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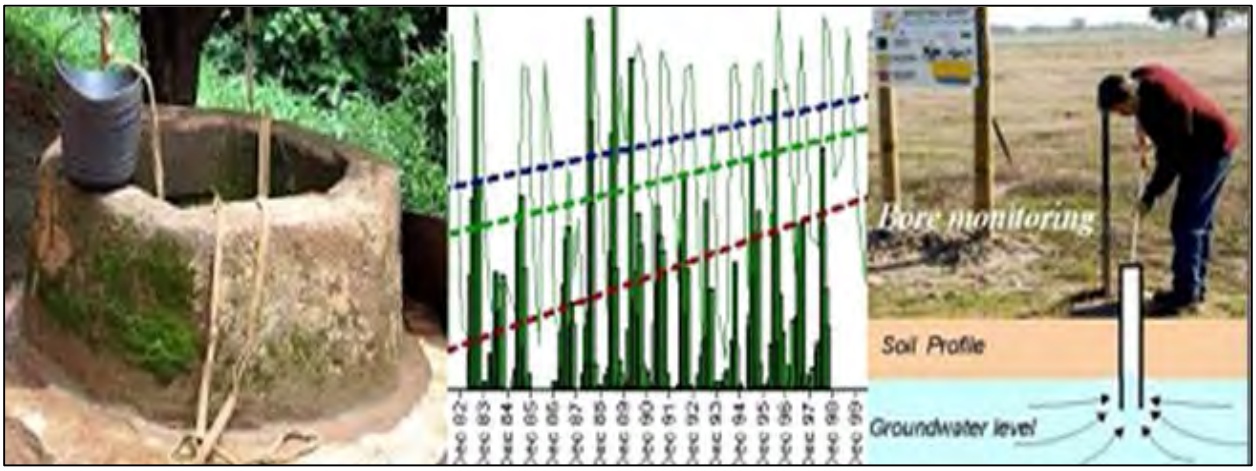
Central Ground Water Board

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

GROUND WATER YEAR BOOK
2013-14
TELANGANA STATE



By
A.B.Kawade, Scientist-C (Sr. Hydrogeologist)
&
P.Sudhakar, Scientist-C (Hydrometeorologist)

Southern Region, Hyderabad
January, 2015

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CONTRIBUTORS

Principal Authors

A. B. Kawade, Scientist-C (Sr. Hydrogeologist)
P. Sudhakar, Scientist-C (Hydrometeorologist)

Ground Water Quality

M. Bhaskar Reddy, Scientist-B
K.M. Prasad, ***Scientist-B***
Y SatyaKumar, Asst.chemist

Map Generation

P. Sudhakar, Scientist-C (Hydrometerologist)
Lubna Koser, Asst. Hydrologist

Report Processing & Issuance

G.Y.Setty, Scientist-C
M.K.Rafiuddin, Scientist-C

Overall Supervision and Guidance

A. D. Rao
Regional Director,
Southern Region, Hyderabad

GROUND WATER YEAR BOOK
2013-14
TELANGANA STATE

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FOREWORD

The historical ground water monitoring data is useful in understanding changes in ground water regime in time and space for preparation of sustainable management plan for the country. Central Ground Water Board has been monitoring ground water regime since 1969. During the year 2013-2014, 122 new ground water monitoring wells (108 dug wells and 14 piezometers) were established forming a network of 699 National Ground Water Monitoring Wells including 345 dug wells and 354 Piezometers as on 31-3-2014. These stations are being monitored four times a year during May, August, November and January to study the seasonal and long term changes. The water samples are also collected once in a year during May for chemical analysis. The ground water monitoring, during 2013-14, carried out by Central Ground Water Board, Southern Region, Hyderabad, outlines the water level behavior 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-C, Sri.P.Sudhakar, Scientist-C (HM), Ms. Lubna Kauser, Asst.Hydrologist, Sri.Bhaskar Reddy, Scientist-B, Sri.K.Maruthi Prasad and Scientist-B and Sri. Y. Satya Kumar, Asstt. Chemist in preparation of the year book are commendable. The efforts of Sri. G.Y.Setty, Scientist-C and Sri M.K.Rafiuddin, Scientist-C, Report Processing Section, in scrutiny, processing and issuance of the report are also appreciated.

It is hoped that the 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
31.01.2015

(A.D.Rao)
REGIONAL DIRECTOR

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

In Telangana State, a total of 699 (345 dug wells and 354 Piezometers) Ground Water Monitoring wells are in existance as on 31-03-2014. The Water levels are being monitored four times in a year i.e, in the months of May, August, November, and January. The Ground Water Year Book-2013-14 pertains to the monitoring carried out during the four monitoring periods in AAP 2013-14. The report elaborates the ground water level scenario in the State and describes the regional behaviour of water levels.

During the year 2013, the State had received annual rainfall of 1243 mm, 32% more than the normal rainfall of 939 mm. It is normal to deficit in all the districts of the state. Highest annual rainfall of 1608 mm is recorded in Adilabad district and lowest annual rainfall of 732 mm is recorded in Mahabubnagar district. Monthly rainfall ranges from 1 mm in December to 374mm in July. July, 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 2013-14, the water levels vary between 0.92 to 43.4 mbgl during pre-monsoon and -0.70 to 36.21 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 (43.4%), and <2 mbgl during post-monsoon.(37.4% of the wells). Number of wells with depth to water level in the range of 0-2 m bgl has increased from 1.4% in May, 2013 to 37.4% in November 2013. Deep water levels (20-40 m bgl) are observed in 6.0% of the wells during May,2013 and reduced to 3.5% during November, 2013.

Rise in Water level was observed during May, 2013 in 56.27% and fall in 36.00% of the wells as compared to May 2012.

Rise in water level was observed in 47.5% and fall in 52.2% of the wells during May 2013 with reference to decadal mean of pre-monsoon(May, 2003-2012). Water level rise of more than 4 m is observed in 4% of the wells and fall of more than 4 m is observed in 6.0% of the wells.

Rise in water level is observed in Novemebr 2013 in comparison with November 2012 in 97.51 % and fall in in 2.25% of the wells. Maximum rise is observed in >4 m range in 60.50 % of wells, maximum fall is observed in 0-2 m range.

Water level fluctuation in November 2013 with reference to decadal mean of November (2003-2012) shows rise in water levels in 87.67% of the wells.

Rise in water levels was observed in 4.7% of the wells as compared the water levels of May 2013 and August 2013. 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 that 67.3% of the wells rise in water levels is observed.

Rise in water level was observed in 70.6% of the wells and fall in 27.46% of the wells as compared the data of Jan 2014 with Jan 2013.

Water table elevation during May, 2013 generally follows the topography which ranges from <100m in east to >900 m in west. The general gradient is from west to east.

During Pre-Monsoon period, the water logging area (0-2m bgl) was 184 sq.km, in 0.30% of the state. The area prone to water logging (2-3 m bgl) during May, 2013 is 862 sq.km, in 0.70% of the State. During the post-monsoon period Nov 2013, the area water logging area is 27,040 sq.km., in 23% of the state. There is an increase from 0.30% to 23% from May to November. The Area prone to water logging during November was 27,140 sq.km, in 24.0% of the state. There is an increase from 0.70% to 24.0% from May to November.

During May, 2013 (pre-monsoon), 303 samples were collected from from shallow aquifers (GWMW) to assess the quality of ground water.

In general pH ranges from 7.2 to 8.8. Electrical conductivity (EC) in ground water ranges from 70 to 9550 micromhos/cm at 25^{o}C. Chloride is in the range of 3.5 to 2091 mg/l. Only 2 % of the samples of the state have chloride concentration beyond BIS permissible limit (1000mg/l). Nitrate concentration is in the range of 0 to 580 mg/l, (60%) of samples exceeds (182 samples) the BIS limit of 40 mg/l. Fluoride concentration varies from 0.05 to 4.5 mg/l, 34 samples (13%) exceeds the BIS limit of 1.5 mg/l.

GROUND WATER YEAR BOOK
(2013– 2014)
TELANGANA STATE

1.0 Introduction

Central Ground Water Board has taken up the task of all 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 has been monitoring a National Network of Hydrograph Stations (NHS) on long term basis since 1969. It is monitored through a network of wells (Dug wells and Piezometers) for studying its long term behaviour due to influencing factors like 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 well water temperatures, four times in a year viz., in the months of May 2013, August 2013, November 2013 and January 2014 and collection of water samples during May 2013, for chemical analysis. As on 01.04.2013, there were 593 operational Ground Water Monitoring Wells (250 dug wells and 343 piezometers).

During the year 2013-2014, Ground water monitoring wells (5 Dug wells and 3 Piezometers) are abandoned and 122 new ground water monitoring wells (108 Dug wells and 14 Piezometers) are established forming a network of 699 operational ground water monitoring wells including 345 Dug wells and 354 Piezometers as on 31-3-2014. The dug wells tapping unconfined aquifers are mostly confined to village limits, which are used for domestic purposes by local public. Some of these are community wells and the rest belong to private individuals. The piezometers tapping unconfined and confined aquifers are drilled 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 Ground water 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 and 464 mandals. The Telangana State consists of ten districts, namely - Adilabad, Karimnagar, Nizamabad, Warangal, Khammam, Nalgonda, Medak, Ranga Reddy, Hyderabad and Mahbubnagar districts.

The present ground water yearbook for the year 2013 - 2014 depicts the ground water level scenario in the State and describes the behaviour of water levels during the period. These wells are distributed more or less uniformly over the State covering over 12 major and minor river basins.

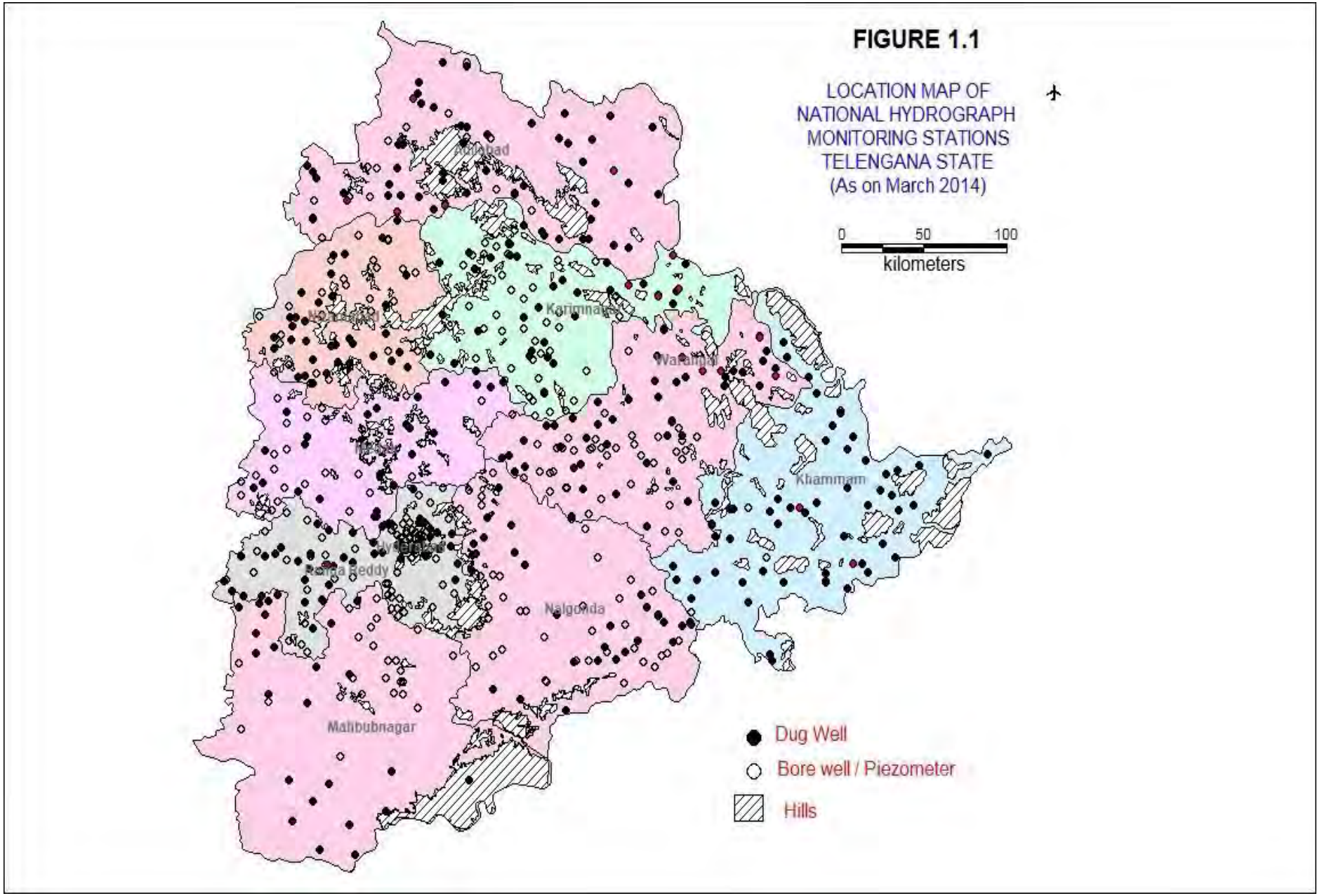
FIGURE 1.1
LOCATION MAP OF
NATIONAL HYDROGRAPH
MONITORING STATIONS
TELENGANA STATE
(As on March 2014)
0
50
100
kilometers
Karimnagar
Warangal
Khammam
Nalgonda
Mahbubnagar
Dug Well
Bore well / Piezometer
Hills

2. PHYSIOGRAPHY, DRAINAGE AND SOIL

2.1 Physiography

Physiographically, the whole of 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 m amsl 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 interspersed by hil ranges.

2.3 Soil

The Soil of Telangana State 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 Telangana 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 parts 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 of (Agricultural department) the state 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 2013 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 Fig.3.1.

3.2.1 Rainfall Analysis - 2013

The salient features of rainfall analysis-2013 are given below:

- 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% of annual in SW monsoon, 13% of annual rainfall in north-east monsoon and 7% in 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 of the state during 2013 is 1243 mm. Season-wise rainfall is 921 mm, 246 mm, 33 mm and 43 mm in monsoon (June-Sept), post-monsoon (Oct-Dec), winter (Jan-Feb) and summer (March-May) respectively contributing 74% of annual rainfall in SW monsoon, 20% of annual rainfall in north-east monsoon and 6% in non-monsoon season. Annual rainfall in 2013 ranges from 911 mm in Mahabubnagar district to 1608 mm in Adilabad district.

- During the year 2013, annual rainfall was excess by 32% in the state. No drought conditions were prevailed in the entire state.

- Annual rainfall in 2013 ranges from 911 mm(excess by 24%) in Mahabubnagar district to 1608 mm(excess by 43%) in Adilabad district

- Monthly mean rainfall ranged from 1 mm in December to 374.1 mm in July.

- The rainfall received during the period Jan 2003 to Dec 2013 is compiled and analysed for correlating with water levels monitored during the period May 2013 to Jan 2014. The data is presented in Table-3.2 to 3.5 and depicted in the Fig. 3.3 to 3.10.

- The data is compiled from the daily and weekly weather reports of India Meteorological Department.

TABLE - 3.1

MONTHLY, NORMAL AND ACTUAL(2013) RAINFALL(mm) IN TELANGANA STATE

		JAN		FEB		MAR		APR		MAY		JUNE		JULY	
S No	**DISTRICT**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**
1	Adilabad	2.5	7.4	42.5	7.1	0.4	9.7	13.4	14.2	6.4	18.2	342.4	178.4	594.4	317.4
2	Hyderabad	1.1	5.9	17.7	7.3	0	12.6	72.2	22.7	15.3	33.8	187	110.7	223.4	176.8
3	Karimnagar	5	10.7	44.8	5.5	0	10.2	17	17.2	18	24	255.3	153.2	497.6	257.3
4	Khammam	1	4.2	19.4	7.4	0	8.8	47.5	26.4	11.7	52.6	199.3	150.3	503.9	282.8
5	Mahbubnagar	0	1.8	18.5	2.8	0	4.9	11.6	17.9	21.6	34.1	91.2	91.1	142.6	161.6
6	Medak	4.1	6.5	18.6	4.4	0	8.9	27.1	20.1	13.2	28	135.3	138.2	348.5	229.4
7	Nalgonda	12	3.9	48.2	4.5	0	8.4	21.4	16.4	12.9	28.7	116.1	103.2	177.6	154.7
8	Nizamabad	8.6	7.9	37.3	4.1	1	7.1	39.2	14.4	4.5	24.5	254.1	161.3	549.1	289.4
9	Rangareddy	0	3.1	17.4	4	0	6.6	45.2	22.6	17	34.6	107.7	109.4	220.8	190.6
10	Warangal	4	8.3	23.8	7.8	0	10.2	19.9	17.3	4.3	28.7	161.3	147.6	483	271.2
	State Mean	**3.8**	**6.0**	**28.8**	**5.5**	**0.1**	**8.7**	**31.5**	**18.9**	**12.5**	**30.7**	**185.0**	**134.3**	**374.1**	**233.1**

		AUG		SEP		OCT		NOV		DEC		ANNUAL		
S No	**District**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**ACTUAL**	**NORMAL**	**DEP(%)**
1	Adilabad	258.9	291.7	168	171.4	174.2	83	0.6	14.8	3.8	7.3	1608	1121	**43%**
2	Hyderabad	138.7	190.5	189.8	165.5	227.9	95.6	15.8	23.7	0	6.4	1089	852	**28%**
3	Karimnagar	188.2	226.7	131.8	163.1	260.4	85.9	9	20.8	0.3	5.9	1427	981	**46%**
4	Khammam	298.2	256.4	170	170.9	231.4	106.9	20.6	24.5	0	4.5	1503	1096	**37%**
5	Mahbubnagar	161.4	158.2	212.9	148.8	244	85.4	7	21.2	0	3.8	911	732	**24%**
6	Medak	130.5	211.1	179.6	165.2	178	86.6	32.5	19.3	0.7	4.8	1068	923	**16%**
7	Nalgonda	212.8	147.2	152.4	149.6	363.4	105.8	29.4	32	0	6.6	1146	761	**51%**
8	Nizamabad	173.8	296.5	117.9	172.9	136.2	91.3	19.1	17.1	0.8	5.5	1342	1092	**23%**
9	Rangareddy	136.6	176.5	186	177.2	215.5	94.5	25.6	19.1	0	4.3	972	843	**15%**
10	Warangal	271.8	222.3	137.3	155.5	231.7	88.9	25.5	22.9	3.6	7.2	1366	988	**38%**
	STATE MEAN	**197.1**	**217.7**	**164.6**	**164.0**	**226.3**	**92.4**	**18.5**	**21.5**	**0.9**	**5.6**	**1243.2**	**938.6**	**32%**

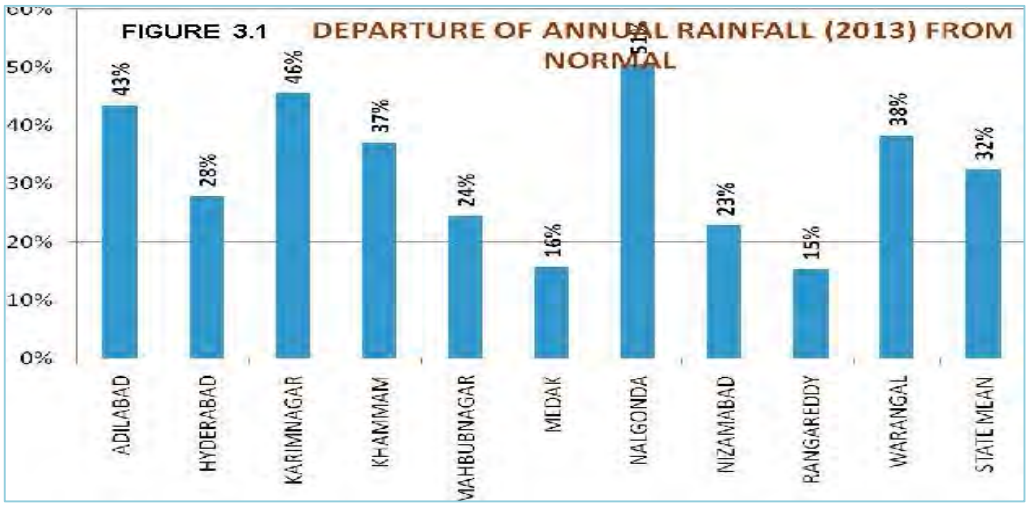
FIGURE 3.1
DEPARTURE OF ANNUAL RAINFALL (2013) FROM NORMAL
50%
40%
30%
20%
10%
0%
43%
28%
46%
37%
24%
16%
51%
23%
15%
38%
32%
ADILABAD
HYDERABAD
KARIMNAGAR
KHAMMAM
MAHBUBNAGAR
MEDAK
NALGONDA
NIZAMABAD
RANGAREDDY
WARANGAL
STATE MEAN

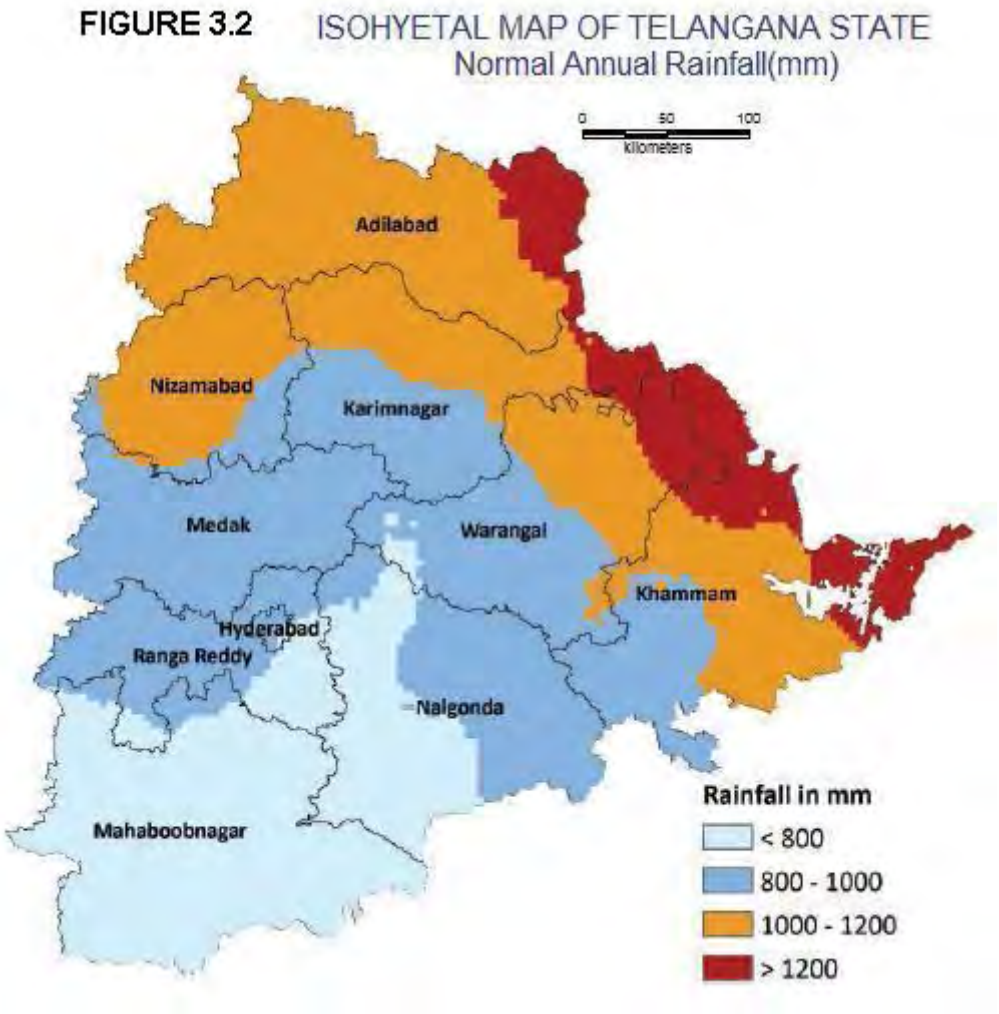
FIGURE 3.2
ISOHYETAL MAP OF TELANGANA STATE
Normal Annual Rainfall(mm)
0
50
100
kilometers
Adilabad
Nizamabad
Karimnagar
Medak
Warangal
Khammam
Hyderabad
Ranga Reddy
Nalgonda
Mahaboobnagar
Rainfall in mm
< 800
800 - 1000
1000 - 1200
> 1200

3.2.2 Rainfall analysis - May 2013

The analysis of rainfall data (India Meteorological Department) has been carried out utilizing weekly weather reports during the period Jun 2003 to May 2013.

Departure of rainfall during June 2012-May 2013 from June 2011-May 2012 rainfall

The district-wise rainfall data for the period Jun'12-May'13, Jun'11-May'12, decadal mean (Jun-May) of 2003-2012 and normals of Jun – May and the respective departures of rainfall during Jun'12-May'13 has been given in the Table-3.2. The thematic maps depicting departure from normal rainfall are shown in the Fig.3.3 to 3.6.

TABLE - 3.2
RAINFALL AND ITS VARIABILITY IN TELANGANA STATE

S No	District	Rainfall(Mm)				Departure Of June'12-May'13 Rainfall From		
		JUNE'12 - MAY'13	JUNE'11 - MAY'12	DECADAL MEAN	NORMAL	JUNE'11 - MAY'12	DECADAL MEAN	NORMAL
1	Adilabad	1101	869	974	1120	21.1%	11.5%	-1.7%
2	Hyderabad	853	620	727	851	27.3%	14.7%	0.2%
3	Karimnagar	1102	734	975	980	33.4%	11.6%	11.1%
4	Khammam	1509	906	119	1095	40.0%	20.7%	27.4%
5	Mahbubnagar	632	485	683	731	23.3%	-8.0%	-
6	Medak	855	707	780	922	17.3%	8.7%	-7.9%
7	Nalgonda	722	529	619	761	26.8%	14.3%	-5.3%
8	Nizamabad	927	933	945	1092	-0.7%	-2.0%	-
9	Rangareddy	1011	543	865	842	46.3%	14.5%	16.8%
10	Warangal	1248	858	943	987	31.2%	24.4%	20.9%
	STATE MEAN	**996**	**718**	**871**	**938**	**27.9%**	**12.6%**	**5.8%**
Source: India Meteorological Department, GOI								

Departure of Jun'12-May'13 rainfall with Jun'11-May'12 rainfall is depicted in the Fig.3.3. It is prepared to correlate with water level fluctuation map of May'13-May'12. The state has received 996 mm of rainfall during the period Jun'12 to May'13 and 718 mm during the period June'11-May'12. The rainfall during the period May'13-May'12 is 28% more than the rainfall received during the same period last year. The departure in percentage ranges from -0.7% in Nizamabad district to 46.3% in Rangareddy district. All the other districts have recorded more rainfall than the last year same period.

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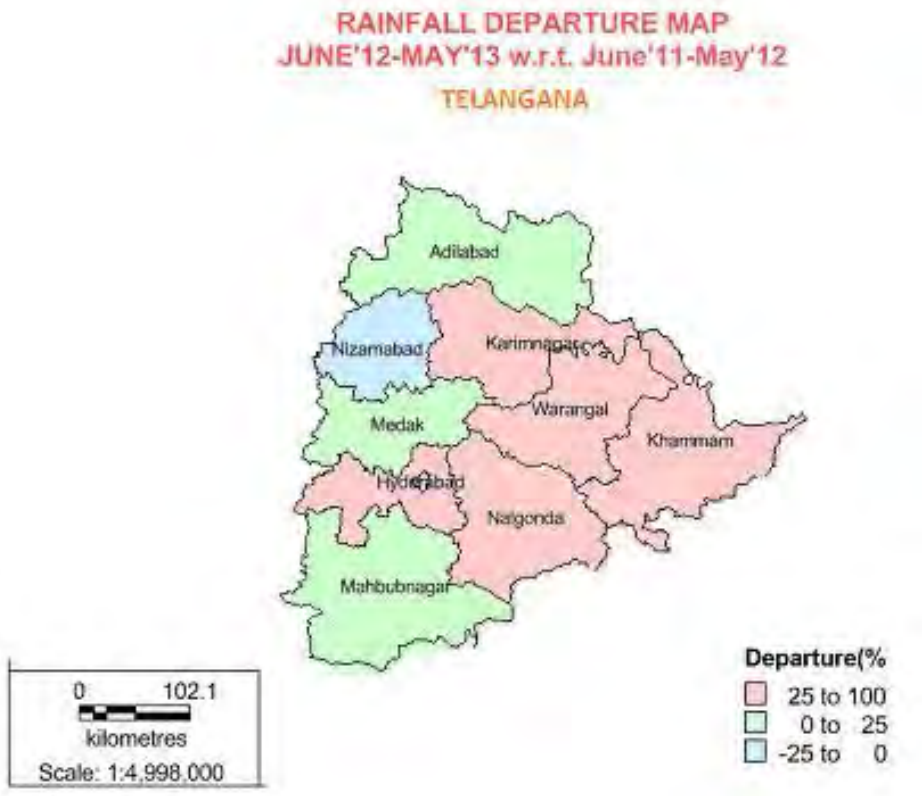
FIGURE 3.3



Departure of rainfall during June 2012-May 2013 from normal rainfall of same period

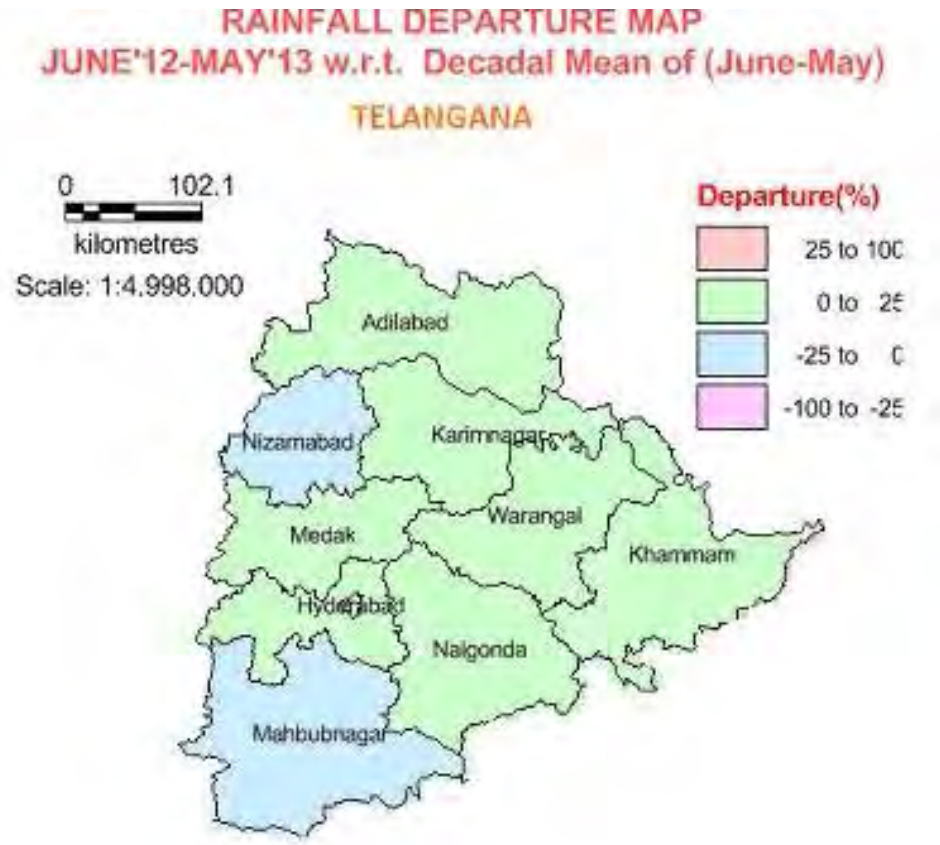
Departure of Jun'12-May'13 rainfall with normals of the same period is depicted in the Fig.3.4. It is prepared to correlate with depth to water level map of May 2013. During the period Jun'12-May'13 the state has received 6% more rainfall than normal. It ranges from -17.8% in Nizamabad district to 27.4% in Khammam district. The normal rainfall during the period June-May is 938 mm . It ranges from 731 mm in Mahabubnagar to 1120 mm in Adilabad district. Khammam, and Warangal districts have recorded Excess (more than 120 % of normal) rainfall and rest all received normal (between 80% to 120 % of normal) rainfall.

Fig.3.4

Departure of rainfall during June 2012-May 2013 from decadal mean rainfall 2003-2012 (Jun-May)

Departure of Jun'12-May'13 rainfall with decadal mean rainfall 2003-2012 (Jun-May) is depicted in the Fig.3.5. It is prepared to correlate with water level fluctuation map of May 2013 – Decadal mean (May). The decadal mean rainfall (Jun-May) of the state is 871 mm. The state has received 12.6% more rainfall than the decadal mean rainfall. The departure in percentage ranges from -2% in Nizamabad to 24.4% in Warangal district. Mahabubnagar and Nizamabad districts received less rainfall than the decadal mean.

