	17	53%	2	6%	1	3%	3	9%	26	6
4	East Godavari	81	47.49	0.01	0.15	4.55	17	21%	19	23%	35	43%	7	9%	2	2%	1	1%	71	10
5	Guntur	85	29.34	0.10	0.16	3.62	31	36%	14	16%	27	32%	9	11%	4	5%	0	0%	72	13
6	Krishna	61	40.27	0.09	0.22	1.79	5	8%	14	23%	36	59%	6	10%	0	0%	0	0%	55	6
7	Kurnool	42	21.36	0.64	0.11	4.09	8	19%	7	17%	21	50%	5	12%	0	0%	1	2%	36	6
8	Nellore	55	14.33	0.12	0.08	2.92	12	22%	9	16%	24	44%	7	13%	3	5%	0	0%	45	10
9	Prakasham	56	32.19	0.28	0.31	5.60	11	20%	8	14%	27	48%	6	11%	3	5%	1	2%	46	10
10	Srikakulam	41	12.72	0.32	0.06	3.18	9	22%	10	24%	13	32%	8	20%	1	2%	0	0%	32	9
11	Visakhapatnam	51	15.10	0.01	2.28	8.53	10	20%	9	18%	30	59%	0	0%	1	2%	1	2%	49	2
12	Vizianagaram	41	10.72	1.36	0.14	2.31	4	10%	15	37%	17	41%	4	10%	1	2%	0	0%	36	5
13	West Godavari	48	37.77	0.59	0.09	1.41	4	8%	4	8%	36	75%	4	8%	0	0%	0	0%	44	4
Total State			**10.72**	**0.01**	**0.06**	**1.41**	**121**	**21%**	**123**	**21%**	**340**	**58%**	**59**	**69%**	**18**	**21%**	**8**	**9%**	**584**	**85**

Annexure- IX: Fluctuation and Frequency distribution from different ranges from one period to other January 2021 from May 2020

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	32	0.44	16.29	0.99	4.00	5	17%	5	17%	20	67%	1	50%	1	50%	0	0%	30	2
2	Chittoor	33	0.55	10.45	0.93	4.59	8	29%	6	21%	14	50%	3	60%	1	20%	1	20%	28	5
3	YSR Kadapa	19	2.15	10.83	3.07	3.28	0	0%	7	41%	10	59%	0	0%	2	100%	0	0%	17	2
4	East Godavari	47	0.14	6.62	0.01	4.02	32	73%	6	14%	6	14%	1	33%	1	33%	1	33%	44	3
5	Guntur	71	0.06	12.85	0.24	1.12	35	51%	22	32%	12	17%	2	100%	0	0%	0	0%	69	2
6	Krishna	46	0.11	11.09	0.37	0.91	23	53%	11	26%	9	21%	3	100%	0	0%	0	0%	43	3
7	Kurnool	25	0.53	11.04	0.00	-0.53	5	20%	10	40%	10	40%	0	0%	0	0%	0	0%	25	0
8	Nellore	34	0.87	11.98	0.00	-0.87	7	21%	8	24%	19	56%	0	0%	0	0%	0	0%	34	0
9	Prakasham	33	0.59	37.33	0.03	0.92	9	31%	11	38%	9	31%	4	100%	0	0%	0	0%	29	4
10	Srikakulam	27	0.09	4.63	0.02	1.70	13	57%	9	39%	1	4%	4	100%	0	0%	0	0%	23	4
11	Visakhapatnam	49	0.09	7.68	0.02	1.48	22	51%	16	37%	5	12%	6	100%	0	0%	0	0%	43	6
12	Vizianagaram	30	0.08	3.32	0.32	2.62	17	61%	11	39%	0	0%	1	50%	1	50%	0	0%	28	2
13	West Godavari	22	0.11	11.76	0.01	1.42	13	72%	2	11%	3	17%	4	100%	0	0%	0	0%	18	4
Total State		**468**	**0.06**	**37.33**	**0**	**4.59**	**189**	**44%**	**124**	**29%**	**118**	**27%**	**29**	**78%**	**6**	**16%**	**2**	**5%**	**431**	**37**

