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Government of India

Ministry of Water Resources, River Development & Ganga Rejuvenation

Central Ground Water Board

GROUND WATER YEAR BOOK

GOA STATE, 2015-16

CENTRAL GROUND WATER BOARD
SOUTH WESTERN REGION
BANGALORE
OCTOBER 2016

FOREWORD

Groundwater is a dynamic and replenishable precious natural resource; it requires to be monitored regularly and also to be appraised of the changes that are taking place in its regime. In this regard, Central Ground Water Board collects the groundwater level and quality data from the Water Level Monitoring Stations. The water levels are monitored four times a year during the months of May, August, November and January. Samples for determination of the quality of the groundwater are collected once a year during the month of May. This report consists of the ground water level for the year 2015-16 and chemical quality data collected during the year 2015 of Goa State. Maps showing the depth to groundwater level in different parts of Goa and the changes observed in the water level in the last one-year and last one decade are included and discussed in the report. The report also consists of the discussions on the distribution and variation of rainfall for normal period. Chemical quality data of groundwater of the samples collected during May 2015 and the interpretation of the data are included in the report.

The data have been compiled and interpreted by Shri. H.P.Jayaprakash, Scientist 'C', Smt. Rakhi U.R., Scientist 'B', Miss. Caroline Louis Scientist 'B', Dr. Lubna Kouser, Asst. Hydrologist, Smt. Hemalatha, STA (HG), Shri. Rahul Vashistha, STA (Chem.), Smt. Lalitha. B.H. STA (Chem.). Hard work and efforts made by various personnel of SWR, Bangalore and WKSU, Belgaum office for the collection of field data are acknowledged. The water samples were analysed by the Regional Chemical Laboratory to bring out the aspects of groundwater quality. Shri. S.S.Hegde, Scientist 'D' of Report Processing section has carried out the necessary processing of the report to bring the report to the final stage.

It is hoped that the information contained in this yearbook will be useful for planners, administrators and other user agencies associated with development and management of water resources in Goa state.

(K.M. Viswanath)
Regional Director

ABSTRACT

Goa state has a geographical area of 3702 Sq km divided into 2 districts with 11 taluks. The Central Ground Water Board has collected water level data of the phreatic aquifer from 103 National Hydrograph Network Stations during the months of May, August, November, 2015 and January 2016. This report contains the analysis and interpretation of the data.

Thematic maps depicting the groundwater scenario during this period are prepared and discussed. Average annual rainfall of the State is 320 cm, increasing from 270 cm in the West (on the coast) to 400 cm in the East. Similarly, rainfall decreases from south to north along the coast as well as the interiors. While the annual rainfall in the North Goa district averages 316 cm it is 330 cm in the south Goa district. The months of June and July are the wettest months with around 100 cm rainfall each month. Rainfall during the months of January and February is negligible. Valpoi in the North Goa and Quepem in the South Goa, both in the interior hilly areas, are the wettest places in the state.

The pre-monsoon depth to water level recorded in the State reveals that about 82% of the wells have water level less than 10 mbgl and the rest show in the range of 10-20 mbgl. The depth to water level during pre-monsoon season ranged from 1.56 mbgl to 19.39 mbgl. It is seen that out of 89 stations analyzed during the month, 8% wells have water level less than 2 mbgl, 48% wells have 2 to 5 mbgl water level, 28% wells have 5 to 10 mbgl water level, 16% wells have 10 to 20 mbgl water level. The water level in the range of 2 to 5 and 5 to 10 m bgl is the general water level in the state. Water level in the range of 10 to 20 mbgl is seen in Pernem, Sanguem, Quepem, Satari, and Cancona taluks as patches.

During post-monsoon season, about 91% of the wells recorded less than 10 mbgl water level and the remaining 9% wells have water level 10-20 mbgl. The depth to water level during post-monsoon season ranged from 0.35 mbgl to 15.47 mbgl. It is seen that out of 86 stations analyzed 20% wells have less than 2 mbgl water levels, 44% wells have 2 to 5 mbgl water levels, 27% wells have 5 to 10 mbgl water level and the remaining 9% wells have 10 to 20 mbgl water level. During post-monsoon mMajor part of the State shows depth to water level in the ranges of <2 m bgl, 2 to 5 mbgl and 5 – 10 m bgl. Depth to water level in the range of < 2 mbgl of water level is observed as patches in almost all the taluks except Sanguem taluk. Water level of more than 10 mbgl is observed as patches in Bicholim, Satari, Quepem, Sanguem and Cancona taluks.

Results of chemical analysis of the samples show that all the samples are suitable for domestic, irrigation and industrial purposes.

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OF GOA STATE

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GROUND WATER YEAR BOOK OF GOA STATE

2015-16

1. GENERAL FEATURES

1.1. Introduction

Central Ground Water Board, South Western Region, Bangalore, is monitoring water levels in the State of Goa from the established network of 103 monitoring stations, as a part of 'Ground Water Regime Monitoring'. This monitoring is done four times in a water year during May, August, November and January for water level. Water samples from these stations are collected once in a year during the month of May to assess the ground water quality.

The State of Goa located between 14°53'54" and 15°48'00" north latitudes and 73° 40' 33"and 74° 20' 13" east longitudes is situated on the western coast of peninsular India. It is bounded in the north by Maharashtra State, in the east and south by Karnataka State and in the west by the Arabian Sea. The State has a total geographical area of 3702 Sq. km., which is administratively divided into two districts with 11 taluks. The talukwise distribution of Ground water monitoring stations being monitored by the Region is given in Table 1.1.

Table 1.1: Districtwise distribution of Ground water monitoring stations

Sl.No.	Taluk	Geographical Area (Sq. km)*	No. of Ground water monitoring stations
District: North Goa			
1	Tiswadi	213.6	6
2	Bardez	264.0	13
3	Pernem	251.7	9
4	Bicholim	238.8	10
5	Satari	495.1	11
6	Ponda	292.8	6
District: South Goa			
7	Sanguem	873.7	18
8	Cancona	352.0	10
9	Quepem	318.3	5
10	Salcete	292.9	13
11	Mormugao	109.1	2

** Source: Statistical Pocket Book of Goa 1993-94, Directorate of Planning, Statistics and Evaluation, Government of Goa*

1.2 Physiography

Goa State forms part of coastal tract of the west coast of India. Physiographically the Goa State is divided into four morphological units namely, 1.Costal plains with dominant Marie land forms on the west, followed successively towards the east 2. Vast stretch plain. 3. Low dissected denudation hills and table land and 4. Deeply dissected high Western Ghats denudation hills occurring all along the eastern part of Goa rising to a maximum of 832 m above MSL. The Alluvial landforms are limited in areal extent.

1.3 Drainage

The State of Goa is drained by the west flowing rivers viz. Terekhol, Chapora, Mandovi and Zuari. The Sahyadri hill ranges in the east form the main watershed. The streams originating here flow in westerly and northwesterly direction to join the Arabian Sea. Major portion of the State is drained by the two rivers, viz. Mandovi and Zuari. The river Terekhol forms the northern boundary of Goa State and separates it from the Maharashtra State. The other smaller rivers draining the State are the rivers Chapora, Baga, Saleri, Sal, Talpona and Galgibaga (Table 1.2). The underlying rocks govern the drainage system in the area. The drainage pattern is generally dentritic type. The major river Zuari follows the major NW synclinal axis. The river valleys are 'V' shaped in the eastern high hill ranges, but broadens in central midlands and become 'U' shaped in the low lands and coastal plains (Fig. 1.1).

Table 1.2: Details of the Major/Minor river Basin area in Goa State

Drainage Basin / Sub Basin	**Area**		**Taluks**
	Sq. km.	%	
Terekhol	71	1.93	Pernem
Chapora	255	6.88	Pernem, Bicholim, Bardez
Baga	50	1.35	Bardez
Mandovi	1580	42.68	Bicholim, Bardez, Satari, Sanguem, Tiswadi & Ponda
Zuari	973	26.28	Tiswadi, Ponda, Salcete, Quepem, Mormugao Sanguem & Cancona
Sal	301	8.13	Mormugao, Salcete, Quepem, & Cancona
Saleri	149	4.03	Quepem, & Cancona
Talpona	233	6.29	Cancona & Sanguem
Galgibaga	90	2.43	Cancona
Total	**3702**	**100**	

1.4 Geology

Major part of the Goa State is underlain by rocks of Precambrian age comprising banded biotite gneisses, meta volcanics, phyllites, biotite and chlorite schists, greywacke, conglomerate (tilloid), pink phyllites with associated banded ferruginous quartzite and chart breccia. These rocks are intruded by ultra basic, basic sills and dykes, followed by granites and pegmatites. Dolerite dykes and quartz veins form the youngest intrusives in the area.

The Deccan Trap basalts of Late Cretaceous to Early Eocene age occupy a small portion in the northeastern part in the high altitudes.

Almost all formations in the state have undergone lateritisation to various degrees depending upon the climate and rock type. The lateritisation is more pronounced in the coastal areas than in the hilly regions. Phyllites, Schists and Meta volcanics are more susceptible to lateritisation and the gneissic / granitic rocks are least susceptible. In general, the thickness of laterites varies from about 3 to 30 mts. Laterites are highly porous due to the process of leaching and weathering. Hence, they have very good capacity to hold and transmit groundwater. Groundwater in laterites occurs under phreatic condition.

Major portion of the state is underlain by crystalline rocks and consolidated and metamorphosed sedimentaries, which do not possess primary porosity. Secondary porosity introduced through weathering, fracturing and jointing, produces the void spaces to hold and transmit ground water. Groundwater in these rocks occurs under water table conditions in the weathered zone and under semi-confined and confined conditions in the deeper fractured zone.

Beach sands along the coast and alluvium along major rivers have limited occurrence and the ground water occurs in the primary porosity under water table conditions.

FIG.1.1

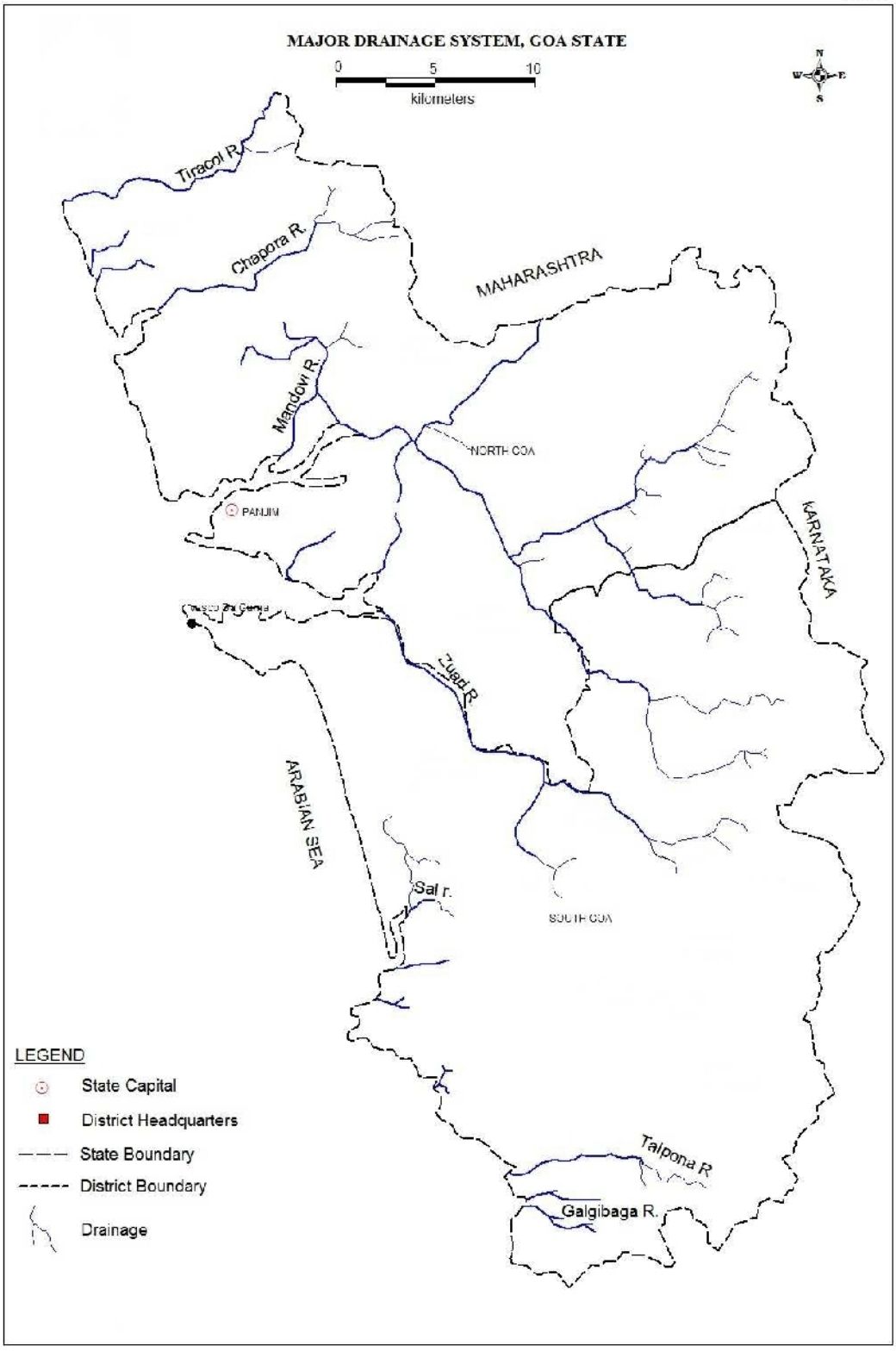

Fig 1.1: Major Drainage System

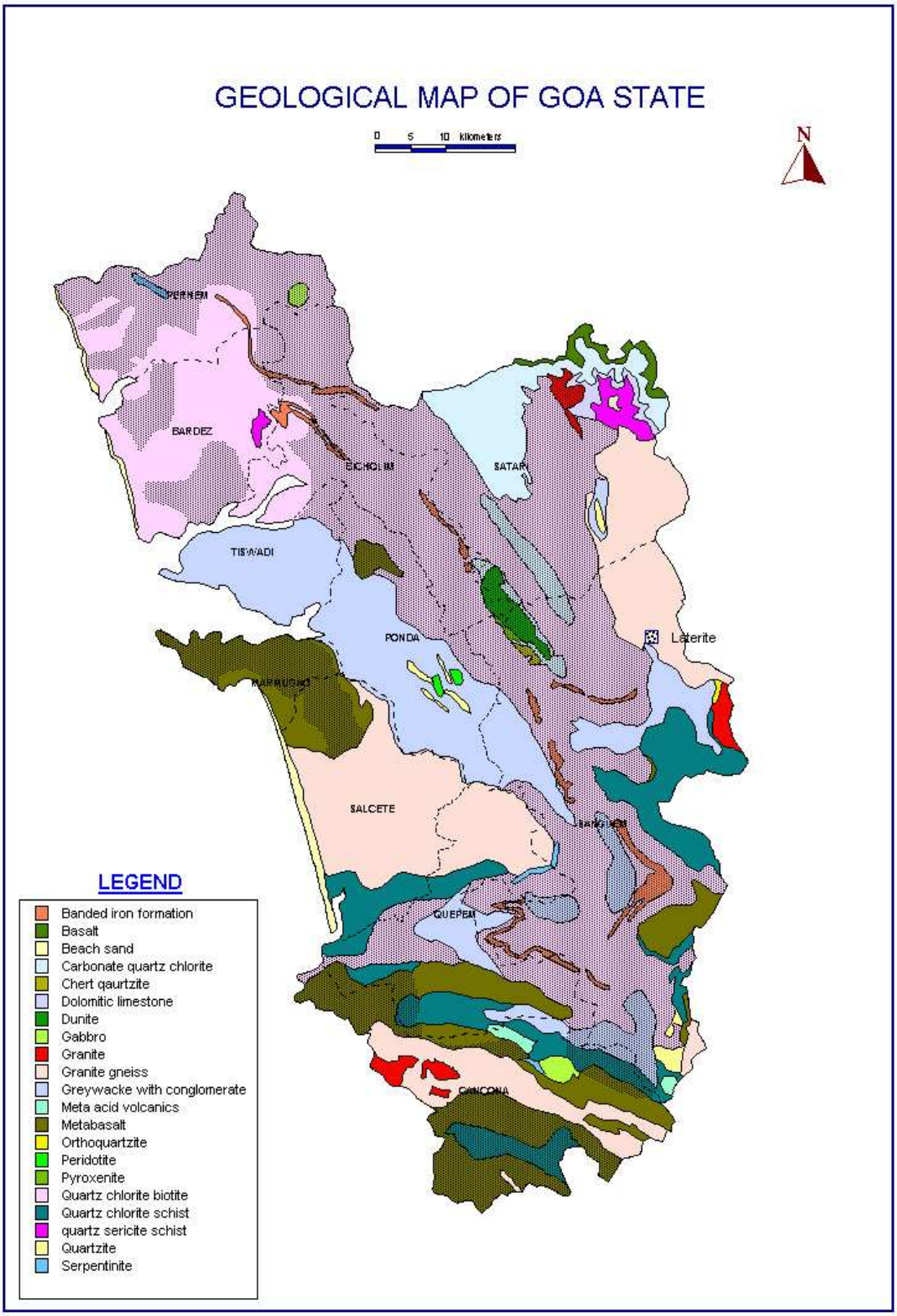

Fig 1.2: Geological map

2. CLIMATE AND RAINFALL

The State has a tropical-maritime monsoonal type climate with distinct orographic influence. The climate is equable and humid throughout the year. Due to the maritime climate, the diurnal variation in temperature is not much. The months of January and February are dry with clear skies and generally pleasant. May is the hottest month with temperature around 30°C and January is the coolest month with temp 25°C.

2.1 Rainfall

Rain occurs during the monsoon period from June to September. Over 90% of annual rainfall occurs during monsoon period. The balance of 10 % occurs during the pre-monsoon period from March to May and post-monsoon period from October to December. However, the rainy period extends from May to November.

The analysis of Rainfall data for the period of 1970 to 2000 from 12 stations over the Goa state indicates that the monsoon rainfall is in the order of 3460mm (90 % of annual rainfall), 218.1mm (6%) during post monsoon period of October to December and 102.5(4%) are from January to May months. The overall annual rainfall over the Goa state based on 30 years rainfall data is of 3483.3mm. The minimum rainfall of 2611.7mm is recorded at Mormugao station falls in South Goa district and maximum of 5090mm is in Sanguem station also from South Goa.

The annual normal rainfall in North Goa ranges from 2766.9 at Panaji along the west coast and highest at Valpoi in the east (Ghats section) indicating rainfall increases from west to east. Average rainfall in North Goa is 3400.1mm. Similarly in South Goa it ranged 2611.7 mm at Marmugao in west coast and maximum at Sanguem in the east, again Ghat section indicating that the rainfall increases from west to east. The overall annual normal rainfall in south Goa is 3733.13mm.

The months of June (840.7mm) and July (1246.9mm) are the wettest months with around 2187.6mm (62.80% of annual normal rainfall) rainfall in two months. Rainfall during the months of January and February is negligible. Valpoi in the north Goa and Sanguem in the south Goa, both in the interior hilly areas, are wettest places in the state. Isohyetal Map of Goa state for the period 1970 to 2000 has been presented in Fig. 2.1 and the Isohyetal Map monsoon rainfall is in Fig. 2.2. Normal monthly rainfall of in respect of 12 stations of Goa state is presented in Annexure - II.

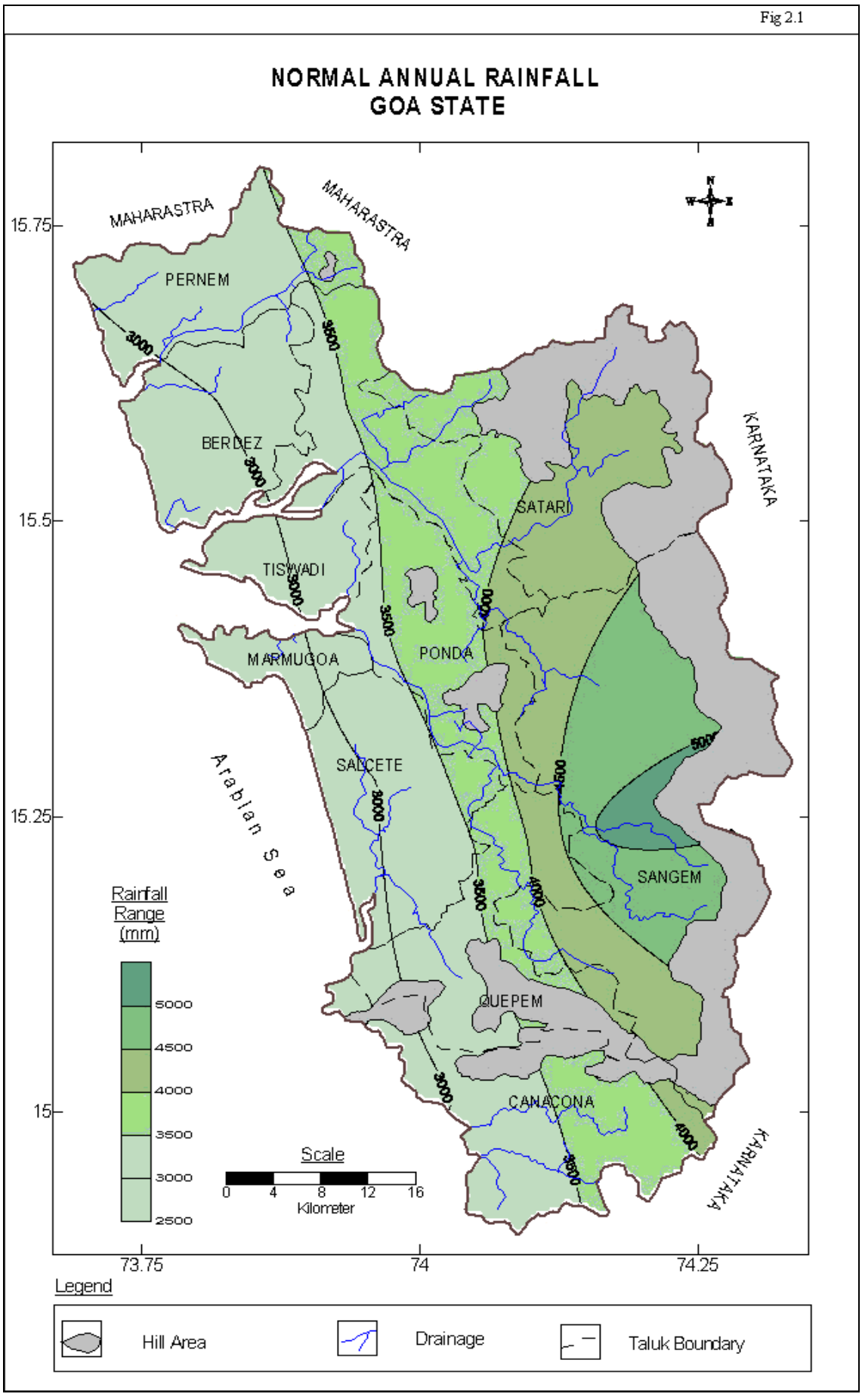

Fig 2.1: Normal Annual Rainfall (1970-2000)

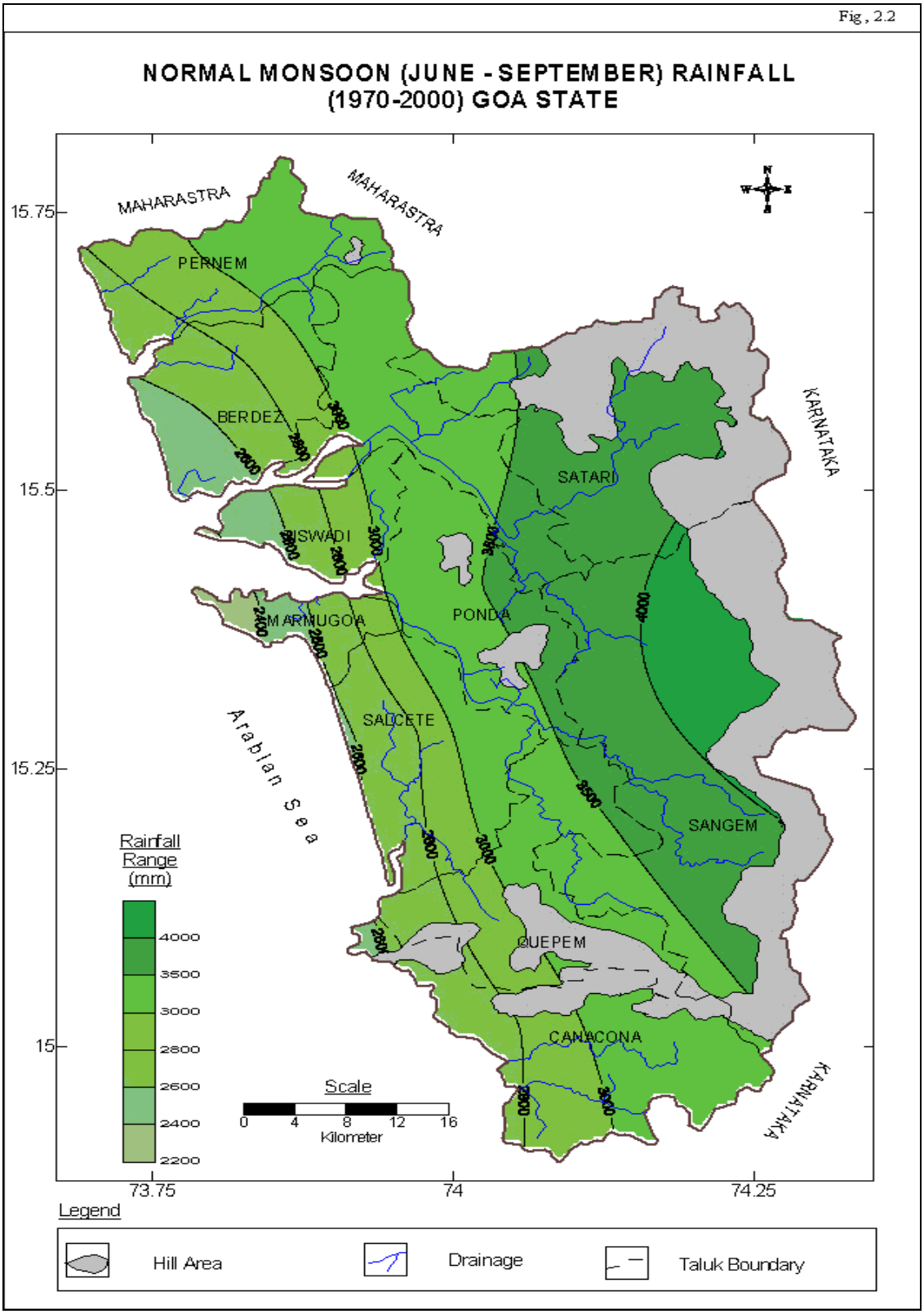

Fig 2.2: Normal Monsoon Rainfall (1970-2000)

3. GROUND WATER LEVELS IN GOA DURING WATER YEAR 2015-16

Central Ground Water Board, South Western Region, Bangalore has a network of 103 Ground Water Monitoring stations in Goa under the Programme 'Ground Water Regime Monitoring' of the Board, which works out to one Ground Water Monitoring Stations in 36 Sq. Km.