Fig.3.5



Rainfall analysis -August 2013

The district wise rainfall data for the period June 2012-August 2012, June 2013-August 2013, decadal mean of June to August and normal's (June-August) and its departures are furnished in the Table-3.3. The thematic maps depict departure of rainfall from normals shown in the Fig.3.6 - 3.8

TABLE - 3.3
RAINFALL AND ITS VARIABILITY IN TELANGANA

S NO	DISTRICT	RAINFALL				Departure of JUNE'13-AUG'13 rainfall from		
		JUNE'13-AUG'13	JUNE'12-AUG'12	DECADAL MEAN	NORMAL	JUNE'12-AUG'12	DECADAL MEAN	NORMAL
		(mm)	(mm)	(mm)	(mm)	(%)	(%)	(%)
1	ADILABAD	1196	664	654	788	44%	83%	52%
2	HYDERABAD	549	513	435	393	7%	26%	40%
3	KARIMNAGAR	941	669	622	637	29%	51%	48%
4	KHAMMAM	1001	862	801	690	14%	25%	45%
5	MAHBUBNAGAR	395	350	355	411	11%	11%	-4%
6	MEDAK	614	517	514	579	16%	19%	6%
7	NALGONDA	507	338	332	405	33%	53%	25%
8	NIZAMABAD	977	518	627	747	47%	56%	31%
9	RANGAREDDY	465	497	475	477	-7%	-2%	-2%
10	WARANGAL	916	768	660	641	16%	39%	43%
TELENGANA		**756**	**570**	**548**	**577**	**25%**	**38%**	**31%**

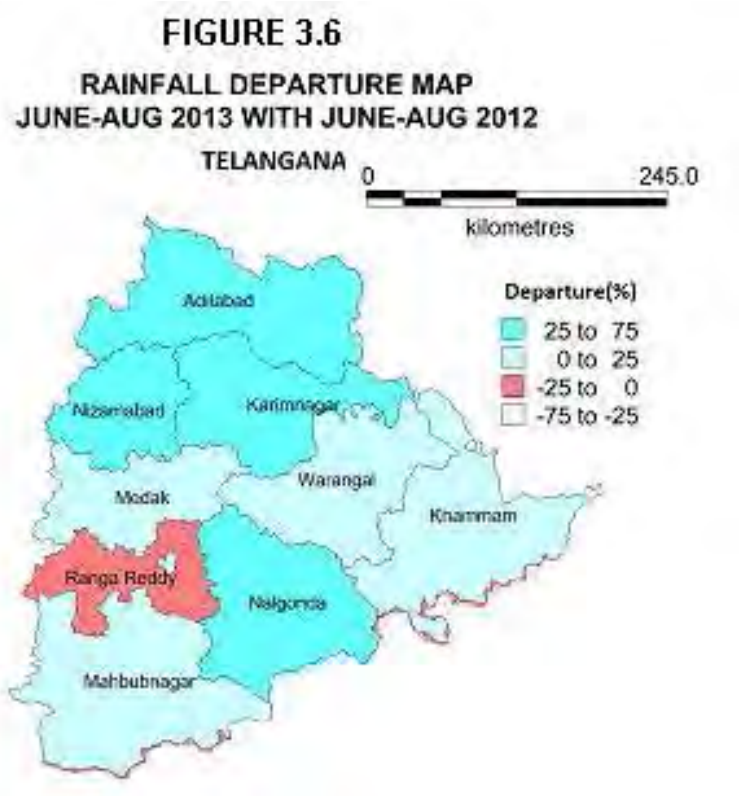
Source: India Meteorological Department, GOI

Departure of rainfall during June to August 2013 from June – August 2012

The state has received 756 mm of rainfall during the period June'13 to Aug'13, which is 25 % more than the rainfall during the same period last year, which was 570 mm. It ranges from 395 mm in Mahabubnagar to 1196 mm in Adilabad district. The departure ranges from -7% in Rangareddy district to 47% in Nizamabad district. The departure map is shown in the Fig.3.6.

FIGURE 3.6

RAINFALL DEPARTURE MAP
JUNE-AUG 2013 WITH JUNE-AUG 2012



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

The decadal mean rainfall for the period June-Aug, 2003-2012, of the state is 548 mm. During the period June-Aug 2013 the state received 38 % more rainfall than the decadal mean. The decadal mean rainfall ranges from 332 mm in Nalgonda district to 801 mm Khammam district. The departure in percentage ranges from -2 % in Rangareddy to 83 % Adilabad districts. The departure map is presented in the Fig-3.7.

FIGURE 3.7

RAINFALL DEPARTURE MAP
JUNE-AUG 2013 WITH DECADAL MEAN (JUNE-AUG)
TELANGANA

Departure of rainfall during June to August 2013 from normal rainfall

The normal rainfall of the state during the period June-Aug is 577 mm. It ranges from 393 mm in Hyderabad to 788 mm in Adilabad district. The departure of June-Aug rainfall with normal ranges from -2 % in Rangareddy district to 52% in Adilabad district. It is Excess (more than 20% of normal) in Adilalabd, Hyderabad,Karimnagar, Khammam,Nalgonda, Nizamabad, and Warangal districts and normal (-19% to + 19% of normal) in the rest of the state. The rainfall departure map is presented in the Fig- 3.8.

FIGURE 3.8

RAINFALL DEPARTURE MAP
JUNE-AUG 2013 WITH NORMAL(JUNE-AUG)
TELANGANA

Rainfall analysis -Nov 2013

The district wise rainfall data for the period June'13 - Oct'13, June'12- Oct'12, normals of June - Oct and decadal mean of June-Oct and the departure of June'13 – Oct'13 and its departures 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
DISTRICT-WISE RAINFALL VARIABILITY AND DEPARTURE IN TELANGANA

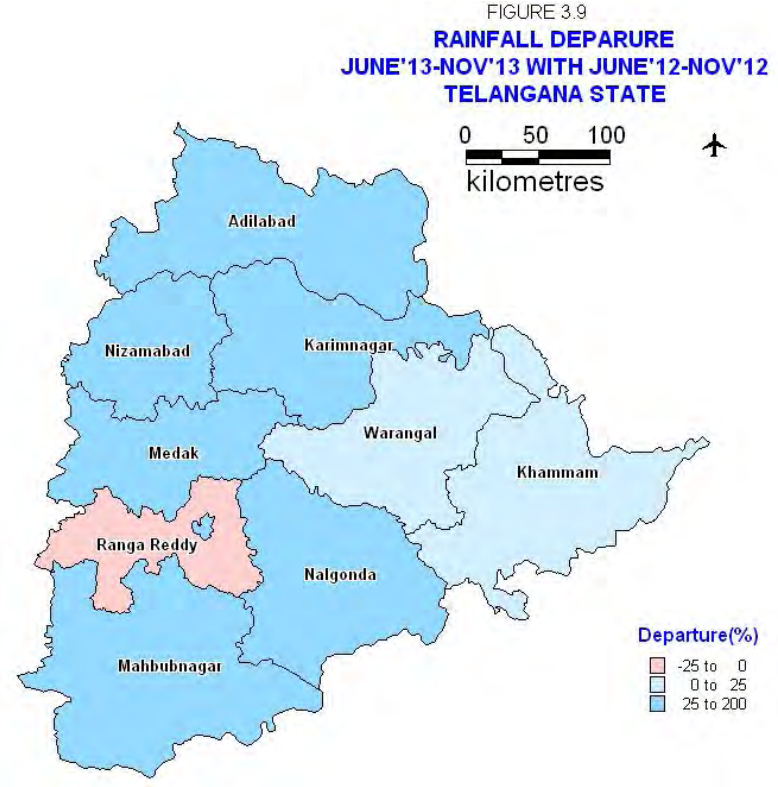
S No	District	(June 2013-Oct 2013)	(June 2012-Oct 2012)	Normal (June-Oct)	Decadal (2003-12) Mean (June-Oct)	Departure of Rainfall (June 2013-Oct 2013) with		
						(June 2012- Oct 2012)	Normal (June - Oct)	Decadal (2003-12) Mean (June-Oct)
		(mm)	**(mm)**	**(mm)**	**(mm)**	**(%)**	**(%)**	**(%)**
1	Adilabad	1538	1023	1042	915	50.3%	47.6%	68.0%
2	Hyderabad	967	720	739	736	34.3%	30.8%	31.4%
3	Karimnagar	1333	988	886	927	34.9%	50.5%	43.8%
4	Khammam	1403	1262	967	1154	11.2%	45.0%	21.6%
5	Mahbubnagar	852	541	645	593	57.5%	32.1%	43.8%
6	Medak	972	737	831	737	31.9%	17.0%	31.8%
7	Nalgonda	1022	496	661	583	106.1%	54.8%	75.2%
8	Nizamabad	1231	809	1011	868	52.2%	21.7%	41.8%
9	Rangareddy	867	905	748	723	-4.2%	15.8%	19.9%
10	Warangal	1285	1129	886	959	13.8%	45.1%	34.0%
	STATE MEAN	**1147**	**861**	**842**	**820**	**33.2%**	**36.3%**	**39.9%**

Source: India Meteorological Department, Government of India

Departure of rain fall during June to October, 2013 from June to October, 2012

The departure in percentage during June to October, 2013 from June to October, 2012 is depicted in the Fig.3.9. The State has received 1147 mm of rainfall during the period June'13 - Oct'13, which is 33% more than the rainfall received during the same period last year, which was 861 mm. The departure in percentage ranges from -4.2% in Rangareddy district to 106.1% in Nalgonda district.

FIGURE 3.9



Departure of rainfall during June to October, 2013 from decadal mean of June to October -2003-12

The decadal mean rainfall in the state during the period June - Oct (2003-12) is 820 mm. During the period June'13 – Oct'13 the state mean rainfall was 40% more than the decadal mean. The departure of current period from decadal mean is depicted in the Fig.3.10. The departure ranges from 20% in Rangareddy district to 75% in Nalgonda district.

Departure of rainfall during June to October, 2013 from normal (June to October)

The state has received 40% more rainfall than normal, during the period June'13 -Oct'13. The normal rainfall during the period June-Oct was 842 mm. Departure in percentage range from 15.8 % in Rangareddy district to 54.8 % in Nalonda district. The whole state has received normal to excess rainfall during the period June-Oct. Excess rainfall (more than 120% of normal rainfall) is received in Adilabad, Hyderabad, Karimnagar, Khammam, Mahabubnagar, Nalgonda, Nizamabad, and Warangal districts. The remaining districts namely Medak and Ranga Reddy districts have received normal rainfall (81% to 119% of normal rainfall). The departure of current period from normal is depicted in the Fig.3.11.

FIGURE 3.10

RAINFALL DEPARURE
JUNE'13-NOV'13 WITH DECADAL MEAN(JUNE-NOV)
TELANGANA STATE

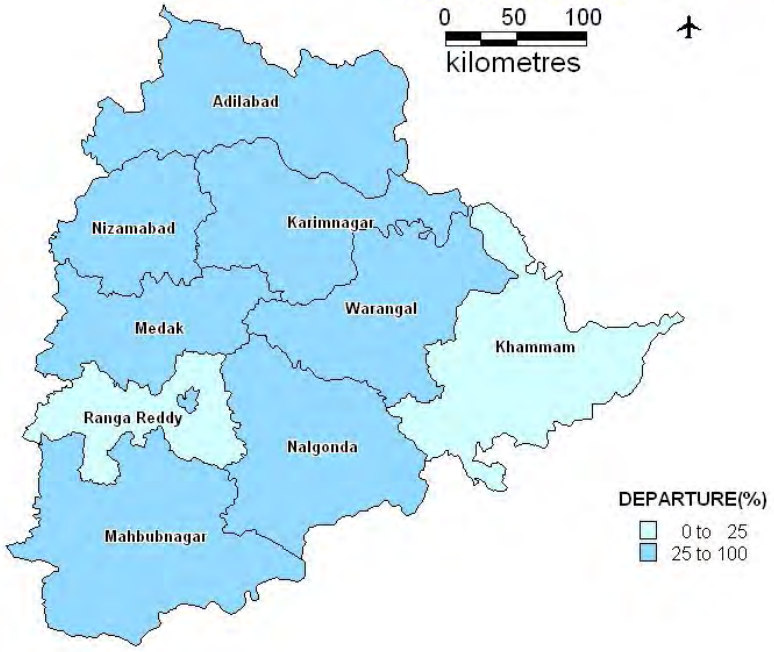
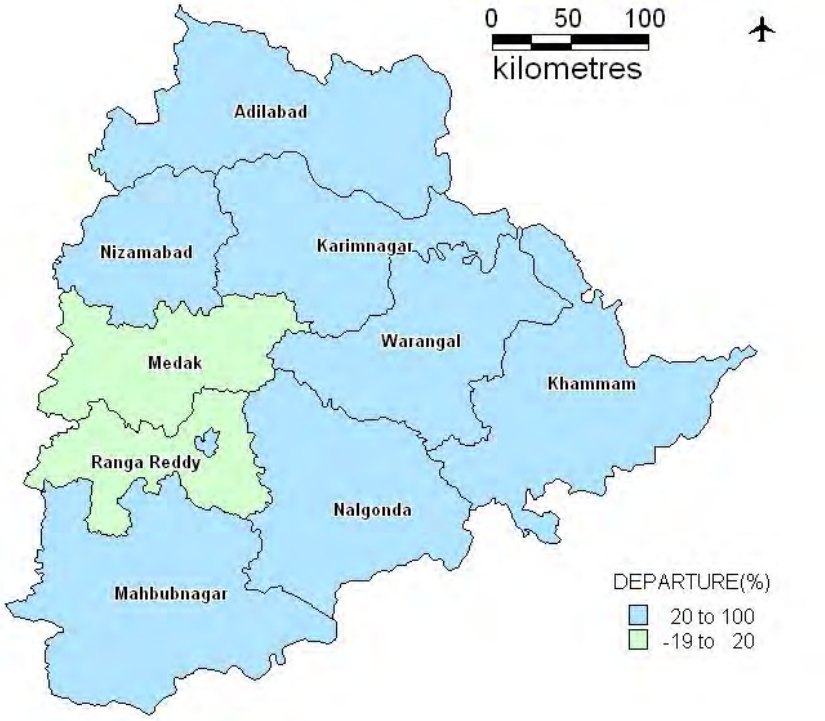


FIGURE 3.11

RAINFALL DEPARURE
JUNE'13-NOV'13 WITH NORMAL(JUNE-NOV)
TELANGANA STATE



Rainfall analysis - Jan 2014

The rainfall data (India Meteorological Department) has been analysed from weekly weather reports from the period Jan 2004 to Dec 2013. District-wise rainfall data for the period Jan'12-Dec'12 Jan'13-Dec'13, decadal mean (Jan-Dec) of 2003-2012 and normals of Jan – Dec and the departure of Jan'13-Dec'13 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(%) Of Column (3)			
		Jan'13 - Dec'13	Jan'12-Dec'12	Decadal Mean (2003-12)	Normal Jan-Dec	From Last Year Same Period	From Decadal Mean	From Normals	
1	Adilabad	1608	1049	1036	1120	53%	55%	44%	
2	Hyderabad	1089	779	901	851	40%	21%	28%	
3	Karimnagar	1427	1047	1119	980	36%	28%	46%	
4	Khammam	1503	1521	1332	1095	-1%	13%	37%	
5	Mahbubnaga	911	633	712	731	44%	28%	25%	
6	Medak	1068	843	867	922	27%	23%	16%	
7	Nalgonda	1146	674	737	761	70%	56%	51%	
8	Nizamabad	1342	845	991	1092	59%	35%	23%	
9	Rangareddy	972	988	852	842	-2%	14%	15%	
10	Warangal	1366	1232	1104	987	11%	24%	38%	
	State Mean	1243	961	965	938	29%	29%	33%	

Source: Weekly Weather Reports, India Meteorological Department, Government of India

Departure of rain fall during Jan to Dec 2013 from Jan-Dec 2012

Departure of rainfall during Jan'13-Dec'13 from Jan'12-Dec'12 rainfall is depicting in the Fig.3.12. The state has received 1243 mm of rainfall during the period Jan'13 to Dec'13 , which is 29% more than the rainfall received during the same period last year, 29% more than the decadal mean(2004-2013) and 33% more than the normal. The state received about 961mm of rainfall during the same period last year. The departure in percentage ranges from -2% in Ranga Reddy district to 59% in Nizamabad district.

Departure of rain fall during Jan to Dec 2013 from decadal mean rainfall Jan-December

Departure of rainfall during Jan'13-Dec'13 from Jan'12-Dec'12 rainfall is depicting in the Fig.3.12. The decadal mean rainfall (Jan-Dec) of the state is 965 mm. The state has received 29% more rainfall than the decadal mean rainfall of Jan-Dec during the period Jan'13-Dec'13. The departure in percentage ranges from 13% in Khammam to 56% in Nalgonda district.

FIGURE 3.12

RAINFALL DEPARTURE MAP
JAN-DEC 2013 WITH JAN-DEC 2012
TELANGANA

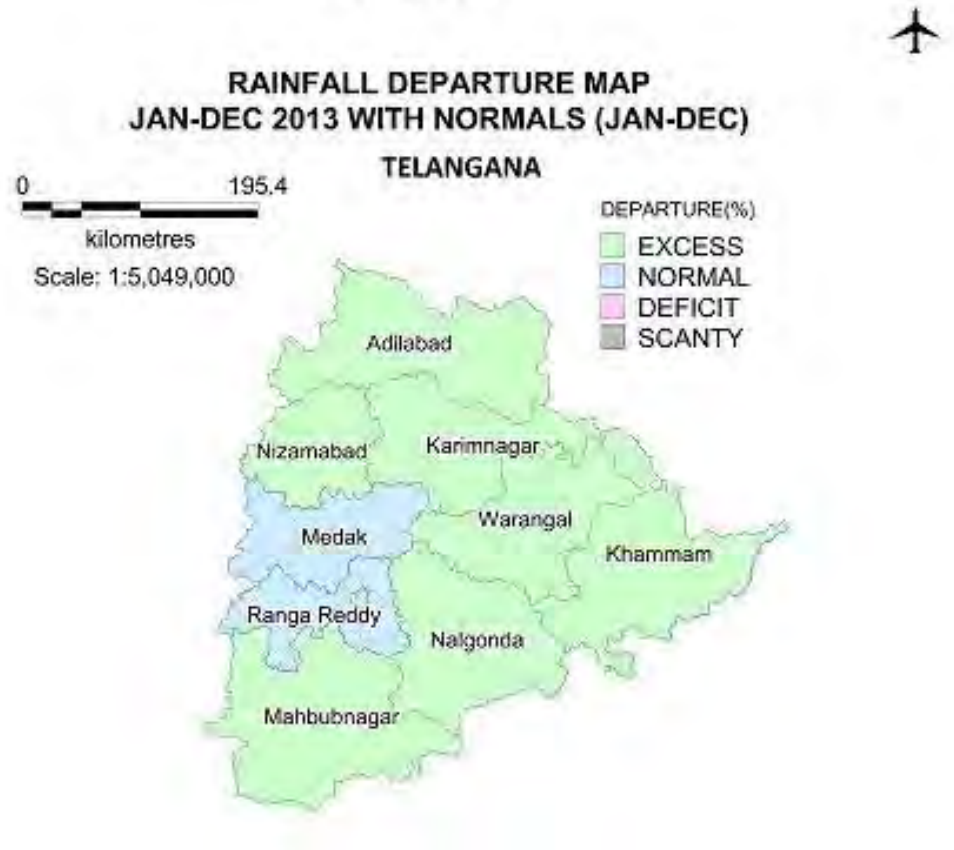
FIGURE 3.13

RAINFALL DEPARTURE MAP
JAN-DEC 2013 WITH DECADAL MEAN (JAN-DEC)
TELANGANA

Departure of rain fall during Jan to Dec 2013 from normals of the same period

Departure of rainfall during Jan'13-Dec'13 from normals of the same period is depiting in the Fig.3.13 and correlated with depth to water level during Jan 2014. During the period Jan'13-Dec'13 the state has received 33% more rainfall than normal. It ranges from 16% in Medak district to +51% in Nalgonda district. Normal rainfall during the period is 938 mm. Entire state received normal to excess rainfall.

FIGURE 3.14



4.0 GEOLOGY

A wide variety of geological formations occur in Telangana State, ranging from the oldest Archaean crystalline rocks to Recent alluvium. The geological set up and principal aquifer system are presented in the Fig.4.1and 4.2. A major part of the State is underlain by gneissic complex with a structural fill of sedimentary rocks and basin-fill of meta-sedimentary rocks. 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 limestones, cherts and sandstones occur between trap flows near Vikarabad and Adilabad.

FIGURE 4.1

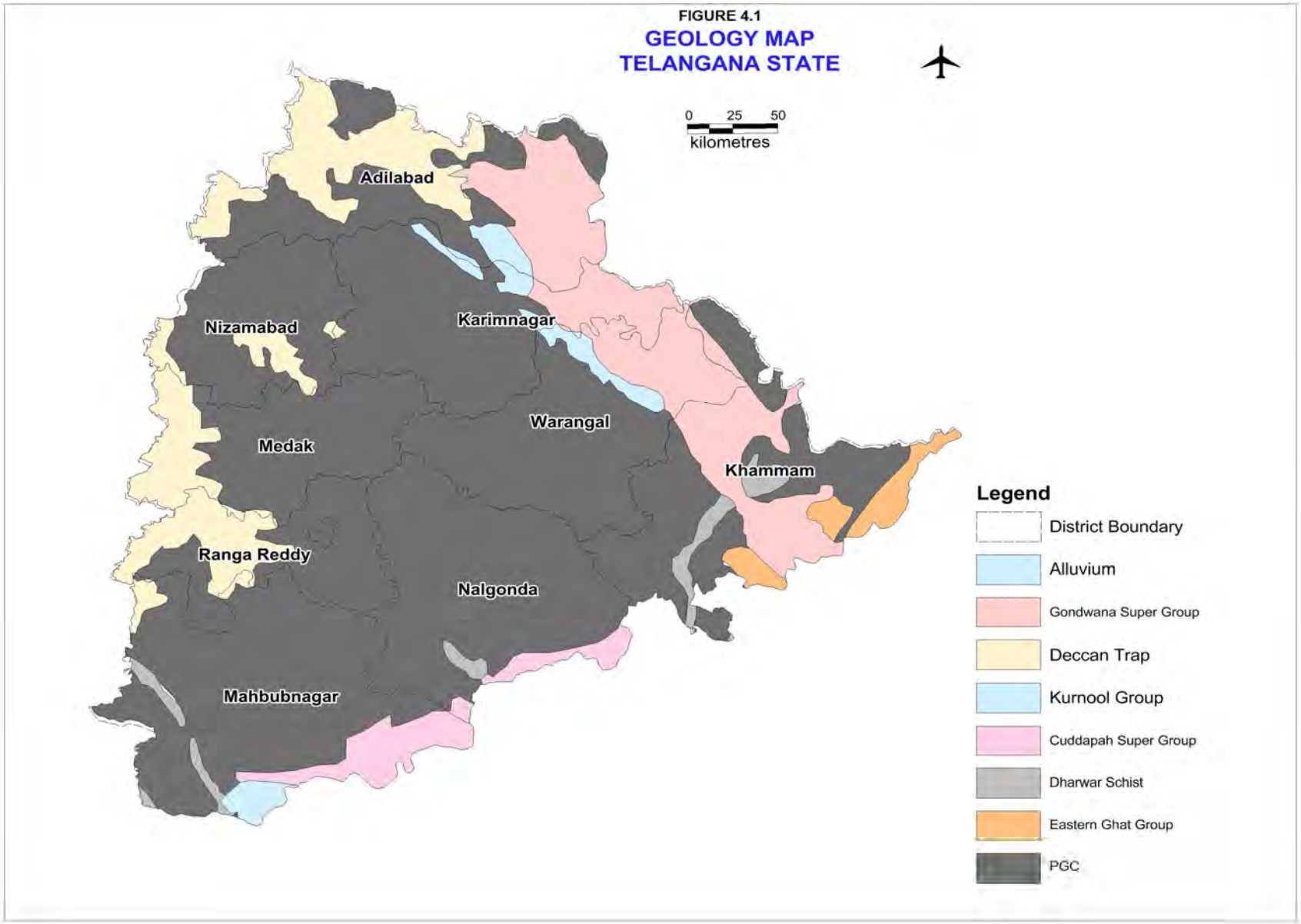
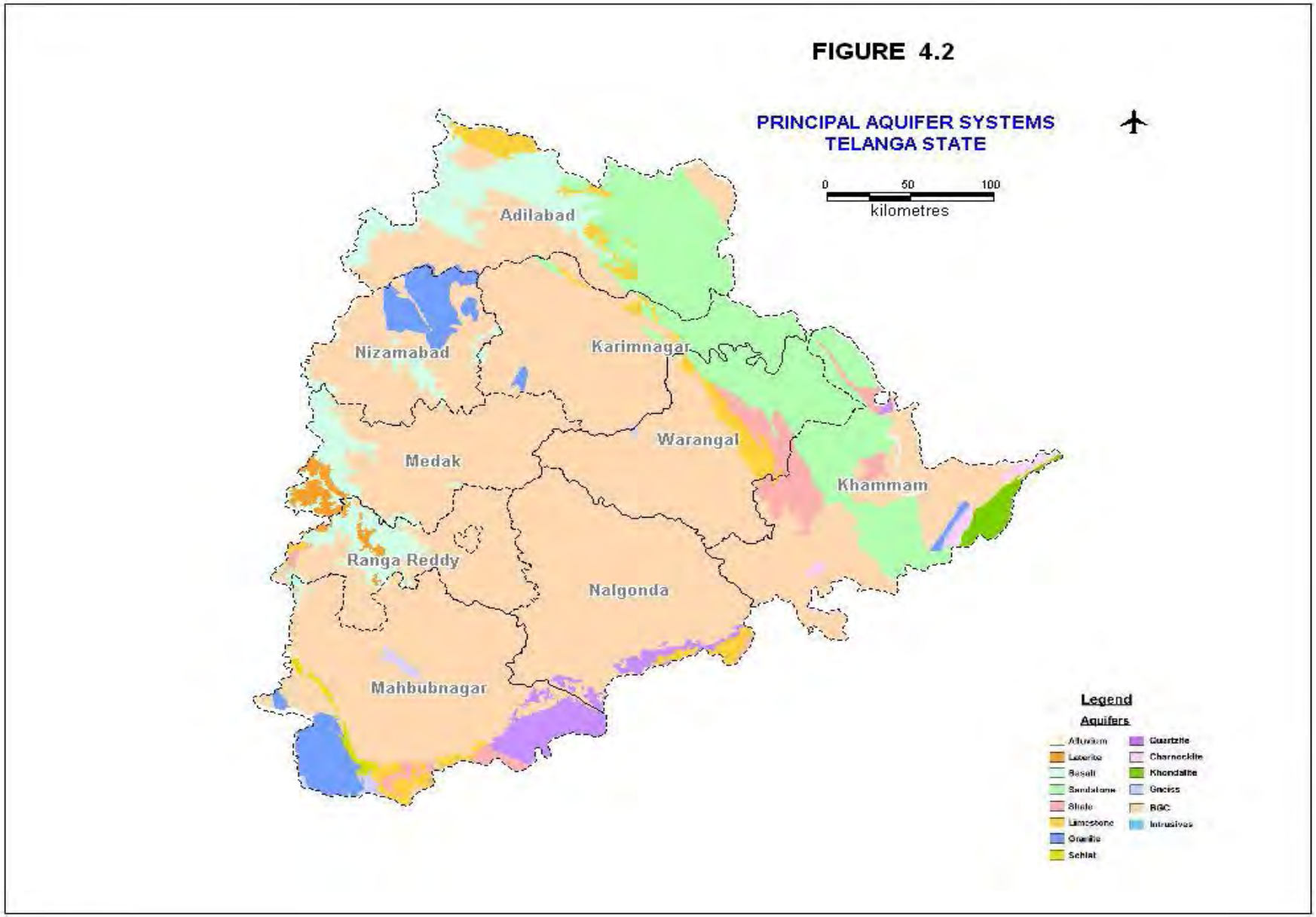

GEOLOGY MAP
TELANGANA STATE
0 25 50
kilometres
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Ranga Reddy
Nalgonda
Mahbubnagar
Legend
District Boundary
Alluvium
Gondwana Super Group
Deccan Trap
Kurnool Group
Cuddapah Super Group
Dharwar Schist
Eastern Ghat Group
PGC

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 hydrogeologically into three groups, namely,

i) consolidated
ii) semi-consolidated and
iii) unconsolidated.

i) Consolidated hard rocks occupy about 83% of 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 in this group of rocks. 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 in these formations.

5.1 Monitoring Methodology

Ground water regime in the State is monitored through a network of ground water structures viz., dug wells and piezometers. The dug wells, which are owned by government and non-government agencies and individual users, are constructed 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 ground water structures 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**

Under Participatory Ground water Monitoring Programme, to observe the periodic and micro-level changes in ground water regime, weekly water level measurements are initiated in phases involving local people as observers. A total number of 163 observers are engaged since May 2005.

5.1.2 Chemical Quality Monitoring

The Chemical Quality of Ground Water in the State is monitored once in a year by collecting water samples from the monitoring wells (dug wells) in the month of May and analysing the samples in Chemical Laboratory. Quality monitoring is carried out to observe the effect of geogenic, anthropogenic factors on the ground water in different hydrogeological environments over a period of time.

5.2 Database on Ground Water Monitoring Wells

The data on water levels and chemical quality is entered in the database, 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, in aquifer systems and canal command areas is presented in the following paragraphs.

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 representation of one Dug well per 800 sq.km in Mahabubnagar district . The highest representation of Piezometer is one well per 9.5 sq.km in Hyderabad district and lowest representation of one Piezometer per well is 1333 sq.km in Khammam district. The highest density of wells combined together of PZ and DW is one well per 7 km in Hyderabad and lowest density of one well per 329sq. km. in Medak district (Table-5.1).

Table-5.1
District-Wise Distribution of National Ground Water Regime Monitoring Stations in Telangana State (As on March 2014)

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	48	25	73	335	644	221
2	Hyderabad	200	8	21	29	25	9.5	7
3	Karimnagar	11800	28	55	83	421	215	133
4	Khammam	16000	55	12	67	290	1333	239
5	Mahabubnagar	18400	23	28	51	800	657	190
6	Medak	9700	27	29	56	359	334	329
7	Nalgonda	14200	43	40	83	330	355	171
8	Nizamabad	8000	30	30	60	267	267	133
9	Ranga Reddy	7500	41	61	102	183	123	74
10	Warangal	12900	42	53	95	307	243	136
	Total	114800	345	354	699	333	324	164.2

5.3.2 Area represented by Ground Water Monitoring Wells

As on 31.03.2013 the highest representation of one well per 7 sq.km was in Hyderabad district and the lowest representation of one well per 376 sq.km was in Mahaboobnagar district and for the State as a whole was one well per 193.6 sq.km. As on 31.03.2014, the highest representation of one well per 7 sq.km is in Hyderabad district and lowest representation of one well per 329 sq.km is in Mahaboonnagar district and for the State as a whole, it is one well per 164.2sq.km. The district wise details are furnished in the the Table-5.2.

Table-5.2
District Wise National Ground Water Monitoring Stations
Area Covered

Sl. No.	District	Area (sq.km)	As on 31.3.2013		As on 31.3.2014	
			Total GWMW	Area Represented	Total GWMW	Area Represented by each
1	Adilabad	16100	64	252	73	221
2	Hyderabad	200	28	7	29	7
3	Karimnagar	11800	79	149	83	133
4	Khammam	16000	60	267	67	239
5	Medak	9700	47	206	51	190
6	Mahabubnagar	18400	49	376	56	329
7	Nalgonda	14200	52	273	83	171
8	Nizamabad	8000	42	190	60	133
9	Ranga Reddy	7500	92	82	102	74
10	Warangal	12900	80	161	95	136
	Total	114800	593	193.6	699	164.2

5.3.3 Basin-wise Distribution of Ground Water Monitoring Wells

The Godavari and Krishna are the major river basins in the State. The state is divided in to 10 sub-basins. The number of network stations in the major basins is 364 in Godavari and 335 in Krishna basins. The basin-wise distribution of Monitoring Wells is presented in the Table-5.3.

Table - 5.3
Basin Wise Distribution of Monitoring Wells – Telangana State

District	Godavari	Krishna	Grand Total
Adilabad	20	53	73
Hyderabad	4	25	29
Karimnagar	11	72	83
Khammam	1	66	67
Mahabubnagar	2	49	51
Medak	56	0	56
Nalgonda	83	0	83
Nizamabad	59	1	60
Ranga Reddy	74	28	102
Warangal	54	41	95
Grand Total	364	335	699
Area Of The Basin	62360	52490	114850

5.3.4 Command area-wise Distribution of Ground Water Monitoring Wells

The Nagarjuna Sagar Right Canal, Nagarjuna Sagar Left Canal, Sri Ram Sagar Project are the major command areas in the State. The number of network stations in the command areas is 145. The command area-wise distribution of Monitoring Wells is given in the Table-5.4.

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

Hydrogeologically, there are three distinct aquifer units in the State. The formations of Archaean and Pre-Cambrian age and the massive Deccan Traps constitute the hard rock aquifers constituting about 87% of the total area.

The semi-consolidated sedimentary formations comprising Gondwanas, Inter-trappeans, Infra-trappeans, etc. form soft rock aquifers. Of the 593 Ground Water monitoring wells existing in the State as on 31.3.2013, 511 wells were located in hard rocks, 82 wells in soft rocks. As on 31.3.2014, of the total 699 wells, 597 and 102, wells are in hard rock and soft rock areas respectively. The district-wise distribution of Ground Water Monitoring Wells in aquifer/litho-units is presented in the Table-5.5.

Table-5.4

National Ground Water Monitoring Stations
Command Area Wise Distribution

District	Command Area	Non-command area	Total
Adilabad	13	60	73
Hyderabad	0	29	29
Karimnagar	36	47	83
Khammam	14	53	67
Mahabubnagar	3	48	51
Medak	1	55	56
Nalgonda	35	48	83
Nizamabad	23	37	60
Ranga Reddy	0	102	102
Warangal	20	75	95
	145	**554**	**699**

5.3.5.1 Hard rocks

The granites, granite gneisses, khondalites and charnockites, constituting the Archaeans and Pre-Cambrian rocks cover major part of the State. Maximum number (597 wells as on 01.04.2014) of Ground Water Monitoring Wells are located in these rocks. The depths of wells in granites, gneisses, vary between 3.8 m and 200 m bgl and depth to water level varied between 0.92 m and 43.4 m bgl with general variation of 5 m to 12 m bgl. during May, 2013 and between -0.7 and 36.21 m bgl with a general variation of 2 m to10 m bgl during November 2013. Water level fluctuation between pre and post monsoon seasons of the year 2013 varied between 0.00 and 31.66 m, generally 2 to >4 m.