Annexure- X: Fluctuation and Frequency distribution from different ranges from one period to other May 2020 from May 2019

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	147	0.12	35.24	0.01	0.15	18	12	32	22	79	53.74	10	7	3	2	5	3	129	18
2	Chittoor	113	0.01	63.69	0.13	30.05	25	22	19	17	48	42.48	12	11	5	4	4	4	92	21
3	YSR Kadapa	108	0.08	19.19	0.29	6.72	22	20	12	11	62	57.41	6	6	2	2	4	4	96	12
4	East Godavari	94	0.04	53.67	0.07	18.83	50	53	17	18	10	10.64	13	14	3	3	1	1	77	17
5	Guntur	120	0.01	49.07	0.01	30.12	65	54	20	17	18	15.00	14	12	1	1	2	2	103	17
6	Krishna	113	0.01	8.49	0.13	16.27	44	39	25	22	10	8.85	25	22	7	6	2	2	79	34
7	Kurnool	145	0.01	30.35	0.02	4.23	61	42	34	23	41	28.28	7	5	1	1	1	1	136	9
8	Nellore	90	0.22	31.93	0.43	30.10	24	27	21	23	38	42.22	5	6	1	1	1	1	83	7
9	Prakasam	87	0.04	51.91	0.71	30.08	14	16	12	14	53	60.92	4	5	0	0	4	5	79	8
10	Srikakulam	42	0.08	4.91	0.23	4.05	24	57	9	21	3	7.14	5	12	0	0	1	2	36	6
11	Visakhapatnam	71	0.19	18.87	0.25	2.10	28	39	23	32	12	16.90	7	10	1	1	0	0	63	8
12	Vizianagaram	45	0.24	6.29	0.80	2.15	22	49	14	31	4	8.89	4	9	1	2	0	0	40	5
13	West Godavari	74	0.10	47.65	0.03	21.19	22	30	18	24	9	12.16	16	22	2	3	7	9	49	25
Total State		**1249**	**0.01**	**63.69**	**0.01**	**30.1**	**419**	**39%**	**256**	**24%**	**387**	**37%**	**128**	**69%**	**27**	**14**	**32**	**17%**	**1062**	**187**

Annexure- XI: Fluctuation and Frequency distribution from different ranges from one period to other August 2020 from August 2019

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	151	0.01	32.3	0.044	15.79	23	18%	23	18%	79	63%	8	33%	7	29%	9	38%	125	24
2	Chittoor	113	0.026	40.781	0.02	11.15	22	22%	17	17%	59	60%	2	17%	3	25%	7	58%	98	12
3	YSR Kadapa	97	0.06	14.545	0.04	7.69	34	62%	15	27%	6	11%	30	71%	7	17%	5	12%	55	42
4	East Godavari	134	0.01	50.43	0.059	42.78	59	55%	24	22%	24	22%	18	72%	6	24%	1	4%	107	25
5	Guntur	109	0.07	31.99	0.42	11.55	15	16%	14	15%	63	68%	11	65%	1	6%	5	29%	92	17
6	Krishna	114	0.06	69.05	0.09	6.11	42	46%	24	26%	25	27%	17	74%	2	9%	4	17%	91	23
7	Kurnool	143	0.01	17.313	0.04	42.50	32	27%	36	30%	51	43%	11	50%	2	9%	9	41%	119	22
8	Nellore	94	0.008	2.545	0.02	5.66	25	32%	23	29%	31	39%	9	75%	2	17%	1	8%	79	12
9	Prakasam	94	0.01	18.546	0.008	11.25	20	28%	15	21%	37	51%	9	47%	3	16%	7	37%	72	19
10	Srikakulam	41	0.05	6.714	0.05	5.368	21	88%	1	4%	2	8%	12	75%	4	25%	0	0%	24	16
11	Visakhapatnam	116	0.01	10.611	0.04	15.94	57	59%	23	24%	16	17%	13	65%	5	25%	2	10%	96	20
12	Vizianagaram	53	0.045	2.87	0.018	28.67	17	41%	13	32%	11	27%	9	82%	2	18%	0	0%	41	11
13	West Godavari	75	0.02	10.32	0.04	14.48	30	63%	9	19%	9	19%	18	72%	3	12%	4	16%	48	25
Total State		**1334**	**0.008**	**69.05**	**0.008**	**42.78**	**397**	**38%**	**237**	**23%**	**413**	**39%**	**167**	**62%**	**47**	**18%**	**54**	**20%**	**1047**	**268**