The above network comprises 103 stations, which are predominantly domestic dug wells and are monitored four times a year during the months of January, May, August and November for water levels and once a year for quality during the month of May. These wells are monitored between 1st to 10th during the month of January and November and between 20th and 30th during the month of May and August. General details of Goa State Ground Water Monitoring Stations are furnished in Annexure I.

3.1 Depth to Ground Water Levels

Monitoring of Ground Water Monitoring Stations in Goa was carried out during May, August, November 2015 and January 2016. The analysis/findings are as below:

Depth to Water Level: May 2015

The depth to water level recorded in the State of Goa during May 2015 ranged from 1.56 mbgl to 19.39 mbgl. It is seen that, out of 89 stations analyzed during the month, 8% wells have water level less than 2 mbgl, 48% wells have 2 to 5 mbgl water level, 28% wells have 5 to 10 mbgl water level, 16% wells have 10 to 20 mbgl water level (Table 3.1).

A map showing the depth to water level in the ranges of <2, 2 to 5, 5 to10 and 10 to 20 mbgl is enclosed as Fig 3.1. Water level in the range of less than 2 mbgl is observed in some parts of Tiswadi taluk and 2-5 mbgl is observed in almost all the taluks of Goa State. Water level in the range of 5 to 10 mbgl is observed in almost all the taluks and >10 mbgl is observed in Pernem, Sanguem, Quepem, Satari, and Cancona taluks.

Depth to Water Level: August 2015

The depth to water level recorded in the State of Goa during August 2015 ranged from 0.13 mbgl to 14.35mbgl. It is seen that, out of 85 stations analyzed during the month, 30.6% wells have water level less than 2 mbgl, 40% wells have 2 to 5 mbgl water level, 24.7% wells have 5 to 10 mbgl water level, 4.7% wells have 10 to 20 mbgl water level (Table 3.2).

A map showing the depth to water level in the ranges of <2, 2 to 5, 5 to10 and 10 to 20 mbgl is enclosed as Fig. 3.2. Water level in the range of less than 2 mbgl is observed in some parts of all taluks and 2-5 mbgl and 5 to 10 mbgl is observed in almost all the taluks. Water level>10 mbgl is observed in Bicholim, Tiswadi, Ponda, Satari, and Cancona taluks.

Depth to Water Level: November 2015

The depth to water level recorded in the State of Goa during November 2015 ranged from 0.35 mbgl to 15.47 mbgl. It is seen that, out of 86 stations analyzed during the month, 20% wells have water level less than 2 mbgl, 44% wells have 2 to 5 mbgl water level, 27% wells have 5 to 10 mbgl water level, 9% wells have 10 to 20 mbgl water level (Table 3.3).

A map showing the depth to water level in the ranges of <2, 2 to 5, 5 to10 and 10 to 20 mbgl is enclosed as Fig 3.3. The depth to water level map shows that the water level in the range of 2 to 5 and 5 to 10 mbgl is the general water level in the State. Less than 2 mbgl of water level is observed as patches in almost all taluks except Sanguem taluk. Water level more than 10 mbgl is observed as patches in of Bicholim, Satari, Quepem, Sanguem and Cancona taluks.

Depth to Water Level: January 2016

The depth to water level recorded in the state of Goa during January 2016 ranged 0 mbgl to 15.47 mbgl. It is seen that out of 80 stations monitored during the month, 12 % wells have less than 2 mbgl water levels, 48 % wells have 2 to 5 mbgl water levels, 29 % wells have 5 to 10 mbgl water level and the remaining 11 % wells have 10 to 20mbgl water level (Table 3.4).

A map showing the depth to water level in the ranges of <2, 2 to 5, 5 to10 and 10 to 20 mbgl is enclosed as Fig- 3.4. Water level of less than 2 mbgl is observed in parts of Pernem, Bardez, Tiswadi, Ponda, Salcete and Bicholim taluks. Depth to water level in the range of 2 to 5 mbgl and 5 to 10 mbgl is observed as major part in the state covering almost all the taluks. Depth to water level of more than 10 mbgl is noticed as small patches in Pernem, Bardez, Bicholim, Sanguem and Cancona taluks.

3.2 Fluctuations in Ground Water Levels

Analysis of fluctuation / rise and fall of ground water levels measured during the different periods was carried out. Pre-monsoon water levels measured during May 2015 are compared with water levels during August 2015, November 2015 and January 2016 to know the Seasonal Fluctuations. Water levels measured for a given month during consecutive years are compared to know the annual fluctuation. Further, water levels of each measurement are compared with the mean water levels pertaining to the same months of the preceding decade to know the long term changes. The fluctuation details are given in Annexure-IV. Summary of the analysis is given below:

Change in Groundwater Level : May 2015 to August 2015

Water levels from 85 stations were compared to know the change in groundwater level in August 2015 as compared with May 2015 in the State of Goa. Among the analysed stations, 83 wells have a recorded rise in water level during August 2015 as compared to May 15 (Table 3.5).

Rise of water level in the range 0-2 m is observed in 51 wells accounting for 60%of the analysed wells. Rise in water level in the range of 2 to 4 m and >4m is recorded in 20 wells (23.4%) and 12 wells (14.2%) respectively. Fall in water level in the range of 0-2 m is recorded in 2 wells accounting for 2.4% in Goa State

A map depicting the change in groundwater level in August 2015 as compared to May 2015, showing rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m is enclosed as Fig. 3.5. The water level rise in the range of 0 to 2 m is the general trend in the Goa State. Rise in water level of 2 to 4 m is observed in almost all the taluks and more than 4 m is observed in Pernem, Bardez, Bicholim, Tiswadi, Satari, Ponda, Mormugao, Sanguem, Quepem and Cancona taluks.

Change in Groundwater Level: May 2015 to November 2015

Water levels from 86 stations were compared to know the change in groundwater level in November 2015 as compared with May 2015 in the State of Goa. Amongst the 86 analysed wells, 78 wells (91%) have a recorded rise in water level and 8 wells (9%) have fall in water level during November 2015 as compared to May 2015 (Table 3.6).

Rise of water level in the range 0-2 m is observed in 56 wells accounting for 65% of the analysed wells. Rise in the range of 2 to 4 m and >4m is recorded in 16 wells (19%) and 6 wells (7%) respectively. Fall in water level of 0-2 m is noticed in 8 wells accounting for 9% of the analysed wells.

A map depicting the change in groundwater level in November 2015 as compared to May 2015, showing rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m is enclosed as Fig 3.6. The water level rise in the range of 0 to 2 m is general in the Goa State. Rise in water level of 2 to 4 m is observed in almost all the taluks and more than 4 m is observed in Bardez, Bicholim, Satari, Salcete, Quepem and Sanguem taluks. Fall in water level is observed as isolated patches in Pernem, Tiswadi, Bicholim, Ponda, Salcete and Sanguem taluks.

Change in Groundwater Level : May 2014 to January 2016

Water levels from 79 stations were compared to know the change in groundwater level in January 2016 with May 2015 in the State of Goa. On the whole, 68 wells accounting for 86% of the analysed wells have recorded a rise in water level during January 2016 as compared with the period May 2015. The remaining 11 wells (14%) have recorded fall in water level (Table 3.7).

In the rise category, the rise of water level in the range 0-2 m is observed in 61 wells accounting for 77% of the analyzed wells. Rise in water level in the range of 2 to 4 m is recorded in 5 wells (6%) and more than 4 m is recorded in 2 wells (3%) . In the fall category, 8 wells (10%) have recorded a fall in the range of 0 to 2 m. Fall in water level in the range of 2-4 m is recorded in 1 well (1%) and more than 4 m is recorded in 2 wells (3%).

A map showing the change in groundwater level in January 2016 as compared to May 2015, showing rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m is enclosed as Fig-3.7. Major part of the state is showing rise in water level in the range of 0 to 2 m and 2-4 m covering Bardez, Ponda, Satari, Sangem, Bicholim and Quepem taluks. Rise in water level of >4 m is observed in Bicholim, Satari and Ponda taluks. Fall in water level in the range of 0-2 m is observed as patches in Bardez, Tiswadi, Bicholim, Satari, Salcete, Sangem, Quepem and Canacona taluks. Fall in water level in the range of 2-4 m is noticed in Bardez, Satari and Canacona taluks. Fall in water level of >4 m is observed in Cancona taluk.

Change in Groundwater Level: May 2014 to May 2015

Water levels from 88 stations were compared to know the change in groundwater level in May 2015 with May 2014 in the State of Goa. It is seen from the table that, 42% of the stations monitored have recorded a rise in water level during May 2015 as compared to May 2014 and 58% have shown fall in water level. Rise in water level in the range of 0-2 m is observed in 29 wells accounting for 33%, 2-4 m is observed in 7 wells accounting for 8% and greater than 4 m is observed in 1 well accounting for 1% respectively. Fall in water level in the range of 0-2 m is recorded in 45 wells accounting for 51%, 2-4 m is recorded in 4 wells accounting for 5% and greater than 4 m is recorded in 2 wells accounting for 2% (Table 3.8).

A map depicting the change in groundwater level in May 2015 as compared to May 2014, showing rise/fall in the ranges of <2 m, 2 to 4 m and >4 m is enclosed as Fig-3.8. Rise in water level in the range of 0-2 m is observed in almost all parts of Goa State except Bicholim taluk. Rise in water level in the range of >2 m is observed in parts of Bardez, Tiswadi, Salcete, Sanguem and Cancona taluks. Fall in water level in the range of >2 m is observed in almost all the taluks of the State. Fall in water level of 2- 4 m is observed in Bardez, Tiswadi, Salcete, Sanguem and Cancona taluks and >4 m is observed in parts of Bicholim and Cancona taluks.

Change in Groundwater Level: August 2014 to August 2015

Water levels from 85 stations were compared to know the change in groundwater level in August 2015 with August 2014 in the State of Goa. It is seen from the table that, 34% of the stations monitored have recorded a rise in water level during August 2015 as compared to August 2014 and 66% have shown fall in water level. Rise in water level in the range of 0-2 m is observed in

23 wells accounting for 27.1%, 2-4 m is observed in 5 wells accounting for 5.9% and greater than 4 m is observed in 1 well accounting for 1.2% . Fall in water level in the range of 0-2 m is recorded in 48 wells accounting for 56%, 2-4 m is recorded in 4 wells accounting for 4.7% and greater than 4 m is recorded in 4 wells accounting for 4.7% (Table 3.9).

A map depicting the change in groundwater level in August 2015 as compared to August 2014, showing rise/fall in the ranges of <2 m, 2 to 4 m and >4 m is enclosed as Fig. 3.9. Rise in water level in the range of 0-2 m is observed in major parts of Tiswadi, Bicholim, Murmgoa, Ponda taluks and in small parts of rest of taluks in Goa State. Rise in water level in the range of >2 m is observed as isolated patches in Bicholim and Tiswadi taluks. Fall in water level in the range of >2 m is observed in almost all taluks of Goa State. Fall in water level of 0 - 2 m is observed in all taluks of the Goa State. Fall in water level is observed as isolated patch in Bardez taluk of Goa State.

Change in Groundwater Level - November 2014 to November 2015

Water levels from 84 stations were compared to know the change in groundwater level in November 2015 as compared with November 2014 in the State of Goa. It is seen from the table that 73% of the stations monitored have recorded a fall in water level during November 2015 as compared to November 2014 and 27% have shown rise in water level. Rise in water level in the range of 0-2 m is observed in 22 wells accounting for 26% and more than 4 m is observed in 1 well accounting for 1% respectively. Fall in water level in the range of 0-2 m is recorded in 53 wells accounting for 63%, 2-4 m is recorded in 7 wells accounting for 9% and >4 m is recorded in 1 well (1%) (Table 3.10).

A map depicting the change in groundwater level in November 2015 as compared to November 2014, showing rise/fall in the ranges of <2 m, 2 to 4 m and >4 m is enclosed as **Fig-3.10**. Rise in water level in the range of 0-2 m is observed as patches in almost all taluks of Goa State. Water level rise in the range of 2-4 and >4 is noticed as isolated patch in Bicholim taluk. Fall in water level in the range of 0-2m is observed in major portion of the Goa State. Fall of 2-4 m is observed in parts of Satari, Sanguem, Salcete, Quepem and Canacona taluks.

Change in Groundwater Level: January 201 to January 2016

Water levels from 78 stations were compared to know the annual change in groundwater level in January 2016 as compared to January 2015 in the State of Goa. On the whole 22 wells accounting for 28% of the analysed wells have recorded a rise in water level during January 2016 as compared with the period January 2015. The remaining 56 wells (72%) have recorded fall in water level (Table- 3b). It is seen from the data that out of 78 stations, 19 wells have rise in water level in the range of 0-2 m accounting for 24% and rise in water level in the range of 2-4 m is recorded in 3 wells (4%) respectively. Fall in water level in the range of 0 to 2 m is recorded in

50 wells accounting for 64%. Fall in the range of 2-4 m and >4 m is observed in 3 wells (4%), and 3 wells (4%) respectively (Table 3.11).

A map showing the change in groundwater level in January 2016 as compared to January 2015, showing rise/fall in the ranges of 0 to 2 and 2 to 4m and > 4m is enclosed as Fig-3.11. Rise in water level of 0-2 m is observed as patches in almost all the taluks of Goa State. Rise in water level of 2-4 m is recorded in Bardez, Satari and Bicholim taluks. Major part of the state shows fall in water level in the range of 0-2 m. Fall in water levels in the range of 2-4 m is recorded in Bardez, Satari, Quepem and Canacona taluks and more than 4 m fall is noticed in Canacona taluk.

Change in Groundwater Level : Mean (May 2005 to May 2014) – May 2015

Mean groundwater level for the period May 2005 to May 2014 was compared with the groundwater level in May 2015 in the State of Goa. It is seen that out of the 40 stations compared, 22 stations accounting for 55% of analyzed wells have shown a rise in water level and 18 wells accounting for 45% of analyzed wells have shown a fall in water level.

In the rise category, 21 wells accounting for 53% of the analyzed wells are in the range of 0 to 2 m and 1 well accounting for 2% are in the range of 2-4 m respectively. In the fall category, 18 wells accounting for 45% of the wells have recorded a range of 0 to 2m water level fluctuation during May 2015 as compared to proceeding decadal mean (Table 3.12).

A map showing the change in groundwater level in January 2016 as compared to January 2015, showing rise/fall in the ranges of 0 to 2 and 2 to 4m and > 4m is enclosed as Fig-3.12. Rise in water level of 0-2 m is observed as patches in almost all taluks of Goa State. Rise in water level of 2-4 m is recorded in Bardez, Satari and Bicholim taluks. Major part of the state shows fall in water level in the range of 0-2 m. Fall in water levels in the range of 2-4 m is recorded in Bardez, Satari, Quepem and Canacona taluks and more than 4 m fall is noticed in Canacona taluk.

Change in Groundwater Level : August 2014 to August 2015

Mean groundwater level for the period August 2005 to August 2014 was compared with the groundwater level in August 2015 in the State of Goa. It is seen that out of the 38 stations compared, 10 stations have shown a rise in water level accounting for 26% of analyzed wells and 28 wells accounting for 74% of analyzed wells have shown a fall in water level.

In the rise category, 9 wells accounting for 23.7% of the analyzed wells are in the range of 0 to 2 m and 1 well accounting for 2.6% are in the range of 2-4 m respectively. In the fall category, 27 wells accounting for 71.1% of the wells have recorded a range of 0 to 2m water level and 1 well accounting for 2.6% of the wells have recorded a range of 2 to 4m fluctuation during August 2015 as compared to preceding decadal mean (Table 3.13).

A map showing the change in water levels, with rise/fall in the ranges of 0-2 m, 2-4 m and >4m is enclosed as Fig. 3. Rise in water levels of 0-2 m is observed in almost all parts of Goa State except Bardez taluk. Rise in water levels of 2-4 m is observed as isolated patches in Bicholim and Tiswadi taluks of Goa State. Fall in water level of 0-2 m is observed dominating in all taluks of Goa State.

Change in Water Level : Mean (November 2005 to November 2014) – November 2015

Mean groundwater level for the period November 2005 to November 2014 was compared with the groundwater level in November 2015 in the State of Goa. It is seen that out of the 37 stations compared, 13 stations accounting for 35% of analyzed wells have shown a rise in water level. The remaining 24 wells accounting for 65% had shown a fall in water level (Table 3.14).

Rise of water level in the range 0-2 m is observed in 13 wells accounting for 35% of the analysed wells. Fall in water level of 0-2 m is noticed in 23 wells accounting for 62% of the analysed wells and 2-4 m is observed in 1 well accounting for 3% respectively.

A map showing the change in water levels in November 2015 with that of preceding decadal mean water level, with rise/fall in the ranges of 0-2 m, 2-4m and >4m is enclosed as Fig-3.14. Rise in water levels of 0-2 m is observed almost all taluks of Goa State. Fall in water level in the range of 0-2 m is observed in major portion of the Goa State. Fall in water level of >2 m is observed in Canacona taluk.

Change in Groundwater Level: Mean (Jan 2006 to Jan 2015) – Jan 2016

Mean groundwater level for the period January 2006 to January 2015 (decadal mean water level) was compared with the groundwater level in January 2016 in the State of Goa. It is seen that out of the 39 stations compared, 12 wells accounting for 31% of analysed wells have shown a rise in the range of 0 to 2 m and 2-4m water level rise is observed in 1 stations (3%) respectively. 23 wells accounting for 59% showed a fall in water level of 0 to 2 m, 2 wells (5%) shows fall of 2-4 m and 1 well (2%) has recorded during January 2016 as compared to preceding decadal mean (Table- 3.15).

A map showing the change in water levels, with rise/fall in the ranges of 0-2 m and 2-4 m and >4m is enclosed as Fig-3.15. Rise in water level in the range of >2 m is observed as patches in almost all taluks except Mormugao and Quepem taluks of Goa State. Rise in the range of 2-4 m is observed in Bardez taluk of Goa State. Major part of the State showing fall in water level in the range of 0 to 2 m. Fall in water level of 2-4 m is observed in Bardez, Quepem and Canacona taluks and more than 4 m fall is recorded in Quepem and Canacona taluks.

3.3 Depth to Water Level : Piezometers

CGWB has a network of 49 piezometers drilled in Goa State under Hydrology Project II. These piezometers are also monitored for manual water level along with the dug well four times in a year. The water level data of these piezometers during the water year 2015-16 is given in Annexure -V. However, the piezometers water levels are not incorporated in the preparation of water level and fluctuation maps discussed below.

4. HYDROCHEMISTRY

Water samples from the NHS are collected once a year during the month of May. The assessment of chemical quality of ground water samples from Ground Water Monitoring Stations (GWMS) of Goa State for the year 2015 is presented in the following sections.

The water samples from 65 monitoring stations of shallow aquifers from 2 districts were collected during the month of May 2015. These samples were analysed in the Regional Chemical Laboratory for 15 parameters (EC, pH, major cations (Ca, Mg, Na K), major anions (Cl, HCO_3, SO_4) and also Nitrate, Fluoride, Phosphate and Boron by employing Standard methods. Based on the hydrochemical data, the potability of these samples has been assessed as per the standards prescribed by the Bureau of Indian Standards and classified into 'Desirable', 'Permissible' and 'Unsuitable' classes. The details of chemical analysis are presented in Annexure - VI.

4.1 Distribution of pH

The hydrogen ion concentration (pH) of water is a measure of its acidity or alkalinity. A neutral pH, neither acid nor alkaline, is 7.0; waters with pH below 7 are acidic and above 7 are alkaline. The pH values in Goa State vary from 7.0 to 8.2 which indicate neutral to alkaline nature of ground water.

4.2 Distribution of Electrical Conductivity

The electrical conductivity (EC) of a solution is a measure of its ability to carry an electric current, the more dissolved ionic solutes in water, greater is its electrical conductivity. BIS has recommended a drinking water standard for total dissolved solids a limit of 500 mg/L (corresponding to about EC of 750 µS/cm at 25°C) that can be extended to a TDS of 2000 mg/L (corresponding to about 3000 µS/cm at 25°C) in case of no alternate source. Waters having TDS more than 2000 mg/L are not suitable for drinking purpose.

Perusal of the data indicates that the distribution of electrical conductivity in the state shows wide variations (50–1990 µS/cm at 25˚C). The maximum value for the parameter was recorded in the samples collected from Pumburpa-palmar of North Goa district.

About 98% of the samples collected are showing EC values generally below 600 μS/cm at 25˚ C station, rendering the samples suitable for drinking. Distribution of Electrical Conductivity during may 2015 in Goa state is presented in Fig. 4.1.

4.3 Distribution of Chloride

It is the most common constituent in natural waters. Physiologically of little concern at lower concentration, but, at higher levels it may be injurious to people suffering from diseases of heart and kidneys. The 'desirable' and 'permissible' limits are 250 mg/L and 1000 mg/L, respectively. The data indicated that all of the samples are in the 'desirable' limits for drinking water except the sample collected at Pumburpa-palmar of North Goa district. Distribution of Chloride during may 2015 in Goa state is presented in Fig. 4.2.

4.4 Distribution of Nitrate

Nitrate is one such anthropogenic pollutant contributed by nitrogen fertilizer, human and animal waste through biochemical activities of nitrifying bacteria. Excessive concentration of nitrate in drinking water may cause methemoglobinemia in small children. The BIS has recommended 45 mg/L as the 'permissible' limit of nitrate.