Table 5.5
District-Wise and Principal Aquifer Wise Number of Monitoring Wells
As on March, 2014 I- Telangana State

District	Banded Gneissic Complex	Basalt	Charnockite	Gniess	Granite	Limestone	Laterite	Quartzite	Shale	Sandstone	Grand Total
Adilabad	35	17				4				17	73
Hyderabad	29										29
Karimnagar	62					2				19	83
Khammam	42		1		0				2	21	66
Mahabubnagar	44	1		3	1	1		0	1		51
Medak	36	16			0		4				56
Nalgonda	82					1		0			83
Nizamabad	44	1			15						60
Ranga Reddy	76	20				0	6				102
Warangal	72					1			2	21	96
Grand Total	522	55	1	3	16	9	10	0	5	78	699

The depth of wells located in Cuddapah, Kurnool, Pakhal and Sullavai formations vary between 4.50 m and 200 m bgl. Depth to water level varied between 1.58 m and 17.35 m bgl with a general variation of 5 m to 10 m bgl during May 2013 and between 0.47 m and 22.29 m bgl with a general variation of up to 10 metres during November 2013, the water levels being shallower in

canal command areas. The water level fluctuation between pre and post monsoon seasons, during the year 2013, varies between 0.3 and 8.54 metres with a general variation of up to 5 metres. The total depths of wells located in basalts vary between 6.47 m and 200 mbgl. The depth to water level varied between 1.40 m and 28.99 m bgl with a general variation of 5 m to 10 m bgl during May, 2013 and between 0.54 m and 16.72 m bgl with a general variation of 0 to 10.0 m during November, 2013. The water level fluctuation between pre and post monsoon seasons, varied between -2.71 and 13.2 m with a general variation of 2 to >4 m, during the year 2013.

5.3.5.2 Semi-consolidated sedimentary formations

The semi-consolidated sedimentary formations, Gondwanas, infra-trappeans, inter-trappeans, Rajahmundry sandstones and laterites, constitute the soft rocks in the State. CentralGround Water Board has constructed shallow and deep piezometers to study the changes in piezometric heads of different aquifers at different depths in the sedimentary soft formations. As on 1.4.2014, 102 Ground Water Monitoring Wells are in existance. The depth of dug wells/phreatic zones vary between 3.92 m and 20 m bgl and depth to water level varied between 1.0 and 20.0 m bgl with a general variation of 2 m to 10 m bgl during May, 2013. It varies between 0.39 to 13.80 mbgl (general variation of 2 to 5 m bgl) during November 2013. The water level fluctuation between pre and post monsoon, during the year 2013 varied between 0.53 and 19.53 m with a general variation of 2 to >4.0 m.

6.0 GROUND WATER LEVEL SCENARIO

Ground Water Level Monitoring is a scientific surveillance system to observe the periodic and long-term changes in ground water regime. The water level data collected over a period of time provides information about changes in ground water levels with progressive ground water development or with input in to the ground water system brought in by natural and artificial recharge and surface water irrigation system.

The establishment of a network of Ground Water Monitoring Wells provides necessary information on ground water regime with a fair degree of accuracy. With the interpolation of data between various representative observation points, keeping in view of the hydrogeological environment in the area, the ground water level scenario in the State is studied periodically. The status of ground water monitoring wells as on March 2013 and number of NHS wells established, abandoned, and ground water monitoring wells as on March 2014 is given in the Table – 6.1.

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

Sl. No	District	No. of NHS wells as on March-12			No. of NHS wells Established during 2013-14			No. of wells Abandoned during 2013-14			No. of NHS wells as on March-14		
		DW	PZ	Total	DW	PZ	Total	DW	PZ	Total	DW	PZ	Total
1	Adilabad	39	25	6	12	0	12	3	0	3	48	25	73
2	Hyderabad	7	21	2	2	0	2	1	0	1	8	21	29
4	Karimnagar	24	55	7	5	0	5	1	0	1	28	55	83
5	Khammam	48	12	6	7	0	7	3	0	3	55	12	67
6	Mahbubnaga	21	28	4	3	0	3	1	0	1	23	28	51
7	Medak	18	29	4	10	0	10	1	0	1	27	29	56
8	Nalgonda	19	33	5	24	8	32	0	1	1	43	40	83
9	Nizamabad	18	24	4	15	6	21	3	0	3	3	30	60
9	Ranga Reddy	31	61	9	12	0	12	2	0	2	41	61	102
10	Warangal	25	55	8	18	0	18	1	2	3	42	53	95
		25	343	5	10	14	12	13	3	16	34	354	699

6.1 Depth to Water Level

The data on periodic monitoring of depth to water levels from Ground water monitoring Wells generally indicates deeper water levels during pre-monsoon period, in the month of May and shallow water levels during post-monsoon period, in the month of November of the same year. The water level measurements carried out during the month of August reveal the passing phase of southwest monsoon. Water level data recorded during November show the peak effects of both southwest and northeast monsoons. The depth to water level maps are prepared for May, November 2012 and January 2013 (unconfined aquifers) using GEMS (Ground Water Management System) software.

6.1.1 Depth to Water Level - MAY, 2013

Analysis of water levels during May, 2013 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during May, 2013 in the State and percentage of variation in depth to 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, 2013 is shown in the Fig.6.2.

Table-6.2
Water Level scenario during May, 2013 Telangana State

Water level Range	Districts
< 2 m bgl	few locations in Khammam, Warangal and Adilabad districts
2 to 5 m bgl zone	As small isolated pockets all over the State
5 -10 m bgl zones	Small isolated areas in parts of Nizamabad, Medak, Rangareddy, Mahbubnagar districts and as large areas all over the State.
10 and 20 m bgl	Mahabubnagar, Ranga Reddy, Medak, Nizamabad
20 and 40 m bgl	As small patches in Mahbubnagar, Rangareddy, Medak, Nizamabad, Adilabad and Nalgonda districts

Table-6.3
Percentage of variation in depth to water level

Water level range	% of wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	1.4% wells	482	0.92 m.bgl (Adilabad district)	43.4 m.bgl (Mahabub nagar district
2-5 m bgl	17.6% of wells			
5-10 m bgl	in 43.4% wells			
10-20 m bgl	31.5% wells			
20 m bgl	6% wells			

Fig.6.1

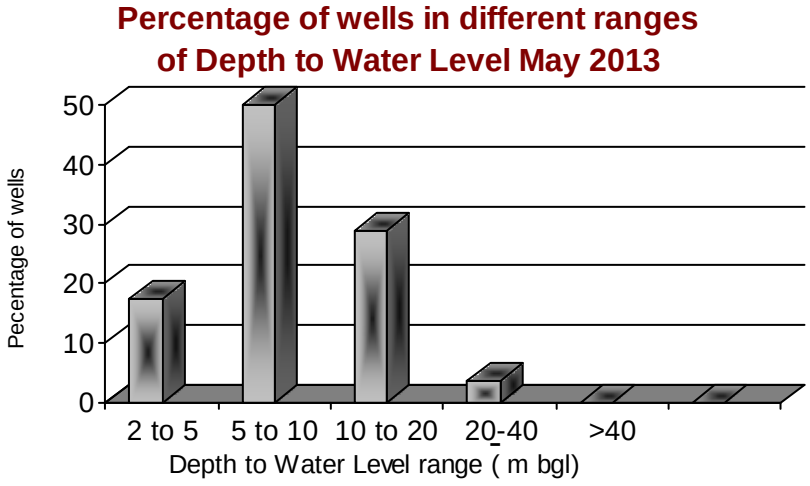


Fig.6.2

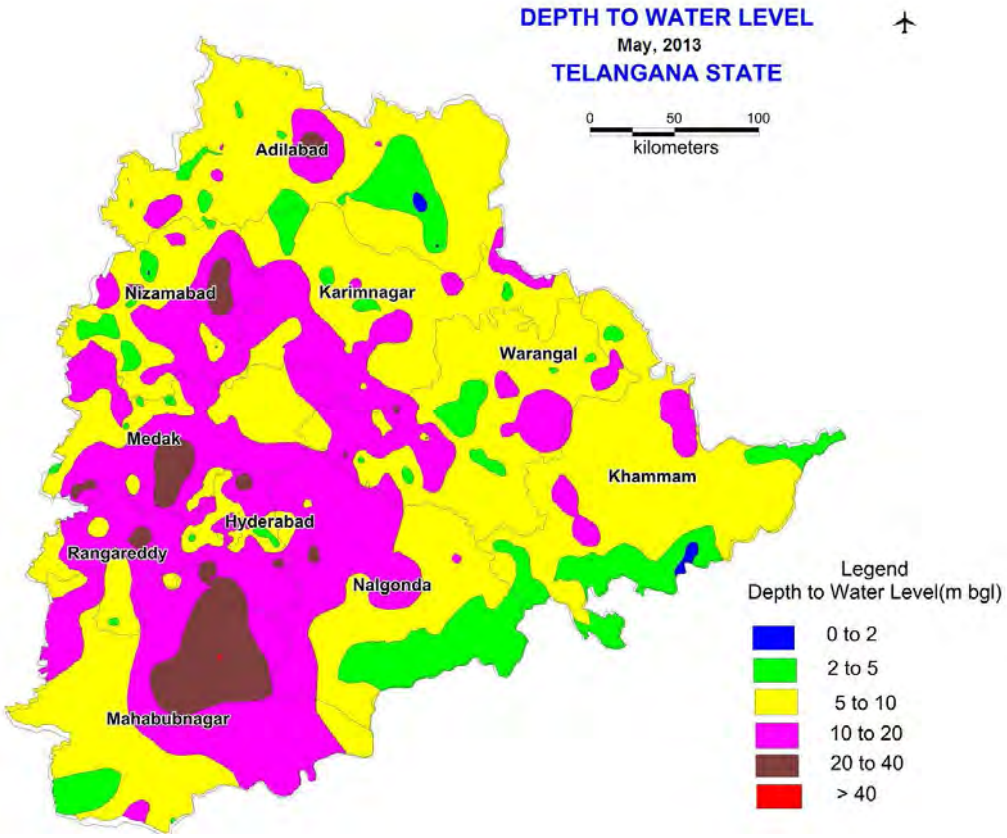

DEPTH TO WATER LEVEL
May, 2013
TELANGANA STATE
0
50
100
kilometers
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Hyderabad
Rangareddy
Nalgonda
Mahabubnagar
Legend
Depth to Water Level(m bgl)
0 to 2
2 to 5
5 to 10
10 to 20
20 to 40
> 40

Table-6.4
Distribution of Percentage of Observation Wells (May 2013)

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	64	0.92	26.15	2	3.13	18	28.13	37	57.81	6	9.38	1	1.56	0	0
2	Hyderabad	14	4.08	20.2	0	0	2	14.29	4	28.57	7	50.0	1	7.24	0	0
3	Karimnagar	59	1.6	19.28	1	1.69	6	10.17	30	50.85	22	37.29	0	0	0	0
4	Khammam	46	1.25	12.78	2	4.35	13	28.26	24	52.17	7	15.22	0	0	0	0
5	Mababoobnagar	32	3.62	43.40	0	0	2	6.25	12	37.5	11	34.38	5	15.63	2	6.25
6	Medak	34	3.0	29.98	0	0	4	11.76	14	41.18	12	35.29	4	1.76	0	0
7	Nalgonda	38	2.94	21.11	0	0	12	31.58	12	31.58	13	34.21	1	2.63	0	0
8	Nizamabad	47	1.6	28.1	1	2.1	10	213	14	29.8	19	40.43	3	6.38	0	0
9	Ranga Reddy	68	1.28	37.95	1	1.47	4	5.88	22	32.35	32	47.06	9	13.24	0	0
10	Warangal	80	2.43	21.85	0	0	14	17.5	40	50.0	23	28.75	3	3.75	0	0
	Total State	482	0.92	43.4	7	1.4	85	17.6	209	43.4	152	31.5	27	5.6	2	0.4

6.1.2 Depth to Water Level - August, 2013

Analysis of water levels during August, 2013 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during August, 2013 in the State and percentage of welss 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, 2013 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	Parts of Adilabad, Warangal, as small areas in Medak, Nizamabad, Karimnagar, Khammam, at few locatrions all over the state
2 to 5 m bgl zone	all over the state
5 -10 m bgl zones	Rangareddy, Mahbubnagar, Medak, Nalgonda, Karimnagar and as Small isolated areas in all other districts
10 and 20 m bgl	Mahabubnagar, Nalgonda, Medak, Rangareddy and in small parts of all other districts of Telangana State.
20 and 40 m bgl	As small patches in Mahabubnagar, Rangareddy and Medak districts

Table-6.6
Percentage of variation in depth to water level

Water level range	% of wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	31.3%	483	-0.70 m.bgl (Khammam district)	44.08 m.bgl (Mahbubnagar district).
2-5 m bgl	30.8%			
5-10 m bgl	22.1%			
10-20 m bgl	12.2%			
20 m bgl	3.5%			

Fig.6.3

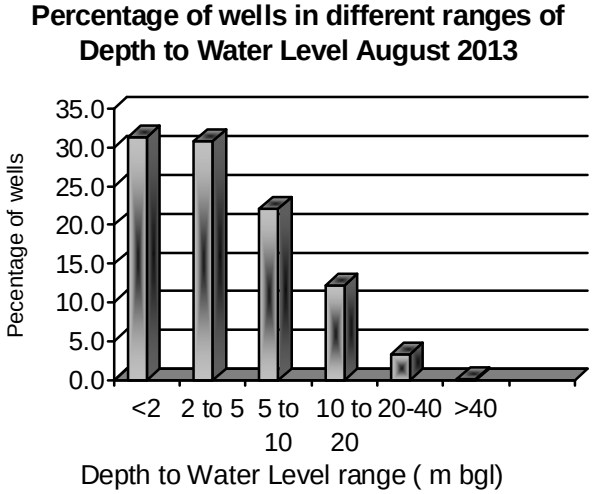


Fig.6.4

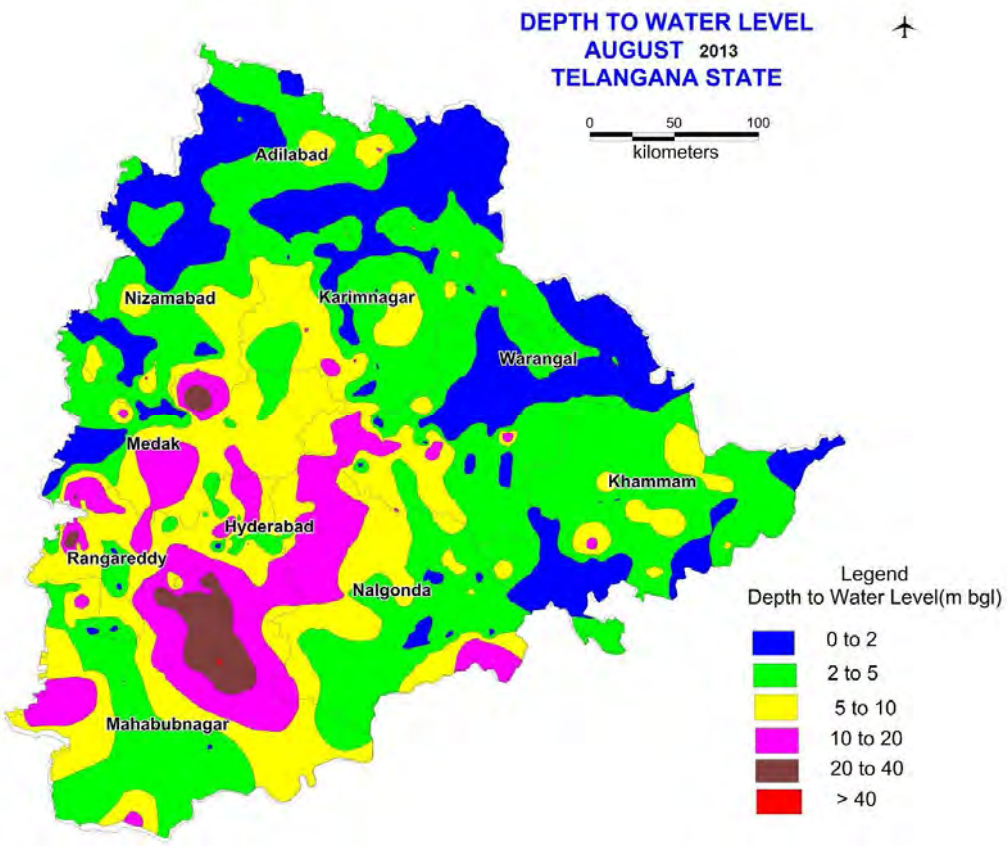

DEPTH TO WATER LEVEL
AUGUST 2013
TELANGANA STATE
0 50 100
kilometers
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Hyderabad
Rangareddy
Nalgonda
Mahabubnagar
Legend
Depth to Water Level(m bgl)
0 to 2
2 to 5
5 to 10
10 to 20
20 to 40
> 40

Table-6.7
Distribution of Percentage of Observation Wells (August, 2013)

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	59	0.03	10.65	37	62.71	18	31.51	3	5.08	1	1.69	0	0	0	0
2	Hyderabad	11	2.24	18.98	0	0	6	54.55	3	27.27	2	18.18	0	0	0	0
3	Karimnagar	60	0.45	11.92	18	30.0	23	38.33	15	25.0	4	6.67	0	0	0	0
4	Khammam	51	-0.7	11.89	19	37.25	21	41.18	10	19.61	1	1.96	0	0	0	0
5	Mababoobnagar	33	1.69	44.1	3	9.1	7	21.21	8	24.24	7	21.21	7	21.21	1	3.03
6	Medak	34	0.03	21.2	10	29.4	6	17.65	9	26.47	8	25.53	1	2.94	0	0
7	Nalgonda	59	0.52	19.5	14	23.73	26	44.07	8	13.56	11	18.64	0	0	0	0
8	Nizamabad	33	0.41	11.56	16	48.48	6	18.18	9	27.27	2	6.06	0	0	0	0
9	Ranga Reddy	67	0.04	37.92	7	10.45	12	17.91	27	40.3	14	21	7	10.45	0	0
10	Warangal	76	0.01	20.71	27	35.53	24	31.58	15	19.74	9	11.84	1	1.32	0	0
	Total State	483	-0.7	44.08	151	31.3	149	30.8	107	22.1	59	12.2	16	3.3	1	0.2

6.1.3 Depth to Water Level - November, 2013

Analysis of water levels during November, 2013 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during November, 2013 in the State and percentage of wells registered in different ranges of depth to water level are furnished in the Table-6.8 & 6.9 respectively. The distribution of percentage of wells in different water level ranges is given in the Table-6.10. 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, 2013 is shown in the Fig.6.6.

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

Water level Range	Districts
< 2 m bgl	Parts of Khammam, Warangal, Karimnagar, Adilabad, and as small isolated areas in all other districts.
2 to 5 m bgl zone	Large parts of Khammam, Adilabad, Warangal, Karimnagar, Nalgonda and as small isolated areas in all other districts of Telangana State.
5 -10 m bgl zones	Small isolated areas in parts of Khammam, Adilabad, Warangal districts and large areas in other districts.
10 and 20 m bgl	Mahabubnagar, Ranga Reddy, Nalgonda, Medak and as isolated areas in Nizamabad, Warangal Karimnagar, Adilabad districts
20 and 40 m bgl	---

Table-6.9
Percentage of variation in depth to water level

Water level range	% of wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	37.4% wells,	502	-0.7 m.bgl (Warangal district)	36.21 m.bgl (Mahabubnagar district).
2-5 m bgl	36.4%			
5-10 m bgl	18.5%			
10-20 m bgl	6.2%			
20 m bgl	1.4%			

Fig.6.5

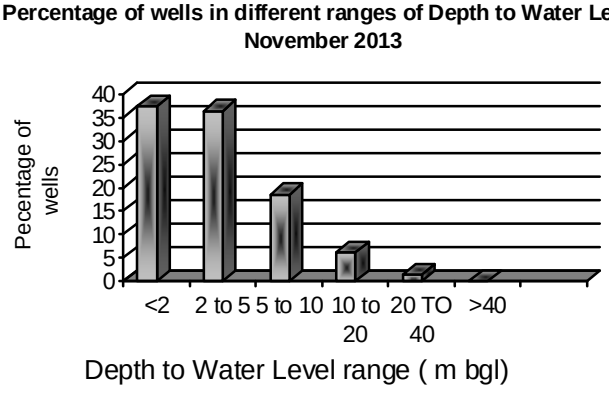


Fig.6.6

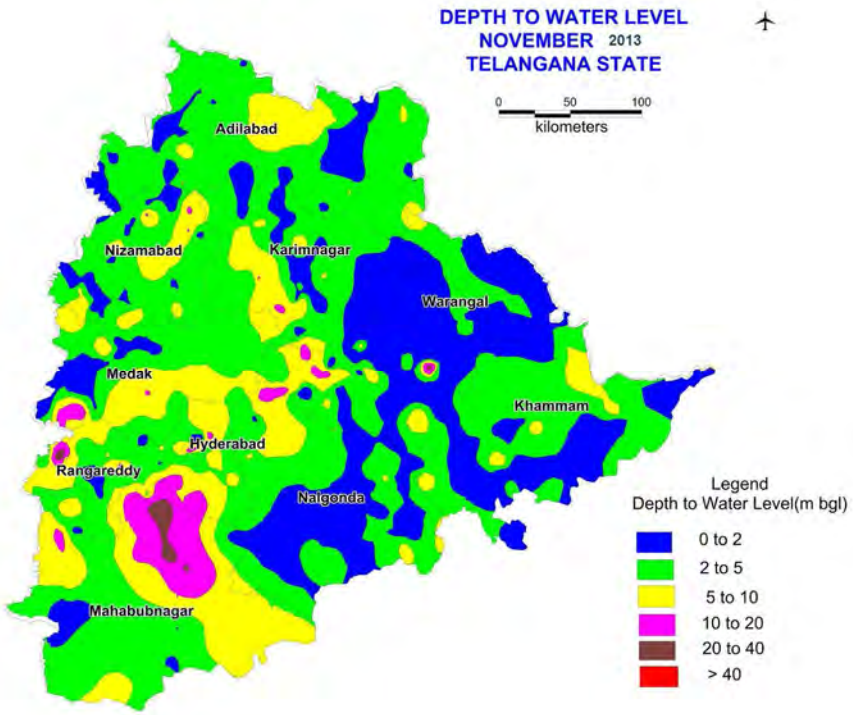

DEPTH TO WATER LEVEL
NOVEMBER 2013
TELANGANA STATE
0
50
100
kilometers
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Hyderabad
Rangareddy
Nalgonda
Mahabubnagar
Legend
Depth to Water Level(m bgl)
0 to 2
2 to 5
5 to 10
10 to 20
20 to 40
> 40

Table-6.10
Distribution of Percentage observation Wells (November, 2013)

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	61	0.29	9.59	24	39.34	30	49.18	7	11.48	0	0	0	0	0	0
2	Hyderabad	13	-0.15	17.46	1	7.69	7	53.85	2	15.38	3	23.08	0	0	0	0
3	Karimnagar	54	-0.39	11.12	22	40.74	19	35.19	10	18.52	3	5.56	0	0	0	0
4	Khammam	55	-0.7	9.06	28	50.91	18	32.73	9	16.36	0	0	0	0	0	0
5	Mababoobnagar	36	-0.05	36.21	6	16.67	14	38.89	5	13.89	7	19.44	4	11.11	0	0
6	Medak	35	0.06	17.93	12	34.29	13	37.14	7	20.0	3	8.57	0	0	0	0
7	Nalgonda	62	0.38	13.01	34	54.84	18	29.03	9	14.52	1	1.61	0	0	0	0
8	Nizamabad	44	0.6	10.71	17	38.64	15	34.09	8	18.89	4	9.09	0	0	0	0
9	Ranga Reddy	71	0.04	32.49	6	8.45	31	43.66	26	36.62	6	8.45	2	2.82	0	0
10	Warangal	71	-0.70	25.05	38	53.52	18	25.35	10	14.08	4	5.63	1	1.41	0	0
	Total State	502	-0.7	36.21	188	37.4	183	36.4	93	18.5	31	6.2	7	1.4	0	0

6.1.4 Depth to Water Level January, 2014

Analysis of water levels during January, 2013 reveals that the depth to water level of 0 to 10 mbgl is more prevalent in the State. The water level scenario during January, 2013 in the State and percentage of wells registered in different ranges of depth to water level 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-6.10. 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 November, 2013 is shown in the Fig.6.7B.

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

Water level Range	Districts
< 2 m bgl	All districts except Nizamabad
2 to 5 m bgl zone	Large areas in Khammam, Adilabad, Warangal, Karimnagar, Nalgonda, and as small isolated areas all ovedr the State
5 -10 m bgl zones	Small areas in parts of Khammam, Adilabad, Warangal, Karimnagar and major parts of all other districts..
10 and 20 m bgl	Mahabubnagar, Rangareddy, Nalgonda, Medak, Nizamabad and in as small pockets in all other districts.
20 and 40 m bgl	As small patches in Mahbubnagar, Rangareddy, Medak, Nizamabad, Warangal districts

Table-6.12
Percentage of variation in depth to water level
January, 2013 Telangana State

Water level range	% of wells registered in the respective water level range	Total No. of wells analysed	Min	Max
2 m bgl	11.9%	552	0.17 m.bgl (Adilabad district)	33.77 m.bgl (Rangareddy district).
2-5 m bgl	44.4%			
5-10 m bgl	31.7%			
10-20 m bgl	10.8%			
20 m bgl	1.1%			

Fig.6.7

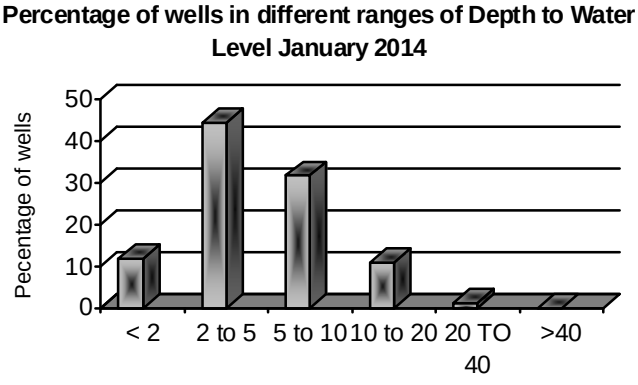


Fig.6.7B

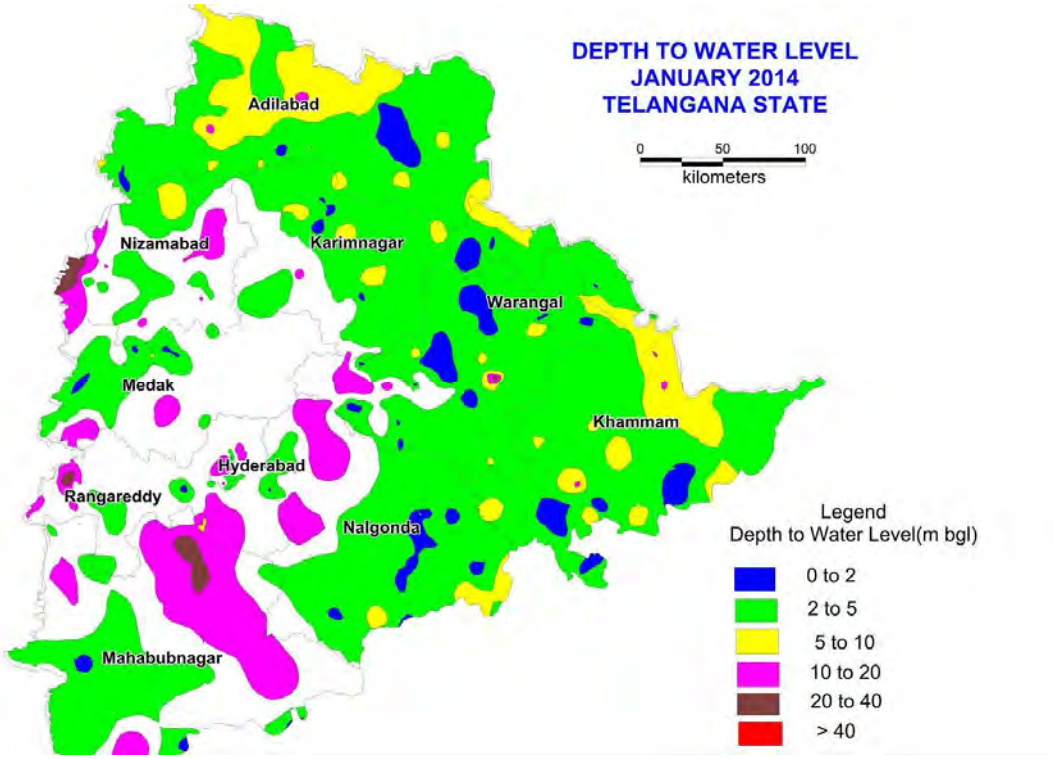

DEPTH TO WATER LEVEL
JANUARY 2014
TELANGANA STATE
0
50
100
kilometers
Adilabad
Nizamabad
Karimnagar
Warangal
Medak
Khammam
Hyderabad
Rangareddy
Nalgonda
Mahabubnagar
Legend
Depth to Water Level(m bgl)
0 to 2
2 to 5
5 to 10
10 to 20
20 to 40
> 40

Table-6.13
Distribution of Percentage of Observation Wells (January, 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	0.17	11.22	6	9.09	42	63.64	16	24.24	2	3.03	0	0	0	0
2	Hyderabad	13	0.86	19	1	7.69	5	38.46	2	15.38	5	38.46	0	0	0	0
3	Karimnagar	65	0.53	11.97	7	10.77	38	58.46	18	27.69	2	3.08	0	0	0	0
4	Khammam	54	0.82	11.3	9	16.67	27	50.0	15	27.78	3	5.56	0	0	0	0
5	Mababoobnagar	29	1.07	28.51	1	2.56	14	35.9	9	23.08	13	33.33	2	5.13	0	0
6	Medak	38	1.3	20.22	4	10.53	13	34.21	18	47.37	2	5.26	1	2.63	0	0
7	Nalgonda	67	0.55	19.68	16	23.88	37	55.22	8	11.94	6	8.96	0	0	0	0
8	Nizamabad	52	1.74	32.1	1	1.92	19	36.54	23	44.23	8	15.38	1	1.92	0	0
9	Ranga Reddy	75	0.2	33.77	4	5.33	8	10.67	48	64.0	14	18.67	1	1.33	0	0
10	Warangal	83	0.56	26.35	17	20.48	42	50.6	18	21.69	5	6.02	1	1.2	0	0
	Total State	552	0.17	33.77	66	11.9	245	44.4	175	31.7	60	10.8	6	1.1	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, 2013, August, 2013, November, 2013 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 1.4% in May 2013 to 37.4% in November 2013 and between 2 and 5 m bgl, increased from 17.6% in May 2013 to 36.4% in November 2013. The number of wells with depth to water level of 5 to 10 m bgl has decreased from 43.4% to 18.5% from May 2013 to November 2013. The number of wells with depth to water level of 10 to 20 m bgl has decreased from 31.5% in May 2013 to 6.2% in November 2013. Impact of very good monsoon is clearly seen in the increases of percentage of wells between 0-2 m bgl and 2-5 m bgl from pre-monsoon to post-monsoon. There is a marginal decrease of percenatage of wells in all other categories of depth to water level.

6.3 Water Table Elevation

Water table elevation maps during pre(May, 2013) and post (November, 2013) monsoon are presented in Fig.6.8 and 6.9.

A perusal of the map reveals the following points

- Water table generally follows the topography.
- Elevation of water table ranges from <10 (zero) metres amsl on eastern side to >700 m (750) metres on southern side of the State.
- The general gradient of water table is from west to east.

