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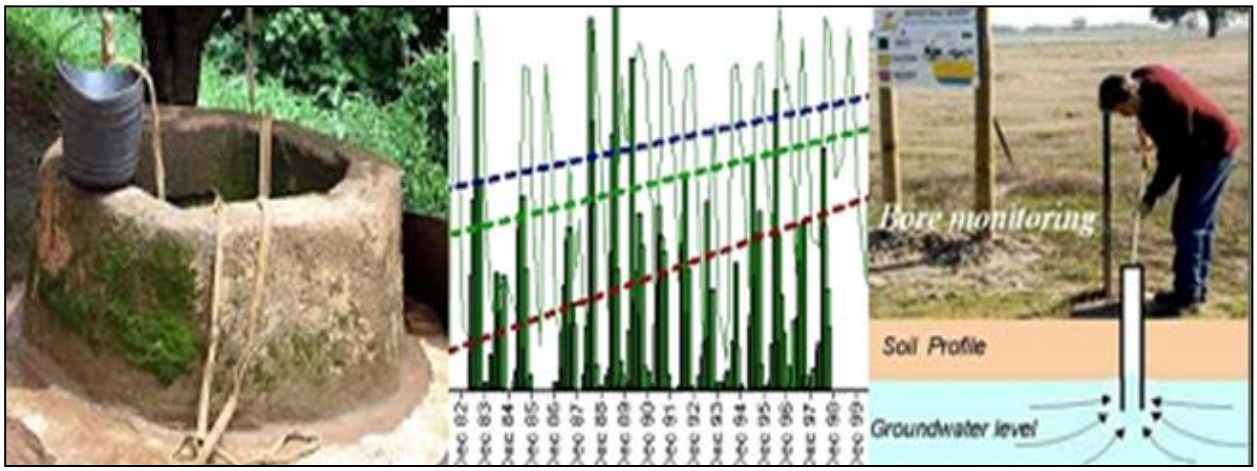
Central Ground Water Board

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

GROUND WATER YEAR BOOK
2014-15
TELANGANA STATE



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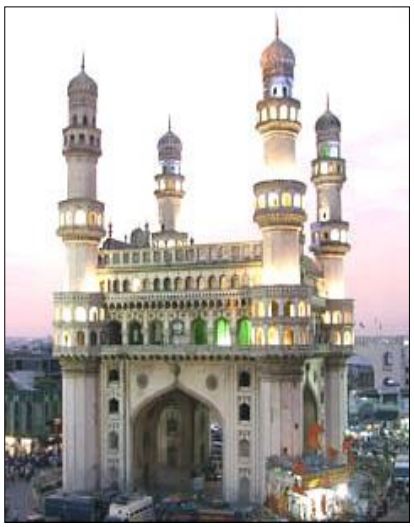

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GROUND WATER YEAR BOOK
2014-15
TELANGANA STATE

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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 for preparation of sustainable development plan for the country. Central Ground Water Board has been monitoring ground water regime since 1969. During the year 2014-15, 56 new ground water monitoring wells were established forming a network of 736 operational ground water monitoring wells including 360 dug wells 376 piezometers as on 31-3-2015. These stations are being monitored four times a year viz., May, August, November and January to study the seasonal and long term changes. The water samples are collected during May for chemical analysis.

The ground water level monitoring carried out by Central Ground Water Board, Southern Region, Hyderabad during 2014-15 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 sincere efforts made by Sri.A.B.Kawade, Scientist-D, Sri. P.Sudhakar, Scientist-C (HM) and Sri.K.Maruthi Prasad, Scientist-B in preparation of the report are commendable. The efforts of Sri. G.Y.Setty, Scientist-D and S.Renuka, Scientist-B(GP) of Report Processing Section in scrutiny, processing and issuance of the report are also appreciated.

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 Telangana.

Hyderabad
14.01.2016

(A. D. RAO)
REGIONAL DIRECTOR

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.

In Telangana State, a total of 736 (360 dug wells and 376 Piezometers) Ground Water Monitoring wells are in existance as on 31-03-2015. The Water levels are being monitored four times in a year during May, August, November, and January. The Ground Water Year Book-2014-15 pertains to the monitoring carried out during the four monitoring periods in AAP 2014-15. The report elaborates the ground water level scenario in the State and describes the regional behaviour of water levels.

During the year 2014, the State had received annual rainfall of 667 mm, 29% of less than the normal rainfall of 939 mm. There is deficit rainfall in all the districts of the state. Highest annual rainfall of 861 mm is recorded in Adilabad district and lowest annual rainfall of 512 mm is recorded in Medak district. Monthly rainfall ranges from 1 mm in janaury to 171mm in August. June, July, August, September and November are the rainiest months of the year.

In general, the water levels are deep during May and shallow in November. Water level rise takes place during August, November and January depending on the monsoon rainfall and degree of ground water development. During the year 2014-15, the water levels vary between -0.14 to 40.03 mbgl during pre-monsoon and -0.17 to 45.01 mbgl during post-monsoon period. The depth to water levels in the range of 5-10m is more prevalent in the State during pre-monsoon and 5-10 mbgl during post-monsoon. Number of wells with depth to water level in the range of 0-2 m bgl has increased from 3.86% of in May, 2014 to 9.87% of in November 2014. Deep water levels (20-40 mbgl) are observed in 2.6% of the wells during May,2014 and reduced to 3.13% of wells during November, 2014.

Rise was observed during May, 2014 in 78.6% of wells and fall in 18.99% of the wells as compared to May, 2013.

Rise was observed in 77.47% of wells and fall in 22.53% of the wells during May, 2014 with reference to decadal mean of pre-monsoon(May, 2004-2013). Water level rise of more than 4 m is observed in 14.52% of the wells and fall of more than 4 m is observed in 2.73% of the wells.

Rise was noticed in Novemebr, 2014 when compared with November, 2013 in 8.36 % of wells and fall in in 91.21% of the wells.

Water level fluctuation during November, 2014 with reference to decadal mean of November (2004-2013) shows fall in 75.95% of the wells.

Rise was observed during August-2014 in 62.97% of the wells as compared with May, 2014. This can be attributed to the normal to excess rainfall recorded in all the districts of the state. Water level fluctuation between August, 2013 and August 2014 indicates fall in 70.99% of the wells, this can be attributed to the deficit rainfall recorded in all the districts of the state during the period.

Rise was observed in 14.26% of the wells and fall in 84.39% of the wells as compared the Jan, 2015 data with Jan 2014.

Water table elevation during May, 2014 generally follows the topography which ranges from <100m in east to >600 m in west. The general gradient is from west to east.

During Pre-Monsoon, May 2014, the water logging area (0-2m bgl) was 519 sq.km, in 0.45% of the state. The area prone to water logging (2-3 m bgl) during May, 2014 is 2403 sq.km, in 2.10% of the State. During the post-monsoon, Nov 2014, the area under water logging area is 3265 sq.km. in 2.8% of the state. There is an increase from 0.45% ofto 2.8% from May to November. The Area prone to water logging during November was 8856 sq.km, in 7.70%of the state. There is an increase from 2.1% ofto 7.7% of wells from May to November.

Monitored 323 ground water monitoring wells during May, 2014 in the state to assess the quality of shallow ground water. In general pH is in the range of 6.8 to 8.9.Total Dissolved Solids (TDS) value is beyond 2000 mg/L in 5.9% of the samples. It is in the range of 500-2000 mg/LAlkalinity exceeds BIS limit of 600mg/L in 16 samples in the state. Sodium is in the range of 4.0 - 2300 mg/L. Potassium is in the range of traces to 625 mg/L. In general it varies from 0 to 10 mg/L.Chloride concentration is beyond BIS permissible limit only in 1.5% of the samples In general it varies from 50 to 500 mg/L. Sulphate exceeds the BIS permissible limit of 400 mg/L in 3.4% of the samples. In general it is in the range of 5 to 200 mg/L. Fluoride exceeds the BIS permissible limit of 1.5 mg/L in 14.6% of the samples. It varies from 0.3 to 1.0 mg/L.Ground water in majority of the locations fall in C_3S_1 class followed by C_2S_1, $C3S2$, C_3S_3, C_4S_4, C_1S_1, C_4S_2, C_4S_3, C_3S_4, C_2S_2 and C_4S_1. Dominant Water types are Ca-HCO_3, Na-Mg-HCO_3 and Na-Ca-HCO_3 type. Most of the samples are suitable for livestock and poultry consumption.Highest values of Electrical Conductivity (11250 µS/cm) Hardness (4850 mg/L) Nitrate (1226 mg/L) are noticed at Mylaram of Warangal district.Maximum values of Chloride (3049 mg/L)and Sulphate (1488 mg/L) are found at Medaram of Adilabad district. High Fluoride levels are (4.2 mg/L) found at Jainoor of Adilabad district.

GROUND WATER YEAR BOOK
(2014–2015)
TELANGANA STATE

1.0 Introduction

Central Ground Water Board has taken up the task of complex issues of ground water management, development, augmentation, protection and regime monitoring both in terms of quality and quantity. 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 from the year 1969.

The monitoring mainly comprises measurement of water levels and temperature, four times in a year viz., in the months of May, August, November and January and collection of water samples during May every year, for chemical analysis. As on 01.04.2014, there were 699 operational Ground Water Monitoring Wells (345 dug wells and 354 piezometers).

During the year (2013-14), 19 Ground water monitoring wells (12 Dug wells and 7 Piezometers) are abandoned and 56 new ground water monitoring wells (27 Dug wells and 29 Piezometers) are established to appearance a network of 736 operational ground water monitoring wells including 360 Dug wells and 376 Piezometers as on 31-3-2015. 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 are constructed under various projects and exploration programmes by the department. Most of these wells are monitored manually four times a year. The location of network of monitoring wells is presented in the Fig.1.1.

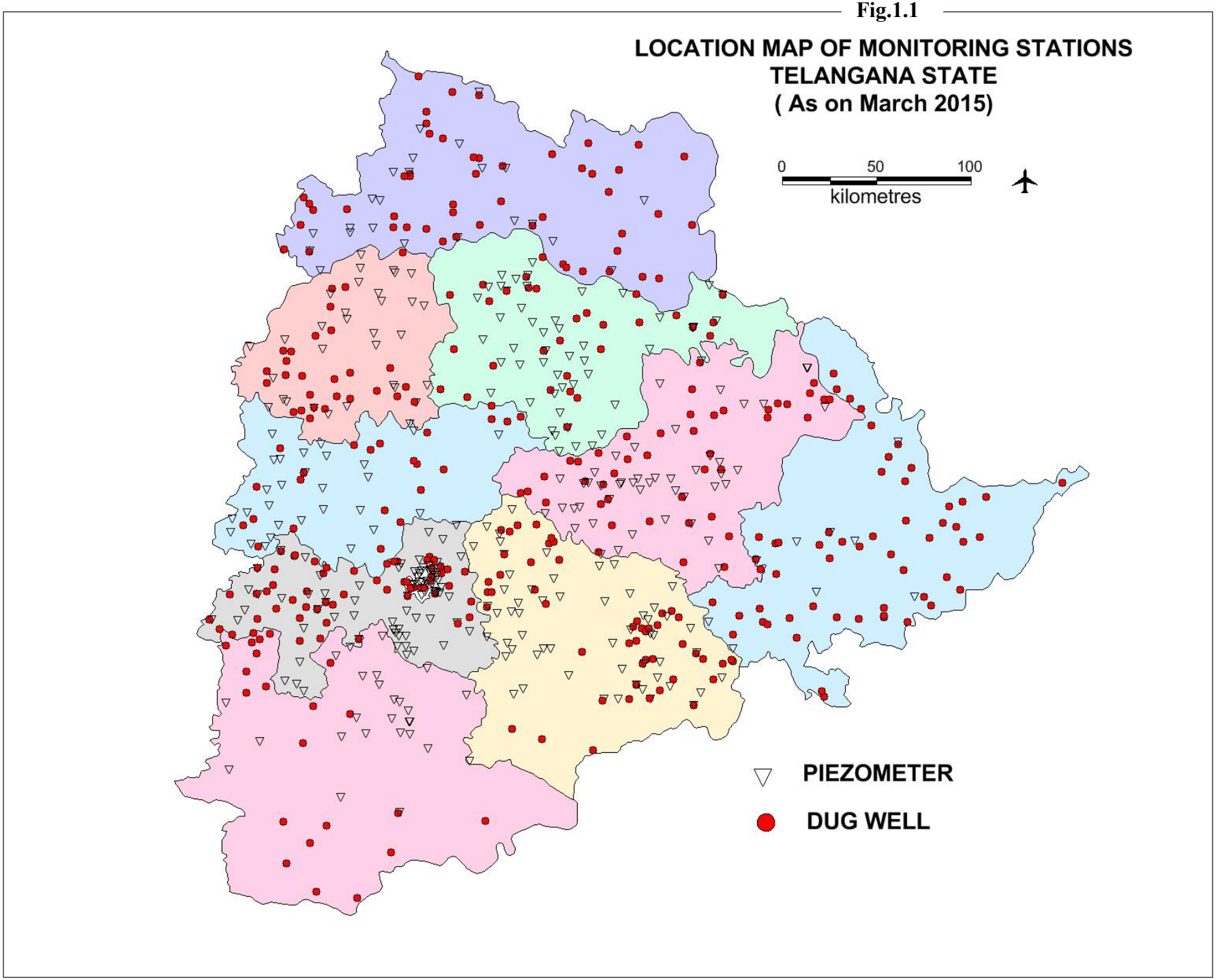
1.1 Location and Extent

Telangana State is the **Twetynineth State** (2014) formed in India covering geographical area of 1,14,800 sq.km. It lies between north latitudes 15° 48’ and 19° 54’ and, east longitudes 77° 12’ and 81° 50’. The State is bounded on the east and south by Andhra Pradesh , on the west by Karnataka and Maharashtra States and on the north by Maharashtra, Madhya Pradesh, Chhattisgarh and Orissa States.

Administratively, the State is divided into 10 districts (Adilabad, Karimnagar, Nizamabad, Warangal, Khammam, Nalgonda, Medak, Ranga Reddy, Hyderabad and Mahbubnagar) and 464 mandals.

The present ground water year book (2014 – 15) depicts the ground water level scenario in the State and describes the behaviour of water levels during the period. The observation wells are distributed more or less uniformly over the State covering 12 major and minor river basins.

Fig.1.1


LOCATION MAP OF MONITORING STATIONS
TELANGANA STATE
(As on March 2015)
0
50
100
kilometres
PIEZOMETER
DUG WELL

2. PHYSIOGRAPHY, DRAINAGE AND SOIL

2.1 Physiography

Physiographically, Telangana State is occupied by western pediplains except a fringe of Eastern Ghats in the northeastern part of Khammam district. The landforms, altitude and drainage pattern are different.

2.1.1 Western Pedeplains

A major part of the State is occupied by Western Pedeplains. The pedeplains depict rolling topography with flat to undulating tracts. This plateau in the interior of the State extends largely between elevations of 150 to 600 mamsl except at places where it is overlain by Basaltic Lava flows, the elevation of which ranges from 600 to 900 m amsl.

2.2 Drainage

The State is drained by two major rivers namely, Godavari and Krishna and their tributaries before entering in to the state of Andhra Pradesh and finally to Bay of Bengal. There are 2 basins and 10 sub basins in the state. The major river basins are Godavari, Krishna and sub basins are lower Krishna, middle Krishna, lower Godavari, Indravati, Waingainga, Pranhita, Manjira, Lower Bhima and middle Godavari.

The pattern of drainage is generally dendritic with wide valleys in western pediplain. The drainage of the Eastern Ghat is coarse and dendritic with steep and narrow valleys. Most of the smaller streams feed innumerable tanks.

The River Godavari with its tributaries viz., Pranahita, Pedda Vagu, Manjira, Maner, Kinnerasani, Sileru and Pamuleru drain whole of northern Telangana. The Tungabhadra, Vedavati, Hindri, Musi, Paleru and Maneru rivers drain southern part of the State.

The drainage basins are charecterised by undulating topography comprising a series of ridges and valleys intersperse by hill ranges.

2.3 Soil

The soil has been classified based on color, texture, formation, and physical, chemical and morphological properties of the formation. The State has a wide variety of soil viz., Red soil, Laterites and Black Cotton soil.

About 60 percent of the State is occupied by red earths with loamy sub-soils covering entire Nalgonda district, a major part of Mahabubnagar, Waranagal, Karimnagar and Nizamabad districts. Black cotton soil commonly occurs in Adilabad and Nizamabad districts. Laterite soil occurs in western part of Ranga Reddy and Medak districts.

3.0 HYDROMETEOROLOGY

3.1 Climate

The climate of the state is tropical in nature and is influenced by the topographical variations. The Deccan plateau has more of a temperate climate. The agro-climatic zone classification (Agricultural department) is as mentioned below.

- North Telangana Zone,
- Southern Telengana Zone,
- High Altitude and
- Tribal Zone.

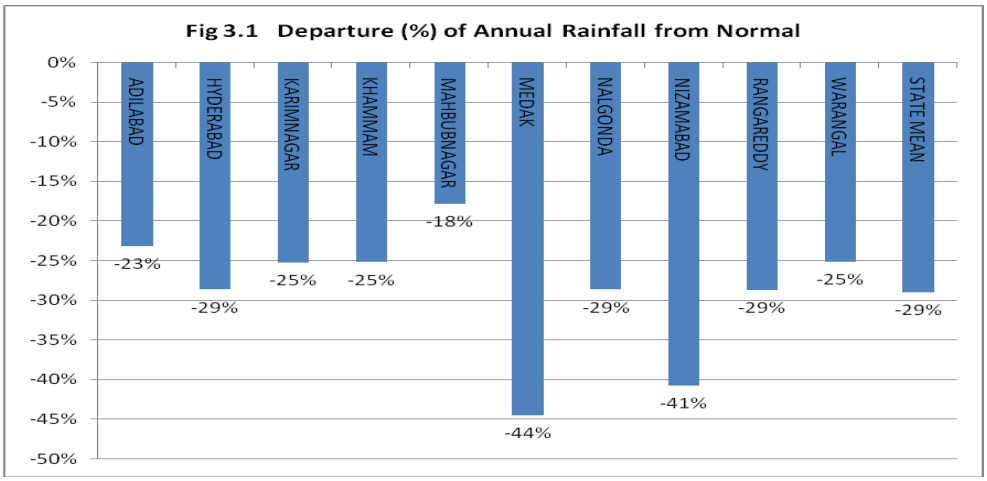
3.2 Rainfall Analysis

District-wise monthly, seasonal and annual rainfall of both normal and actual of the year 2014 and its departure from normal is presented in the Table-3.1. The district-wise normal annual rainfall and its departure from normal is depicted in the Fig.3.1**.**

TABLE 3.1 MONTHLY NORMAL AND ACTUAL(2014) RAINFALL(mm) IN TELANGANA STATE

		JAN		FEB		MAR		APR		MAY		JUNE		JULY	
	DISTRICT	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal
1	ADILABAD	0	7.4	7.9	7.1	89.6	9.7	11.8	14.2	37.1	18.2	84.8	178.4	161	317.4
2	HYDERABAD	0	5.9	0.6	7.3	55.5	12.6	9	22.7	41.9	33.8	58.6	110.7	137.7	176.8
3	KARIMNAGAR	0	10.7	2.4	5.5	66.7	10.2	9.1	17.2	66.1	24	84.9	153.2	169.4	257.3
4	KHAMMAM	0	4.2	0	7.4	18.9	8.8	2.7	26.4	76.9	52.6	24.1	150.3	229.3	282.8
5	MAHBUBNAGAR	0	1.8	0	2.8	22	4.9	20	17.9	85.6	34.1	75.4	91.1	107.7	161.6
6	MEDAK	0	6.5	0	4.4	83.8	8.9	4.2	20.1	52.2	28	30.7	138.2	104	229.4
7	NALGONDA	0.7	3.9	0	4.5	6.2	8.4	7.5	16.4	73.7	28.7	30.5	103.2	85.2	154.7
8	NIZAMABAD	0	7.9	8	4.1	102.1	7.1	14.2	14.4	49.9	24.5	57.2	161.3	127.2	289.4
9	RANGAREDDY	0	3.1	0.1	4	37	6.6	15.4	22.6	79.2	34.6	43.3	109.4	90.4	190.6
10	WARANGAL	0.5	8.3	0	7.8	42.1	10.2	5	17.3	105.6	28.7	53.9	147.6	172.1	271.2
	STATE MEAN	**0.1**	**6.0**	**1.9**	**5.5**	**52.4**	**8.7**	**9.9**	**18.9**	**66.8**	**30.7**	**54.3**	**134.3**	**138.4**	**233.1**

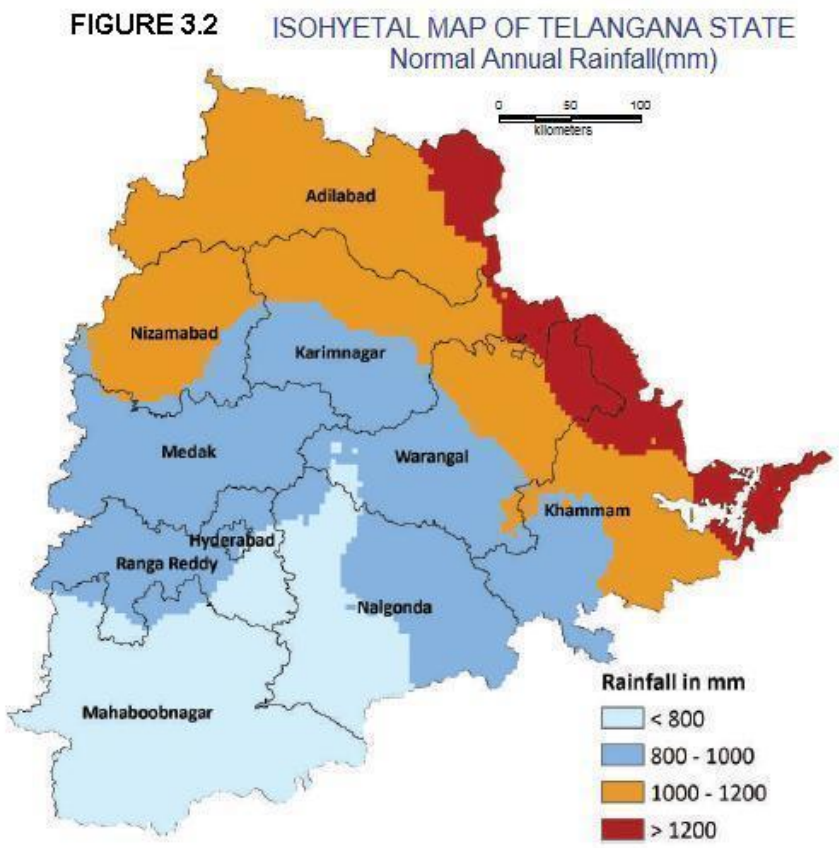
		AUG		SEP		OCT		NOV		DEC		ANNUAL		
1	DISTRICT	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	DEP(%)
2	ADILABAD	214.8	291.7	222.5	171.4	24.3	83	6.7	14.8	0.9	7.3	861	1121	-23%
3	HYDERABAD	131.1	190.5	95.8	165.5	23.9	95.6	53.4	23.7	0.2	6.4	608	852	-29%
4	KARIMNAGAR	195.1	226.7	122.5	163.1	12.1	85.9	4.1	20.8	0.8	5.9	733	981	-25%
5	KHAMMAM	183.3	256.4	179.6	170.9	90.6	106.9	14.4	24.5	0	4.5	820	1096	-25%
6	MAHBUBNAGAR	143.9	158.2	94.1	148.8	34.3	85.4	12.9	21.2	5.2	3.8	601	732	-18%
7	MEDAK	143.6	211.1	52.2	165.2	23.7	86.6	17.4	19.3	0.3	4.8	512	923	-44%
8	NALGONDA	110.2	147.2	119.8	149.6	94	105.8	14.8	32	0.6	6.6	543	761	-29%
9	NIZAMABAD	188.8	296.5	67.6	172.9	15.4	91.3	12.6	17.1	4	5.5	647	1092	-41%
10	RANGAREDDY	197	176.5	83.7	177.2	37.1	94.5	16.1	19.1	1.3	4.3	601	843	-29%
	WARANGAL	201.7	222.3	118.3	155.5	29.5	88.9	11	22.9	0	7.2	740	988	-25%
	STATE MEAN	**171.0**	**217.7**	**115.6**	**164.0**	**38.5**	**92.4**	**16.3**	**21.5**	**1.3**	**5.6**	**666.6**	**938.6**	**-29%**



3.2.1 Rainfall Analysis - 2014

The salient features;

- The normal annual rainfall of the state is 939 mm. Season-wise normal rainfall is 749 mm, 120 mm, 12 mm and 58 mm in monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively contributing 80% ofof annual in SW monsoon, 13% ofof annual rainfall in north-east monsoon and 7% ofin non-monsoon season. Annual normal rainfall ranges from 732 mm in Mahabubnagar district to 1121 mm in Adilabad district (Fig.3.2).



The annual rainfall during 2014 is 667 mm. Season-wise rainfall is 480 mm, 56 mm, 2 mm and 129 mm in monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively contributing 72% ofof annual rainfall in SW monsoon, 9% of annual rainfall in north-east monsoon and 19% ofin non-monsoon season.

During the year 2014, annual rainfall was deficit by 29%. Drought conditions prevailed in the state except in Mahabubnagar district.

Annual rainfall in 2014 ranges from 512 mm(Deficit by 44%) in Medak district to 861 mm(deficit by 23%)in Adilabad district. Monthly mean rainfall ranged from 0.1 mm in January to 171 mm in July. The rainfall during the period Jan, 2004 to Dec, 2014 is analysed for correlating with water levels during the May, 2014 to Jan, 2015. The data is presented in the Table-3.2 to 3.5 and depicted in the Fig. 3.3 to 3.10.

3.2.2 Rainfall analysis – May, 2014

The rainfall data from India Meteorological Department and weekly weather reports have been used for analysis of rainfall for the period June, 2004 to May, 2014. district-wise rainfall for the period June'12-May'13, Jun'13-May'14, decadal mean (Jun-May) of 2004-2013 and normals of June – May and departure of May'14 rainfall from June'13 are given in the Table-3.2. Departure values are used to generate the thematic maps (Fig. 3.3-3.5).

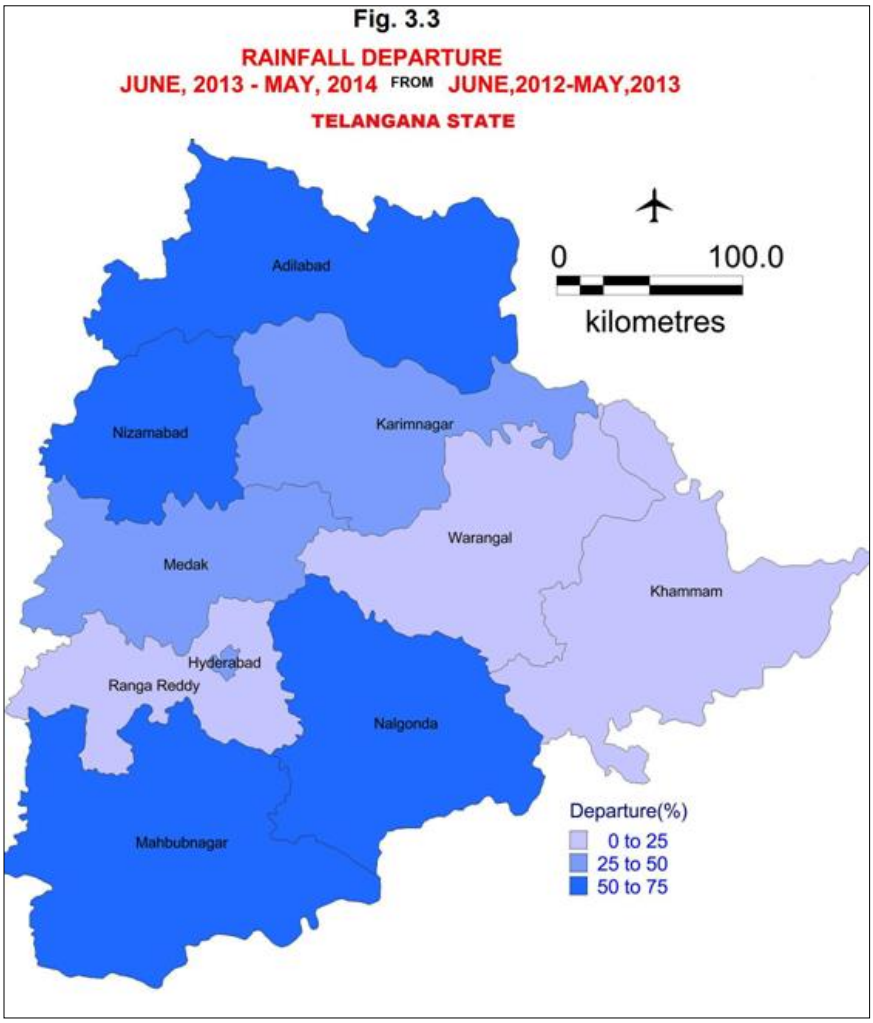
TABLE - 3.2 RAINFALL AND ITS VARIABILITY IN TELANGANA

S No	District	Rainfall(Mm)				Departure of May'14 Rainfall from June'13		
		June'13 To May'14	Jun'12 To May'13	Decadal Mean	Normal	June'12 To May'13	Decadal Mean (June-May)	Normal (June-May)
1	Adilabad	1689	1101	1026	1120	53.4%	64.6%	50.8%
2	Hyderabad	1090	853	873	851	27.8%	24.9%	28.0%
3	Karimnagar	1487	1102	1055	980	34.9%	41.0%	51.8%
4	Khammam	1522	1509	1307	1095	0.9%	16.4%	39.0%
5	Mahbubnagar	987	632	681	731	56.0%	44.8%	35.0%
6	Medak	1145	855	840	922	34.0%	36.3%	24.2%
7	Nalgonda	1140	722	699	761	57.8%	63.1%	49.9%
8	Nizamabad	1425	927	945	1092	53.8%	50.8%	30.5%
9	Rangareddy	1024	1011	839	842	1.2%	22.0%	21.6%
10	Warangal	1467	1248	1062	987	17.6%	38.2%	48.7%
	STATE MEAN	1298	996	933	938	30.3%	39.1%	38.3%
Source: India Meteorological Department, GOI								

Departure of rainfall during June, 2013-May 2014 from June, 2012-May, 2013 rainfall

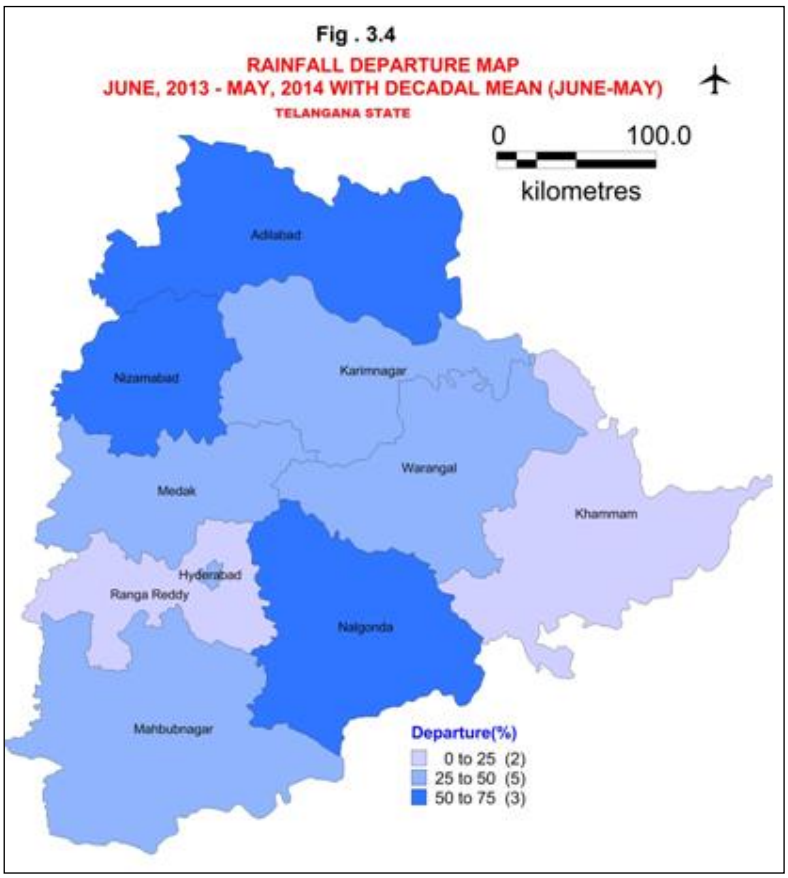
The thematic map depicting departure of rainfall during Jun'13-May'14 from Jun'12-May'13 is given in the Fig.**3.3**. Water level fluctuation during May, 2014-May, 2013 is correlated with departure of rainfall. The rainfall recorded during Jun'13 to May'14 was 1298 mm, which is 30.3% ofmore during the same period previous year and 39.1% ofmore than the decadal mean(2004-2013) and 39.3% ofmore than the normal. About 996mm of rainfall was recorded during the same period last year. The departure ranges from 0.9% ofin Khammam district to 58% ofin Nalgonda district.

Fig. 3.3



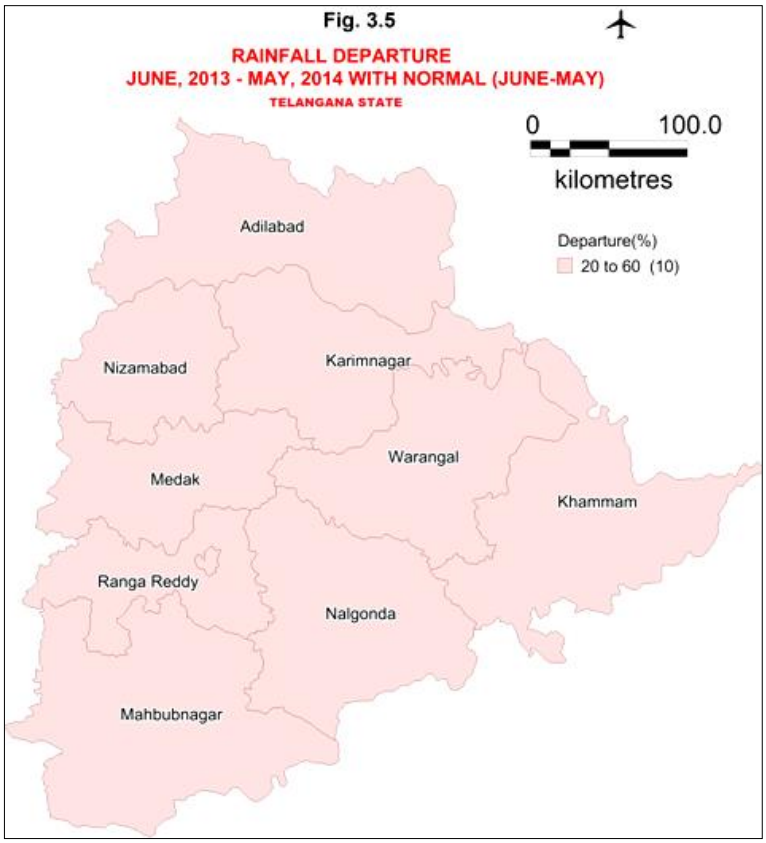
Departure of rainfall during June 2013-May, 2014 from decadal mean rainfall; Jun-May,2004-2013

Departure of Jun'13-May'14 rainfall from decadal mean rainfall 2004-2013 (Jun-May) is depicted in the Fig.3.4. Water level fluctuation during May, 2014-May, 2013 is correlated with departure of rainfall. The decadal mean rainfall (Jun-May) is 933 mm. The rainfall is 39.1% ofmore than the decadal mean rainfall. The departures range from -2% ofin Nizamabad to 24.4% ofin Warangal district.



Departure of rainfall during June 2013-May 2014 from normal rainfall of same period

Departure of Jun'13-May'14 rainfall from normals of the same period is depicted in the Fig.3.5. Water levels during May, 2014 is correlated with departure of rainfall. The rainfall was recorded during Jun'13-May'14 was 38.3% ofmore than the normal. The normal rainfall during the period June-May is 938 mm . It ranges from 731 mm in Mahabubnagar to 1120 mm in Adilabad district. Rainfall was excess in the state i.e more than 120 % ofof the normal.



Rainfall analysis
August, 2014

The district wise rainfall for the period June, 2013 – August, 2013, June, 2014-August, 2014, decadal mean of June to August; normal's (June-August) and its departures are furnished in the Table-3.3. The thematic maps depicting departure of rainfall from normals are shown in the Fig.3.6 - 3.8.

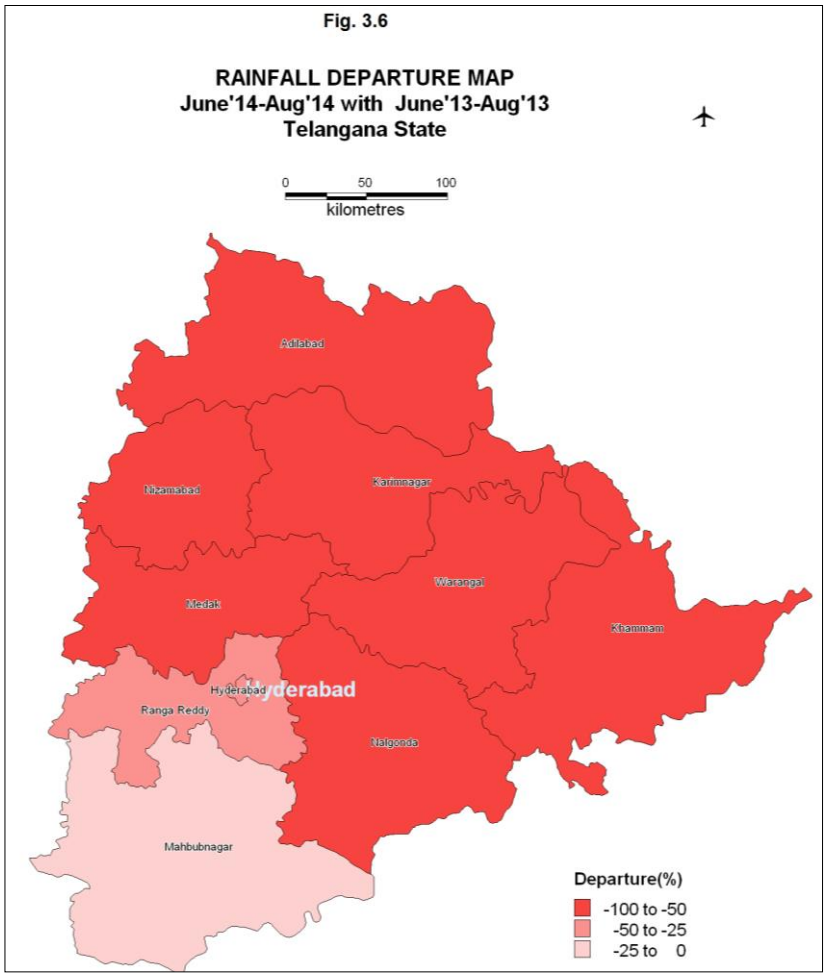
TABLE - 3.3 RAINFALL AND ITS VARIABILITY IN TELANGANA

S No	District	Rainfall(Mm)				Departure of June'14-Aug'14 Rainfall From		
		June'14 - Aug'14	Jun'13 - Aug'13	Decadal Mean (June-Aug)	Normal	June'13 - Aug'13	Decadal Mean (June-Aug)	Normal (June-Aug)
1	Adilabad	461	1196	727	788	-61.5%	-36.6%	-41.5%
2	Hyderabad	327	549	507	478	-40.4%	-35.4%	-31.5%
3	Karimnagar	449	941	664	637	-52.2%	-32.3%	-29.5%
4	Khammam	437	1001	817	690	-56.4%	-46.6%	-36.7%
5	Mahbubnagar	327	395	355	411	-17.3%	-7.8%	-20.4%
6	Medak	278	614	521	579	-54.7%	-46.5%	-51.9%
7	Nalgonda	226	507	340	405	-55.4%	-33.6%	-44.2%
8	Nizamabad	373	977	658	747	-61.8%	-43.3%	-50.1%
9	Rangareddy	331	465	465	477	-28.9%	-28.8%	-30.6%
10	Warangal	428	916	690	641	-53.3%	-38.0%	-33.3%
	STATE MEAN	364	756	574	585	-51.9%	-36.7%	-37.8%
Source: India Meteorological Department, GOI								

Departure of rainfall during June'14 to August 2014 from June'13 – August'13

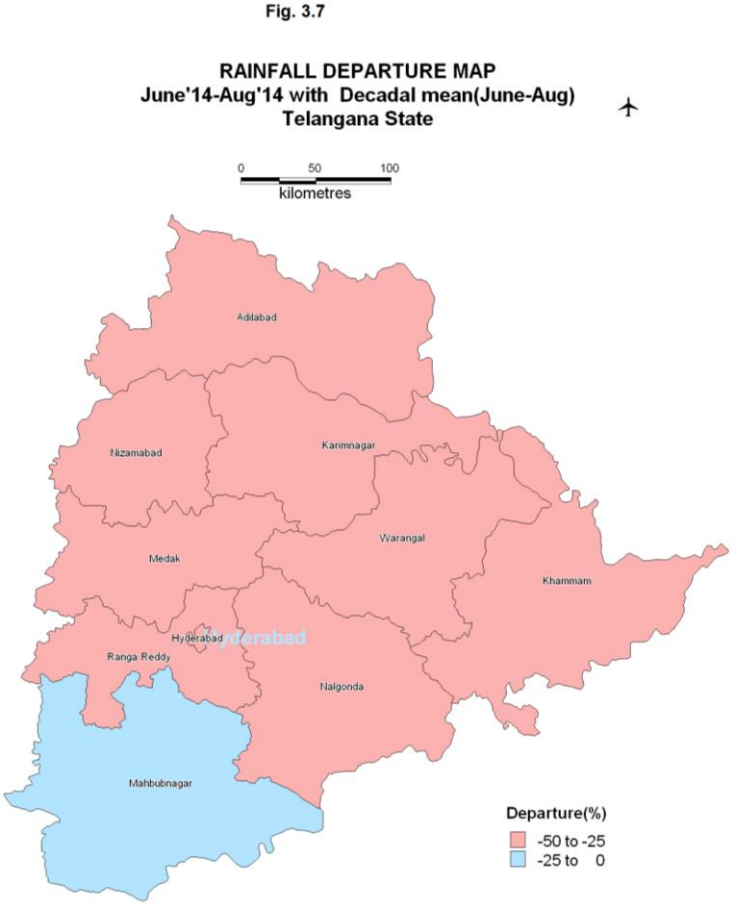
Departure of June'14-Aug'14 rainfall from June'13-Aug'13 rainfall is depicted in the Fig.3.6. Water level fluctuation during May, 2014-Aug, 2013 is correlated with departure of rainfall. Rainfall of 364 mm was recorded (Table-3.3) during the period Jun'14 to Aug'14 which is 52% of less than the rainfall during the same period previous year(756mm). The departure ranges from –61.8% ofin Nizamabad to –17.3% ofin Mahabubnagar districts. Entire State has received less rainfall than the same period last year.