The occurrence of Nitrate in ground waters of Goa State shows variation from 0.2 mg/L to 40 mg/L. All the samples collected over the state showing Nitrate values below 45 mg/L rendering the samples suitable for drinking. Distribution of Nitrate during may 2015 in Goa state is presented in Fig. 4.3.

4.5 Distribution of Fluoride

Flouride is found in all natural water at some concentration. Fluoride is an essential element at low levels and harmful at higher levels. In ground water however, low or high concentration of fluoride can occur depending on the nature of rocks and the occurrence of fluoride bearing minerals.

As per BIS Drinking water standards (IS 10500:2012) 'desirable' limit of Fluoride is 1.0 mg/L in drinking water, which can be extended to 1.5 mg/L (In case of no alternative source of water is available). Water with fluoride concentration more than 1.5 mg/L is not suitable for drinking purpose.

The occurrence of fluoride in ground water in the State varies from 0.02 mg/L to 0.61 mg/L. All the samples are in well within 'desirable' limit as per the drinking water standards.

4.6 Distribution of Calcium

It is a constituent in natural waters resulting from the dissolution of limestone, dolomite and gypsum. It is essential for nervous and muscular system and coagulation of blood. High concentration leads to kidney stones and irritation in urinary passage. The 'desirable' and 'permissible' limits are 75 mg/L and 200 mg/L, respectively.

The occurrence of Calcium in ground waters of Goa State shows variation from 2 mg/L to 92 mg/L. All the samples are in well within the limit.

The analysis is carried out for Phospahte, and Boron in Ground water sample and found to revealed that are also within the permissible limits.

5. CONCLUSIONS

The present report includes results of a study on the behavior of the Ground Water Regime in the State of Goa through a network 103 National Groundwater monitoring Stations tapping the phreatic aquifer.

Out of the 103 stations, 35% of the stations fall in the Mandovi basin, 24% fall in the Zuari basin, 16% fall in the Sal basin, and the remaining 25% fall in the West flowing minor river basins. Quartz Chlorite Biotite occupies the largest area in the state and 52% of stations fall in these areas. This is followed by Metabasalt rocks and Granite gneiss, in which 12% and 11% respectively of the monitoring stations are located. The remaining 25% of the stations are in Greywacke, Carbonate, quartz-chlorite and recent alluvium.

The data of depth to water levels shows that during the pre-monsoon period of 2015 about 87% of the analysed wells have water levels within 10 mbgl. Moderately deep water levels of 10 to 20 mbgl are seen in about 13% wells. No well shows deeper water levels of >20mbgl. The depth to water level during August 2015 ranged from 0.5 mbgl to 16.85 mbgl, about 36.5% of analysed wells have less than 2 mbgl water levels, 39.6% wells have 2 to 5 mbgl water level, 18.8% wells have 5 to 10 mbgl water level and the remaining 5.2% wells have 10 to 20 mbgl water level. During post-monsoon period of 2015, about 90% of the analysed wells have water levels within 10 mbgl. Moderately deep water levels of 10 to 20 mbgl are seen in 10% wells. The depth to water level during January 2015 ranged from1.14 mbgl to 19.15 mbgl, about 11 % analysed wells have less than 2 mbgl water levels, 48 % wells have 2 to 5 mbgl water levels, 31 % wells have 5 to 10 mbgl water level and the remaining 10 % wells have 10 to 20mbgl water level.

The chemical quality of ground water collected from 65 water level monitoring stations representing the shallow aquifers during May 2015 indicate, the quality of all the samples are good and suitable for domestic, irrigation and industrial purpose except the sample at Pumburpa-palmar of North Goa district.

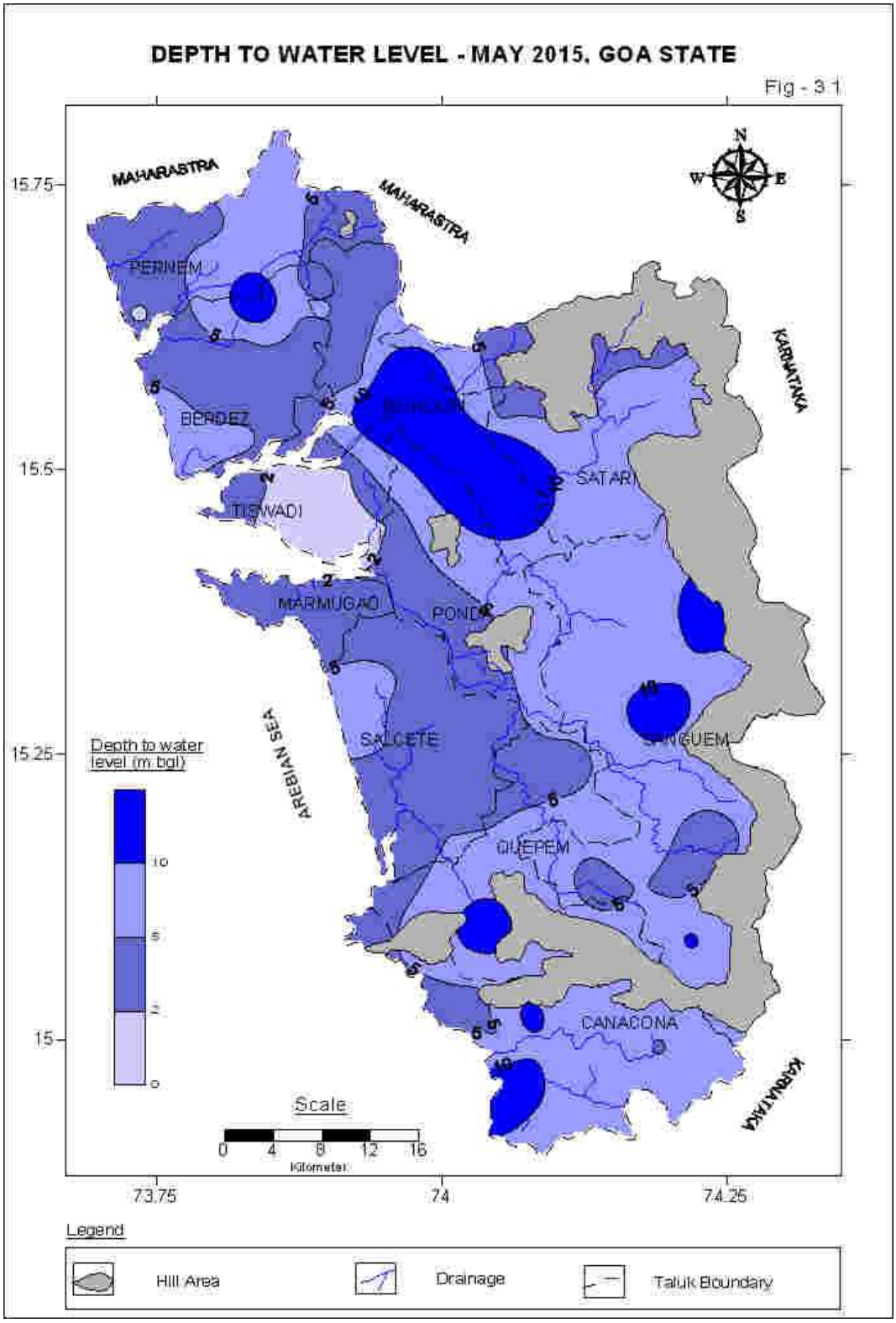

Fig 3.1: Depth to water level (May-2015)

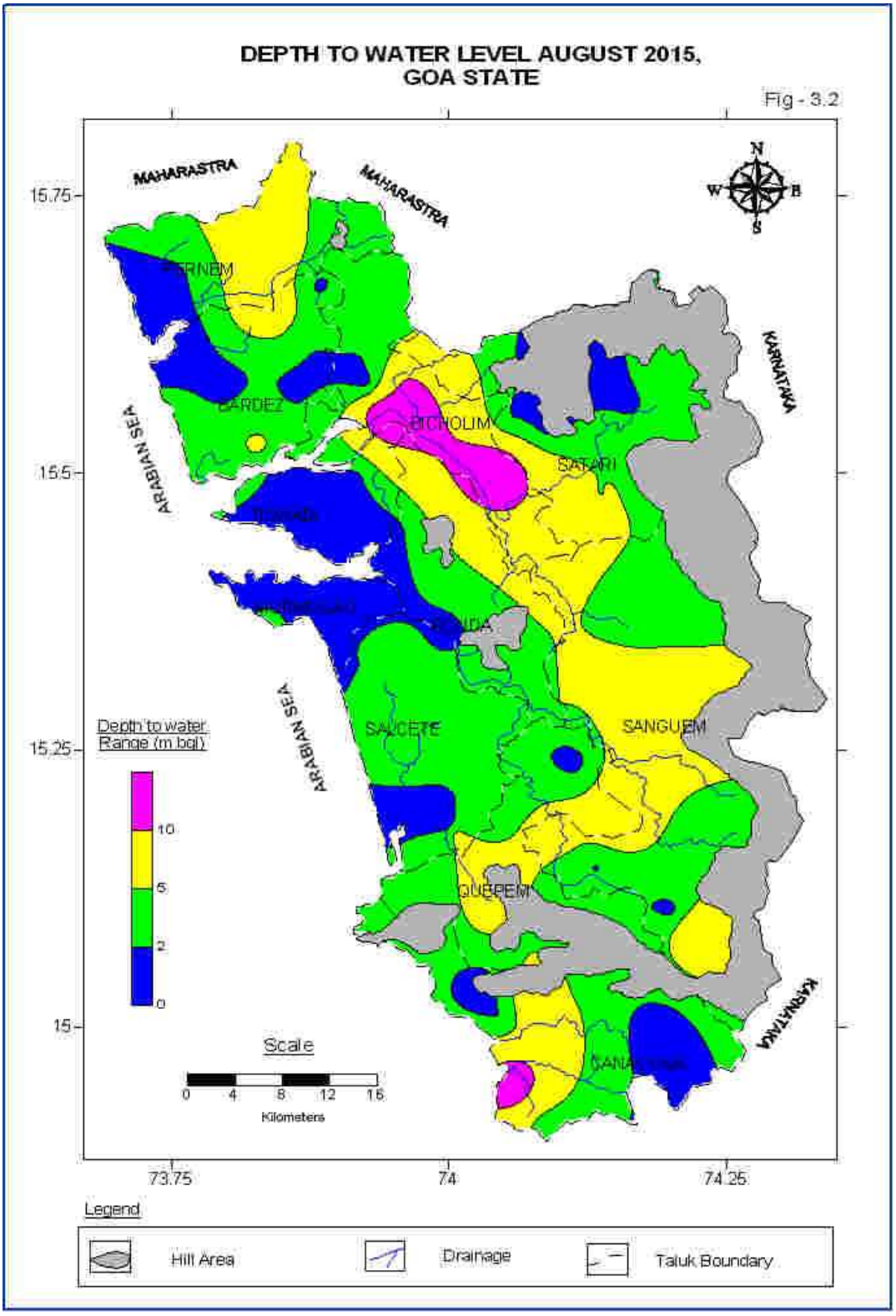

Fig 3.2: Depth to water level (August-2015)

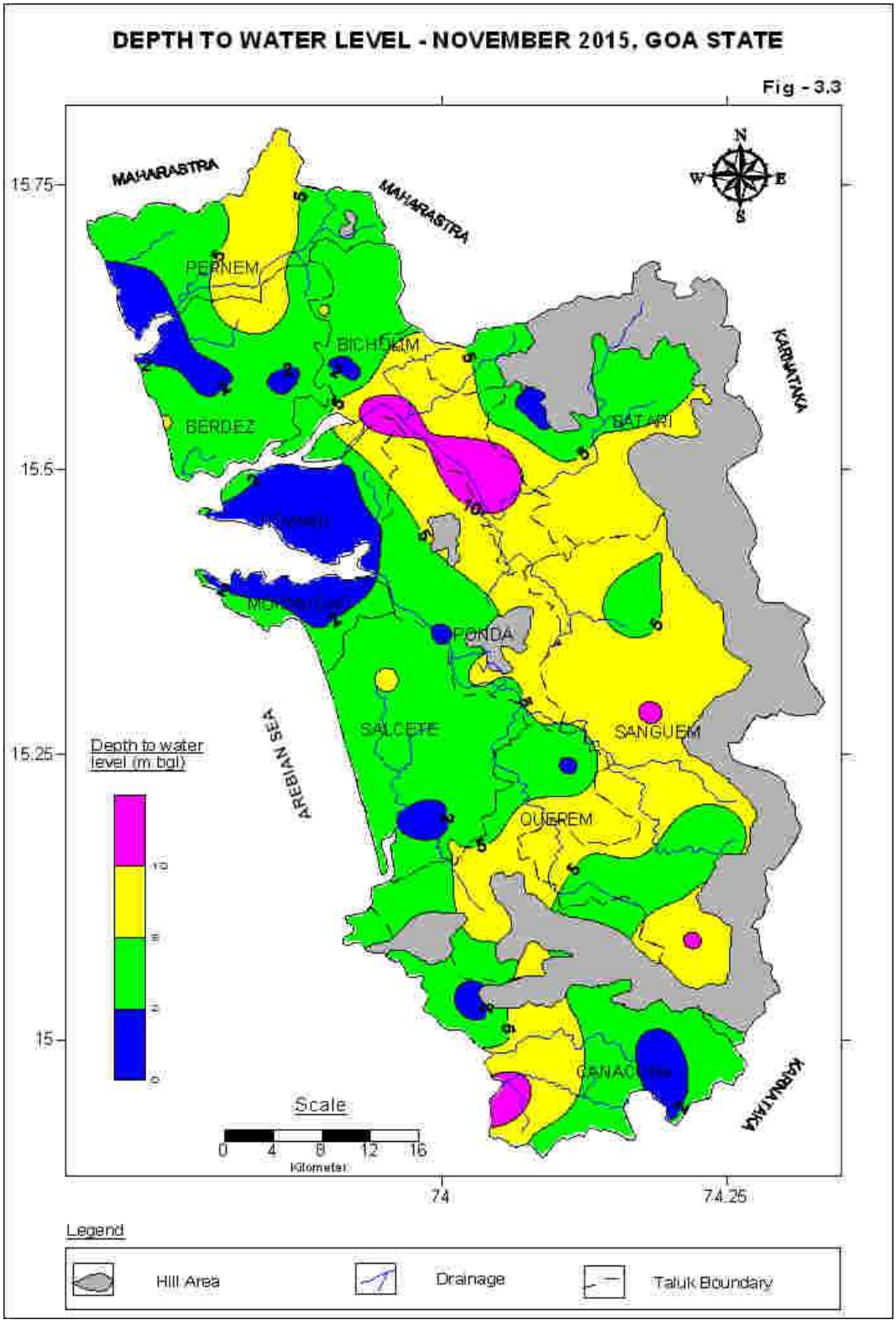

Fig 3.3: Depth to water level (November-2015)

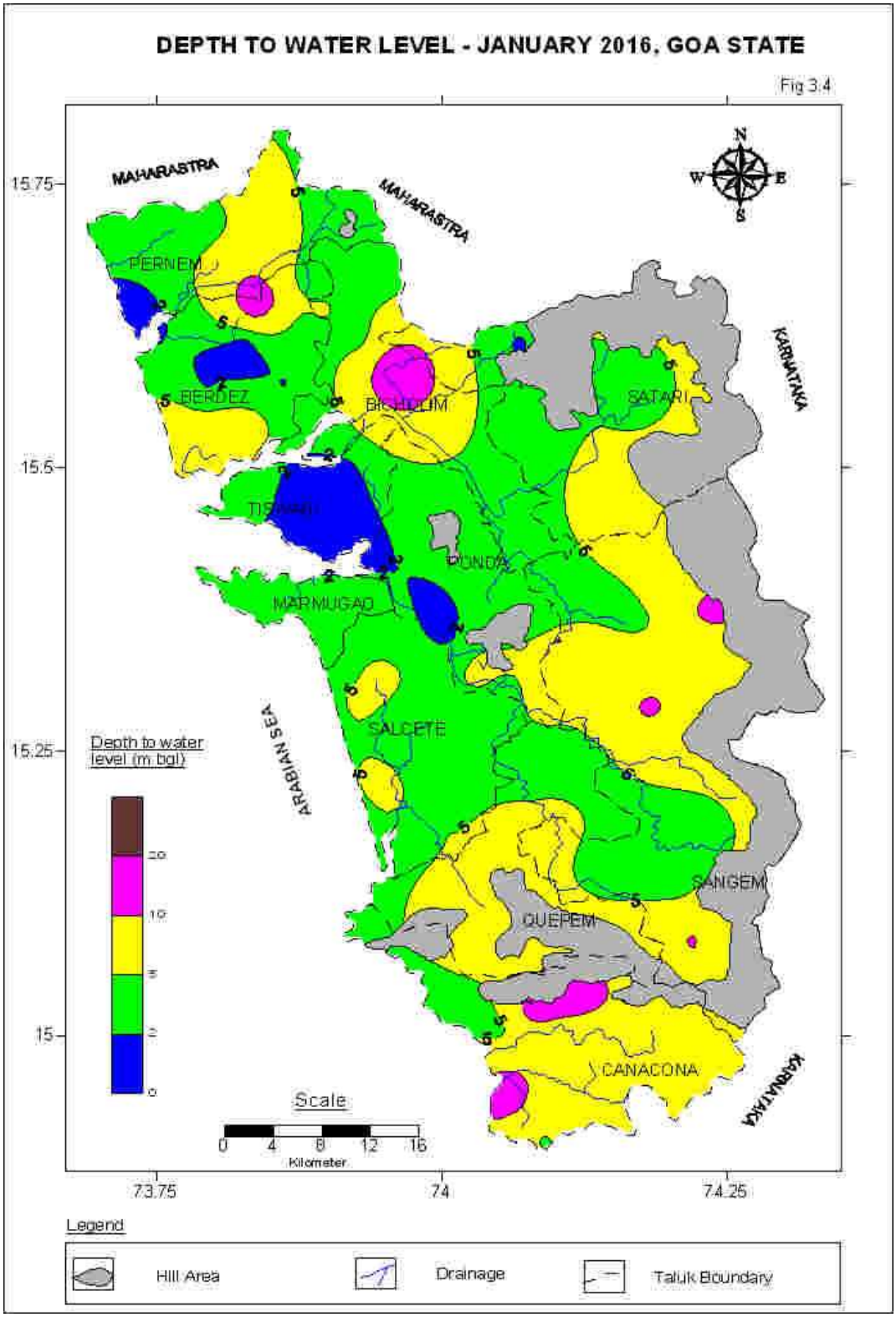

Fig 3.4: Depth to water level (January-2016)

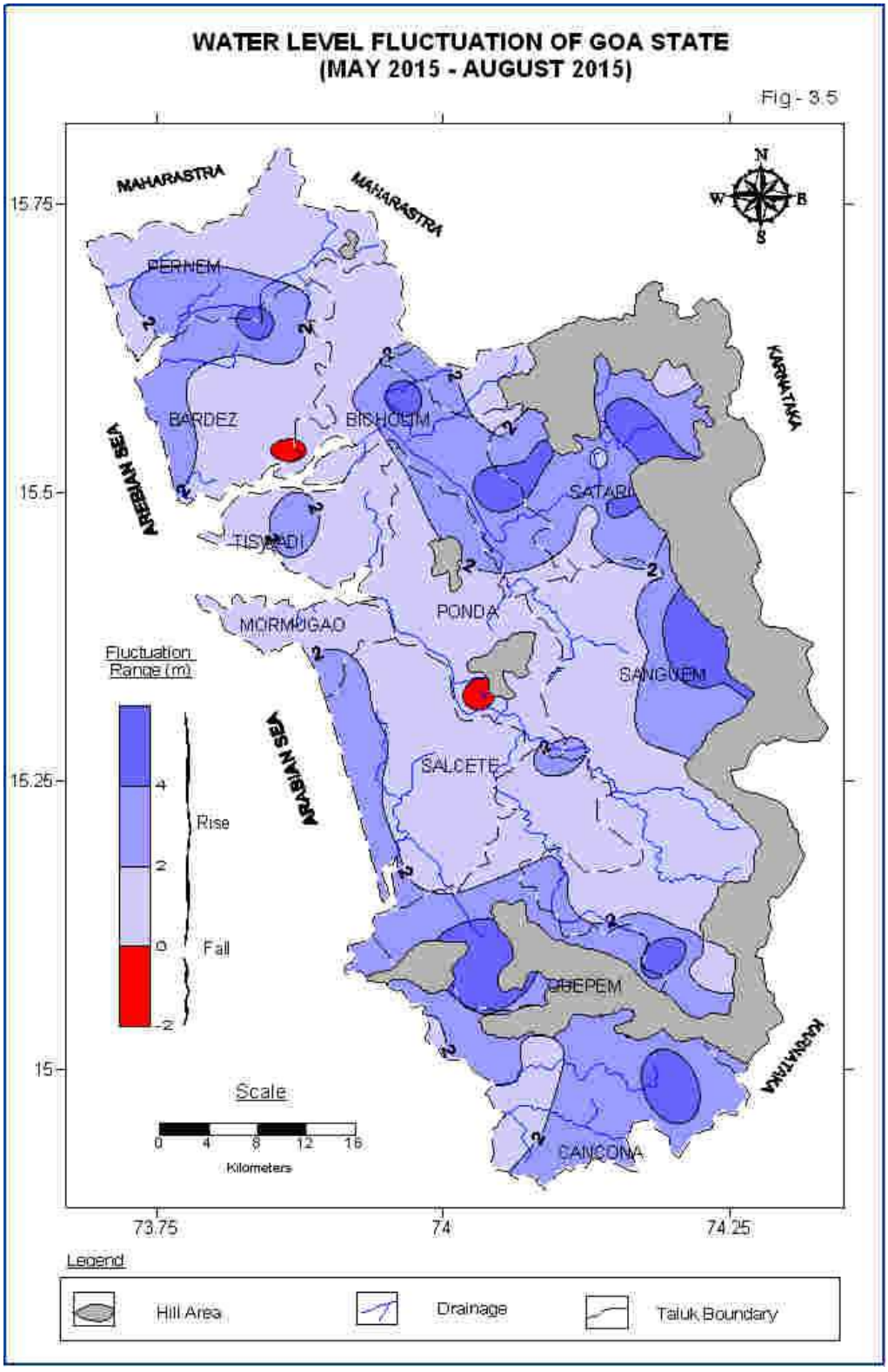

Fig 3.5: Water level Fluctuation (May 2015 – August 2015)

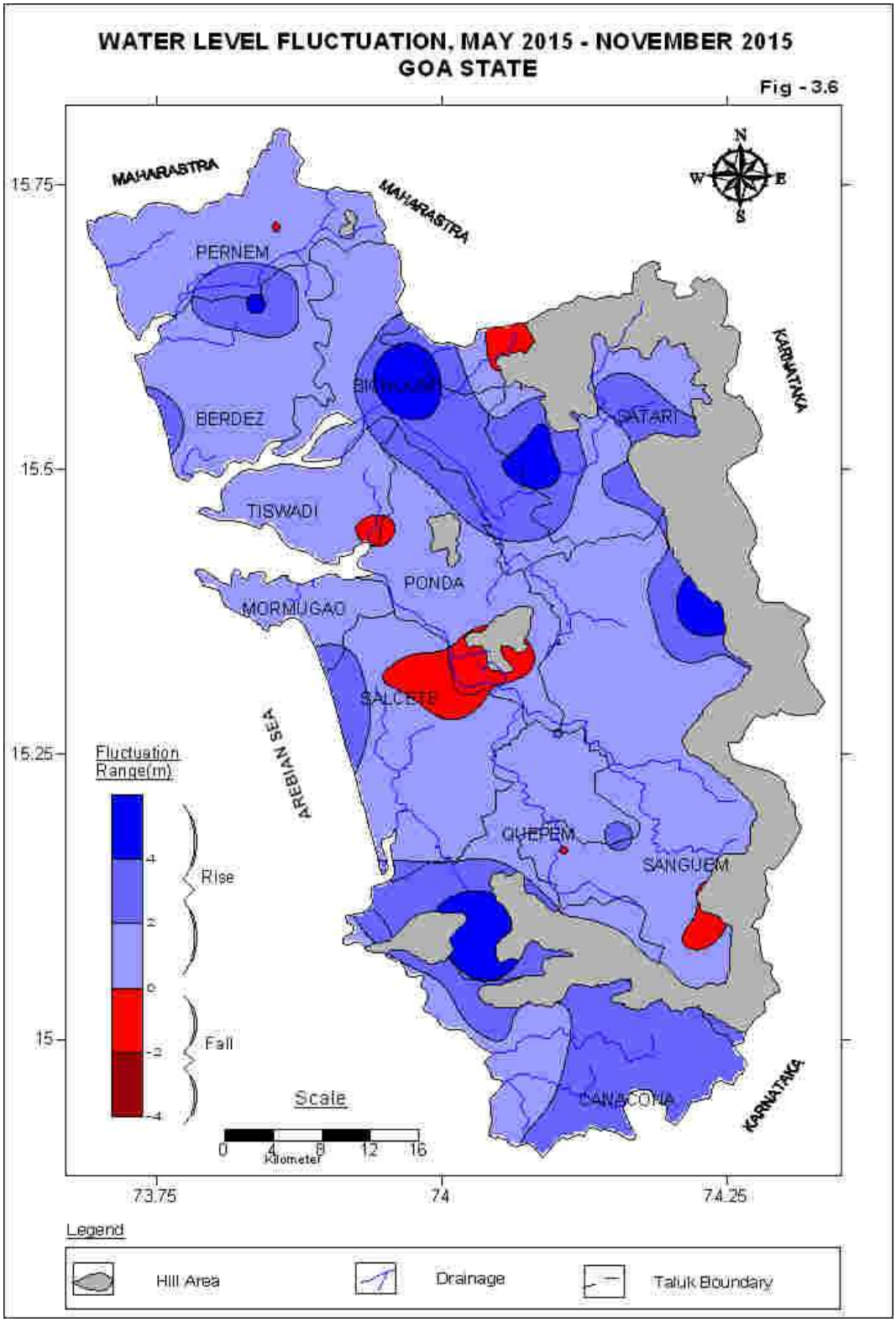

Fig 3.6: Water level Fluctuation (May 2015 – November 2015)