Fig.6.8

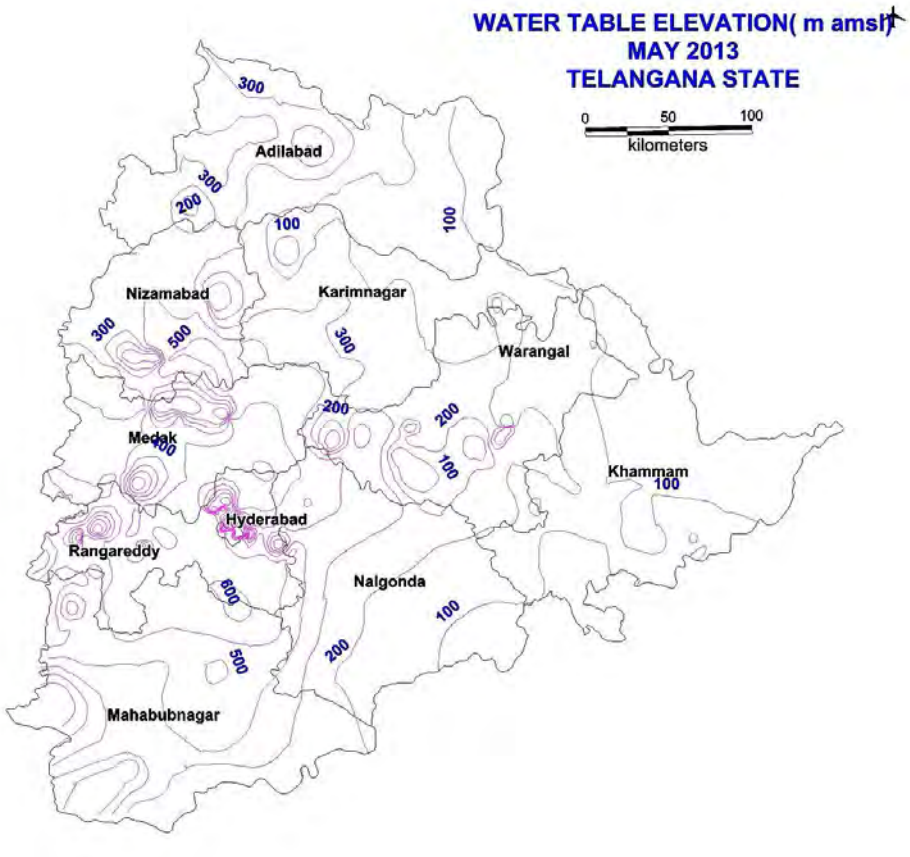
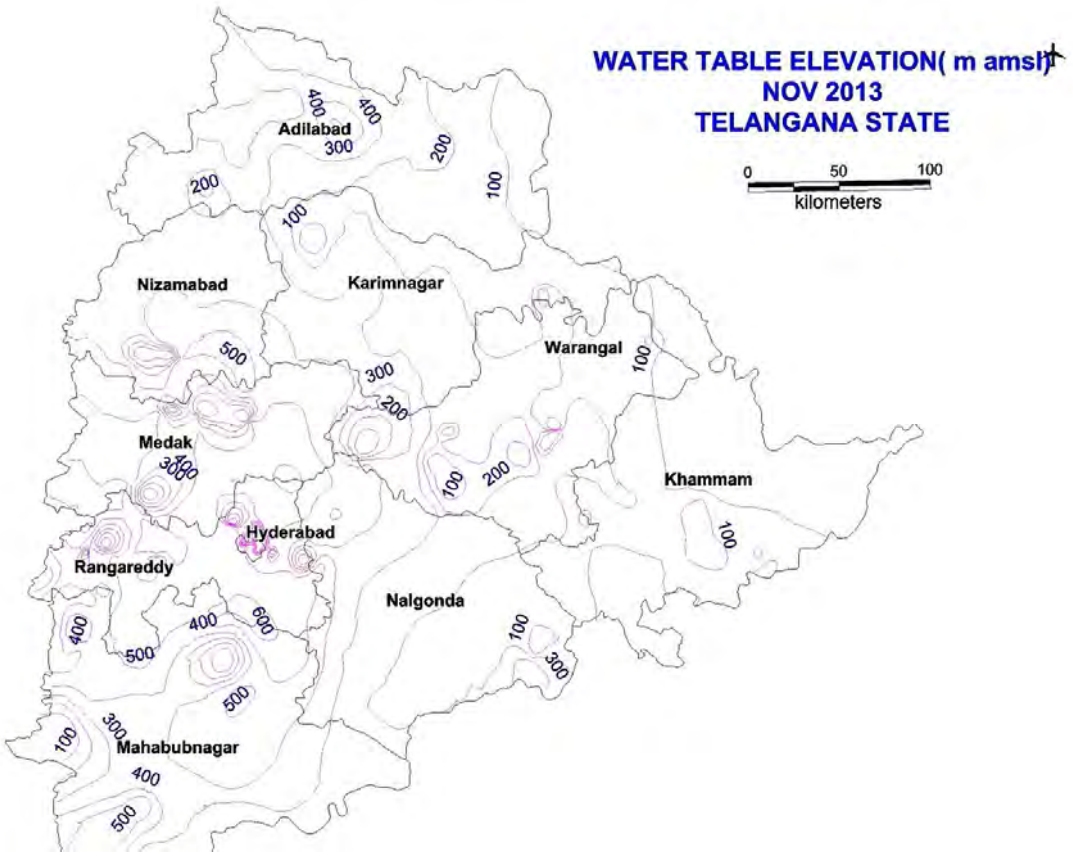


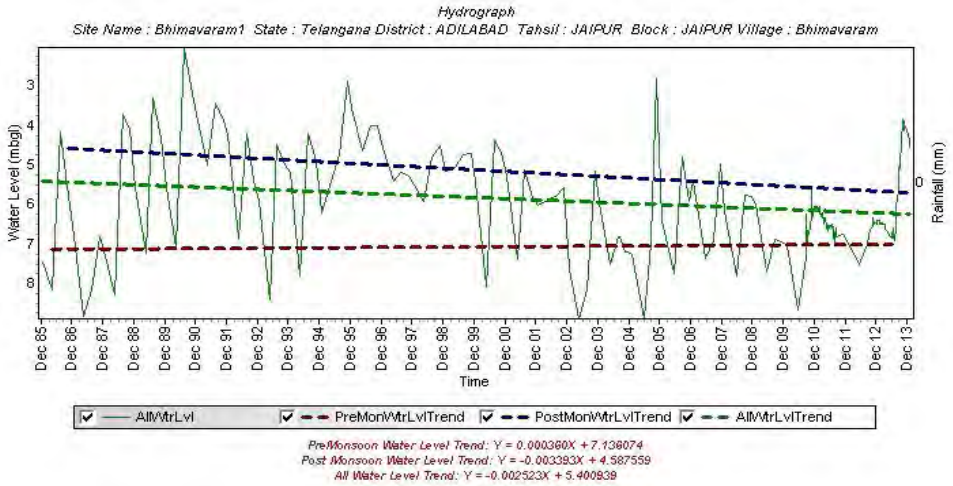
Fig.6.9



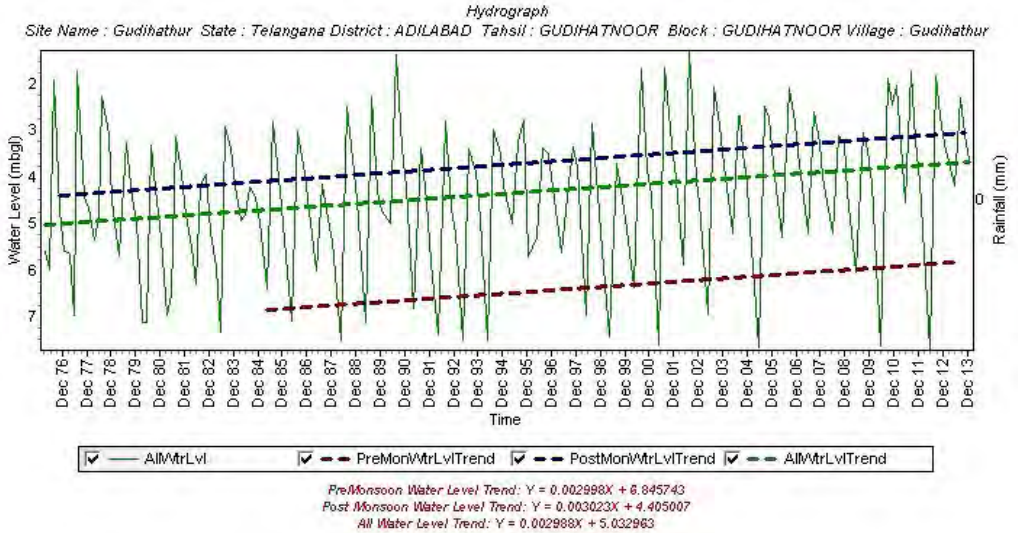
6.4. Hydroraphs of National Water Level Monitoring Wells

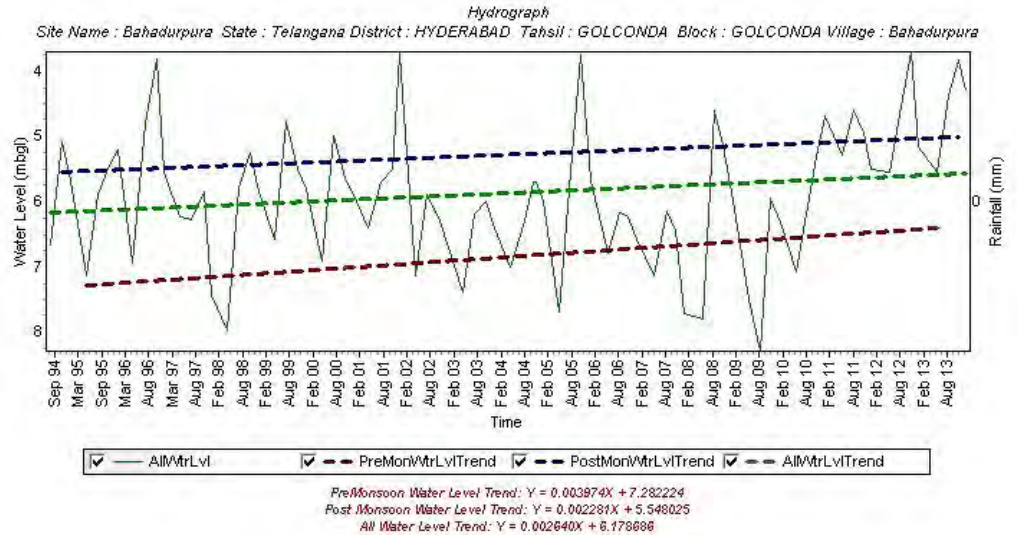
Variations in ground water level with time, due to recharge and discharge, is generally depicted in hydrographs. A study of long term water level trend for the last 15 to 25 years, indicate the annual and seasonal fluctuations. It depends on recharge factors such as rainfall, seepage from canals, irrigated areas, water storage bodies, etc. The fluctuations are observed to be high along drainage divides, upland areas and in chronically drought-affected areas. The fluctuations 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 - 6.13.

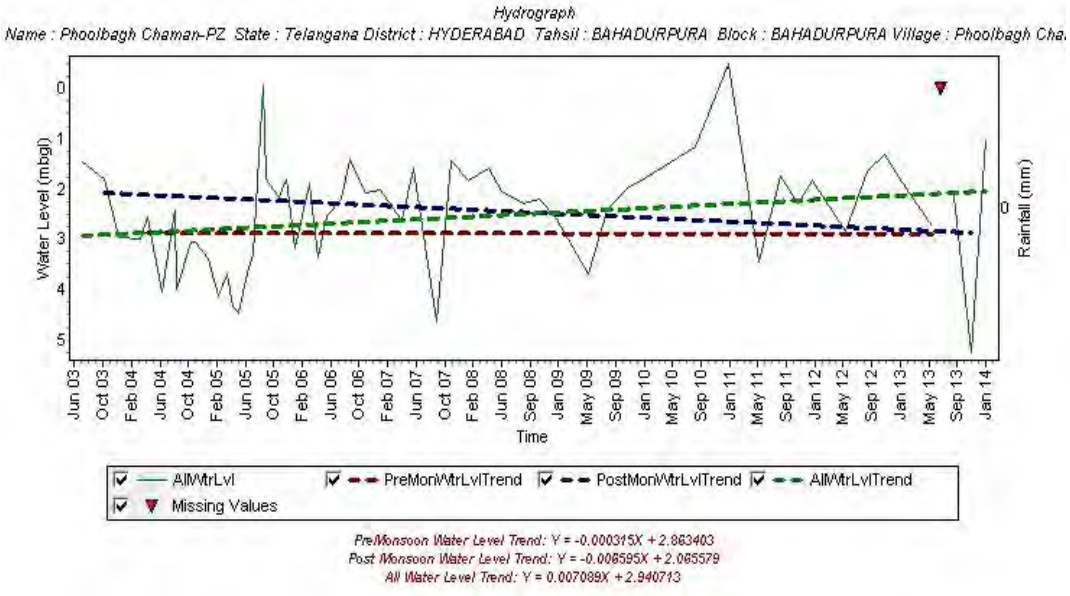
Fig.6.10
Hydroraphs of National Water Level Monitoring Wells



Hydroraphs of National Water Level Monitoring Wells

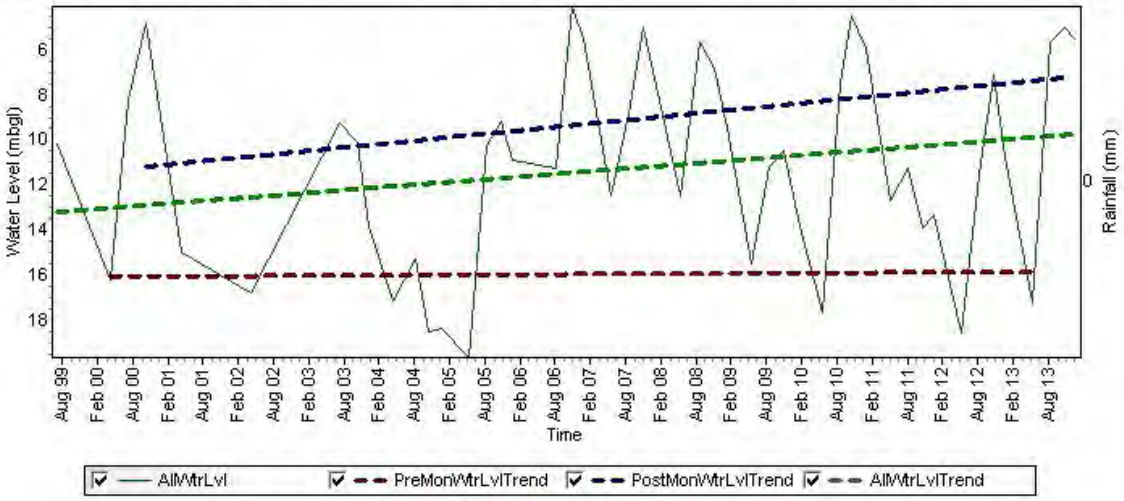






Hydrograph

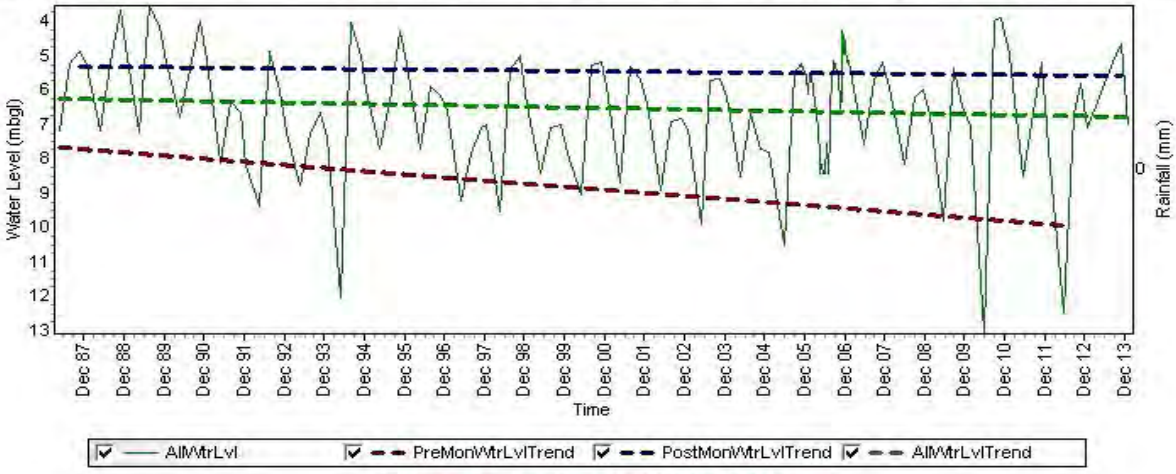
ite Name : Chigurumamidi-PZ State : Telangana District : KARIMNAGAR Tahsil : CHIGURUMAMIDI Block : CHIGURUMAMIDI Village : Chigurumami



PreMonsoon Water Level Trend: Y = 0.001050X + 16.050032
Post Monsoon Water Level Trend: Y = 0.025252X + 11.215559
All Water Level Trend: Y = 0.019652X + 13.189911

Hydrograph

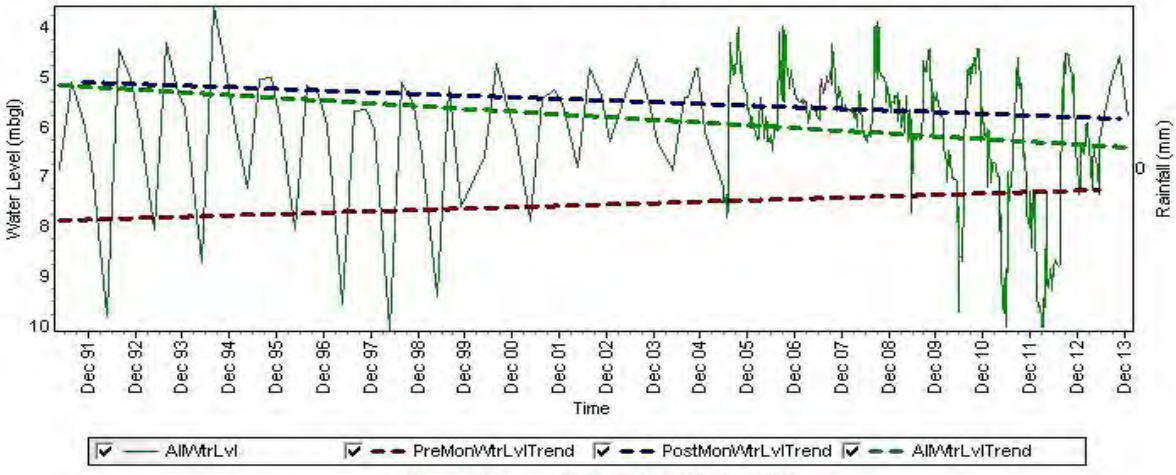
Site Name : Dharmapuri-new State : Telangana District : KARIMNAGAR Tahsil : DHARMAPURI Block : DHARMAPURI Village : Dharmapuri-new



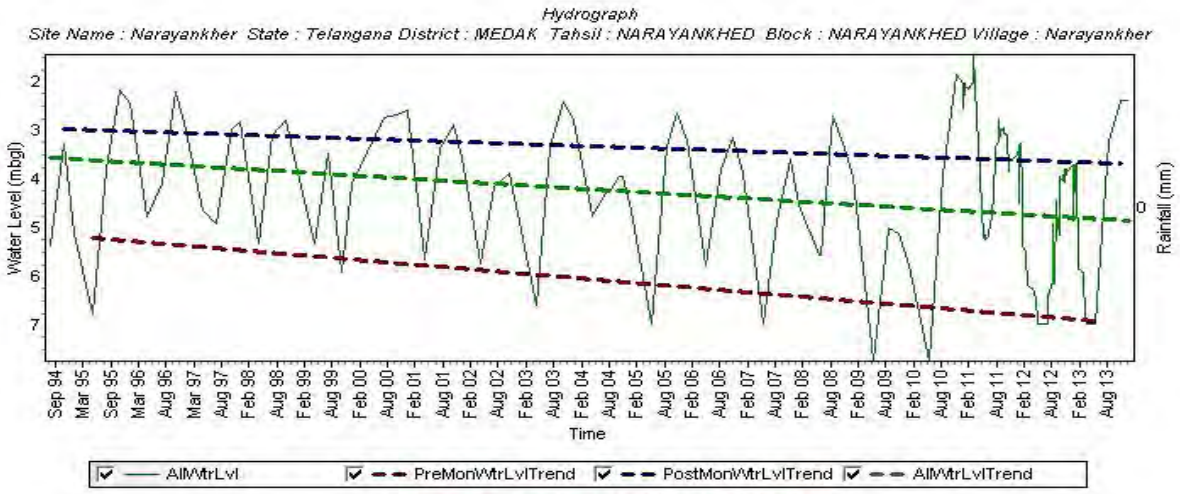
PreMonsoon Water Level Trend: Y = -0.007339X + 7.692174
Post Monsoon Water Level Trend: Y = -0.000814X + 5.316587
All Water Level Trend: Y = -0.001595X + 6.274510

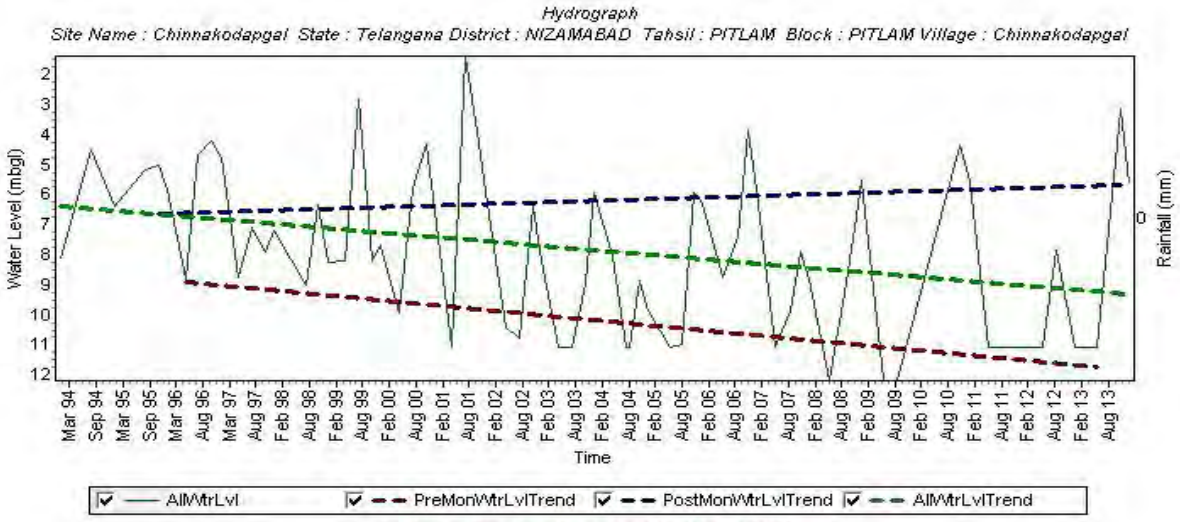
Hydrograph

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



PreMonsoon Water Level Trend: Y = 0.002325X + 7.875805
Post Monsoon Water Level Trend: Y = -0.002721X + 5.093164
All Water Level Trend: Y = -0.004658X + 5.145922


Hydrograph
Site Name : Narayankher State : Telangana District : MEDAK Tahsil : NARAYANKHED Block : NARAYANKHED Village : Narayankher
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.007712X + 5.199493
Post Monsoon Water Level Trend: Y = -0.002984X + 2.987378
All Water Level Trend: Y = -0.005540X + 3.556725


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 = -0.013622X + 8.906551
Post Monsoon Water Level Trend: Y = 0.004309X + 6.608915
All Water Level Trend: Y = -0.012095X + 8.403279

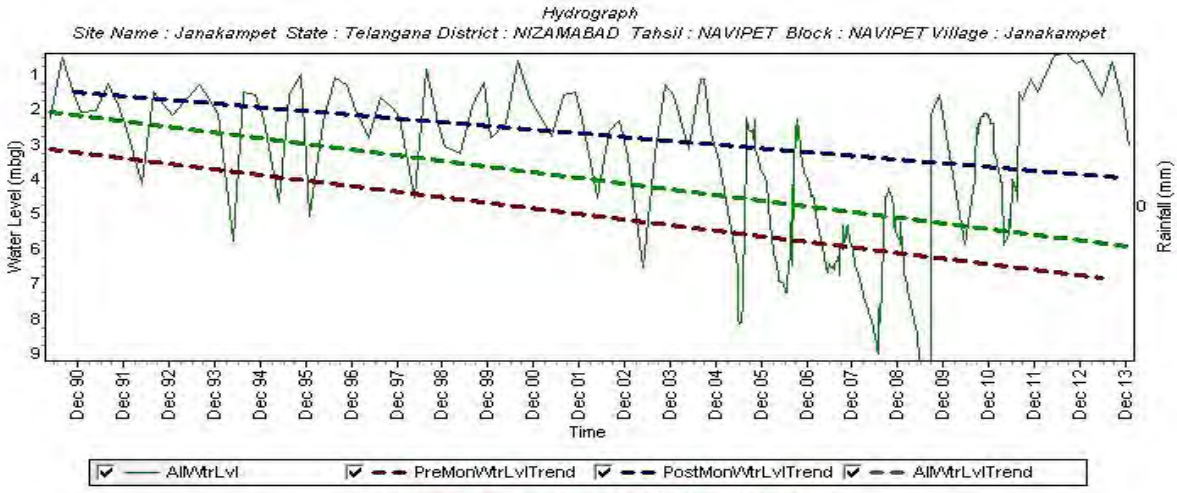

Hydrograph
Site Name : Janakampet State : Telangana District : NIZAMABAD Tahsil : NAVIPET Block : NAVIPET Village : Janakampet
Water Level (mbgl)
Rainfall (mm)
Time
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.013094X + 3.139480
Post Monsoon Water Level Trend: Y = -0.008702X + 1.518448
All Water Level Trend: Y = -0.013511X + 2.086077

Fig.6.11

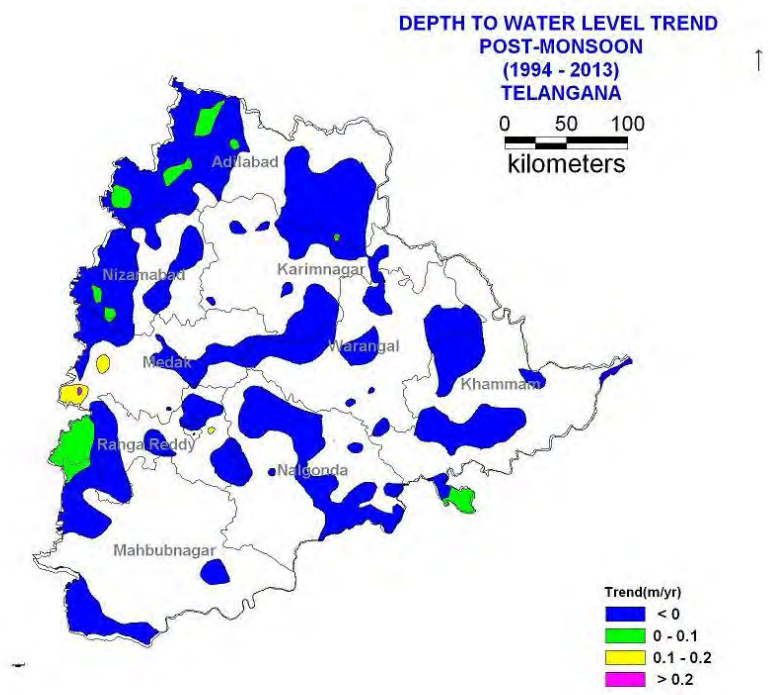


Fig.6.12

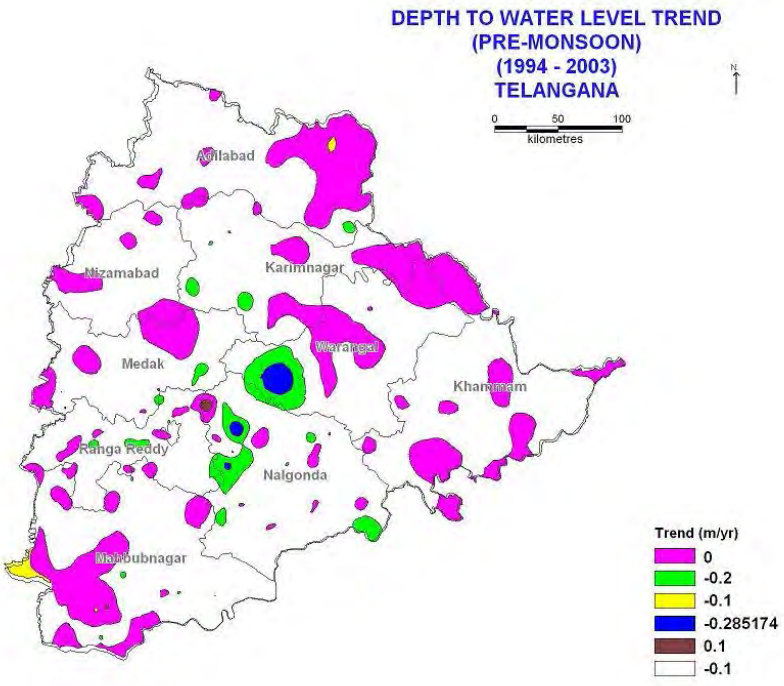
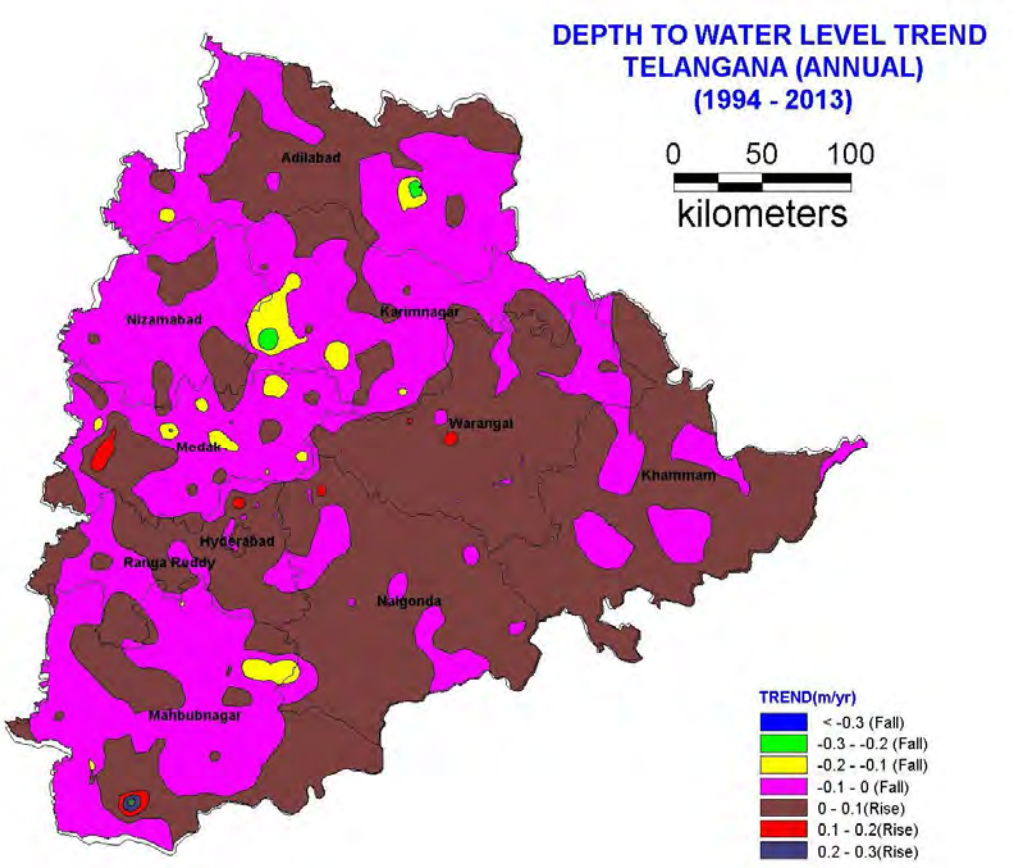


Fig.6.13



6.5 Water Level Fluctuation

The periodic monitoring of Ground Water Monitoring Wells depicts 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 2012 vs. May 2013

Fluctuation of water levels during May, 2012 with reference to May 2013 is depicted in the Fig.6.14 and categorization of water level fluctuation May, 2012 Vs. May 2013 in presented in the Fig.6.15**.** It is observed that rise in water levels in 56.27% of wells in the State.

Rise of less than 2 m is observed in major parts of Khammam, Warangal, Karimnagar, Adilabad and small parts in all other districts of Telangana State. Water level rise of 2-4 m is observed in small parts in all districts. Rise of more than 4 m is observed in small parts of Rangareddy, Nizamabad, Adilabad, Karimnagar, Warangal and Nalgonda districts.

Fall of less than 2 m is observed in small parts of Khammam, Warangal, Karimnagar and major parts in all other districts. 2-4 m and >4m are noticed in considerable areas in Mahabubnagar, Nizamabad, Nalgonda and in small parts of all other districts.

Water level fluctuation data of May 2012- May 2013 is presented in the Table-6.14**.** An analysis of data of 311 wells shows that rise is recorded in 56.27% of wells (175), fall is recorded in 36.0% of wells (112), while in 7.73 % of wells (24) no fluctuation is recorded.

Rise of less than 2 m is recorded in 36.9% of wells, 2-4 m in 12.8% of wells and rise of more than 4 m is recorded in 6.4% of wells. Fall of less than 2 m is recorded in 23.8% of wells and in the range of 2-4 m, in 7.7% of wells. Fall of more than 4 m is registered in 3.2% of wells. Rise of more than 4 m is recorded maximum in Adilabad district (21.43 % wells) while fall of more than 4 m is registered maximum in Mahabubnagar district (10.53%) wells.

Rise

Out of175 wells that have registered a rise in water levels, 66% wells recorded rise of less than 2 m, 23% of wells in the range of 2 to 4 m while 11% of wells recorded rise of more than 4 m.

Fall

Out of 112 wells that have registered fall in water levels, majority of them (70%) have recorded less than 2 m fall, in the range of 2-4 m in 21% of wells and 9% of wells registered fall of more than 4 m.