Fig. 3.6



Departure of rainfall during June to August, 2013 from decadal mean

Fig. 3.7



Departure of June'14-Aug'14 rainfall from decadal mean (Jun-May)is depicted in the Fig.3.7. Water level fluctuation map of Aug 2014 with Decadal mean (Aug).is correlated with departure of rainfall. Decadal mean rainfall (Jun-May) of the state is 574 mm (Table-1). The departure ranges from -7.8% ofin Mahabubnagar district to –46.6% ofin Khammam district. Entire state has received less rainfall than the same period last year which is 37% ofless than the decadal mean which is 52% ofless than the last year.

Departure of rainfall during June to August, 2014 from normal rainfall

Departure of June'14-Aug'14 rainfall from normals of the same period is depicted in the Fig.3.8 and correlated with depth to water levels during Aug, 2014. Rainfall of 585 mm was recorded during the period. It ranges from –25.4 7% ofin Mahabubnagar district to -51.9% ofin Medak district. Entire state has received less rainfall than the normal which is 38% ofless than normal

Fig. 3.8

Rainfall analysis –November, 2014

The district wise rainfall data for the period June'14 - Oct'14, June'13- Oct'13, normals of June - Oct and decadal mean of June-Oct and the departure of June'14 – Oct'14 and are furnished in the Table-3.4. The thematic maps depict departure of rainfall from normals shown in the Fig.3.9 - 3.11.

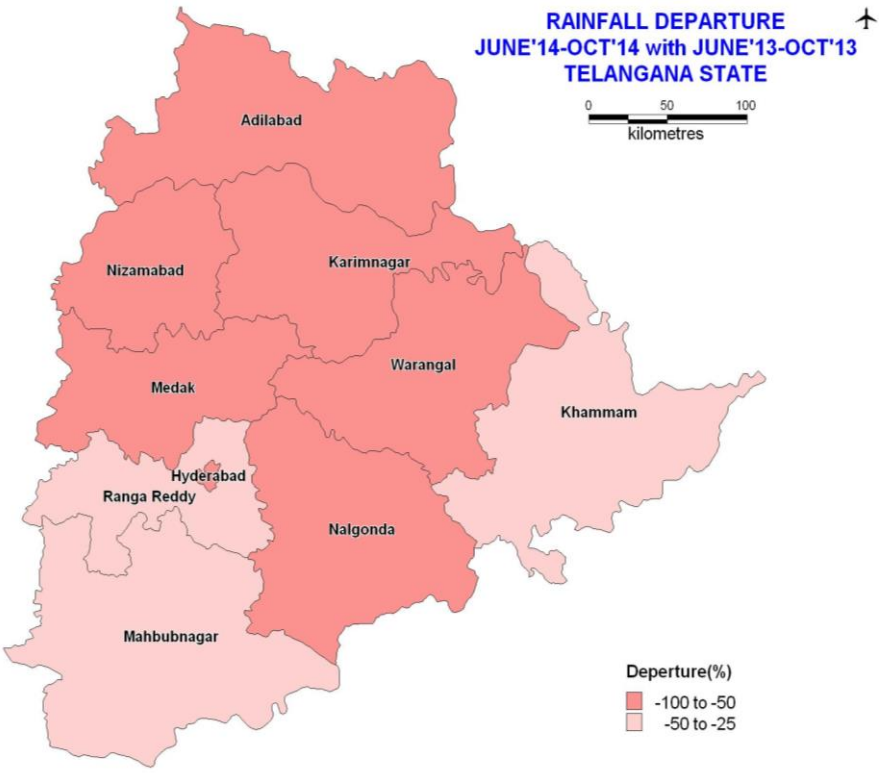
TABLE 3.4 RAINFALL AND ITS VARIABILITY IN TELANGANA

SNO	DISTRICT	RAINFALL(mm)				Departure of JUNE '14 - OCT'14 rainfall from		
		June'14 - Oct'14	Jun'13 - Oct'13	Decadal Mean (June-Oct)	Normal	June'13 - Oct'13	Decadal Mean (June-Oct)	Normal (June-Oct)
1	Adilabad	707	1538	1005	1042	-54.0%	-29.6%	-32.1%
2	Hyderabad	447	967	771	739	-53.8%	-42.0%	-39.5%
3	Karimnagar	584	1333	991	886	-56.2%	-41.1%	-34.1%
4	Khammam	707	1403	1183	967	-49.6%	-40.2%	-26.9%
5	Mahbubnagar	455	852	622	645	-46.5%	-26.8%	-29.4%
6	Medak	354	972	761	831	-63.6%	-53.5%	-57.4%
7	Nalgonda	440	1022	618	661	-57.0%	-28.9%	-33.4%
8	Nizamabad	456	1231	912	1011	-62.9%	-50.0%	-54.9%
9	Rangareddy	452	867	734	748	-47.9%	-38.5%	-39.7%
10	Warangal	576	1285	999	886	-55.2%	-42.4%	-35.0%
	STATE MEAN	**518**	**1147**	**860**	**842**	**-54.9%**	**-39.8%**	**-38.5%**

Source: India Meteorological Department, GOI

Departure of rain fall during June, 2014 to October, 2014 from June, 2013 to October, 2013

Fig. 3.9

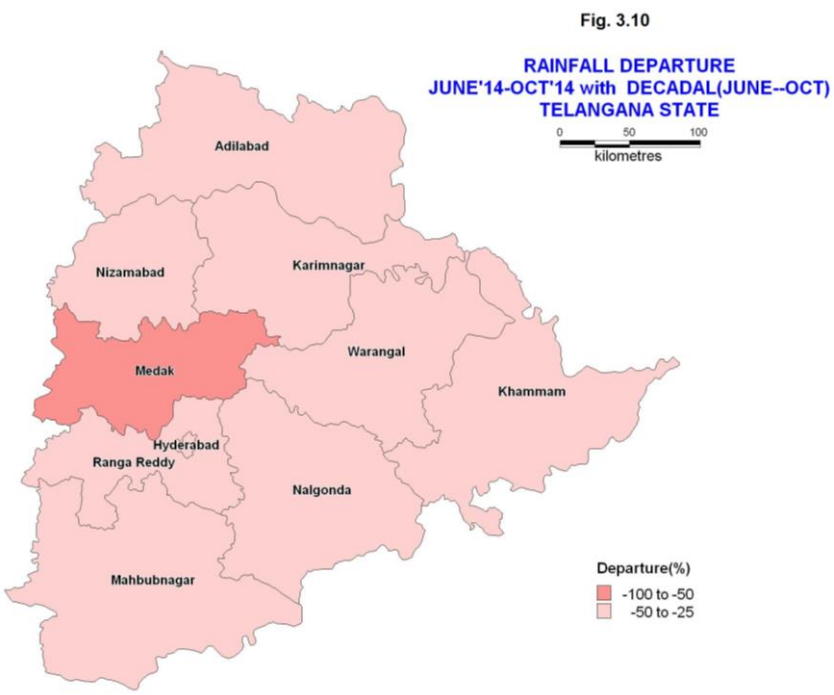


Departure of Jun'14- Oct'14 rainfall from Jun'13- Oct'13 is depicted in the Fig.3.9 and correlated with water level fluctuation during May 2014-Oct 2013. The state has received 518 mm of rainfall during Jun'14 to Oct'14 (354 mm in Medak district to 707 mm in Adilabad and Khammam districts) , which is 55% of less than the rainfall received during the same period previous year. Rainfall of 1147 mm was recorded during the same period previous year. The departure ranges from –63.6% ofin Medak district to –46.5% ofin Mahabubnagar district. Entire state has received less rainfall than the same period last year.

Departure of rainfall during June to October, 2014 from decadal mean of June to October -2004-13

The map depicting departure of Jun'14- Oct'14 rainfall from decadal mean (Jun- Oct) is given in the Fig.3.10. It is prepared to correlate with water level fluctuation during Aug, 2014 with Decadal mean (Oct). The decadal mean rainfall (Jun- Oct) of the state is 860 mm (Table 3.4). The departure ranges from -53.5% ofin Medak district to –29.6% ofin Adilabad district. The state has received less rainfall than the same period previous year, which is 40% ofless than the decadal mean.

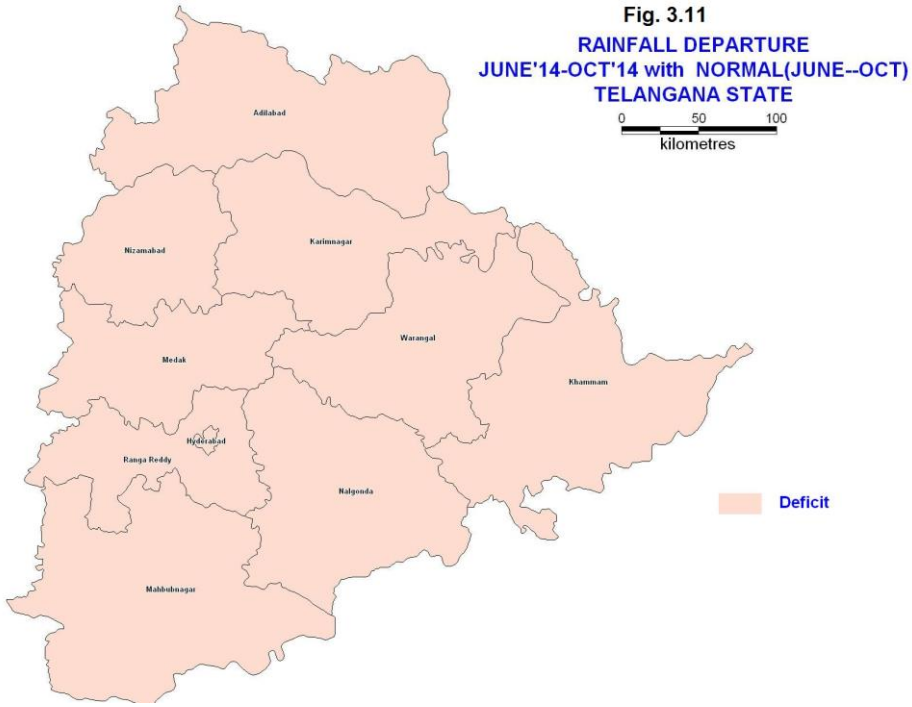
Fig. 3.10



Departure of rainfall during June to October, 2014 from normal (June to October)

The departure of Jun'14-Oct'14 rainfall from normals of the same period is depicted in the Fig.3.11 and correlated with depth to water levels of Nov, 2014. During the period Jun'14-Oct'14, the state has received 518 mm of rainfall, which is 40% ofless than the normal (June-Oct). It ranges from –57.4% ofin Mahabubnagar district to -26.9% ofin Khammam district. Entire state has received less rainfall than the normal which is 38% ofless than normal.

Fig. 3.11



Rainfall analysis - Jan 2015

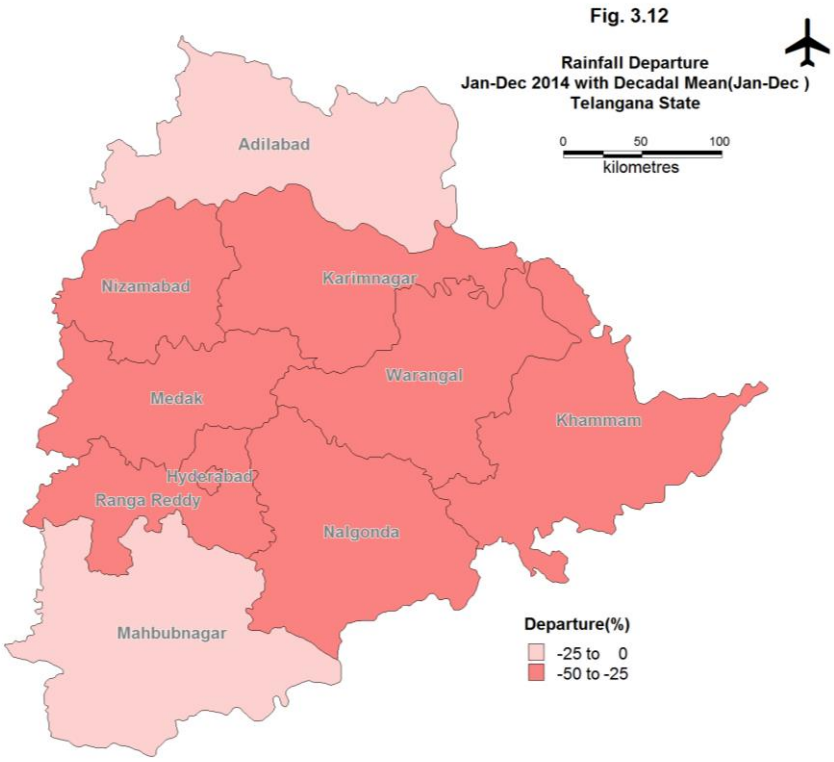
The rainfall data (India Meteorological Department) has been analysed from weekly weather reports during the period Jan, 2004 to Dec, 2014. District-wise rainfall data for the period Jan'14-Dec'14, Jan'13-Dec'13, decadal mean (Jan-Dec) of 2004-2013 and normals of Jan – Dec and the departure during Jan'14-Dec'14 rainfall from the respective periods are given in the Table-3.5. The thematic maps depicting rainfall departure from different periods are presented in the Fig. 3.12, 3.13 & 3.14.

TABLE 3.5 RAINFALL DISTRIBUTION AND ITS VARIABILITY IN TELANGANA STATE

S No	District	Rainfall(mm)				Depature(%)			Remark
		Jan'14 - Dec'14	Jan'13 - Dec'13	Decadal Mean (2004-13)	Normal Jan-Dec	From Last Year Same Period	From Decadal Mean	From Normals	
1	Adilabad	861	1608	1076	1120	-46%	-20%	-23%	Deficit
2	Hyderabad	608	1089	901	851	-44%	-33%	-29%	Deficit
3	Karimnagar	733	1427	1119	980	-49%	-34%	-25%	Deficit
4	Khammam	820	1503	1332	1095	-45%	-38%	-25%	Deficit
5	Mahbubnagar	601	911	712	731	-34%	-16%	-18%	Normal
6	Medak	512	1068	867	922	-52%	-41%	-44%	Deficit
7	Nalgonda	543	1146	736	761	-53%	-26%	-29%	Deficit
8	Nizamabad	647	1342	991	1092	-52%	-35%	-41%	Deficit
9	Rangareddy	601	972	852	842	-38%	-30%	-29%	Deficit
10	Warangal	740	1366	1104	987	-46%	-33%	-25%	Deficit
	State mean	667	1243	969	938	-46.4%	-31%	-29%	Deficit
Source: India Meteorological Department, GOI									

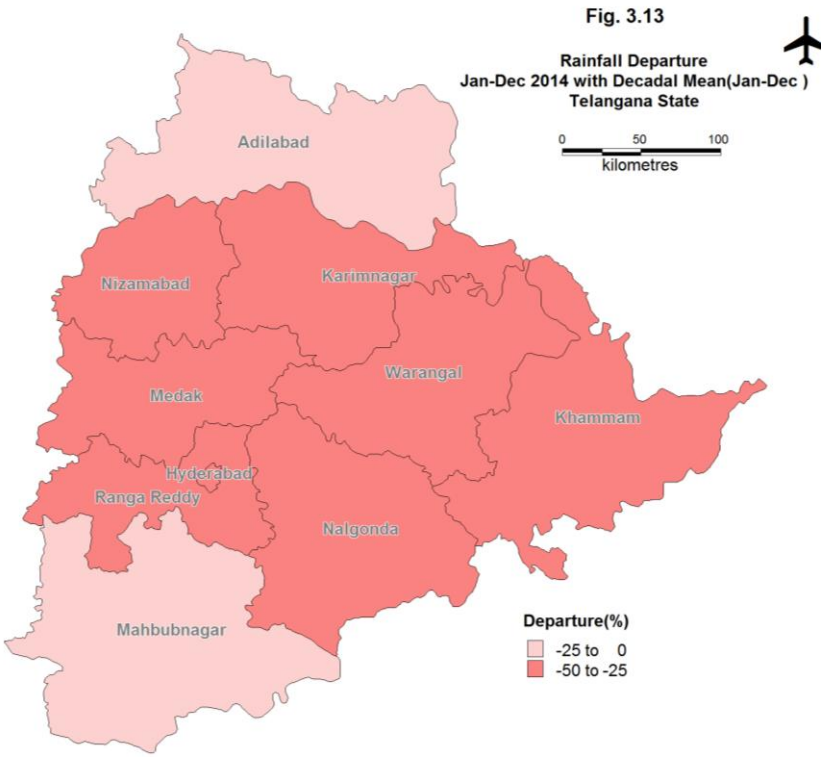
Departure of rain fall during Jan to Dec 2014 from Jan-Dec 2013

Departure of Jan'14-Dec'14 rainfall from Jan'13-Dec'13 is depicted in the Fig.3.12 and correlate with water level fluctuation during Jan 2014-Dec, 2014. Rainfall of 667mm (Table-1) was registered during the period Jan'14- Dec'14, which is 46% of less than the rainfall during the same period previous year(1243mm). The departure ranges from -53% ofin Nalgonda district to -34% ofin Mahabubnagar district. Entire state has received less rainfall than the same period last year.



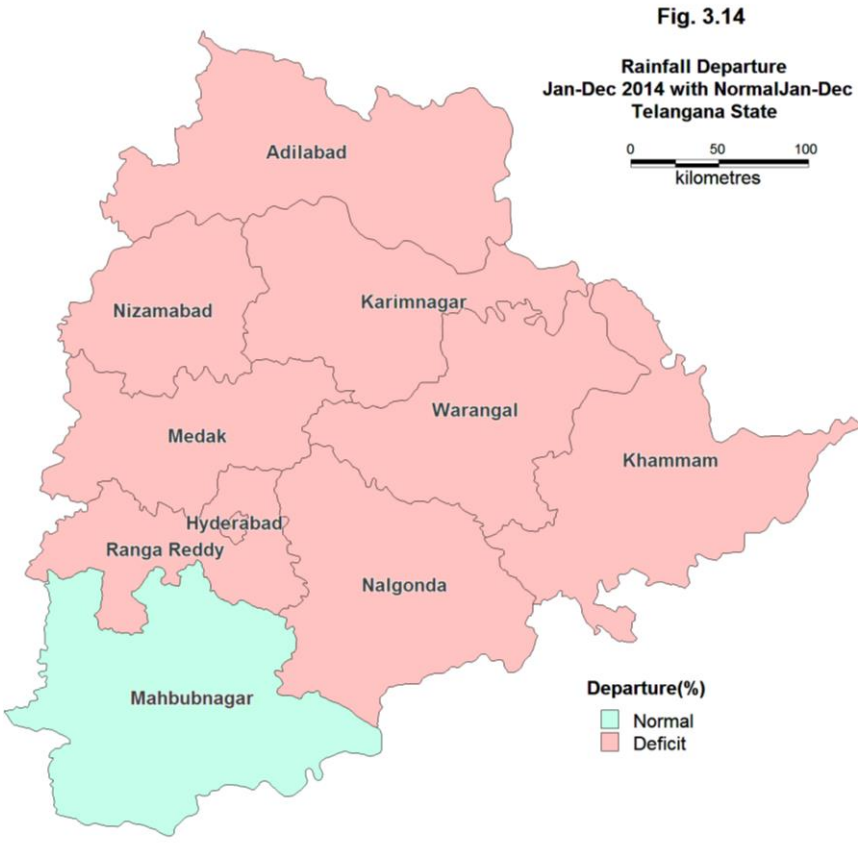
Departure of rain fall during Jan to Dec 2014 from decadal mean rainfall Jan-December

Departure of Jan'14- Dec'14 rainfall from decadal mean rainfall (Jan-Dec) is depicted in the Fig.3.13 and correlated with water level fluctuation during Jan, 2015 with respect to Decadal mean (Jan-Dec). The decadal mean rainfall (Jan-Dec) of the state is 969 mm(Table-1). During the period Jan'14 to Dec'14 the state has received 31% ofless rainfall than the decadal mean (Jan-Dec). The departure ranges from -41% ofin Medak district to -16% ofin Mahabubnagar district. Less rainfall was recorded in the state during the period than the decadal mean.



Departure of rain fall during Jan to Dec 2014 from normals of the same period

Departure of Jan'14- Dec'14 rainfall from normals of the same period is depicted in the Fig.3.14. Depth to water level during Jan, 2015 is correlated with wirh departure of rainfall. During the period Jan'14- Dec'14, the state has received 29% ofless rainfall than the normal, which is deficit. It ranges from –44% ofin Medak district to -18% ofin Mahabubnagar district. Rainfall was deficit except Mahabubnagar district.



4.0 GEOLOGY

A wide variety of geological formations occur in Telangana State, ranging from the Oldest Archaean crystalline formations to Recent alluvium. The geological set up and principal aquifer system is presented in the Fig.4.1and 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 – granites, dolerites, pegmatites, etc.

4.1 Archaean and Lower Pre-Cambrian Formations

Peninsular gneiss, which is predominant rock type of Archaean, is dominant in Telangana State. It is intruded by Clospet granite and dolerite dykes. Dharwars, comprising amphibolites, gneisses, schists, and quartzites occur as narrow isolated bands with in granites in Mahbubnagar, Nalgonda, Khammam, Warangal, Karimnagar and Adilabad districts.

4.2 Upper Pre-Cambrian to Early Pre-Cambrian Formations

The group includes Cuddapahs, Pakhals, Pengangas, Kurnools and Sullavais comprising shales, limestones, dolomites, sandstones and conglomerates. The Cuddapah Super Group of rocks occurs in parts of Nalgonda and Mahbubnagar districts. The Pengangas, which are considered as equivalent of Pakhals, are exposed in Adilabad district. Sullavais are exposed in Godavari valley. Gondwana Formations, comprising lower group of rocks, the Talchirs, Barakars and Kamthis and upper group of rocks, the Maleris, Kotas and Chikialas, occupy parts of Khammam, Warangal, Karimnagar and Adilabad districts.

4.3 Deccan Trap and associated Rocks

Deccan traps, the horizontally disposed lava flows are confined to Adilabad, Nizamabad, Medak, Ranga Reddy and Mahbubnagar districts. The thickness of individual flow varies between few metres to as much as 30 m. Inter-trappean beds comprising limestone, chert and sandstone occur between trap flows near Vikarabad and Adilabad.

FIGURE 4.1

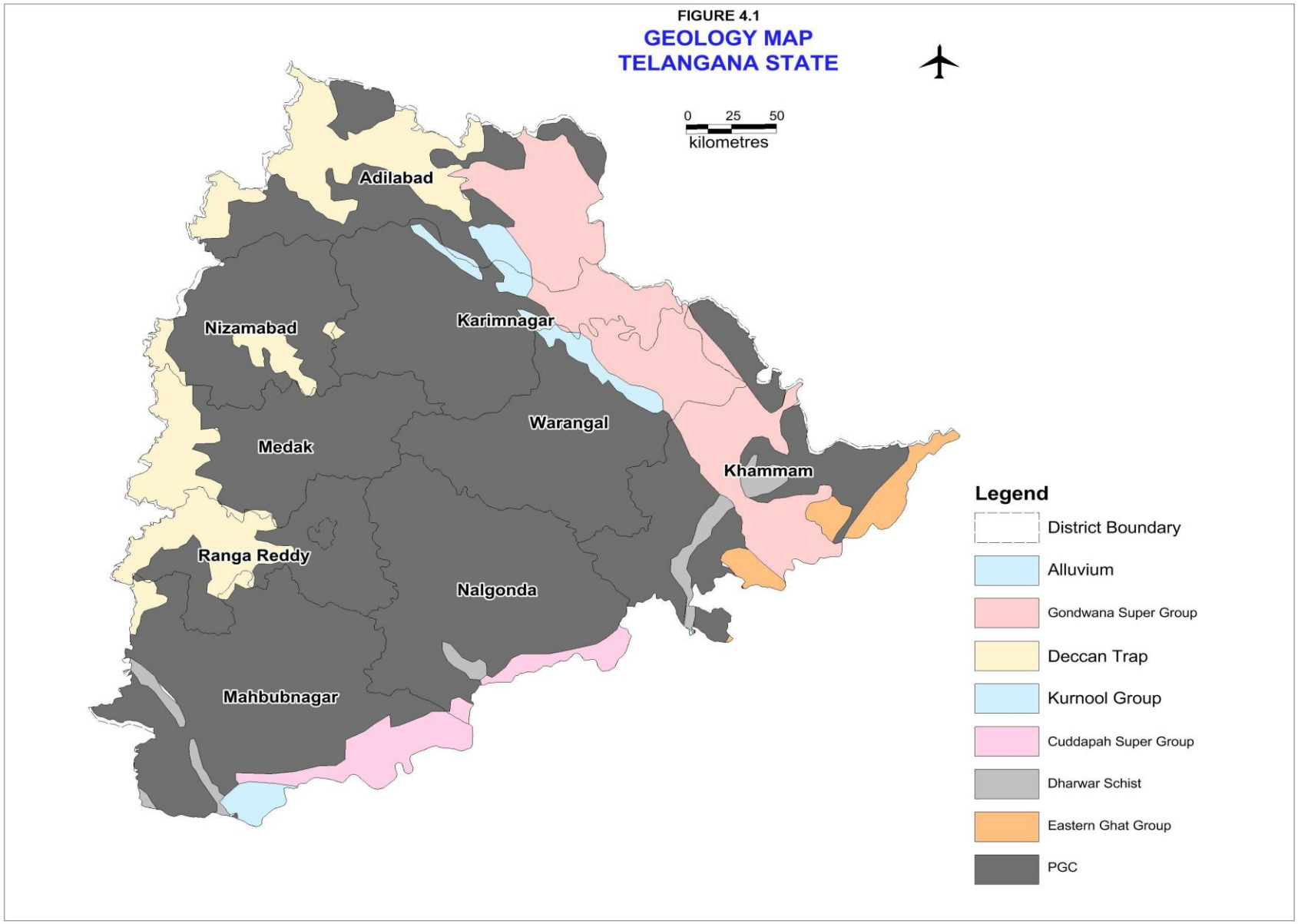
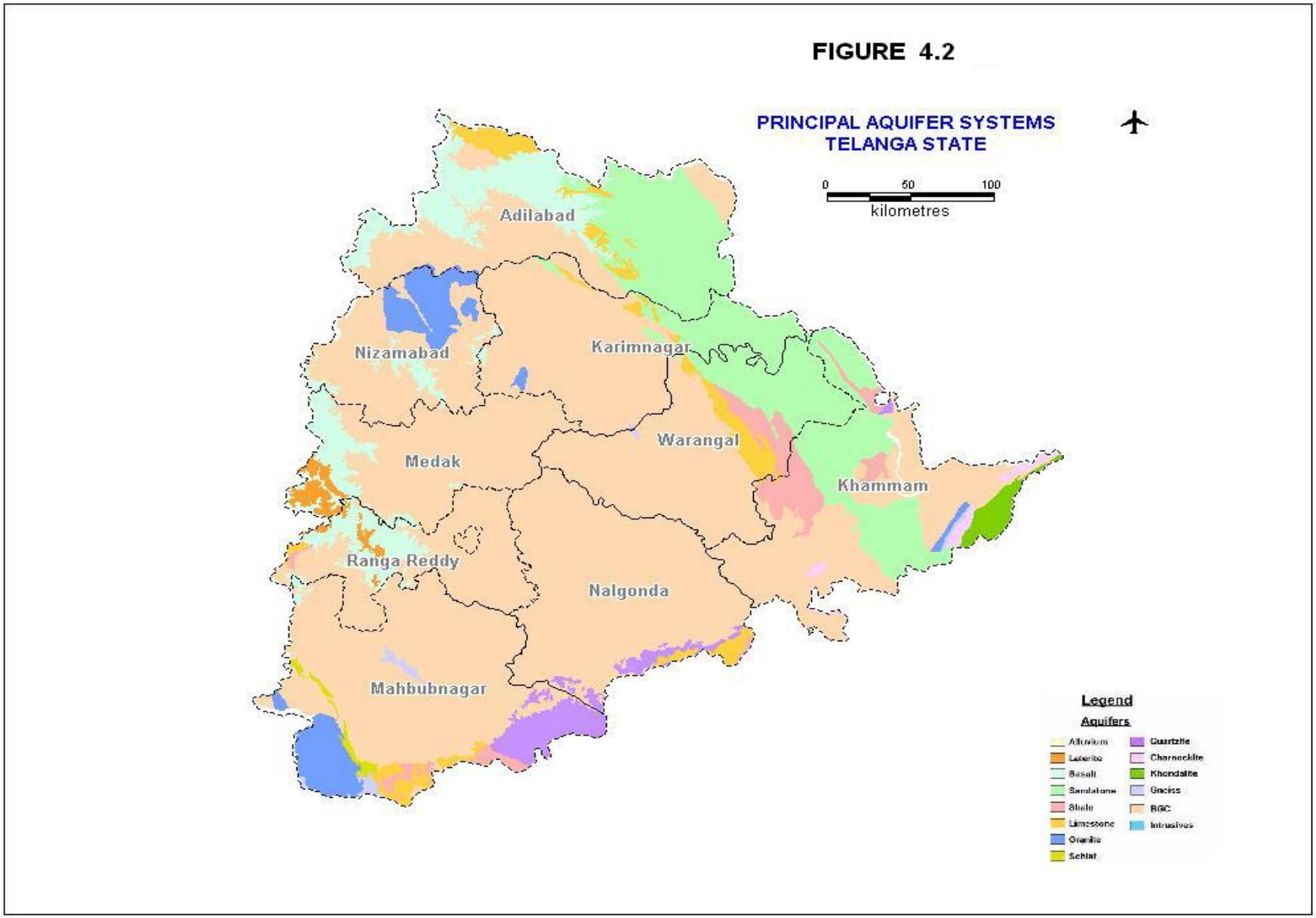

GEOLOGY MAP
TELANGANA STATE
0 25 50
kilometres
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Ranga Reddy
Nalgonda
Mahbubnagar
Legend
District Boundary
Alluvium
Gondwana Super Group
Deccan Trap
Kurnool Group
Cuddapah Super Group
Dharwar Schist
Eastern Ghat Group
PGC

FIGURE 4.2


PRINCIPAL AQUIFER SYSTEMS
TELANGA STATE
0
50
100
kilometres
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Ranga Reddy
Nalgonda
Mahbubnagar
Legend
Aquifers
Alluvium
Laterite
Basalt
Sandstone
Shale
Limestone
Granite
Schist
Quartzite
Charnockite
Khondalite
Gneiss
BGC
Intrusives

5.0 GROUND WATER REGIME MONITORING

The litho units in the State are classified, ground water point of view, into three groups, namely,

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

i) Consolidated formations occupy about 83% ofof geographical area of the State. They comprise rocks of Archaean age, limestones, quartzites and slates of pre-Cambrian age and massive Deccan traps of Cretaceous to Eocene age. Weathered and fractured zones form the aquifer systems. Vesicular zones, inter and infra-trappean contacts constitute aquifer systems in Deccan Traps. Fractures and cavernous zones are the main aquifers in the limestones. The aquifer system extends down to 100 m in general and down to 150 m at places.

ii) Semi-consolidated formations comprise Gondwana sandstones & shales, inter and infra-trappeans and Rajahmundry sandstones. Coarse-grained sandstones down to 700 m form the main aquifers.

5.1 Monitoring Methodology

Ground water regime is monitored through a network of dug wells and piezometers. The dug wells, which are owned by government and non-government agencies and individual users, are tapped in the shallow aquifer system. Piezometers (basically bore wells/tube wells) constructed exclusively for ground water regime monitoring by Central Ground Water Board, tap shallow and deeper aquifer systems independently.

The network of observation wells is manually monitored by Central Ground Water Board during the following periods, every year.

i) 1st to 10th January
ii) 20th to 30th May
iii) 20th to 30th August
iv) 1st to 10th November

5.1.1 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. A total number of 163 observers are engaged since May, 2005.

5.1.2 Chemical Quality Monitoring

The chemical quality of ground water is monitored (dug wells) once in the month of May to observe the effect of geogenic, anthropogenic factors on ground water in different hydrogeological environments over a period of time.

5.2 Maintenance of Database on Ground Water Monitoring Wells

The database on water levels and chemical quality is entered in the, 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.

5.3 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 the following session.

5.3.1 District-Wise Distribution of Ground Water Monitoring Wells

The highest representation of dug wells is one well per 25 sq.km in Hyderabad district and the lowest is one dug well per 836 sq.km in Mahabubnagar district. The highest representation of Piezometer is one per 9.5 sq.km in Hyderabad district and lowest is one Piezometer per 1230 km in Khammam district. The highest density of wells (PZ & DW) is one per 7 km in Hyderabad and lowest is one per 368sq.km in Mahabubnagar district (Table-5.1).

Table-5.1
Distribution of National Ground Water Regime Monitoring Stations
Telangana State (As on March, 2015)

S No	District	Area (Sq.Km.)	No.Of NGWRM Stations			Area represented by each GWMW (Sq.Km)		
			DW	PZ	Total	DW	PZ	Total
1	Adilabad	16100	51	25	76	316	644	212
2	Hyderabad	200	8	21	29	25	9.5	7
3	Karimnagar	11800	29	54	83	407	218	142
4	Khammam	16000	55	13	68	290	1230	235
5	Mahabubnag	18400	22	28	50	836	657	368
6	Medak	9700	24	29	53	404	334	183
7	Nalgonda	14200	50	64	114	284	222	124
8	Nizamabad	8000	28	30	58	286	267	138
9	Ranga Reddy	7500	48	60	108	156	125	69
10	Warangal	12900	45	52	97	287	248	133
	Total	114800	360	376	736	319	324	156

5.3.2 Basin-wise Distribution of Ground Water Monitoring Wells

The Godavari and Krishna are the major river basins in the State. The number of network stations located in Godavari and Krishna basins is 351 and 385 respectively. The basin-wise distribution of monitoring wells is given in the Table-5.2.

Table-5.2

Basin-wise distribution of Monitoring stations
Andhra Pradesh (as on March, 2015)

Dist	Godavari	Krishna	Total
Adilabad	76		76
Karimnagar	83		83
Khammam	36	32	68
Mahbubnagar		50	50
Medak	50	3	53
Nalgonda		114	114
Nizamabad	58		58
Ranga Reddy	12	96	108
Hyderabad		29	29
Warangal	36	61	97
Grand Total	351	385	736

5.3.5 District-Wise and Aquifer-Wise Distribution of Ground Water Monitoring Wells

Of the 736 Ground Water monitoring wells existing as on 31.3.2015, 629 wells are located in hard rocks, 107 wells in soft rocks. The distribution of ground water monitoring wells, district- and aquifer wise isgiven in the Table-5.3.

Table- 5.3

Distribution of monitoring stations - Principal Aquifer-wise
Telangaga state (as on March, 2015)

DIST	BG	BS	CK	GN	GR	LS	LT	QZ	SH	ST	Total
Adilabad	36	18				5				16	75
Karimnagar	64					1				19	84
Khammam	39		1		1				2	23	68
Mahbubnagar	43			3	1	1		1			49
Medak	33	14					5				52
Nalgonda	113							1			114
Nizamabad	41	1			17						59
Ranga Reddy	76	23				1	10				110
Hyderabad	29										29
Warangal	72					1			2	21	96
Total	548	56	1	3	19	9	15	2	4	79	736

6.0 GROUND WATER LEVEL SCENARIO

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. The status of ground water monitoring wells as on March 2014 (total No. of wells, wells established, abandoned) and March, 2015 is given in the Table – 6.1.

Table-6.1
Status of Ground Water Monitoring Wells (NHNS) in Telangana State

Sl. No	District	No. of NHS wells as on March-14			No. of NHS wells Established during			No. of wells Abandoned during 2014-15			No. of NHS wells as on March-15		
		DW	PZ	Total	DW	PZ	Total	DW	PZ	Total	DW	PZ	Total
1	Adilabad	48	25	73	4	0	4	1	0	1	51	25	76
2	Hyderabad	8	21	29	0	0	0	0	0	0	8	21	29
4	Karimnagar	28	55	83	1	0	1	0	1	1	29	54	83
5	Khammam	55	12	67	3	1	4	2	0	2	55	13	68
6	Mahbubnagar	23	28	51	0	0	0	1	0	1	22	28	50
7	Medak	27	29	56	0	0	0	3	0	3	24	29	53
8	Nalgonda	43	40	83	7	26	33	0	2	2	50	64	114
9	Nizamabad	3	30	60	0	6	0	2	0	2	28	30	58
9	Ranga Reddy	41	61	102	9	2	11	2	3	5	48	60	108
10	Warangal	42	53	95	3	0	3	1	1	2	45	52	97
		34	354	699	27	29	56	1	7	19	360	376	736

6.1 Depth to Water Level

The data on periodic monitoring of water levels from ground water monitoring wells generally indicates deeper water levels exists during pre-monsoon in the month of May and shallow water levels during post-monsoon during November of the same year. The water level measurements carried out during August reveal the transient phase of southwest monsoon. Water level during November shows the effect of both southwest and northeast monsoons. The maps depicting depth to water level during for May2014, August, 2014, November, 2014 and January, 2015 (unconfined aquifers) have been generated using GEMS (Ground Water Management System) software.