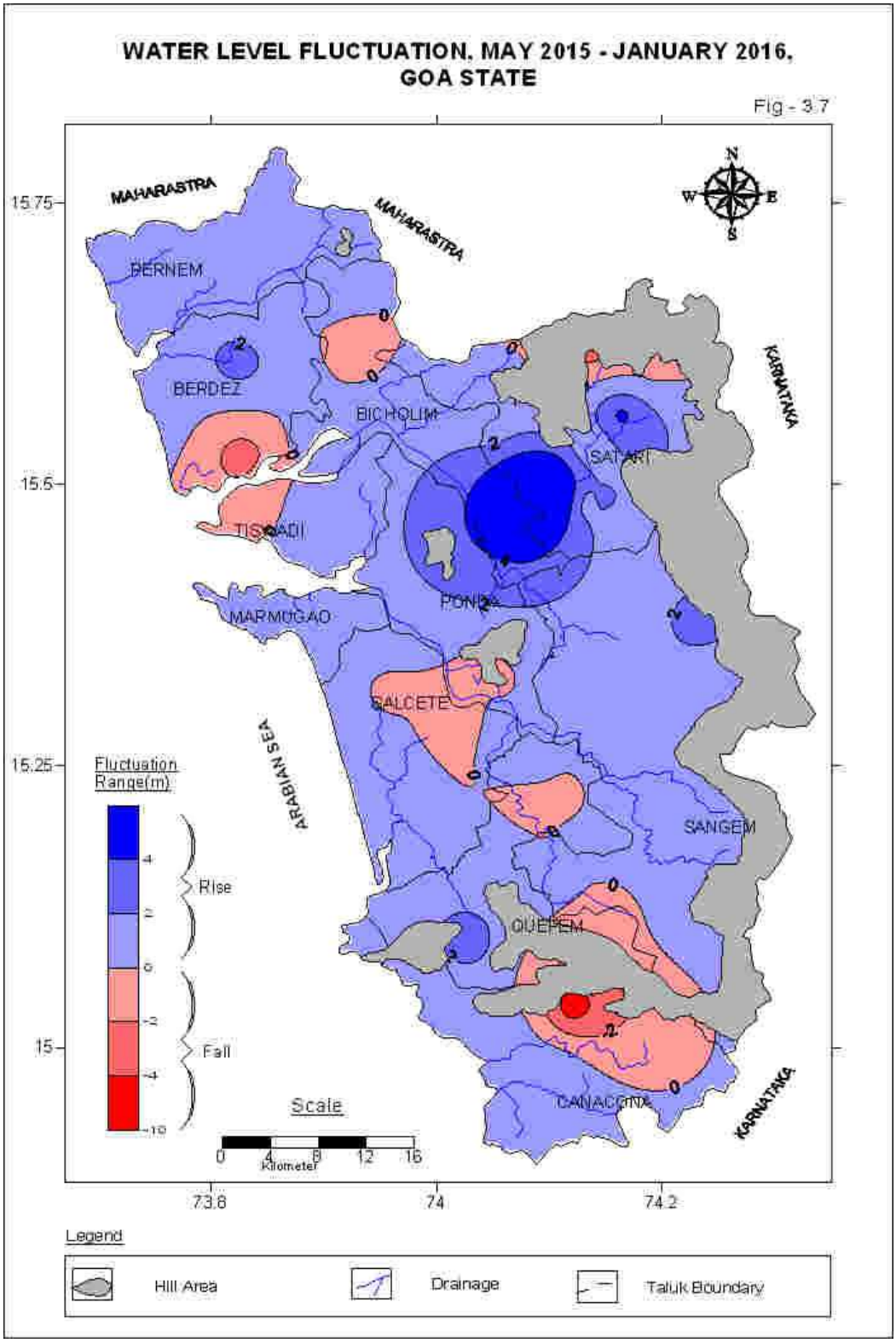

Fig 3.7: Water level Fluctuation (May 2015 – January 2016)

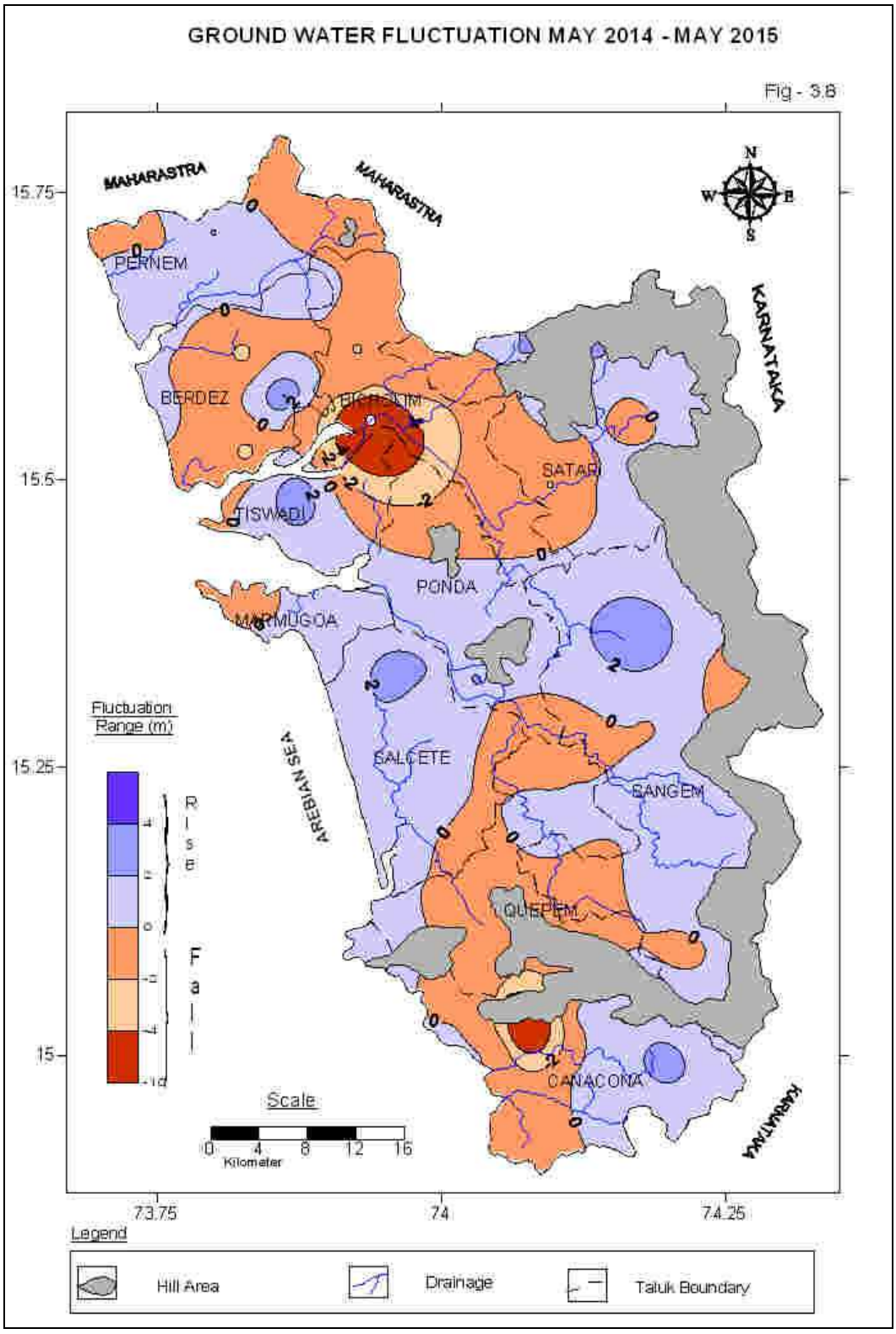

Fig 3.8: Water level Fluctuation (May 2015 – May 2016)

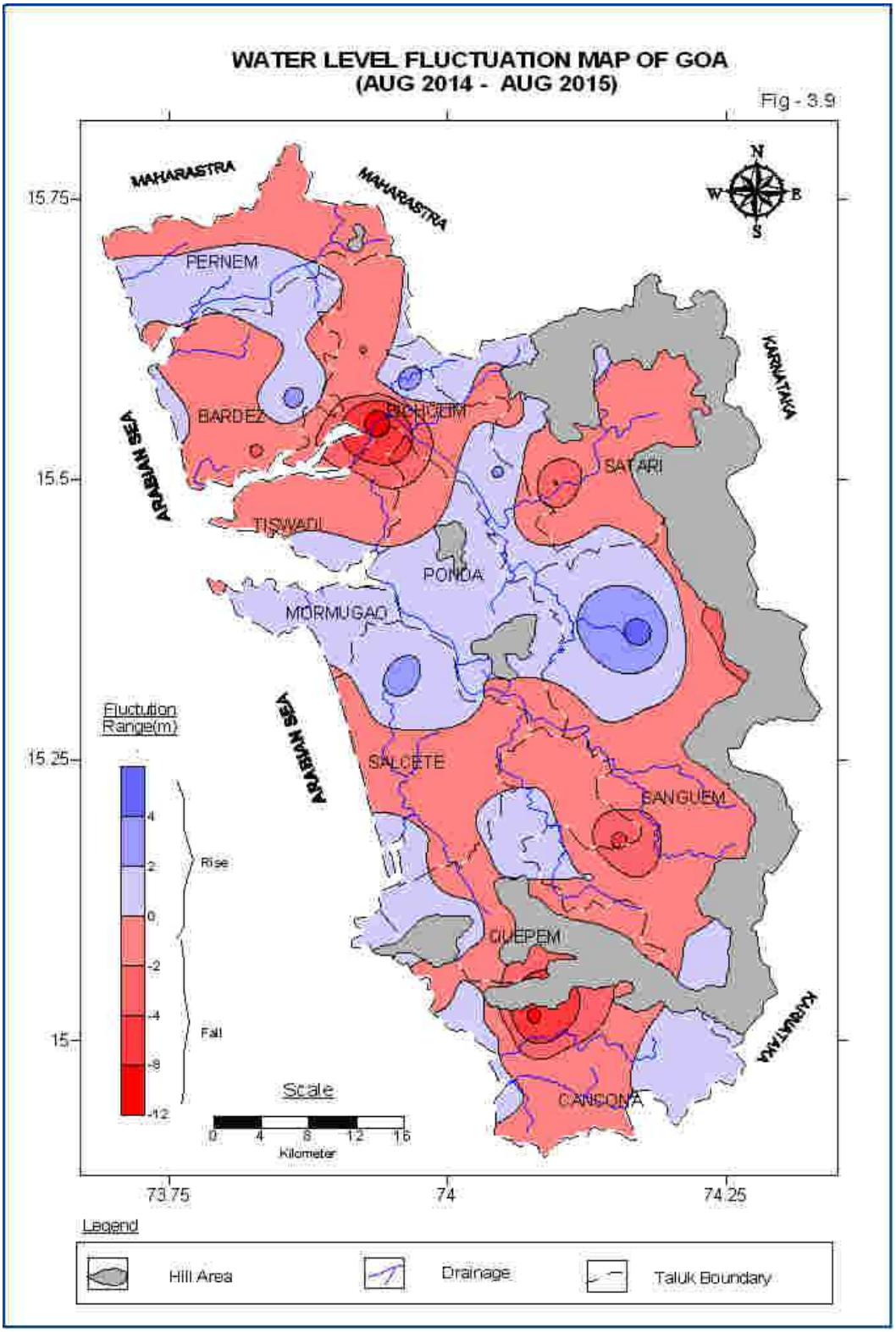

Fig 3.9: Water level Fluctuation (August 2014 – August 2015)

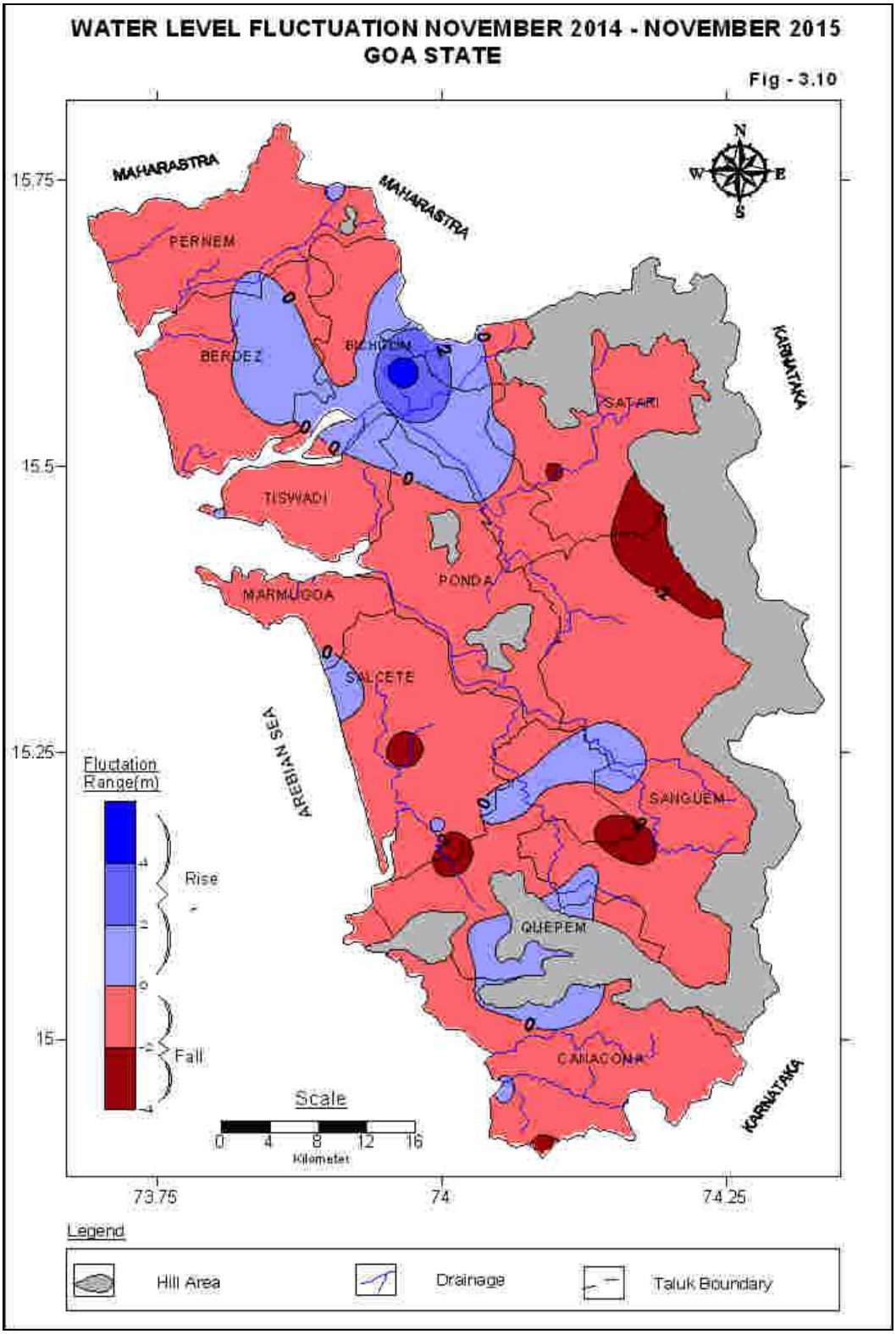

Fig 3.10: Water level Fluctuation (November 2014 – November 2015)

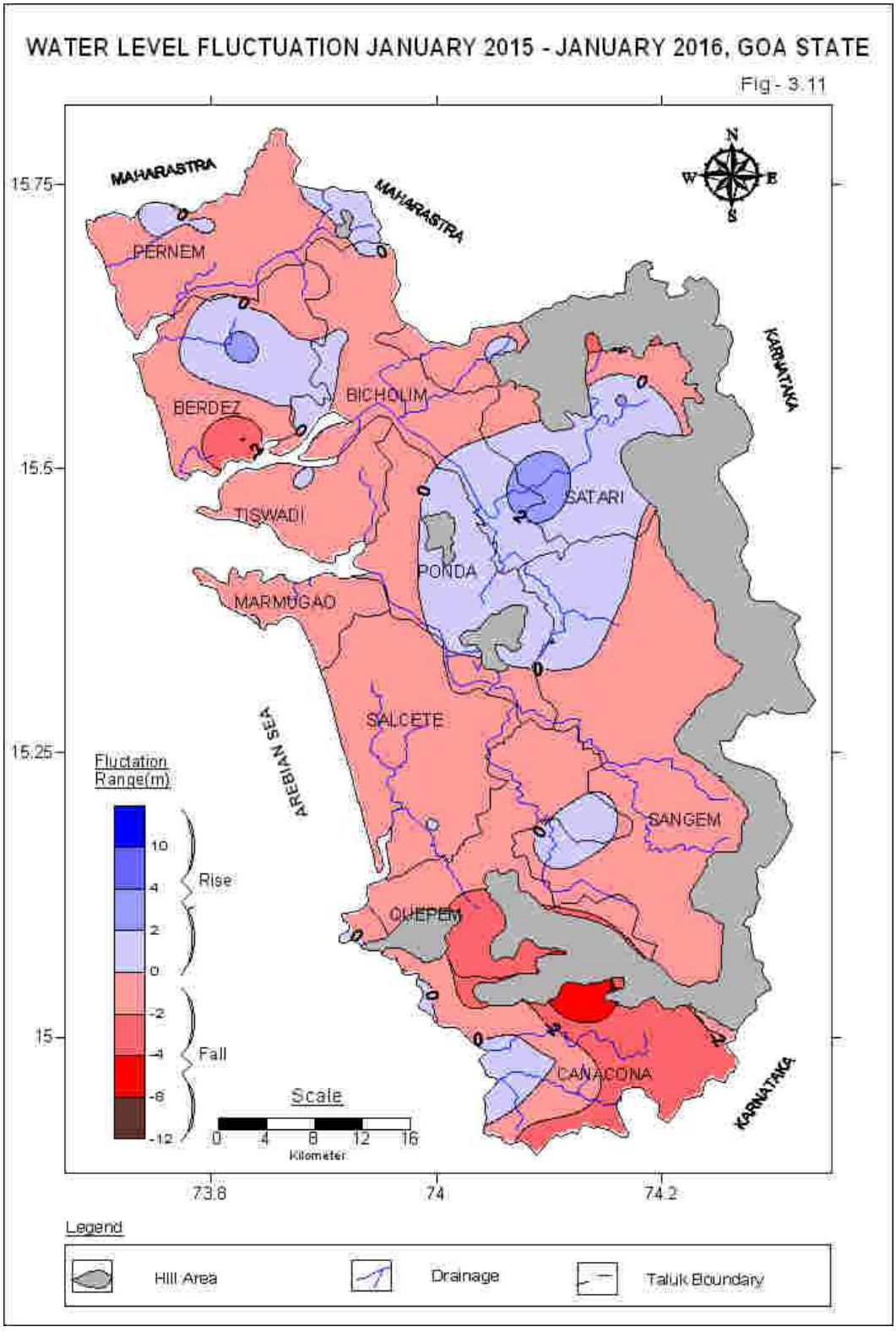

Fig 3.11: Water level Fluctuation (January 2015 – January 2016)