Fig.6.14

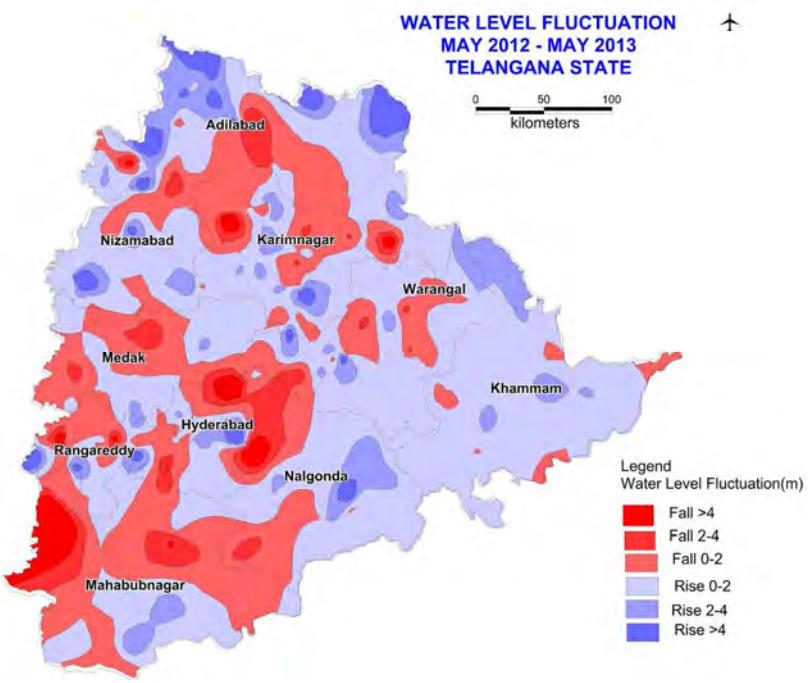


Fig.6.15
Categorisation of fluctuation of water levels (May 2012 - May 2013)

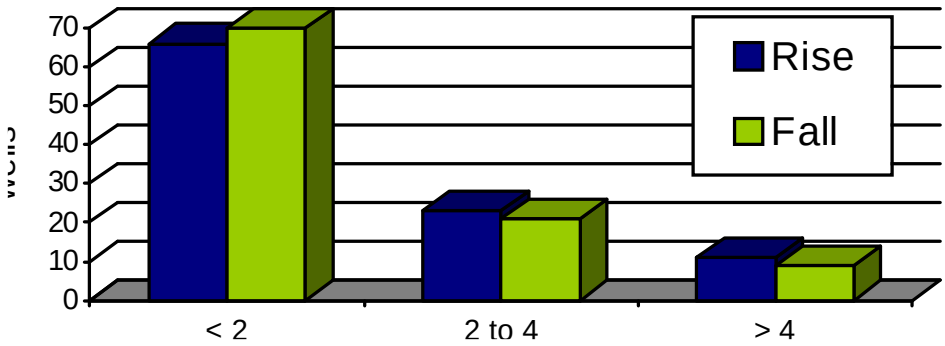


Table-6.14
District Wise Water Level Fluctuation and Frequency Distribution – May,2012 – May 2013

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Adilabad	42	0.06	9.34	0.36	5.35	14	33.33	5	19.9	9	21.43	8	19.05	4	9.52	1	2.38	28	13
2	Hyderabad	9	1.08	2.58	0.07	1.51	2	22.22	1	11.11	0		5	55.56	0	0	0	0	3	5
3	Karimnagar	52	0.03	6.19	0.12	7.51	19	36.54	7	13.46	3	5.77	17	32.69	3	5.77	2	3.85	29	22
4	Khammam	39	0.1	3.8	0.05	1.05	23	58.97	5	12.82	0		9	23.08	0	0	0	0	28	9
5	Mababoobnagar	19	0.38	4.95	0	9.25	4	21.05	2	10.53	1	5.26	9	47.37	0	0	2	10.53	7	11
6	Medak	20	0.38	2.35	0.08	3.28	4	20.0	3	15.0	0		2	10.0	3	15.0	0	0	7	5
7	Nalgonda	22	0.3	9.1	0.2	7.8	6	27.27	5	22.73	2	9.09	2	9.09	3	13.64	2	9.09	13	7
8	Nizamabad	22	0.13	10.6	0.45	3.25	8	36.36	3	13.64	2	9.09	4	18.18	1	4.55	0	0	13	5
9	Ranga Reddy	40	0.05	7.7	0.3	6.95	14	35.0	4	10.0	2	5.0	10	25.0	4	10.0	3	7.5	20	17
10	Warangal	46	0.03	5.71	0.05	3.38	21	45.65	5	10.87	1	2.17	12	26.09	6	13.04	0	0	27	18
	Total State	311	0.03	9.34	0.0	9.25	115	36.9	40	12.8	20	6.4	78	23.8	24	7.7	10	3.2	175	112

6 .6.2 Water Level Fluctuation May, 2013 vs August, 2013

Fluctuation of water levels during August 2013 with reference to May 2013 is depicted in Fig.6.16 and categorization of water level fluctuation May, 2013 vs August, 2013 is presented in the Fig.6.17. Rise of water levels in 94.76% of wells is observed in theState.

Rise in water level of less than 2 m is observed in parts of all the districts. Rise of 2-4 m is observed in major parts of Khammam, Nalgonda and as small isolated areas in parts of all other districts. Rise of more than 4 m is observed in small parts of Nalgonda, Khammam and major parts of all other districts.

Fall of less than 2 m is observed in small parts of Mahabubnagar, Nalgonda, Warangal, Karimnagar and Karimnagar districts . Fall of 2-4 m is noticed in very small areas in Warangal and Karimnagar districts and fall of more than 4 m is observed in very small areas in Warangal and Karimnagar districts.

Water level fluctuation data, May 2013 - August 2013, is furnished in the Table- **6.16.** An analysis of data of 439 wells shows that rise is recorded in 94.76% of wells (416), l fall is r in 03.4% of wells (15), while no fluctuation is observed in 1.60% of wells (08).

Rise of less than 2 m is recorded in 17.3% wells in the range of 2-4 m in 28.9% of wells and rise of more than 4 m is recorded in 48.5% of wells. Fall of less than 2 m is recorded in 2.7% wells in the range of 2-4 m. Fall of more than 4 m is registered in 0.4% wells. More than 4 m is recorded maximum in Karimnagar district (72.41% wells) while fall of more than 4 m is registered maximum in Hyderabad district (9.09% of wells).

Fig.6.16

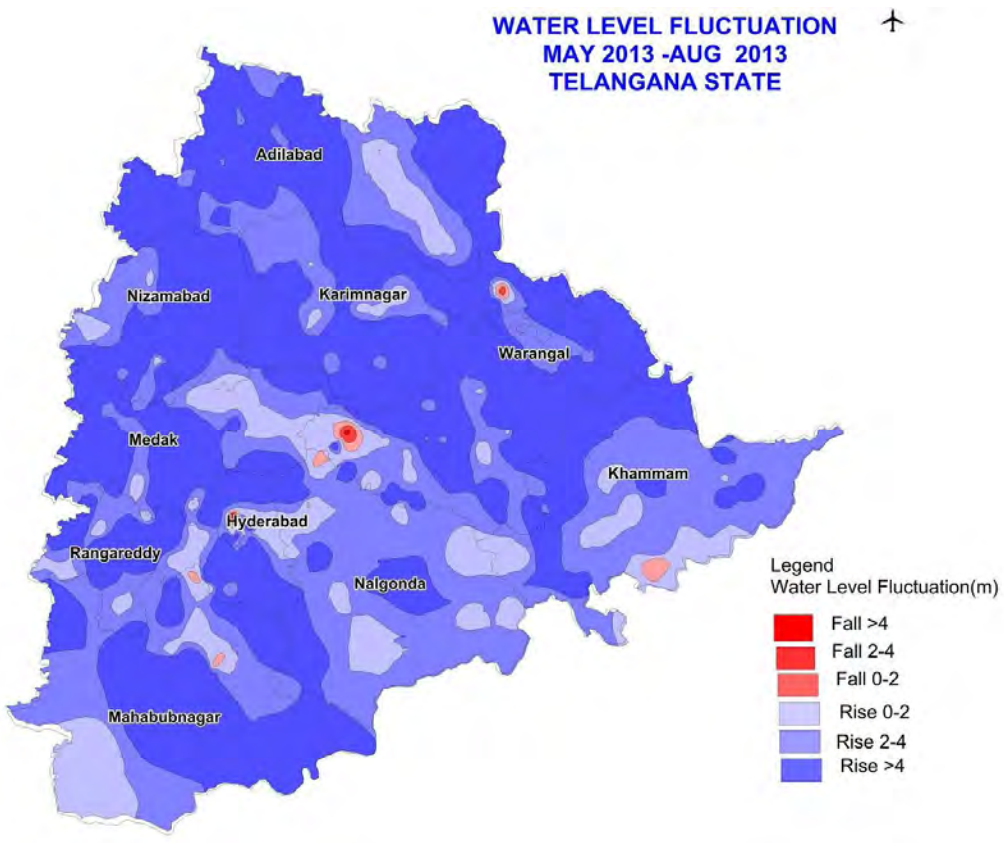
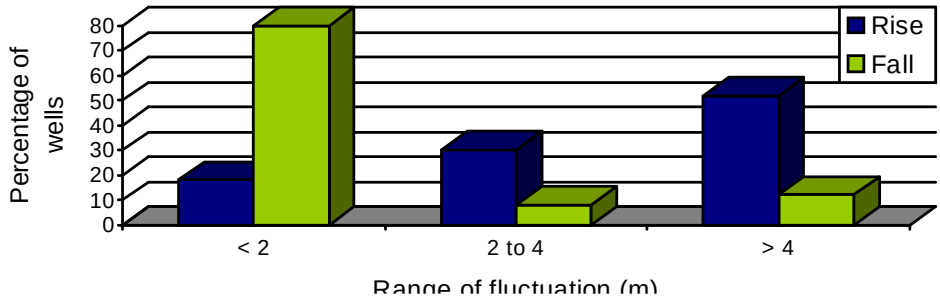


Fig.6.17
Categorisation of fluctuation of water levels (May 2013 - August 2013)



Rise

Out of 416 wells that have registered a rise in water levels, 18.12% of wells recorded water level rise of less than 2 m, 30.19% of wells in the range of 2 to 4 m while 51.69% of wells recorded rise of more than 4 m.

Fall

Out of the 15 wells that have registered fall in water levels, 80% of them have recorded less than 2 m fall, 8% of wells shows 2-4 m fall and the 12% of wells registered fall of more than 4 m.

Table-6.15
District wise water level fluctuation and frequency distribution in different fluctuation ranges – May, 2013 – August, 2013

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Adilabad	57	0.16	19.07	0.01	0.05	4	7.02	17	29.82	34	59.65	2	3.51	0	0	0	0	55	2
2	Hyderabad	11	0.31	7.47	7.56	7.56	3	27.27	3	27.27	4	36.36	0	0	0	0	1	9.09	10	1
3	Karimnagar	58	0.67	12.4	3.82	3.82	6	10.34	9	15.52	42	72.41	0.	0	1	1.72	0	0	57	1
4	Khammam	46	0.16	9.48	1.9	1.9	13	28.26	18	39.13	14	30.43	1	2.17	0	0	0	0	45	1
5	Mababoobnagar	29	0.05	28.77	0.47	0.98	7	24.14	8	27.59	10	34.48	3	10.34	0	0	0	0	25	3
6	Medak	33	1.58	15.79	0.05	0.05	2	6.06	10	30.30	16	48.48	1	3.03	0	0	0	0	28	1
7	Nalgonda	38	0.45	9.10	0.01	0.54	9	23.68	18	47.37	8	21.05	3	7.89	0	0	0	0	35	3
8	Nizamabad	32	0.46	19.33	-	-	5	15.63	10	31.25	17	53.13	0	-	0	-	0	-	32	0
9	Ranga Reddy	60	0.17	16.39	-	-	16	26.67	12	20.0	30	50.0	0	-	0	-	0	-	58	0
10	Warangal	75	0.12	13.5	0.54	4.86	11	14.67	22	29.33	38	50.67	2	2.67	0	0	1	1.33	71	3
	Total State	439	0.05	28.77	0.01	7.56	76	17.3	127	28.9	213	48.5	12	2.7	1	0.2	2	0.4	416	15

6.6.3 Fluctuation of water levels - May, 2013 vs November, 2013

Fluctuation of water levels during May 2013 with reference to November 2013 is depicted in Fig.6.18 and categorization of water level fluctuation May, 2013 vs November, 2013 is presented in the Fig.6.19. Rise of water levels in 97.51% of wells is observed in theState.

Rise in water level of less than 2 m is observed in major parts of Mahabubnagar and small parts in all other districts. Rise of 2-4 m is observed in small parts of all districts. More than 4 m is observed in major parts of all the districts. **Fall** of less than 2 m is observed in small parts of Mahabubnagar and very small parts of Nalgonda, Warangal, Karimnagar and Medak districts. Fall of 2-4 m and >4m are noticed in Mahabubnagar, Karimnagar and Nalgonda districts of Telangana.

Water level fluctuation data of May 2013- November 2013 is presented in Table-6.16**.** An analysis of data of 443 wells shows that water level rise is recorded in 97.51% of wells (432), Fall is recorded in 2.25% of wells (10), while 0.24% of wells (1) has no fluctuation.

Rise of less than 2 m is recorded in 10.8% of wells in the range of 2-4 m in 26.2% wells and rise of more than 4 m is recorded in 60.5% of wells. Fall of less than 2 m is recorded in 1.1% of wells in the range of 2-4 m and fall of more than 4 m is registered in 0.4% wells. Rise of more than 4 m is recorded maximum in Adilabad district (49.15%of wells) while fall of more than 4 m is registered maximum in Hyderabad district (7.69% of wells).

Rise

Out of the 432 wells that have registered a rise in water levels, 11% of wells recorded water level rise of less than 2 m, 27% of wells in the range of 2 to 4 m while 62% of wells recorded rise of more than 4 m.

Fall

Out of 10 wells that have registered fall in water levels, majority of them (50%) have recorded less than 2 m fall, 2-4 m range in 30% of wells and 20% of wells registered fall of more than 4 m**.**

Fig.6.18

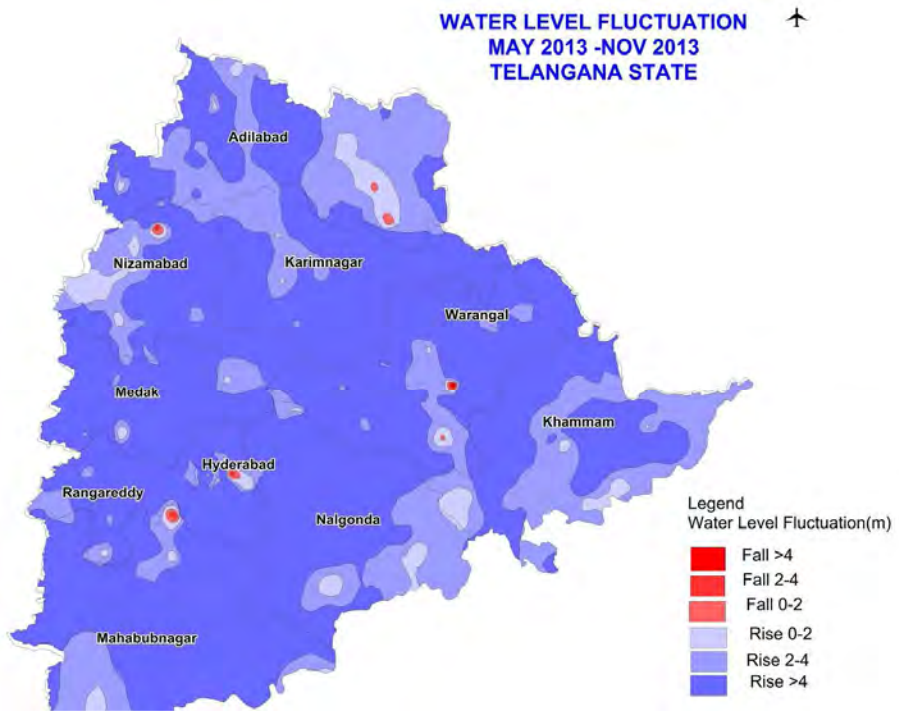


Fig.6.19
Categorisation of fluctuation of water levels (May 2013 - November 2013)

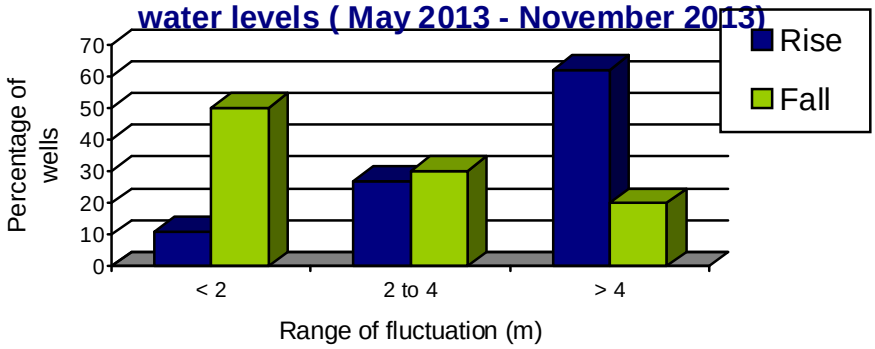


Table-6.16
District Wise Fluctuation and Frequency Distribution in Different Ranges
May, 2013 to November, 2013

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	59	0.43	16.56	0.35	1.12	6	10.17	29	49.15	22	37.29	2	3.39	0	0	0	0	57	2
2	Hyderabad	13	0.24	13.6	6.04	6.04	2	15.38	3	23.08	7	53.85	0	0	0	0	1	7.69	12	1
3	Karimnagar	53	1.26	11.25	0	0	4	7.55	8	15.09	41	77.36	0	0	0	0	0	0	53	0
4	Khammam	46	0.51	8.31	0	0	10	21.74	14	30.43	22	47.83	0	0	0	0	0	0	46	0
5	Mababoobnagar	30	0.71	31.66	3.46	3.46	2	6.67	7	23.33	20	66.67	0	0	1	3.33	0	0	29	1
6	Medak	33	1.56	23.22	-	-	1	3.03	5	15.15	26	78.79	0	0	0	0	0	0	32	0
7	Nalgonda	37	0.69	18.03	0	0	6	16.22	12	32.43	19	51.35	0	0	0	0	0	0	37	0
8	Nizamabad	40	0.81	17.08	0.13	3.45	8	20.0	10	25.0	20	50.0	1	2.5	1	2.5	0	0	38	2
9	Ranga Reddy	62	0.34	31.51	2.98	2.98	6	9.68	9	14.52	46	74.19	0	0	1	1.61	0	0	61	1
10	Warangal	70	1.25	19.4	0.39	6.52	3	4.29	19	27.14	45	64.29	2	2.86	0	0	1	1.43	67	3
	Total State	443	0.24	31.66	0	6.52	48	10.8	116	26.2	268	60.5	5	1.1	3	0.7	2	0.4	432	10

6.6.4 – Fluctuation of water levels – May, 2013 vs January, 2014

Fluctuation of water levels during May 2013 with reference to January 2014 is depicted in the Fig-6.20 and categorization of water level fluctuation May, 2013 vs January, 2014 is presented in the Fig.6.21. A perusal of the map shows that predominantly there is rise in water levels in 92.39% of wells of the State. Rise in water level of less than 2 m and 2-4 m zones are observed in major parts of Khammam, Adilabad, districts. Rise of more than 4 m is observed in small parts of Khammam, Adilabad and in larger areas of all other districts in Telangana.

Fall of less than 2 m and 2-4 m zones are observed as isolated pockets in parts of Khammam, Mahabubnagar, Nalgonda, Nizamabad, Rangareddy, Warangal and Adilabad districts. Fall of more than 4 m is observed in small areas in Mahabubnagar , Ranga Reddy, Nizamabad, Warnagal districts of Telangana.

Water level rise of less than 2 m is recorded in 23.9% of wells in the range of 2-4 m. 28.9% of wells shows rise of more than 4 m. Fall of less than 2 m is recorded in 4.0% of wells in the range of 2-4 m and fall of more than 4 m is registered in 1.5% of wells. Water level rise of more than 4 m is recorded maximum in Karimnagar district (61.02% wells) while water level fall of more than 4 m is registered maximum in Hyderabad district (8.23%) wells.

Water level fluctuation data of May 2013 - January 2014 is presented in the Table-6.17. An analysis of data of 460wells shows that rise is recorded in 92.39% of wells (425), fall is recorded in 6.3% of wells (29), while 1.31% of wells (6) shows no fluctuation.

Rise

Out of the 425 wells that have registered a rise in water levels, 26% wells recorded water level rise of less than 2 m, 31% wells in the range of 2 to 4 m while the rest 43% wells recorded water level rise of more than 4 m.

Fall

Of the 29 wells that have registered fall in water levels, majority of them (59%) have recorded less than 2 m fall, in the range of 2-4 m in 17% wells and the rest 24% wells registered water level fall of more than 4 m.

Fig.6.20

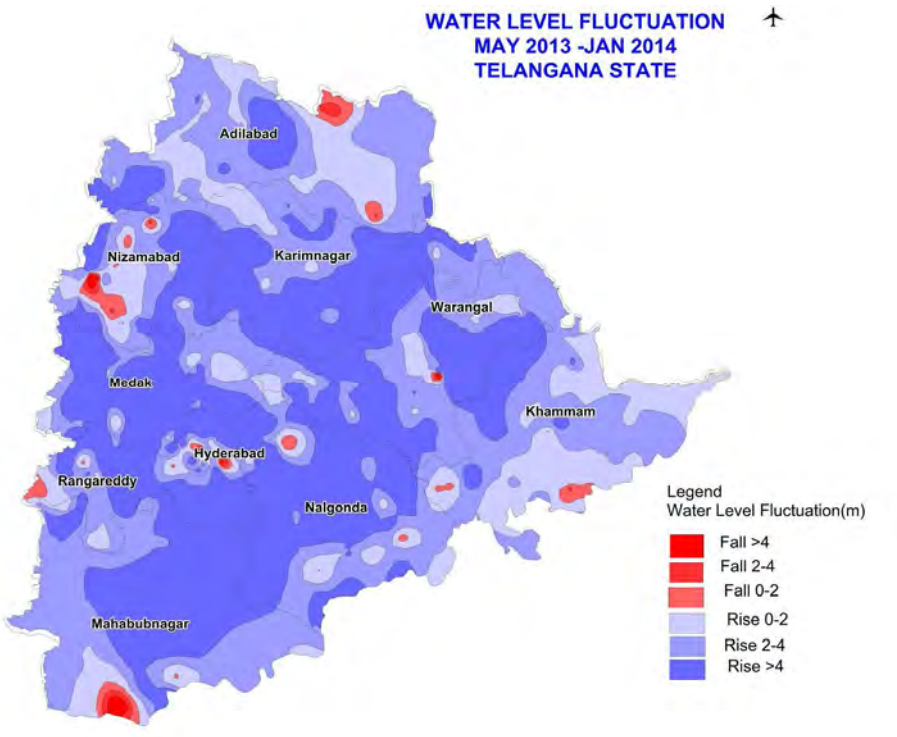


Fig.6.21

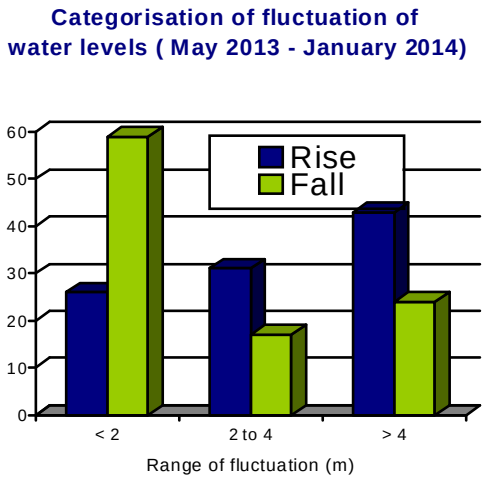


Table-6.17
District Wise Fluctuation and Frequency Distribution in Different Ranges
May, 2013 to January, 2014

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	62	0.55	16.32	2.31	2.82	30	48.39	18	29.03	11	17.74	0	0	2	3.23	0	0	59	2
2	Hyderabad	12	0.48	6.07	4.63	4.63	4	33.38	4	33.33	3	25.0	0	0	0	0	1	8.33	11	1
3	Karimnagar	59	0.35	10.44	0	0	7	11.86	16	27.12	36	61.02	0	0	0	0	0	0	59	0
4	Khammam	42	0.02	6.0	0.12	2.36	14	33.33	18	42.86	4	9.52	5	11.9	1	2.38	0	0	36	6
5	Mababoobnagar	31	0.25	29.26	0.32	6.45	5	16.13	7	22.58	17	5.84	1	3.23	0	0	1	2.23	29	2
6	Medak	33	0.76	18.33	0	0	4	12.12	10	30.3	16	48.48	0	0	0	0	0	0	30	0
7	Nalgonda	37	0.98	16.4	0.07	1.59	9	24.32	10	27.03	15	40.54	3	8.11	0	0	0	0	34	3
8	Nizamabad	42	0.25	16.05	0.08	6.68	9	21.43	9	20.43	15	35.71	3	7.14	2	4.76	3.	7.14	33	8
9	Ranga Reddy	64	0.25	27.8	0.25	4.7	12	18.75	16	25.0	30	46.88	4	6.25	0	0	1	1.56	58	5
10	Warangal	78	0.11	18.1	0.02	7.82	16	20.51	25	32.05	35	44.87	1	1.28	0	0	1	1.28	76	2
	Total State	460	0.02	29.26	0	7.82	110	23.9	13	28.9	18	39.6	17	4.0	5	1.0	7	1.5	425	29

6.6.5 Fluctuation of Water Levels - August 2012 Vs August 2013

Fluctuation of water levels during August 2012 with reference to August 2013 is depicted in the Fig. 6.22 and categorization of water level fluctuation August 2012 vs August 2013 is presented in the Fig.6.23.

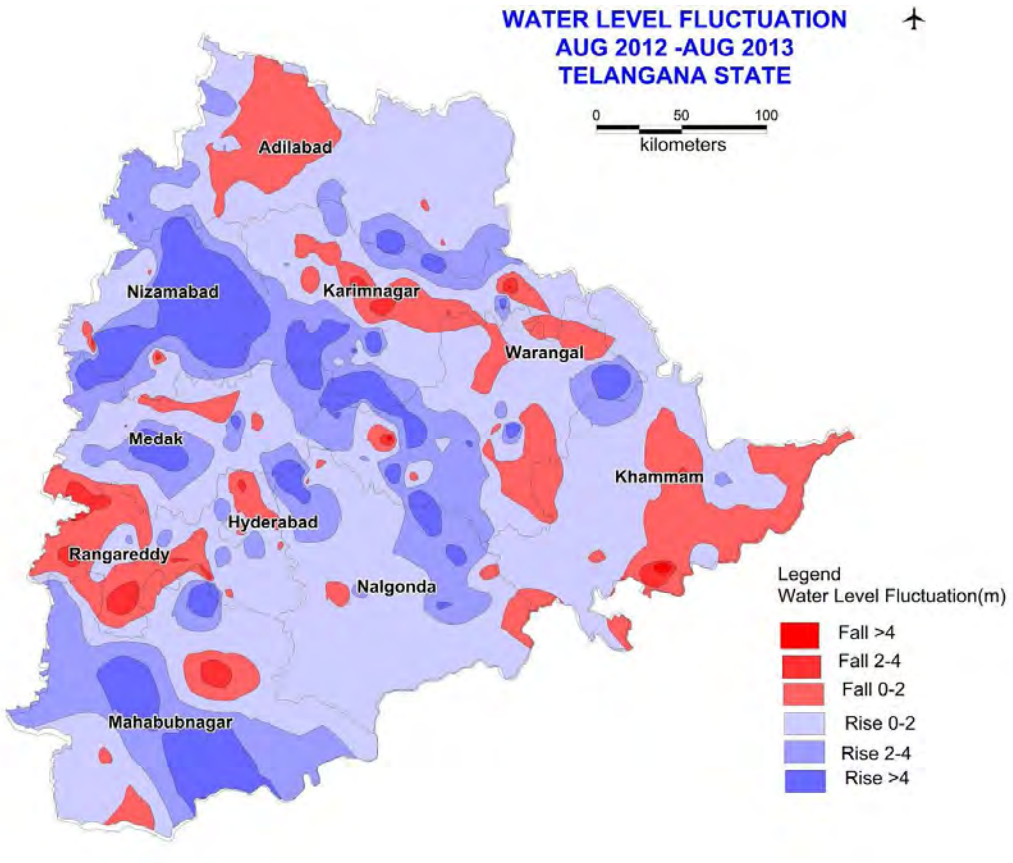
Rise in water level of less than 2 m and 2-4 m zones are observed in large areas in parts of all districts. Rise of more than 4 m is observed in major parts of Mahabubnagar, Nizamabad and as isolated areas in all other districts except Khammam district.

Fall of less than 2 m and 2-4 m zones are observed in parts of Khammam, Adilabad and as small isolated areas in other districts. More than 4 m fall rage as noticed in small areas in Khammam, Warangal, Nizamabad and Karimnagar districts.

Water level fluctuation data of August 2012-August 2013 in Telangana State is presented in Table - 6.17. An analysis of data of 332 wells shows that water level rise is recorded in 66.46% of wells (224), fall is recorded in 31.02% of wells (103), while 2.52% of wells (05) has no fluctuation.

Water level rise of less than 2 m is recorded in 36.1% of wells, 2-4 m range in 17.7% of wells and rise of more than 4 m is recorded in 13.5% wells. Water level fall of less than 2 m is recorded in 24.4% of wells . 2-4 m fall in 5.4% of wells and fall of more than 4 m is registered in 1.2% wells. Water level rise of more than 4 m is recorded maximum in Karimnagar district (23.21% of wells) while fall of more than 4 m is registered maximum in Nizamabad district (5.56% of wells).

Fig.6.22



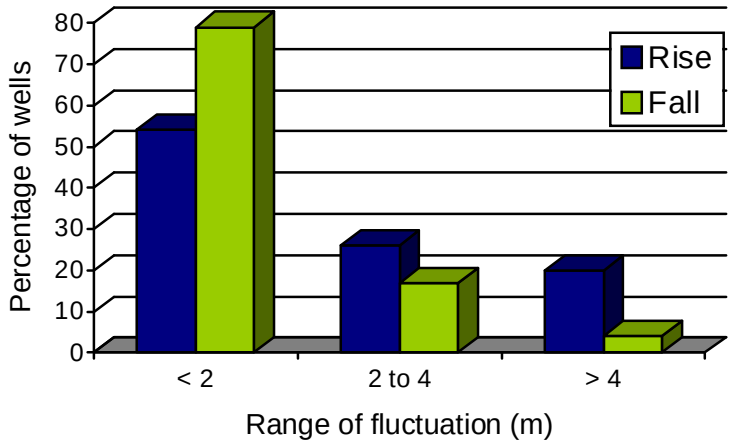
Rise

Out of the 224 wells that have registered a rise in water levels, 54% of wells recorded water level rise of less than 2 m, 26% wells in the range of 2 to 4 m while 20% of wells recorded water level rise of more than 4 m.

Fall

Out of the 103 wells that have registered fall in water levels, majority of them (79%) have recorded less than 2 m fall, in the range of 2-4 m in 17% of wells and 4% wells registered water level fall of more than 4 m.

Fig.6.23
Categorisation of fluctuation of water levels (August 2012 - August 2013)



6.6.6 – NOVEMBER 2012 vs NOVEMBER 201 3

Fluctuation of water levels in November 2012with reference to November 2013 is depicted in Fig-6.24 and categorization of water level fluctuation is presented in the Fig.6.25. A perusal of the map shows that there is rise in water levels in the State.

Rise in water level of less than 2 m and 2-4 m zones are observed in parts of Khammam, Nizamabad and Warangal districts. Rise of more than 4 m is observed as isolated areas in parts of Mahabubnagar, Medak, Nizamabad, Karimnagar, Warangal, Khammam districts. Fall in water levels of less than 2 m is observed in major parts of Mahbubnagar, Nalgonda. Fall of 2-4 m is noticed in small areas in all districts except Khammam in Telangana State. Fall of Water level more than 4 m noticed as small isolated areas in parts of all districts except Adilabad, Medak and Khammam districts in Telangana.

Table-6.18
District Wise Fluctuation and Frequency Distribution In Different Ranges
November, 2012 Vs November, 201 3

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	42	0.01	5.15	0.05	1.76	15	35.71	7	16.67	3	7.14	17	40.48	0	0	0	0	25	17
2	Hyderabad	7	0.17	2.04	0.03	0.7	4	57.14	1	14.29	0	0	2	28.57	0	0	0	0	5	2
3	Karimnagar	56	0.09	8.21	0.24	4.25	16	28.57	12	21.43	13	23.21	9	16.07	4	7.14	1	1.79	41	14
4	Khammam	42	0.06	2.04	0.05	5.63	24	57.14	1	2.38	0	0	15	35.71	1	2.38	1	2.38	25	17
5	Mababoobnagar	17	0.1	6.75	0.22	3.81	6	35.29	4	23.53	3	17.65	3	17.65	1	5.88	0	0	13	4
6	Medak	28	0.16	6.59	0.07	3.8	9	32.14	5	17.86	4	14.29	5	17.86	2	17.1	0	0	18	7
7	Nalgonda	29	0.05	7.29	0.12	0.85	14	48.28	6	20.69	4	13.79	5	17.24	0	0	0	0	24	5
8	Nizamabad	18	0.1	11.6	0.23	4.06	4	22.22	1	5.56	9	50.0	2	11.11	1	5.56	1	5.56	14	4
9	Ranga Reddy	39	0.05	8.98	0.19	3.77	10	25.64	9	23.08	1	2.56	12	30.77	7	17.9	0	0	20	19
10	Warangal	54	0.02	8.71	0.02	5.53	18	33.33	13	24.07	8	14.81	11	20.37	2	3.7	1	1.85	39	14
	Total State	332	0.01	11.6	0.02	5.63	120	36.1	59	17.7	45	13.5	81	24.4	18	5.4	4	1.2	224	103

Water level fluctuation data of November 2012-November 2013 is presented in the Table 6.18. An analysis of data of 341 wells shows that water level rise is recorded in 77.41% of wells (264), water level fall is recorded in 22.28% of wells (76), while 0.31% of wells (01) shows no fluctuation. Water level rise of less than 2 m is recorded in 40.7% of wells. 2-4 m rage in 18.5% of wells and rise of more than 4 m is recorded in 18.2% of wells. F all of less than 2 m is recorded in 18.5% of wells. 3.0% of wells have ben recorded 2-4 m range. Fall of more than 4 m is registered in 1.0% of wells. More than 4 m is recorded maximum in Ranga Reddy district (39.02% of wells) while fall of more than 4 m is registered maximum in Warangal district (3.7% of wells).