6.1.1 Depth to Water Level - MAY, 2014

Analysis of water levels during May, 2014 reveals that the water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during May, 2014 and percentage of variation in water level are furnished in the Table-6.2 & 6.3 respectively. The graphical representation of percentage of wells in different depth ranges is presented in the Fig.6.1 and theomatic map depicting water level scenario during May, 2014 is shown in the Fig.6.2. The distribution of percentage of wells in different water level ranges is given in the Table-6.4

Table-6.2
Water Level scenario during May, 2014 Telangana State

Water level Range	Districts
< 2 m bgl	of all districts of Telangana state except Hyderabad and Mahbubnagar
2 to 5 m bgl zone	As small isolated pockets all over the State
5 -10 m bgl zones	major parts in all the districts
10 and 20 m bgl	Mostly in Mahabubnagar, Ranga Reddy, Medak, Nizamabad districts and in small parts of all other districts
20 and 40 m bgl	As small patches in Mahbubnagar, Rangareddy, Medak, Nizamabad and Adilabad districts

Table-6.3
Percentage of variation in depth to water level

Water level range	% ofof wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	3.86% ofwells	543	-0.14 m.bgl (Karimnagar district)	40.03 m.bgl (Ranga Reddy district
2-5 m bgl	29.46%of wells			
5-10 m bgl	in 41.98% ofwells			
10-20 m bgl	21.54% ofwells			
20 m bgl	3.13% ofwells			

Fig.6.1

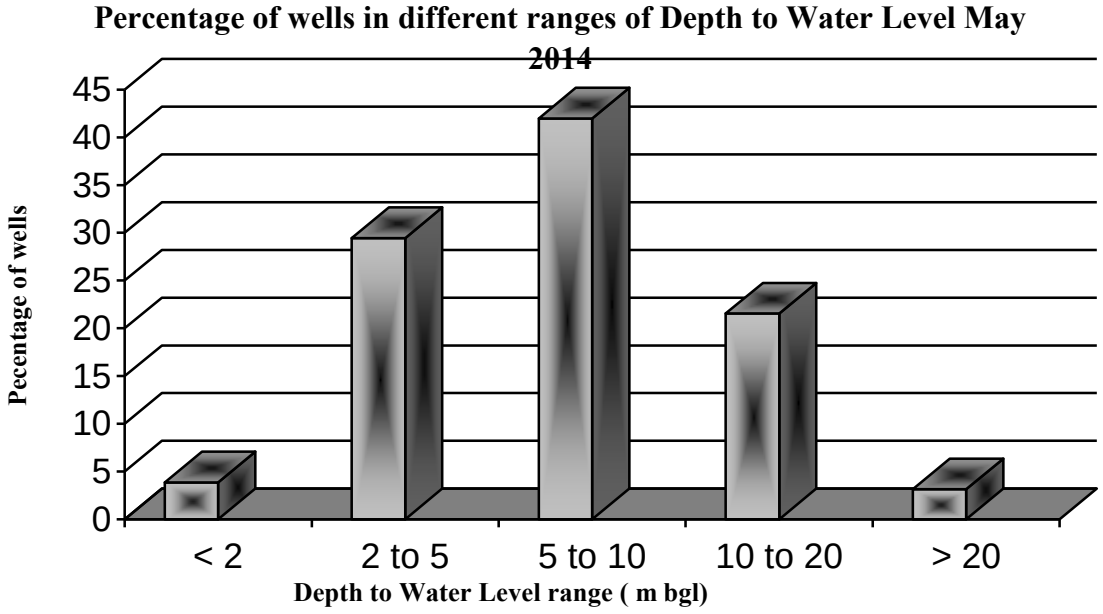


Fig.6.2

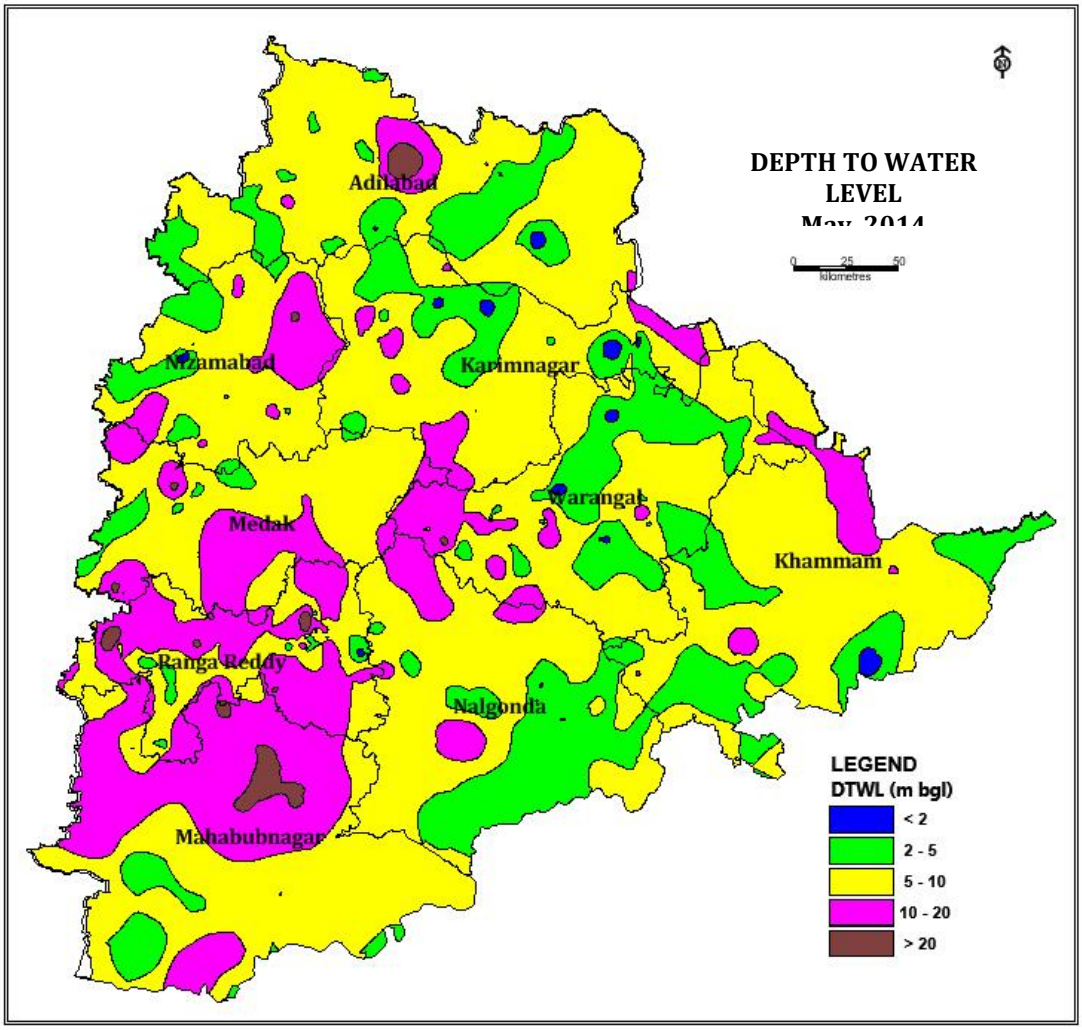


Table-6.4 Distribution of Percentage of Observation Wells (May 2014)

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	Adilabad	66	0.22	31.25	3	4.55	24	36.36	36	54.55	2	3.03	1	1.52	0	0
2	Hyderabad	13	2.68	29.1	0	0	5	38.46	1	7.69	5	38.46	2	15.38	0	0
3	Karimnagar	64	-0.14	16.94	4	6.25	17	26.56	32	50	11	17.19	0	0	0	0
4	Khammam	57	1.4	14.51	2	3.51	19	33.33	26	45.61	10	17.54	0	0	0	0
5	Mababoobnagar	37	2.28	26.22	0	0	5	13.51	13	35.14	12	32.43	7	18.92	0	0
6	Medak	35	1.9	22.6	1	2.86	6	17.14	18	51.43	8	22.86	2	5.71	0	0
7	Nalgonda	65	1.82	18.7	3	4.62	35	53.85	21	32.31	6	9.23	0	0	0	0
8	Nizamabad	49	0.98	21.5	1	2.04	15	30.61	19	38.78	13	26.53	1	2.04	0	0
9	Ranga Reddy	76	0.5	40.03	2	2.63	7	9.21	28	36.84	36	47.37	2	2.63	1	1.32
10	Warangal	81	1.13	22.75	5	6.17	27	33.33	34	41.98	14	17.28	1	1.23	0	0
	Total State	543	-0.14	40.03	21	3.86	160	29.46	228	41.98	117	21.54	16	3.13	1	

6.1.2 Depth to Water Level - August, 2014

Analysis of water levels during August, 2014 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during August, 2014 and percentage of wells registered in different ranges of depth to water level are furnished in the Table-6.5 & 6.6 respectively. The distribution of percentage of wells in different water level ranges is given in the Table-6.7. The graphical representation of percentage of wells in different depth ranges is presented in the Fig.6.3 and theomatic map depicting water level scenario during August, 2014 is shown in the Fig.6.4.

Table-6.5
Water Level scenario during August, 2013 - Telangana State

Water level Range	Districts
< 2 m bgl	All the districts of state except Hyderabad district
2 to 5 m bgl	Mainly in Adilabad, Karimnagar, Warangal and Khammam disticts and in isolated patches in other parts of Telangana state.
5 -10 m bgl	in major parts Of all the districts
10 and 20 mgl	mostly in Mahabubnagar, Rangareddy, Medak, Hyderabad and in small parts of all other districts
20 and 40 m bgl	As small patches in Mahbubnagar, Hyderabad, Rangareddy, Medak and Nizamabad districts

Table-6.6
Percentage of variation in depth to water level

Water level range	% ofof wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	12.86%	544	-0.67m.bgl (Khammam district)	43.55 m.bgl (Mahbubnagar district).
2-5 m bgl	30.33%			
5-10 m bgl	36.58%			
10-20 m bgl	16.36%			
20 m bgl	3.8%			

Fig.6.3

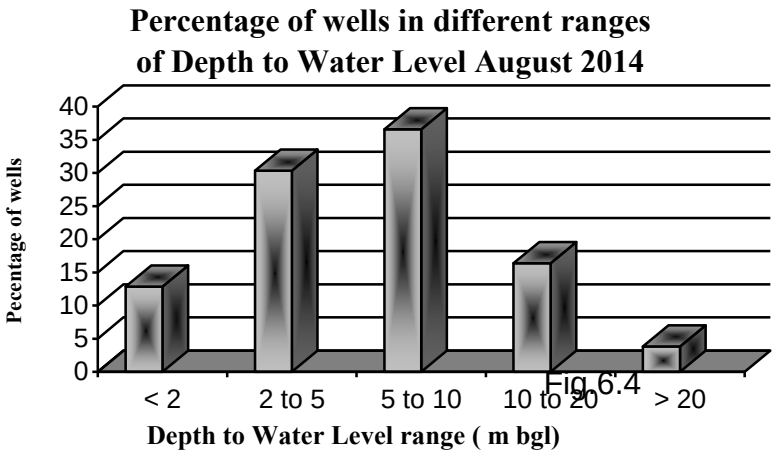


Fig.6.4

Fig.6.4

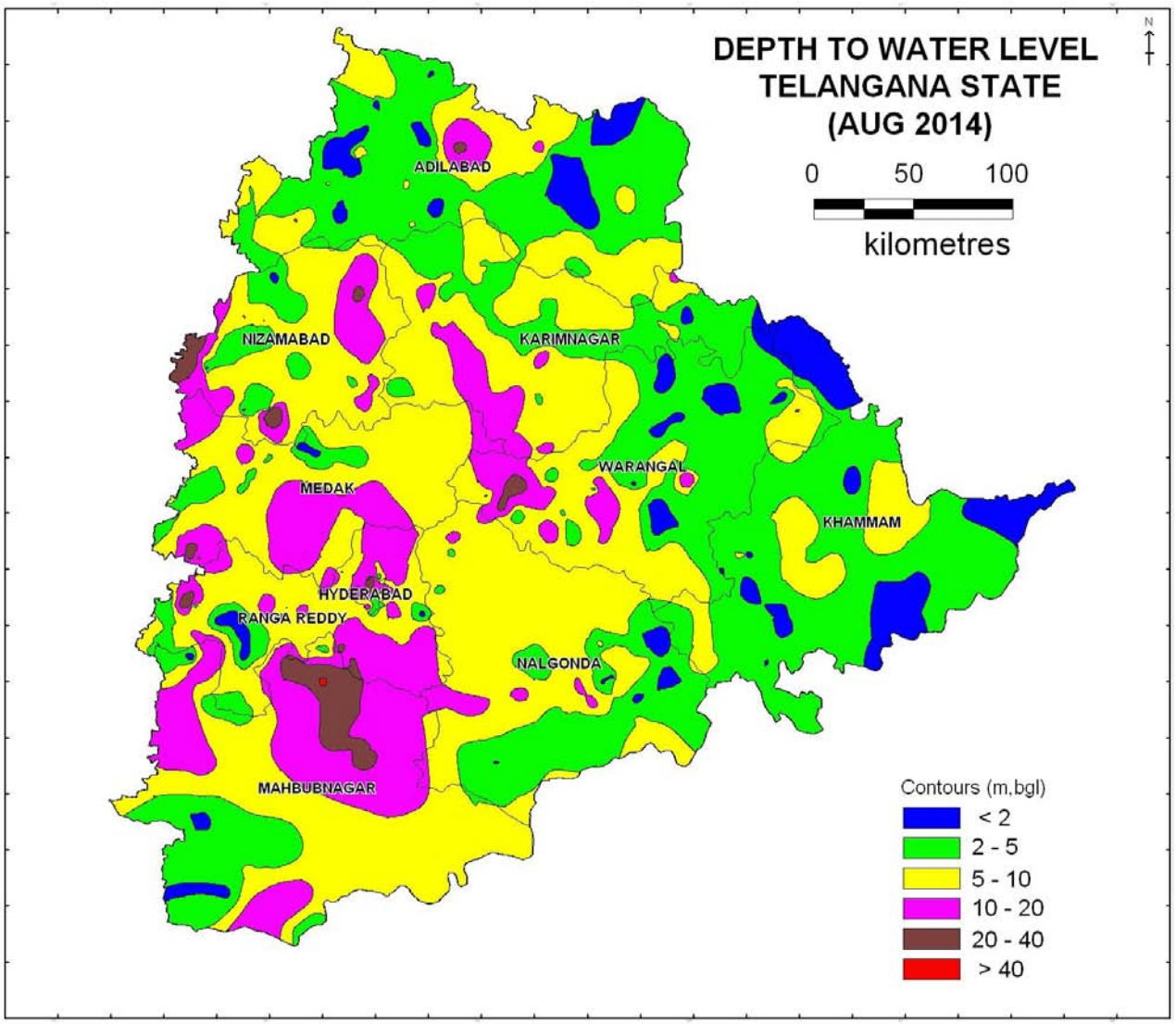


Table-6.7 Distribution of Percentage of Observation Wells (August, 2014)

Sl. No	District	No of Wells Analysed	Depth to Water Table (m bgl)		No and Percentage of Wells Showing Depth to Water Table (m								
					0.0 - 2.0		2.0 - 5.0		5.0 - 10.0		10.0 - 20.0		20.0 -
			Min	Max	No	%	No	%	No	%	No	%	No
1	Adilabad	65	0.04	22.45	15	23.08	30	46.15	17	26.15	2	36.08	1
2	Hyderabad	14	2.36	22.62	0	0	5	35.71	2	14.29	4	28.57	3
3	Karimnagar	64	0.17	17.0	1	1.56	19	29.69	32	50.0	12	18.75	0
4	Khammam	49	-0.67	9.6	17	34.69	20	40.82	12	24.49	0	0	0
5	Mababoobnag	38	0.22	43.35	3	7.89	8	21.05	7	18.42	13	34.21	6
6	Medak	36	0.6	25.75	2	5.56	6	16.67	19	52.78	8	22.22	1
7	Nalgonda	67	0.65	11.87	8	11.94	27	40.3	26	38.81	6	8.96	0
8	Nizamabad	52	1.2	34.5	4	7.69	12	23.08	25	48.08	8	15.38	3
9	Ranga Reddy	74	0.55	35.0	8	10.81	13	17.57	25	33.78	24	32.43	4
1	Warangal	85	-0.4	25.3	12	14.12	25	29.41	34	40.0	12	14.12	2
	Total State	544	-0.67	43.55	70	12.86	16	30.33	19	36.58	89	16.36	20

6.1.3 Depth to Water Level - November, 2014

Analysis of water levels during November, 2014 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during November, 2014 and percentage of wells registered in different ranges of depth to water level are furnished in the Table-6.8 & 6.9 respectively. The graphical representation of percentage of wells in different depth ranges is presented in the Fig.6.5 and theomatic map depicting water level scenario during November, 2014 is shown in the Fig.6.6. The distribution of percentage of wells in different water level ranges is given in the Table-6.10.

Table-6.8
Water Level scenario during August, 2013 - Telangana State

Water level Range	Districts
< 2 mbgl	Small parts of all the districts of Telangana state except Hyderabad district.
2 to 5 mbgl	Large parts of Khammam, Adilabad, Warangal, Hyderabad, and Nalgonda and as small isolated areas in all other districts of Telangana State.
5 -10 mbgl	Major parts in all the districts
10 and 20 mbgl	Mostly in Mahabubnagar, Rangareddy, Nizambad and Hyderabad districts and in small parts of all other districts
20 and 40 mbgl	small patches in Hyderabad, Khammam and Rangareddy districts.

Table-6.9 Percentage of variation in depth to water level

Water level range	% ofof wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	9.87 wells,	577	-0.17 m.bgl (Khammam district)	45.01 m.bgl (Mahabubna-gar district).
2-5 m bgl	29.81%			
5-10 m bgl	38.47%			
10-20 m bgl	19.06%			
20 m bgl	2.6%			

Fig.6.5

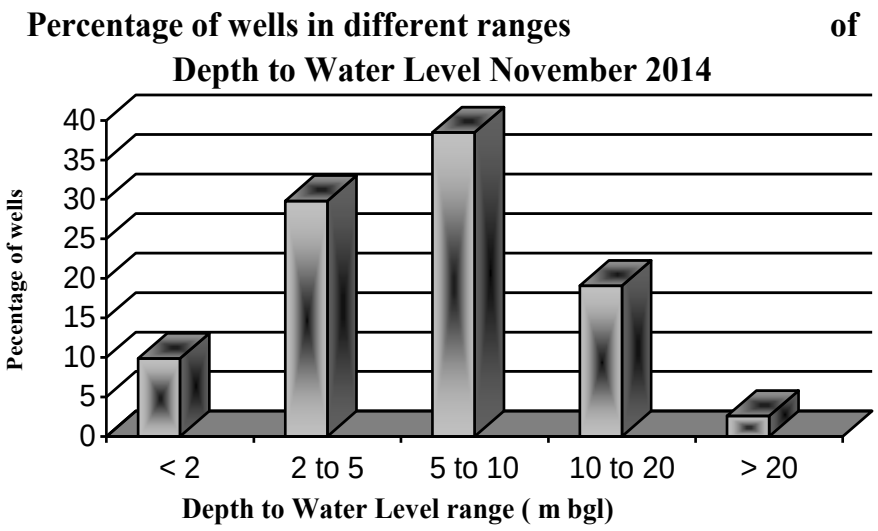


Fig.6.6

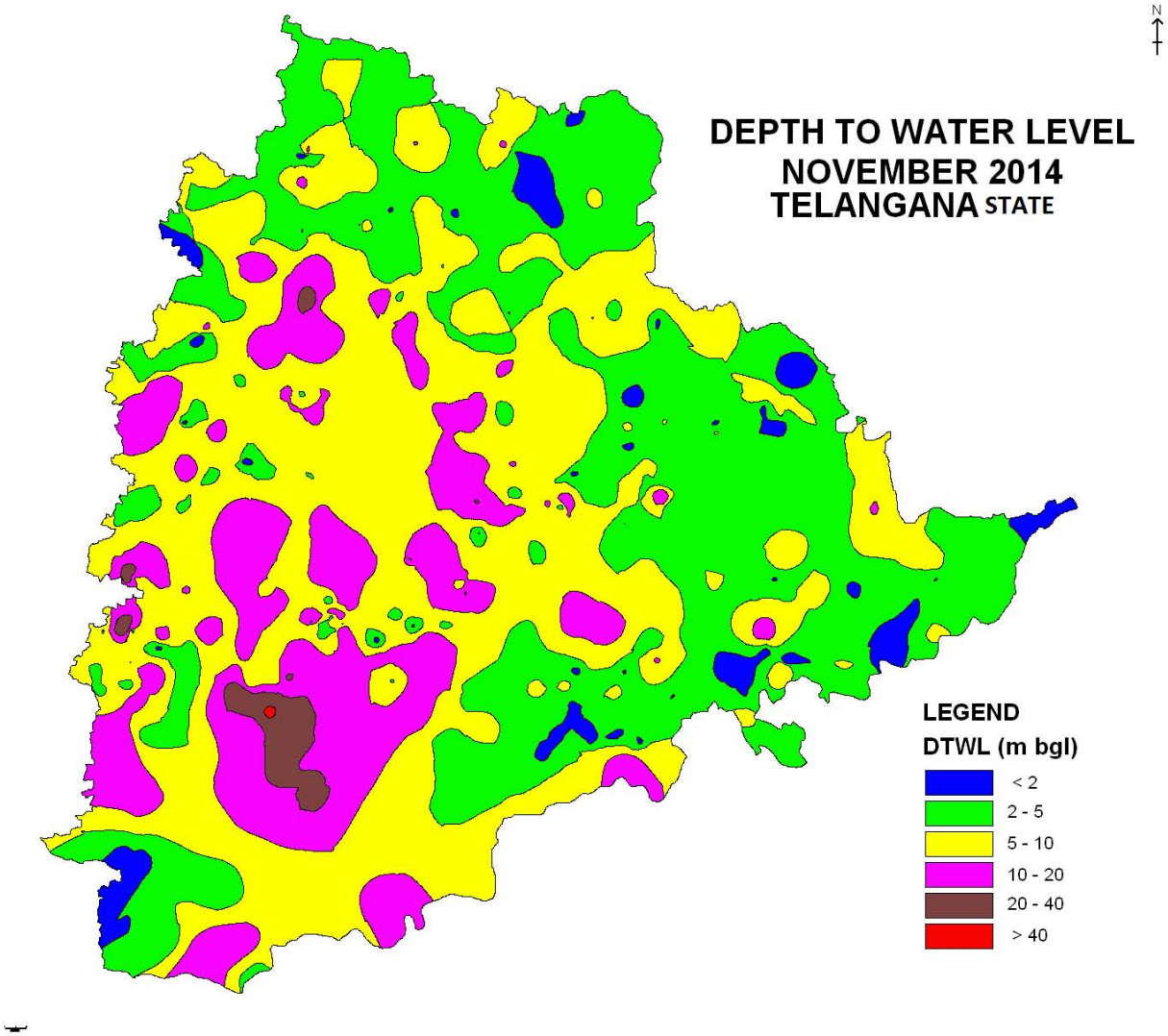


Table – 6.10 Distribution of Percentage observation Wells (November, 2014)

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	Adilabad	70	-0.03	11.90	11	15.71	37	52.86	18	25.71	4	5.71	0	0.00	0	0
2	Hyderabad	10	2.33	21.28	0	0.00	5	50.00	1	10.00	3	30.00	1	10.00	0	0
3	Karimnagar	62	1.07	17.36	2	3.23	16	25.81	35	56.45	9	14.52	0	0.00	0	0
4	Khammam	59	-0.17	13.44	14	23.73	25	42.37	17	28.81	3	5.08	0	0.00	0	0
5	Mahaboobnagar	38	0.63	45.01	2	5.26	7	18.42	8	21.05	14	36.84	6	15.79	1	3
6	Medak	36	0.91	26.82	1	2.78	5	13.89	22	61.11	7	19.44	1	2.78	0	0
7	Nalgonda	89	0.15	20.74	13	14.61	28	31.46	32	35.96	15	16.85	1	1.12	0	0
8	Nizamabad	51	0.79	25.82	2	3.92	12	23.53	19	37.25	17	33.33	1	1.96	0	0
9	Ranga Reddy	79	1.15	38.30	2	3.92	12	23.53	19	37.25	17	33.33	1	1.96	0	0
10	Warangal	83	0.90	20.59	10	12.05	25	30.12	37	44.58	10	12.05	1	1.20	0	0
	Total State	577	-0.17	45.01	57	9.87	172	29.81	222	38.47	110	19.06	15	2.59	1	0.17

6.1.4 Depth to Water Level - January, 2015

Analysis of water levels during January, 2015 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during January, 2015 and percentage of wells registered in different ranges of water levels are furnished in the Table-6.11 & 6.12 respectively. The distribution of percentage of wells in different water level ranges is given in the Table-6.13. The graphical representation of percentage of wells in different depth ranges is presented in the Fig.6.7 and theomatic map depicting water level scenario during January, 2015 is shown in the Fig.6.8. The distribution of percentage of wells in different water level ranges is given in the Table-6.13.

Table – 6.11 Water Level scenario during January, 2013 **- Telangana State**

Water level Range	Districts
< 2 mbgl	All districts except Hyderabad
2 to 5 mbgl	Large areas in Khammam, Adilabad, Hyderabadl, Nalgonda, and as small isolated areas all ovedr the State
5 -10 mbgl	Major parts Of all the districts
10 and 20 mbgl	Mahabubnagar, Rangareddy, Hyderabad, Nizamabad and in as small pockets in all other districts.
20 and 40 mbgl	As small patches in Mahbubnagar and Hyderabad districts

Table-6.12 Percentage of variation in depth to water level January, 2015 Telangana State

Water level range	% ofof wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	5.24%	572	-0.19 m.bgl (Adilabad district)	37.9 m.bgl (Rangareddy district).
2-5 m bgl	26.92%			
5-10 m bgl	38.99%			
10-20 m bgl	25.33%			
20 m bgl	3.49%			

Fig.6.7

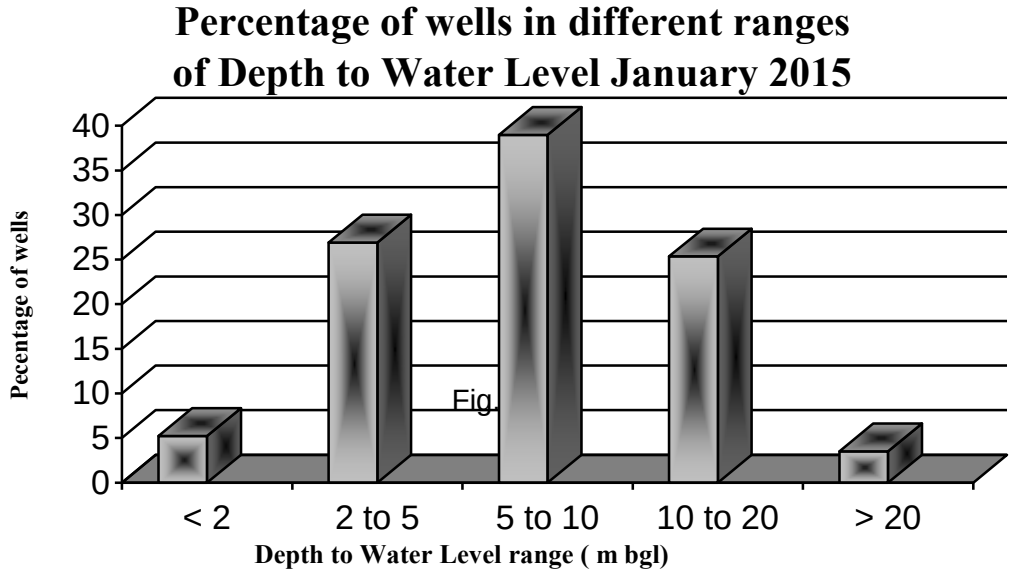


Fig.

Fig.6.8

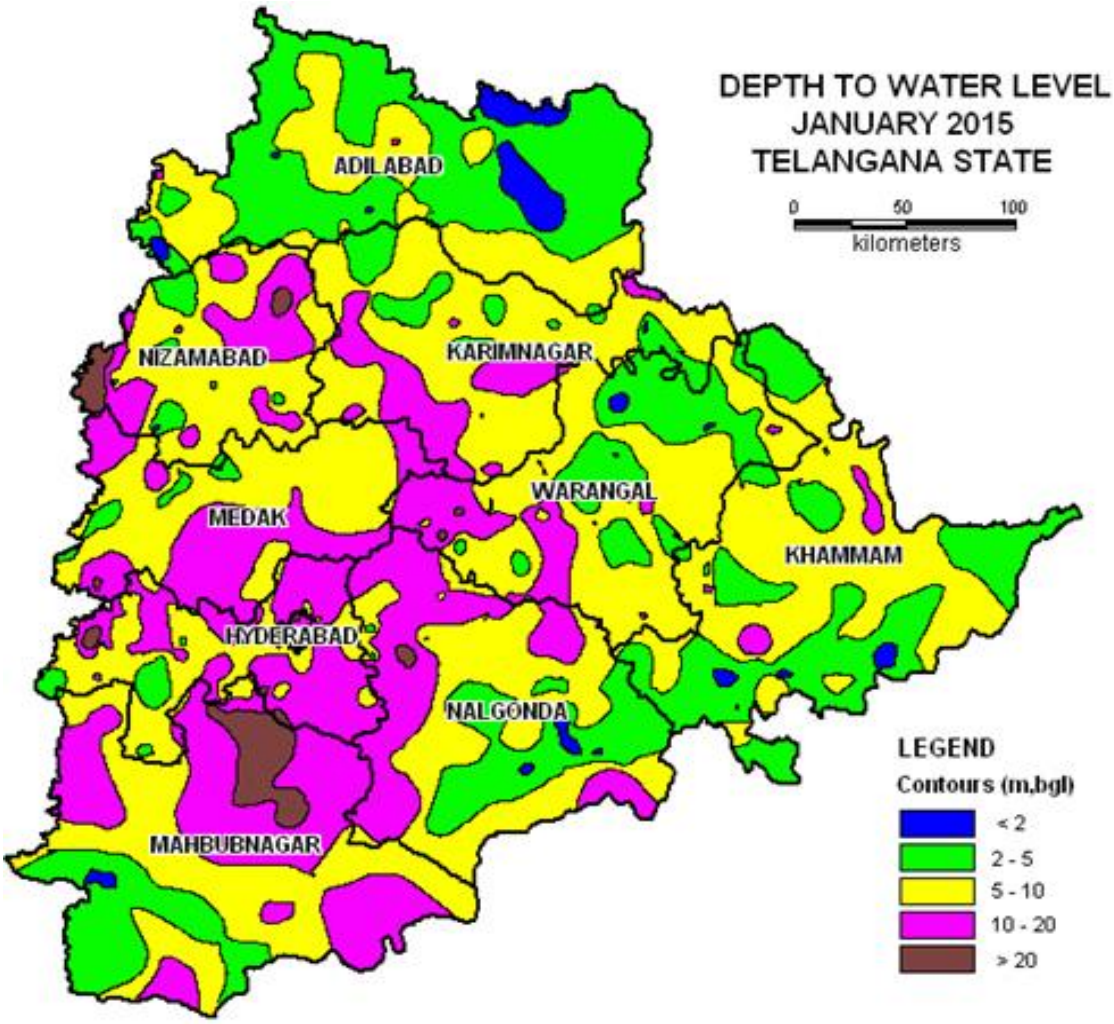


Table -6.13 Distribution of Percentage of Observation Wells (January, 2015)

Sl. No	District	Wells Analysed	Water level (m bgl)		No and % 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	Adilabad	67	-0.19	10.45	9	13.43	33	49.25	23	34.33	2	2.99	0	0	0	0
2	Hyderabad	12	2.67	23.16	0	0	5	41.67	2	16.67	3	25	2	16.67	0	0
3	Karimnagar	61	1.04	18.54	1	1.64	13	21.31	30	49.18	17	27.87	0	0	0	0
4	Khammam	57	0.6	15	5	8.77	22	38.6	25	43.86	5	8.77	0	0	0	0
5	Mababoobnagar	38	1.17	34.2	2	5.26	4	10.53	11	28.95	13	34.21	8	21.05	0	0
6	Medak	34	1.4	22.5	1	2.94	6	17.65	16	47.06	10	29.41	1	2.94	0	0
7	Nalgonda	86	0.85	24.25	6	6.98	27	31.4	31	36.05	21	24.42	1	1.16	0	0
8	Nizamabad	50	0.95	32.1	1	2	11	22	19	38	17	34	2	4	0	0
9	Ranga Reddy	83	0.02	37.9	1	1.2	8	9.64	35	42.17	35	42.17	4	4.82	0	0
10	Warangal	84	0.89	22.63	4	4.76	25	29.76	31	36.9	22	26.19	2	2.38	0	0
	Total	572	-0.19	37.9	30	5.24	154	26.92	223	38.99	145	25.35	20	3.49	0	0

6.2 Frequency Distribution of Depth to Water Level

The district-wise categorization of depth to water levels for Ground Water monitoring wells with its percentages during May, 2014, August, 2014, November, 2014 and January, 2014 are furnished in the Table-6.4, 6.7, 6.10, 6.13. An analysis of frequency distribution of depth to water level indicates that the percentage of number of wells with depth to water levels of less than 2 m bgl have increased from 3.86% ofin May 2014 to 9.87% ofin November 2014 and 2 and 5 m bgl range increased from 29.46% ofin May 2014 to 29.81% ofin November 2014. The number of wells with depth to water level of 5 to 10 m bgl has decreased from 41.98% ofto 34.47% offrom May 2014 to November 2014; 10 to 20 m bgl has decreased from 21.54% ofin May 2014 to 19.06% ofin November 2014. Increase in percentage of wells in the category 0-2 and 2-5mbgl from pre-monsoon to post-monsoon has been observed, due to good monsoon. There is a marginal decrease of percenatage of wells in all other categories of water level.

6.3 Water Table Elevation

Maps depicting water table elevation during pre (May, 2014) and post (November, 2014) monsoon are presented in the Fig.6.9 and 6.10.

A perusal of the map reveals the following observations

- Water table generally follows the topography.
- Elevation of water table ranges from <100 metres amsl on eastern and northern side to >600 m metres on southern and western side of the State.
- The general gradient of water table is from west to east.

Fig.6.9

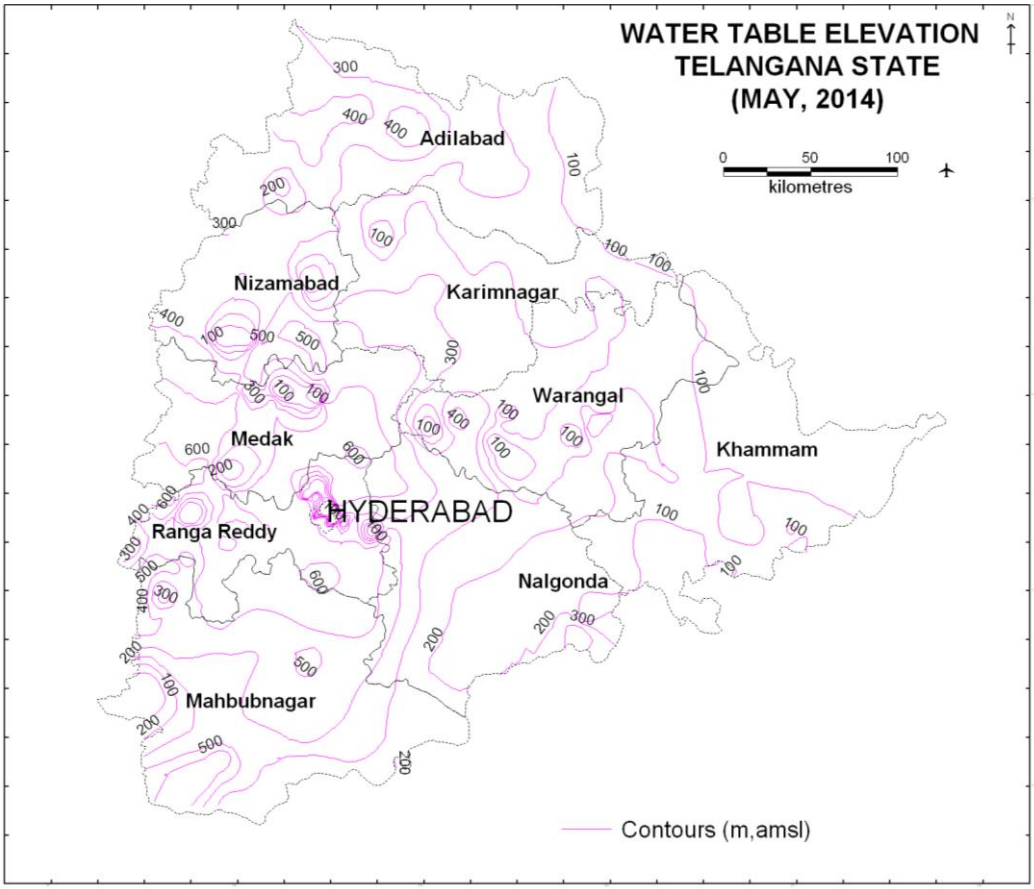
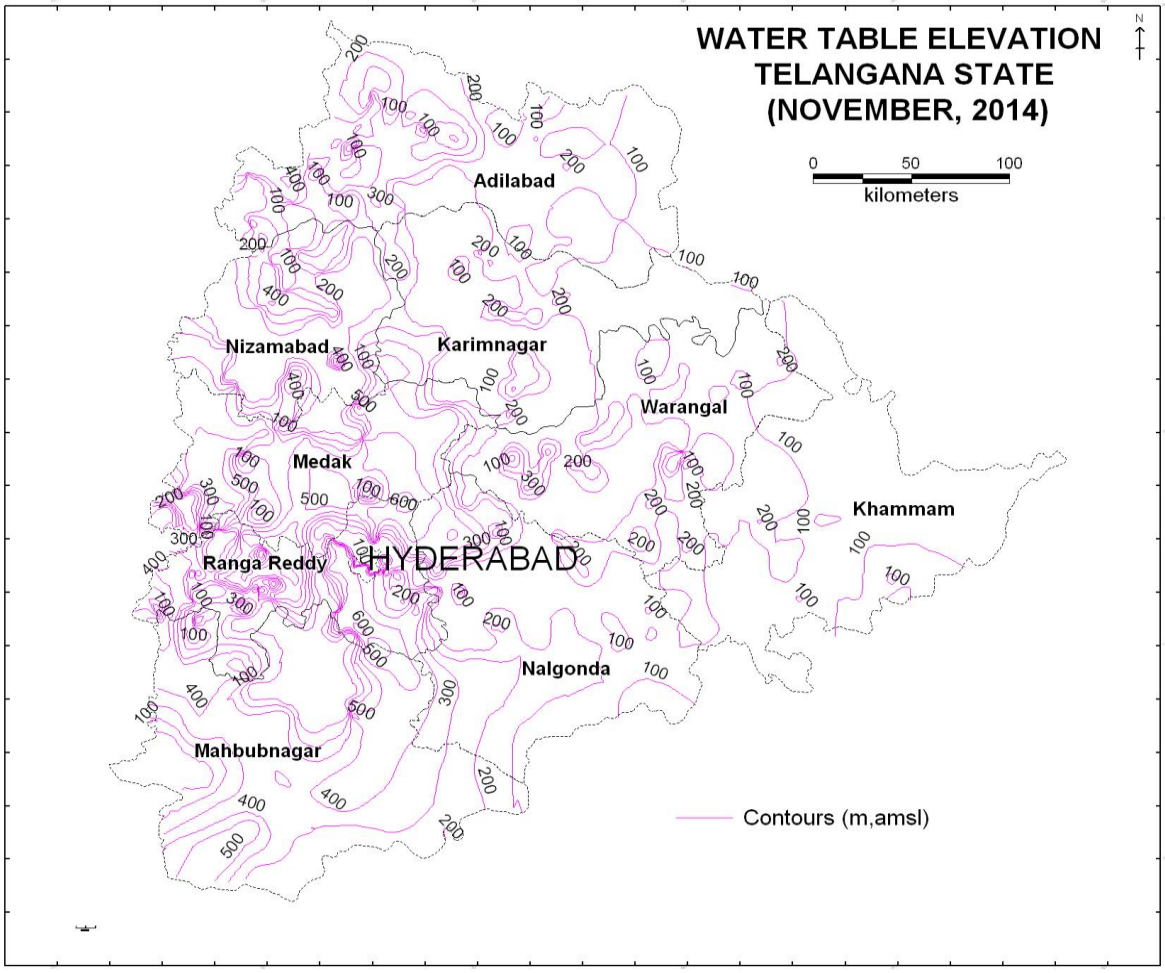


Fig.6.10



6.4. Hydroraphs - National Water Level Monitoring Wells

Variations in ground water level with time, due to recharge and discharge, is generally depicted in hydrographs. A study of long term water level trend for the last 15 to 25 years, indicate the annual and seasonal fluctuations. It depends on recharge factors such as rainfall, seepage from canals, irrigated areas, water storage bodies, etc. The fluctuations are observed to be high along drainage divides, upland areas and in chronically drought-affected areas and are minimum/low in low-lying, canal command and in coastal alluvial areas. The hydrographs of select wells have been depicted in the Fig.6.10. The water level trends during pre and post monsoon and for annual are presented in the Fig.6.11 - 6.14.