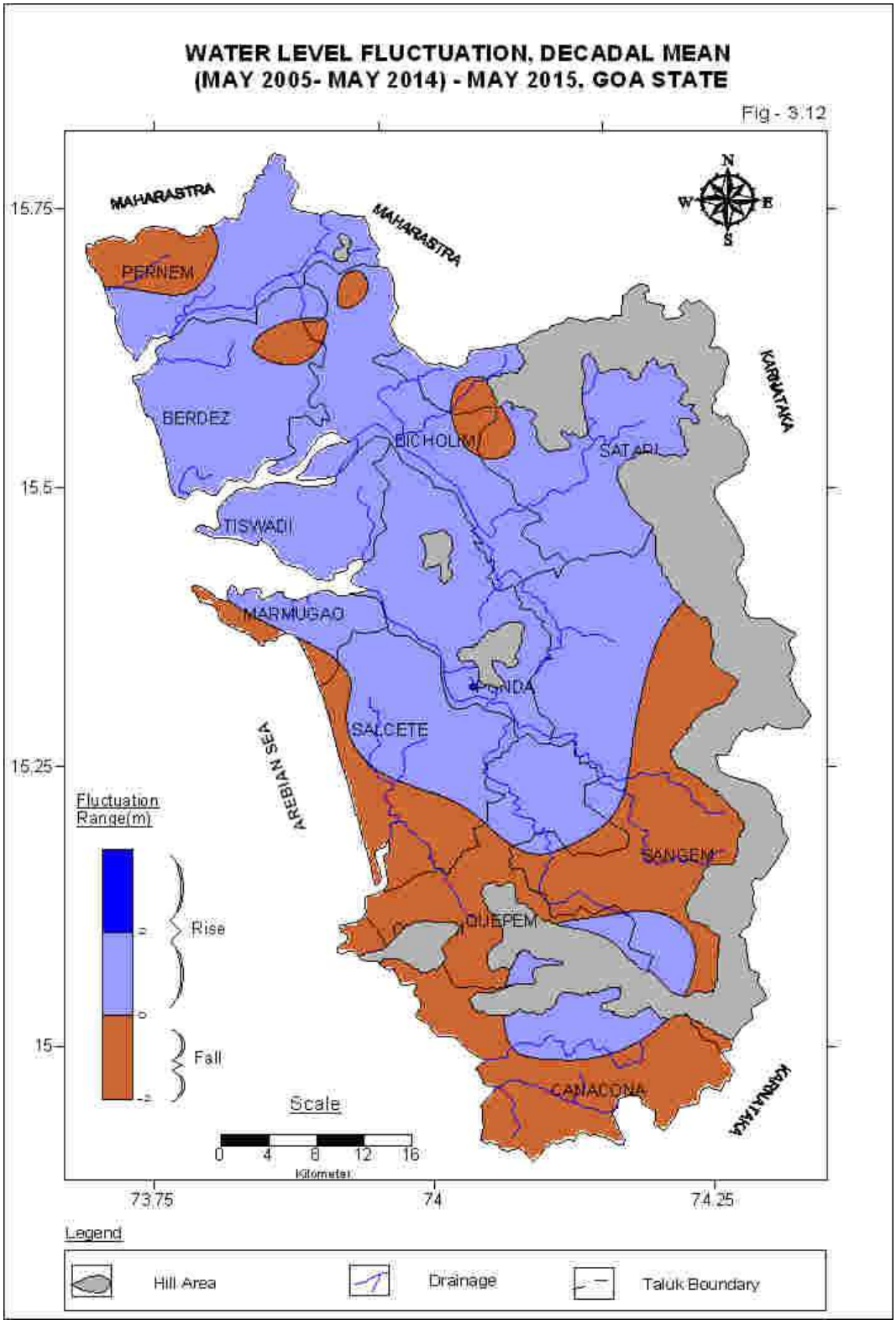

Fig 3.12: Water level Fluctuation, Decadal mean (May 2005 – May 2014) – May 2015

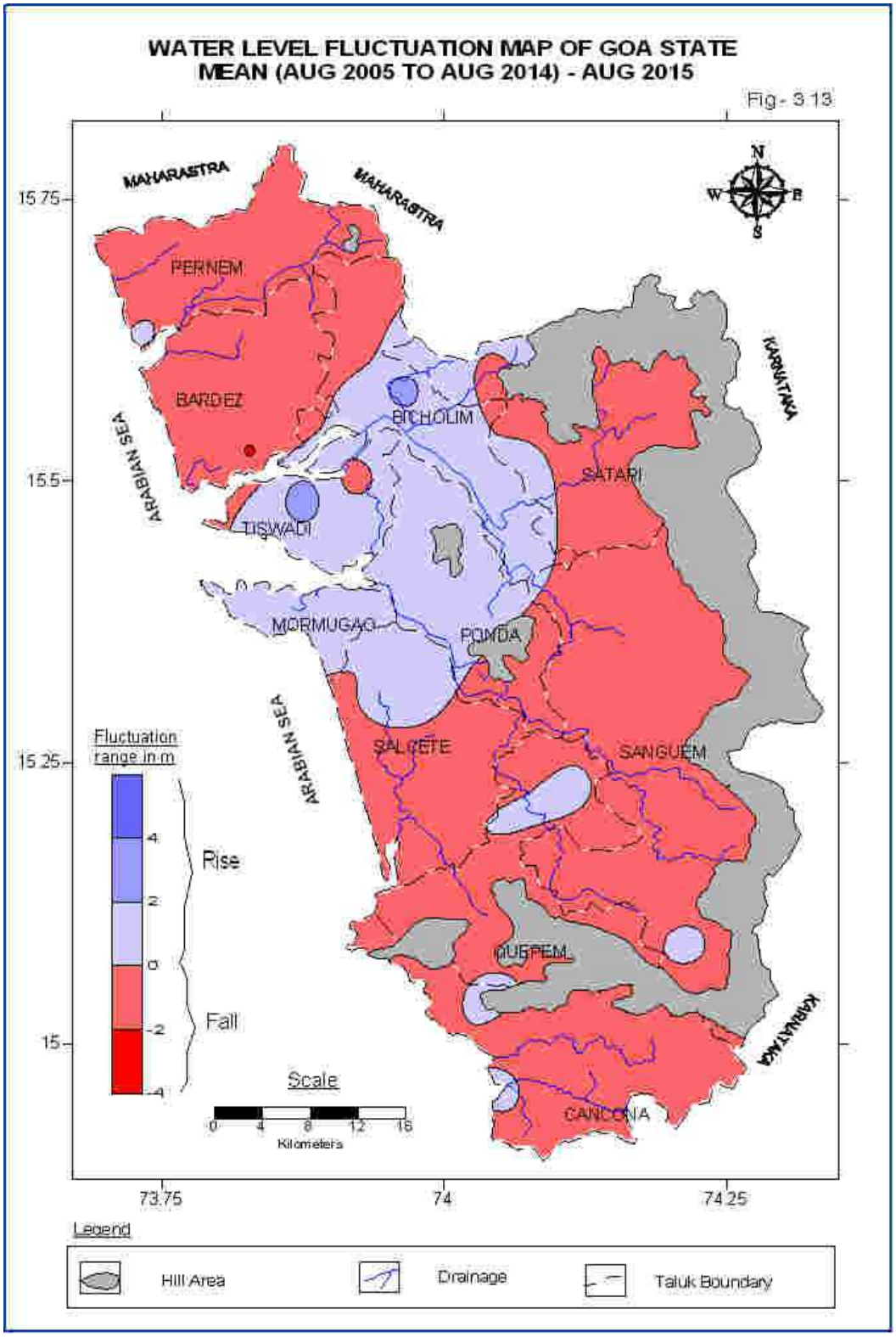

Fig 3.13: Water level Fluctuation, Decadal mean (August 2005 – August 2014) – August 2015

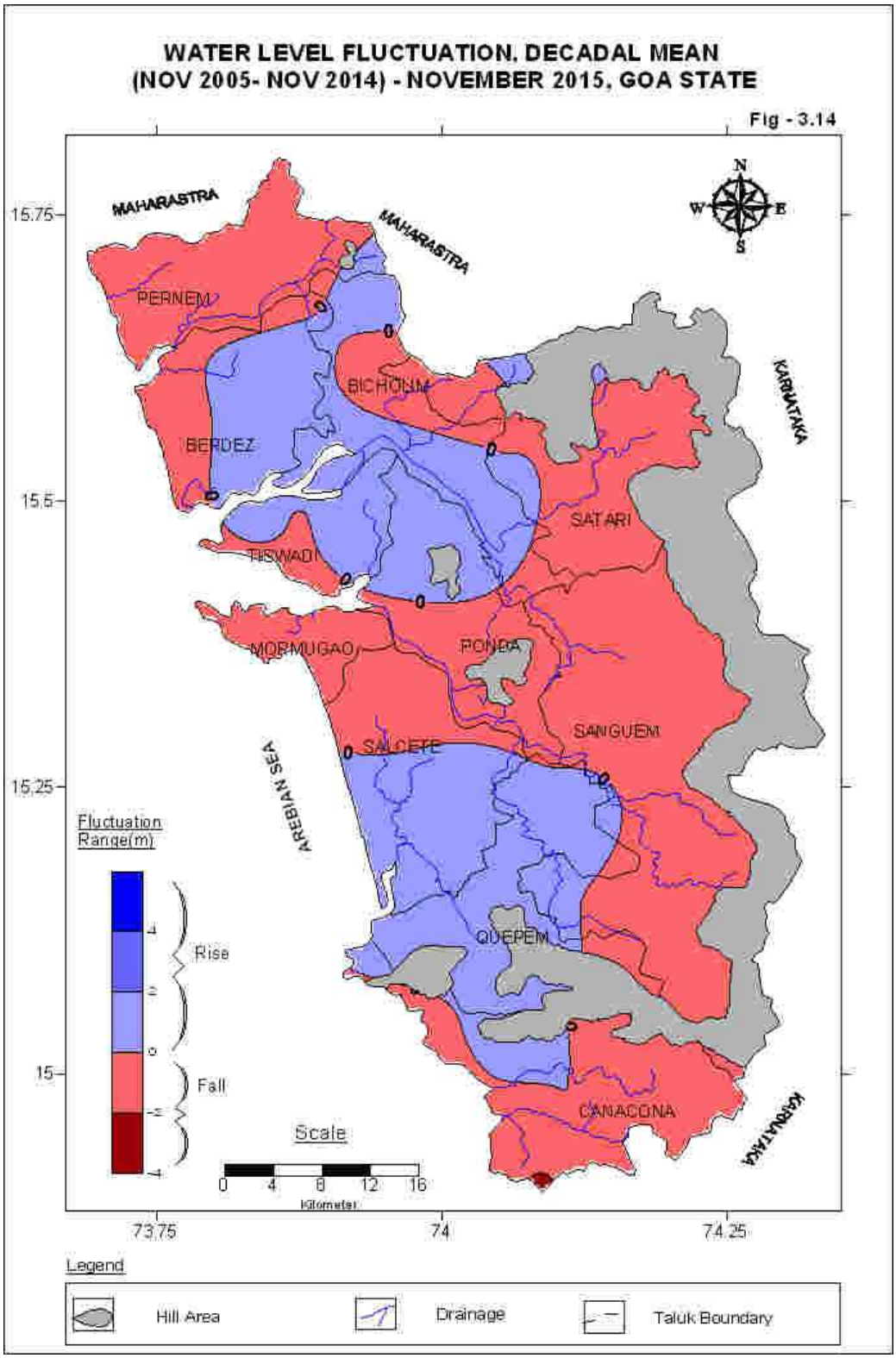

Fig 3.14: Water level Fluctuation, Decadal mean (November 2005 – November 2014) – November 2015

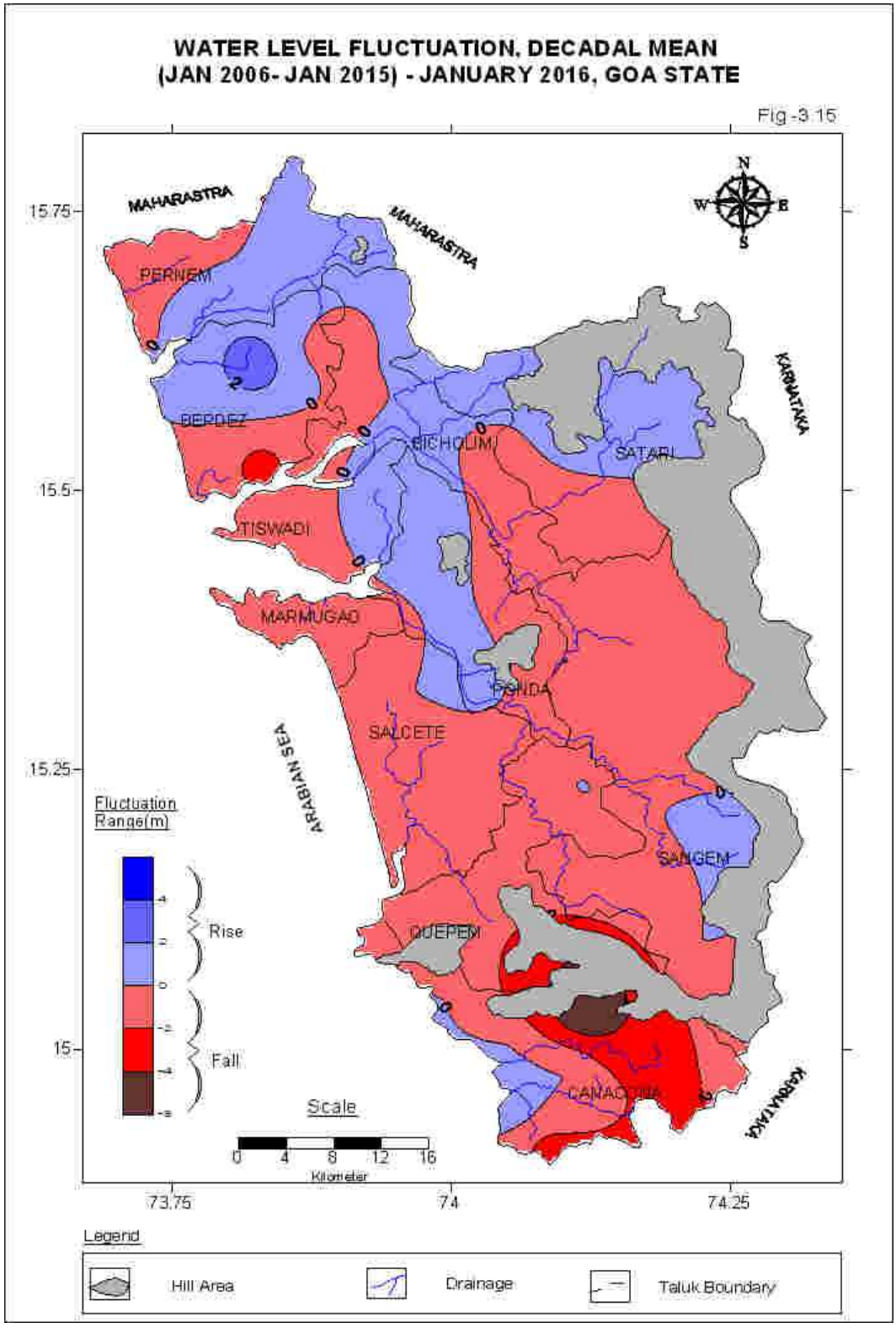

Fig 3.15: Water level Fluctuation, Decadal mean (January 2006 – January 2015) – January 2016

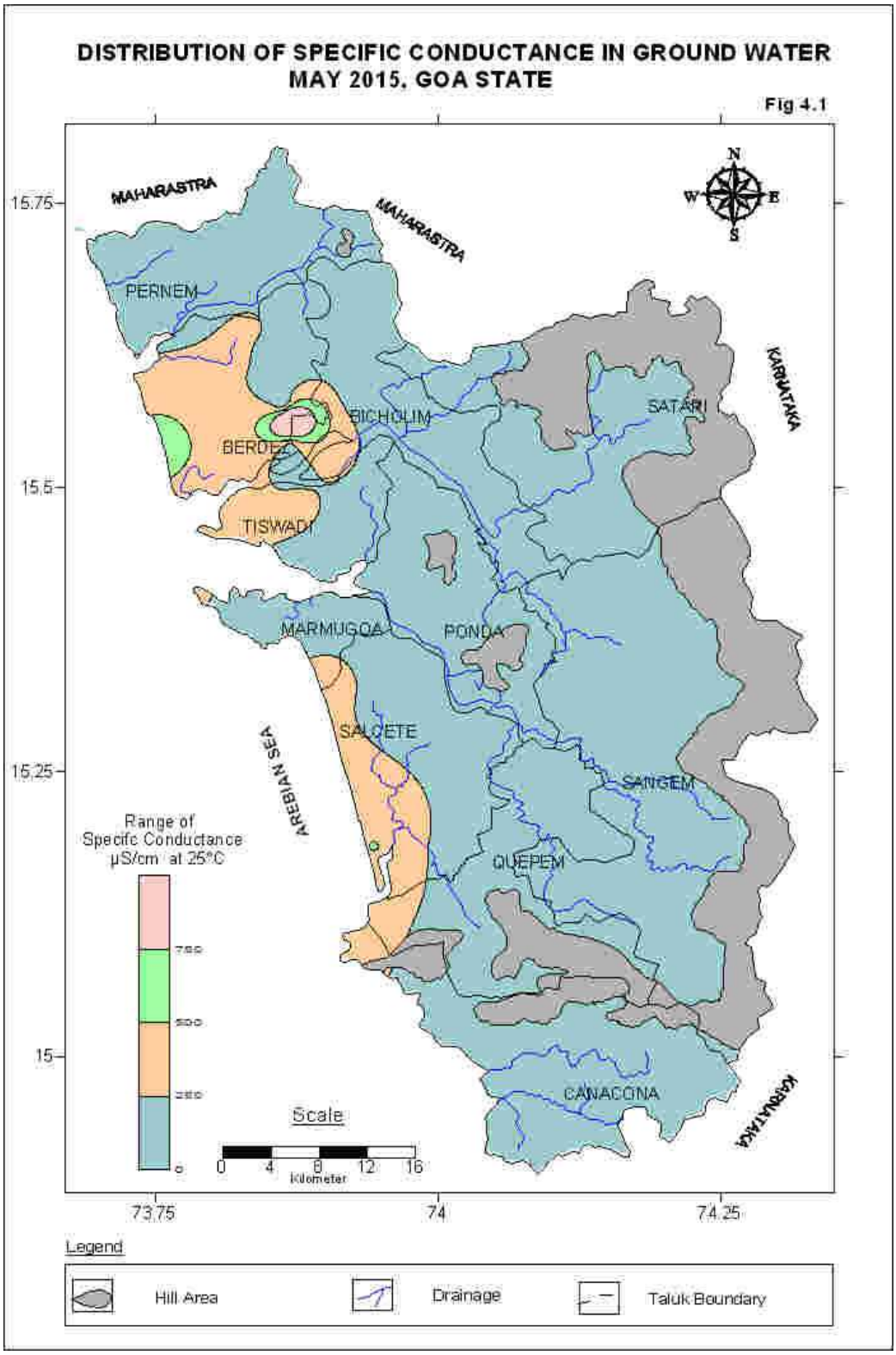

Fig 4.1: Distribution of Electrical Conductance (May 2015)

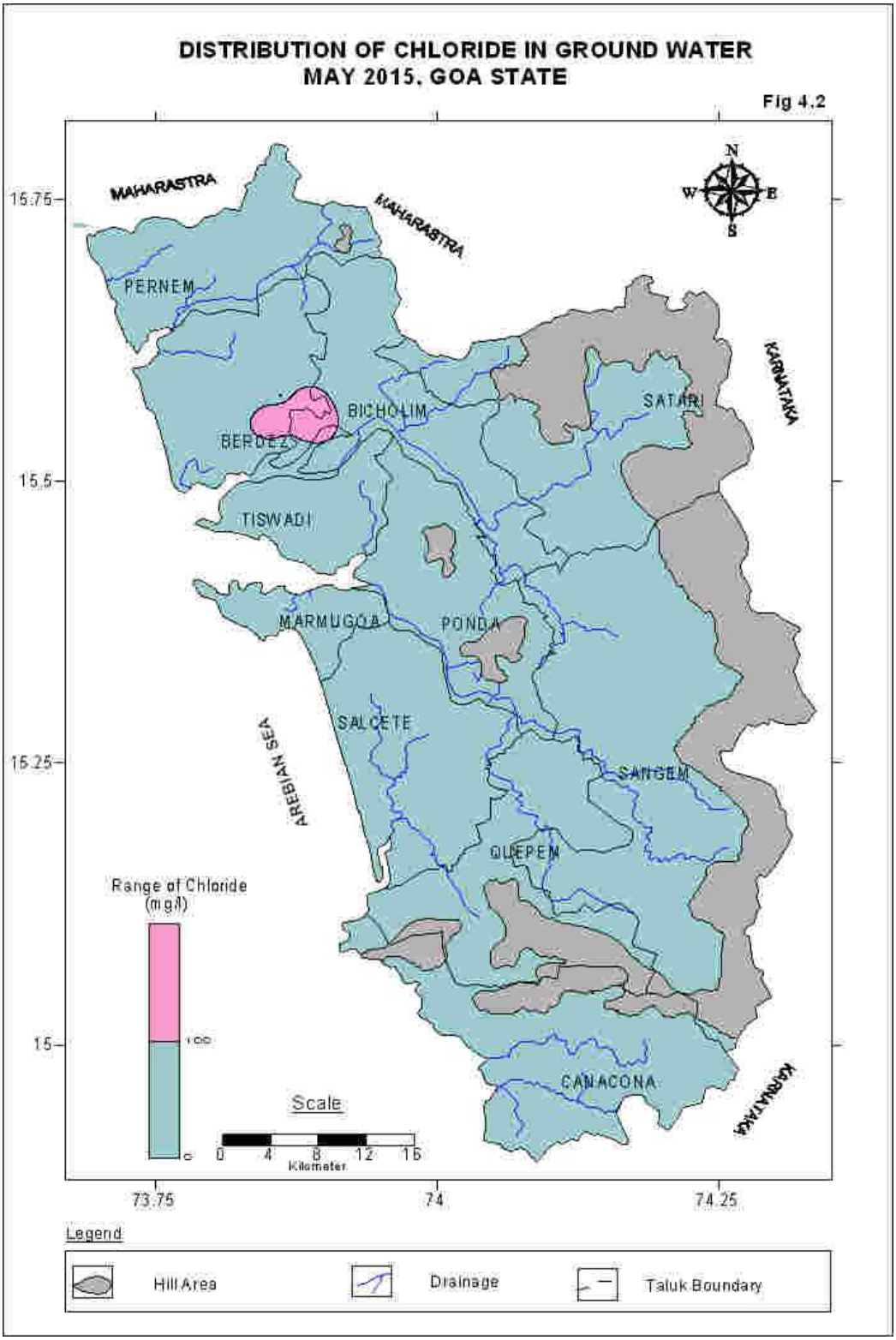

Fig 4.2: Distribution of Chloride (May 2015)

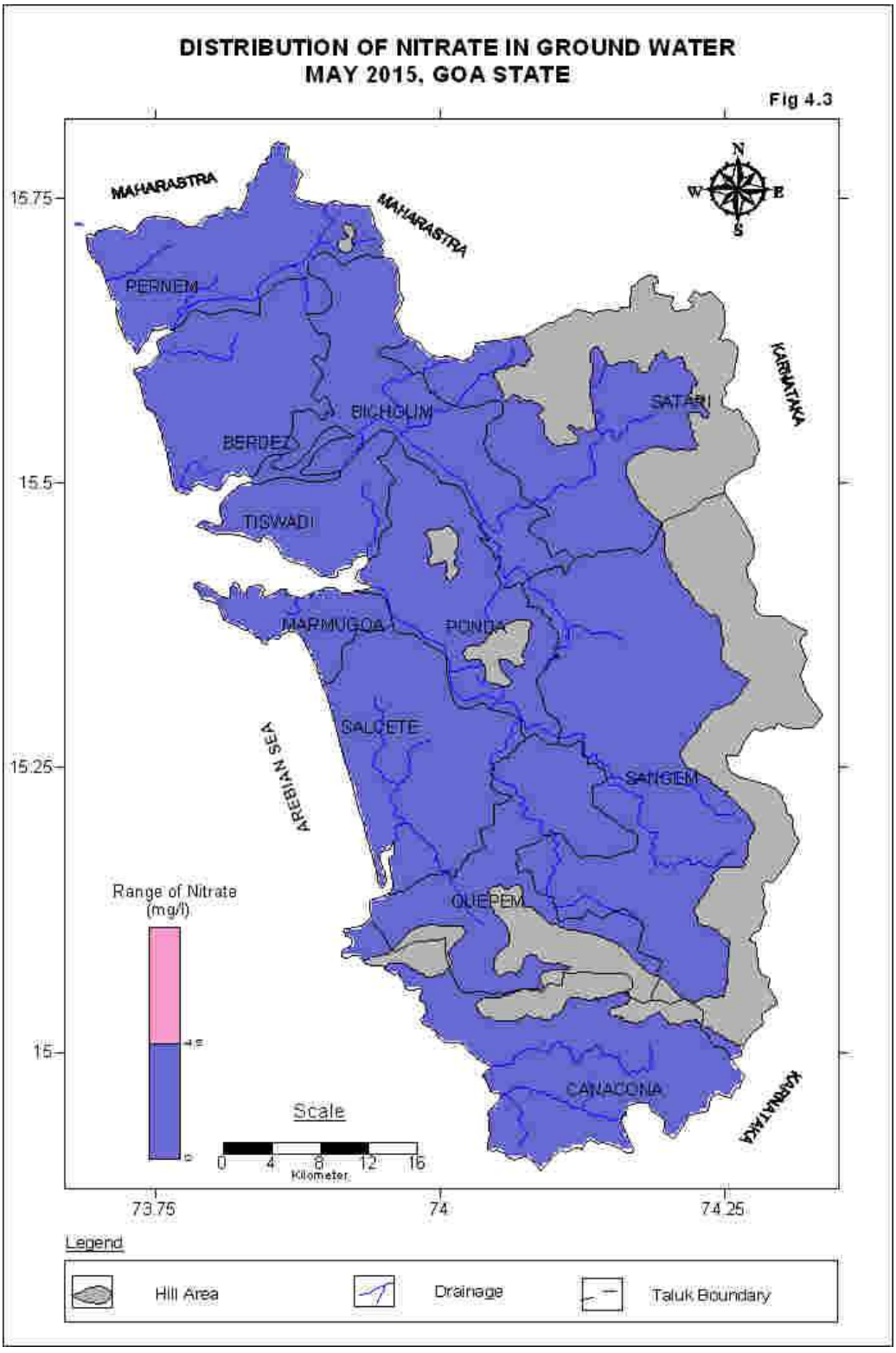

Fig 4.3: Distribution of Nitrate (May 2015)

Table 3.1

Taluk wise Well Frequency for Different Ranges of Depth to Water Level

Month / Year: May-2015

Taluk	No of WL measured	D.T.W. (m bgl)		0 - 2 (m)		2 - 5 (m)		5 -10 (m)		10 - 20 (m)		> 20 (m)	
		Min.	Max.	No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	1.68	9.31	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0
Sattari	10	1.56	9.95	1	10.0	4	40.0	5	50.0	0	0.0	0	0.0
Sangeum	14	2.67	13.83	0	0.0	4	28.6	5	35.7	5	35.7	0	0.0
Salcete	12	1.98	12.76	1	8.3	6	50.0	4	33.3	1	8.3	0	0.0
Quepem	4	1.77	6.20	1	25.0	2	50.0	1	25.0	0	0.0	0	0.0
Ponda	5	1.82	6.75	1	20.0	3	60.0	1	20.0	0	0.0	0	0.0
Pernem	9	1.72	7.61	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Marmugoa	1	2.98	2.98	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	9	3.79	15.06	0	0.0	4	44.4	3	33.3	2	22.2	0	0.0
Bicholim	9	2.14	19.39	0	0.0	4	44.4	1	11.1	4	44.4	0	0.0
Bardez	12	2.08	14.82	0	0.0	8	66.7	2	16.7	2	16.7	0	0.0
Total	**89**			**7**	**7.9**	**43**	**48.3**	**25**	**28.1**	**14**	**15.7**	**0**	**0.0**