Rise

Out of the 264 wells that have registered a rise in water levels, 53% of wells recorded water level rise of less than 2 m, 24.0% of wells in the range of 2 to 4 m while 23% of wells recorded water level rise of more than 4 m.

Fall

Out of the 76 wells that have registered fall in water levels, majority of them (83%) have recorded less than 2 m fall, in the range of 2-4 m in 13% of wells and the rest 4% of wells registered water level fall of more than 4 m.

Fig.6.24

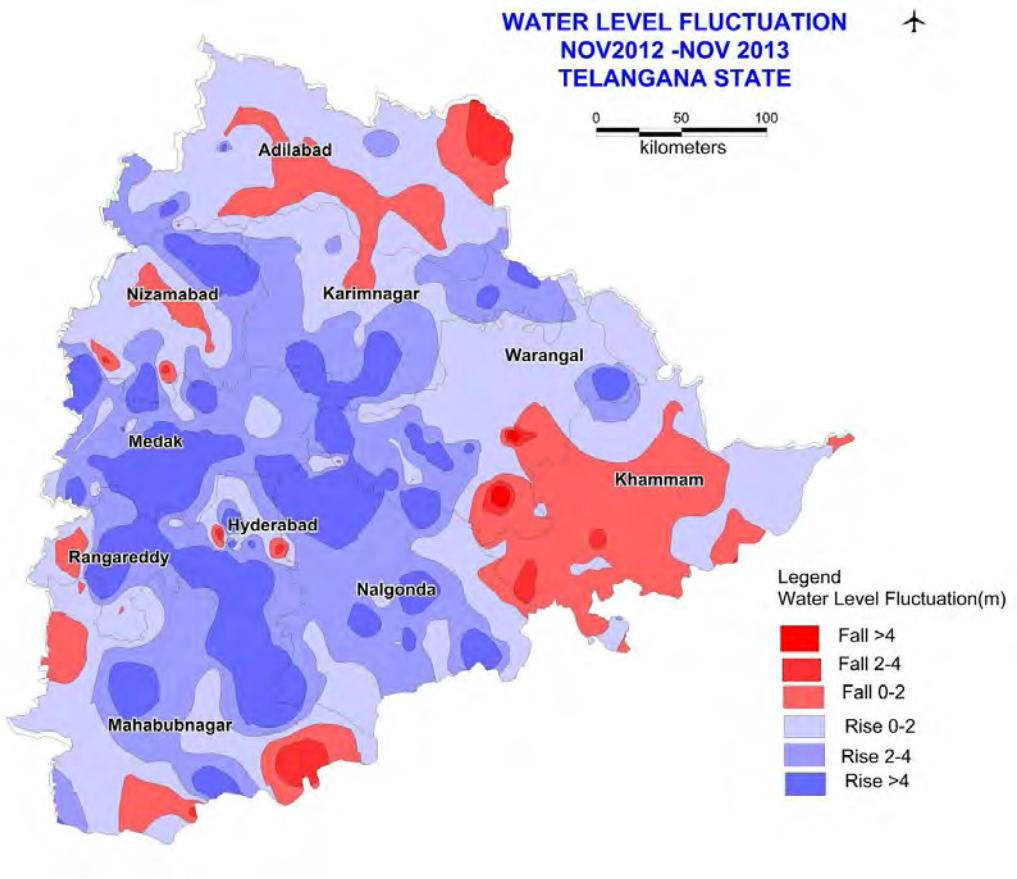
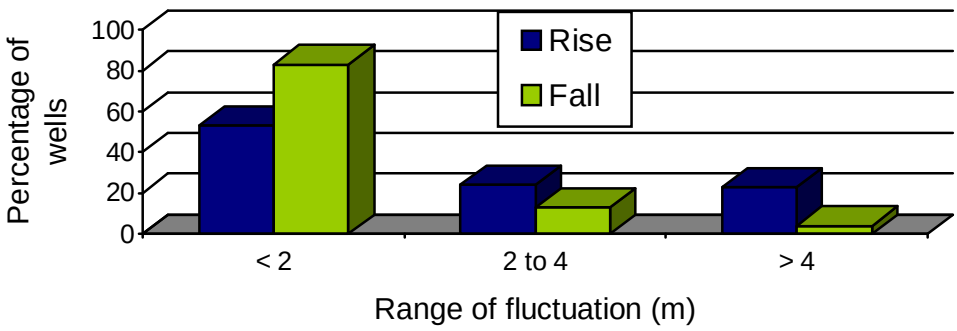


Fig. 6.25
Categorisation of fluctuation of water levels (November 2012 - November 2013)



6.6.7 Fluctuation of water levels January 2013 vs January 2014

Fluctuation of water levels in January 2013 with reference to January 2014 is depicted in Fig.6.26 and categorization of water level fluctuation is presented in the Fig.6.27. A perusal of the map shows that there is rise in water levels in the State.

Rise in water level of less than 2 m and 2-4 m zones are observed in major parts of Warangal, Adilabad, Karimnagar districts except Khammam, Hyderabad in Telangana State. Rise of Water level more than 4 m is observed in major parts of Mahabubnagar, Rangareddy, small parts of Adilabad Karimnagar, Medak, Nalgonda, Nizamabad, Warangal districts in Telangana State.

Fall in water levels of less than 2 m is observed in major parts of Khammam, Adilabad, Nizamabad, small parts of all other districts in Telangana State. Water level fall of 2-4 m is noticed in small areas in Khammam, Nizamabad, Rangareddy, Warangal districts in Telangana State. Fall of Water level more than 4 m noticed in small parts of Adilabad, Khammam, Mahbubnagar, Medak, Nizamabad, Warangal districts.

Water level fluctuation data of January 2013-January 2014 is presented in the Table 6.19. An analysis of data of 415 wells shows that water level rise is recorded in 70.6% of wells (293), water level fall is recorded in 27.46% wells (114), while in the rest, 1.94% wells (8) no fluctuation is recorded.

Water level rise of less than 2 m is recorded in 37.1% wells in the range of 2-4 m in 17.1% wells and rise of more than 4 m is recorded in 6.4% wells. Water level fall of less than 2 m is recorded in 22.9% wells in the range of 2-4 m in 2.6% and water level fall of more than 4 m is registered in 2.0% wells. Water level rise of more than 4 m is recorded maximum in Mahabubnagar district (31.43% wells) while water level fall of more than 4 m is registered maximum in Nizamabad district (16.67%) wells.

Rise

Out of the 293 wells that have registered a rise in water levels, 53% wells recorded water level rise of less than 2 m, 24% wells in the range of 2 to 4 m while the rest 23% wells recorded water level rise of more than 4 m.

Fall

Out of the 114 wells that have registered fall in water levels, majority of them (83%) have recorded less than 2 m fall, in the range of 2-4 m in 10% wells and the rest 7% wells registered water level fall of more than 4 m.

Fig.6.26

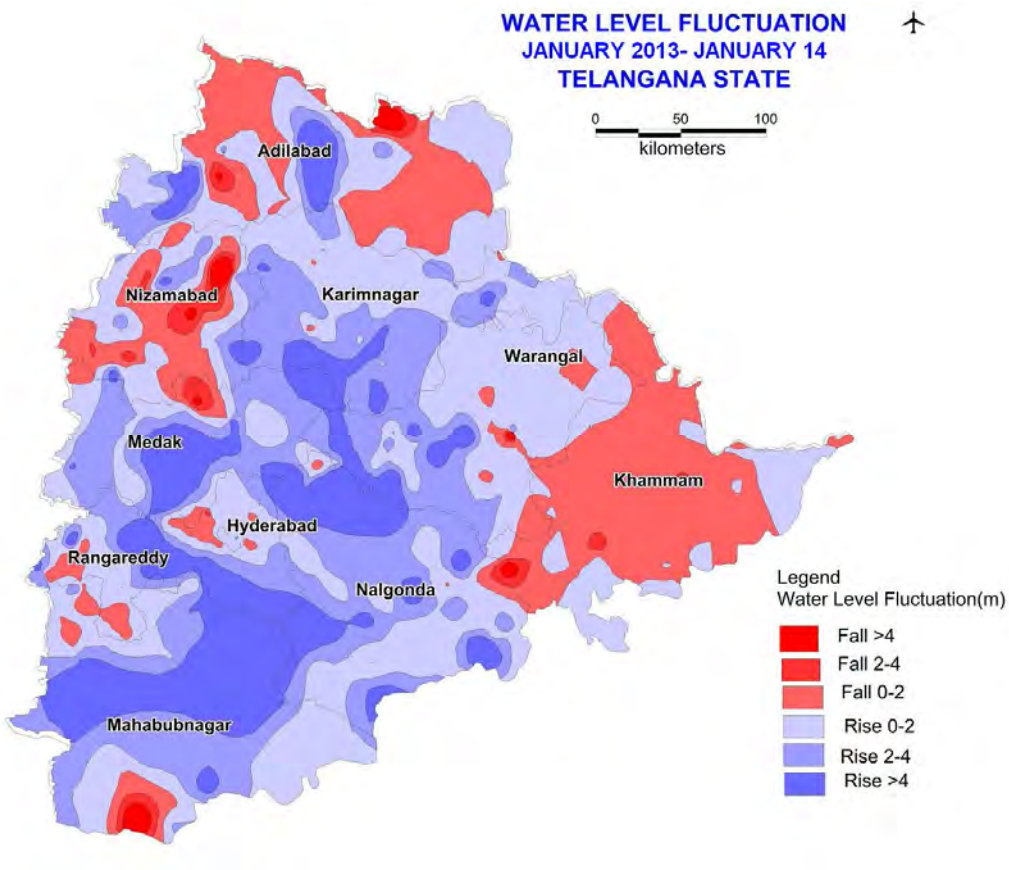


Fig.6.27
Categorisation of fluctuation of water levels (January 2013 - January 2014)

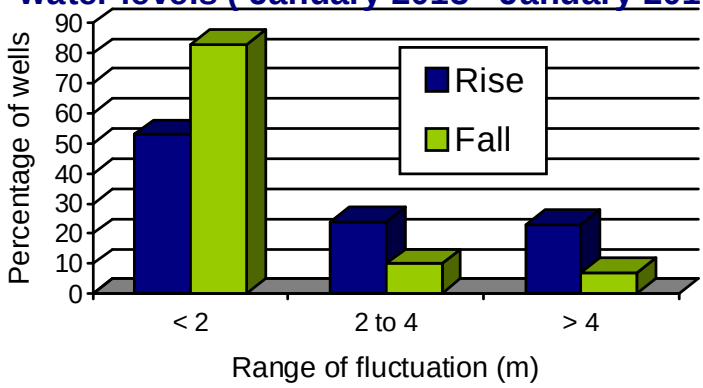


Table-6.19
District Wise Fluctuation and Frequency Distribution in Different Ranges
January, 2013 vs January, 2014

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	52	0.15	10.8	0.05	5.5	15	28.85	3	5.77	5	9.62	23	44.23	0	0	2	3.38	23	25
2	Hyderabad	10	0.25	2.7	0.02	0.17	6	60.0	2	20.0	0	0	2	20.0	0	0	0	0	8	2
3	Karimnagar	59	0.06	9.35	0.13	0.67	23	38.98	22	37.29	11	18.64	3	5.08	0	0	0	0	56	3
4	Khammam	47	0.01	0.89	0.02	5.71	15	31.91	0	0	0	0	28	59.57	3	6.38	1	2.13	15	32
5	Mababoobnagar	35	0.02	28.75	0.1	7.52	12	34.29	6	17.14	11	31.43	5	14.29	0	0	1	2.86	29	6
6	Medak	31	0.2	13.09	0.54	4.7	12	38.71	9	29.03	5	16.13	1	3.23	0	0	1	3.23	26	2
7	Nalgonda	36	0.18	11.62	0.04	1.47	19	52.78	6	16.67	7	19.44	4	11.11	0	0	0	0	32	4
8	Nizamabad	30	0.37	5.5	0.05	11.50	8	26.67	4	13.33	3	10.3	7	23.33	6	20.0	2	6.67	15	15
9	Ranga Reddy	57	0.02	26.6	0.12	3.6	14	24.56	9	15.79	17	29.82	15	26.32	1	1.75	0	0	40	16
10	Warangal	58	0.16	7.37	0.08	10.10	30	51.72	10	17.24	9	15.52	7	12.07	1	1.72	1	1.72	49	9
	Total State	415	0.01	28.75	0.02	11.50	154	37.1	71	17.1	68	16.4	95	22.9	11	2.6	8	2.0	293	114

6.6.8 Water Level Fluctuation - Decadal Mean of May (2003-2012) Vs May 2013

Water level fluctuation between decadal mean of May 2003-2012 and May 2013 is depicted in Fig.6.28 and categorization of water level fluctuation is presented in the Fig.6.29. A perusal of the map shows that there is rise in water levels in the State. Perusal of the map shows a general fall in water levels in about 52.26% wells. Rise of less than 2 m is observed in major parts Khammam, Warangal, Karimnagar, Adilabad, Nizamabad and in small parts of all other districts. Water level rise of 2-4 m is observed in small parts in all districts except Medak and Mahbubnagar districts. Water level rise of more than 4 m is observed in small isolated areas in Adilabad, Nizamabad, Rangareddy, Nalgonda, Warangal districts..

Water level fall of less than 2 m is noticed in major parts of Mahbubnagar, Nalgonda, Medak districts, small parts of all other districts of Telangana State. Fall of 2-4 m is noticed in major parts of Mahabubnagar, Nalgonda, Rangareddy and small parts in all districts of Telangana State. Fall of more than 4 m is noticed in Mahabubnagar, Rangareddy, Medak, Adilabad, Warangal, Nalgonda, Nizamabad districts.
of the State.

Water level fluctuation of May, 2013 with reference to Decadal mean of May, (2003-2012) is presented in the Table 6.20. An analysis of data of 333 wells show that 47.74% wells (159) registered rise in water levels while the rest 52.26% wells (174) recorded fall in water levels.

Water level rise of less than 2 m is recorded in 34.5% wells in the range of 2-4 m in 9% wells and rise of more than 4 m is recorded in 4% of wells. Fall of less than 2 m is recorded in 32.7% of wells in the range of 2-4 m in 13.5% of and water level fall of more than 4 m is registered in 6.0% of wells. Water level rise of more than 4 m is recorded maximum in Nizamabad district (16.67% of wells) while water level fall of more than 4 m is registered maximum in Nalgonda district (14.29%of wells).

Rise

Out of the 159 wells that have registered a rise in water levels, 73% wells recorded water level rise of less than 2 m, 19% wells in the range of 2 to 4 m while the rest 8% wells recorded water level rise of more than 4 m.

Fall

Out of the 174 wells that have registered fall in water levels, majority of them (63%) have recorded less than 2m fall, in the range of 2-4m in 26% of wells and the rest 11% of wells registered water level fall of more than 4m.

Fig.6.28

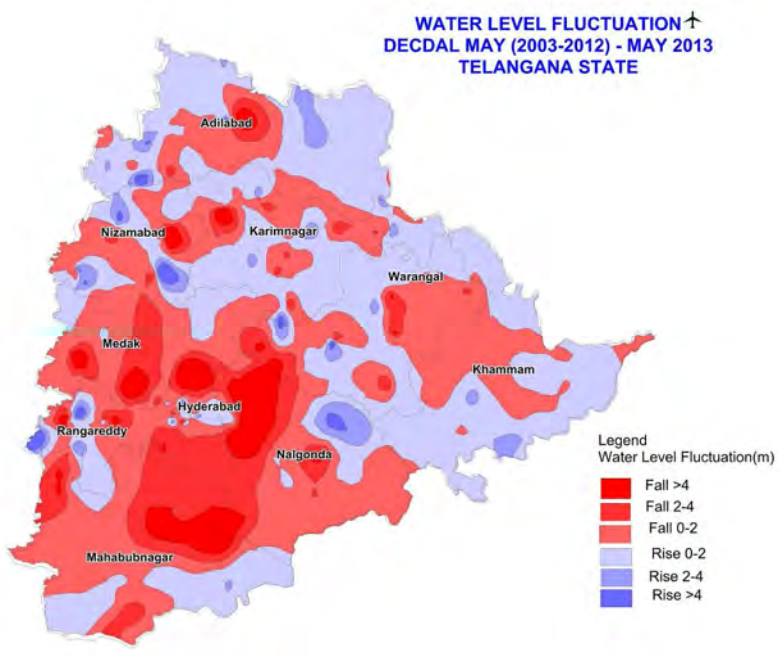


Fig.6.29
Categorisation of fluctuation of water levels
Decadal mean ofMay (2003-2012) with May 2013

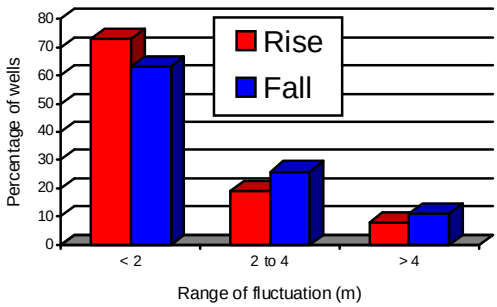


Table-6.20
District Wise Fluctuation and Frequency Distribution in Different Ranges
Decadal Mean of May (2003-2012) Vs May 2013

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	%	No	%	No	%	No	%	No	%	No	%		
1	Adilabad	44	0.05	7.62	0.02	5.71	21	47.73	6	13.64	3	6.82	11	25.0	2	4.55	1	2.27	30	14
2	Hyderabad	9	0.15	5.5	0.89	4.4	4	44.44	0	0	1	11.11	2	22.22	1	11.11	1	11.11	5	4
3	Karimnagar	53	0.04	5.39	0.16	7.51	19	35.85	8	15.09	1	1.89	16	30.19	8	15.09	1	1.89	28	25
4	Khammam	41	0	3.65	0.01	1.19	22	53.66	5	12.2	0	0	14	34.15	0	0	0	0	27	14
5	Mababoobnagar	21	0.12	3.53	0.15	6.83	5	23.81	4	19.05	0	0	5	23.81	5	23.81	2	9.52	9	12
6	Medak	20	0.0	2.05	0.08	8.42	4	20.0	1	5.0	0	0	11	55.0	2	10.0	2	10.0	5	15
7	Nalgonda	28	0.26	4.94	0.13	8.53	7	25.0	1	3.57	1	3.57	10	35.71	5	17.86	4	14.29	9	19
8	Nizamabad	24	0.04	7.88	0.24	8.66	7	29.17	1	4.17	4	16.67	8	33.33	3	12.5	1	4.17	12	12
9	Ranga Reddy	44	0.05	7.7	0.11	11.69	9	20.45	2	4.55	3	6.82	14	31.82	12	27.27	4	9.09	14	30
10	Warangal	49	0.08	5.71	0.05	5.32	17	34.69	2	4.08	1	2.04	18	36.73	7	14.29	4	8.16	20	29
	Total State	333	0	7.88	0.01	11.69	115	34.5	30	9.0	14	4.0	109	32.7	45	13.5	20	6.0	159	174

6.6.9 Decadal Mean of August (2003-2012) Vs August 2013

Water level fluctuation between decadal mean of August 2003-2012 and August 2013 is depicted in the Fig.6.30 and categorization of water level fluctuation is presented in the Fig.6.31 A Perusal of the map shows a general rise in water levels in about 73%wells in the State.

Rise of less than 2 m is observed in parts of Ranga Reddy and Major parts of all other districts , water level rise of 2-4 m is observed in parts of Nizamabad, Karimnagar , Warangal and small parts in all other districts and water level rise of more than 4 m is observed in major parts of Nizamabad and small parts of all other district except Khammam district of Telangana State.

Fall of less than 2 m is noticed in major parts of Mahabubnagar, Nalgonda, Rangareddy, Khammam and small parts in all other districts, fall of 2-4 m is noticed in parts of Mahabubnagar, Nalgonda and small parts of Rangareddy, Medak, Karimnagar and Warangal districts and fall of more than 4 m is noticed in parts of Mahabubnagar, Rangareddy and Nalgonda districts of Telangana State.

Water level fluctuation of August, 2013 with reference to Decadal means of August, (2003-2012) is presented in Table 6.21. An analysis of data of 354 wells show that 72.6% of wells (257) registered rise in water levels while the rest 27.4% of wells (97) recorded fall in water levels.

Fig.6.30

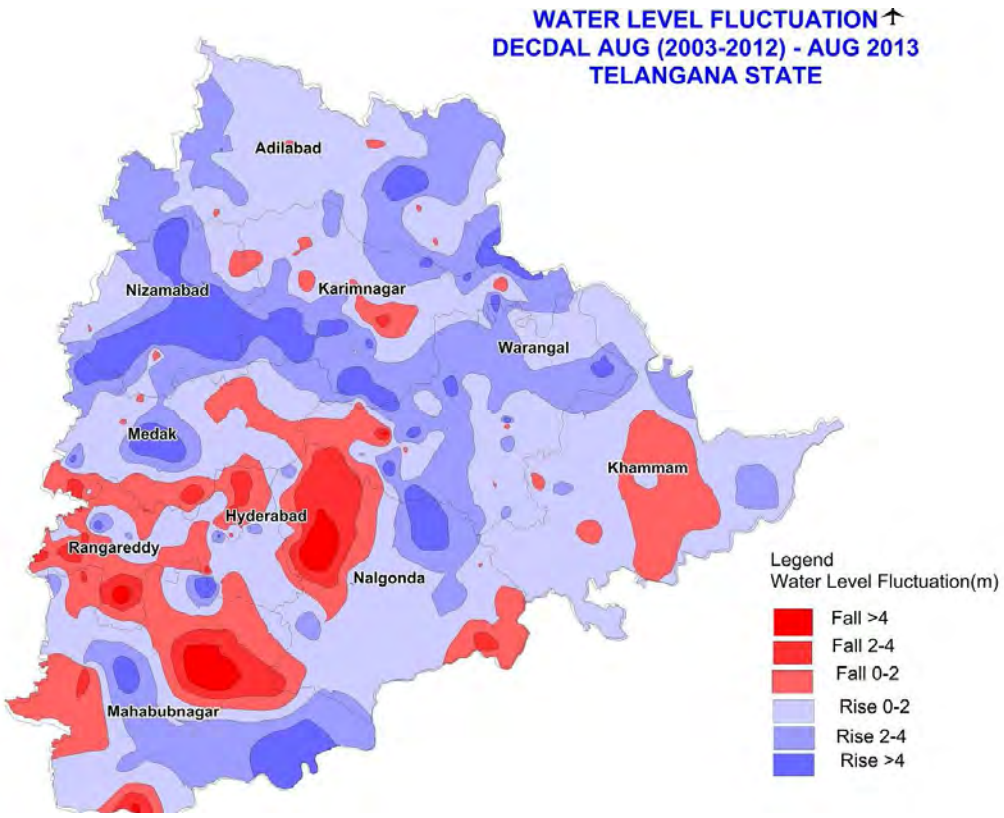
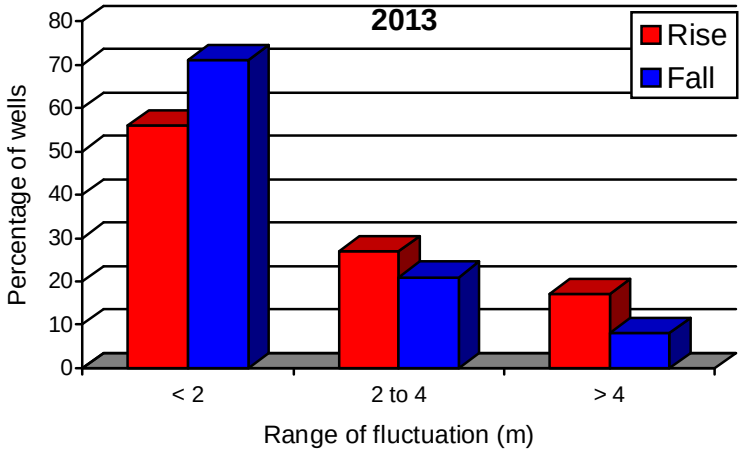


Fig.6.31
Categorisation of fluctuation of water levels Decadal mean of August (2003-2012) with August 2013



Water level rise of less than 2 m is recorded in 40.4% of wells. The rise in range of 2-4 m observed in 19.8% of wells and more than 4 m rise is recorded in 12.4% of wells. Water level fall of less than 2 m is recorded in 19.5% of wells and 2-4 m range in 6.0% of wells. Fall of more than 4 m is registered in 2.0% of wells. Water level rise of more than 4 m is recorded maximum in Nizamabad district (36.84% of wells) while water level fall of more than 4 m is registered maximum in Hyderabad district (14.29% of wells).

Rise

Out of the 257 wells that have registered a rise in water levels, 56 % of wells recorded water level rise of less than 2 m 27.0% of wells in the range of 2 to 4 m while the rest 17.0% wells recorded water level rise of more than 4 m.

Fall

Out of the 97 wells that have registered fall in water levels, majority of them (71.0% of wells) have recorded less than 2m fall, in the range of 2-4m in 21% of wells and the rest 8.0%of wells registered water level fall of more than 4m.

6.6.10 Decadal Mean of November (2003-2012) Vs November 2013

Water level fluctuation between decadal mean of November 2003-2012 and November 2013 is depicted in the Fig.32 and categorization of water level fluctuation is presented in the Fig.6.33. A Perusal of the map shows a general rise in water levels in about 87.67% of wells of the State.

Rise Water level rise of less than 2 m is observed in Khammam, Warangal, Karimnagar, Nizamabad, Nalgonda and Adilabad districts and small parts of all other districts. Rise of 2-4 m is observed as small isolated areas in all districts except Nalgonda. Water level rise of more than 4 m is observed as small isolated areas in Adilabad, Nizamabad, Karimnagar, Nalgonda and Khammam districts.

Fall Water level fall of less than 2 m is noticed in major parts of Mahbubnagar, Rangareddy, Medak, small parts of all other districts. Fall of 2-4 m is noticed in major parts of Mahabubnagar and small parts in all districts except Khammam district of Telangana State. Fall of more than 4 m is noticed in Mahabubnagar, Rangareddy, Medak, Karimnagar, Warangal, Nalgonda and Nizamabad districts.

Water level fluctuation of November, 2013 with reference to Decadal mean of November, (2002-2011) is presented in the Table - 6.22. An analysis of data of 365 wells show that 87.67% of wells (320) registered rise in water levels while 12.33% of wells (45) recorded fall in water levels.

Water level rise of less than 2 m is recorded in 44.5% of wells in the range of 2-4 m in 27.4% of wells and rise of more than 4 m is recorded in 17% of wells. Water level fall of less than 2 m is recorded in 9.3% of wells in the range of 2-4 m in 2.2% of wells and water level fall of more than 4 m is registered in 1.0% of wells. Water level rise of more than 4 m is recorded maximum in Medak district (26.67% of wells) while water level fall of more than 4 m is registered maximum in Hyderabad district (12.5% wells).

Table-6.21
District Wise Fluctuation and Frequency Distribution in Different Ranges
August (2003-2012) Vs August 2013

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	%	No	%	No	%	No	%	No	%	No	%		
1	Adilabad	43	0.06	7.74	0.11	0.5	21	48.84	13	30.23	3	6.98	6	13.95	0	0	0	0	37	6
2	Hyderabad	7	1.01	1.43	0.2	4.38	2	28.57	0	0	0	0	4	57.14	0	0	1	14.29	2	5
3	Karimnagar	57	0.1	7.35	0.12	2.82	19	33.33	13	22.81	14	24.56	10	17.54	1	1.75	0	0	46	11
4	Khammam	42	0.08	3.38	0.13	1.84	26	61.9	4	9.52	0	0	12	28.57	0	0	0	0	30	12
5	Mababoobnagar	20	1.06	5.37	0.13	9.08	3	15.0	6	30.0	2	10.0	3	15.0	4	20.0	2	10.0	11	9
6	Medak	28	0.05	6.59	0.1	3.96	12	42.86	1	3.57	4	14.29	9	32.14	2	7.14	0	0	17	11
7	Nalgonda	34	0.01	4.6	0.03	6.98	15	44.12	7	20.59	2	5.88	4	11.76	4	11.76	2	5.88	24	10
8	Nizamabad	19	0.45	8.2	0.11	1.52	4	21.05	5	26.32	7	36.84	3	15.79	0	0	0	0	16	3
9	Ranga Reddy	46	0.28	8.98	0.33	5.39	20	43.48	2	4.35	4	8.7	11	23.91	8	17.39	1	2.17	26	20
10	Warangal	58	0.06	7.57	0.05	5.53	21	36.21	19	32.76	8	13.79	7	12.07	2	3.45	1	1.72	48	10
	Total State	354	0.01	8.98	0.03	9.08	143	40.4	70	19.8	44	12.4	69	19.5	21	6.0	7	2.0	257	97

Rise

Out of the 320 wells that have registered a rise in water levels, 49% of wells recorded water level rise of less than 2 m, 32% of wells in the range of 2 to 4 m while the rest 19% of wells recorded water level rise of more than 4 m.

Fall

Out of the 45 wells that have registered fall in water levels, majority of them (76%of wells) have recorded less than 2m fall, in the range of 2-4m in 18%of wells and the rest 6% of wells registered water level fall of more than 4m.

Fig.6.32

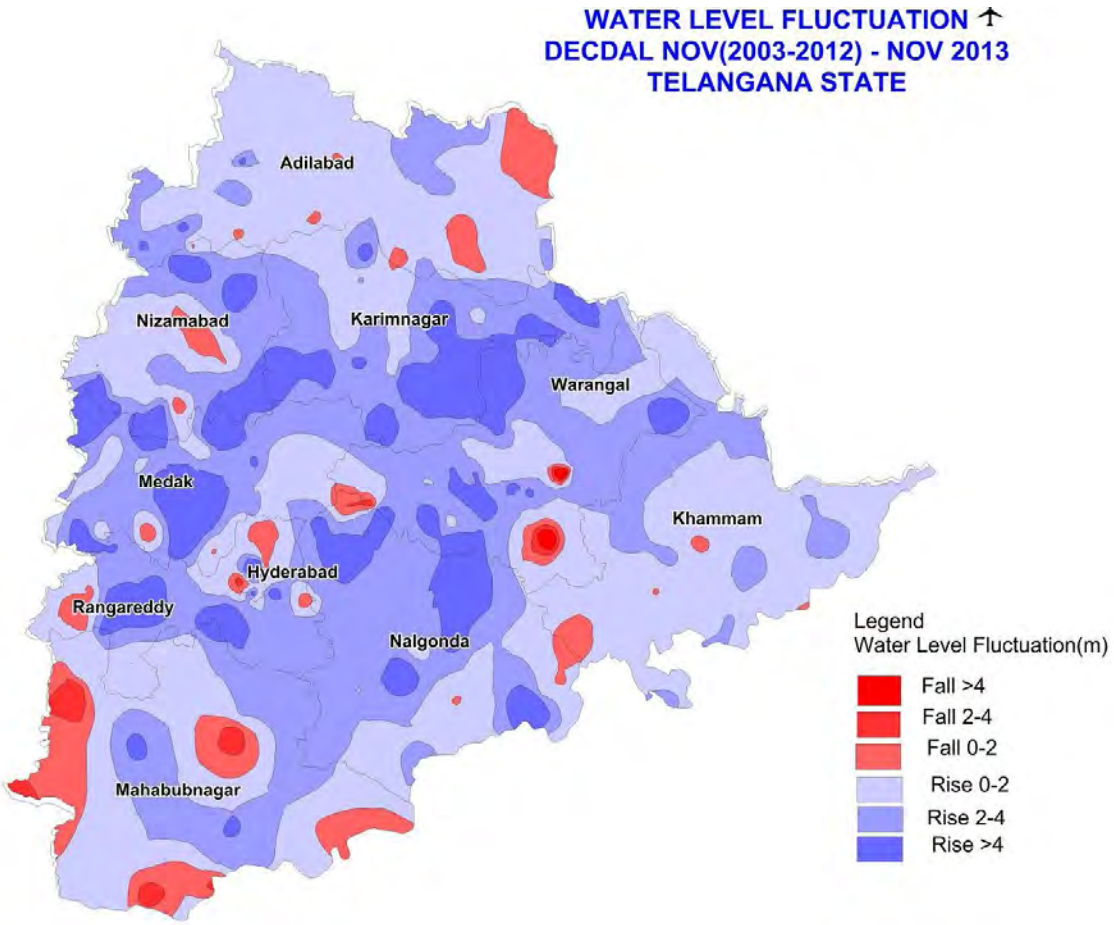


Fig.6.33
Categorisation of fluctuation of water levels
Decadal mean of November (2003-2012) with November 2013

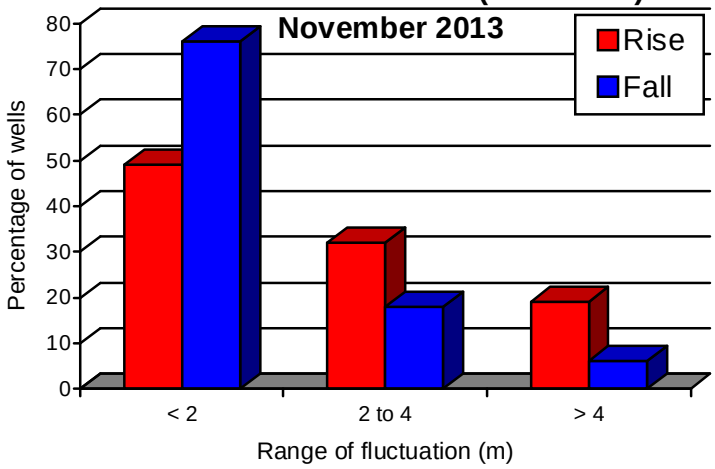


Table-6.22
District Wise Fluctuation and Frequency Distribution in Different Ranges
November (2003-2012) Vs November 2013

Sl. No	District	No of Wells Analysed	Range of Fluctuation (m)				No of Wells / Percentage Showing Fluctuation													
			Rise		Fall		Rise						Fall						Total No. of Wells	
							0 to 2		2 to 4		> 4		0 to 2		2 to 4		> 4		Rise	Fall
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%		
1	Adilabad	49	0.06	5.52	0.02	1.95	30	61.22	8	16.33	2	4.08	9	18.37	0	0	0	0	40	9
2	Hyderabad	8	0.11	5.68	0.75	6.24	4	50.0	0	0	1	12.5	1	12.5	1	12.5	1	12.5	5	3
3	Karimnagar	53	0.11	6.88	0	0	16	30.19	24	45.28	13	24.53	0	0	0	0	0	0	53	0
4	Khammam	42	0.06	3.44	0.36	1.56	28	66.66	10	23.81	0	0	4	9.52	0	0	0	0	38	4
5	Mababoobnagar	21	0.08	4.46	0.19	3.57	10	47.62	3	14.29	3	14.29	2	9.52	3	14.29	0	0	16	5
6	Medak	30	0.27	11.98	0.26	1.45	9	30.0	11	36.67	8	26.67	2	6.67	0	0	0	0	28	2
7	Nalgonda	35	0.08	7.86	0.4	2.45	17	48.57	7	20.0	8	22.86	2	5.71	1	2.86	0	0	32	3
8	Nizamabad	25	0.21	7.02	0.02	1.77	10	40.2	6	24.0	4	16.0	5	20.0	0	0	0	0	20	5
9	Ranga Reddy	45	0.15	10.96	0.01	2.24	12	26.67	12	26.67	11	24.44	8	17.78	2	4.44	0	0	35	10
10	Warangal	57	0.05	8.95	1.2	10.47	22	38.6	19	33.33	12	21.05	1	1.75	1	1.75	2	3.51	53	4
	Total State	365	0.05	11.98	0	10.47	158	44.5	100	27.4	62	17.0	34	9.3	8	2.2	3	1.0	320	45

6.6.11 Decadal Mean of January (2004-2013) Vs January 2014

Decadal fluctuation of water levels during January 2004-2013 with reference to January 2014 is depicted in Fig.6.34 and categorization of decadal water level fluctuation during January (2001-2013) vs January 2014 is presented in the Fig.6.35. Rise of water levels in 78.06% of wells is observed in the state.