Annexure- XII: Fluctuation and Frequency distribution from different ranges from one period to other November 2020 from November 2019

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	36	0.05	7.23	0.06	5.30	20	56	3	8	2	6	10	27.78	0	0	1	2.78	25	11
2	Chittoor	40	0.02	9.70	0.16	5.21	13	33	6	15	10	25	10	25	0	0	1	2.5	29	11
3	YSR Kadapa	32	0.06	36.90	0.12	11.03	9	28	3	9	14	44	4	12.5	0	0	2	6.25	26	6
4	East Godavari	81	0.01	2.74	0.01	1.67	39	48	2	2	0	0	39	48.15	0	0	0	0	41	39
5	Guntur	85	0.01	27.80	0.01	3.25	45	53	8	9	5	6	24	28.24	2	2.35	0	0	58	26
6	Krishna	61	0.02	16.90	0.01	1.96	37	61	4	7	4	7	16	26.23	0	0	0	0	45	16
7	Kurnool	42	0.08	8.33	0.07	3.21	17	40	10	24	4	10	10	23.81	1	2.38	0	0	31	11
8	Nellore	55	0.12	6.31	0.01	2.06	19	35	9	16	4	7	22	40	1	1.82	0	0	32	23
9	Prakasham	56	0.01	22.26	0.04	2.87	21	38	7	13	9	16	17	30.36	2	3.57	0	0	37	19
10	Srikakulam	41	0.02	1.64	0.12	3.47	7	17	0	0	0	0	30	73.17	4	9.76	0	0	7	34
11	Visakhapatnam	54	0.01	2.18	0.02	4.80	28	52	1	2	0	0	23	42.59	1	1.85	1	1.85	29	25
12	Vizianagaram	41	0.01	1.59	0.09	5.44	15	37	0	0	0	0	23	56.1	2	4.88	1	2.44	15	26
13	West Godavari	48	0.07	7.15	0.05	2.83	11	23	2	4	1	2	32	66.67	2	4.17	0	0	14	34
Total State		**672**	**0.01**	**36.90**	**0.01**	**11.03**	**281**	**72%**	**55**	**14%**	**53**	**14%**	**260**	**93%**	**15**	**5%**	**6**	**2%**	**389**	**281**

Annexure-XIII: Fluctuation and Frequency distribution from different ranges from one period to other January 2021 from January2020

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4		Rise	Fall
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%		
1	Anantapur	36	0.03	5.92	0.06	5.81	16	57%	7	25%	5	18%	7	88%	0	0%	1	13%	28	8
2	Chittoor	42	0.04	14.22	0.09	5.96	11	38%	11	38%	7	24%	10	83%	1	8%	1	8%	29	12
3	YSR Kadapa	34	0.11	51.76	0.08	8.18	7	27%	5	19%	14	54%	5	71%	1	14%	1	14%	26	7
4	East Godavari	83	0.02	4.07	0.01	1.76	68	93%	4	5%	1	1%	10	100%	0	0%	0	0%	73	10
5	Guntur	84	0.02	23.82	0.01	2.19	48	80%	9	15%	3	5%	21	95%	1	5%	0	0%	60	22
6	Krishna	65	0.05	8.45	0.08	4.30	47	90%	3	6%	2	4%	10	83%	1	8%	1	8%	52	12
7	Kurnool	45	0.02	36.58	0.19	1.50	27	66%	8	20%	6	15%	4	100%	0	0%	0	0%	41	4
8	Nellore	55	0.01	12.28	0.06	3.76	29	71%	3	7%	9	22%	12	92%	1	8%	0	0%	41	13
9	Prakasham	55	0.07	21.30	0.04	1.38	19	41%	15	33%	12	26%	8	100%	0	0%	0	0%	46	8
10	Srikakulam	43	0.03	2.27	0.05	4.11	9	90%	1	10%	0	0%	31	94%	1	3%	1	3%	10	33
11	Visakhapatnam	55	0.03	4.91	0.02	3.85	33	87%	4	11%	1	3%	15	88%	2	12%	0	0%	38	17
12	Vizianagaram	46	0.03	3.50	0.01	4.71	20	95%	1	5%	0	0%	19	76%	4	16%	2	8%	21	25
13	West Godavari	47	0.03	8.41	0.03	2.76	28	85%	4	12%	1	3%	9	82%	2	18%	0	0%	33	11
Total State		**690**	**0.01**	**51.76**	**0.19**	**8.18**	**362**	**73%**	**75**	**15%**	**61**	**12%**	**161**	**88%**	**14**	**8%**	**7**	**4%**	**498**	**182**