Fig.6.11 Hydrographs of select wells

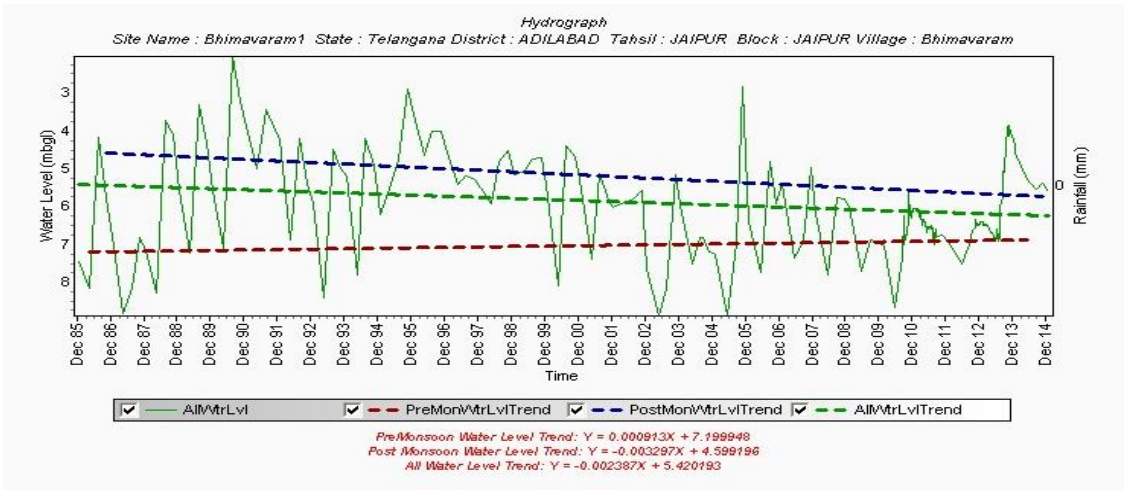
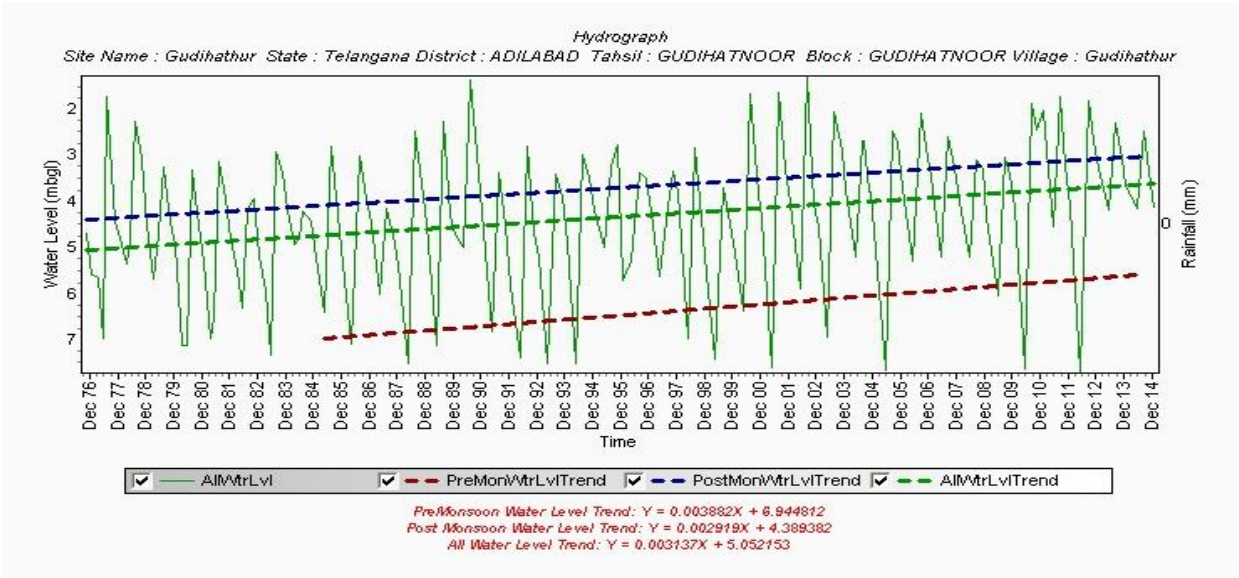
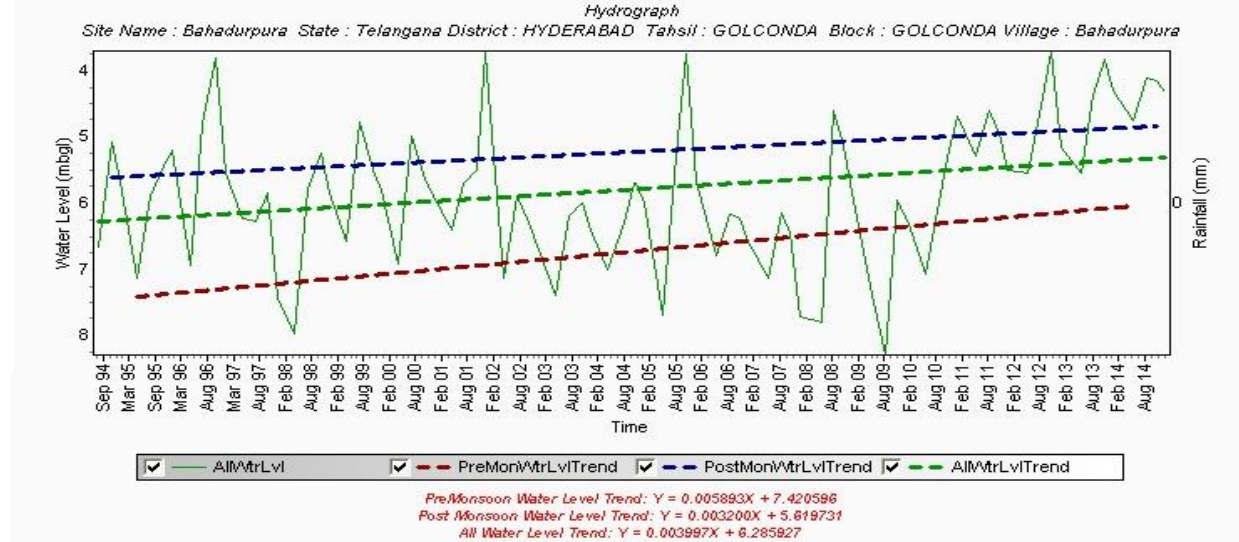
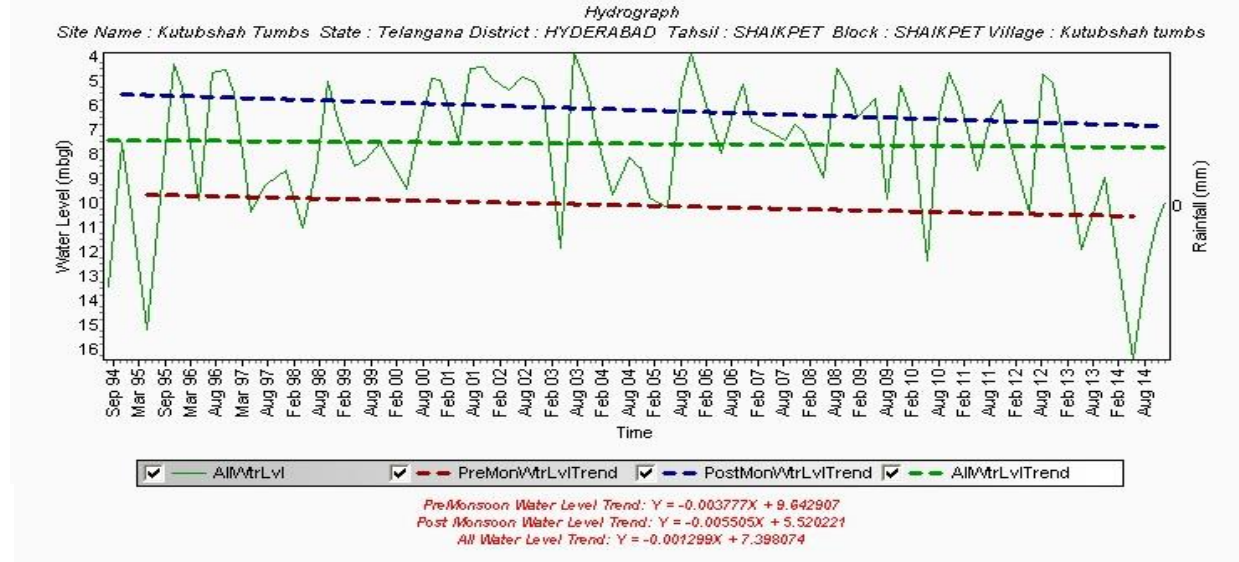
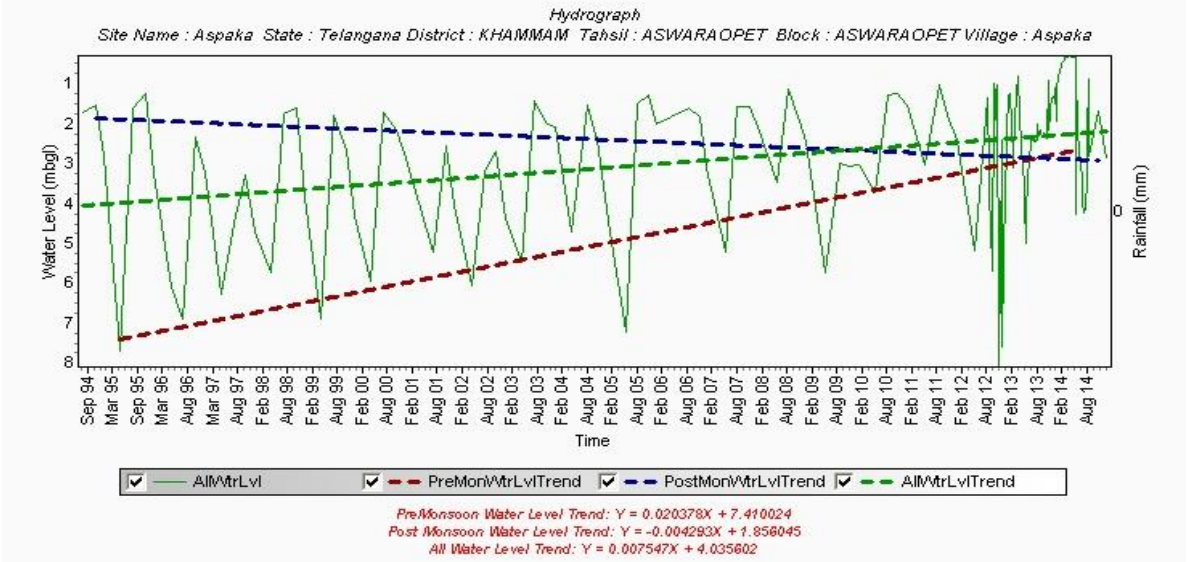


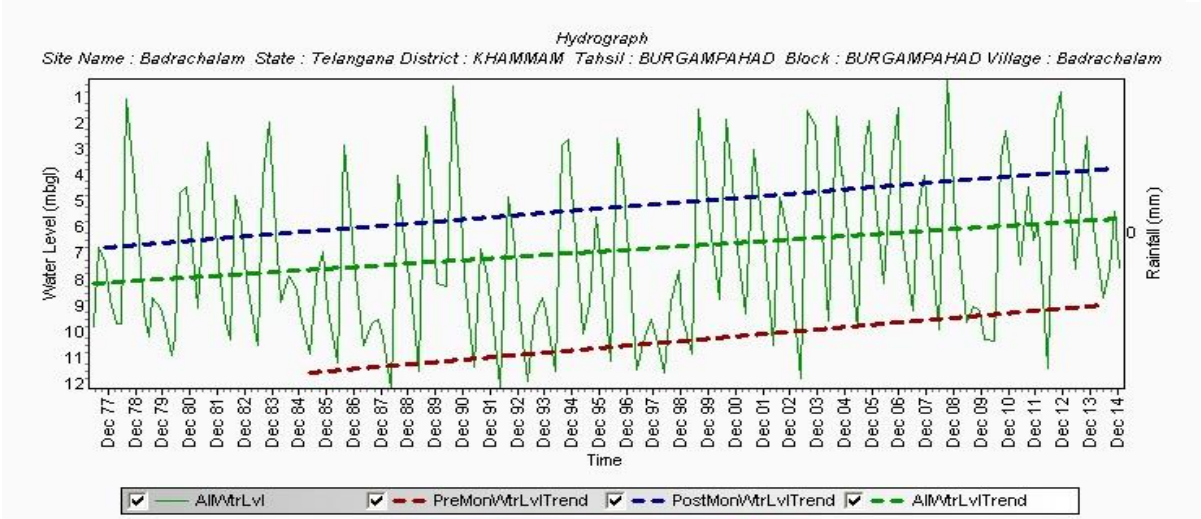
Fig.6.10 Hydrographs of select wells

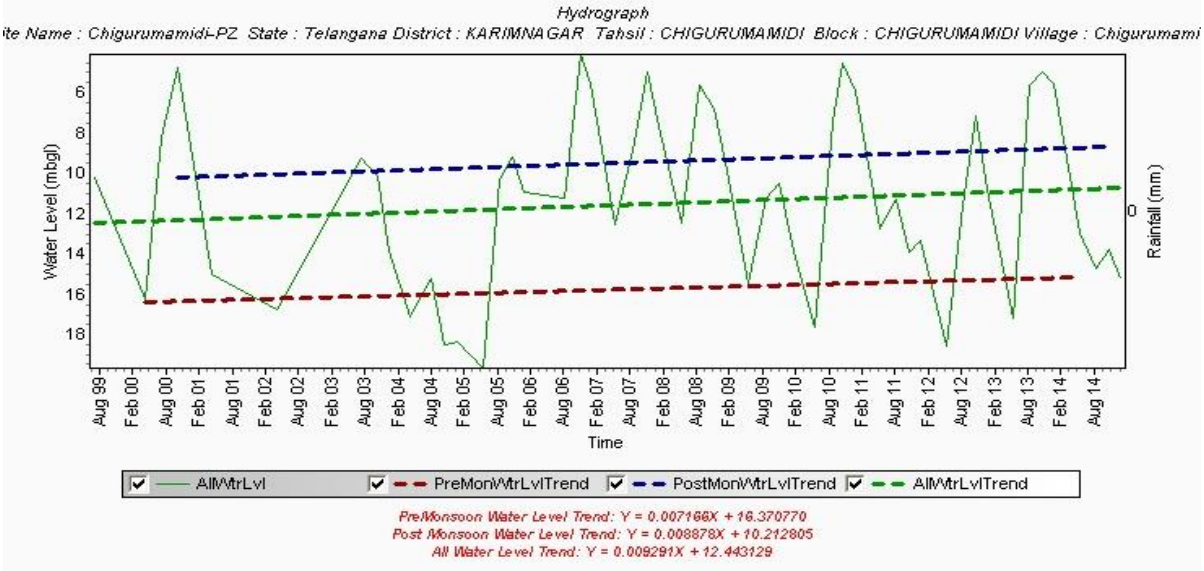






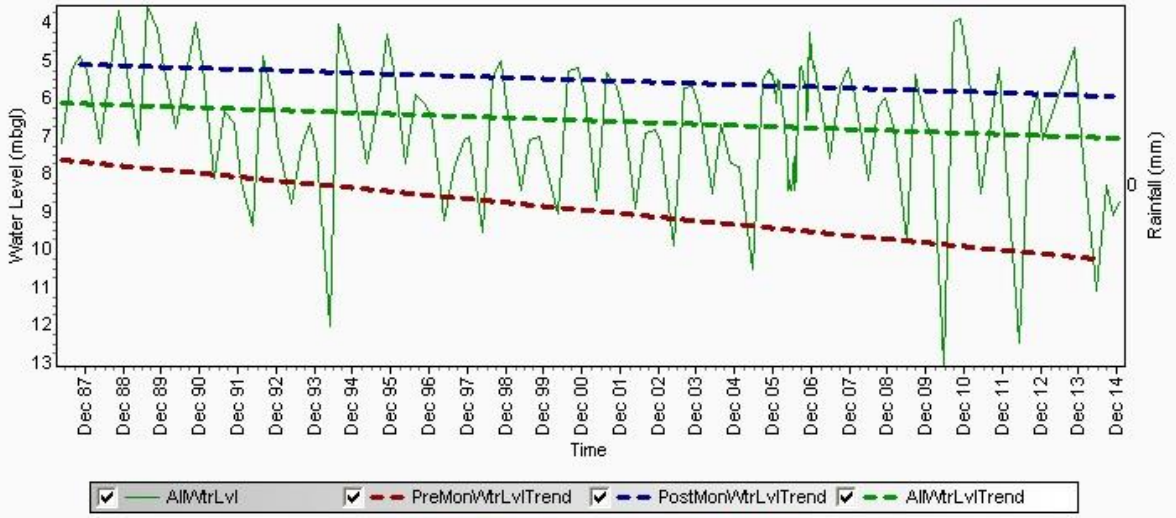

Hydrograph
Site Name : Aspaka State : Telangana District : KHAMMAM Tahsil : ASWARAOPET Block : ASWARAOPET Village : Aspaka
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.020378X + 7.410024
Post Monsoon Water Level Trend: Y = -0.004293X + 1.856045
All Water Level Trend: Y = 0.007547X + 4.035602


Hydrograph
Site Name : Badrachalam State : Telangana District : KHAMMAM Tahsil : BURGAMPAHAD Block : BURGAMPAHAD Village : Badrachalam
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.007244X + 11.534430
Post Monsoon Water Level Trend: Y = 0.006764X + 6.745072
All Water Level Trend: Y = 0.005551X + 8.155433


Hydrograph
te Name : Chigurumamidi-PZ State : Telangana District : KARIMNAGAR Tahsil : CHIGURUMAMIDI Block : CHIGURUMAMIDI Village : Chigurumami
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.007166X + 16.370770
Post Monsoon Water Level Trend: Y = 0.008878X + 10.212805
All Water Level Trend: Y = 0.009291X + 12.443129

Hydrograph

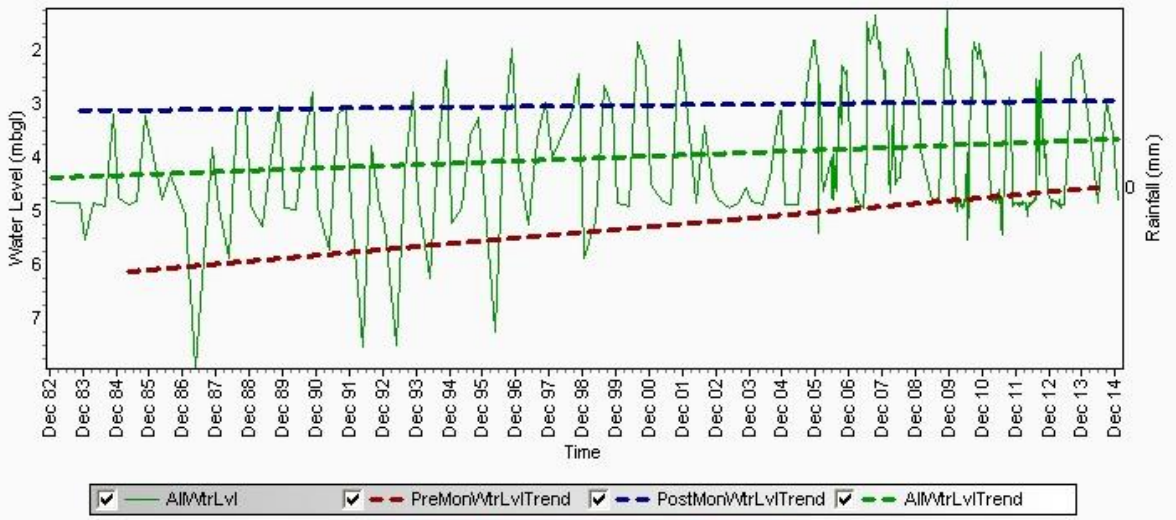
Site Name : Dharmapuri-new State : Telangana District : KARIMNAGAR Tahsil : DHARMAPURI Block : DHARMAPURI Village : Dharmapuri-new



PreMonsoon Water Level Trend: Y = -0.007972X + 7.620452
Post Monsoon Water Level Trend: Y = -0.002628X + 5.095406
All Water Level Trend: Y = -0.002831X + 6.108234

Hydrograph

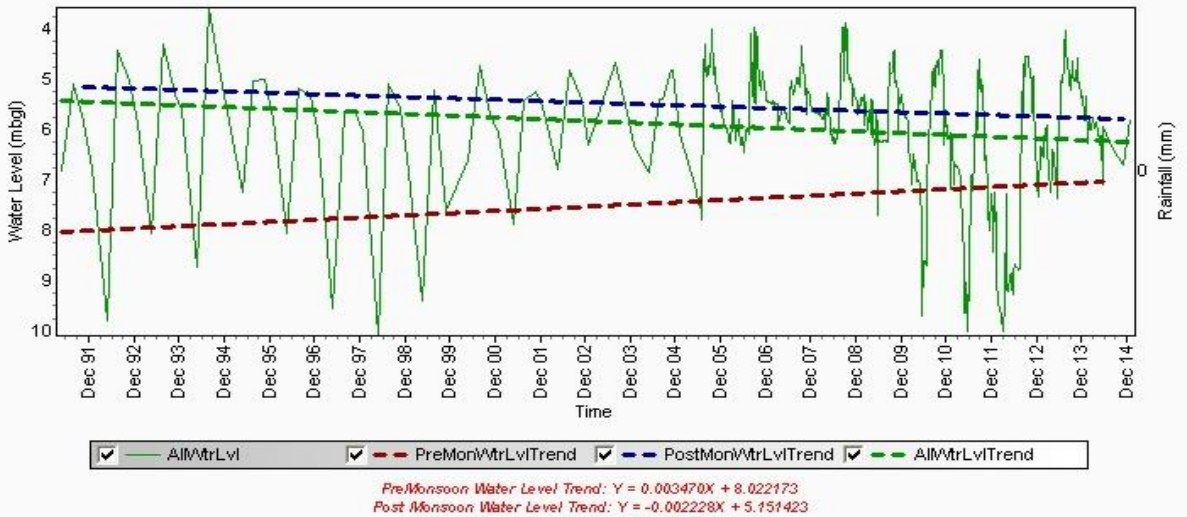
Site Name : Alampur1 State : Telangana District : MAHBUBNAGAR Tahsil : ALAMPUR Block : ALAMPUR Village : Alampur



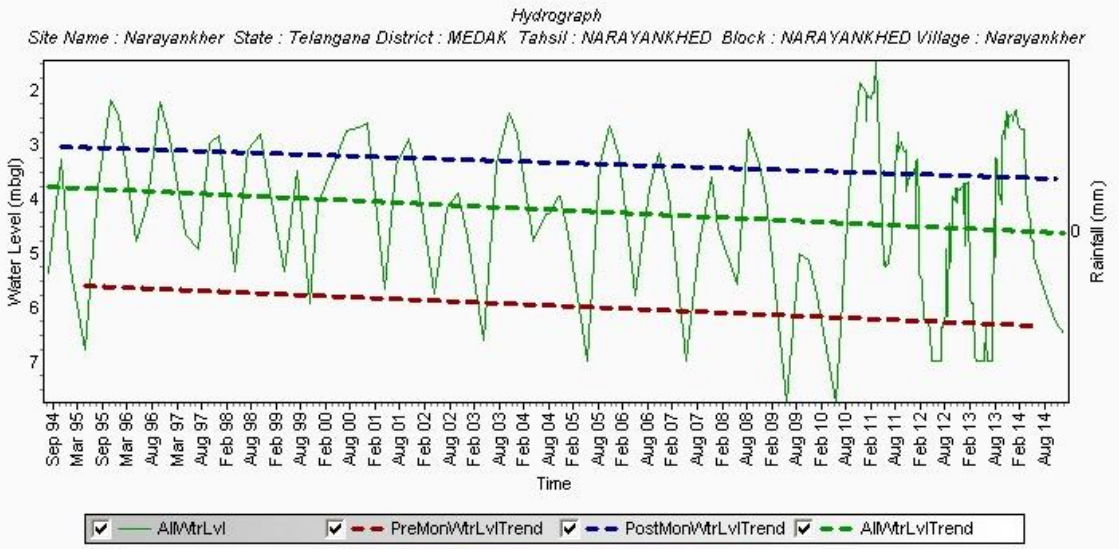
PreMonsoon Water Level Trend: Y = 0.004430X + 6.123475
Post Monsoon Water Level Trend: Y = 0.000499X + 3.121765
All Water Level Trend: Y = 0.001909X + 4.389296

Hydrograph

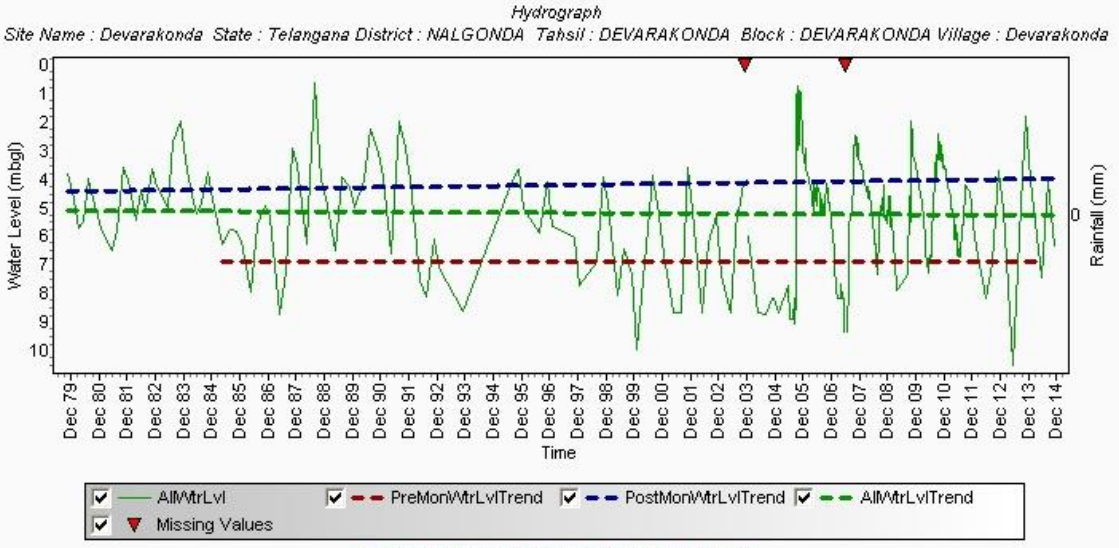
Site Name : Nacharam State : Telangana District : MEDAK Tahsil : DAULATABAD Block : DAULATABAD Village : Nacharam



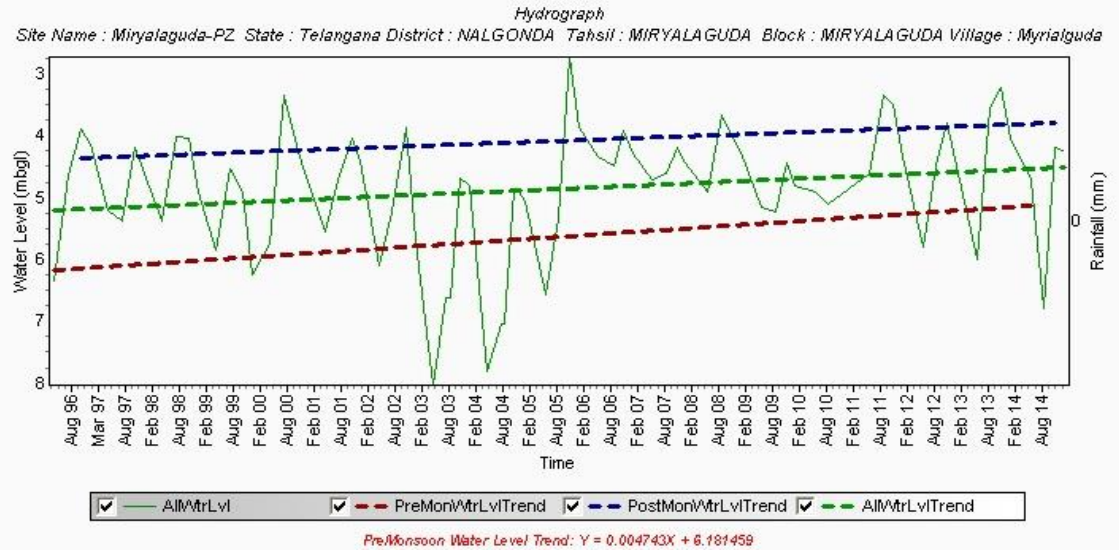
PreMonsoon Water Level Trend: Y = 0.003470X + 8.022173
Post Monsoon Water Level Trend: Y = -0.002228X + 5.151423
All Water Level Trend: Y = -0.002827X + 5.437308



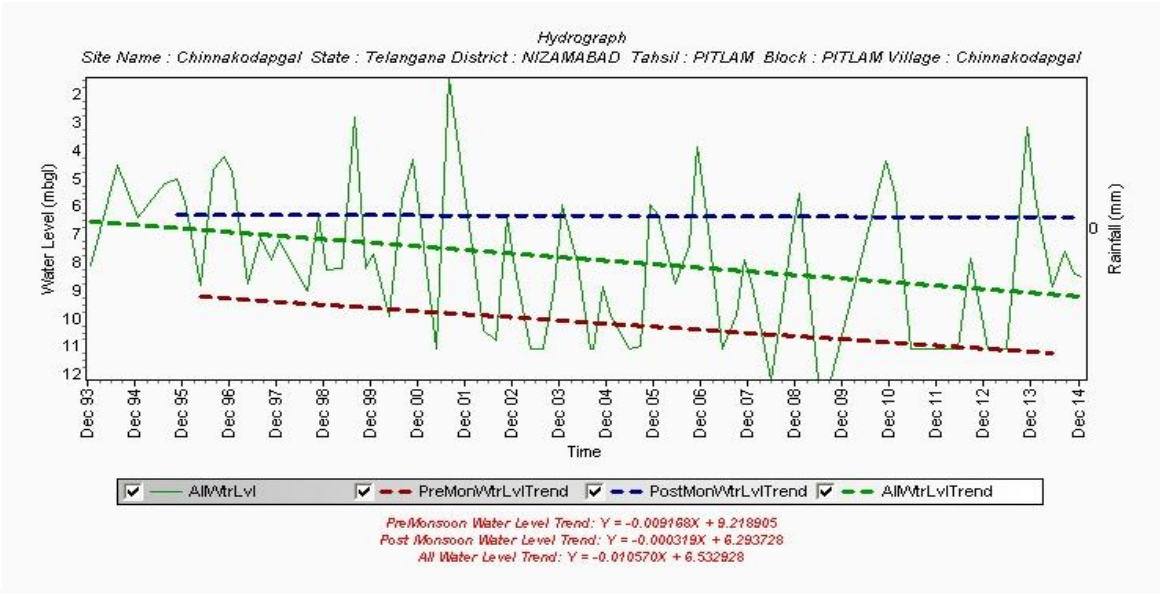
PreMonsoon Water Level Trend: Y = -0.003220X + 5.574106
Post Monsoon Water Level Trend: Y = -0.002384X + 3.024489
All Water Level Trend: Y = -0.003458X + 3.776208

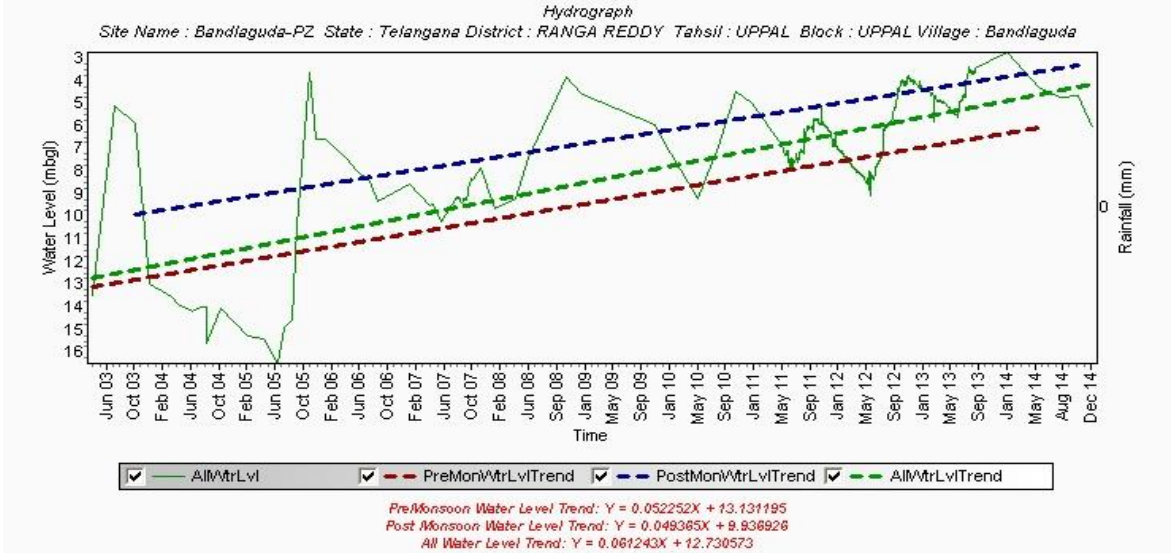


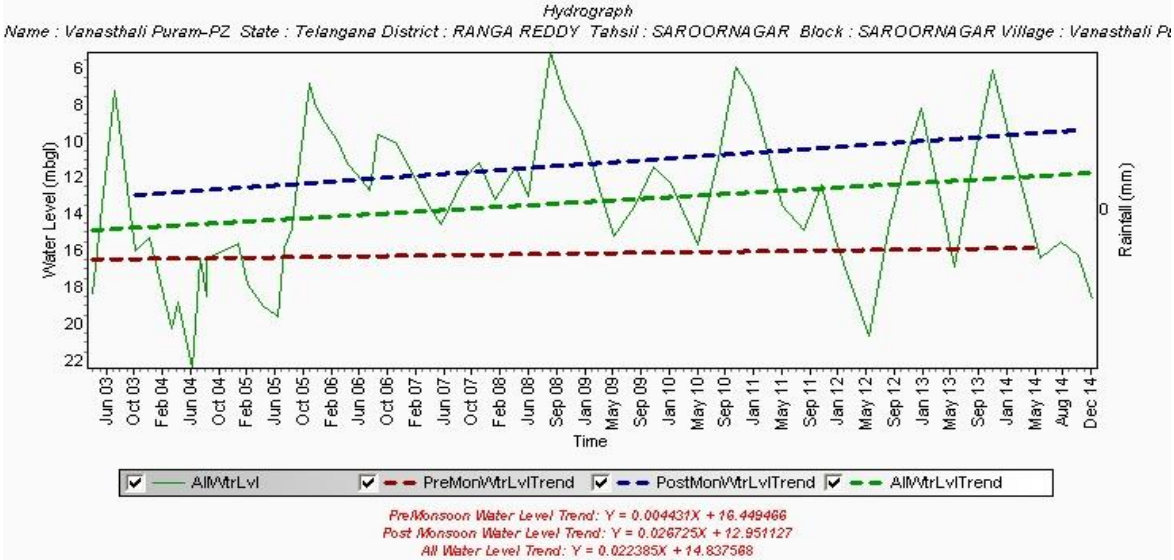
PreMonsoon Water Level Trend: Y = -0.000059X + 6.865838
Post Monsoon Water Level Trend: Y = 0.001153X + 4.433901
All Water Level Trend: Y = -0.000439X + 5.067342



PreMonsoon Water Level Trend: Y = 0.004743X + 6.181459
Post Monsoon Water Level Trend: Y = 0.002615X + 4.360786
All Water Level Trend: Y = 0.003124X + 5.215567


Hydrograph
Site Name : Chinnakodapgal State : Telangana District : NIZAMABAD Tahsil : PITLAM Block : PITLAM Village : Chinnakodapgal
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.009168X + 9.218905
Post Monsoon Water Level Trend: Y = -0.000319X + 6.293728
All Water Level Trend: Y = -0.010570X + 6.532928


Hydrograph
Site Name : Bandlaguda-PZ State : Telangana District : RANGA REDDY Tahsil : UPPAL Block : UPPAL Village : Bandlaguda
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.052252X + 13.131195
Post Monsoon Water Level Trend: Y = 0.049365X + 9.936926
All Water Level Trend: Y = 0.061243X + 12.730573


Hydrograph
Name : Vanasthali Puram-PZ State : Telangana District : RANGA REDDY Tahsil : SAROORNAGAR Block : SAROORNAGAR Village : Vanasthali Pu
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.004431X + 16.449466
Post Monsoon Water Level Trend: Y = 0.026725X + 12.951127
All Water Level Trend: Y = 0.022385X + 14.837568

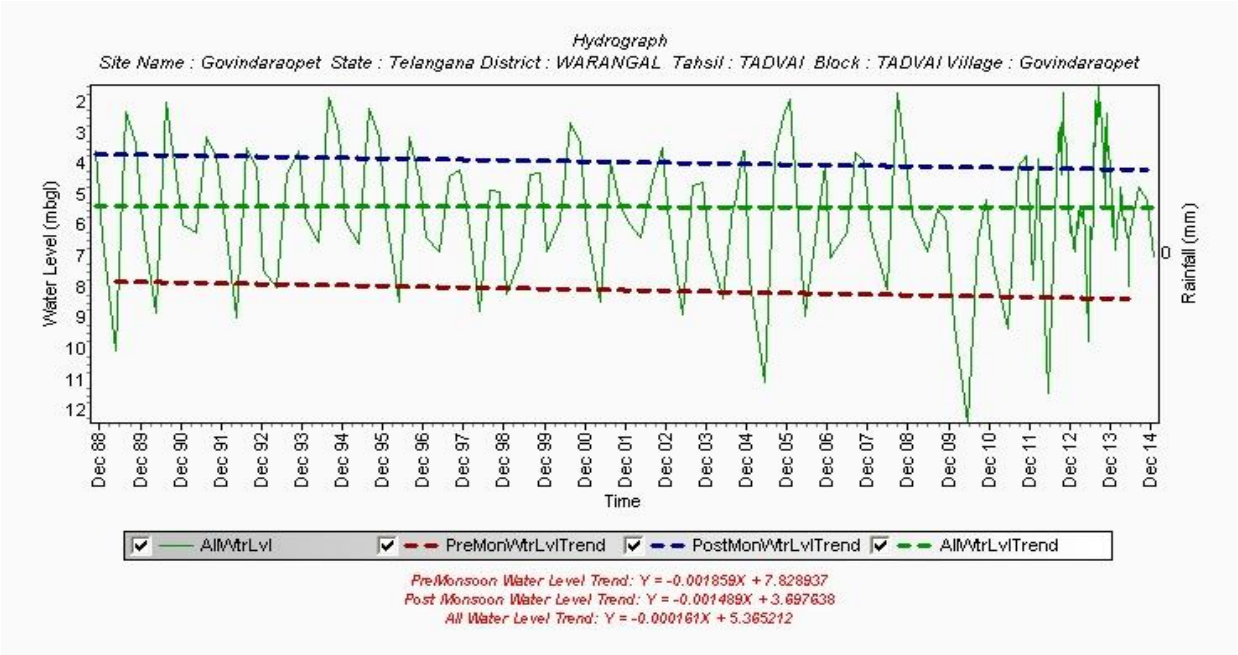

Hydrograph
Site Name : Govindaraopet State : Telangana District : WARANGAL Tahsil : TADVAI Block : TADVAI Village : Govindaraopet
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.001859X + 7.828937
Post Monsoon Water Level Trend: Y = -0.001489X + 3.697638
All Water Level Trend: Y = -0.000161X + 5.365212