Rise of less than 2 m is observed in of all districts. 2 – 4m rise zone is observed in major parts of Karimnagar, Warangal, Nalgonda, and as small isolated areas in parts of all other districts. Rise of more than 4 m is observed in small parts of Mahabubnagar, Nalgonda and as small isolated areas of all other districts.

Fall of < 2 m and 2-4 m zones are observed in Nizamabad, Medak, Nalgonda, Nizamabad, Rangareddy and Warangal districts. Fall of more than 4 m is observed in Khammam, Mahabubnagar, Medak, Nizamabad and Warangal districts.

Water level fluctuation data, January 2014 with reference to decadal mean of January, (2004-2013) is furnished in the Table-6.23. An analysis of data of 433 wells shows that the rise is recorded 78.06% of wells (338) and fall is observed in 21.47% of wells (93).

Rise of less than 2 m is recorded in 44.6% wells in the range of 2-4 m in 18.0% wells and rise of more than 4 m is recorded in 15.5% wells. Fall of less than 2 m is recorded in 18.2% wells in the range of 2-4 m. Fall of more than 4 m in 1.6% of wells. More than 4 m is recorded maximum in Mahabubnagar district (28.57% wells) while fall of more than 4 m is registered maximum in Nizamabad district (6.25% of wells).

Rise

Out of the 338 wells that have registered a rise in water levels, 57% wells recorded water level rise of less than 2 m, 23% wells in the range of 2 to 4 m while the rest 20% of wells recorded water level rise of more than 4 m.

Fall

Out of 93 wells that have registered fall in water levels, 85% of them have recorded less than 2m fall, 8% of wells shows 2-4 fall and the 7% of wells registered water level fall of more than 4m.

Fig.6.34

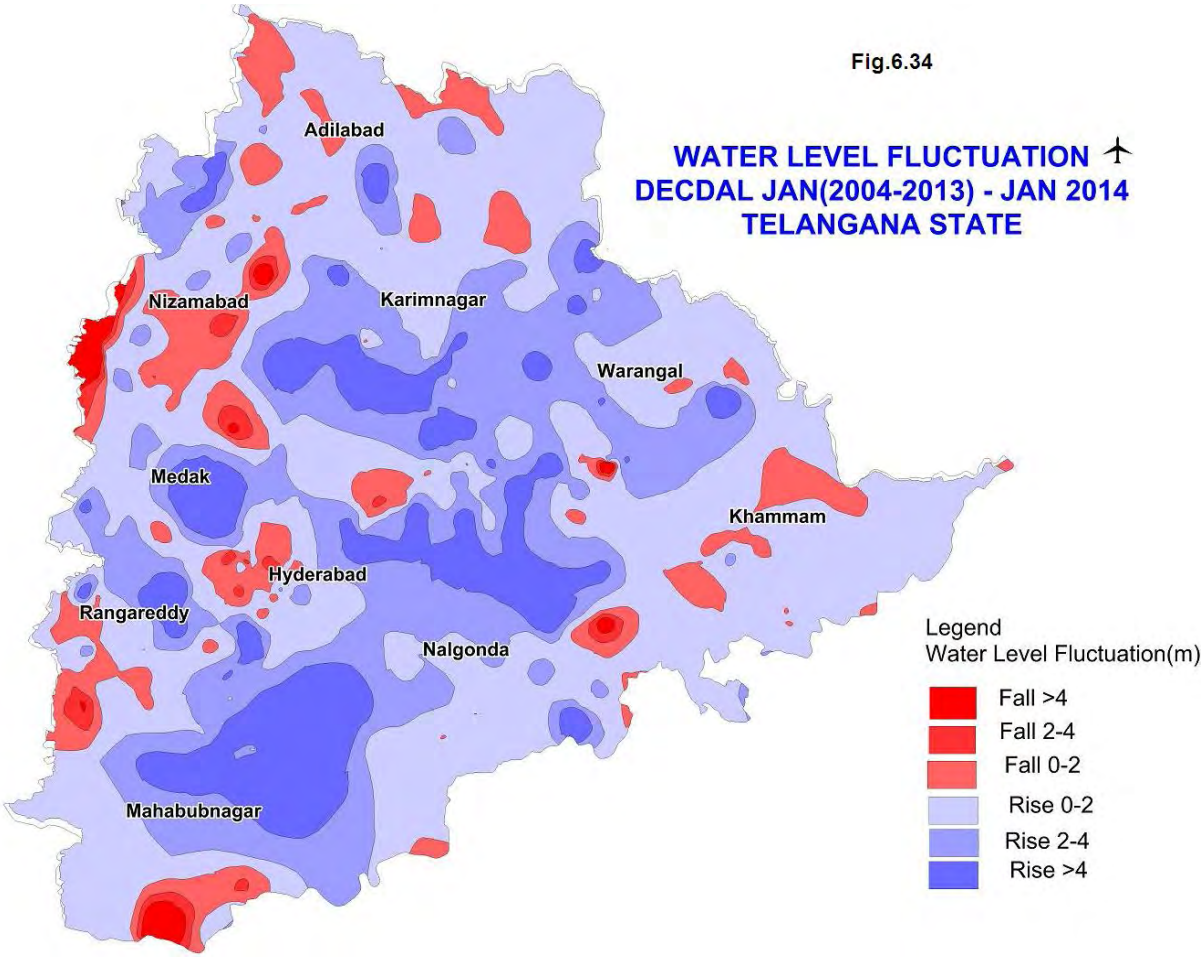


Fig.6.35
Categorisation of fluctuation of water levels Decadal mean of January (2004-2013) with January 2014

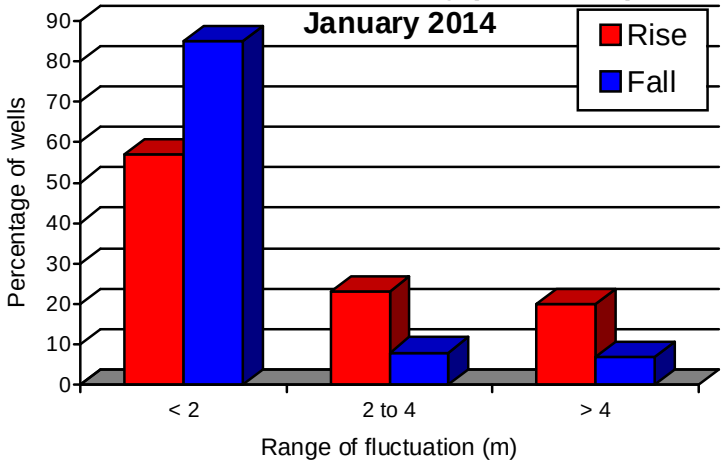


Table-6.23
District Wise Fluctuation and Frequency Distribution in Different Ranges
January (2004-2013) Vs January, 2014

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			
			Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	Rise	Fall
1	Adilabad	54	0.06	7.83	0.01	1.73	28	51.85	3	5.56	4	7.41	18	33.33	0	0	0	0	35	18
2	Hyderabad	11	0.97	2.7	0.01	3.07	4	36.36	2	18.18	0	0	4	36.36	1	9.09	0	0	6	5
3	Karimnagar	60	0.08	8.23	0.31	0.61	22	36.67	20	33.33	16	26.67	2	3.33	0	0	0	0	58	2
4	Khammam	47	0.01	2.54	0.01	5.71	31	65.96	1	2.13	0	0	14	29.79	0	0	1	2.13	32	15
5	Mababoobnagar	35	0.54	21.23	0.1	11.0	12	34.29	5	14.29	10	28.57	6	17.14	0	0	2	5.71	27	8
6	Medak	31	0.2	13.09	0.1	4.7	18	58.06	7	22.58	2	6.45	2	6.45	1	3.23	1	3.23	27	4
7	Nalgonda	41	0.1	7.34	0.04	2.39	23	56.1	9	21.95	6	14.63	2	4.88	1	2.44	0	0	38	3
8	Nizamabad	32	0.22	6.20	0.31	18.6	16	50.0	5	15.63	1	3.13	7	21.88	1	3.13	2	6.25	22	10
9	Ranga Reddy	60	0.02	27.45	0.04	3.6	14	23.33	12	20.2	14	23.33	17	28.33	2	3.33	0	0	40	19
10	Warangal	62	0.21	6.34	0.01	12.7	25	40.43	14	22.58	14	22.58	7	11.29	1	1.61	1	1.61	53	9
	Total State	433	0.01	27.45	0.01	18.6	193	44.6	78	18.0	67	15.5	79	18.2	7	1.6	7	1.6	338	93

6.7 Water Logged Area and the Area Prone to Water Logging

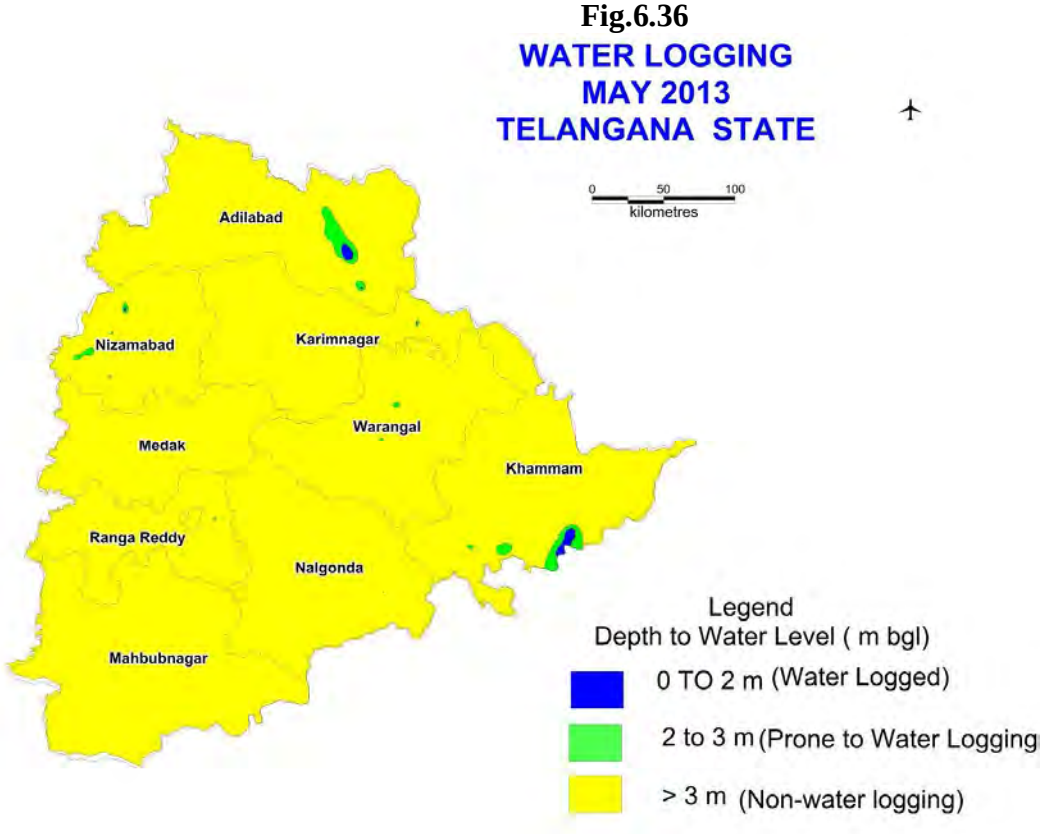
6.7.1 Pre-monsoon Period
Water Logged Area

A map with demarcation of water logged area and the area prone to water logging during pre-monsoon May, 2013 is shown in the Fig.6.36. A perusal of the map reveals that water logged areas are observed in smaller extents mainly in Khammama and Adilabad districts of the state. The total water logged area during pre-monsoon in the State is 184 sq.km. viz about 0.3% of the total area of the State.

Area Prone to Water Logging

A perusal of the Fig.6.36 shows that during pre-monsoon (May, 2013) area prone to water logging with depth to water levels of 2 to 3m are observed in small patches of Adialbad and Khammam districts. The total area prone to water logging during pre-monsoon in the State is 862 Sq. km viz about 0.7% of the total area of the State.

Fig.6.36



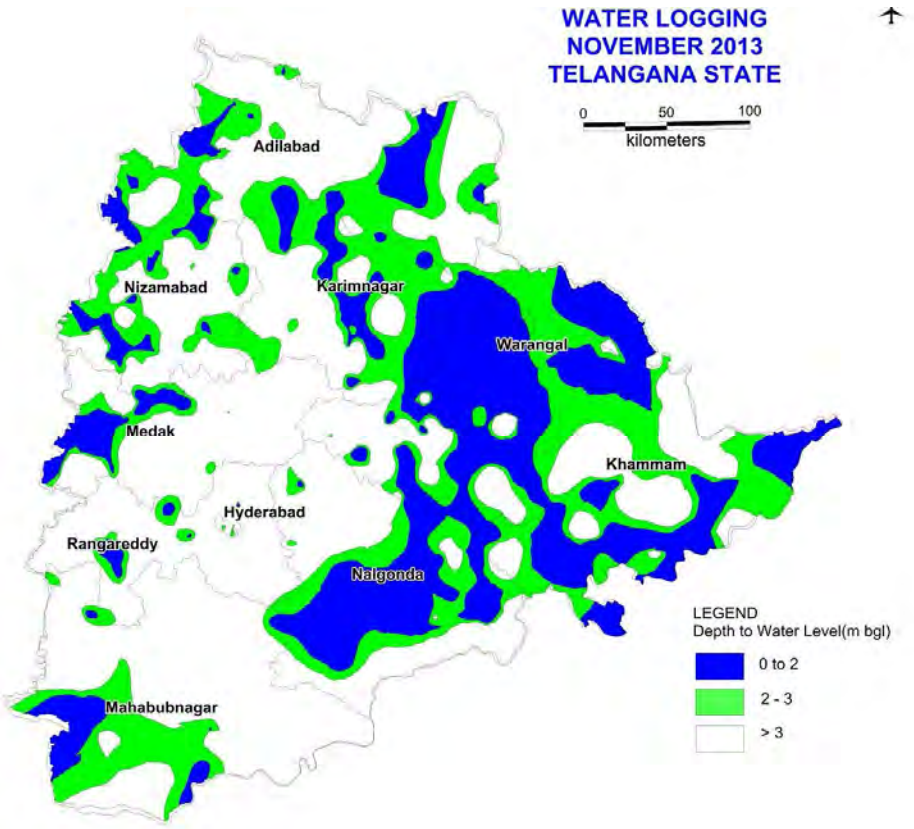
6.7.2 Post-monsoon Period
Water Logged Area

Waterlogged areas and the areas prone to water logging during post-monsoon (November 2013) is presented in the Fig.6.37. A perusal of the map shows that water logged area with less than 2 m depth to water levels are observed in most of the areas in Khammam, Warangal and Nalgonda districts and as isolated areas in all other districts . The total water logged area during the post-monsoon period in the State is 27,040 sq.km viz about 23% 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 m is observed as in parts of Khammam, Warangal and Nalgonda districts and as an isolated areas in all other districts. The total area under prone to water logging during post monsoon period is 27,140 sq.km constituting 24% of total geographical area of the State.

Fig.6.37



7.0 QUALITY OF GROUND WATER

Groundwater plays an important role in global drinking water supply and food security. It is estimated that two billion people, worldwide, depend on groundwater for drinking purpose. Its regional importance is demonstrated by its provision of 70% of drinking water in the EU, 80% of rural water supply in Sub-Saharan Africa, and 60% of agricultural irrigation in India (IAH, 2006). Groundwater depletion and contamination will result in spiralling costs for water access, claiming valuable economic resources with the poor suffering most. At the start of groundwater exploitation, fresh water was easy to find and available at limited cost because of the shallow depth and short transportation distances from the point of use. In the case of groundwater depletion, the water level in the aquifers drop and the quality of water deteriorates. Over time, the freshest and most easily accessible water is depleted, leaving behind marginal quality water at much greater depth. Deeper wells, larger capacity pumps and additional treatment facilities will be needed to make the water potable. The combination of deteriorating water quality, increasing depth and increasing distance from centre of use creates a 'perfect storm' of extreme water scarcity and spiralling cost. Because of its local availability and generally good quality, limiting treatment costs, groundwater is often cheap compared to alternative sources of supply.

The occurrence of ground water and availability is largely governed by the state of cementation and compaction of the formation, which control the pore volume. The geological formations encountered in the state are broadly divided into consolidated, semi-consolidated and unconsolidated. In Telangana State, sizeable 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.

In many locations, over-abstraction has resulted in sharp declines in the groundwater table and, at times, even to exhaustion of the resource. In other areas, groundwater resources have been gradually rendered useless as a result of pollution. Major sources of groundwater pollution are infiltration of untreated waste water, pesticides and nitrates from agricultural activities, and effluents from industrial and mining activities. Probably even more dramatic is the loss of groundwater resources due to pollution from natural sources that is often aggravated as a result of poor aquifer management. Natural pollution sources include saline water intrusion in coastal aquifers and pollution by toxic elements present in aquifers or adjacent geological formations like arsenic, fluoride and radioactive isotopes. Notwithstanding the increasing number of examples of deteriorating groundwater conditions knowledge on the status of groundwater resources is scattered and there is a lack of solid data.

Ground water studies are incomplete unless the physical and chemical dynamics of the aquifer system is established. In groundwater studies, the physical characteristics of the ground water flow system describe the potential for ground water to move from one place to another. The geochemistry of ground water explains its chemical nature and changes takes place along the path. This area of research, known as hydro-geochemistry, allows researchers to determine the time and source of recharge, estimation of residence time in the aquifer, the degree of mixing between waters of various sources and evaluate type of chemical processes occurred during the journey through the system. This information provides a broad, more regionally extensive understanding of groundwater system. Furthermore, this improved knowledge can be used to formulate 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 various 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 in the aquifer system. 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 is generated by monitoring the ground water monitoring wells.

7.1 QUALITY OF SHALLOW GROUNDWATER

Rainwater infiltrates into the soil and interacts with carbon dioxide to become acidic. The 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. Groundwater interacts with the soils and other materials as it flows and becoming more mineralized over time, and distance. The earth material, such as glacial tills or marine shale, contain soluble minerals that dissolve relatively rapidly in groundwater and can cause deterioration in groundwater quality at a shallow depth. A network of national ground water monitoring wells has been periodically monitored for assessing quality and variability of chemical constituents of ground water 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. The Water used for drinking and domestic purposes should be safe chemically 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.

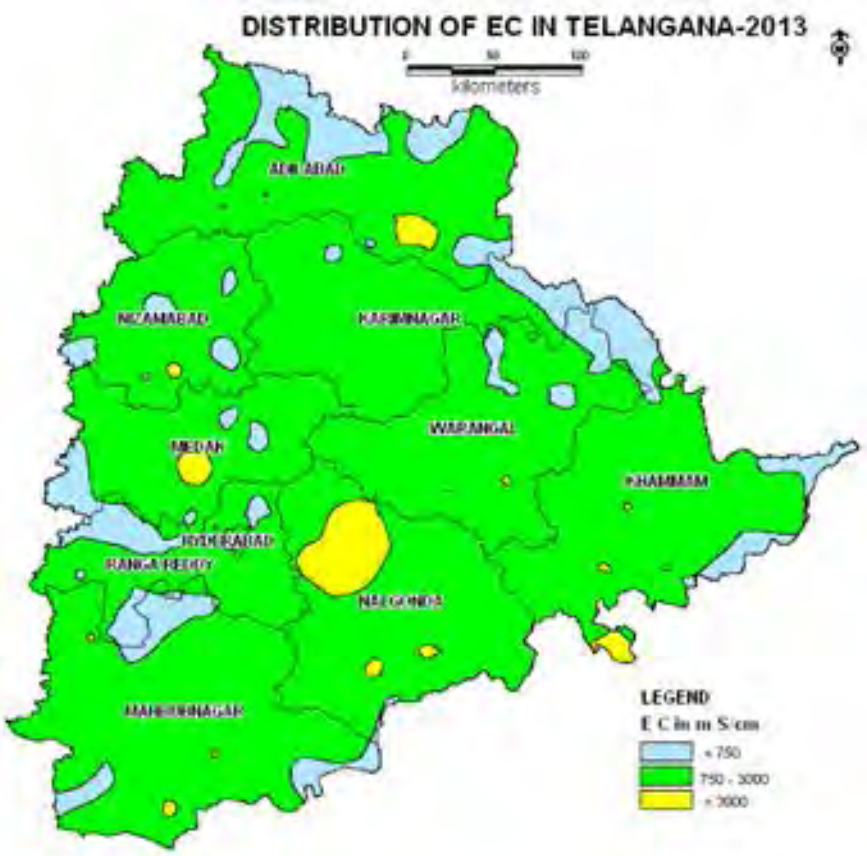
pH

pH is the measure of acidity/alkalinity balance in a solution. It is also a measure of availability of hydrogen ions (H+) in solution, known as “protons”. pH is sometimes referred to as an indicator of “proton acidity” of a groundwater. In formal terms, pH is defined as the negative logarithm (to base 10) of the hydrogen ion activity (in moles/liter). Values are commonly in between 0 to 14, normally reported without units. The pH of ground water varies from 7.2 to 8.08 and it is beyond BIS limits at 6 (1.98%) locations.

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 waters, in millisiemens per centimeter (mS/cm). (1 mS/cm = 1000 μS/cm) at 25^{o}C. Electrical conductivity varying from 76 to 13600 μS/cm at 25^{0}C. The distribution of electrical conductivity is presented in the Fig.7.1. Electrical conductivity of ground water varies from 70 to 9550 μS/cm at 25^{0}C in the state (Fig.7.1).

Fig.7.1



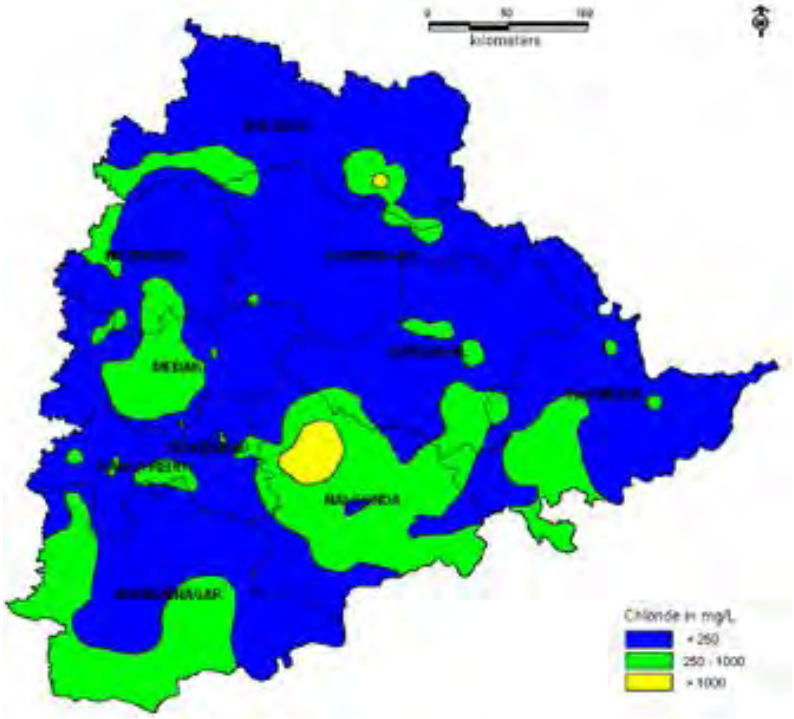
Chloride

Halite dissolution is the main natural source of Chloride in ground water. Small amount of chloride 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 ground water 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. Chloride in reasonable concentration is not harmful to human beings. At concentrations above 1000 mg/l, water acquires salty taste which is objectionable to many people. Only 0.66% of the samples in the state have chloride concentration beyond BIS permissible limit. The distribution of chloride concentration in ground water in the state of Telangana is presented in the 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. Nitrate exceeds the BIS permissible limit of 45 mg/L in 60.1% of the samples in the state. the average levels of Nitrate (89ppm) is much higher than BIS recommended standards. Distribution of Nitrate concentration in ground water in Telangana State is shown in the Fig.7.3.

Fig.7.2
Distribution of chloride concentration in ground water in Telangana state-2013



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 such water is consumed for long time. Fluoride exceeds the BIS permissible limit of 1.5 mg/L in 12.9% of the samples in the state. The distribution of Fluoride in Telangana State is shown in the Fig.7.4.

Fig.7.3
Distribution of Nitrate concentration in ground water in Telangana state-2013

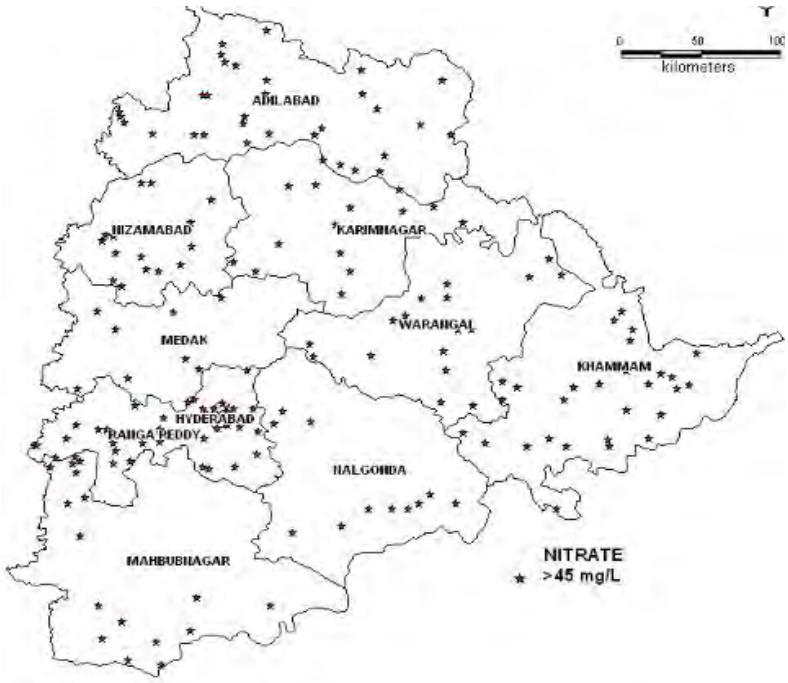


Fig.7.4
Distribution ofFluoride concentration in ground water in Telangana state-2013

7.2 Quality of Ground Water for Drinking Purpose

The hydrochemical data is compared with the drinking water quality standards set by Bureau of Indian Standards to assess the suitability of ground water from shallow aquifers for drinking purpose. The minimum, maximum and average concentrations of various chemical parameters in the state is presented in the Table-7.1 and ground water not suitable of drinking purpose with respect to chemical parameters is shown in the Table-7.2. In general, ground water from shallow aquifers in the state is alkaline in nature and average value of p^H is 7.9.

Electrical conductivity of ground water in the state varies from 72 to 9550µs/cm at 25^0C with an average value of 1307 µs/cm at 25^0C. Ground Water is suitable for drinking purpose with respect to electrical conductivity in Rangareddy, Hyderabad and Karimnagar districts.

The average value of EC is highest in Nalgonda district followed by Mahbubnagar and Khammam in the state, in all 4.6% of samples are beyond permissible limit of BIS. It is also evident from the Fig.7.1 that the EC of ground water in the state varies from 750-3000µs/ cm.

Chloride concentration in ground water from shallow aquifers in the state varies from 3.5 to 2091. 0.66% of samples in the state exceeds the BIS permissibility levels. The percent of samples having chloride concentration is very high in Nalgonda and Adilanad districts and ground water is not suitable for drinking purpose. Whereas, the chloride value is less than 250 mg/L in majority of samples (Fig.7.2).

The average nitrate concentration in ground water in the state is 88.7 mg/L. . 60% of samples are exceeding the BIS permissible limit, indicating anthropogenic contamination. The chemical analyses reveal that ground water is not suitable for drinking purpose in many parts of Mahbubnagar, Nalgonda and Karimnagar districts.

Fluoride content in the state varies from 0.05 to 4.2 mg/L, with an average value of 0.85 mg/L. 12.9% of samples in the state exceeds BIS permissible limit. Ground water is not suitable for drinking purpose, in terms of fluoride, in many parts of Karimnagar Anathapur, Khammam and Hyderabad districts.

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

District	Maxima Minima Average	pH	EC µs/cm at 25^0C	Cl	NO3	F
				mg/L		
TELANGANA	Maxima	8.8	9550	2091	580	4.2
	Minima	7.2	70	3.5	00	0.05
	Average	7.9	1307	198	89	0.85
Adilabad	Maxima	8.4	9550	1560	427	2.1
	Minima	7.2	292	7.1	2.5	0.2
	Average	7.7	1312	180	113	0.70
Nizambad	Maxima	8.4	3630	964	518	1.7
	Minima	7.3	260	14	8.0	0.18
	Average	7.8	1239	187	81	0.75
Medak	Maxima	8.8	3925	645	202	2.5
	Minima	7.7	360	25	0	0.08
	Average	8.1	1319	218	56	0.76
Ranga Reddy	Maxima	8.6	1989	518	204	3.7
	Minima	7.5	170	11	0	0.08
	Average	7.9	996	141	62	0.81
Hyderabad	Maxima	8.5	2052	440	110	2.3
	Minima	7.7	458	39	0.75	0.39
	Average	8.0	982	132	38	1.01
Mahbubnagar	Maxima	8.3	3280	752	372	1.8
	Minima	7.3	722	78	2.5	0.10
	Average	7.8	1793	328	148	0.65
Nalgonda	Maxima	8.2	7600	2092	431	3.0
	Minima	7.5	688	64	2.9	0.17
	Average	8.0	2104	378	113	0.87
Khammam	Maxima	8.7	3420	922	378	4.2
	Minima	7.5	142	14	0	0.05
	Average	8.0	1462	227	107	0.88
Warangal	Maxima	8.4	3330	709	580	3.1
	Minima	7.3	70	11	0	0.05
	Average	7.9	1240	169	103	1.0
Karimnagar	Maxima	8.4	2571	475	202	2.7
	Minima	7.5	163	3.5	0.0	0.29
	Average	8.0	1246	163	72	1.1

Table- 7.2
No. of samples not suitable for drinking purpose with respect to different chemical constituents

District	Total Samples	% Samples Of Unsuitability			
		EC	Cl	NO3	F
Adilabad	45	0.0	2.2	68.9	8.89
Nizamabad	27	3.7	0.0	55.6	3.7
Medak	20	5.0	0.0	40.0	10.0
Rangareddy	61	0.0	0.0	50.8	11.5
Hyderabad	22	0.0	0.0	40.1	13.6
Mahbubnagar	21	14.3	0.0	76.2	9.52
Nalgonda	18	16.7	5.56	72.2	16.7
Khammam	42	7.1	0.0	64.3	16.7
Warangal	29	3.4	0.0	37.8	20.7
Karimnagar	21	0.0	0.0	71.4	19.0
TELANGANA	303	4.6	0.66	60.0	12.9

7.3 Quality of ground water for irrigation purpose

The most extensive use of ground water in the world is for irrigation consumption. The chemical quality of ground water is an important factor in evaluating its usefulness for irrigation. Poor quality ground water may adversely affect the crop production due to salinity, specific ion toxicity or infiltration problem in soil.