Annexure- XIV: Fluctuation and Frequency distribution from different ranges from one period to other May 2020 from Decadal mean of May (2010-19)

Mean (2009 May-2018 May) -May/ 2019																				
Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	45	0.15	15.85	0.11	26.51	3	7	4	9	14	31.11	9	20	4	9	11	24	21	24
2	Chittoor	29	1.04	16.11	0.05	13.95	3	10	5	17	12	41.38	3	10	0	0	6	21	20	9
3	YSR Kadapa	15	0.98	17.16	0.38	13.19	2	13	3	20	7	46.67	1	7	0	0	2	13	12	3
4	East Godavari	33	0.28	6.49	0.25	27.31	6	18	5	15	5	15.15	9	27	3	9	5	15	16	17
5	Guntur	32	0.14	7.09	0.14	21.31	13	41	5	16	3	9.38	3	9	5	16	3	9	21	11
6	Krishna	36	0.18	9.27	0.69	19.52	8	22	5	14	2	5.56	6	17	6	17	9	25	15	21
7	Kurnool	40	0.01	11.76	0.17	10.66	17	43	1	3	5	12.50	8	20	5	13	4	10	23	17
8	Nellore	24	0.49	8.25	0.75	32.37	5	21	2	8	6	25.00	4	17	3	13	4	17	13	11
9	Prakasam	42	0.01	12.74	0.03	8.36	11	26	3	7	6	14.29	8	19	5	12	9	21	20	22
10	Srikakulam	33	0.36	7.36	0.00	7.94	9	27	8	24	8	24.24	5	15	1	3	2	6	25	8
11	Visakhapatnam	27	0.64	5.95	0.16	3.17	4	15	7	26	3	11.11	9	33	4	15	0	0	14	13
12	Vizianagaram	29	0.14	6.14	0.05	7.56	8	28	7	24	4	13.79	6	21	3	10	1	3	19	10
13	West Godavari	17	0.22	6.10	0.31	15.79	3	18	3	18	1	5.88	3	18	4	24	3	18	7	10
Total State		**402**	**0.01**	**17.16**	**0.00**	**32.37**	**92**	**40%**	**58**	**6%**	**76**	**34%**	**74**	**42%**	**43**	**24%**	**59**	**34%**	**226**	**176**

Annexure-XV: Fluctuation and Frequency distribution from different ranges from one period to other November 2020 from Decadal mean of November (2010-19)