Fig.6.12

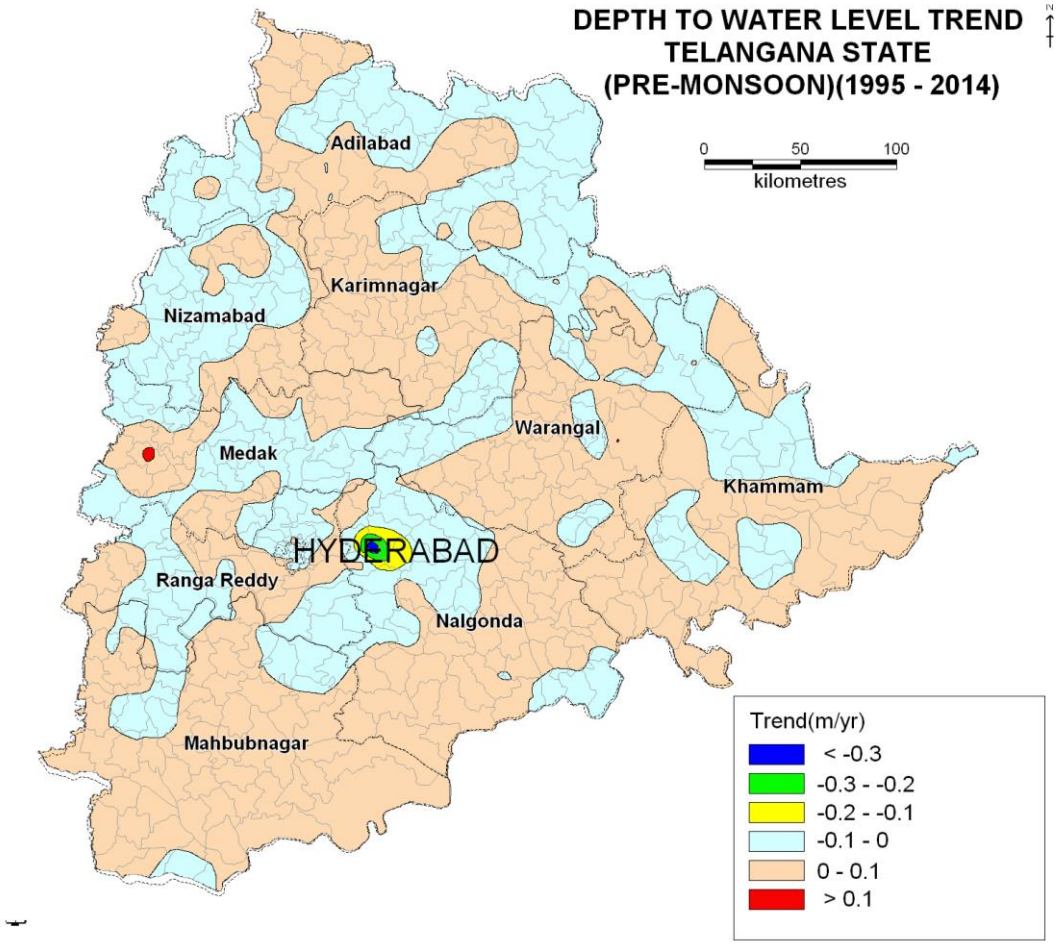

DEPTH TO WATER LEVEL TREND
TELANGANA STATE
(PRE-MONSOON)(1995 - 2014)
0 50 100
kilometres
Adilabad
Karimnagar
Nizamabad
Warangal
Medak
Khammam
HYDERABAD
Ranga Reddy
Nalgonda
Mahbubnagar
Trend(m/yr)
< -0.3
-0.3 - -0.2
-0.2 - -0.1
-0.1 - 0
0 - 0.1
> 0.1

Fig.6.13

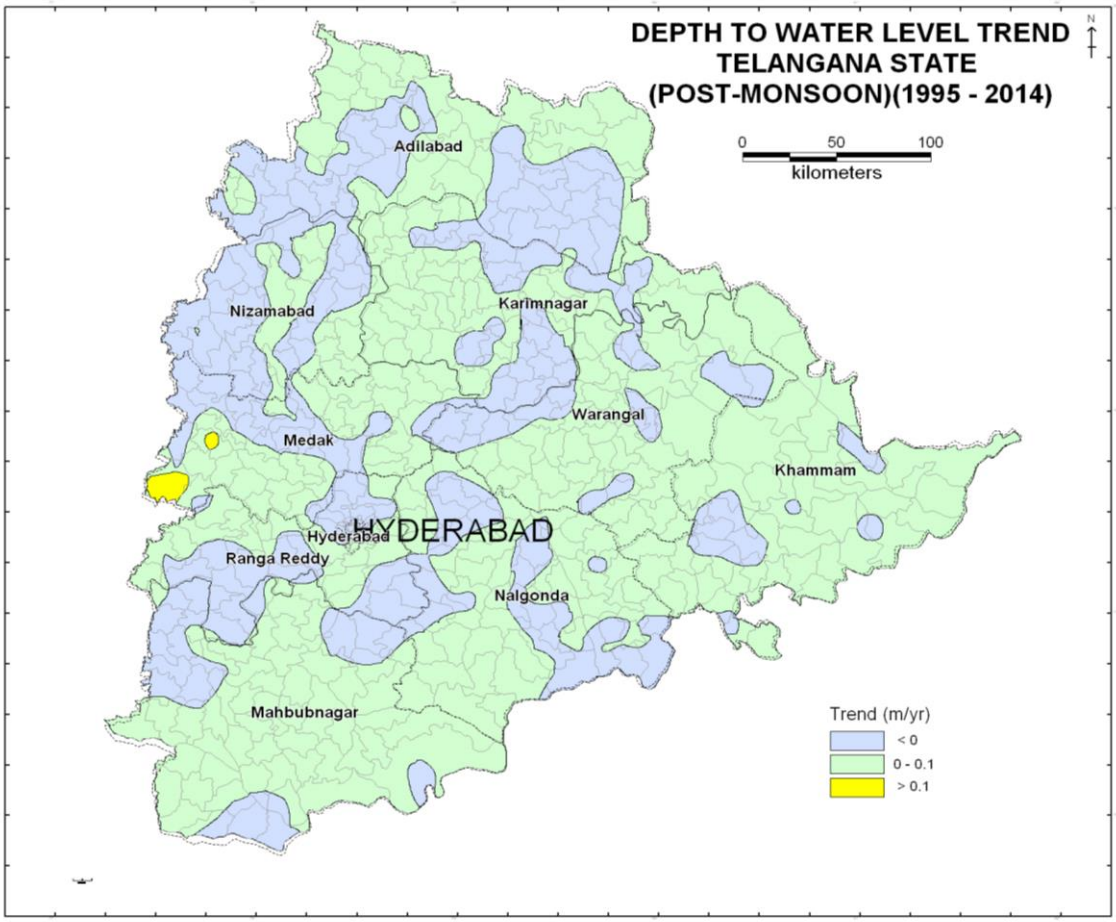
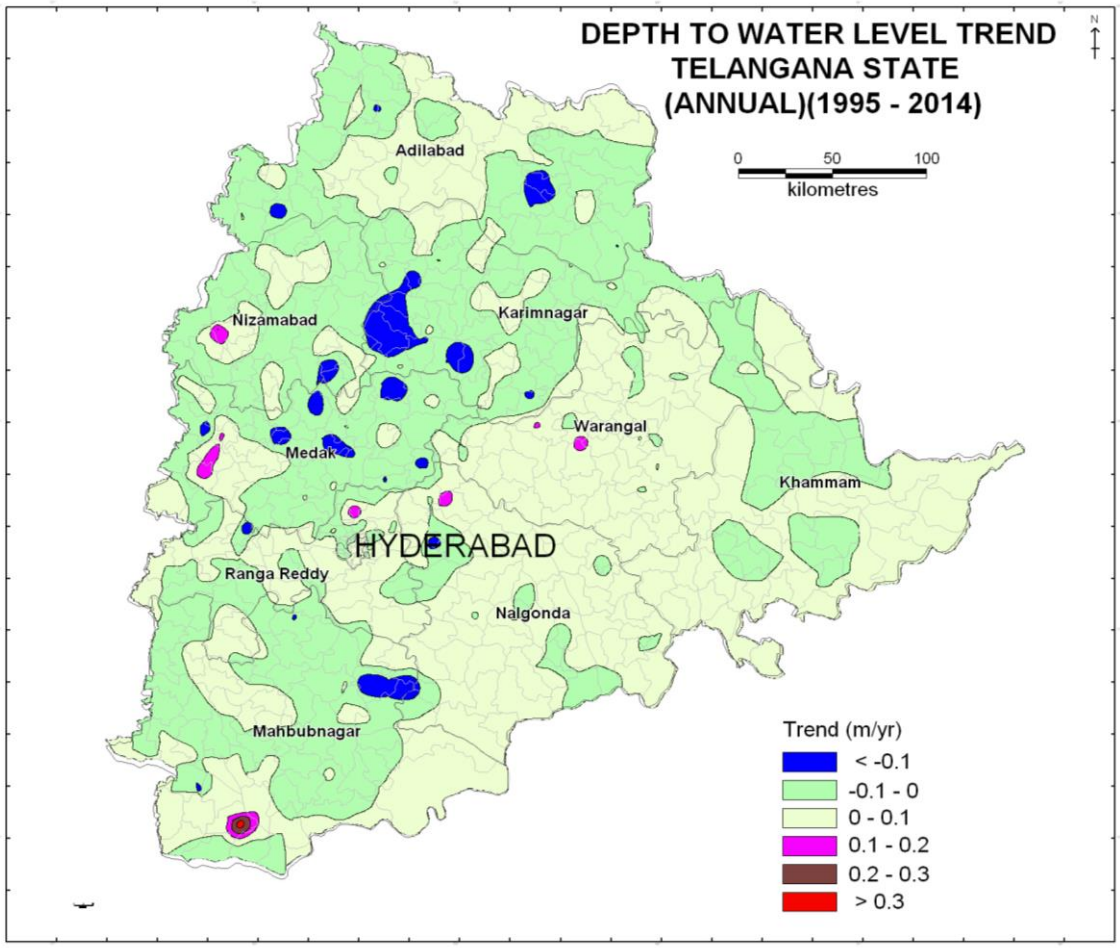


Fig.6.14



6.5 Water Level Fluctuation

The periodic monitoring of Ground Water Monitoring portray long term, seasonal and annual trend changes due to ground water withdrawal, canal seepage, and other input and output components.

6.6.1 Water Level Fluctuation – May, 2014 with respect to MAY, 2013

Fluctuation of water levels during May, 2014 with reference to May, 2013 is depicted in the Fig.6.15 and categorization of water level fluctuation is presented in the Fig.6.16**.** Rise is observed in 78.60% of wells analysed. Water level fluctuation data, May 2014 vs May 2013 is furnished in the Table-6.14**.** An analysis of 458 wells data shows that rise is recorded in 78.60% of wells (360), fall is recorded in 18.99% ofof wells (87), while no fluctuation is recorded in 2.41 % of wells (11).

Water level rise of less than 2 m is recorded in 43.23% of wells
2-4 m is recorded in 20.08% of wells and more than 4 m in 15.28% of wells.

Fall of less than 2 m is recorded in 13.75% of wells
Fall of 2-4 m is registered in 2.18% and more than 4 m in 3.05% of wells.

Rise of more than 4 m is recorded maximum in Mahbubnagar district (26.67 % ofwells) while fall of more than 4 m is registered highest in Hyderabad district (15.38%).

RISE IN WATER LEVELS

The rise in water level between May, 2014 and May, 2013 is generalised as follows;

Out of 360 wells that have registered a rise in water levels,
55.0% of wells recorded rise of less than 2 m, 25.5% of wells 2 to 4 m while the rest 19.5% of wells recorded rise of more than 4 m.

Rise of less than 2 m is observed in major parts of Khammam, Warangal, Karimnagar, Adilabad, and Nalgonda and as smaller areas in all other districts. (43.23% of wells).

Rise of 2-4 m is observed as small patches in all districts (20.08% of wells).
Rise of more than 4 m is noticed mostly in Rangareddy and Mahbubnagar districts and as smaller areas in all other districts (15.28% of wells).

FALL IN WATER LEVELS

The fall in water level between May, 2014 and May, 2013 is generalised as follows;

Out of the 87 wells that have registered fall in water levels; 72.41% of wells have recorded less than 2 m fall, 2-4 m in 11.49% of wells and more than 4 m is registered in 16.09% of wells.

Fall of less than 2 m is observed as smaller parts in all districts (13.75% of wells).
Fall of 2-4 m is noticed in smaller areas in all districts of the state except Hyderabad, Mahbubnagar and Medak districts (2.18% of wells).
Fall of more than 4 m is observed as small patches in all districts except Karimnagar and Nizamabad(3.05% of wells).

Fig.6.15

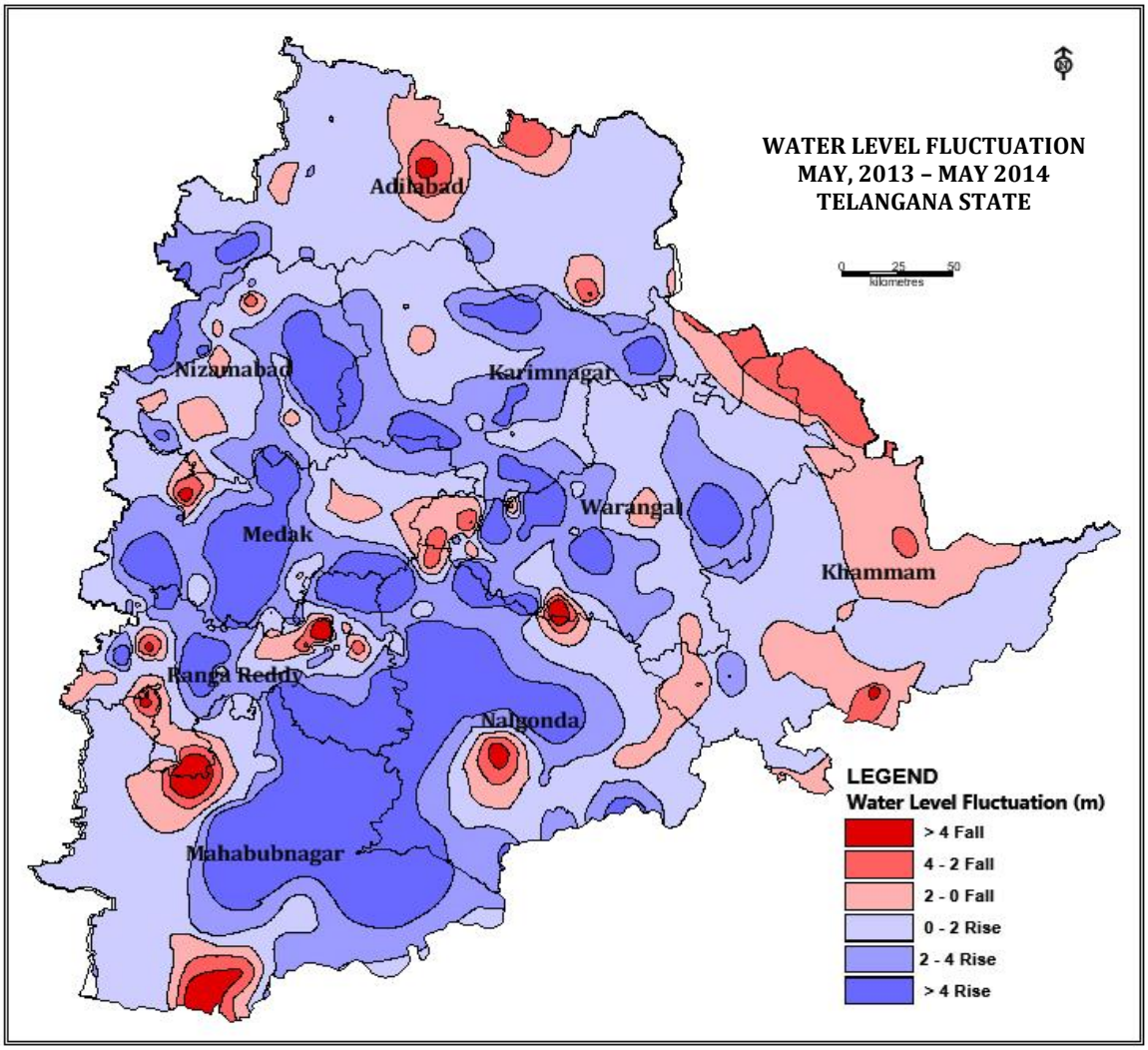


Fig. 6.16

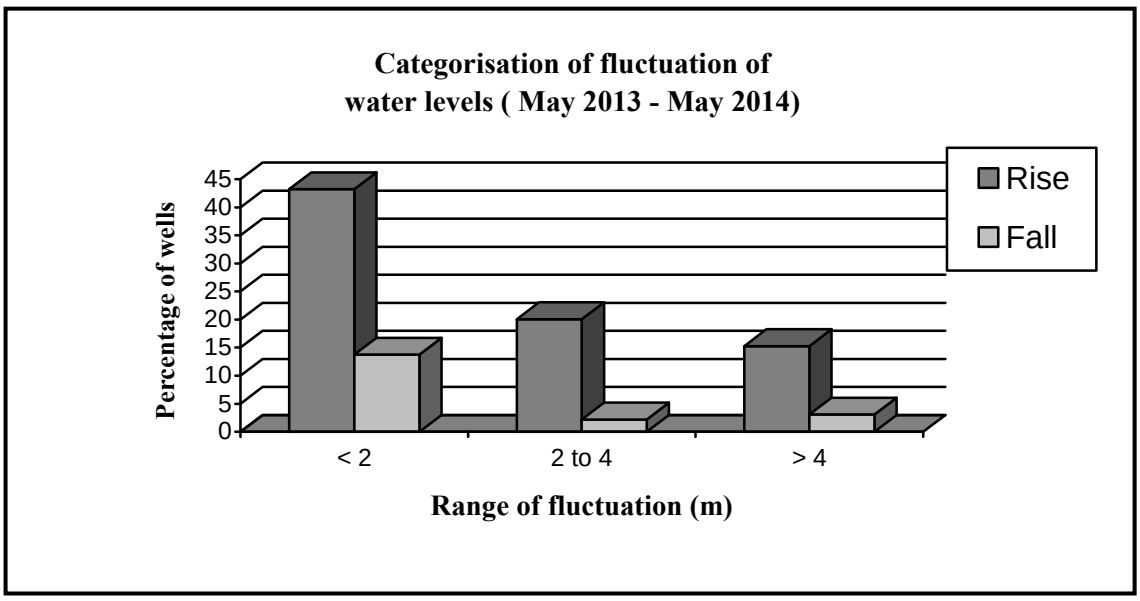


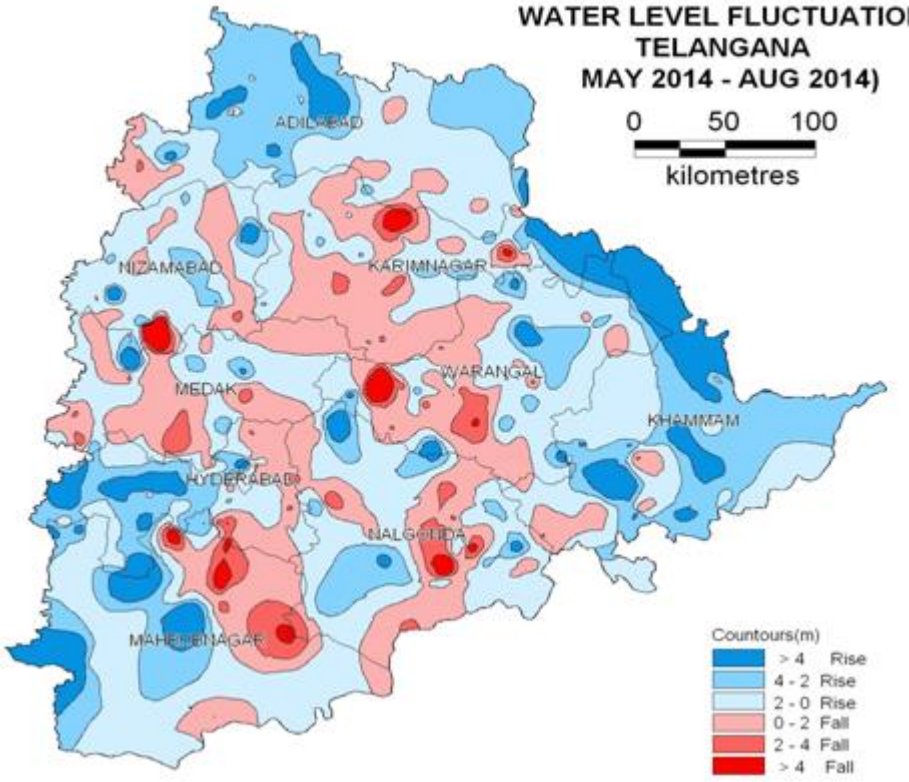
Table-6.14
Water Level Fluctuation and Frequency Distribution – May,2013– May 2014

Sl.No.	District Name	No. of wells analyzed	Range of Fluctuation (m)				No. of wells/Percentage Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall			Rise	Fall
			Mini	Maxi	Mini	Maxi	0 to 2	2 to 4	> 4	0 to 2	2 to 4	> 4		
1	Adilabad	61	0.02	8.97	0.09	5.1	47	6	2	2	1	2	55	5
							77.05%	9.84%	3.28%	3.28%	1.64%	3.28%		
2	Hyderabad	13	0.8	4.14	0.05	17.68	4	2	1	4	0	2	7	6
							30.77%	15.38%	7.69%	30.77 %	0.00%	15.38%		
3	Karimnagar	58	0.25	9.07	0.17	2.3	24	20	10	3	1	0	54	4
							41.38%	34.48%	17.24%	5.17%	1.72%	0.00%		
4	Khammam	46	0.01	4.09	0.12	4.88	21	0	1	19	3	1	22	23
							45.65%	0.00%	2.17%	41.30 %	6.52%	2.17%		
5	Mahbubnagar	30	0.03	18.94	0.2	6.45	10	3	8	3	0	3	21	6
							33.33%	10.00%	26.67%	10.00 %	0.00%	10.00%		
6	Medak	32	0.77	12.45	0.05	5.5	8	8	6	6	0	1	22	7
							25.00%	25.00%	18.75%	18.75 %	0.00%	3.13%		
7	Nalgonda	35	0.07	17.51	0.3	5.5	16	8	6	3	1	1	30	5
							45.71%	22.86%	17.14%	8.57%	2.86%	2.86%		
8	Nizamabad	41	0.25	12.65	0.05	3.64	13	10	7	9	1	0	30	10
							31.71%	24.39%	17.07%	21.95 %	2.44%	0.00%		
9	Ranga Reddy	66	0.14	18.72	0.08	9	23	13	17	8	1	2	53	11
							34.85%	19.70%	25.76%	12.12 %	1.52%	3.03%		
10	Warangal	76	0.06	14.2	0.03	7.53	32	22	12	6	2	2	66	10
							42.11%	28.95%	15.79%	7.89%	2.63%	2.63%		
	Total	458	0.01	18.94	0.03	17.68	198	92	70	63	10	14	360	87

6 .6.2 Water Level Fluctuation during August, 14 with respect to May, 2014

Fluctuation of water levels during August 2014 with reference to May 2014 is depicted in Fig.6.17 and categorization of water level fluctuation is presented in the Fig.6.18. Rise of water levels is observed in 62.97% of wells in theState.

Fig.6.17



Water level fluctuation data is furnished in the Table-6.15. An analysis of 524 wells data shows that rise is recorded in 62.97% of wells (330), fall is recorded in 35.11% of wells (184), while no fluctuation is recorded in 1.90% of wells (10).

Rise of less than 2 m is recorded in 34.73% of wells
2-4 m is recorded in 16.79% of wells and rise of more than 4 m in 11.45% of wells.

Fall of less than 2 m is registered in 25.76% of *wells.*
2-4 m is registered in 7.06% of wells
Fall of more than 4 m is registered in 2.29% of wells.

Rise of more than 4 m is recorded maximum in Khammam district (32% of wells) while fall of more than 4 m is registered highest in Mahbubnagar district (5.56%).

RISE IN WATER LEVELS

The rise in water level between August 2014 and May 2014is generalised as follows;

Out of 330 wells that have registered a rise in water levels,

55.15% of wells recorded rise of less than 2 m,
26.66% of wells in the range of 2 to 4 m while rise of more than 4 m recorded in 18.18% of wells.
Rise of less than 2m is observed in major parts of Warangal, Karimnagar, Adilabad, Nizamabad district and as smaller parts in all other districts (55.15% of wells).
Rise of 2-4 m (26.66% of wells) and >4 m are observed mostly in Khammam and Adilabad and as small patches in all other districts (18.18%).

FALL IN WATER LEVELS

Fall in water level between August, 2014 and May 2014 generalised as follows;

Out of 184 wells that have registered fall in water levels;

73.36% of wells have recorded less than 2 m fall, 2-4 m in 20.10% of wells and the rest 6.52% of wells registered fall of more than 4 m.
Fall of less than 2 m is observed mostly in Mahbubnagar, Hyderabad, Karimnagar and Warnagal districts and as small parts in all other districts (73.36% of wells).
Fall of 2-4 m is noticed in Mabubnagar, Warangal, Karimnagar and Hyderabad districts. Out of total fall this range is observed in 20.10% of wells.
Fall of more than 4 m is observed as smaller parts in all districts except Adilabad and Khammam (6.52% of wells).

Fig.6.18

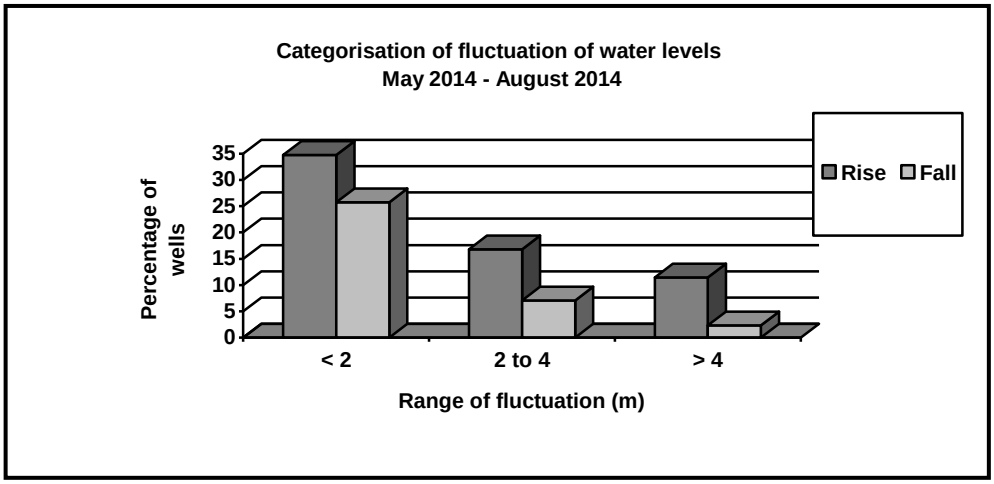


Table-6.15
District wise water level fluctuation and frequency distribution in different fluctuation ranges August, 2014 & May, 2014

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	Adilabad	64	0.1	8.8	0.0	2.75	26	40.6	18	28.1	7	10.9	12	18.7	1	1.56	0	0	51	13
2	Hyderabad	13	0.2	6.48	0.2	1.83	8	61.5	1	7.69	1	7.69	3	23.0	0	0	0	0	10	3
3	Karimnagar	63	0.0	11.1	0.1	7.67	13	20.6	9	14.2	1	1.59	34	53.5	4	6.35	2	3.1	23	40
4	Khammam	50	0.0	12.6	1.2	2.28	17	34.0	12	24.0	16	32.0	3	6.0	2	4.0	0	0	45	5
5	Mababoobnaga	36	0.6	7.98	0.1	6.83	13	36.1	2	5.56	5	13.8	7	19.4	2	5.56	2	5.5	20	11
6	Medak	35	0.0	9.3	0.0	3.86	8	22.8	3	8.57	3	8.57	12	34.2	6	17.1	0	0	14	18
7	Nalgonda	60	0.0	7.8	0.1	9.55	24	40.0	7	11.6	4	6.67	14	23.3	8	13.3	3	5.0	35	25
8	Nizamabad	49	0.1	7.7	0.0	23.5	22	44.9	8	16.3	3	6.12	12	24.4	1	2.04	1	2.0	33	14
9	Ranga Reddy	73	0.1	12.5	0.1	4.8	19	26.0	20	27.4	15	20.5	12	16.4	5	6.85	2	2.7	54	19
10	Warangal	81	0.0	8.15	0.0	15.1	32	39.5	8	9.88	5	6.17	26	32.1	8	9.88	2	2.4	45	36
	Total State	524	0.0	12.6	0.0	23.5	18	34.7	88	16.7	60	11.4	13	25.7	37	7.06	12	2.2	330	184

6.6.3 Fluctuation of water levels - November, 2014 with respect to May, 2014

Fluctuation of water levels during November, 2014 with reference to May, 2014 is depicted in Fig.6.19 and categorization of water level fluctuation is presented in the Fig.6.20. Rise of water levels in 58.35% of wells is observed in the State.

Water level fluctuation data of is furnished in the Table-6.16**.** An analysis of data of 521 wells reveals that rise is recorded in 58.35% of wells (304), fall is registered in 38.77% of wells (202), while no fluctuation is observed in 2.88% of wells (15).

Rise of less than 2 m is recorded in 39.15% of wells.
Rise of 2-4 m is recorded in 14.58% of wells and more than 4 m in 4.6% of wells.
Fall of less than 2 m is recorded in 27.83% of wells.
Fall of 2-4 m in 7.67% of wells and more than 4 m is registered in 3.26% of wells.
Rise of more than 4 m is recorded maximum in Khammam district (14.29% of wells) while fall of more than 4 m is registered maximum in Mahbubnagar district (8.33%).

RISE IN WATER LEVELS

The rise in water level between November, 2014 and May, 2014 and is generalised as follows:

Out of 304 wells that have registered rise in water levels;

Rise of less than 2 m is recorded in 67.1% of wells, 2 to 4 m in 25.0% of wells while 7.89% of wells recorded rise of more than 4 m.
Rise in less than 2 m(67.1% of wells) and 2-4 m (25.0% of wells) is observed in major parts of Warangal, Karimnagar, Adilabad, Khammam district and as smaller areas in other districts
Rise of 4 m is observed mostly in Khammam district and in small parts of all other districts (7.89% of wells).

FALL IN WATER LEVELS

The fall in water level between November 2014 and May 2014 is generalised as follows;

Out of 202 wells that have registered fall in water levels;

Fall of less than 2 m is registered in 71.78% of wells, 2-4 m in 19.8% of wells and the rest 8.4% of wells have registered fall of more than 4 m.

Fall of less than 2 m is observed mostly in Mahbubnagar, Nizamabad and Karimnagar districts and as small parts in all other districts(71.78% of wells).
Fall of 2-4 m is noticed mostly in Mabubnagar and Nalgonda districts and as small patches in all other districts except Khammam district (19.8% of wells).
Fall of more than 4 m observed mostly in Nalgonda and Mahbubnagar district and as small parts in all districts except Adilabad and Khammam (8.4% of wells).

Fig.6.19

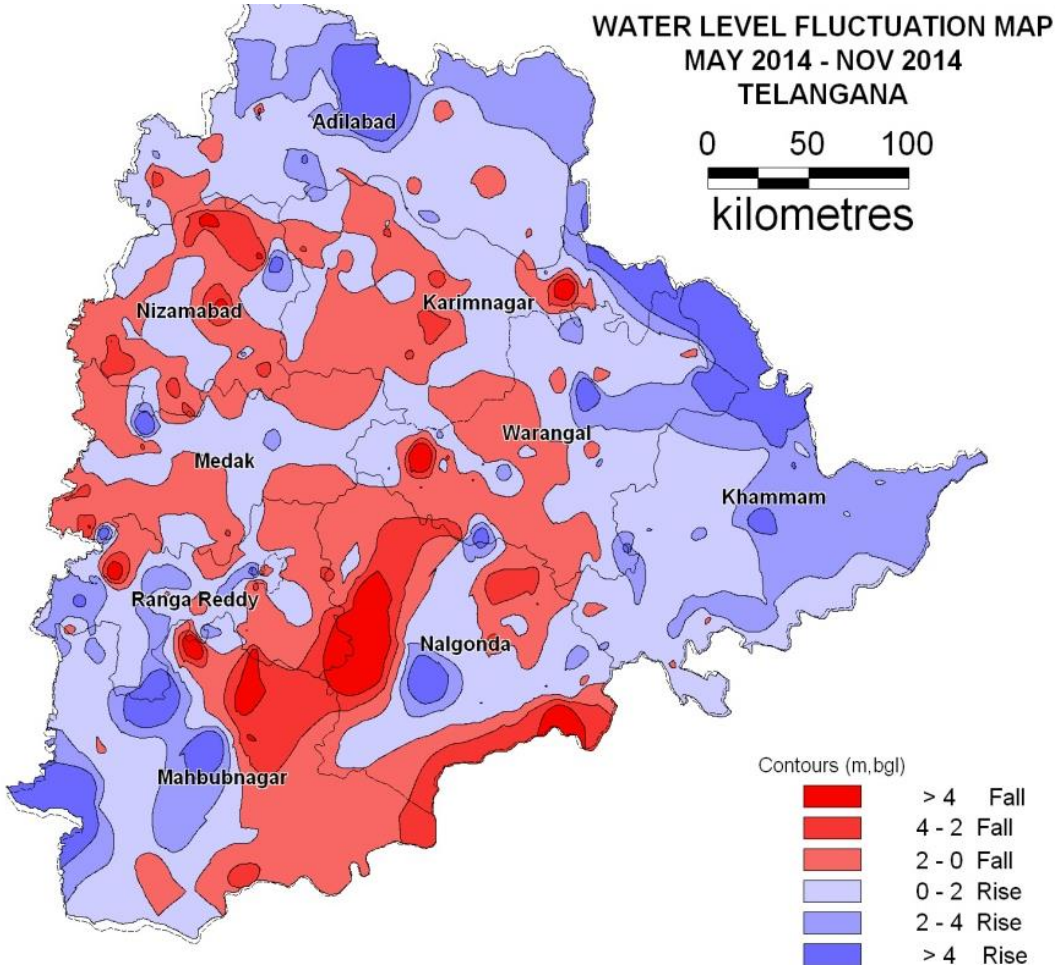


Fig.6.20

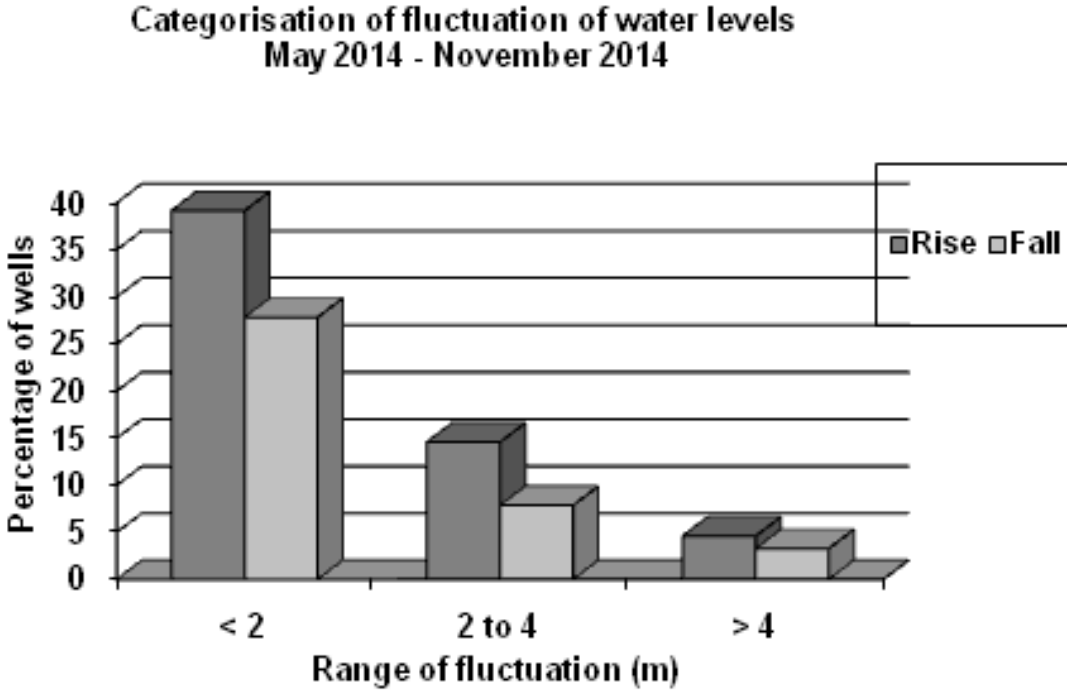


Table-6.16
Fluctuation and Frequency Distribution in Different Ranges
May, 2014 to November, 2014

Sl No	District	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	Adilabad	65	0.07	21.00	0.02	3.35	36	55.38	17	26.15	2	3.08	7	10.77	2	3.08	0	0.00	55	9
2	Hyderabad	10	0.25	5.61	0.21	2.95	7	70.00	0	0.00	1	10.00	1	10.00	1	10.00	0	0.00	8	2
3	Karimnagar	61	0.02	7.00	0.13	7.73	20	32.79	5	8.20	1	1.64	27	44.26	7	11.48	1	1.64	26	35
4	Khammam	56	0.01	7.39	0.08	1.17	25	44.64	19	33.93	8	14.29	4	7.14	0	0.00	0	0.00	52	4
5	Mahaboobnagar	36	0.52	8.33	0.17	8.22	11	30.56	4	11.11	2	5.56	6	16.67	5	13.89	3	8.39	17	14
6	Medak	35	0.02	8.15	0.17	4.22	13	37.14	1	2.86	2	5.71	9	25.71	6	17.14	1	2.86	16	16
7	Nalgonda	62	0.13	8.98	0.01	11.48	26	41.94	5	8.06	1	1.61	17	27.42	7	11.29	5	8.06	32	29
8	Nizamabad	49	0.05	5.50	0.05	6.20	18	36.73	1	2.04	1	2.04	16	32.65	5	10.20	4	8.16	20	25
9	Ranga Reddy	69	0.01	11.69	0.17	6.12	21	30.43	13	18.84	3	4.33	27	39.13	2	2.90	2	2.90	37	31
10	Warangal	78	0.07	9.73	0.02	10.39	27	34.62	11	14.10	3	3.83	31	39.74	5	6.41	1	1.28	41	37
	Total State	521	0.52	5.50	0.01	11.48	204	61.00	76	25.00	24	7.89	145	71.78	40	19.80	17	8.40	304	202

6.6.4 – Fluctuation of water levels – January, 2015 with respect to May, 2014

Fluctuation of water levels during January 2015 with reference to May 2014 is depicted in the Fig.6.21 and categorization of fluctuation is presented in the Fig.6.22. Fall in water levels is predominant in 54.93% of wells.

Fluctuation data is presented in the Table-6.17. An analysis of 517 wells data reveals rise is recorded in 43.33% of wells (224), fall is observed in 54.93% of wells (284), no fluctuation is noticed in 1.7% of wells (9).

Rise of less than 2 m is recorded in 34.43% of wells, 2-4 m is recorded in 5.60% of wells and more than 4 m in 3.28% of wells.
Fall of less than 2 m is recorded in 34.82% of wells, 2-4 m is registered in 14.31% of wells and more than 4 m fall in 5.80% of wells.
Rise of more than 4 m is recorded maximum in Ranga Reddy district (5.56% of wells) while fall of more than 4 m is registered maximum in Nalgonda district (20.97% wells).

RISE IN WATER LEVELS

The rise in water level during January, 2015 with respect to May, 2014 is generalised as follows;
Out of 224 wells that have registered rise, 79.46% of wells recorded rise of less than 2 m, 12.95% of wells in the range of 2 to 4 m while 7.58% of wells recorded rise of more than 4 m.
Rise of less than 2 m is observed in major parts of Adilabad, Khammam, Mahbubnagar, Nalgonda, Rangareddy, Warangal districts and as smaller areas in parts of all other districts. (79.46% of wells).

Rise of 2-4 m is observed mostly in Khammam and Adilabad and as small isolated areas in parts of Karimnagar, Mahbubnagar, Rangareddy and Warangal districts(12.95% of wells).
Rise of more than 4 m is observed mostly in Adilabad and Khammam districts and in small isolated patches in all other districts (7.58% of wells).

FALL IN WATER LEVELS

The fall in water level during January, 2015 with respect to May, 2014 is generalised as follows;

1. Out of the 284 wells that have registered fall in water levels, 63.38% of wells have recorded less than 2 m fall, 2-4 m in 26.06% of wells and the rest 10.56% of wells registered fall of more than 4 m.

2. Fall less than 2 m is observed in all the districts(63.38% of wells).

3. Water level fall of 2-4 m is noticed mostly in Adilabad, Mabubnagar, Nalgonda, Khammam and Warangal districts and as small parts in all other districts (26.06% of wells).

4. Fall of more than 4 m is observed as small isolated areas in all the districts except Adilabad, Hyderabad and Khammam(0.53% of wells).