It is important to ascertain the nature of soil, crop and the prevailing climatic conditions in addition to the quality of water used for irrigation purpose. In arid regions, soil having heavy texture and high pH, usually develop alkalinity and salinity problems much more quickly than the light sandy soil. Besides texture; permeability, drainage, water table, calcium status and pH are other factors, which govern the effect of the water on properties of soil. Some crops are more tolerant to saline water than others. In areas of good rainfall even low 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. The constraints of water quality in irrigation can be examined using a number of empirical indices that have been established on the basis of field experience and experiments.

7.3.1 US salinity laboratory classification

The laboratory has constructed a diagram and described 16 classes with reference to (SAR) Sodium Absorption Ratio (index for sodium hazard) and electrical conductivity (index for salinity hazard). US salinity laboratory classification diagrams for the state of Andhra Pradesh is presented in the Fig.7.5 and for the individual districts are depicted in the Fig.7.7 - 7.15.

SAR is defined as

$$SAR = (Na^{+})/Sqrt\{(Ca^{+2}+Mg^{+2})/2\}$$

Where concentrations are expressed in meq/L.

The ground water (samples collected from the monitoring wells) is grouped into 9 classes (Fig.7.5) as described below.

C_1S_1 Class

Low salinity and low sodium waters are good for irrigation and can be used with most of the crops with no restriction on use on most of the soils.

$C2S_1$ Class

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.

$C3S_1$ Class

The high salinity and low sodium waters require good drainage. Crops with good salt tolerance should be selected.

C3S2 Class

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

C3S2 Class

These 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.

$C4S_1$ Class

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.

C4S2 Class

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.

C4S3 Class

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 Class

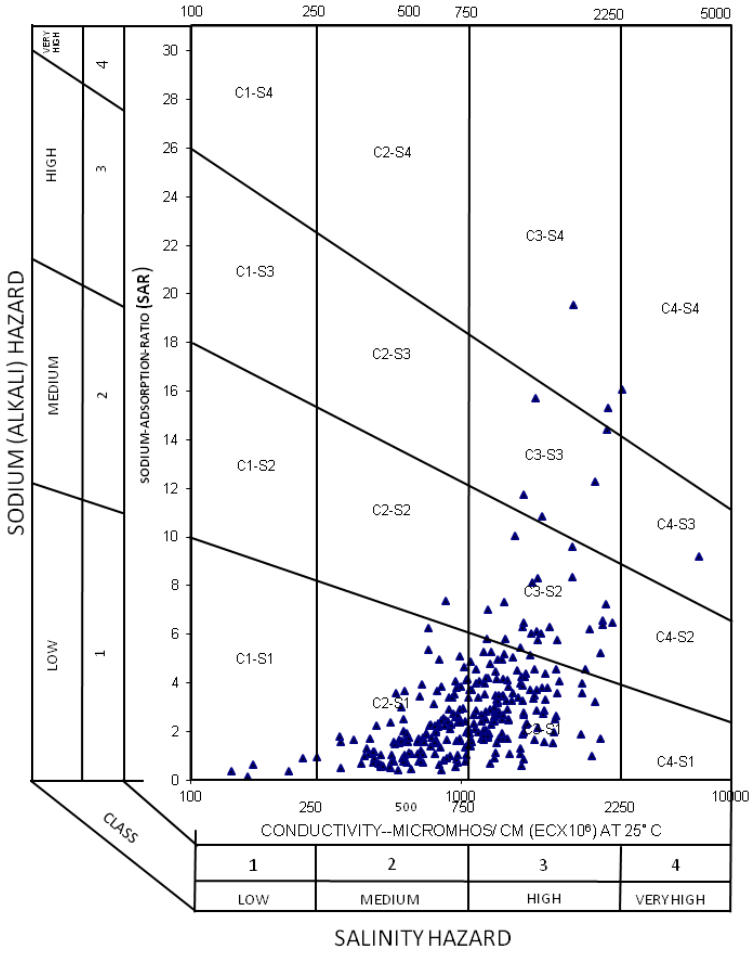
Very high salinity and very high sodium waters are generally unsuitable for irrigation purpose. These are sodium chloride type of waters and can cause sodium hazard. Can be used on coarse

textured soils with very good drainage for very high salt tolerant crops. Gypsum amendments make feasible the use of these waters.

The US salinity diagram (Fig.7.5) for shallow aquifer in Telangana State it is observed that 43.6% of water samples are falling in C_2S_1 class, 42.9% of water samples are falling in C_3S_1 class, 7.6% of samples falling in C_3S_2 class, 2.3% and 1.7%, samples falling in C_1S_1, and C_3S_3, and remaining samples falls in C_1S_1, C_4S_2, C_4S_3, C_3S_4, C_2S_2 and C_4S_1 classes respectively.

Fig.7.5

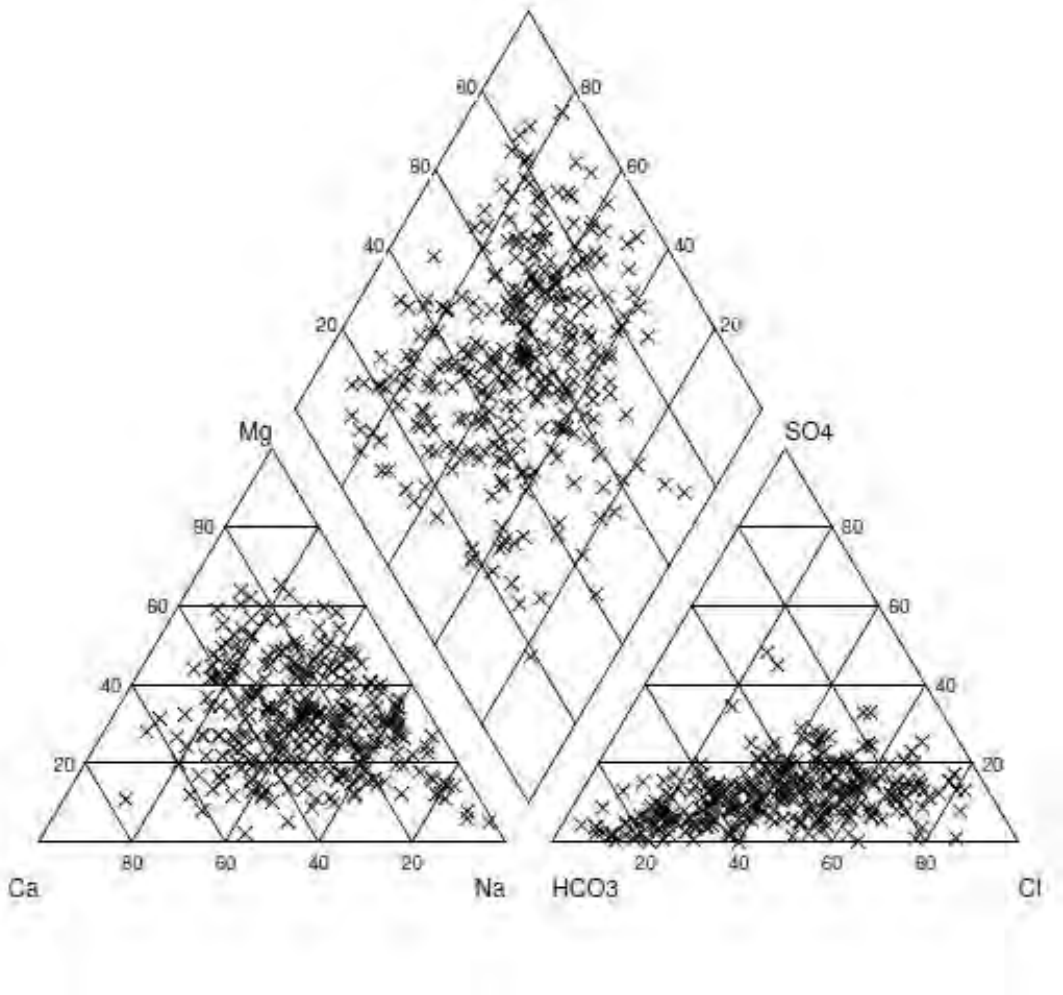
U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of TELANGANA



7.4 Piper Trilinear Diagram – Types of Water

The Piper Trilinear diagrams to determine the types of water in the state of Telangana are presented in the Fig.7.6 and for the individual districts in the Fig.7.17 - 7.26. The most dominant water types are Ca-HCO_3, Na-Mg-HCO_3 and Na-Ca-HCO_3.

Fig.7.6
Piper Trilinear Diagram – Shallow aquifers – Types of Water
Telangana State



7.5 Water quality for live stock and poultry

Though there was no livestock standards regulated in India, based on FAO and other international organizations standards 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 the usage of ground water for the livestock. Magnesium and Nitrate (except in one case) are within the range specified and suitable for live stock. Guide for use of saline water for livestock and poultry and number of samples in limits and suggested limits for magnesium in drinking water for livestock[1] are given in the Table-7.3 & 7.4 respectively. Guide for use of water containing nitrates for livestock is summarized in the Table-7.5.

Table - 7.3
Guidelines 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	221	Excellent for all classes of livestock and poultry
1 000-3 000 mg/litre (1.5-5 dS/m)	Very satisfactory	80	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	1	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	1	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]	302	<250	<21
Swine[2]	302	<250	<21
Horses	302	250	<21
Cows (lactating)	302	250	<21
Ewes with lambs	302	250	<21
Beef cattle	303	400	33
Adult sheep on dry feed	303	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
Guidelines 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	301	Experimental evidence indicates this water should not harm livestock or poultry.
100 to 300	440 - 1320	2	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).

7.6 Ground Water Quality - Over View

- Monitored 303 number of ground water monitoring wells to assess the quality of ground water from shallow aquifers in Telangana during May, 2011.
- In general pH is in the range of 7.2 to 8.8
- Higher values of Electrical conductivity of ground water (>3000 micromhos/cm at 25°C) have been observed in 4.62% of the samples. In general it is in the range of 750-3000 micromhos/cm at 25°C.
- Alkalinity exceeds BIS limit of 600mg/L in 11 samples.
- Sodium is in the range of 3.2 - 2162 mg/L.
- Potassium varies from traces to 300 mg/L with a general range of 0 to 10 mg/L.
- Chloride concentration is beyond BIS permissible limit only in 0.66% of the samples. The general range varies from 50 to 500 mg/L.
- Sulphate concentration exceeds BIS permissible limit of 400 mg/L in 0.7% of the samples with a general range of 5 to 100 mg/L.
- Fluoride concentration is beyond BIS permissible limit of 1.5 mg/L in 12.9% of the samples. In general it is in the range of 0.3 to 1.0 mg/L.
- Majority of the water samples in the state fall in C_2S_1 class followed by C_3S_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.
- Most of the samples are suitable for livestock and poultry consumption.

Higher values of chemical constituents (Table-7.6) in ground water in the state are observed in the following locations.

Table-7.6
Place of occurrence of higher concentration of chemical constituents in ground water in Telangana State

Chemical constituents	Concentration	Locations
Electrical Conductivity	9550 µS/cm at 25°C	Medaram, Adilabad district
Hardness	1900 mg/l	Nagaram, Nizamabad district Konijarla, Khammam district
Chloride	2092 mg/l	Nagaram, Nizamabad district
Sulphate	1224 mg/l	Medaram of Adilabad district
Nitrate	580 mg/l	Cherial of Warangal district
Fluoride	4.2 mg/l	Ashwapuram, Khammam

Fig.7.7-7.8

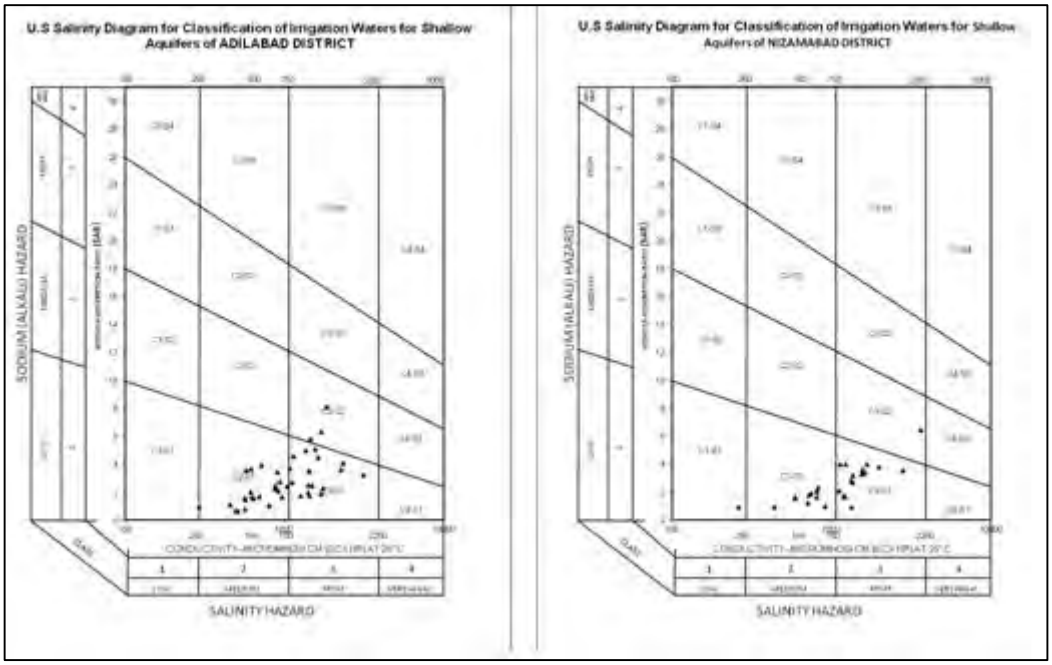
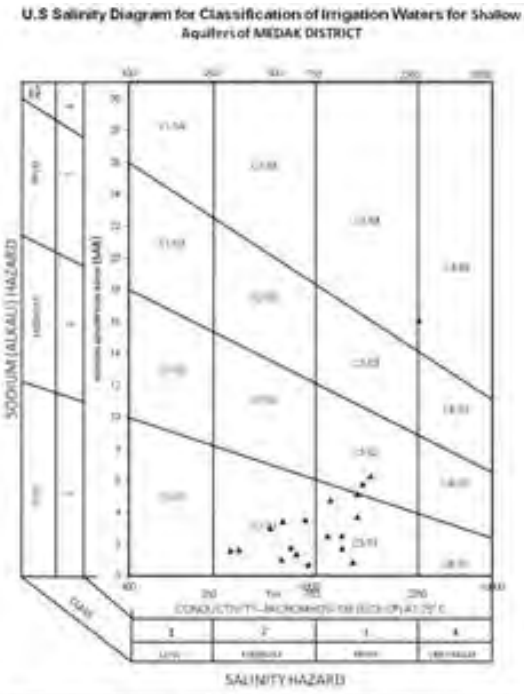
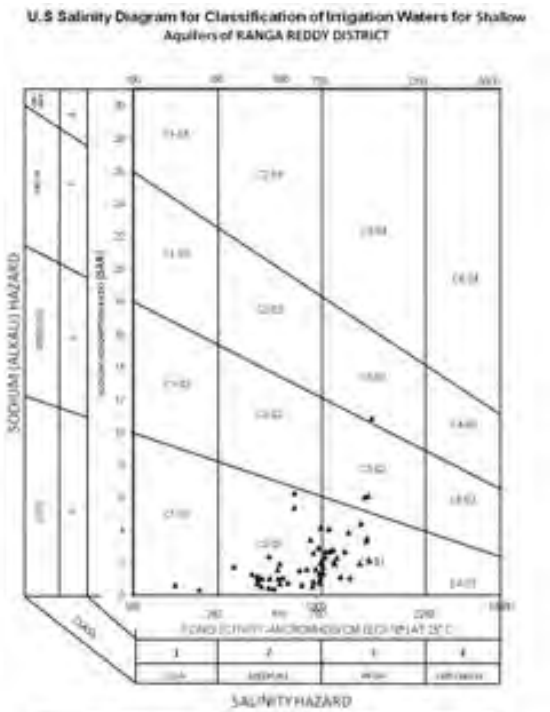
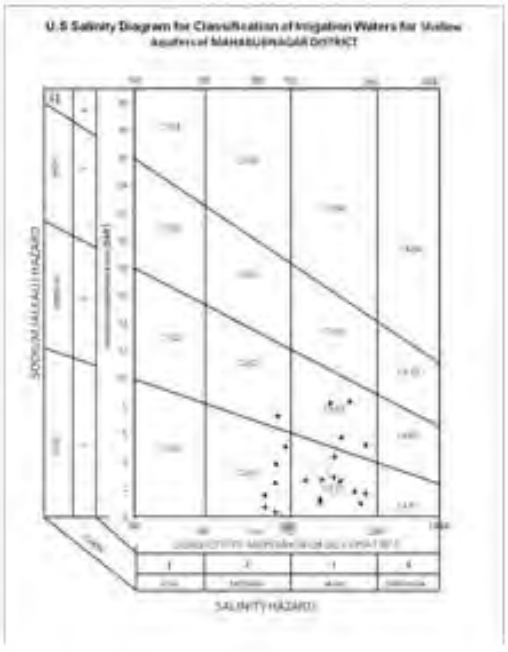


Fig.7.9-7.12


U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of MEDAK DISTRICT
SODIUM (ALKALI) HAZARD
SALINITY HAZARD


U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of RANGA REDDY DISTRICT
SODIUM (ALKALI) HAZARD
SALINITY HAZARD


U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of MAHABUBNAGAR DISTRICT
SODIUM (ALKALI) HAZARD
SALINITY HAZARD

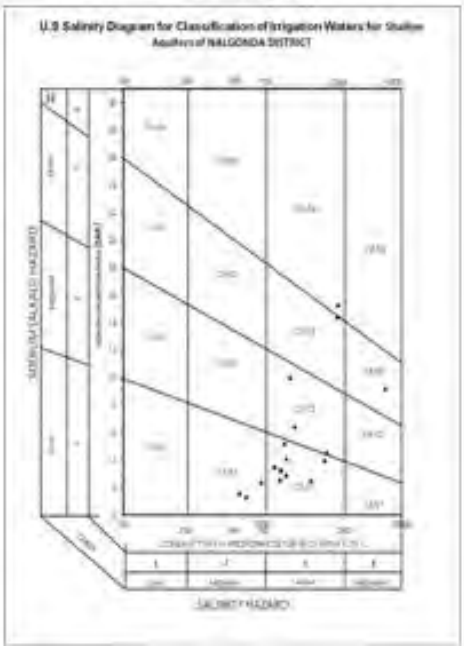
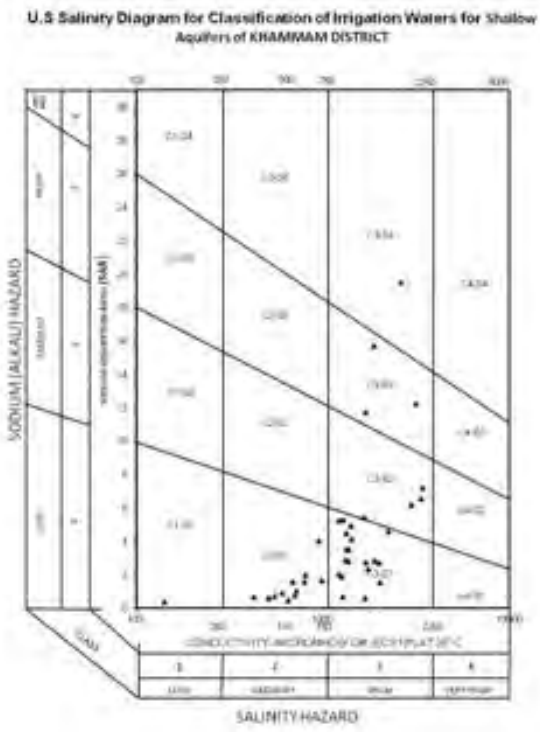
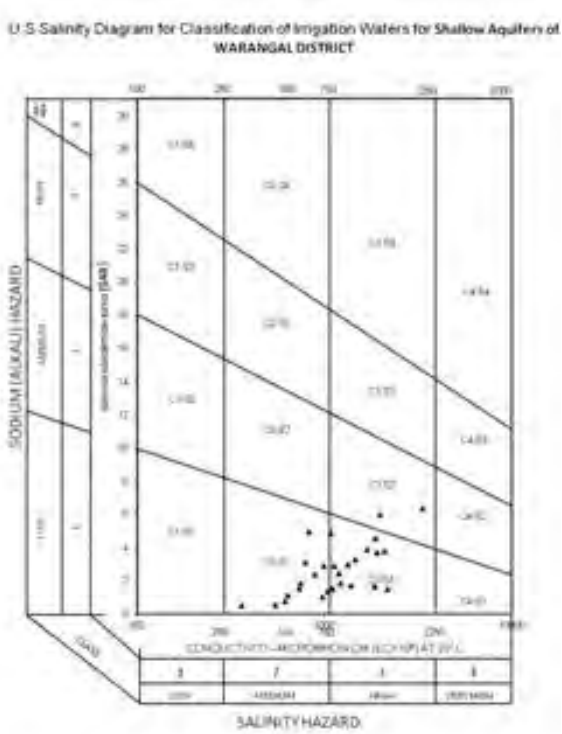

U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of NALGONDA DISTRICT

Fig.7.13-7.15


U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of KHAMMAM DISTRICT
SODIUM (ALKALI) HAZARD
SALINITY HAZARD


U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of WARANGAL DISTRICT
SODIUM (ALKALI) HAZARD
SALINITY HAZARD

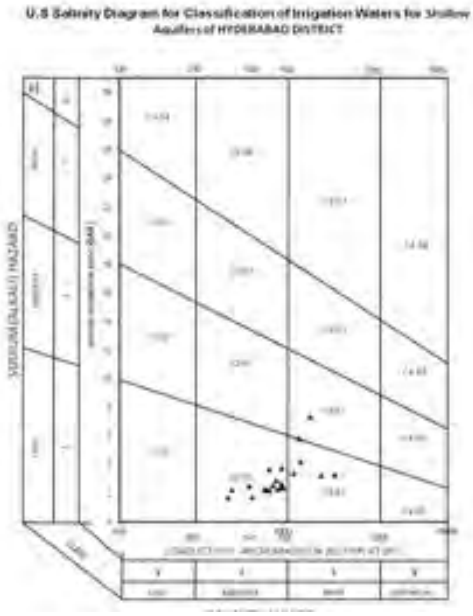
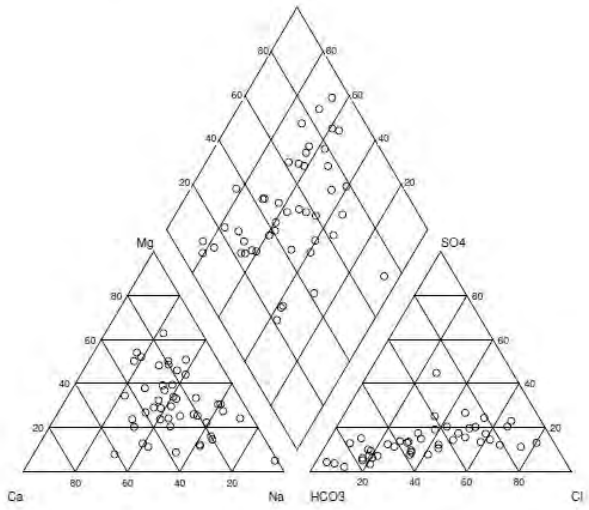
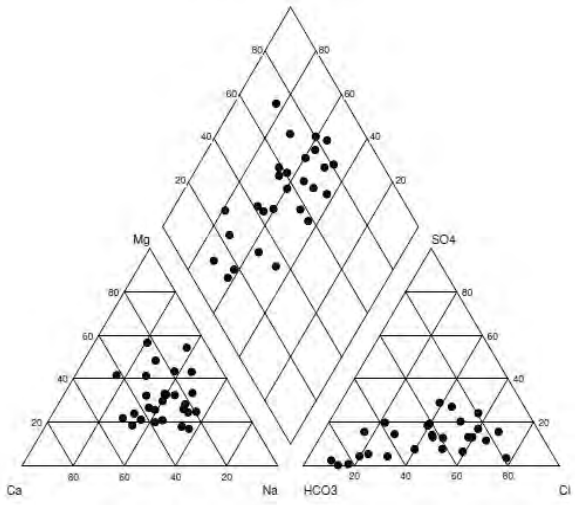

U.S Salinity Diagram for Classification of Irrigation Waters for Shallow Aquifers of HYDERABAD DISTRICT
SODIUM (ALKALI) HAZARD

Fig.7.16 -7.22

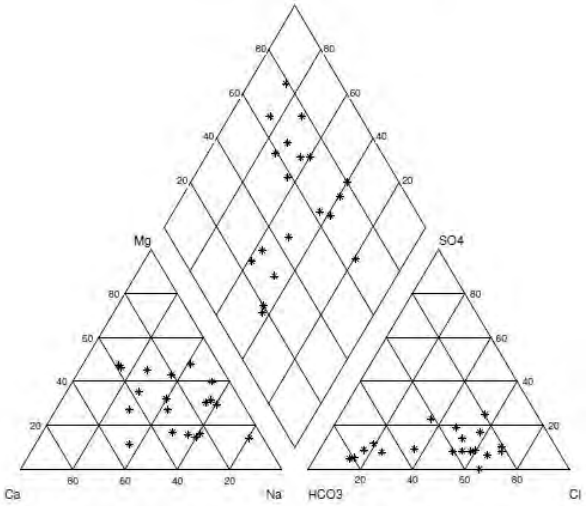
TRILINEAR DIAGRAM OF ADILABAD DISTRICT



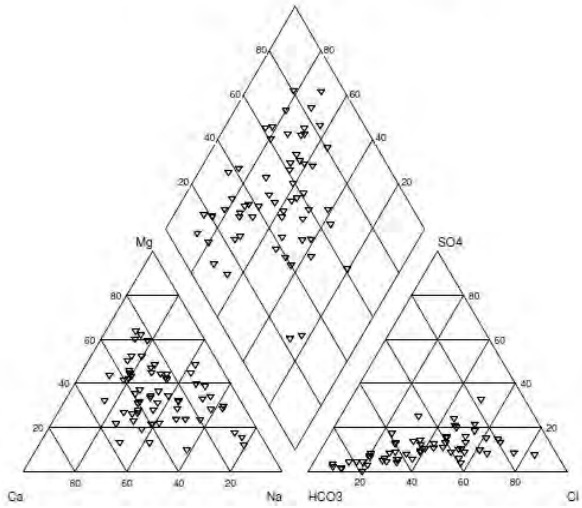
TRILINEAR DIAGRAM OF NIZAMABAD



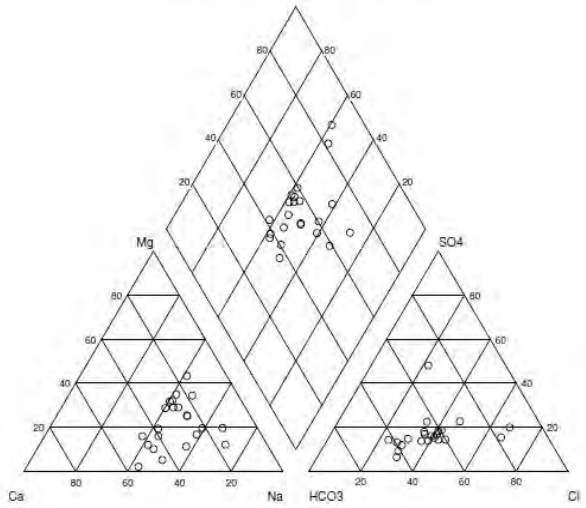
TRILINEAR DIAGRAM OF MEDAK



TRILINEAR DIAGRAM OF RANGAREDDY DISTRICT



TRILINEAR DIAGRAM OF HYDERABAD DISTRICT



TRILINEAR DIAGRAM OF MAHBUBNAGAR DISTRICT

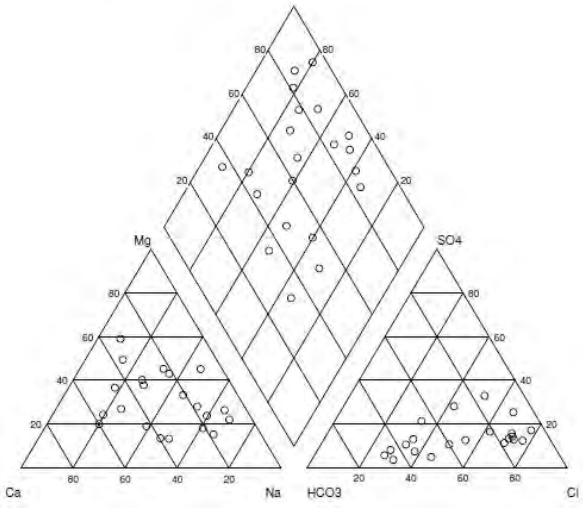
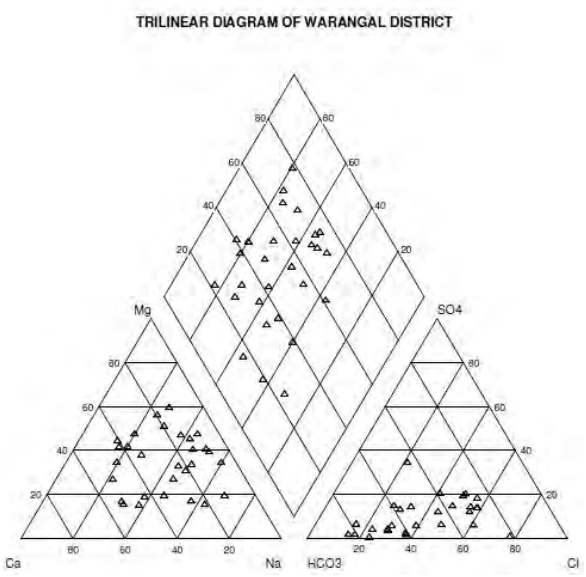
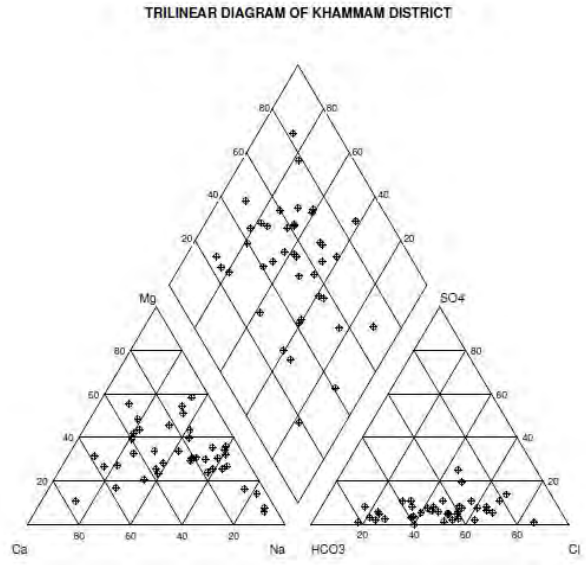
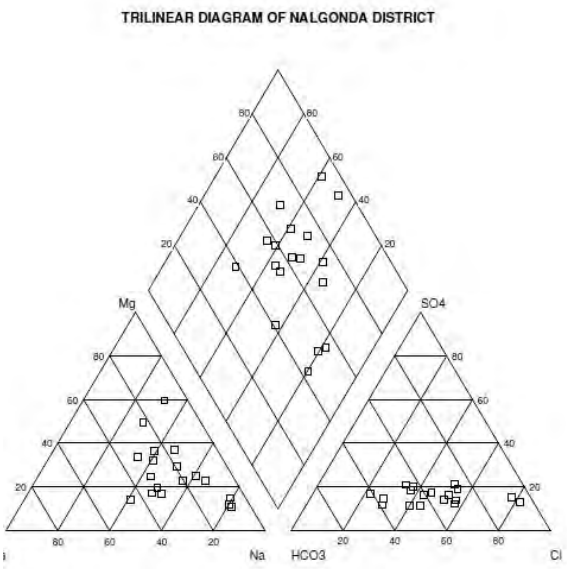
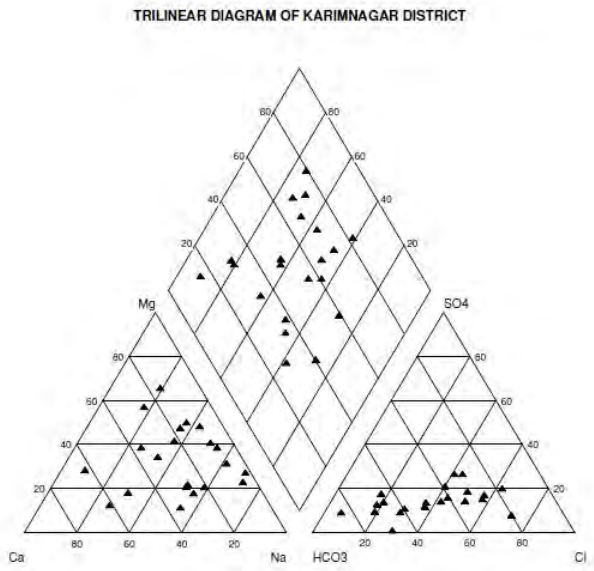


Fig.7.23 -7.26


TRILINEAR DIAGRAM OF WARANGAL DISTRICT
Mg
SO4
Ca
Na
HCO3
Cl


TRILINEAR DIAGRAM OF KHAMMAM DISTRICT
Mg
SO4
Ca
Na
HCO3
Cl


TRILINEAR DIAGRAM OF NALGONDA DISTRICT
Mg
SO4
Na
HCO3
Cl


TRILINEAR DIAGRAM OF KARIMNAGAR DISTRICT
Mg
SO4
Ca
Na
HCO3
Cl