Mean (2009 NOV-2018 NOV) -NOV/ 2019																				
Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Anantapur	37	0.43	8.78	0.25	3.36	13	35	15	41	5	13.51	3	8	1	3	0	0	33	4
2	Chittoor	40	0.16	5.78	0.06	1.76	18	45	14	35	4	10	4	10	0	0	0	0	36	4
3	YSR Kadapa	32	0.08	36.9	0.12	11.03	7	22	9	28	10	31.25	4	13	0	0	2	6	26	6
4	East Godavari	84	0.02	3.43	0.02	3.76	60	71	4	5	0	0	18	21	2	2	0	0	64	20
5	Guntur	88	0.01	14.68	0.02	3.24	54	61	12	14	3	3.41	17	19	2	2	0	0	69	19
6	Krishna	62	0.06	16.9	0.03	5.4	44	71	7	11	3	4.84	7	11	0	0	1	2	54	8
7	Kurnool	45	0.21	13.28	0.17	2.85	22	49	11	24	8	17.78	3	7	1	2	0	0	41	4
8	Nellore	55	0.03	4.12	0.03	4.00	22	40	8	15	1	1.82	23	42	0	0	1	2	31	24
9	Prakasham	56	0.1	22.95	0.09	10.33	29	52	9	16	2	3.57	12	21	3	5	1	2	40	16
10	Srikakulam	42	0	1.7	0.09	1.67	22	52	0	0	0	0	20	48	0	0	0	0	22	20
11	Visakhapatnam	56	0.02	3.57	0.07	3.53	44	79	3	5	0	0	8	14	1	2	0	0	47	9
12	Vizianagaram	44	0.02	2.72	0.1	3.1	30	68	1	2	0	0	11	25	2	5	0	0	31	13
13	West Godavari	50	0.04	5.18	0.01	1.75	30	60	3	6	2	4	15	30	0	0	0	0	35	15
Total State		**691**	**0**	**36.9**	**0.01**	**11.03**	**395**	**75%**	**96**	**18%**	**38**	**7%**	**145**	**90%**	**12**	**7%**	**5**	**3%**	**529**	**162**

Annexure-XVI: Fluctuation and Frequency distribution from different ranges from one period to other Jan, 2020 from Decadal mean of Jan (2011-20)

Decadal Mean (January 2010- January 2019) to January -2020																				
Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4		Rise	Fall
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%		
1	Anantapur	37	0.18	7.38	0.62	5.2	11	32%	16	47%	7	21%	2	67%	0	0%	1	33%	34	3
2	Chittoor	44	0.06	8.78	0.12	5.27	16	44%	11	31%	9	25%	4	50%	3	38%	1	13%	36	8
3	YSR Kadapa	34	0.24	49.03	0.03	5.13	7	25%	4	14%	17	61%	3	50%	2	33%	1	17%	28	6
4	East Godavari	84	0.03	4.83	0.06	4.41	57	84%	10	15%	1	1%	14	88%	1	6%	1	6%	68	16
5	Guntur	90	0.02	14.72	0.02	1.79	63	83%	11	14%	2	3%	14	100%	0	0%	0	0%	76	14
6	Krishna	66	0.06	6.78	0.13	2.43	48	80%	8	13%	4	7%	5	83%	1	17%	0	0%	60	6
7	Kurnool	45	0.05	36.58	0.16	0.16	20	45%	13	30%	11	25%	1	100%	0	0%	0	0%	44	1
8	Nellore	55	0.02	9.23	0.04	1.27	33	65%	7	14%	11	22%	4	100%	0	0%	0	0%	51	4
9	Prakasham	57	0.01	27.2	0.09	17.56	25	52%	14	29%	9	19%	8	89%	0	0%	1	11%	48	9
10	Srikakulam	47	0	4.1	0.03	2.61	20	95%	0	0%	1	5%	25	96%	1	4%	0	0%	21	26
11	Visakhapatnam	57	0.03	3.85	0.02	1.55	39	93%	3	7%	0	0%	15	100%	0	0%	0	0%	42	15
12	Vizianagaram	46	0.04	4.58	0.02	3.44	24	96%	0	0%	1	4%	17	81%	4	19%	0	0%	25	21
13	West Godavari	50	0.05	9.67	0.03	2.2	34	85%	4	10%	2	5%	9	90%	1	10%	0	0%	40	10
Total State		**712**	**0**	**49.03**	**0.02**	**17.56**	**397**	**69%**	**101**	**18%**	**75**	**13%**	**121**	**87%**	**13**	**9%**	**5**	**4%**	**573**	**139**

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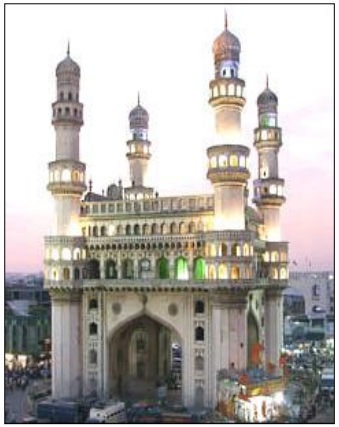

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