Fig.6.21

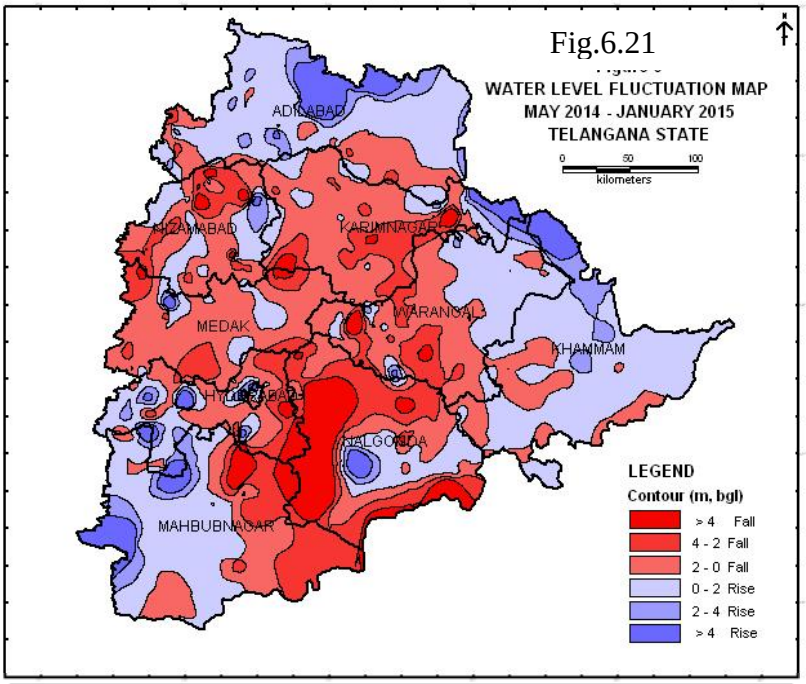


Fig.6.22

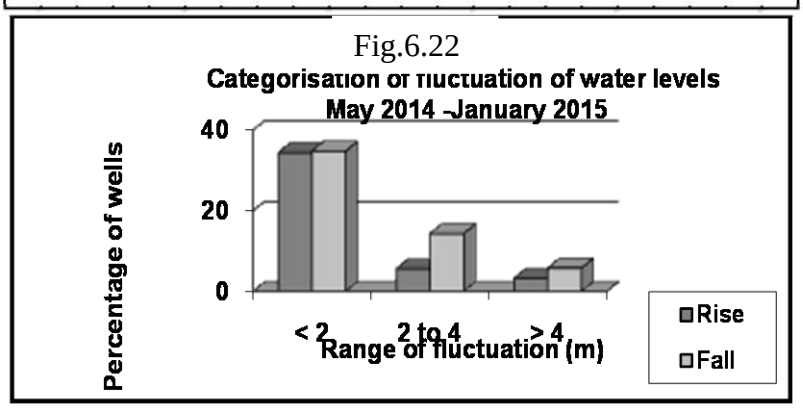


Table-6.17
Fluctuation and Frequency Distribution in Different Fluctuation Ranges
January, 2015 Vs May, 2014

Sl. No	District	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	Adilabad	62	0.09	20.8	0.01	2.98	33	53.23	11	17.74	3	4.84	10	16.13	5	8.06	0	0	47	15
2	Hyderabad	12	0.03	6.47	0.09	3.15	4	33.33	0	0	2	16.67	5	41.67	1	8.33	0	0	6	6
3	Karimnagar	59	0.08	6.02	0.05	9.07	10	16.95	2	3.39	1	1.69	31	52.54	11	18.64	4	6.78	13	46
4	Khammam	54	0.11	6.15	0.05	2.13	28	51.85	8	14.81	1	1.85	15	27.78	2	3.7	0	0	37	17
5	Mahaboobnagar	36	0.02	10.4	0.12	10.48	15	41.67	1	2.78	2	5.56	8	22.22	4	11.11	2	5.56	18	14
6	Medak	33	0.1	6.9	0.02	4.63	10	30.3	0	0	1	3.03	13	39.39	6	18.18	1	3.03	11	20
7	Nalgonda	62	0.3	8.77	0.08	15.2	22	35.48	0	0	1	1.61	19	30.65	6	9.68	13	21	23	38
8	Nizamabad	48	0.13	5.26	0.25	7.32	18	37.5	0	0	1	2.08	13	27.08	9	18.75	6	12.5	19	28
9	Ranga Reddy	72	0.15	18.05	0.05	7.24	19	26.39	4	5.56	4	5.56	32	44.44	11	15.28	2	2.78	27	45
10	Warangal	79	0.05	5.18	0.04	10.83	19	24.05	3	3.8	1	1.27	34	43.04	19	24.05	2	2.53	23	55
	Total State	517	0.02	20.8	0.01	15.2	179	34.43	29	5.6	17	3.28	180	34.82	74	14.31	30	5.8	224	284

6.6.5 Fluctuation of Water Levels – August, 2014 with respect to August, 2013

Fluctuation of water levels during August, 2014 with reference to August, 2013 is depicted in the Fig.6.23 and categorization of water level fluctuation is presented in the Fig.6.24. Fluctuation data is presented in the Table - 6.18

An analysis of 462 wells data indicates that rise is recorded in 27.70% of wells (128), fall is registered in 70.99% of wells (328), while no fluctuation is observed in 1.31% of wells (6). Rise of less than 2 m is recorded in 17.09% of wells, 2-4 m in 5.19% of wells and more than 4 m is recorded in 5.41% of wells.

Fall of less than 2 m is recorded in 32.25% of wells, 2-4 m in 20.12% of wells and more than 4 m is registered in 18.61% of wells. Water level rise of more than 4 m is recorded maximum in Nalgonda district (14.29% of wells) while fall of more than 4 m is registered maximum in Karimnagar district (38.98%).

RISE IN WATER LEVELS

The rise in water level between August 2014 and August 2013 is generalised as follows;
Out of 128 wells that have registered a rise in water levels, 61.71% of wells recorded rise of less than 2 m, 18.75% of wells in the range of 2 to 4 m, while the rest of 19.53% of wells recorded rise of more than 4 m.
Rise of less than 2 m is observed mostly in Hyderabad, Rangareddy, Mahbubnagar and Khammam districts and as smaller parts in all other districts(71% of wells).
Rise of 2-4 m is observed mostly in Nalgonda and Mahbubnagar districts and as small areas in all other districts (18.75% of wells).
Rise of more than 4 m is observed as isolated areas in parts of Mahbubnagar, Hyderabad, Rangareddy, Medak and Khammam districts (19.53% of wells).

FALL IN WATER LEVELS **Fig.6.23**

The fall in water level between August 2014 and August 2013 is generalized as follows;
Out of the 328 wells that have registered fall in water levels, 45.42% of wells have recorded less than 2 m fall, 2-4 m in 28.35% of wells and the rest 24.02% of wells registered water level fall of more than 4 m.
Fall of less than 2 m (45.42% of wells) and 2-4 m (28.35% of wells) are observed in all the districts.
Fall of more than 4 m observed as small isolated parts in all the districts (24.02% of wells).

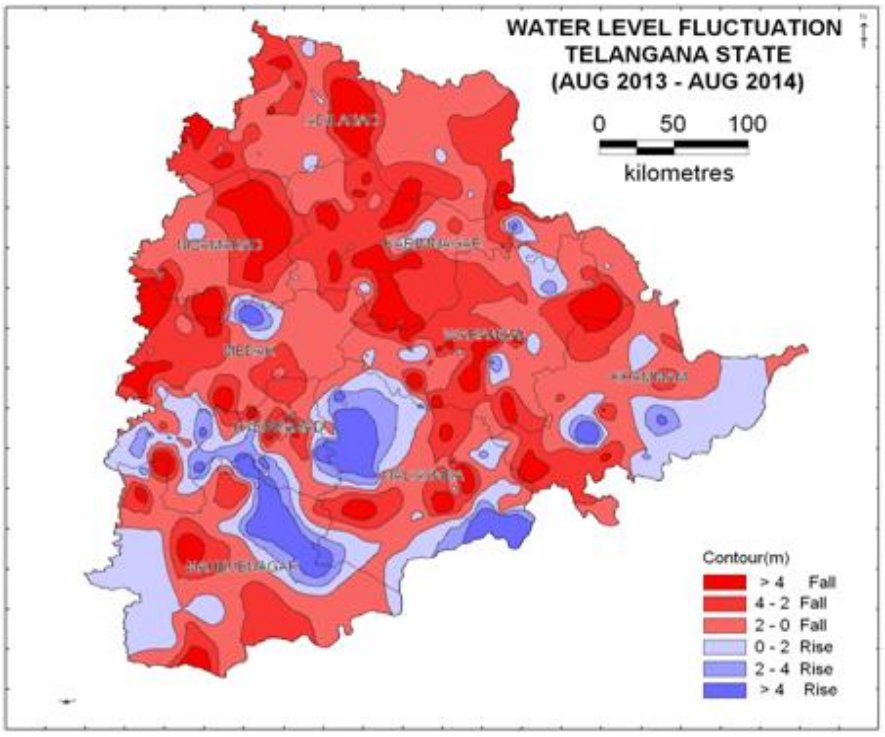


Fig.6.24

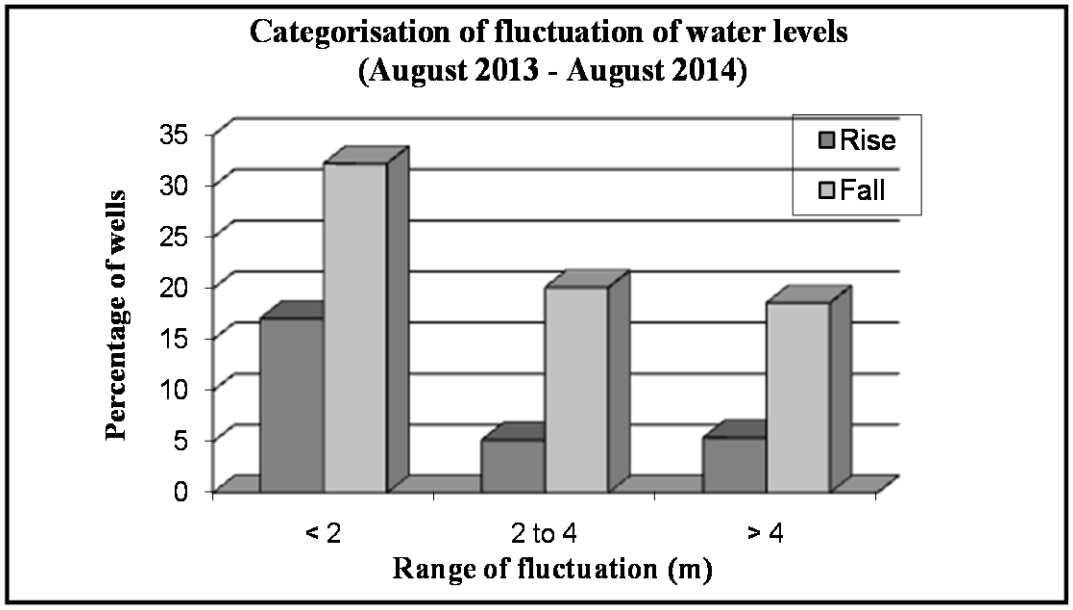


Table-6.18
Fluctuation and Frequency Distribution in Different Fluctuation Ranges
August, 2014 Vs August, 2013

Sl. No	District	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	Adilabad	56	0.04	0.8	0.04	15.37	7	12.5	0	0	0	0	28	50.0	11	19.64	9	16.07	7	48
2	Hyderabad	11	0.08	0.33	0.56	4.85	4	3.36	0	0	0	0	1	9.09	4	36.36	2	18.18	4	7
3	Karimnagar	59	0.19	5.25	0.25	8.37	4	6.78	0	0	1	1.69	13	22.03	18	30.51	23	38.98	5	54
4	Khammam	44	0.1	10.09	0.1	5.84	14	31.82	1	2.27	2	4.55	17	38.64	6	13.64	3	6.82	17	26
5	Mahaboobnagar	32	0.15	20.98	0.11	11.4	8	25.0	3	9.38	4	12.5	6	18.75	7	21.88	4	12.5	15	17
6	Medak	32	1.14	7.83	0.02	8.9	2	6.25	0	0	1	3.13	11	34.38	7	21.88	8	25.0	3	26
7	Nalgonda	56	0.1	13.53	0.02	11.1	9	16.07	3	5.36	8	14.29	26	46.43	4	7.14	6	10.71	20	36
8	Nizamabad	32	0.05	1.36	0.07	23.9	3	9.38	0	0	0	0	10	31.25	8	25.0	11	34.38	3	29
9	Ranga Reddy	64	0.08	7.2	0.02	8.0	17	25.56	12	18.75	8	12.5	15	23.44	7	10.94	5	7.81	37	27
10	Warangal	76	0.01	4.29	0.2	9.65	11	14.47	5	6.58	1	1.32	22	28.95	21	27.63	15	19.74	17	58
	Total State	462	0.01	20.98	0.02	23.9	79	17.09	24	5.19	25	5.41	149	32.25	93	20.12	86	18.61	128	328

6.6.6 **Fluctuation of Water Levels – November 2014 with reference to November 2013**

Fluctuation of water levels during November 2013 with reference to November 2014 is depicted in Fig.6.25 and categorization of fluctuation is presented in the Fig.6.26. Fall of water levels is observed in 91.21% of wells (Table-6.19).

An analysis of 478 wells data reveals that rise is recorded in 8.36% of wells (40), fall is noticed in 91.21% of wells (436), while no fluctuation is observed in the rest of 0.43% of wells (2).

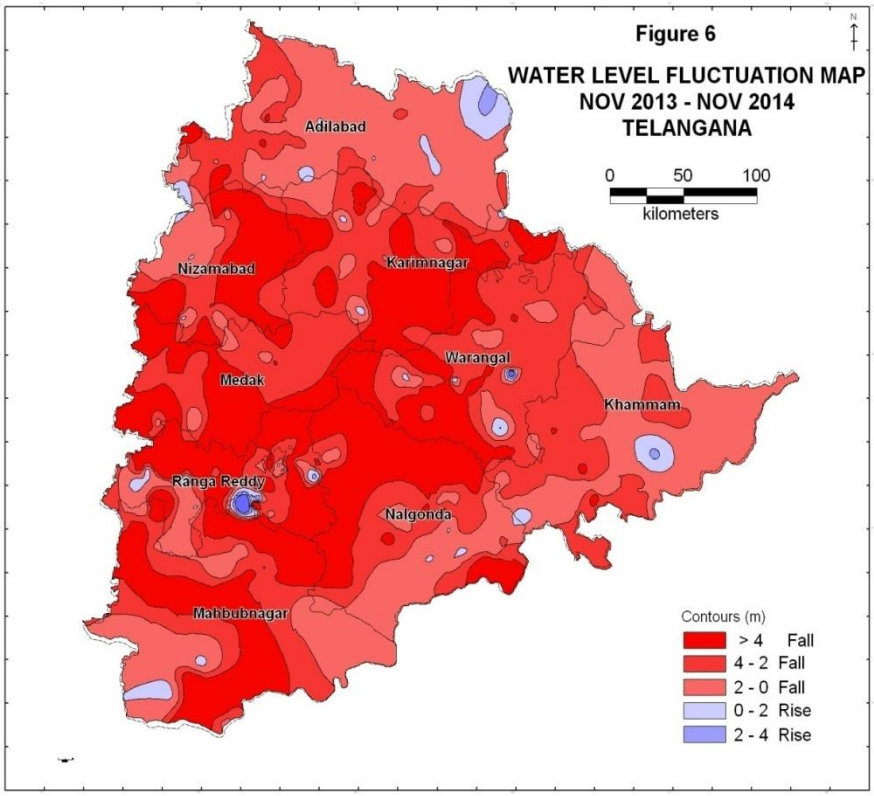
Rise of less than 2 m is recorded in 6.27% of wells, 2-4 m in 1.46% of wells and rise of more than 4 m is recorded in 0.63% of wells. Fall of less than 2 m is recorded in 31.58% of wells, 2-4 m in 24.89% of wells and more than 4 m is registered in 34.72% of wells.

Water level rise of more than 4 m is recorded maximum in Mahbubnagar district (2.78% of wells) while fall of more than 4 m is registered maximum in Medak district (55.88%).

Fig.6.25

RISE IN WATER LEVELS

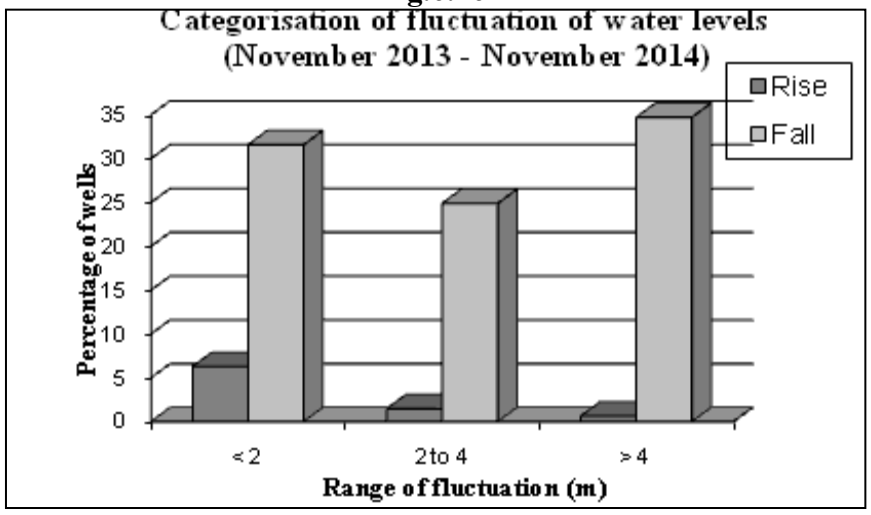
The rise in water level between November 2014 and November 2013 is generalised as follows;



Out of 40 wells that have registered rise in water levels, 75% of wells recorded rise of less than 2 m, 17.5% of wells in the range of 2 to 4 m while the rest 7.5% of wells recorded water level rise of more than 4 m.

Rise in water level of less than 2 m is observed as small isolated areas in all the districts except Medak district(6.27% of wells).

Fig.6.26



Rise of 2-4 m is observed as very small areas in Adilabad, Khammam and Ranga Reddy districts (17.5% of wells). Rise of Water level more than 4 m is observed as small parts of Mahbubnagar and Ranga Reddy districts (7.5% of wells).

FALL IN WATER LEVELS

The fall in water level between November 2014 and November 2013 is generalized as follows;

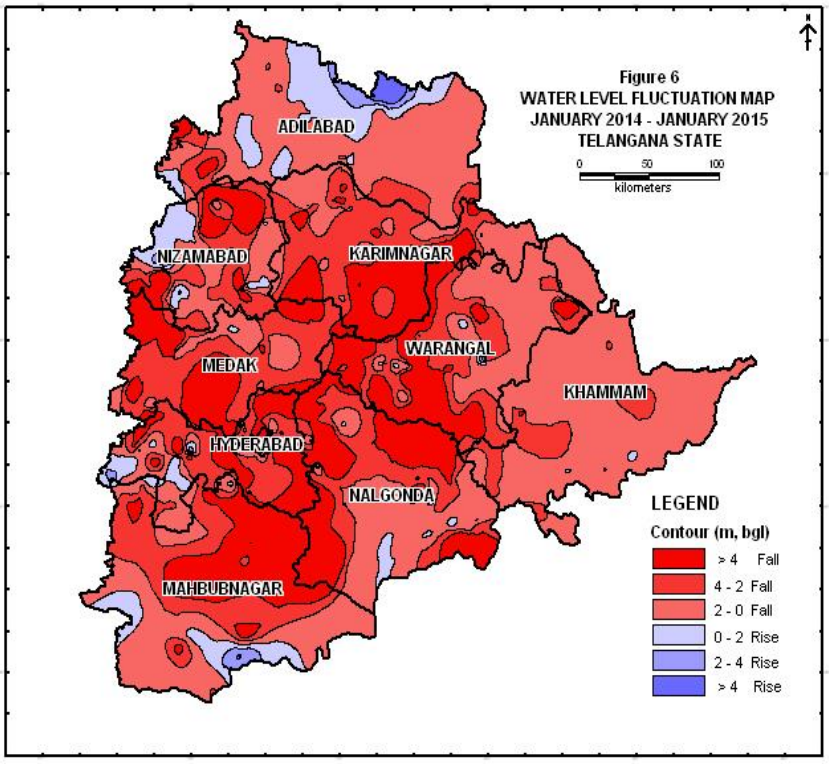
Out of 436 wells that have registered fall in water levels, 34.63% of wells have recorded less than 2 m fall, 2-4 m in 27.29% of wells and the rest of 38.07% of wells registered fall of more than 4 m. Fall of less than 2 m (34.63% of wells) & 2-4 m (27.29% of wells) 4 m in 38.07% of wells in all districts.

Table-6.19
Fluctuation and Frequency Distribution In Different Ranges
November, 2014 Vs November, 2013

Sl. No	District	Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total 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	Adilabad	61	0.07	2.37	0.18	6.46	7	11.48	1	1.64	0	0	35	57.38	13	21.31	5	8.2	8	53
2	Hyderabad	10	0.27	0.81	0.33	8.02	2	20	0	0	0	0	3	30	3	30	2	20	2	8
3	Karimnagar	52	0.21	1.41	1.03	8.6	3	5.77	0	0	0	0	7	13.46	16	30.77	25	48.08	3	48
4	Khammam	54	0.09	2.45	0.28	4.66	2	3.7	1	1.85	0	0	29	53.7	18	33.33	4	7.41	3	51
5	Mahaboobnagar	36	0.44	10.07	0.04	13.74	2	5.56	0	0	1	2.78	11	30.56	6	16.67	16	44.44	3	33
6	Medak	34	-	-	0.01	11.7	0	0	0	0	0	0	3	8.82	11	32.35	19	55.88	0	33
7	Nalgonda	58	0.2	0.71	0.04	8.19	4	6.9	0	0	0	0	25	43.1	10	17.24	19	32.76	4	54
8	Nizamabad	42	0.15	2.83	0.13	15.87	2	4.76	1	2.38	0	0	11	26.19	7	16.67	21	50	3	39
9	Ranga Reddy	65	0.15	4.28	0.48	14.68	6	9.23	2	3.08	1	1.54	14	21.54	11	16.92	31	47.69	9	56
10	Warangal	66	0.43	6.62	0.12	9.13	2	3.03	2	3.03	1	1.52	13	19.7	24	36.36	24	36.36	5	61
	Total State	478	0.44	0.71	0.01	15.87	30	75	7	17.5	3	7.5	151	34.63	119	27.29	16	38.07	40	436

6.6.7 Fluctuation of water levels January, 2015 with respect to January, 2014

Fig.6.27



Fluctuation of water levels during January, 2014 with reference to January, 2015 is depicted in Fig.6.26 and categorization of fluctuation is presented in the Fig.6.27. Fall in water levels is predominant in the State (Table-6.19).

An analysis of 519 wells data indicates that rise is recorded in 14.26% of wells (74), fall is recorded in 84.39% of wells (438), while no fluctuation is recorded in 1.34% of wells (7).

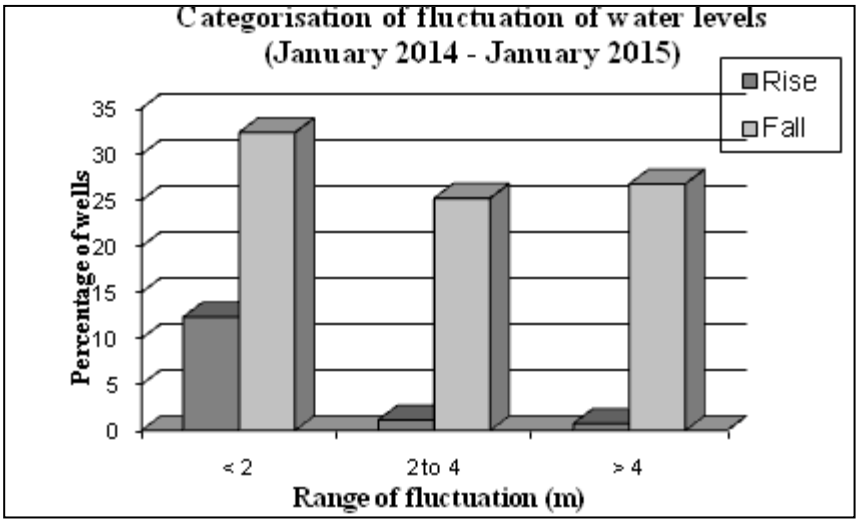
Rise of less than 2 m is recorded in 12.33% of wells, 2-4 m in 1.15% of wells and rise of more than 4 m is recorded in 0.77% of wells. Fall of less than 2 m is recorded in 32.37% of wells 2-4 m in 25.24% of wells and fall of more than 4 m is registered in 26.78% of wells. Rise of more than 4 m is recorded maximum in Mahbubnagar district (2.63% of wells) while fall of more than 4 m is registered maximum in Karimnagar district (41.67%).

RISE IN WATER LEVELS

The rise in water level between January 2015 and January 2014 is generalised as follows;

Out of 74 wells that have registered rise in water levels, 86.44% of wells recorded rise of less than 2 m, 8.10% of wells 2 to 4 m while 5.40% of wells recorded rise of more than 4 m. Rise less than 2 m is observed mostly Adilabad district and as very small isolated areas in parts of all the other districts (86.44% of wells).

Fig.6.28



ise of 2-4 m is observed as very small areas in Adilabad, Khammam and Rangareddy districts(8.40% of wells).

Rise of more than 4 m is observed in Adilabad, Mahbubnagar, Nizamabad and Warangal districts as small isolated areas (5.40% of wells).

FALL IN WATER LEVELS

The fall in water level between January 2015 and January 2014 is generalised as follows;
Out of 438 wells that have registered fall in water levels, 38.36% of wells have recorded less than 2 m fall, 2-4 m in 29.91% of wells and the rest 31.74% of wells have registered fall of more than 4 m. Fall less than 2 m (38.36% of wells), 2-4 m (29.91% of wells) and more than 4 m 31.74% of wells.

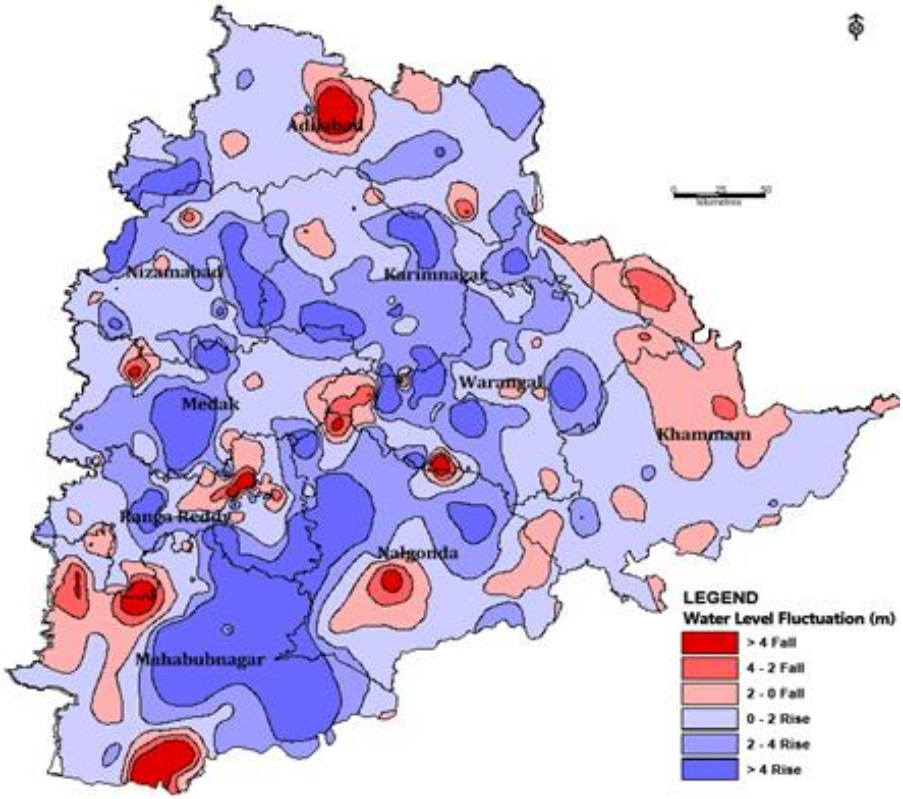
Table-6.20
Fluctuation and Frequency Distribution in Different Fluctuation Ranges
January, 2015vs January, 2014

Sl. No	District	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	Adilabad	63	0.04	7.09	0.03	7.06	20	31.75	1	1.59	1	1.59	28	44.44	8	12.7	2	3.17	22	38
2	Hyderabad	11	0.13	0.35	0.03	7.7	2	18.18	0	0	0	0	2	18.18	4	36.36	3	27.3	2	9
3	Karimnagar	60	0.04	0.21	0.18	9.27	2	3.33	0	0	0	0	15	25	17	28.33	25	41.7	2	57
4	Khammam	50	0.01	0.28	0.1	5.1	4	8	0	0	0	0	33	66	11	22	2	4	4	46
5	Mababoobnagar	38	0.56	4.22	0.07	9.62	4	10.53	0	0	1	2.63	7	18.42	11	28.95	14	36.8	5	32
6	Medak	34	0.01	0.28	0.1	8.93	2	5.88	0	0	0	0	7	20.59	13	38.24	11	32.4	2	31
7	Nalgonda	64	0.02	0.69	0.02	15.35	8	12.5	0	0	0	0	25	39.06	14	21.88	17	26.6	8	56
8	Nizamabad	49	0.16	5.86	0.36	12.4	10	20.41	2	4.08	1	2.04	12	24.49	11	22.45	12	24.5	13	35
9	Ranga Reddy	71	0.18	3.14	0.15	11.26	9	12.68	2	2.82	0	0	16	22.54	22	30.99	22	31	11	60
10	Warangal	79	0.62	7.17	0.01	12.96	3	3.8	1	1.27	1	1.27	23	29.11	20	25.32	31	39.2	5	74
	Total State	519	0.01	7.17	0.01	15.35	64	12.33	6	1.15	4	0.77	168	32.37	131	25.24	139	26.8	74	438

6.6.8 Water Level Fluctuation - May, 2014 with respect to Decadal Mean of (2004-2013) May, 2014

Water level fluctuation between May, 2014 and decadal mean of May, 2004-2013 is depicted in the Fig.6.29 and categorization of fluctuation is presented in the Fig.6.30 respectively. Rise in water levels is predominant in the State in 77.47% of wells (Table-6.21).

Fig.6.29
Water level fluctuation between May, 2014 and Decadal mean of May, 2004-2013



An analysis of 475 wells data indicate that 77.47% of wells (368) registered rise in water levels and 22.53% of wells (106) recorded fall in water levels.

Rise of less than 2 m is recorded in 43.15% of wells, 2-4 m in 19.78% of wells and more than 4 m is recorded in 14.52% of wells. Fall of less than 2 m is recorded in 16.63% of wells, 2-4 m in 2.94% of wells and fall of more than 4 m is registered in 2.73% of wells. Rise of more than 4 m is recorded maximum in Rangareddy district (23.19% of wells) while fall of more than 4 m is observed maximum in Hyderabad district (15.38% of wells).

DECADAL RISE IN WATER LEVELS

The rise in water level between May, 2014 and decadal mean of May (2004-13) is generalized as follows:

Out of 368 wells that have registered rise in water levels,
55.70% of wells recorded rise of less than 2 m, 25.54% of wells in 2 to 4 m while the rest of 18.75% of wells recorded rise of more than 4 m.
Rise of less than 2 m is observed in major parts of Khammam, Nalgonda, Adilabad and Nizamabad districts and as small isolated areas in all other districts (55.7% of wells).
Rise of 2-4 m is observed as small parts in all districts except Hyderabad district(25.54% of wells).
Rise of more than 4 m is observed mostly in Mahbubnagar and Rangareddy districts and as isolated areas in all other districts (18.75% of wells).

DECADAL FALL IN WATER LEVELS

Fall in water level between May, 2014 and decadal mean of May (2004-13) is generalized as follows:

Out of 106 wells that have registered fall in water levels,
74.52% of wells have recorded less than 2m fall, 2-4m in 13.20% of wells and the rest 12.26% of wells registered fall of more than 4m.
Fall of less than 2 m is noticed mostly in Khammam and Hyderabad districts and in smaller parts in all other districts(74.52% of wells).
Fall of 2-4 m is noticed in all districts except Adilabad, Hyderabad and Nalgonda districts as small isolated parts(13.2% of wells).
Fall of more than 4 m is noticed mostly in Hyderabad and Mahbubnagar districts(12.26% of wells).

Fig.6.30

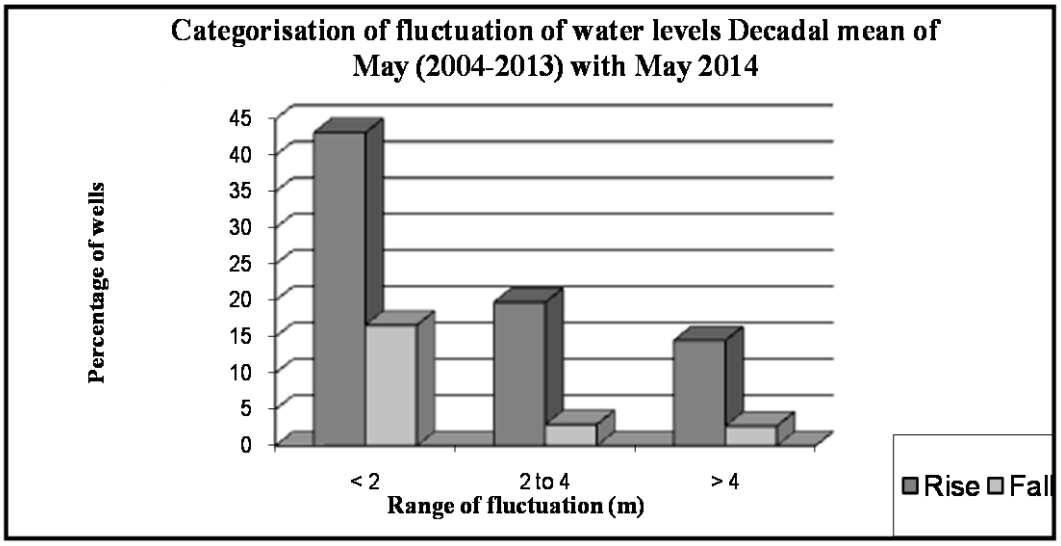


Table-6.21
Fluctuation and Frequency Distribution in Different fluctuation Ranges
May, 2014 Vs Decadal mean of May (2004-2013)

Sl No	District	Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation												Total No.	
			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	Adilabad	64	0.16	8.19	0.52	11.4	45	70.31	9	14.06	5	7.981	3	4.69	0	0	2	3.13	59	5
2	Hyderabad	13	0.07	4.14	0.05	12.87	5	38.46	0	0	1	7.69	5	38.46	0	0	2	15.38	6	7
3	Karimnagar	59	0.32	7.75	0.67	2.96	23	38.98	21	35.59	10	16.95	3	5.08	2	3.39	0	0	54	5
4	Khammam	47	0.29	4.09	0.02	3.97	21	44.68	2	4.26	1	2.13	21	44.68	2	4.26	0	0	24	23
5	Mababoobnagar	32	0.27	18.94	0.13	9.55	10	31.25	5	15.63	7	21.88	5	15.63	2	6.25	3	9.38	22	10
6	Medak	33	0	12.38	0.05	5.5	14	42.42	8	24.24	4	12.12	5	15.15	1	3.03	1	3.03	26	7
7	Nalgonda	41	0	13.2	0.13	5.57	18	43.9	6	14.63	7	17.07	8	19.51	0	0	2	4.88	31	10
8	Nizamabad	41	0.18	7.54	0.06	3.64	19	46.34	11	26.83	6	14.63	4	9.76	1	2.44	0	0	36	5
9	Ranga Reddy	69	0.1	18.72	0.08	8.53	20	28.99	13	18.84	16	23.19	15	21.74	3	4.35	1	1.45	49	19
10	Warangal	76	0.05	14.2	0.04	8.05	30	39.47	19	25.0	12	15.79	10	13.16	3	3.95	2	2.63	61	15
	Total State	475	0.0	18.94	0.02	12.87	205	43.15	94	19.78	69	14.52	79	16.63	14	2.94	13	2.73	368	106

6.6.9 Water Level Fluctuation during August 2014 with respect to decadal mean of August (2004-2013)

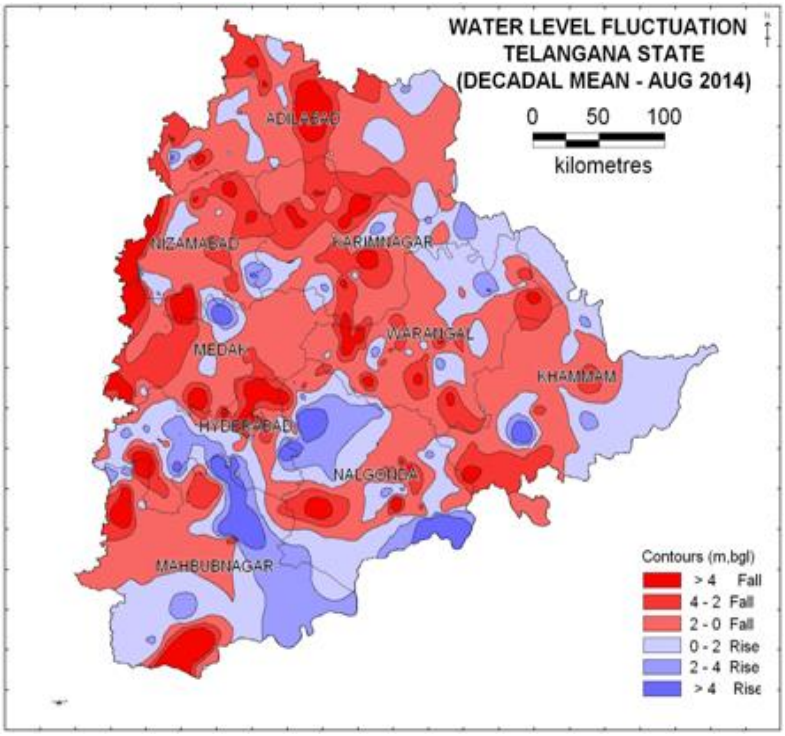
Water level fluctuation between August 2014 and decadal mean of August 2004-2013 is depicted in the Fig.6.31 and categorization of fluctuation is presented in the Fig.6.32. A general fall in water levels is prevalent in the State in 62.35% of wells (Table 6.22).An analysis of water level data of 494 wells reveals that 37.24% of wells have (184) registered rise, fall is recorded in 62.35% of wells (308) while no fluctuation is observed in 0.1% of wells (4).

Rise of less than 2 m is recorded in 24.69% of wells, 2-4 m in 8.3% of wells and rise of more than 4 m is recorded in 4.25% of wells. Fall of less than 2 m is recorded in 33.40% of wells in the range of 2-4 m in 17.2% of wells and fall of more than 4 m is registered in 11.74% of wells. Rise of more than 4 m is recorded maximum in Rangareddy district (13.24% of wells) while water level fall of more than 4 m is registered maximum in Hyderabad district (46.15% of wells).

RISE IN WATER LEVELS – DECADAL MEAN

The rise during August, 2014 with respect to decadal mean fluctuation (August - 2004-13) is generalised as follows;

Fig.6.31



Out of 184 wells that have registered rise in water levels, 66.3% of wells recorded rise of less than 2 m, 22.28% of wells in the range of 2 to 4 m while the rest of 11.41% of wells recorded l rise of more than 4 m.

Rise of less than 2 m is observed mostly in Khammam, Nalgonda and Mahbubnagar districts (66.3% of wells).

Rise of 2-4 m is observed as smaller parts in Mahbubnagar, Hyderabad, Rangareddy and Nalgonda districts(2.28% of wells).

Rise of more than 4 m is observed is observed in Mahbubnagar, Nalgonda and Rangareddy districts(11.41% of wells).

DECADAL FALL IN WATER LEVELS

The fall during August, 2014 with respect to decadal mean fluctuation (August - 2004-13) is generalized as follows;

Out of 308 wells that have registered fall in water levels, 53.57% of wells have recorded less than 2m fall, 2-4m in 27.59% of wells and 18.83% of wells registered of more than 4m.

Fall of less than 2 m is noticed mostly observed in all districts(53.57% of wells).

Fall of 2-4 m is noticed as smaller parts covering Hyderabad, Medak, Mahbubnagar, Rangareddy, Nalgonda and Kareemnagar districts(27.59% of wells). Fall of more than 4 m is noticed as smallisolated areas in all districts(83% of wells).