Table: 3.2

Taluk wise Well Frequency for Different Ranges of Depth to Water Level

Month / Year: Aug-2015

Taluk	No of WL measured	D.T.W. (m bgl)		0 - 2 (m)		2 - 5 (m)		5 - 10 (m)		10 - 20 (m)		> 20 (m)	
		Min.	Max.	No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	1.18	5.54	3	75.0	0	0.0	1	25.0	0	0.0	0	0.0
Sattari	9	1.16	5.24	3	33.3	5	55.6	1	11.1	0	0.0	0	0.0
Sangeum	14	1.43	9.69	2	14.3	5	35.7	7	50.0	0	0.0	0	0.0
Salcete	11	0.53	5.70	4	36.4	5	45.5	2	18.2	0	0.0	0	0.0
Quepem	3	0.87	3.35	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Ponda	5	0.98	5.30	2	40.0	2	40.0	1	20.0	0	0.0	0	0.0
Pernem	8	0.13	7.48	2	25.0	4	50.0	2	25.0	0	0.0	0	0.0
Marmugoa	1	2.43	2.43	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	9	0.26	14.16	3	33.3	3	33.3	2	22.2	1	11.1	0	0.0
Bicholim	9	1.20	14.35	2	22.2	2	22.2	2	22.2	3	33.3	0	0.0
Bardez	12	0.88	9.53	4	33.3	5	41.7	3	25.0	0	0.0	0	0.0
Total	**85**			**26**	**30.6**	**34**	**40.0**	**21**	**24.7**	**4**	**4.7**	**0**	**0.0**

Table: 3.3

Taluk wise Well Frequency for Different Ranges of Depth to Water Level

Month / Year: November - 2015

Taluk	No of WL measured	D.T.W. (m bgl)		0 - 2 (m)		2 - 5 (m)		5 -10 (m)		10 - 20 (m)		> 20 (m)	
		Min.	Max.	No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	1.28	7.73	3	75.0	0	0.0	1	25.0	0	0.0	0	0.0
Sattari	9	1.36	7.29	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Sangeum	14	2.31	11.00	0	0.0	5	35.7	7	50.0	2	14.3	0	0.0
Salcete	11	0.98	6.03	2	18.2	6	54.5	3	27.3	0	0.0	0	0.0
Quepem	3	1.16	3.87	1	33.3	2	66.7	0	0.0	0	0.0	0	0.0
Ponda	5	1.38	6.47	1	20.0	2	40.0	2	40.0	0	0.0	0	0.0
Pernem	9	0.35	7.74	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Marmugoa	1	2.80	2.80	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	9	0.43	14.55	2	22.2	4	44.4	1	11.1	2	22.2	0	0.0
Bicholim	9	1.44	15.47	2	22.2	2	22.2	3	33.3	2	22.2	0	0.0
Bardez	12	1.25	10.50	4	33.3	4	33.3	2	16.7	2	16.7	0	0.0
Total	**86**			**17**	**19.8**	**38**	**44.2**	**23**	**26.7**	**8**	**9.3**	**0**	**0.0**

Table: 3.4

Taluk wise Well Frequency for Different Ranges of Depth to Water Level

Month / Year:January-2016

Taluk	No of WL measured	D.T.W. (m bgl)		0 - 2 (m)		2 - 5 (m)		5 -10 (m)		10 - 20 (m)		> 20 (m)	
		Min.	Max.	No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	1.28	8.75	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0
Sattari	10	1.72	7.34	1	10.0	5	50.0	4	40.0	0	0.0	0	0.0
Sangeum	12	2.57	10.66	0	0.0	4	33.3	5	41.7	3	25.0	0	0.0
Salcete	10	1.95	9.87	1	10.0	4	40.0	5	50.0	0	0.0	0	0.0
Quepem	3	2.02	4.70	0	0.0	3	100.0	0	0.0	0	0.0	0	0.0
Ponda	5	1.08	6.65	1	20.0	2	40.0	2	40.0	0	0.0	0	0.0
Pernem	9	0.73	7.48	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Marmugoa	1	2.90	2.90	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	8	3.70	13.30	0	0.0	4	50.0	1	12.5	3	37.5	0	0.0
Bicholim	6	0.00	15.47	2	33.3	2	33.3	1	16.7	1	16.7	0	0.0
Bardez	12	0.72	14.10	2	16.7	6	50.0	2	16.7	2	16.7	0	0.0
Total	**80**			**10**	**12.5**	**38**	**47.5**	**23**	**28.7**	**9**	**11.3**	**0**	**0.0**

Table: 3.5

Taluk wise Categorization of Water Level Fluctuation

(May-2015 to August-2015)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0 - 2	%	2 - 4	%	> 4	%	0 - 2	%	2- 4	%	> 4	%
Bardez	12	1	8.3	0	0.0	0	0.0	5	41.7	4	33.3	2	16.7
Bicholim	9	0	0.0	0	0.0	0	0.0	5	55.6	2	22.2	2	22.2
Canacona	9	0	0.0	0	0.0	0	0.0	3	33.3	5	55.6	1	11.1
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	8	0	0.0	0	0.0	0	0.0	7	87.5	1	12.5	0	0.0
Ponda	5	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Quepem	3	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0
Salcete	11	0	0.0	0	0.0	0	0.0	7	63.6	3	27.3	1	9.1
Sangeum	14	0	0.0	0	0.0	0	0.0	8	57.1	3	21.4	3	21.4
Sattari	9	0	0.0	0	0.0	0	0.0	6	66.7	0	0.0	3	33.3
Tiswadi	4	0	0.0	0	0.0	0	0.0	3	75.0	1	25.0	0	0.0
Total	**85**	**2**	**2.4**	**0**	**0.0**	**0**	**0.0**	**51**	**60.0**	**20**	**23.5**	**12**	**14.1**

Table: 3.6

Taluk wise Categorization of Water Level Fluctuation

(May-2015 to November-2015)

Taluk	Number of Station Analyzed	Fall in m						Rise in m					
		0 - 2	%	2 - 4	%	> 4	%	0 - 2	%	2 - 4	%	> 4	%
Bardez	12	0	0.0	0	0.0	0	0.0	10	83.3	1	8.3	1	8.3
Bicholim	9	0	0.0	0	0.0	0	0.0	4	44.4	3	33.3	2	22.2
Canacona	9	0	0.0	0	0.0	0	0.0	4	44.4	5	55.6	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	9	1	11.1	0	0.0	0	0.0	8	88.9	0	0.0	0	0.0
Ponda	5	2	40.0	0	0.0	0	0.0	3	60.0	0	0.0	0	0.0
Quepem	3	0	0.0	0	0.0	0	0.0	2	66.7	1	33.3	0	0.0
Salcete	11	1	9.1	0	0.0	0	0.0	7	63.6	2	18.2	1	9.1
Sangeum	14	2	14.3	0	0.0	0	0.0	9	64.3	2	14.3	1	7.1
Sattari	9	2	22.2	0	0.0	0	0.0	4	44.4	2	22.2	1	11.1
Tiswadi	4	0	0.0	0	0.0	0	0.0	4	100.0	0	0.0	0	0.0
Total	**86**	**8**	**9.3**	**0**	**0.0**	**0**	**0.0**	**56**	**65.1**	**16**	**18.6**	**6**	**7.0**

Table: 3.7

Talukwise Categorisation of Water Level Fluctuation

(May-2015 to January-2016)

Taluk	Number of Station Analyzed	Fall in m						Rise in m					
		0 - 2	%	2 -4	%	>4	%	0 - 2	%	2- 4	%	> 4	%
Bardez	12	1	8.3	1	8.3	0	0.0	9	75.0	1	8.3	0	0.0
Bicholim	6	1	16.7	0	0.0	0	0.0	4	66.7	0	0.0	1	16.7
Canacona	8	0	0.0	0	0.0	1	12.5	7	87.5	0	0.0	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	9	0	0.0	0	0.0	0	0.0	9	100.0	0	0.0	0	0.0
Ponda	5	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Quepem	3	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Salcete	9	1	11.1	0	0.0	0	0.0	7	77.8	1	11.1	0	0.0
Sangeum	12	1	8.3	0	0.0	0	0.0	10	83.3	1	8.3	0	0.0
Sattari	10	0	0.0	0	0.0	1	10.0	6	60.0	2	20.0	1	10.0
Tiswadi	4	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Total	**79**	**8**	**10.1**	**1**	**1.3**	**2**	**2.5**	**61**	**77.2**	**5**	**6.3**	**2**	**2.5**

Table: 3.8

Taluk wise Categorization of Water Level Fluctuation

(May 2014 to May 2015)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0 - 2	%	2 - 4	%	> 4	%	0 - 2	%	2 - 4	%	> 4	%
Bardez	12	6	50.0	2	16.7	0	0.0	4	33.3	0	0.0	0	0.0
Bicholim	9	4	44.4	2	22.2	1	11.1	1	11.1	0	0.0	1	11.1
Canacona	9	6	66.7	0	0.0	1	11.1	1	11.1	1	11.1	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	9	4	44.4	0	0.0	0	0.0	4	44.4	1	11.1	0	0.0
Ponda	5	3	60.0	0	0.0	0	0.0	1	20.0	1	20.0	0	0.0
Quepem	4	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0
Salcete	12	5	41.7	0	0.0	0	0.0	6	50.0	1	8.3	0	0.0
Sangeum	14	7	50.0	0	0.0	0	0.0	6	42.9	1	7.1	0	0.0
Sattari	10	5	50.0	0	0.0	0	0.0	4	40.0	1	10.0	0	0.0
Tiswadi	3	2	66.7	0	0.0	0	0.0	0	0.0	1	33.3	0	0.0
Total	**88**	**45**	**51.1**	**4**	**4.5**	**2**	**2.3**	**29**	**33.0**	**7**	**8.0**	**1**	**1.1**

Table: 3.9

Taluk wise Categorization of Water Level Fluctuation

(August - 2014 to August - 2015)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0 - 2	%	2- 4	%	> 4	%	0 - 2	%	2 - 4	%	> 4	%
Bardez	12	7	58.3	1	8.3	0	0.0	4	33.3	0	0.0	0	0.0
Bicholim	9	3	33.3	1	11.1	2	22.2	0	0.0	3	33.3	0	0.0
Canacona	9	3	33.3	1	11.1	1	11.1	4	44.4	0	0.0	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	8	7	87.5	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0
Ponda	5	4	80.0	0	0.0	0	0.0	1	20.0	0	0.0	0	0.0
Quepem	3	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Salcete	11	5	45.5	0	0.0	0	0.0	5	45.5	1	9.1	0	0.0
Sangeum	14	7	50.0	1	7.1	1	7.1	4	28.6	0	0.0	1	7.1
Sattari	9	7	77.8	0	0.0	0	0.0	2	22.2	0	0.0	0	0.0
Tiswadi	4	3	75.0	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0
Total	**85**	**48**	**56.5**	**4**	**4.7**	**4**	**4.7**	**23**	**27.1**	**5**	**5.9**	**1**	**1.2**

Table: 3.10

Taluk wise Categorization of Water Level Fluctuation

(November-2014 to November-2015)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0 - 2	%	2 - 4	%	> 4	%	0 - 2	%	2- 4	%	> 4	%
Bardez	12	7	58.3	0	0.0	1	8.3	4	33.3	0	0.0	0	0.0
Bicholim	9	4	44.4	1	11.1	0	0.0	3	33.3	0	0.0	1	11.1
Canacona	9	3	33.3	1	11.1	0	0.0	5	55.6	0	0.0	0	0.0
Marmugoa	1	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pernem	9	7	77.8	0	0.0	0	0.0	2	22.2	0	0.0	0	0.0
Ponda	5	5	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Quepem	3	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Salcete	10	5	50.0	2	20.0	0	0.0	3	30.0	0	0.0	0	0.0
Sangeum	14	9	64.3	3	21.4	0	0.0	2	14.3	0	0.0	0	0.0
Sattari	9	9	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Tiswadi	3	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Total	**84**	**53**	**63.1**	**7**	**8.3**	**1**	**1.2**	**22**	**26.2**	**0**	**0.0**	**1**	**1.2**

Table: 3.11

Taluk wise Categorization of Water Level Fluctuation

(January-2015 to January-2016)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0 - 2	%	2 - 4	%	> 4	%	0 - 2	%	2 - 4	%	> 4	%
Bardez	12	9	75.0	0	0.0	1	8.3	1	8.3	1	8.3	0	0.0
Bicholim	6	4	66.7	0	0.0	0	0.0	1	16.7	1	16.7	0	0.0
Canacona	8	3	37.5	2	25.0	1	12.5	2	25.0	0	0.0	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	9	5	55.6	0	0.0	0	0.0	4	44.4	0	0.0	0	0.0
Ponda	5	4	80.0	0	0.0	0	0.0	1	20.0	0	0.0	0	0.0
Quepem	3	3	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Salcete	9	7	77.8	1	11.1	0	0.0	1	11.1	0	0.0	0	0.0
Sangeum	12	10	83.3	0	0.0	0	0.0	2	16.7	0	0.0	0	0.0
Sattari	10	3	30.0	0	0.0	1	10.0	5	50.0	1	10.0	0	0.0
Tiswadi	3	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Total	**78**	**50**	**64.1**	**3**	**3.8**	**3**	**3.8**	**19**	**24.4**	**3**	**3.8**	**0**	**0.0**

Table: 3.12

Talukwise Categorisation of Change in Water Level

10 Yrs Mean (May 2005 - May 2014) to May-15

Taluk	Number of Station Analysed	Range in m				Rise in m						Fall in m					
		Rise		Fall		0 - 2		2 -4		> 4		0 -2		2 -4		> 4	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	4	0.06	1.37	0.26	0.26	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0
Bicholim	4	0.28	0.85	0.14	0.14	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0
Canacona	7	0.84	0.84	0.08	1.84	1	14.3	0	0.0	0	0.0	6	85.7	0	0.0	0	0.0
Pernem	5	0.26	1.25	0.17	0.20	3	60.0	0	0.0	0	0.0	2	40.0	0	0.0	0	0.0
Ponda	2	0.39	2.06			1	50.0	1	50.0	0	0.0	0	0.0	0	0.0	0	0.0
Quepem	3	0.37	0.71	0.25	0.25	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Salcete	3	1.03	1.03	0.34	1.14	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Sangeum	4	0.07	0.32	0.18	0.28	2	50.0	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0
Sattari	5	0.31	1.80	0.32	0.34	3	60.0	0	0.0	0	0.0	2	40.0	0	0.0	0	0.0
Tiswadi	3	0.22	1.41	0.42	0.42	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Total	**40**					**21**	**52.5**	**1**	**2.5**	**0**	**0.0**	**18**	**45.0**	**0**	**0.0**	**0**	**0.0**

Table: 3.13

Taluk wise Categorization of Change in Water Level

10 Yrs Mean (August – 2005 to August -2014) -August – 2015

Taluk	Number of Station Analysed	Range in m				Rise in m						Fall in m					
		Rise		Fall		0 - 2		2 -4		> 4		0 -2		2 -4		> 4	
	Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%	
Bardez	4			0.35	2.18	0	0.0	0	0.0	0	0.0	3	75.0	1	25.0	0	0.0
Bicholim	4	1.98	2.65	0.45	0.78	1	25.0	1	25.0	0	0.0	2	50.0	0	0.0	0	0.0
Canacona	7	0.30	0.32	0.10	1.81	2	28.6	0	0.0	0	0.0	5	71.4	0	0.0	0	0.0
Pernem	4	0.08	0.08	0.63	1.49	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Ponda	2			0.21	0.93	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Quepem	2	0.06	0.22			2	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Salcete	3	0.46	0.46	0.08	1.18	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Sangeum	4	0.12	0.12	0.35	1.46	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Sattari	5	0.47	0.47	0.42	1.16	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Tiswadi	3			0.15	1.79	0	0.0	0	0.0	0	0.0	3	100.	0	0.0	0	0.0
Total	**38**					**9**	**23.7**	**1**	**2.6**	**0**	**0.0**	**27**	**71.1**	**1**	**2.6**	**0**	**0.0**

Table: 3.14

Taluk wise Categorization of Change in Water Level

10 Yrs Mean (November-2005 - November-2014) to November-2015

Taluk	Number of Station Analysed	Range in m				Rise in m						Fall in m					
		Rise		Fall		0 - 2		2 -4		> 4		0- 2		2 -4		> 4	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	4	0.22	0.69	0.87	0.87	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0
Bicholim	3	0.20	0.98	0.20	0.20	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Canacona	7	0.18	0.28	0.01	2.11	2	28.6	0	0.0	0	0.0	4	57.1	1	14.3	0	0.0
Pernem	5	0.53	0.53	0.05	0.74	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Ponda	2			0.27	0.33	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Quepem	2	0.43	1.53			2	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Salcete	3	1.80	1.80	0.12	0.51	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Sangeum	4			0.18	0.72	0	0.0	0	0.0	0	0.0	4	100.	0	0.0	0	0.0
Sattari	5	0.55	0.55	0.10	1.17	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Tiswadi	2	0.24	0.24	0.38	0.38	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0
Total	**37**					**13**	**35.1**	**0**	**0.0**	**0**	**0.0**	**23**	**62.2**	**1**	**2.7**	**0**	**0.0**

Table: 3.15

Taluk wise Categorization of Change in Water Level

10 Yrs Mean (January-2006 - January-2015) to January-2016

Taluk	Number of Station Analysed	Range in m				Rise in m						Fall in m					
		Rise		Fall		0 - 2		2 - 4		>4		0 - 2		2 - 4		>4	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	4	3.48	3.48	0.26	2.87	0	0.0	1	25.0	0	0.0	2	50.0	1	25.0	0	0.0
Bicholim	3	0.03	0.16	0.04	0.04	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Canacona	7	0.09	1.45	0.03	6.85	2	28.6	0	0.0	0	0.0	3	42.9	1	14.3	1	14.3
Pernem	5	0.27	0.51	0.02	0.41	2	40.0	0	0.0	0	0.0	3	60.0	0	0.0	0	0.0
Ponda	2	0.13	0.13	0.68	0.68	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0
Quepem	2	0.03	0.03	0.31	0.31	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0
Salcete	4			0.04	0.70	0	0.0	0	0.0	0	0.0	4	100.	0	0.0	0	0.0
Sangeum	4			0.05	0.57	0	0.0	0	0.0	0	0.0	4	100.	0	0.0	0	0.0
Sattari	5	0.20	1.48	0.20	0.26	3	60.0	0	0.0	0	0.0	2	40.0	0	0.0	0	0.0
Tiswadi	3	0.59	0.59	0.20	0.37	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Total	**39**					**12**	**30.8**	**1**	**2.6**	**0**	**0.0**	**23**	**59.0**	**2**	**5.1**	**1**	**2.6**

ANNEXURE - I

GENERAL DETAILS OF HYDROGRAPH NETWORK STATIONS
SOUTH WESTERN REGION
GOA STATE

Sl No.	Well No.	District	Talulk	Village	Latitude	Longitude	Total Depth (mbgl)
1	GAJY1307	North Goa	Bicholim	Adavapal	15°38'23"	73°53'45"	9.48
2	48E2D12	North Goa	Bardoz	Alto Betim Porvorim	15°31'25"	73°49'49"	17.6
3		North Goa	Pernem	Ambernem	15°44'26"	73°49'28"	8
4	GAJY1302	North Goa	Bardez	Anjuna Beach	15°35'03"	74°44'17"	13.12
5	48E2D10	North Goa	Bardoz	Baga	15°33'37"	73°45'03"	3.37
6	48I2A2	North Goa	Sattari	Bayalwadikeri(querim)	15°36'36"	74°04'00"	8.45
7	GAJY1303	North Goa	Sattari	Bhamber(Nanoda Cross)	15°35'16"	74°11'28"	7.26
8	GAJY1311	North Goa	Sattari	Bhujpal	15°32'21"	74°05'17"	8.35
9	48E2D8	North Goa	Bicholim	Bicholim	15°35'05"	73°57'27"	6.81
10	48E2D9	North Goa	Bicholim	Bicholim(pz)	15°35'00"	73°57'40"	46.7
11	GAJY1310	North Goa	Ponda	Bori	15°21'10"	74°00'12"	7.92
12	GAMY1301	North Goa	Bardez	Britona	15°30'45"	73°50'34"	4.1
13	48I3A6	North Goa	Tiswadi	Collem(kolamba)	15°20'03"	74°14'39"	10.5
14	48E2D11	North Goa	Bardoz	Calangute	15°32'43"	73°45'29"	9.7
15	GAJY1312	North Goa	Sattari	Charayode	15°37'40"	74°07'50"	7.32
16	GAMY1303	North Goa	Bardez	Colval	15°38'38"	73°50'14"	30
17		North Goa	Bicholim	Devulawada Narve	15°33'16"	73°56'14"	5.4
18		North Goa	Bicholim	Dhatwado Vante	15°29'46"	74°05'51"	15.2
19	GAMY1305	North Goa	Tiswadi	Gauli Mola	15°27'41"	73°53'53"	5.4
20	GAJY1305	North Goa	Tiswadi	Gavalebhat, Chimbel(kirl)	15°29'22"	73°52'27"	8.3
21	48E3D3	North Goa	Tiswadi	Goa Velha	15°26'29"	73°52'47"	2.4
22		North Goa	Pernem	Hasapur	15°44'15.5"	73°54'13"	7.1
23		North Goa	Pernem	Hasaravanni Vaipal	15°43'17"	73°53'39'	4.6
24	48I2A1	North Goa	Sattari	Hivre Budruk	15°37'55"	74°08'47"	9.8
25	48I2A4	North Goa	Sattari	Honda	15°32'48"	74°03'02"	6.16
26		North Goa	Bicholim	Jambhul Batt	15°34'49.7"	73°55'34"	4.1
27	48E3D2	North Goa	Tiswadi	Karanjhalen	15°27'29"	73°48'15"	6.38
28	48I3A1	North Goa	Sattari	Khadki(harijanwada)	15°29'04"	74°08'26"	14.47
29	GAJY1313	North Goa	Sattari	Khotodem	15°28'58"	74°08'13"	8.5
30	48E2D3	North Goa	Pernem	Korgaon	15°42'29"	73°45'05"	6.9
31		North Goa	Ponda	Kundel Dassalwada	15°27'10"	73°57'10'	6.95
32	GAJY1309	North Goa	Ponda	Mankem	15°18'19"	74°02'54"	7.22
33	48E2D7	North Goa	Bardoz	Mapuca	15°36'34"	73°49'35"	8.55
34	48E2C1	North Goa	Pernem	Morji	15°38'15"	73°44'12"	3.71
35	48I2A3	North Goa	Sattari	Morlem	15°35'35"	74°02'47"	6.51
36	48E2D6	North Goa	Bicholim	Mulgaon Shivalkherwad	15°36'49"	73°55'35"	5.04
37	GAJY1304	North Goa	Sattari	Nagargoan	15°33'41"	74°09'47"	8
38	48E2D2	North Goa	Pernem	Nagjhar	15°42'31"	73°51'18"	7.95