Fig.6.32

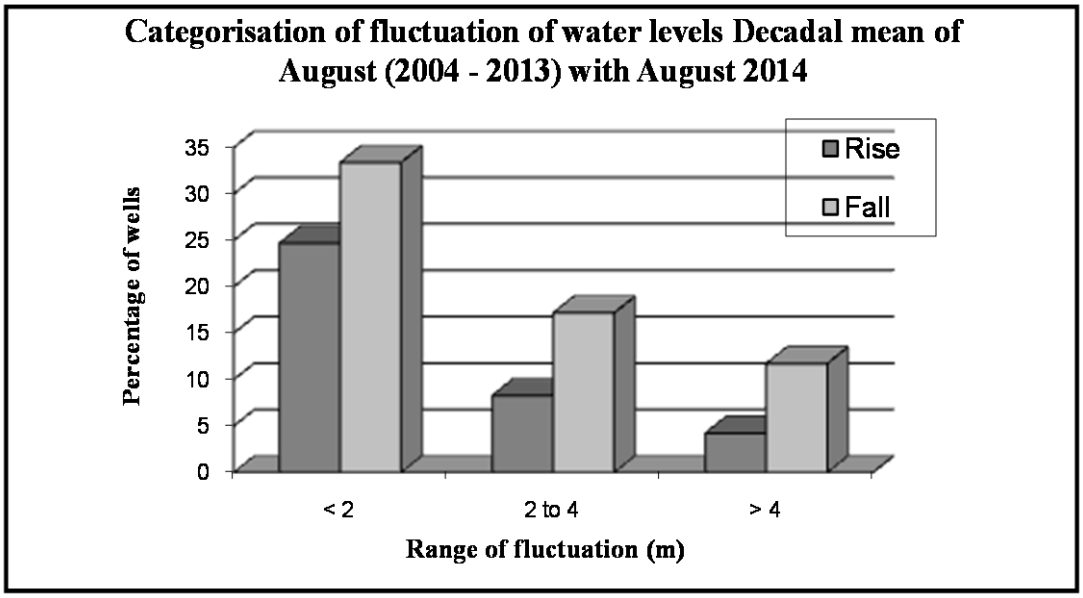


Table-6.22
District Wise Fluctuation and Frequency Distribution in Different Ranges
August (2004-2013) Vs August 2014

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No.	
							0 to 2		2 to 4		>4		0 to 2		2 to 4		>4		Rise	Fall
			Min	Max	Min	Max	No	%	N	%	No	%	No	%	N	%	No	%		
1	Adilabad	63	0.01	4.65	0.08	14.98	20	31.75	0	0	1	1.59	27	42.86	9	14.29	6	9.52	21	42
2	Hyderabad	13	0.08	1.49	0.16	7.43	4	30.77	0	0	0	0	1	7.69	2	15.38	6	46.1	4	9
3	Karimnagar	60	0.01	3.83	0.01	7.08	9	15.0	7	11.6	0	0	17	28.33	1	28.33	10	16.6	16	44
4	Khammam	44	0.13	9.33	0.09	5.37	20	45.45	2	4.55	1	2.27	13	29.55	6	13.64	1	2.27	23	20
5	Mababoobnaga	35	0.09	19.49	0.03	11.34	8	22.86	4	11.4	4	11.43	8	22.86	5	14.29	6	17.1	16	19
6	Medak	33	0.08	7.83	0.02	7.88	3	9.09	0	0	1	3.03	14	42.42	9	27.27	5	15.1	4	28
7	Nalgonda	60	0.06	13.53	0.02	9.97	13	21.67	9	15.0	4	6.67	22	36.67	7	11.67	5	8.33	26	34
8	Nizamabad	39	0.05	3.66	0.0	22.61	6	15.38	3	7.69	0	0	18	45.15	6	15.38	6	15.3	9	30
9	Ranga Reddy	68	0.19	12.04	0.14	7.09	19	27.94	1	17.6	9	13.24	17	25.0	6	8.82	5	7.35	40	28
10	Warangal	79	0.1	4.33	0.07	9.2	20	25.32	4	5.06	1	1.27	28	35.44	1	22.78	8	10.1	25	54
	Total State	494	0.01	19.49	0.0	22.61	122	17.09	4	5.19	21	5.41	165	32.25	8	20.12	58		18	308

6.6.10 Water level fluctuation during November, 2014 with respect to Decadal Mean fluctuation of November (2004-2013)

Water level fluctuation between November, 2014 and decadal means of November 2004-2013 is depicted in the Fig6.33 and categorization of fluctuation is presented in the Fig.6.34. A general fall in water levels in 79.95% of wells (Table - 6.23) is observed in the State.
An analysis of data of 499 wells divulges that 20.05% of wells (100) registered rise while fall in 79.95% of wells (399).

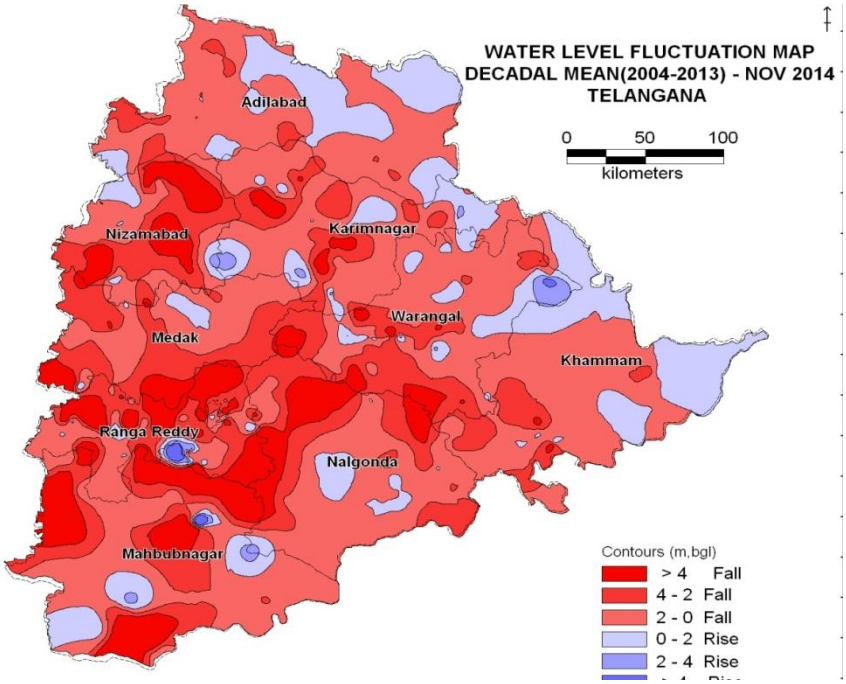
Rise of less than 2 m is recorded in 16.63% of wells, 2-4 m in 2.6% of wells and rise of more than 4 m is recorded in 0.8% of wells. Fall of less than 2 m is recorded in 38.67% of wells in the range of 2-4 m in 22.44% of wells and fall of more than 4 m is registered in 18.83% of wells.

Rise of more than 4 m is recorded maximum in Mahbubnagar district (5.41% of wells), fall of more than 4 m is registered maximum in Rangareddy district (37.31% of wells).

DECADAL RISE IN WATER LEVELS **Fig.6.33**

Rise in during November, 2014 with reference to decadal mean fluctuation of November (2004-13) is generalised as follows;

Out of 100 wells that have registered rise in water levels, 83% of wells recorded rise of less than 2 m in Khammam, Hyderabad and Adilabad districts, 13% of wells have registered 2 to 4 m as small isolated parts in Karimnagar, Mahbubnagar , Nizamabad and Rangareddy districts, while 4% of wells recorded rise of more than 4 m in Mahbubnagar, Warangal and Rangareddy districts.



DECADAL FALL IN WATER LEVELS

Fall during November, 2014 with reference to decadal mean fluctuation of November (2004-13) is generalised as follows;

Out of 399 wells that have registered fall in water levels, 48.37% of wells have recorded less than 2m fall in Adilabad and Nalgonda and as small part in all the districts, 2-4m in 28.07% of wells covering all the districts and 23.55% of wells registered fall of more than 4m as small areas in all districts except Adilabad district.

Fig.6.34

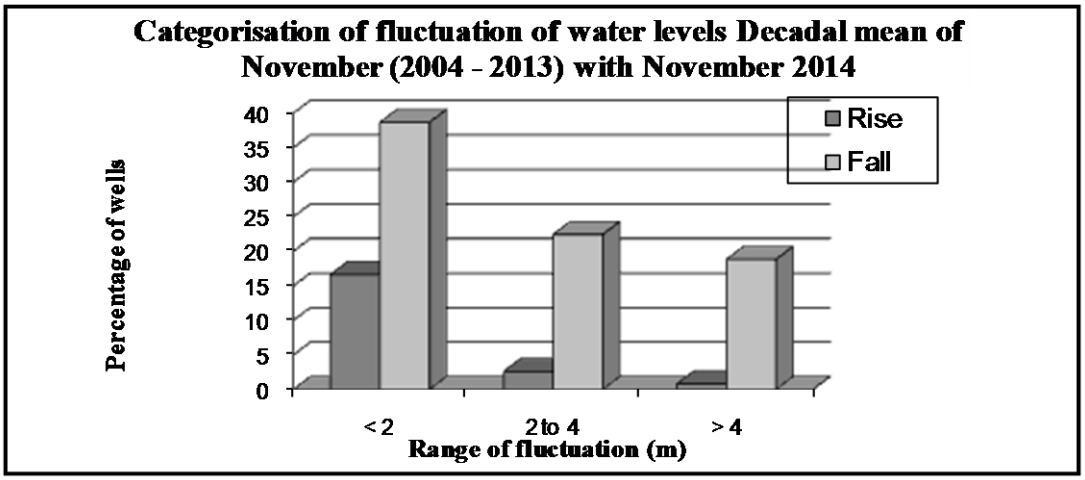


Table-6.23
Fluctuation and Frequency Distribution in Different Ranges of fluctuation
November, 2014 Vs decadal mean of November(2004-2013)

s no	District		Rise		Fall		Rise						Fall						Total No. of	
							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	Adilabad	65	0.02	1.62	0.05	3.44	18	27.69	0	0.00	0	0	34	52.31	13	20	0	0	18	47
2	Hyderabad	10	0.27	0.95	0.82	8.70	3	30.00	0	0.00	0	0	2	20.00	2	20	3	30	3	7
3	Karimnagar	58	0.20	3.07	0.15	5.96	9	15.52	4	6.90	0	0	23	39.66	12	20.69	10	17.24	13	45
4	Khammam	54	0.01	1.23	0.01	4.70	19	35.19	0	0.00	0	0	25	46.30	8	14.81	2	3.7	19	35
5	Mahaboobnagar	37	1.09	11.70	0.04	12.87	1	2.70	1	2.70	2	5.41	12	32.43	8	21.62	13	35.14	4	33
6	Medak	34	0.31	1.92	0.01	7.94	4	11.76	0	0.00	0	0	10	29.41	12	35.29	8	23.53	4	30
7	Nalgonda	60	0.05	3.08	0.02	8.19	9	15.00	1	1.67	0	0	30	50.00	11	18.33	9	15	10	50
8	Nizamabad	44	0.15	3.13	0.20	14.80	3	6.82	2	4.55	0	0	12	27.27	13	29.55	14	31.82	5	39
9	Ranga Reddy	67	0.15	4.28	0.05	13.55	6	8.96	3	4.48	1	1.49	21	31.34	11	16.42	25	37.31	10	57
10	Warangal	70	0.06	4.79	0.03	7.89	11	15.71	2	2.86	1	1.43	24	34.29	22	31.43	10	14.29	14	56
	Total State	499	0.95	1.09	0.01	14.80	83	16.63	13	2.6	4	0.8	193	38.67	112	22.44	94	18.83	100	399

6.6.11 Decadal Mean of January (2005-2014) Vs January 2015

Fluctuation of water levels during January, 2015 with reference to decadal mean fluctuation of January (2005-2014) is depicted in Fig.6.35 and categorization of fluctuation is presented in the Fig.6.36. Fall of water levels in 74.86% of wells (Table-6.24) is observed in the state. An analysis of water level data of 529 wells indicate that 21.76% of wells have (131) registered rise in water levels, fall in 74.86% of wells (397) while no fluctuation is recorded in, 0.37% of wells (2).

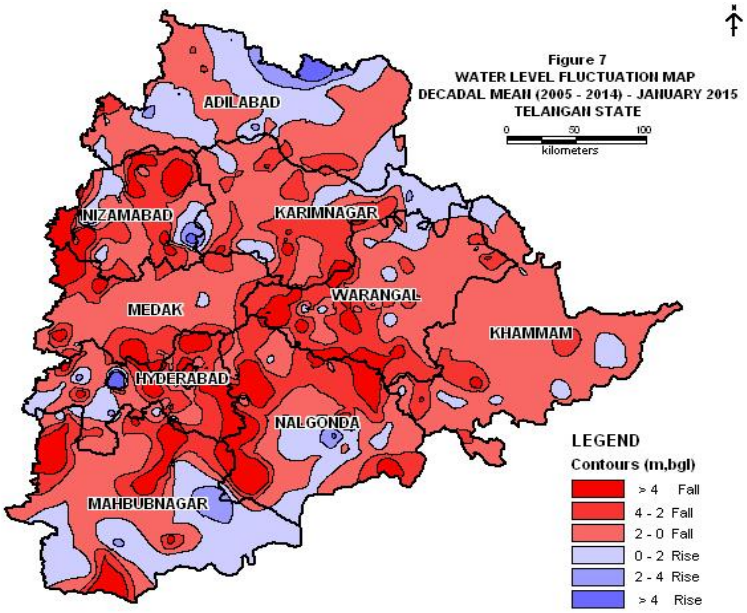
Rise of less than 2 m is recorded in 20.42% of wells, 2-4 m in 3.21% of wells and rise of more than 4 m is recorded in 1.13% of wells. Fall of less than 2 m is recorded in 38.56% of wells, 2-4 m in 20.42% of wells and fall of more than 4 m is registered in 15.88% of wells. Water level rise of more than 4 m is recorded maximum in Nizamabad district (4.08% of wells) while water level fall of more than 4 m is registered maximum in Warangal district (22.78% of wells).

DECADAL RISE IN WATER LEVELS

Fig.6.35

The rise during January, 2015 with reference to decadal mean fluctuation of January (2005-14) is generalised as follows;

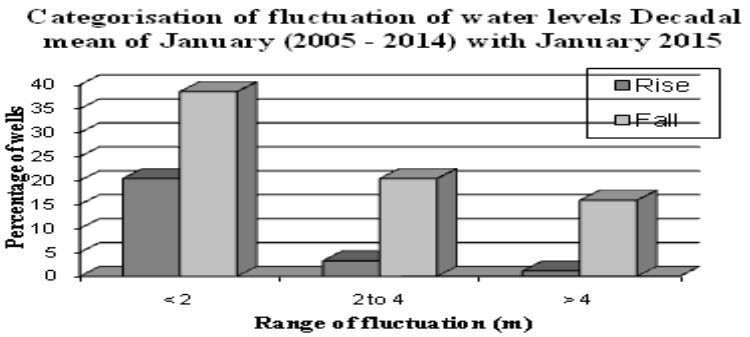
Out of the 131 wells that have registered rise in water levels, 82.44% of wells recorded rise of less than 2 m mostly in Adilabad and Nalgonda districts and as small parts in all other districts, 2 to 4 m rise in 12.98% of wells in all districts except Hyderabad, Khammam and Medak districts, while rise of more than 4 m has recorded in 4.58% of wells as small isolated parts in Adilabad, Mahbubnagar,Nalgonda,Nizamabad and Rangareddy districts.



DECADAL FALL IN WATER LEVELS

The fall during January, 2015 with reference to decadal mean fluctuation of January (2005-14) is generalised as follows;

Fig-6.36



Out of 396 wells that have registered fall in 51.52% of wells have recorded less than 2m fall mostly in Adilabad, Karimnagar, Medak, Nalgonda, Rangareddy & Warangal and as small parts in all the districts. 2-4m fall is noticed in 27.27% of wells as smaller areas covering all the districts. Fall of more than 4m is observed in 21.21% of wells in all districts as isolated areas.

Table-6.24

Fluctuation and Frequency Distribution in Different Ranges of Fluctuation January, 2015 Vs Decadal mean fluctuation of January (2005-2014)

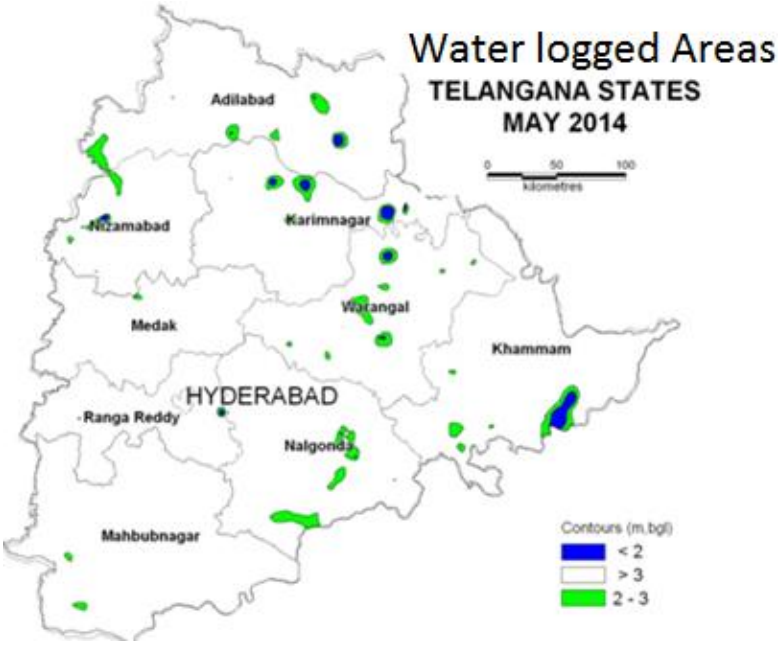
Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells/ Percentage Showing Fluctuation												Total No. of Wells	
			Rise		Fall		Rise						Fall							
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4		Rise	Fall
			Min	Max	Min	Max	No	%	N	%	No	%	No	%	No	%	N	%		
1	Adilabad	63	0.02	5.92	0.12	4.21	27	42.8	6	9.52	1	1.59	20	31.75	5	7.94	2	3.17	34	27
2	Hyderabad	12	0.27	1.46	0.14	9.76	3	25	0	0	0	0	2	16.67	5	41.6	2	16.7	3	9
3	Karimnagar	60	0.04	3.01	0.08	5.91	12	20	1	1.67	0	0	21	35	20	33.3	6	10	13	47
4	Khammam	54	0.01	0.71	0.02	5	9	16.6	0	0	0	0	37	68.52	7	12.9	1	1.85	9	45
5	Mahaboobnaga	38	0.66	9.97	0.1	10.0	7	18.4	3	7.89	1	2.63	12	31.58	3	7.89	12	31.6	11	27
6	Medak	34	0.08	0.33	0.08	8.57	3	8.82	0	0	0	0	17	50	8	23.5	6	17.7	3	31
7	Nalgonda	68	0.08	4.35	0.12	13.7	20	29.4	1	1.47	1	1.47	21	30.88	13	19.1	12	17.7	22	46
8	Nizamabad	49	0.05	5.86	0.2	16.2	9	18.3	1	2.04	2	4.08	15	30.61	12	24.4	10	20.4	12	37
9	Ranga Reddy	72	0.1	21.44	0.08	11.1	8	11.1	4	5.56	1	1.39	30	41.67	14	19.4	15	20.8	13	59
10	Warangal	79	0.04	2.43	0	12.9	10	12.6	1	1.27	0	0	29	36.71	21	26.5	18	22.8	11	68
	Total State	529	0.01	21.44	0	16.26	108	20.42	17	3.21	6	1.13	204	38.56	108	20.42	84	15.9	131	396

6.7 Water Logged and Area Prone to Water Logging

6.7.1 Pre-monsoon Period

Water Logged Area

Fig.6.37



Map depicting demarcation of water logged area and area prone to water logging during pre-monsoon (May,2014) is presented in the Fig.6.37. Water logged areas are observed as small patches in Khammama, Karimnagar, Warangal and Adilabad districts. The total water logged area during pre-monsoon is 519 sq.km viz about 0.45% of the total area of the State.

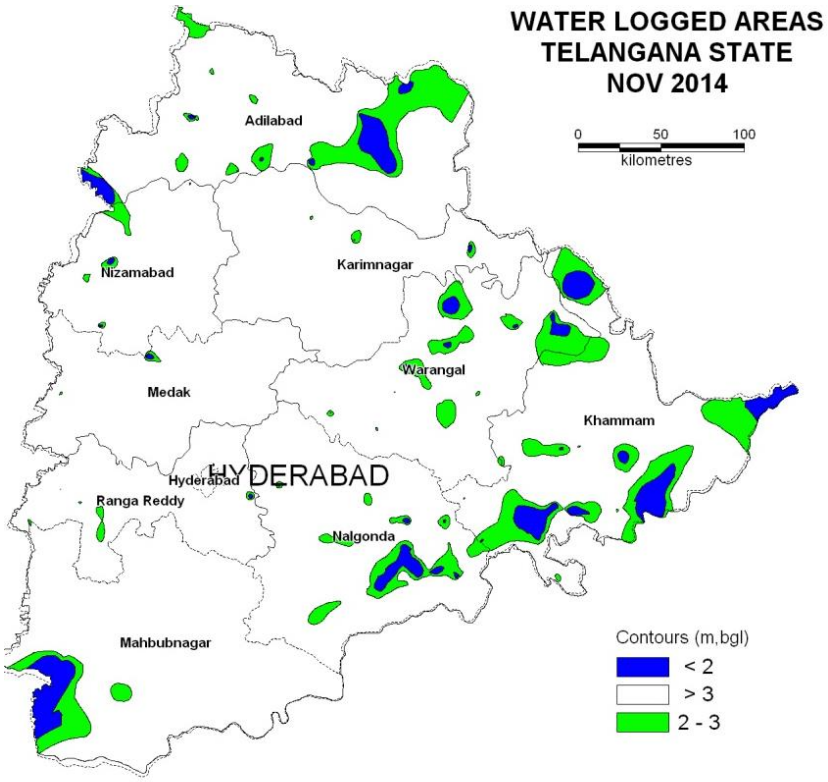
Area Prone to Water Logging

During pre-monsoon (May, 2014), area prone to water logging (depth to water level, 2 to 3mbgl) is observed as small isolated areas in Adialbad, Nizamabad, Karimnagar, Warangal, Nalgonda and Khammam districts. The total area prone to water logging during pre-monsoon is 2403 Sq. km viz 2.1% of the total area of the State.

6.7.2 Post-monsoon Period

Water Logged Area

Fig.6.38



Water logged areas and the areas prone to water logging during post-monsoon (November 2014) is presented in the Fig.6.38. Water logged areas with depth to water level less than 2mbgl are observed as small patches in Adilabad, Warangal, Khammam, Nalgonda and Mahabubnagar districts. The total water logged area during the post-monsoon is 3265 sq.km viz 2.8% of the total area of the State.

Area Prone to Water Logging

A perusal of the Fig.6.37 shows that the area prove to water logging with water level between 2 to 3 mbgl is observed as small isolated areas in Khammam, Warangal, Adilabad, Mahabubnagar and Nalgonda districts. The total estimated area prone to water logging during post monsoon is 8856 sq.km constituting 7.7% of total geographical area of the State.

7.0 GROUND WATER QUALITY

The ground water occurrence and availability is largely governed by the state of cementation and compaction of formation, which control the pore volume. In Telangana a sizable proportion of population is dependent on ground water for drinking and other household utilities besides its use in irrigation at large. Due to limited cost effective treatment options for polluted ground water, the affected resource is generally lost for drinking and other utilities.

The quality of ground water in some parts of the country, particularly shallow ground water, is changing as a result of human activities. Ground water is less susceptible to bacterial pollution than surface water because the soil and rocks through which ground water flows screen out most of the bacteria. Bacteria, however, occasionally find their way into ground water, sometimes in dangerously high concentrations. But freedom from bacterial pollution alone does not mean that the water is fit to drink. Many unseen dissolved mineral and organic constituents are present in ground water in various concentrations. Most are harmless or even beneficial; though occurring infrequently, others are harmful, and a few may be highly toxic.

Water is a solvent and dissolves minerals from the rocks with which it comes in contact. Ground water may contain dissolved minerals and gases that give tangy taste enjoyed by many people. Without these minerals and gases, the water would taste flat. The most common dissolved mineral substances are sodium, calcium, magnesium, potassium, chloride, bicarbonate, and sulfate. In water chemistry, these substances are called common constituents.

Water typically is not considered desirable for drinking if the quantity of dissolved minerals exceeds 1,000 mg/L (milligrams per liter). Water with a few thousand mg/L of dissolved minerals is classed as slightly saline, but it is sometimes used in areas where less-mineralized water is not available. Water from some wells and springs contains very large concentrations of dissolved minerals and cannot be tolerated by human and animals or plants.

Ground water studies are incomplete until understanding both the physical and chemical dynamics of the system. In ground water studies, the physical characteristics of the flow system tell us the potential for ground water to move from one place to another. Chemistry tells us where it went and what it did along the way. This area of research, known as hydro-geochemistry, allows researchers to determine the time and source of recharge, estimate how long the water has been in the aquifer (residence time), identify the mineralogy of the aquifer material, examine the degree of mixing between waters of various sources and evaluate what types of chemical processes have occurred during the it's journey through the system. This information provides a broad, more regionally extensive understanding of groundwater systems. Furthermore, this improved knowledge can be used to create more comprehensive management and conservation plans, and more equitable groundwater regulations.

With rapid growth of population, the development and use of ground water for domestic, irrigation and industrial purposes has increased too many fold. At the same time, this vital resource is polluted anthrophogenically in the process, to such an extent it is rendered unsuitable for above purposes, in certain areas. Once the pollution has entered the sub-surface environment, it may remain concealed for many years and dispersed over wide areas of ground water aquifers. Because natural dilution is slow, artificial flushing is expensive and treatment is impractical, the effects of such pollution may continue for indefinite period. In this context the evaluation of ground water in terms of physical, chemical and bacteriological characteristics is important to determine its suitability for drinking, irrigation and industrial uses and to remedial

measures to protect it from further deterioration. A data base on ground water quality is generated by monitoring the observation wells.

7.1 QUALITY OF SHALLOW GROUNDWATER

Rainwater infiltrates into the soil and interacts with carbon dioxide in soils to become acidic. This acidic water then comes in contact and dissolves minerals in the soil. Eventually the water becomes neutral to mildly alkaline. This process is even more enhanced when cation exchange (in the case of calcium for sodium) takes place. Ground water interacts with the soils and other materials as it flows through them, becoming more mineralized over time, and distance. Some earth material, such as glacial tills or marine shales, contains soluble minerals that dissolve relatively rapidly in groundwater and can cause deterioration of groundwater quality at a shallow depth.

Water that contains a lot of calcium and magnesium is said to be hard. The hardness of water is expressed in terms of the amount of calcium carbonate-the principal constituent of limestone-or equivalent minerals that would be formed if the water is evaporated. Water is considered as soft if it contains 0 to 60 mg/L of hardness, moderately hard from 61 to 120 mg/L, hard between 121 and 180 mg/L, and very hard if more than 180 mg/L. Very hard water is not desirable for many domestic uses; it will leave a scaly deposit on the inside of pipes, boilers, and tanks. Hard water can be softened at a fairly reasonable cost, but it is not always desirable to remove all the minerals that make water hard. Extremely soft water is likely to corrode metals, although it is preferred for laundering, dish washing, and bathing.

In recent years, the growth of industry, technology, population, and water use has increased the stress upon both our land and water resources. Locally, the quality of ground water has been degraded. Municipal and industrial wastes and chemical fertilizers, herbicides, and pesticides not properly contained have entered the soil, infiltrated some aquifers, and degraded the ground-water quality. Other pollution problems include sewer leakage, faulty septic-tank operation, and landfill leachates. In some coastal areas, intensive pumping of fresh ground water has caused salt water to intrude into fresh-water aquifers.

In recognition of the potential for pollution, biological and chemical analyses are made routinely on municipal and industrial water supplies. Central, State, and local agencies are taking steps to increase water-quality monitoring. Analytical techniques have been refined so that early warning can be given, and plans can be implemented to mitigate or prevent water-quality hazards.

A network of monitoring wells has been periodically monitored for water quality determination. This monitoring is intended to provide scientific information regarding the variability of chemical constituents within aquifers in the state. During May, 2013(pre-monsoon), 303 samples were collected from Ground Water Monitoring Wells (GWMW) to assess the quality of ground water from shallow aquifers in the state of Telangana. Water to be used for drinking and domestic purposes should be chemically safe and free from undesirable physical properties such as temperature, colour, turbidity and unpleasant taste or odour. The potability of ground water is judged based on drinking water specifications of Bureau of Indian Standards (BIS)-IS-10500(2003): 2012

pH

pH is the most common measure of the acidity/alkalinity balance in a solution. It is a measure of the availability of hydrogen ions (H+) in solution, also known as “protons”; this is why pH is

sometimes referred to as an indicator of the "proton acidity" of ground water. In formal terms, pH is defined as the negative logarithm (to base 10) of the hydrogen ion activity (in moles/liter). Values commonly fall in the range between 0 to 14, normally reported without units. The pH of ground water is varying from 6.8 to 8.9. On the observation made, found 9(2.8%) locations crossed the BIS limits.

Fig.7.1

Electrical conductivity (EC)

Although strictly termed "specific electrical conductance" in practice the term "conductivity" is very widely used. The ability of given water to conduct electricity is directly proportional to the amount of dissolved, charged species (ions) which it contains. Conductivity values are normally expressed in units of microsiemens per centimeter (µS/cm), or else for more saline water, in millisiemens per centimeter (mS/cm). (1 mS/cm = 1000 µS/cm) at 25ºC. By use of an empirical factor, Electrical conductivity enables a rough estimate to be made of the dissolved mineral content of water samples. Electrical conductivity varying from 84 to 11,250 µS/cm at 25^0C (Fig.7.1).

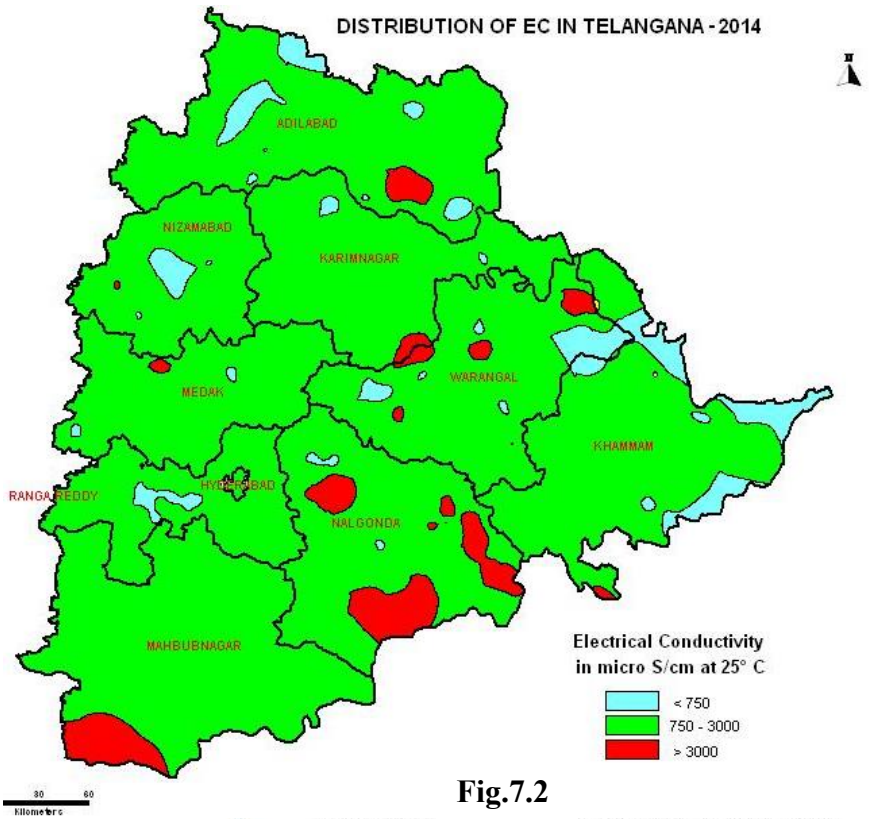
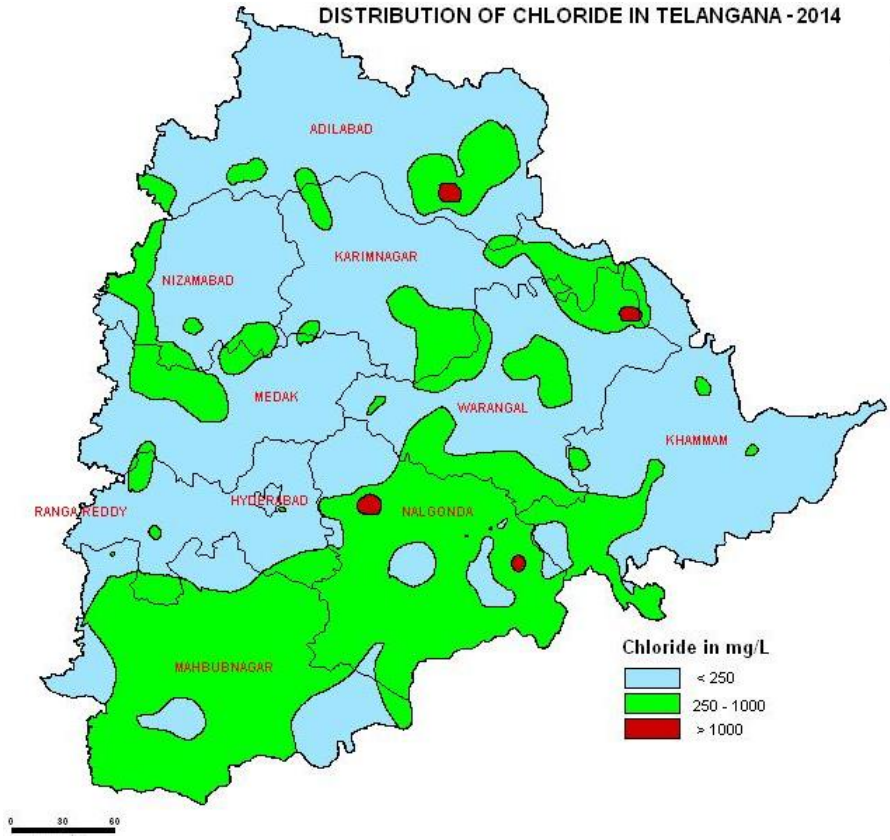


Fig.7.2

Electrical conductivity in proportion to Total Dissolved Solids (TDS) exceeds BIS permissible limit of 3000 micromhos /cm in 6.8% of the samples.

Chloride

A main natural source of chloride is Halite dissolution. Small amounts occur naturally in rainfall. Pollutant Cl^- is very common, and occurs in human, animal and industrial wastes. Chloride is very conservative chemically, and is therefore a good groundwater tracer, unlike sulphate, for instance, which is retarded by reactions. Chloride

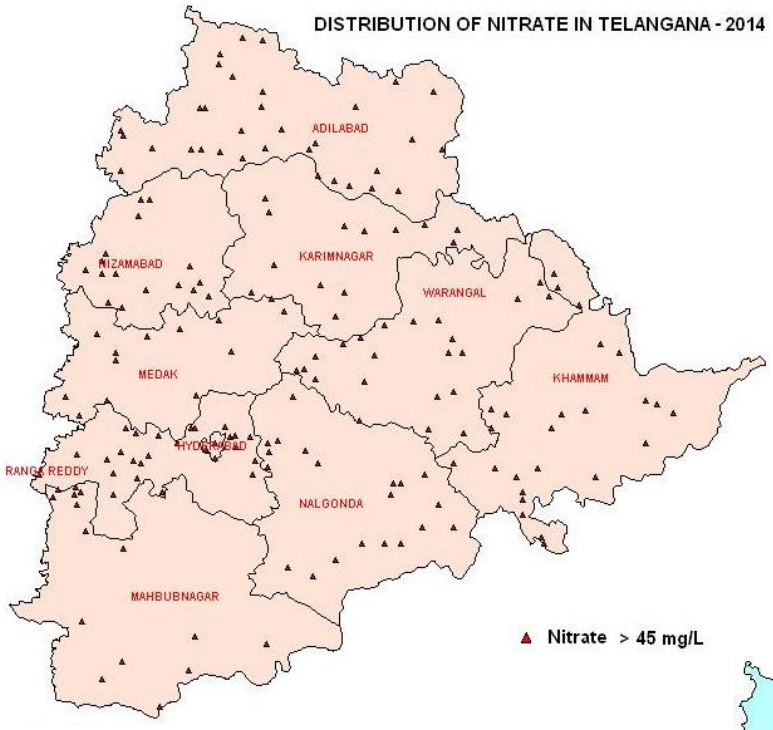


occurs in all natural waters in varying concentrations. The chloride content increase as the soluble mineral content increases. Chlorides in reasonable concentrations are not harmful to human beings. At concentrations above 1000 mg/L water acquires salty taste which is objectionable to many people. Only 1.5% of the samples of the state have chloride concentration beyond BIS permissible limit (Fig.7.2).

Nitrate

The presence of high nitrate concentration would normally indicate pollution of ground water at some state of its history. Since presence of excess nitrate ions is deleterious to human health, their occurrence in ground water is a matter of great concern. The leaching of nitrate from agriculture land has been a major research topic in recent years. Although commercial fertilizers are suspected to be a major source of nitrate in ground water, researchers have also identified natural organic nitrogen, livestock, septic tanks and atmospheric inputs as contributing factors.

Fig.7.3

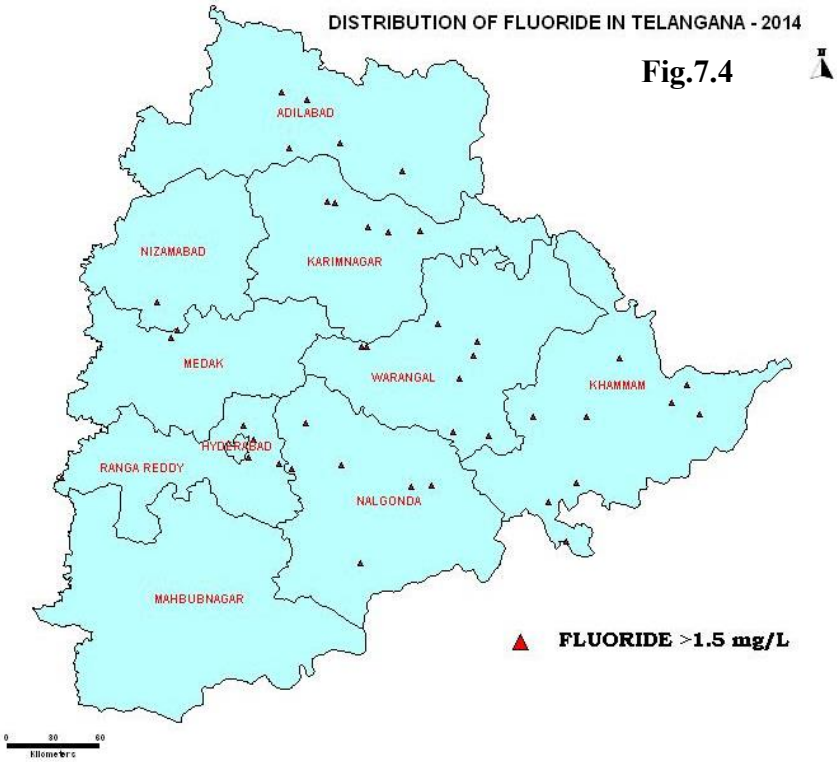


Nitrate exceeds the BIS permissible limit of 45 mg/L in 58.2% of the samples. When we observe closely the average levels of Nitrate (102 ppm) is much higher than BIS recommended. Distribution of Nitrate in Telangana is shown in the Fig.7.3.

Fluoride

It is a minor constituent of natural water, but plays an important role in assessing the quality of water for domestic use. Deleterious effects of fluoride on human system are well known. Fluoride acts as two edged sword. It is beneficial when present in concentrations of 0.8-1.0mg/L for calcification of dental enamel especially for the children below 8 years of age. Below this limit it can cause dental carries. It can cause dental fluorosis if present in excess of 1.5mg/L and if such water consumed for long. Fluoride exceeds the BIS permissible limit of 1.5 mg/L in 14.6% of the samples. The distribution of Fluoride in Telangana State is presented in the Fig.7.4.

Fig.7.4



7.2 QUALITY OF GROUND WATER FOR DRINKING PURPOSE

The hydro chemical data is compared with the drinking water quality standards set by Bureau of Indian Standards to asses the suitability of ground water from shallow aquifers for drinking purposes. The minimum, maximum and average concentrations of various chemical parameters in all the districts of the state are presented in the Table-7.1. Unsuitability of the ground water (shallow aquifers) for drinking purposes with reference to chemical parameters is presented in the Table-7.2. Spatial distribution of electrical conductivity, chloride, nitrate and fluoride in the state are shown in the Fig.7.1 -7.4. In general, the ground water from shallow aquifers is alkaline in nature and average p^H value is 7.8.