39	GAMY1302	North Goa	Bicholim	Olaulim	15°34'10"	73°51'48"	9.6
40	48I3A8	North Goa	Ponda	Panchawadi(pz)	15°16'57"	74°05'45"	-
41	GAJY1301	North Goa	Bardez	Parra	15°34'22"	73°47'33"	7.85
42	48E2D1	North Goa	Pernem	Pernem	15°43'03"	73°47'56"	4.25
43	GAMY1304	North Goa	Bardez	Pirna	15°40'06"	73°52'53"	6.8
44		North Goa	Bardez	Pomburpa Palmar	15°33'33.2"	73°52'03"	4.8
45	48I3A4	North Goa	Ponda	Ponda(pz)	15°23'27"	74°00'01"	30
46	48E2D4	North Goa	Bicholim	Sal	15°41'11"	73°55'38"	5.82
47		North Goa	Bardez	Salwardhar Dumun	15°32'15"	73°52'07'	4.35
48	GAJY1306	North Goa	Pernem	Sawanthwada(mandrem)	15°40'53"	73°45'08"	6.27
49	48I3A7	North Goa	Ponda	Shiroda	15°19'12"	74°02'08"	10.91
50	GAJY1308	North Goa	Bardez	Shivoli (brahmanwada)	15°37'24"	73°46'03"	5.2
51	48E2D5	North Goa	Bardoz	Sirsaim	15°37'36"	73°52'35"	5.21
52	48I2A6	North Goa	Bicholim	Surla(pz)	15°30'26"	74°02'47"	41.76
53	48E1D1	North Goa	Pernem	Uguem(ugawe)	15°45'08"	74°50'20"	6.2
54	48I2A5	North Goa	Sattari	Valpoi	15°31'55"	74°08'18"	9.13
55	48E3D1	North Goa	Tiswadi	Velha Goa	15°29'59"	73°55'00"	14.4
56	48I4D3	South Goa	Canacona	Agonda Desaiwada	15°02'25"	73°59'32"	7.9
57	48I4A5	South Goa	Quepem	Akamol Ambavalli	15°11'25"	74°02'17"	8.21
58		South Goa	Mormugoa	Bagmola	15°22'17"	73°50'15"	4.17
59	48E3D6	South Goa	Salcete	Ballynuvhen	15°18'56"	73°56'55"	10.77
60	Jy13117	South Goa	Salcete	Barodi Velni (betul)	15°08'59"	73°57'39"	5.4
61	Jy13116	South Goa	Salcete	Betalbatti	15°18'02"	73°55'12"	7.5
62	Jy13114	South Goa	Sanguem	Bhati	15°10'54"	74°13'35"	7.7
63	48I3A2	South Goa	Sanguem	Bolkharnem	15°25'42"	74°11'36"	8.24
64	48I4A12	South Goa	Canacona	Canacona	15°00'23"	74°03'02"	8.8
65	48E4D1	South Goa	Salcete	Carmona	15°12'10"	73°57'09"	9.42
66	Jy1306	South Goa	Salcete	Chikalim	15°23'53"	73°50'12"	3.5
67	Jy13118	South Goa	Salcete	Cuncalim	15°10'48"	74°00'00"	4.3
68	48I4A6	South Goa	Salcete	Cuncalim(pz)	15°10'28"	74°00'22"	20
69	48J1A2	South Goa	Canacona	Daptamol Lolien	14°56'56"	74°03'22"	16.27
70	48I3A3	South Goa	Sanguem	Darbandahra(pz)	15°23'25"	74°07'28"	14.07
71	48I4A7	South Goa	Sanguem	Deulwada Kolamba	15°08'56"	74°07'55"	4.52
72	48I3D7	South Goa	Salcete	Fathorda Margao(pz)	15°17'17"	73°58'10"	-
73	48I4A1	South Goa	Quepem	Ghadiawada	15°14'17"	74°06'50"	7.78
74	Jy1312	South Goa	Sanguem	Guddemal	15°17'08"	74°46'08"	13.5
75	48I4A11	South Goa	Canacona	Gulem Velipwada	15°02'12"	74°01'52"	5.6
76	48J1A1	South Goa	Canacona	Hattipal Poinguinem	14°59'00"	74°06'33"	9.41
77	Jy13120	South Goa	Sanguem	Jambavli	15°11'11"	74°05'43"	13.31
78	Jy1311	South Goa	Sanguem	Kalay	15°17'18"	74°10'48"	13.45
79	48E4D2	South Goa	Quepem	Kanagini(pz)	15°07'24	73°56'48"	42.12
80		South Goa	Quepem	Kapsa	15°16'24"	74°06'02"	7.6
81	Jy1305	South Goa	Salecete	Kaveslium	15°11'08"	73°56'50"	6.14
82	48E3D5	South Goa	Salcete	Majorda Bpada Curilo	15°19'28"	73°55'04"	6.17
83	Jy1301	South Goa	Sangeum	Malkarnem	15°10'41"	74°09'06"	11.28

84	48E3D4	South Goa	Marmugoa	Marmagoa	15°24'22"	73°47'54"	7.1
85	Jy1309	South Goa	Salcete	Mashe	14°01'30"	74°08'49"	5.6
86	48I3A5	South Goa	Sanguem	Molem	15°22'33"	74°13'49"	15.49
87	Jy13115	South Goa	Salcete	Navelim	15°15'16"	73°58'02"	7.41
88	48I4A9	South Goa	Sanguem	Netrolim	15°05'22"	74°13'00"	11.42
89	Jy13119	South Goa	Salcete	Padi	15°05'34"	74°01'50"	14.2
90	48J1A3	South Goa	Canacona	Polem(polen)	14°54'39"	74°05'11"	6.57
91	Jy1308	South Goa	Canacona	Ponquini	14°58'31"	74°05'43"	18.1
92	48I4A4	South Goa	Quepem	Quepem	15°13'01"	74°04'53"	9.13
93	Jy13121	South Goa	Sanguem	Revona	15°09'51"	74°06'24"	10.62
94	48I4A10	South Goa	Canacona	Shrishtal Gaondongar	15°02'07"	74°07'08"	25
95	Jy1307	South Goa	Canacona	Sristal	15°01'12"	74°04'31"	7.9
96	Jy1310	South Goa	Sanguem	Suktali (molem)	15°21'49"	74°10'31"	7.45
97	Jy13113	South Goa	Sanguem	Themchewada	15°13'10"	74°09'27"	15.58
98	48I4A2	South Goa	Sanguem	Ugem(pz)	15°13'47"	74°10'55"	6.2
99	Jy1303	South Goa	Sangeum	Vadam	15°07'50"	74°12'27"	9.15
100	48I4A3	South Goa	Sanguem	Valkinim	15°13'12"	74°12'53"	26.3
101	Jy1302	South Goa	Sangeum	Vichundrem	15°06'12"	74°12'11"	8.26
102	48I4A8	South Goa	Sanguem	Waddem(pz)	15°07'27"	74°12'37"	24.45
103	Jy1304	South Goa	Canacona	Yedda	14°59'52"	74°11'28"	16.12

ANNEXURE - II

MONTHLY NORMAL RAINFALL OF GOA STATE

Station	JAN	FEB	Winter	MAR	APR	MAY	Pre Mon	JUN	JUL	AUG	SEP	SW Mon	OCT	NOV	DEC	NE mon	ANNUAL
PERNEM	1.0	0.3	1.3	0.8	13.6	69.5	83.9	923.8	1220.8	623.3	277.7	3045.6	146.4	34.0	2.9	183.3	3314.1
MAPUSA	1.1	0.2	1.3	0.2	15.8	89.8	105.8	870.0	1009.3	538.9	276.0	2694.2	127.5	33.8	2.6	163.9	2965.3
BICHOLIM	1.0	0.2	1.2	0.1	10.0	64.4	74.5	957.5	1264.9	659.6	312.1	3194.1	196.7	50.0	3.6	250.3	3520.1
PONDA	1.2	0.1	1.3	0.3	21.0	91.0	112.3	1072.6	1358.0	691.2	323.3	3445.1	177.4	46.4	2.7	226.5	3785.2
VALPOI	1.4	0.1	1.5	0.9	13.7	92.3	106.9	955.5	1486.3	849.0	378.4	3669.2	216.6	51.2	4.1	271.9	4049.5
COLEM	1.4	0.3	1.7	1.7	19.8	111.5	133.0	1075.2	1800.1	1091.7	516.7	4483.7	266.3	60.8	5.3	332.4	4950.8
MARGAO	1.3	0.4	1.7	0.1	16.4	86.8	103.3	913.1	1054.4	505.8	257.2	2730.5	117.8	40.1	3.9	161.8	2997.3
QUEPEM	0.2	0.3	0.5	0.0	12.2	93.1	105.3	960.9	1378.2	712.7	320.2	3372.0	165.0	56.4	0.3	221.7	3699.5
SANGUEM	0.6	0.0	0.6	1.6	11.5	78.9	92.0	1010.5	1537.2	774.7	391.6	3714.0	215.0	64.5	3.9	283.4	5090.0
CANACONA	0.6	0.0	0.6	0.4	16.2	96.2	112.8	902.0	1025.0	537.4	293.2	2757.6	130.1	41.2	7.2	178.5	3049.5
PANAJI	1.7	0.1	1.8	0.7	18.4	86.6	105.7	869.4	923.4	456.2	252.7	2501.7	118.9	35.8	3.0	157.7	2766.9
MORMUGOA	1.8	0.0	1.8	0.4	20.3	81.3	102.0	777.8	905.1	412.9	225.9	2321.7	138.7	42.6	4.9	186.2	2611.7
MEAN	1.1	0.2	1.3	0.6	15.7	86.2	102.5	940.7	1246.9	954.3	318.7	3460.6	168.0	46.4	3.7	218.1	3483.3

ANNEXURE - III

WATER LEVEL DATA FOR GROUNDWATER MONITORING STATIONS FOR WATER YEAR 2015-2016

SOUTH WESTERN REGION, GOA

S.No	Well No	District	Location	Depth to water level (mbgl)				Decadal mean water level (mbgl)			
				May-15	Aug-15	Nov-15	Jan-16	May-15	Aug-15	Nov-15	Jan-16
1	GAJY1307	North Goa	Adavapal	5.61	5.1	5.51	5.57	-	-	-	-
2	48I4D3	South Goa	Agonda Desaiwada	4.07	2.47	3.34	3.7	3.913	1.992	2.728	3.795
3	48I4A5	South Goa	Akamol Ambavalli	-	3.35	3.45	-	4.088	3.406	4.982	-
4	48E2D12	North Goa	Alto Betim Porvorim	6.16	5.99	5.05	9.76	7.53	3.81	5.736	6.887
5		North Goa	Amberem	7.28	6.9	6.85	7.08	-	-	-	-
6	GAJY1302	North Goa	Anjuna Beach	12.06	7.48	10.5	10.81	-	-	-	-
7	48E2D10	North Goa	Baga	-	-	-	-	-	-	-	-
8		South Goa	Bagmola	2.98	2.43	2.8	2.9	-	-	-	-
9	48E3D6	South Goa	Ballynuvhen	5.81	5	6.03	6.26	6.838	5.46	5.519	6.225
10	Jy13117	South Goa	Barodi Velni (betul)	-	-	-	-	-	-	-	-
11	48I2A2	North Goa	Bayalwadikeri(querim)	2.34	1.56	3.49	1.72	4.137	2.027	4.038	3.2
12	Jy13116	South Goa	Betalbatti	6.21	2.26	2.48	5.09	-	-	-	-
13	GAJY1303	North Goa	Bhamber(Nanoda Cross)	4.98	3.45	4.41	4.73	-	-	-	-
14	Jy13114	South Goa	Bhati	3.29	2.58	3.08	3.29	-	-	-	-
15	GAJY1311	North Goa	Bhujpal	5.63	1.16	1.36	3.03	-	-	-	-
16		North Goa	Bicholim	-	-	-	-	-	-	-	-
17	48E2D9	North Goa	Bicholim(pz)	15.77	-	-	15.47	16.619	13.085	-	15.502
18	48I3A2	South Goa	Bolkharnem	6.66	4.76	4.97	6.18	6.98	4.412	4.659	5.766
19	GAJY1310	North Goa	Bori	1.82	0.98	1.38	1.08	-	-	-	-
20		North Goa	Britona	2.08	1.47	1.93	3.15	-	-	-	-
21	48E2D11	North Goa	Calangute	7.68	4.2	5.27	6.65	8.177	3.819	4.399	6.392
22	48I4A12	South Goa	Canacona	4.79	1.93	2.46	3.83	4.674	1.656	2.642	3.735
23	48E4D1	South Goa	Carmona	-	-	-	6.07	-	-	-	5.373

24	GAJY1312	North Goa	Charayode	1.56	-	-	5.78	-	-	-	-
25	Jy1306	South Goa	Chikalim	2.31	0.53	1.48	2.19	-	-	-	-
26		North Goa	Collem(kolamba)	9.31	5.54	7.73	8.75	8.894	3.746	7.349	8.379
27		North Goa	Colval	14.82	9.53	10.09	14.1	-	-	-	-
28	Jy13118	South Goa	Cuncalim	1.98	1.2	0.98	1.95	-	-	-	-
29	48I4A6	South Goa	Cuncalim(pz)	5.98	5.56	5.16	5.5	4.836	4.383	6.956	4.886
30	48J1A2	South Goa	Daptamol Lolien	15.06	14.16	14.55	13.3	14.873	14.484	13.758	14.755
31	48I3A3	South Goa	Darbandahra(pz)	-	-	-	-	-	-	-	-
32	48I4A7	South Goa	Deulwada Kolamba	2.67	1.85	2.31	2.57	2.394	1.32	2.13	2.004
33		North Goa	Devulawada Narve	-	14.35	13.28	-	-	-	-	-
34		North Goa	Dhatwad Vante	10.61	7.36	5.85	-	-	-	-	-
35		South Goa	Fathorda Margao(pz)	3.9	-	-	3.77	-	-	-	-
36		North Goa	Gauli Mola	-	-	-	-	-	-	-	-
37	GAJY1305	North Goa	Gavalebhat Chimbel(kirl)	1.53	-	1.18	1.68	-	-	-	-
38	48I4A1	South Goa	Ghadiawada	1.77	0.87	1.16	2.02	2.136	1.094	1.59	2.052
39	48E3D3	North Goa	Goa Velha	-	-	-	-	-	-	-	-
40	Jy1312	South Goa	Guddemal	11.7	6.87	8.02	9.85	-	-	-	-
41	48I4A11	South Goa	Gulem Velipwada	3.79	0.26	0.43	3.79	3.422	0.558	0.709	2.428
42		North Goa	Hasapur	4.69	3.67	3.7	2.95	-	-	-	-
43		North Goa	Hasaravanni Vaipal	3.58	2.39	2.55	3.56	-	-	-	-
44	48J1A1	South Goa	Hattipal Poinguinem	8.36	6.16	6.36	6.57	8.276	5.528	6.349	6.539
45		North Goa	Hivre Budruk	-	-	-	-	-	-	-	-
46	48I2A4	North Goa	Honda	4.27	2.3	2.5	3.45	3.951	1.878	2.395	3.249
47	Jy13120	South Goa	Jambavli	8.81	6.8	8.71	8.87	-	-	-	-
48		North Goa	Jambhul Bhatt	-	1.2	1.44	-	-	-	-	-
49	Jy1311	South Goa	Kalay	11.8	9.69	10.71	10.66	-	-	-	-
50	48E4D2	South Goa	Kanagini(pz)	-	-	-	-	-	-	-	-
51		South Goa	Kapsa	6.2	3.21	3.87	4.7	-	-	-	-
52	48E3D2	North Goa	Karanjhalen	2.82	1.74	1.56	2.85	3.039	1.595	-	2.649

53	Jy1305	South Goa	Kaveslium	3.87	1.4	2.18	2.88	-	-	-	-
54	48I3A1	North Goa	Khadki(harijanwada)	9.95	5.24	7.29	7.34	10.499	4.079	6.123	7.076
55	GAJY1313	North Goa	Khotodem	6.25	4.73	5.99	6.19	-	-	-	-
56	48E2D3	North Goa	Korgaon	4.96	3.67	3.79	4.1	4.794	2.588	3.287	3.692
57		North Goa	Kundel Dassolwada	2.13	1.47	2.33	2.13	-	-	-	-
58	48E3D5	South Goa	Majorda Bpada Curilo	5.28	1.94	2.25	4.2	4.939	1.859	2.133	3.507
59	Jy1301	South Goa	Malkarnem	-	8.54	7.52	-	-	-	-	-
60	GAJY1309	North Goa	Mankem	4.1	2.67	3.64	3.75	-	-	-	-
61	48E2D7	North Goa	Mapuca	3.87	3	3.14	0.72	3.928	2.436	3.41	4.199
62		South Goa	Marmagoa	-	-	-	-	-	-	-	-
63	Jy1309	South Goa	Mashe	-	3.18	3.57	-	-	-	-	-
64	48I3A5	South Goa	Molem	13.83	3.28	7.07	10.65	13.648	1.822	6.691	10.233
65	48E2C1	North Goa	Morji	1.72	0.13	0.35	0.73	1.978	0.214	0.295	0.712
66	48I2A3	North Goa	Morlem	3.79	3.43	4.1	2.97	3.447	2.714	3.522	3.497
67	48E2D6	North Goa	Mulgaon Shivalkherwad	3.13	2.53	2.8	3.49	3.5	1.749	2.598	3.454
68	GAJY1304	North Goa	Nagargoan	7.77	1.5	3.88	3.08	-	-	-	-
69	48E2D2	North Goa	Nagjhar	7.61	7.48	7.74	7.48	8.861	5.994	7.152	7.986
70	Jy13115	South Goa	Navelim	-	3.59	4.08	-	-	-	-	-
71	48I4A9	South Goa	Netrolim	10.53	9.04	11	10.06	10.595	9.158	10.284	10.013
72		North Goa	Olaulim	2.14	1.44	1.55	1.9	-	-	-	-
73	Jy13119	South Goa	Padi	12.76	5.7	5.41	9.87	-	-	-	-
74	48I3A8	North Goa	Panchawadi(pz)	6.75	4.91	6.47	6.65	7.143	3.977	6.197	5.971
75	GAJY1301	North Goa	Parra	2.38	1.04	1.25	1.78	-	-	-	-
76	48E2D1	North Goa	Pernem	3.64	3.02	3.12	3.28	3.438	2.085	2.383	3.059
77		North Goa	Pirna	3.57	1.5	1.91	3	-	-	-	-
78	48J1A3	South Goa	Polem(polen)	5.88	2.96	3.27	4.9	4.036	1.149	1.162	1.998
79		North Goa	Pomburpa Palmar	3.49	2.56	3.36	3.26	-	-	-	-
80	48I3A4	North Goa	Ponda(pz)	-	-	-	-	-	-	-	-
81	Jy1308	South Goa	Ponquini	-	-	-	-	-	-	-	-

82	48I4A4	South Goa	Quepem	3.31	-	-	3.53	4.018	-	-	3.221
83	Jy13121	South Goa	Revona	7.73	5.64	7.83	6.54				
84	48E2D4	North Goa	Sal	3.17	2.25	2.41	2.76	3.034	1.799	2.615	2.923
85		North Goa	Salwardhar Dumun	2.98	3.55	2.73	2.88	-	-	-	-
86	GAJY1306	North Goa	Sawanthwada(mandrem)	3.79	-	-	3.38	-	-	-	-
87	48I3A7	North Goa	Shiroda	4.67	5.3	6.23	6.62	6.734	5.091	5.903	6.752
88	GAJY1308	North Goa	Shivoli (brahmanwada)	3.24	0.88	1.48	2.35	-	-	-	-
89		South Goa	Shrishtal Gaondongar	5.97	3.68	3.86	11.2	6.807	3.577	3.774	4.345
90	48E2D5	North Goa	Sirsaim	4.43	2.18	2.49	4.2	4.166	1.831	2.712	3.674
91	Jy1307	South Goa	Sristal	11.48	9.98	10.14	10.88	-	-	-	-
92	Jy1310	South Goa	Suktali (molem)	4.96	3.36	3.96	4.26	-	-	-	-
93	48I2A6	North Goa	Surla(pz)	-	-	-	-	-	-	-	-
94	Jy13113	South Goa	Themchewada	-	7.8	8.12	-	-	-	-	-
95		South Goa	Ugem(pz)	-	-	-	-	-	-	-	-
96	48E1D1	North Goa	Uguem(ugawe)	3.35	3.34	3.29	2.92	3.71	2.713	3.82	3.191
97	Jy1303	South Goa	Vadam	4.15	3.54	4.05	3.8	-	-	-	-
98		South Goa	Valkinim	-	-	-	-	-	-	-	-
99	48I2A5	North Goa	Valpoi	5.33	4.02	5	5.29	5.643	3.077	4.393	5.495
100	48E3D1	North Goa	Velha Goa	1.83	1.68	1.28	1.28	3.236	1.062	1.524	1.874
101	Jy1302	South Goa	Vichundrem	7.54	1.43	6.6	7.02	-	-	-	-
102		South Goa	Waddem(pz)	-	-	-	-	-	-	-	-
103	Jy1304	South Goa	Yedda	-	0.32	0.97	-	-	-	-	-

ANNEXURE-IV

FLUCTUATION DATA OF GROUND WATER MONITORING STATIONS FOR WATER YEAR 2015-2016

SOUTH WESTERN REGION, GOA STATE

S.No	Well No	Location	District	Seasonal Water Level Fluctuation (m)			Annual Water Level Fluctuation (m)				Water Level Fluctuation with respect to decadal mean water level (m)			
				May 15-Aug 15	May 15-Nov 15	May 15-Jan 15	May 14-May 15	Aug 14-Aug 15	Nov 14-Nov 15	Jan 15-Jan 16	Mean May(2005-2014) to May 2015	Mean Aug(2005-2014) to Aug 2015	Mean Nov(2005-2014) to Nov 2015	Mean Jan (2005-2014) to Jan 2016
1	GAJY1307	Adavapal	North Goa	0.51	0.1	0.04	0.03	-0.69	-0.22	-0.03	-	-	-	-
2	48I4D3	Agonda Desaiwada	South Goa	1.6	0.73	0.37	-0.13	-0.44	-1.81	0.4	-0.157	-0.478	-0.612	0.095
3	48I4A5	Akamol Ambavalli	South Goa	0.99	0.89	-0.22	-0.25	0.33	0.16	-0.92	-0.252	-	1.532	-0.309
4	48E2D12	Alto Betim Porvorim	North Goa	0.17	1.11	-3.6	-2.53	-2.42	-0.45	-4.31	1.37	-2.18	0.686	-2.873
5		Ambernem	North Goa	0.38	0.43	0.2	0.04	-0.42	-0.91	-1.98	-	-	-	-
6	GAJY1302	Anjuna Beach	North Goa	4.58	1.56	1.25	-0.53	-1.04	-4.27	-0.91	-	-	-	-
7	48E2D10	Baga	North Goa	-	-	-	-	-	-	-	-	-	-	-
8		Bagmola	South Goa	0.55	0.18	0.08	0.17	0.06	-0.23	0.07	-		-	-
9	48E3D6	Ballynuvhen	South Goa	0.81	-0.22	-0.45	2.72	2.66	-1.18	-0.15	1.028	0.46	-0.511	-0.035
10	Jy13117	Barodi Velni (betul)	South Goa	-	-	-	0.11	-	-	-	-	-	-	-
11	48I2A2	Bayalwadikeri(querim)	North Goa	0.78	-1.15	0.62	1.95	1.65	-1.16	0.21	1.797	0.467	0.548	1.48
12	Jy13116	Betalbatti	South Goa	3.95	3.73	1.12	0.08	-0.42	0.81	-0.6	-	-	-	-
13	GAJY1303	Bhamber(Nanoda cross)	North Goa	1.53	0.57	0.25	0.87	-0.83	-0.49	-1.25	-	-	-	-
14	Jy13114	Bhati	South Goa	0.71	0.21	-	1.88	-0.29	-0.88	-0.59	-	-	-	-
15	GAJY1311	Bhujpal	North Goa	4.47	4.27	2.6	-0.17	-0.08	-0.27	0.01	-	-	-	-
16		Bicholim	North Goa	5.33	7.73	0.3	-0.2	2.97	5.43	-1.1	0.849	2.645	-	0.032
17	48E2D9	Bicholim(pz)	North Goa	1.9	1.69	0.48	0.11	-0.18	-3.71	-0.84	0.32	-0.348	-0.311	-0.614
18	48I3A2	Bolkharnem	South Goa	-	-	-	-	-	-	-	-	-	-	-
19	GAJY1310	Bori	North Goa	0.84	0.44	0.74	1.78	1.66	-0.09	0.04	-	-	-	-

20	GAMY1301	Britona	North Goa	0.61	0.15	-1.07	-0.2	-0.06	-0.16	-1.22	-	-	-	-
21	48E2D11	Calangute	North Goa	3.48	2.41	1.03	0.27	0.28	-1.19	-0.65	0.497	-0.381	-0.871	-0.258
22	48I4A12	Canacona	South Goa	2.86	2.33	0.96	-0.5	-0.43	-0.24	-0.32	-0.116	-0.274	0.182	-0.095
23	48E4D1	Carmona	South Goa	-	-	-	-	-	-	-	-	-	-	-
24	GAJY1312	Charayode	North Goa	-	-	-4.22	2.99	-	-	-4.25	-	-	-	-
25	Jy1306	Chikalim	South Goa	1.78	0.83	0.12	-0.89	0.45	-0.82	-0.99	-	-	-	-
26		Collem(kolamba)	North Goa	3.77	1.58	3.18	-0.53	-1.92	-0.75	-0.36	-0.416	-1.794	-0.381	-0.417
27	GAMY1303	Colval	North Goa	5.29	4.73	0.72	0.09	0.84	0.36	-0.3	-	-	-	-
28	Jy13118	Cuncalim	South Goa	0.78	1	0.03	-0.12	-0.07	0.35	0.07	-	-	-	-
29	48I4A6	Cuncalim(pz)	South Goa	0.42	0.82	0.13	-0.14	-0.81	-3.93	-0.19	-1.144	-1.177	1.796	-
30	48J1A2	Daptamol Lolien	South Goa	0.9	0.51	1.76	-0.14	0.64	0.2	1.65	-0.187	0.324	-0.792	1.455
31	48I3A3	Darbandahra(pz)	South Goa	-	-	-	-	-	-	-	-	-	-	-
32	48I4A7	Deulwada Kolamba	South Goa	0.82	0.36	0.56	-0.36	0.06	0.4	-0.97	-0.276	-0.53	-0.18	-0.371
33		Devulawada Narve	North Goa	1.4	2.47	10.61	-10.99	-11.23	0.97	3.88	-	-	-	-
34		Dhatwado Vante	North Goa	3.25	4.76	-	-2.13	-4.3	-2.35	-	-	-	-	-
35	48I3D7	Fathorda	South Goa	1.55	0.38	-	0.6	0.95	-1.06	-	-	-	-	-0.697
36		Gauli Mola	North Goa	-	-	-	-	-	-	-	-	-	-	-
37	GAJY1305	Gavalebhat	North Goa	-	-	-	-	0.5	0.26	0.21	3.62	-	-0.04	0.06
38	48I4A1	Ghadiawada	South Goa	0.9	0.61	0.47	-0.02	-0.1	0.24	-0.32	0.366	0.224	0.43	-0.047
39	48E3D3	Goa Velha	North Goa	-	-	-	-	-	-	-	-	-	-	-
40	Jy1312	Guddemal	South Goa	4.83	3.68	1.85	-1.77	-0.17	-0.42	-0.91	-	-	-	-
41	48I4A11	Gulem Velipwada	South Goa	3.53	3.36	-	-0.45	0.35	0.12	-3.18	-0.368	0.298	0.279	-1.362
42		Hasapur	North Goa	1.02	0.99	1.74	-0.57	-0.16	0.1	1.25	-	-	-	-
43		Hasaravanni Vaipal	North Goa	1.19	1.03	0.02	-1.46	-1.83	-0.2	-0.58	-	-	-	-
44	48J1A1	Hattipal Poinguinem	South Goa	2.2	2	1.79	-0.25	-0.5	.	-0.04	-0.084	-0.632	-0.011	-0.031
45		Hivre Budruk	North Goa	-	-	-	-	-	-	-	-	-	-	-
46	48I2A4	Honda	North Goa	1.97	1.77	0.82	-0.62	-0.06	-0.32	-0.82	-0.319	-0.422	-0.105	-0.201
47	Jy13120	Jambavli	South Goa	2.01	0.1	-0.06	0.24	0.25	-0.26	-0.02	-	-	-	-
48		Jambhul Batt	North Goa	2.33	2.09	-	-0.83	-0.1	-0.06	-	-	-	-	-

49	Jy1311	Kalay	South Goa	2.11	1.09	1.14	-0.08	-0.37	-0.32	-0.06	-	-	-	-
50	48E4D2	Kanagini(pz)	South Goa	-	-	-	-	-	-	-	-	-	-	-
51		Kapsa	South Goa	2.99	2.33	1.5	-1.7	-0.23	-0.22	-0.3	-	-	-	-
52	48E3D2	Karanjhalen	North Goa	1.08	1.26	-0.03	-0.29	-0.61	0.06	-0.33	0.219	-0.145	-	-0.201
53	Jy1305	Kaveslium	South Goa	2.47	1.69	0.99	1.06	0.55	-0.82	-0.32	-	-	-	-
54	48I3A1	Khadki(harijanwada)	North Goa	4.71	2.66	2.61	0.82	-0.92	-1.55	0.36	0.549	-1.161	-1.167	-0.264
55	GAJY1313	Khotodem	North Goa	1.52	0.26	0.06	-0.18	0.3	-0.87	-	-	-	-	-
56	48E2D3	Korgaon	North Goa	1.29	1.17	0.86	-0.38	-0.27	-0.12	0.26	-0.166	-1.082	-0.503	-0.408
57		Kundel Dassalwada	North Goa	0.66	-0.2	.	-0.48	-0.37	-1.61	-0.52	-	-	-	-
58	48E3D5	Majorda Bpada Curilo	South Goa	3.34	3.03	1.08	1.08	0.13	-	-0.74	-0.341	-0.081	-0.117	-0.693
59	Jy1301	Malkarnem	South Goa	1.77	2.79	-	-0.17	-4.79	-3.86	-	-	-	-	-
60	GAJY1309	Mankem	North Goa	1.43	0.46	0.35	-0.15	-0.1	-0.39	-0.17	-	-	-	-
61	48E2D7	Mapuca	North Goa	0.87	0.73	3.15	-2.62	-1.89	0.05	3.13	0.058	-0.564	0.27	3.479
62		Marmagoa	South Goa	-	-	-	-	-	-	-	-	-	-	-
63	Jy1309	Mashe	South Goa	1.2	0.81	-	-0.28	-0.03	-0.13	-	-	-	-	-
64	48I3A5	Molem	South Goa	10.55	6.76	0.48	-	-2.28	-2.35	-0.26	-0.182	-1.458	-0.379	-0.414
65	48E2C1	Morji	North Goa	1.59	1.37	0.99	0.08	-0.05	-0.22	-0.35	0.258	0.084	-0.055	-0.018
66	48I2A3	Morlem	North Goa	0.36	-0.31	0.82	-0.96	-0.79	-0.4	0.01	-0.343	-0.716	-0.578	0.527
67	48E2D6	Mulgaon Shivalkherwad	North Goa	0.6	0.33	-0.36	-2.33	-2.32	-0.58	-0.01	0.37	-0.781	-0.202	-0.036
68	GAJY1304	Nagargoan	North Goa	6.27	3.89	4.69	-0.49	-0.75	-0.88	2.42	-	3.12	-	-
69	48E2D2	Nagjhar	North Goa	0.13	-0.13	0.13	0.19	-0.14	-0.31	-0.19	1.251	-1.486	-0.588	0.506
70	Jy13115	Navelim	South Goa	1.29	0.8	-	0.64	-1.76	-2.81	-	-	-	-	-
71	48I4A9	Netrolim	South Goa	1.49	-0.47	0.1	-0.42	0.17	-0.55	-0.3	0.065	0.118	-0.716	-0.566
72	GAMY1302	Olaulim	North Goa	0.7	0.59	0.24	4.74	3.29	1.17	1.3	-	-	-	-
73	Jy13119	Padi	South Goa	7.06	7.35	2.89	-0.23	0.09	0.34	-3.28	-	-	-	-
74	48I3A8	Panchawadi(pz)	North Goa	1.84	0.28	0.1	-1.24	-1.74	-0.52	-0.29	0.393	-0.933	-0.272	-0.679
75	GAJY1301	Parra	North Goa	1.34	1.13	0.6	-0.21	-0.42	-0.35	-0.26	-	-	-	-
76	48E2D1	Pernem	North Goa	0.62	0.52	0.36	2.13	1.64	0.02	0.14	-0.202	-0.935	-0.737	-0.221
77	GAMY1304	Pirna	North Goa	2.07	1.66	0.57	1.38	1.41	-0.38	-0.97	-	-	-	-

78	48J1A3	Polem(polen)	South Goa	2.92	2.61	0.98	-1	-2.07	-2.25	-3.18	-1.844	-1.811	-2.107	-2.902
79		Pomburpa Palmar	North Goa	0.93	0.13	0.23	-0.27	0.29	.	0.01	-	-	-	-
80	48I3A4	Ponda(pz)	North Goa	-	-	-	-	-	-	-	-	-	-	-
81	Jy1308	Ponquini	South Goa	-	-	-	-	-	-	-	-	-	-	-
82	48I4A4	Quepem	South Goa	-	-	-0.25	0.41	-	-	-0.25	0.708	0.056	-	0.032
83	Jy13121	Revona	South Goa	2.09	-0.1	1.19	-0.14	0.09	-1.02	1.07	-	-	-	-
84	48E2D4	Sal	North Goa	0.92	0.76	0.41	-0.35	-0.39	-0.69	-0.04	-0.136	-0.451	0.205	0.163
85		Salwardhar Dumun	North Goa	-0.57	0.25	0.1	-0.16	-1.44	-0.07	-0.03	-	-	-	-
86	GAJY1306	Sawanthwada(mandrem)	North Goa	2.76	1.44	0.41	1.08	0.55	-1.25	-1.73	-	-	-	-
87	48I3A7	Shiroda	North Goa	-0.63	-1.56	-1.95	2.06	-0.1	-0.28	-0.12	2.064	-0.209	-0.327	0.132
88	GAJY1308	Shivoli (brahmanwada)	North Goa	2.36	1.76	0.89	0.16	-0.15	-0.58	-0.37	-	-	-	-
89	48I4A10	Shrishtal Gaondongar	South Goa	2.29	2.11	-5.23	0.23	.	0.29	-6.75	0.837	-0.103	-0.086	-6.855
90	48E2D5	Sirsaim	North Goa	2.25	1.94	0.23	-0.64	-0.11	0.03	-0.65	-0.264	-0.349	0.222	-0.526
91	Jy1307	Sristal	South Goa	1.5	1.34	0.6	-7.95	-9.3	0.04	-0.54	-	-	-	-
92	Jy1310	Suktali (molem)	South Goa	1.6	1	0.7	3.93	5.05	-0.2	-0.2	-	-	-	-
93	48I2A6	Surla(pz)	North Goa	5.13	3.92	-	-0.67	2.39	1.09	-	0.276	1.981	0.984	-
94	Jy13113	Themchewada	South Goa	0.9	0.58	-	0.53	-0.9	0.41	-	-	-	-	-
95		Ugem(pz)	South Goa	-	-	-	-	-	-	-	-	-	-	-
96	48E1D1	Uguem(ugawe)	North Goa	0.01	0.06	0.43	-0.29	-0.79	-0.27	0.21	0.36	-0.627	0.53	0.271
97	Jy1303	Vadam	South Goa	0.61	0.1	0.35	0.75	-0.99	-1.79	-0.25	-	-	-	-
98		Valkinim	South Goa	-	-	-	-	-	-	-	-	-	-	-
99	48I2A5	Valpoi	North Goa	1.31	0.33	0.04	0.13	-1.02	-1.47	-0.07	0.313	-0.943	-0.607	0.205
100	48E3D1	Velha Goa	North Goa	0.15	0.55	0.55	-	-1.07	-	-	1.406	-0.618	0.244	0.594
101	Jy1302	Vichundrem	South Goa	6.11	0.94	0.52	-0.14	-0.88	-1.37	0.01	-	-	-	-
102		Waddem(pz)	South Goa	-	-	-	-	-	-	-	-	-	-	-
103	Jy1304	Yedda	South Goa	4.53	3.88	-	2.38	0.66	-0.77	-	-	-	-	-

ANNEXURE - V

Depth to Water Level of Piezometers in Goa State during 2015-16

Sl No.	District	Taluk	Location	Depth to Water Level			
				May-15	Aug-15	Nov-15	Jan-16
1	North Goa	Bardez	Adavapal	5.7	4.76	5.16	5.25
2	North Goa	Tiswadi	Ajosi	5	3.85	4.26	4.92
3	North Goa	Bardez	Aldona	16.69	14.25	14.72	15.81
4	North Goa	Bardez	Aropora	3.25	GL	1.08	2.18
5	South Goa	Canacona	Aven	10.29	6.62	8.3	8.68
6	North Goa	Ponda	Betki	17.17	14.27	14.82	17.32
7	South Goa	Mormugao	Bogmola	1.03	0.54	0.97	0.97
8	South Goa	Salcete	Canabonulim	6.34	4.06	4.27	5.22
9	South Goa	Salcete	Chandvar	3	1.98	2.46	2.66
10	South Goa	Salcete	Chinchinim	2.67	0.68	1.09	1.77
11	South Goa	Sanquem	Collem	6.78	5.27	5.84	6.93
12	North Goa	Pernem	Colvale	14.67	10.21	10.84	13.66
13	South Goa	Canacona	Dabel	12.98	8.15	9.85	10.8
14	South Goa	Sanquem	Dhat Farm	-	-	-	-
15	South Goa	Salcete	Dovorlim	5.74	4.92	5.37	5.61
16	North Goa	Pernem	Hassapur	6.6	4.7	4.97	5.86
17	South Goa	Sanquem	Kalay	5.92	3.94	4	3.75
18	South Goa	Salcete	Karmona	7.1	5.94	6.32	6.31
19	North Goa	Bicholim	Kasar Pal	10.37	8.36	8.95	10.1
20	South Goa	Salcete	Kavelosim	2.86	1.2	1.6	2.15
21	North Goa	Bardez	Kirl Pirna	9.82	7.11	8.19	8.9
22	North Goa	Pernem	Korgoan	12.6	11.97	11.1	-
23	North Goa	Tiswadi	Krilwada	2.21	1.56	1.92	2.05
24	South Goa	Canacona	Kuske	-	-	-	-
25	North Goa	Ponda	Madakai	22.1	17.69	17.3	20.7

26	South Goa	Salcete	Manora Rai	7.53	4.44	4.75	5.9
27	North Goa	Bicholim	Mayam	6.8	6.08	6.35	6.5
28	South Goa	Sanquem	Meidawada	13.75	8.19	10.7	11.37
29	North Goa	Tiswadi	Mola	1.27	1.06	1	1.02
30	South Goa	Sanquem	Molem	9.94	2.14	4.3	8.45
31	North Goa	Pernem	Morjum	3.13	2.22	2.38	2.58
32	North Goa	Satari	Morlem	5.12	2.8	3.65	3.22
33	North Goa	Satari	Nanoda	20.02	18.9	20.05	18.33
34	North Goa	Bicholim	Narve	13.15	10.29	10.68	12.58
35	South Goa	Sanquem	Natravlim	-	-	-	-
36	North Goa	Pernem	Parsekarwada	9.22	18.25	19.55	18.6
37	South Goa	Canacona	Patnem	8.16	3	4.15	5.88
38	South Goa	Canacona	Ponquini	9.59	8.48	9.18	9.3
39	South Goa	Quepem	Quiescond	16.98	12.2	14.62	16.98
40	North Goa	Bicholim	Sanqulim	24.9	18.84	22.04	25.4
41	North Goa	Satari	Sanvordam	15.32	12.65	14.45	14.8
42	North Goa	Pernem	Sawanthwada	5.78	3.97	4.82	5.35
43	North Goa	Pernem	Silolium	5.81	4.6	5	5.26
44	North Goa	Satari	Thane	10.2	6.72	7.6	8.32
45	North Goa	Bardez	Tivim	21.4	17.69	18.26	20.87
46	North Goa	Pernem	Tuem	-	-	-	-
47	North Goa	Pernem	Varkhand	15.53	11.6	14.05	14.94
48	South Goa	Salcete	Verna	2.42	1.26	2.13	2.38
49	South Goa	Canacona	Yedda	10.55	4.77	8.02	8.93

ANNEXURE-VI

HYDROCHEMICAL DATA OF GROUND WATER MONITORING STATIONS, GOA STATE

S.NO.	Location	pH	Specifc Conduct. in µS/cm at 25°C	$C0_3$	$HC0_3$	Cl	$N0_3$	$S0_4$	F	PO_4	Ca	Mg	TH	Na	K	PO_4	
1	Morlem	7.8	140	0	30	28	1	2	0.06	-	8	2	30	17	1.8	0.10	ND
2	Bhuipal	8.2	200	0	24	50	5.0	4	0.05	-	6	8	50	21	1.5	0.11	ND
3	Valpoi	7.9	160	0	37	21	6	10	0.50	-	8	7	50	10	4.0	0.11	ND
4	Bamber	7.9	170	0	43	21	2	12	0.20	-	12	2.4	40	18	1.9	0.15	ND
5	Khadki	8.2	120	0	30	21	0.9	3	0.10	-	8	2.4	30	13	0.7	0.12	ND
6	Kotaden	7.8	190	0	49	28	4.0	10	0.11	-	16	2.4	50	20	0.9	0.11	ND
7	Dhat-wado-Vante	7.2	110	0	18	21	3.0	4	0.09	-	8	2.4	30	10	1.0	0.15	ND
8	Jambhulbatt	7.9	80	0	18	14	0.5	2	0.06	-	4	2.4	20	8	0.5	0.16	ND
9	Mapusa	8.2	220	0	55	32	5.0	12	0.08	-	20	5	70	16	2.6	0.14	ND
10	Parra	8.0	350	0	98	36	6.0	38	0.10	-	32	10	120	22	7.4	0.12	ND
11	Calangute	7.9	610	0	146	99	40.0	6	0.41	-	40	24	200	47	0.4	0.11	0.006
12	Silolium	7.8	280	0	85	28	5.0	19	0.41	-	24	5	80	26	2.2	0.07	0.007
13	Morji	7.9	160	0	43	21	2.0	8	0.10	-	8	7	50	12	0.9	0.11	0.003
14	Sawanthawada	8.0	70	0	12	14	0.2	4	0.06	-	4	2.4	20	6.4	0.1	0.10	0.001
15	Kargaon	7.8	100	0	24	14	2.5	4	0.06	-	4	5	30	7.6	0.4	0.25	ND
16	Uguem	7.8	90	0	12	21	2.0	2	0.06	-	4	4.8	30	6	1.1	0.01	ND

17	Amberem	7.7	150	0	30	28	5.0	3	0.08	-	8	5	40	15	1.2	0.37	ND
18	Nagjhar	7.5	90	0	24	14	1.0	4	0.07	-	4	2	20	10.4	1.8	0.16	ND
19	Hasaravanni Valpoi	7.7	120	0	30	21	0.7	2	0.04	-	8	2.4	30	11	3.1	0.11	ND
20	Adavpal	7.6	60	0	12	11	3.5	1	0.02	-	4	2.4	20	4	0.5	0.01	ND
21	Pirna	7.4	60	0	12	7	2.0	4	0.05	-	4	2.4	20	2.6	0.4	0.16	ND
22	Sal	7.6	140	0	37	14	5	14	0.08	-	12	5	50	7.6	0.8	0.15	ND
23	Mulgaon	7.7	170	0	49	21	4.0	10	0.08	-	12	2.4	40	18.6	1.9	0.06	0.001
24	Sirsaim	7.4	90	0	24	14	0.4	3	0.04	-	4	2	20	10.4	1.8	0.09	0.002
25	Mapuca	7.8	280	0	30	50	31.0	14	0.16	-	16	10	80	25	2.1	0.11	ND
26	Colvol	7.6	290	0	67	21	34.0	24	0.10	-	28	10	110	14	0.4	0.11	ND
27	Olauim	7.9	120	0	18	21	3.0	8	0.10	-	12	2.4	40	7	1.2	0.07	ND
28	Pomburpa-Palmar	7.4	1990	0	140	554	11.0	74	0.40	-	92	36.3	380	258	39.2	0.06	ND
29	Salwardhar Dumun	8.2	100	0	24	14	4	3	0.06	-	4	5	30	7.3	1	0.10	ND
30	Karanjhalen	8.0	310	0	79	35.5	34	8	0.12	-	24	5	80	33	0.5	0.19	ND
31	Gavalebhat	8.0	290	0	55	43	10	24	0.13	-	16	10	80	27	1.9	0.06	ND
32	Velha Goa	7.9	210	0	67	28	3	3	0.10	-	16	2.4	50	23	1.7	0.17	ND
33	Chikalem	8.1	170	0	49	21	9	2	0.08	-	16	5	60	9	1.2	0.11	0.014
34	Bagmola	8.2	160	0	24	21	15	14	0.09	-	8	2	30	21	1.9	0.24	0.006
35	Ballynuvhen	7.9	100	0	18	14	8	5	0.02	-	6	1.2	20	12	1.3	0.11	0.002
36	Majorda	8	320	0	73	43	20	18	0.43	-	20	5	70	39.0	1.90	0.08	0.002

37	Betalbatti		Sample Leaked							-						0.20	0.001
38	Kavaselium	7.5	510	0	177	43	26	16	0.61	-	28	17	140	49	2.0	0.11	0.005
39	Cunculium	7.4	200	0	43	28	17	10	0.35	-	20	2.4	60	19	1.3	0.07	ND
40	Padi	7.3	80	0	18	14	2	1	0.04	-	4	2	20	7	1.8	0.14	ND
41	Gulem Velipawada	7.3	130	0	30	21	8	2	0.07	-	8	5	40	10	1	0.21	0.035
42	Agonda	7.2	180	0	30	35	1	10	0.06	-	8	2.4	30	24	2.1	0.13	0.004
43	Sristal	7.1	130	0	24	21	5	6	0.05	-	12	2.4	40	9.4	1.1	0.06	0.002
44	Polem	7.7	120	0	18	25	6	4	0.10	-	8	5	40	8	2	0.09	0.012
45	Deptamol Lolien	7.4	60	0	12	7	1.3	4	0.05	-	4	2.4	20	2.4	0.4	0.03	0.004
46	Hattipal Poinguinem	7.5	100	0	18	21	0.4	4	0.06	-	8	2	30	8.5	0.2	0.11	ND
47	Yedda	7.4	140	0	30	28	1	4	0.12	-	16	2.4	50	8.8	0.52	0.16	ND
48	Shrishtal Gaondongar	7.2	90	0	12	21	3	2	0.04	-	4	5	30	6	0.6	0.07	0.003
49	Netrolim	7.4	100	0	30	14	2	1	0.05	-	4	7	40	4	0.26	0.03	0.024
50	Vaddem	8.0	90	0	24	14	2	1	0.03	-	4	5	30	5	1.3	0.11	0.004
51	Vinchurdem	7.5	80	0	30	7	1	2	0.10	-	8	2.4	30	3	0.5	0.08	0.001
52	Deulwada Kolamba	7.7	110	0	24	21	0.8	4	0.08	-	12	2.4	40	6.5	0.35	0.1	ND
53	Revona	7.4	120	0	30	21	1	4	0.12	-	12	2.4	40	7.6	1.30	0.03	0.001
54	Jambavali	7.2	60	0	12	11	0.9	3	0.05	-	2	3.6	20	4	0.5	0.16	0.007
55	Gudemal	7.6	140	0	30	28	2	1	0.12	-	10	6	50	7.5	0.52	0.09	ND
56	Panchawadi	7.5	120	0	18	28	3	2	0.10	-	4	5	30	13	0.02	0.07	0.001

57	Shiroda	7.4	130	0	30	21	2	6	0.06	-	8	5	40	10	0.41	0.22	ND
58	Ghadiawada	7.4	110	0	24	21	1	2	0.07	-	6	1.2	20	14.6	0.36	0.15	0.006
59	Malkarnem	7.5	130	0	24	28	2	2	0.04	-	8	2.4	30	15	0.6	0.18	0.004
60	Kalya	7.7	50	0	12	7.1	1.8	1	0.05	-	2	1.2	10	6	0.4	0.1	0.002
61	Collem	7.3	90	0	18	18	1	1	0.06	-	6	3.6	30	4.6	0.8	0.11	0.001
62	Molem	7.4	160	0	30	36	1	3	0.07	-	12	5	50	12	1.30	0.06	ND
63	Bolkarnem	7.1	70	0	12	14	0.8	4	0.10	-	4	2.4	20	6.4	0.08	0.12	0.008
64	Marcel	7.1	50	0	12	7	1.3	2	0.05	-	4	2.4	20	1.6	0.4	0.08	0.014
65	Keri	7.0	60	0	12	7	2.0	4	0.05	-	4	2.4	20	2.6	0.4	0.11	0.001