Electrical conductivity varies from 84 to 11250µs/cm at 25^0C with an average value of 1557 µs/cm at 25^0C. In Nalgonda district the average value of EC is highest followed by Mahbubnagar and Medak, in all 2.8% of samples are beyond permissible limit of BIS. It is also evident from the F.g7.1, majority of samples have EC values between 750-3000µs/ cm at 25^0C.

Chloride Content in shallow ground water samples varies from 7.1 to 3049 mg/L. 1.55% of samples exceeds the BIS permissibility. Highest percent of samples in Nalgonda(7.32%) and Warangal(2.38%) districts are unsuitable for drinking. It is evident from the Fig.7.2 that chloride value is less than 250mg/l in majority of samples.

The average Nitrate content in the ground water is 102 mg/L. 58% of samples are exceeding the BIS permissible value indicating the anthropogenic contamination, which is less than the previous years. Highest percent of samples in Mahbubnagar and Rangareddy districts are unfit for drinking.

Fluoride content varies from 0.04 to 4.2 mg/L, with an average of 0.81 mg/L, which is less when compared to previous year. 14.6% of samples in the state exceeds BIS permissibility. Highest percent of samples in Nalgonda and followed by Khammam and Adilabad districts are unfit for drinking.

7.3 QUALITY FOR IRRIGATION

The most extensive use of ground water in the world is for irrigation purpose. The chemical quality of ground water is an important factor to be considered in evaluating its usefulness for irrigation as poor quality ground water may cause salinity, specific ion toxicity or infiltration problem in soils and adversely affect crop production. Successful usage of particular ground water for irrigation purpose depends on many factors; not directly associated with water consumption. In addition to the quality of water used for irrigation purpose, it is also important to know nature of soil, nature of crop, climate condition. In arid regions soils of heavy texture and of high pH, usually develop alkalinity and salinity problems much more quickly than the light sandy soils. Besides texture, permeability, drainage, water table, calcium status and pH are other factors, which govern the effect of the water on soil. Some crops are more tolerant to saline water than others. In areas of good rainfall even poor quality of water can be used with advantage as number of irrigations would be small and high rainfall will have moderate effect by leaching salts.

Water quality constraints in irrigation can be examined using a number of empirical indices that have been established on the basis of field experience and experiments. Each has been useful but none has been entirely satisfactory because of the wide variability in field conditions.

Table-7.1
Minimum, Maximum and Average values of various Chemical Parameters in Telangana State

District	Maxima Minima Average	pH	EC µs/cm at 25^{0}C	Cl	NO3	F
				mg/L		
TELANGANA	Maxima	8.9	11250	3049	1226	4.2
	Minima	6.8	84	7.1	0	0.04
	Average	7.8	1557	227	102	0.81
Adilabad	Maxima	8.4	10700	1843	369	4.2
	Minima	7.2	343	14	0.0	0.09
	Average	7.9	1377	178	95	0.82
Nizambad	Maxima	8.4	3393	553	660	3.4
	Minima	7.1	425	21	0.25	0.14
	Average	7.6	1436	207	116	0.67
Medak	Maxima	8.3	3466	560	424	2.9
	Minima	7.0	630	21	1.2	0.1
	Average	7.7	1477	198	92	0.82
Ranga Reddy	Maxima	8.3	2191	369	211	2.8
	Minima	7.3	600	28	7.4	0.12
	Average	7.7	1177	142	83	0.74
Hyderabad	Maxima	8.3	1250	177	66	1.1
	Minima	7.4	558	43	2.2	0.42
	Average	7.9	921	100	34	0.73
Mahbubnagar	Maxima	8.3	4443	709	457	0.85
	Minima	7.3	1070	110	16	0.24
	Average	7.7	2024	312	156	0.47
Nalgonda	Maxima	8.4	7860	1843	627	3.3
	Minima	7.3	608	35	0.0	0.13
	Average	7.8	2331	409	122	0.86
Khammam	Maxima	8.6	3270	688	285	4.0
	Minima	7.4	92	7	0.0	0.04
	Average	7.9	1387	173	70	0.9
Warangal	Maxima	8.6	11250	3049	1226	2.3
	Minima	6.8	84	7	0	0.11
	Average	7.8	1730	293	133	0.8
Karimnagar	Maxima	8.6	2790	581	662	2.6
	Minima	7.0	485	21	0.6	0.07
	Average	7.8	1356	180	99	1.0

Table- 7.2
Unsuitability of ground water with respect to different chemical constituents for drinking purpose.

District	Total Samples	% Samples Of Unsuitability			
		TDS	Cl	NO3	F
Adilabad	48	2.1	2.1	66.7	14.8
Nizamabad	29	3.5	0.0	58.6	3.45
Medak	22	4.5	0.0	59.1	13.6
Rangareddy	35	0.0	0.0	71.4	14.3
Hyderabad	8	0.0	0.0	37.5	0.0
Mahbubnagar	17	5.9	0.0	82.4	0.0
Nalgonda	41	19.5	7.3	48.8	19.5
Khammam	54	3.7	11.0	50.0	18.5
Warangal	42	2.4	2.4	4.8	0.0
Karimnagar	27	4.8	0.0	52.4	14.3
TELANGANA	323	5.9	1.55	58.0	14.6

US salinity laboratory classification

The laboratory has constructed a diagram and described 16 classes with reference to Sodium Absorption Ratio (SAR) as an index for sodium hazard and electrical conductivity as an index for salinity hazard. SAR is defined as

$$SAR = (Na^{+})/Sqrt\{(Ca^{+2}+Mg^{+2})/2\}$$ Where concentrations are expressed in meq/L

The ground water in Telangana State comes under 9 classes as described below;

C_1S_1:
Low salinity and low sodium waters are good for irrigation and can be used for most of the crops with no restriction on use on most of the soils.
C_2S_1:
Medium salinity and low sodium waters are good for irrigation and can be used on all most all soils with a little danger of development of harmful levels of exchangeable sodium if moderate amount of leaching occurs. Crops can be grown without any special consideration for salinity control.

C_3S_1:
High salinity and low sodium waters require good drainage. Crops with good salt tolerance should be selected.

C_3S_2: High salinity and medium sodium waters require good drainage and can be used on coarse textured or organic soils having good permeability.

C_3S_3:
High salinity and high sodium waters require special soil management, good drainage, high leaching and organic matter additions. Gypsum amendments make feasible the use of these waters.

C_4S_1:
Very high salinity and low sodium waters are not suitable for irrigation unless the soil must be permeable and drainage must be adequate. Irrigation waters must be applied in excess to provide considerable leaching. Salt tolerant crops must be selected.

C_4S_2:
Very high salinity and medium sodium waters are not suitable for irrigation on fine textured soils and low leaching conditions and can be used for irrigation on coarse textured or organic soils having good permeability.

C_4S_3:
Very high salinity and high sodium waters produce harmful levels of exchangeable sodium in most soils and will require special soil management, good drainage, high leaching and organic matter additions. Gypsum amendements makes feasible the use of these waters.

C_4S_4:
Very high salinity and very high sodium waters are generally unsuitable for irrigation purpose. These are sodium chloride type of waters and can cause sodium hazard. Can be used on coarse textured soils with very good drainage for very high salt tolerant crops. Gypsum amendments make feasible the use of these waters.

The locations of ground water samples in the State plotted on the US salinity diagram is shown in the Fig.7.5 and district wise diagrams are shown in the Fig.7.5A to J. It is observed that 34.7% of samples are falling in C_2S_1 class, 49.2% in C_3S_1 class, 9.9% in C_3S_2 class, 1.6% in C_4S_3, 1.2% of samples falling in C_3S_3, and remaining samples comes under C_1S_1, C_4S_2, C_4S_3, C_3S_4, C_2S_2 and C_4S_1 classes.

Fig.7.5

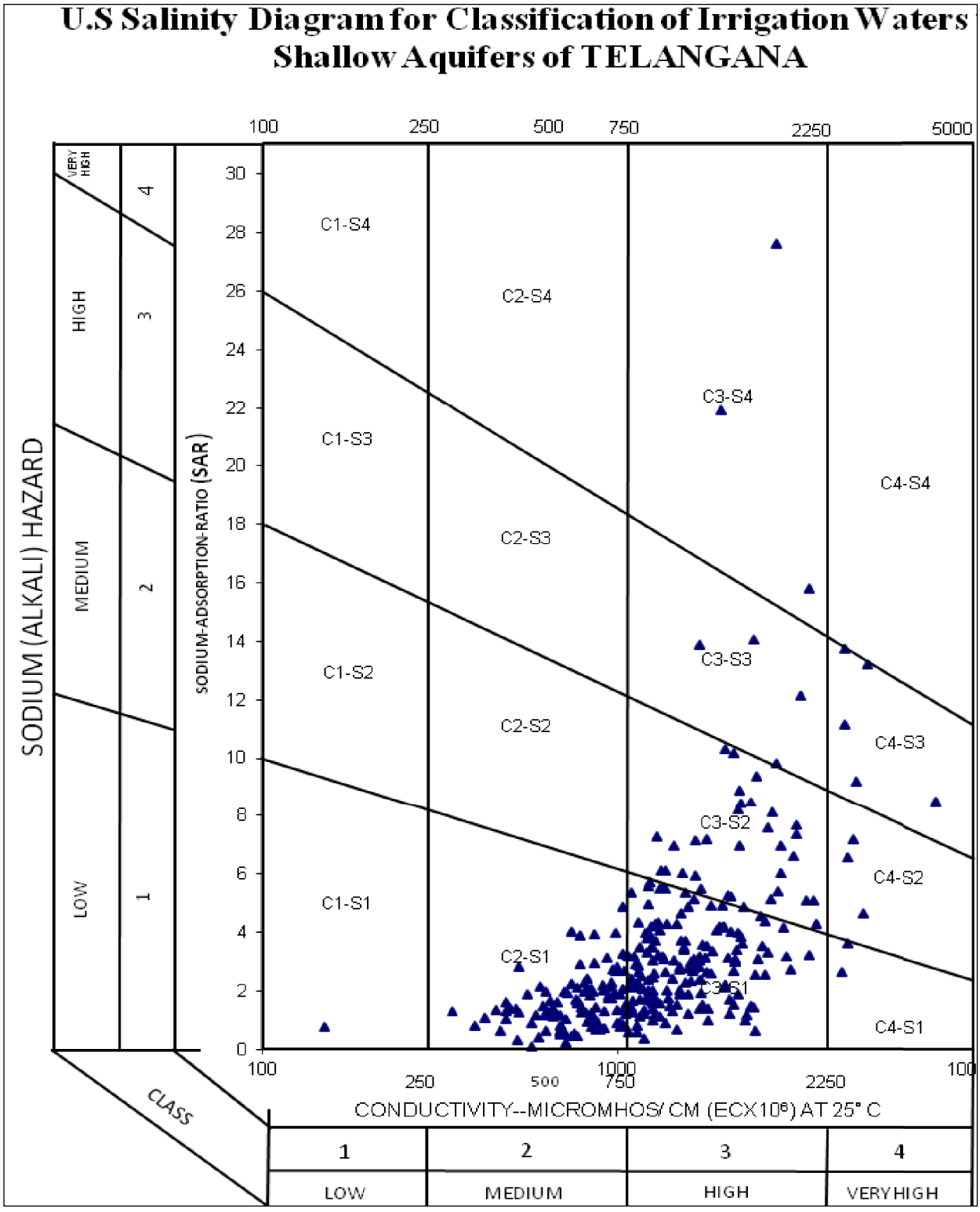


Fig.7.5A to F DISTRICT WISE - US SALINITY DIGRAMS

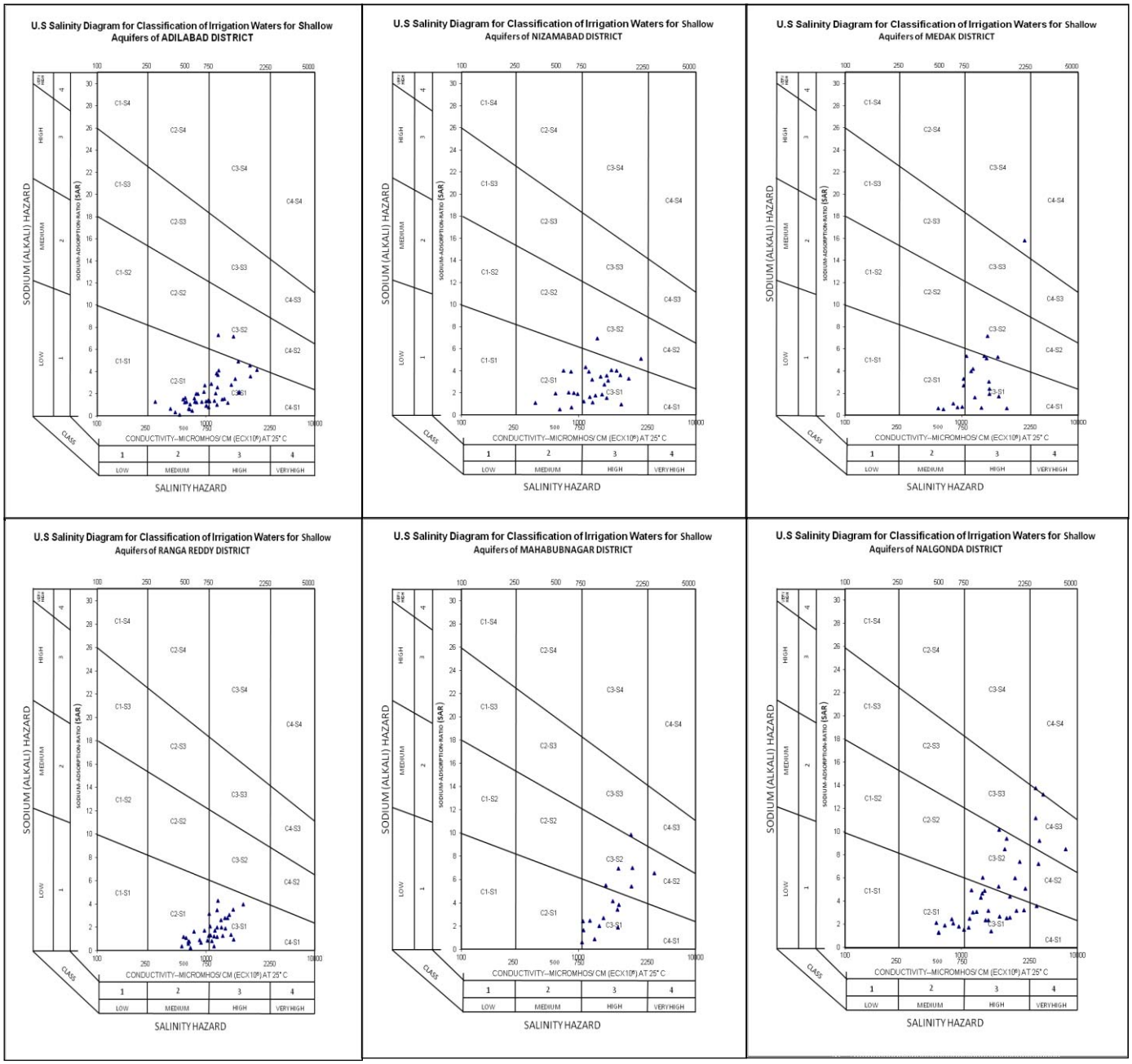
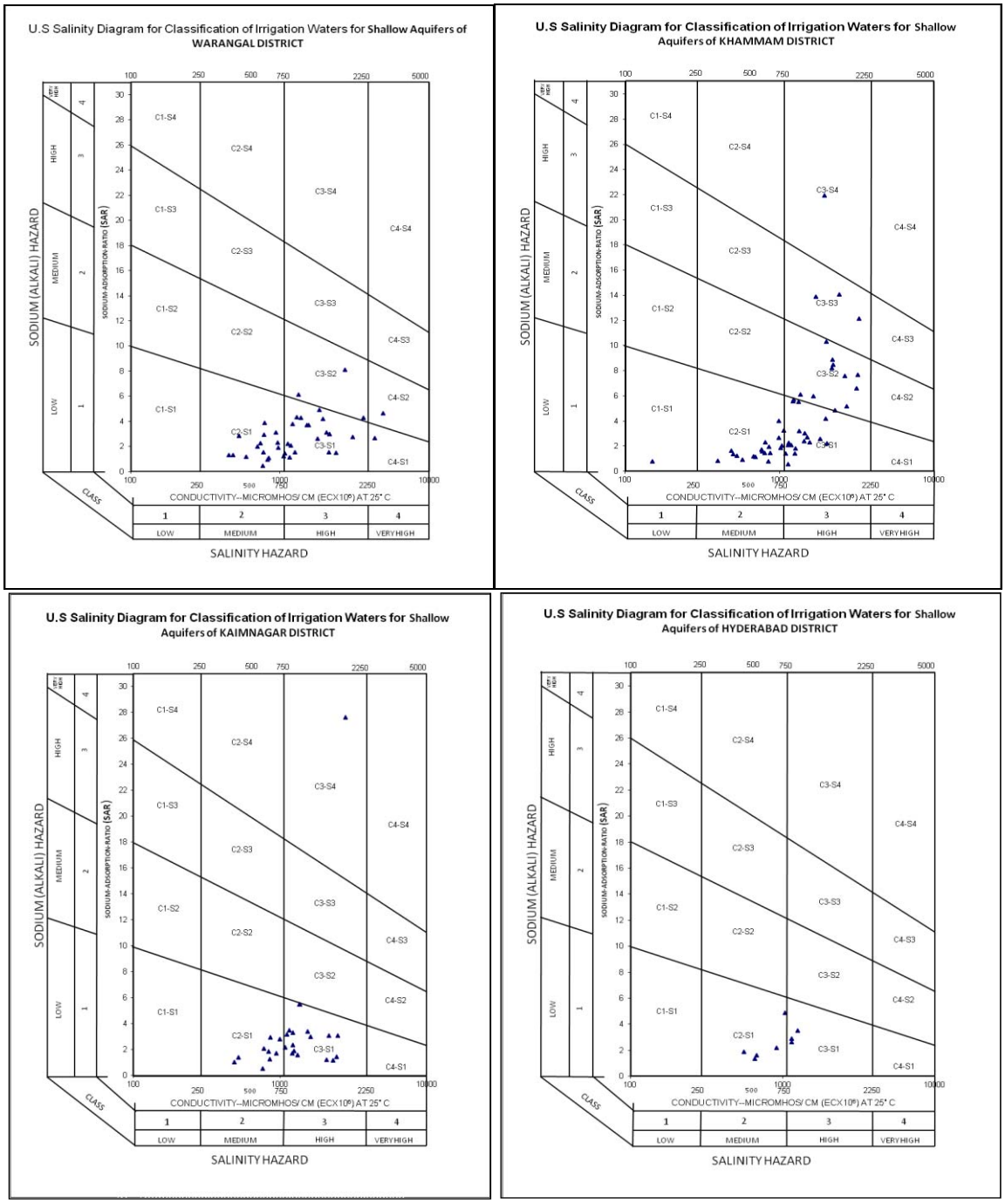


Fig.7.5G to J DISTRICT WISE - US SALINITY DIGRAMS



Piper Trilinear linear diagram is presented in the Fig.7.6 The most dominanat water types in the Sate are Ca-HCO_3, Na-Mg-HCO_3 and Na-Ca-HCO_3 type.

Fig.7.6

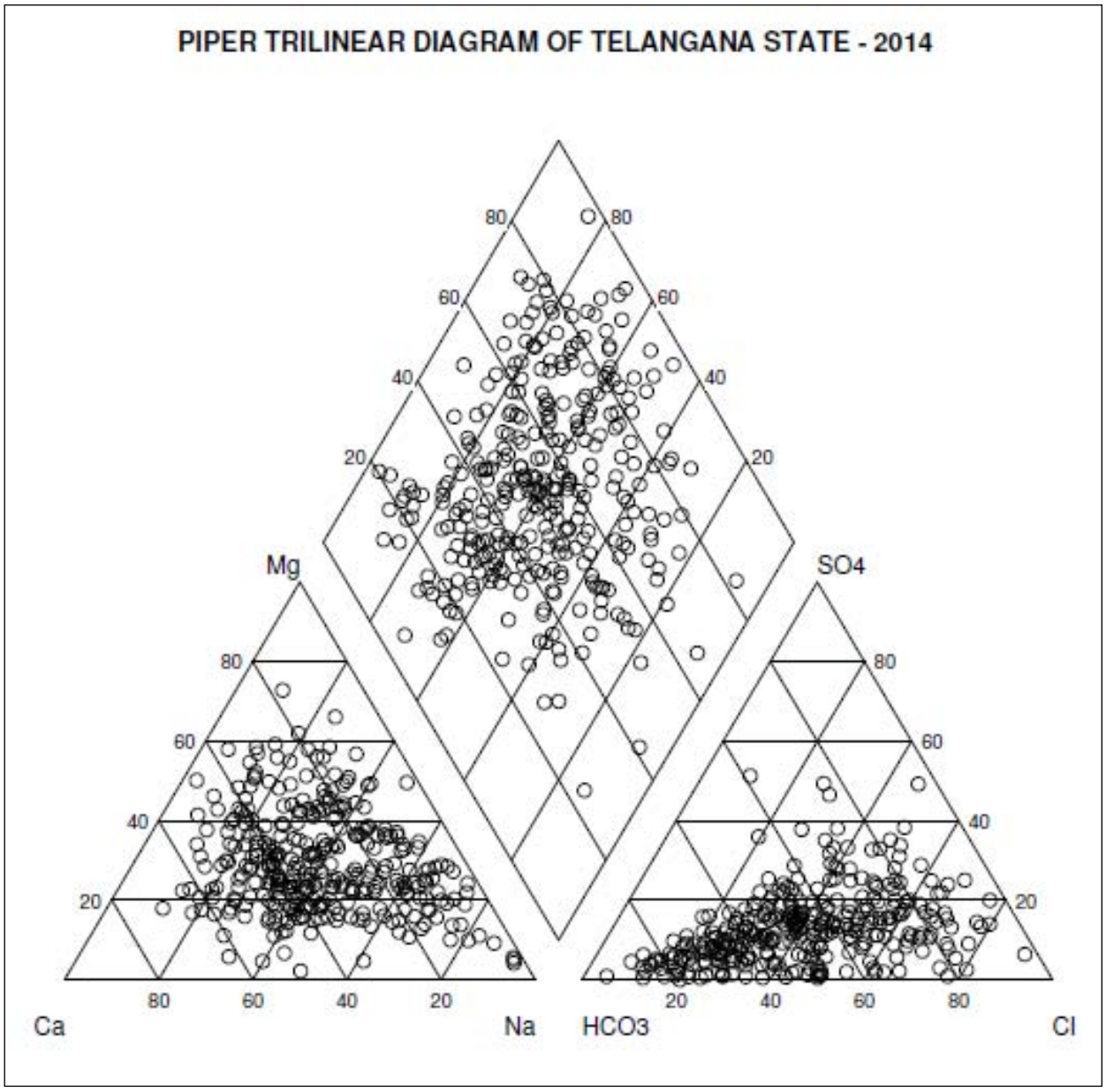
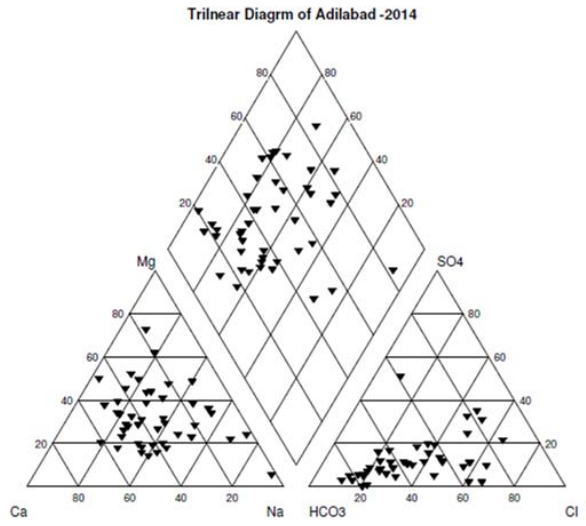
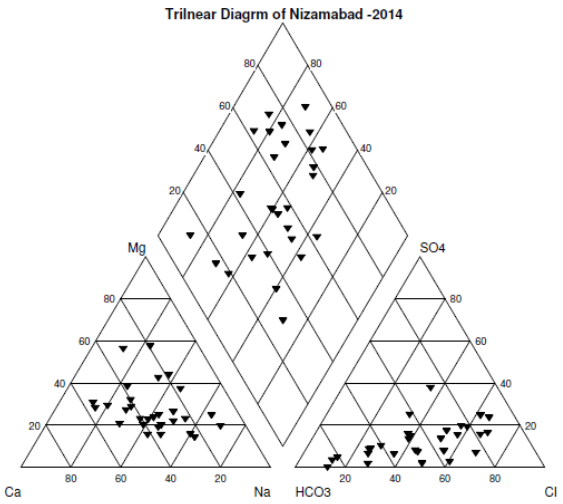
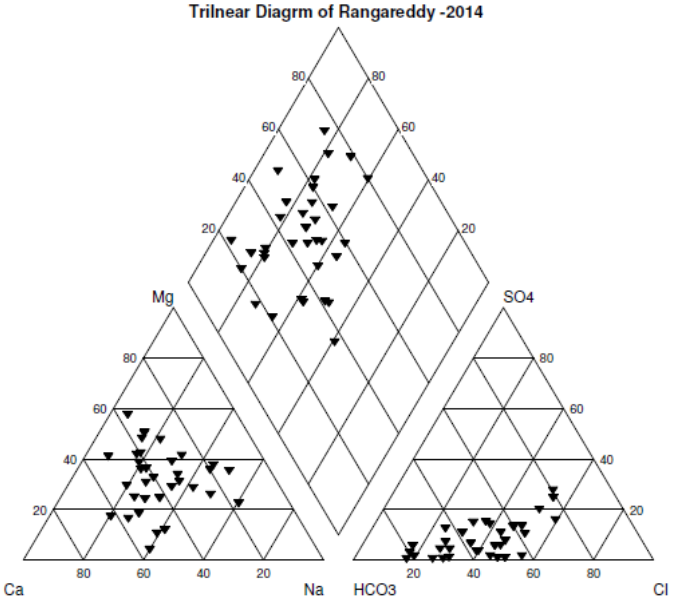


Fig.7.6 A-J
Disdtict wise Piper Trilinear linear diagram





Trilnear Diagrm of Rangareddy -2014



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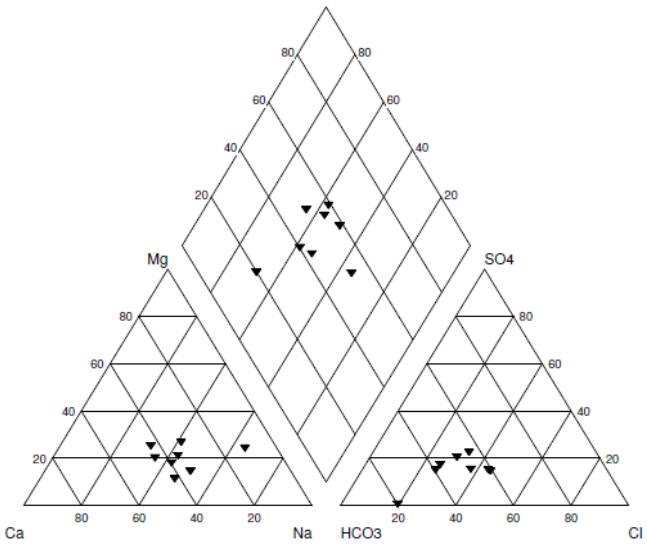

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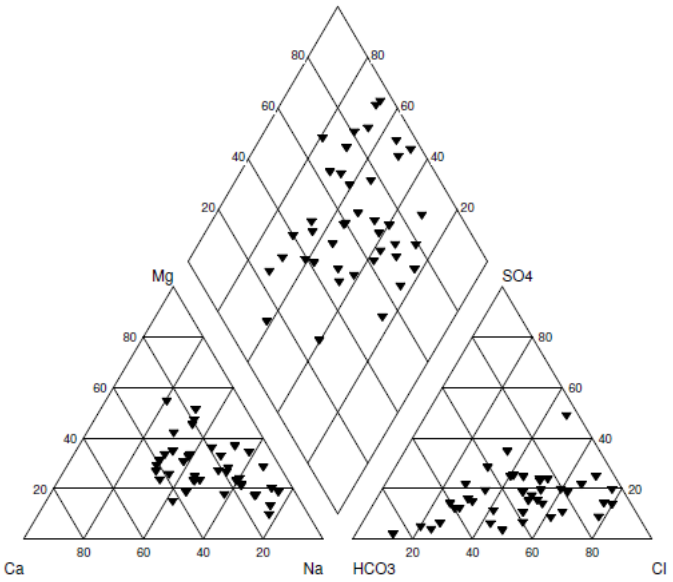

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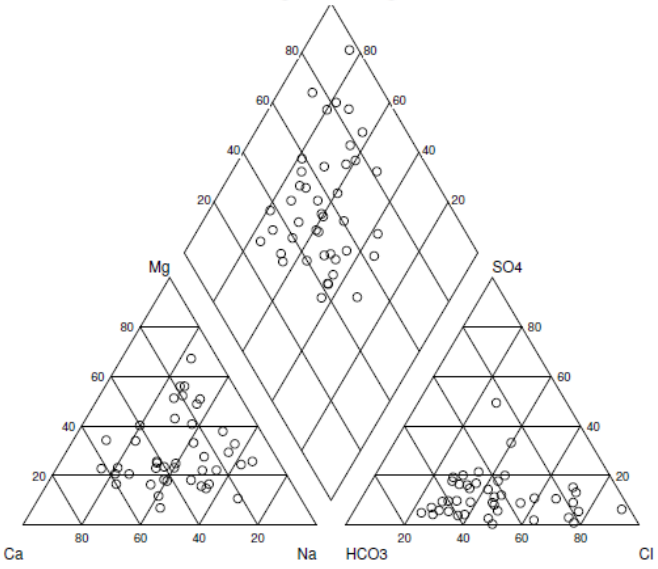

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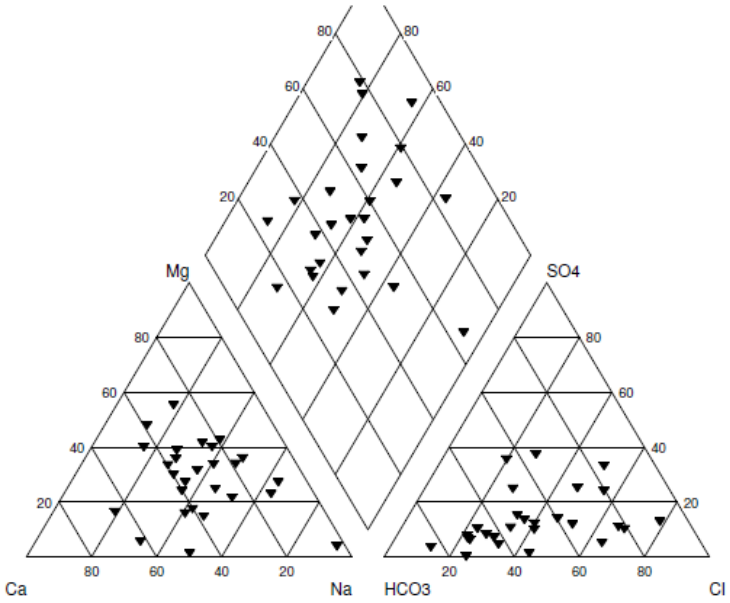

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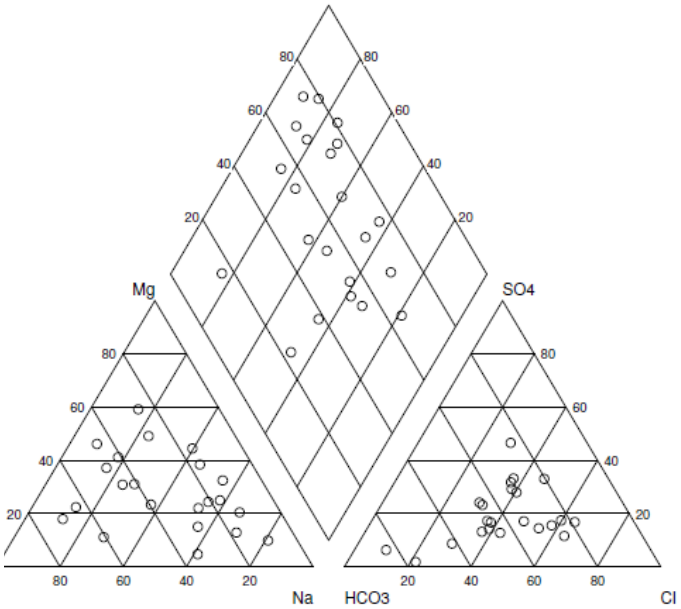

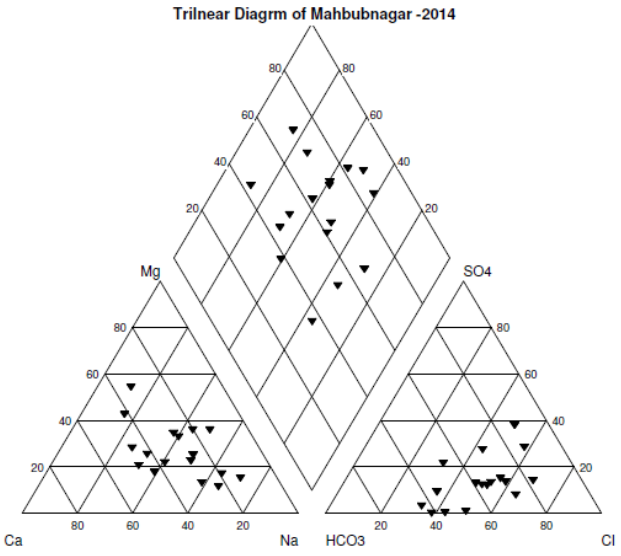

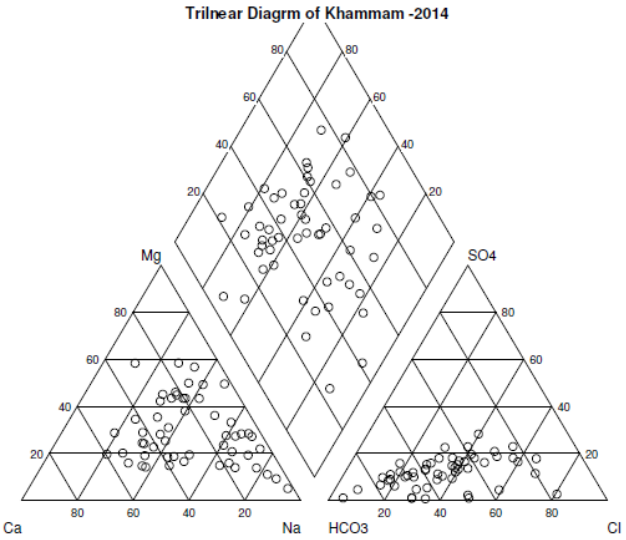

7.4 WATER SUITABILITY FOR LIVE STOCK AND POULTRY

Though there was no Livestock standards regulated in India, based on FAO and other international organizations classified the water quality for Livestock and Poultry. One of the important parameter is Salinity/Electrical Conductivity, which moderately shows the suitability of most of the samples in usable. Magnesium and Nitrate are other important parameters to be considered for usage of ground water for the livestock. Magnesium is also with in the range specified. Nitrate concentration is suitable for the live stock, except in one case.

Table-7.3
Guide for use of saline water for livestock and poultry and no of samples in limits

Soluble salt content	Rating	No of samples in the range	Uses
< 1 000 mg/litre (<1.5 dS/m)	Excellent	226	Excellent for all classes of livestock and poultry
1 000-3 000 mg/litre (1.5-5 dS/m)	Very satisfactory	93	Satisfactory for all classes of livestock. May cause temporary mild diarrhoea in livestock not accustomed to them. Those waters approaching the upper limits may cause some watery droppings in poultry.
3 000-5 000 mg/litre (5-8 dS/m)	Satisfactory for livestock Unfit for poultry	2	Satisfactory for livestock but may be refused by animals not accustomed to it. If sulphate salts predominate, animals may show temporary diarrhoea. Poor waters for poultry, often causing watery faeces, increased mortality and decreased growth especially in turkeys.
5 000-7 000 mg/litre (8-11 dS/m)	Limited use for livestock Unfit for poultry	2	This water can be used for livestock except for those that are pregnant or lactating. It may have some laxative effect and may be refused by animals until they become accustomed to it. It is unsatisfactory for poultry
7 000-10 000 mg/litre (11-16 dS/m)	Very limited use	0	Considerable risk for pregnant and lactating cows, horses, sheep and for the young of these species. It may be used for older ruminants or horses. Unfit for poultry and probably swine.
> 10 000 mg/litre (> 16 dS/m)	Not recommended	0	This water is unsatisfactory for all classes of livestock and poultry.

Source: FAO, 1985b, and Guyer, 1996

Table - 7.4 Suggested Limits For Magnesium In Drinking Water For Livestock[1]			
Livestock	No of Samples within the range	Magnesium (mg/l)	Concentration (me/l)
Poultry[2]	320	<250	<21
Swine[2]	320	<250	<21
Horses	320	250	<21
Cows (lactating)	320	250	<21
Ewes with lambs	320	250	<21
Beef cattle	323	400	33
Adult sheep on dry feed	323	500	41

[1] Adapted from Australian Water Resources Council (1969).
[2] The tolerance of swine and poultry for magnesium is unknown but could well be less than 250 mg/l.

Table-7.5
Guide to use of waters containing nitrates for livestock

Nitrate content* as parts per million (ppm) of nitrate nitrogen (NO3-N)**	As Nitrate, NO3	No samples in the range	Comments
Less than 100	<440	316	Experimental evidence indicates this water should not harm livestock or poultry.
100 to 300	440 - 1320	7	This water by itself should not harm livestock or poultry. If hays or silages contain high levels of nitrate this water may contribute significantly to a nitrate problem in cattle, sheep, or horses.
More than 300	> 1320	0	This water could cause typical nitrate poisoning in cattle, sheep, or horses, and its use for these animals is not recommended. Because this level of nitrate contributes to the salts content in a significant amount, use of this water for swine or poultry should be avoided.

Source : Water Quality for Livestock and Poultry, FO-1864-GO. University of Minnesota Extension Division, 1990.
* The values shown include nitrate and nitrite nitrogen. In no case should the waters contain more than 50 ppm nitrite nitrogen (NO2N) because of the greater toxicity of the nitrite form.
**1 ppm of nitrate nitrogen is equivalent to 4.4 ppm of nitrate (NO3).

7.5 OVER VIEW OF GROUND WATER QUALITY

- Monitored 323 ground water monitoring wells during May, 2014 in the state to assess the quality of shallow ground water.
- In general pH is in the range of 6.8 to 8.9.
- Total Dissolved Solids (TDS) value is beyond 2000 mg/L in 5.9% of the samples. In general it is in the range of 500-2000 mg/L
- Alkalinity exceeds BIS limit of 600mg/L in 16 samples in the state.
- Sodium is in the range of 4.0 - 2300 mg/L.
- Potassium is in the range of traces to 625 mg/L. In general it varies from 0 to 10 mg/L.
- Chloride concentration is beyond BIS permissible limit only in 1.5% of the samples In general it varies from 50 to 500 mg/L.
- Sulphate exceeds the BIS permissible limit of 400 mg/L in 3.4% of the samples. In general it is in the range of 5 to 200 mg/L.
- Fluoride exceeds the BIS permissible limit of 1.5 mg/L in 14.6% of the samples. it varies from 0.3 to 1.0 mg/L.
- Ground water in majority of the locations fall in C_3S_1 class followed by C_2S_1 , C_3S_2 , C_3S_3, C_4S_4, C_1S_1, C_4S_2, C_4S_3, C_3S_4, C_2S_2 and C_4S_1.

- Dominant Water types are Ca-HCO_3, Na-Mg-HCO_3 and Na-Ca-HCO_3 type.
- Most of the samples are suitable for livestock and poultry consumption.
- Highest values of Electrical Conductivity (11250 μS/cm) Hardness (4850 mg/L) Nitrate (1226 mg/L) are noticed at Mylaram of Warangal district.
- Maximum values of Chloride (3049 mg/L)and Sulphate (1488 mg/L) are found at Medaram of Adilabad district.
- High Fluoride levels are (4.2 mg/L) found at Jainoor of Adilabad district.