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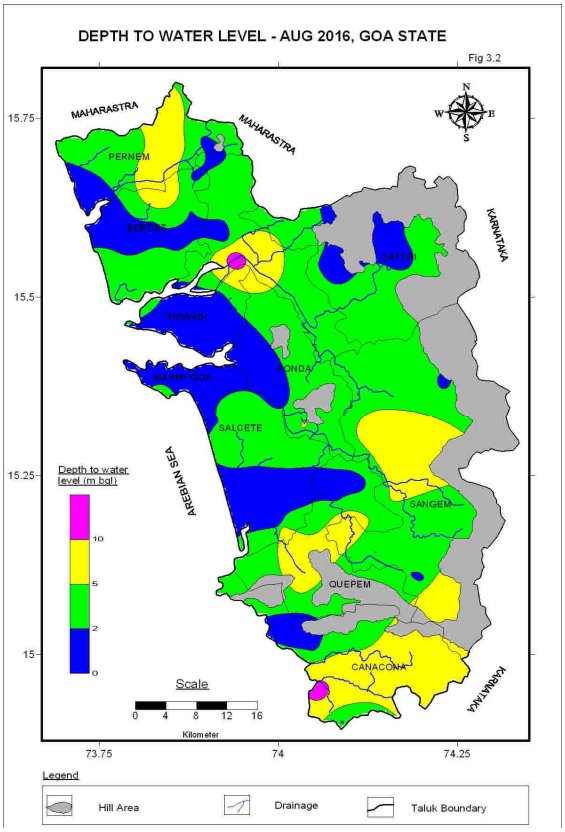
Government of India

Ministry of Water Resources,
River Development and Ganga Rejuvenation

Central Ground Water Board

GROUND WATER YEAR BOOK
GOA STATE
2016-17



CENTRAL GROUND WATER BOARD
SOUTH WESTERN REGION
BANGALORE
September 2017

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. The 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 2016-17 and chemical quality data collected during the year 2015. 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 distribution and variation of rainfall for normal period. Chemical quality of groundwater on the basis of the samples collected during May 2015 and the interpretation of the data is included in the report.

The data has 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, Assistant Hydrologist, Smt. Hemalatha, STA (HG), Shri Rahul Vashistha, STA (Chem) and Lalitha. B.H., STA (Chem). Lot of efforts have been put in by various personnel of SWR, Bangalore and WKSU Belgaum offices for the collection of field data. The water samples were analysed by the Regional Chemical Laboratory to bring out the aspects of groundwater quality. Dr. M. A. Farooqi 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 the 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 2016 and January 2017. This report contains the analysis and interpretation of the water level and water quality data.

Thematic maps depicting the groundwater scenario during this period are prepared and discussed. Average annual rainfall is of the order of 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 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 90% of the wells have water level less than 10 mbgl and the rest are in the range of 10-20 mbgl. The depth to water level recorded in the State of Goa during pre-monsoon season ranged from 1.7 mbgl to 18.84 mbgl. It is seen that out of 89 stations analyzed during the month, 2% wells have water level less than 2 mbgl, 42% wells have 2 to 5 mbgl water level, 46% wells have 5 to 10 mbgl water level, 10% 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 parts of Berdez, Bicholim, Ponda, Salcete, Sanguem, Satari, and Cancona taluks.

During post-monsoon season, about 92% of the wells recorded less than 10 mbgl water level and the remaining 8% wells have water level in the range of 10-20 mbgl. The depth to water level recorded in the State of Goa during post-monsoon season ranged from 0.61 mbgl to 14.49 mbgl. It is seen that out of 82 stations analyzed, 27% wells have less than 2 mbgl water levels, 39% wells have 2 to 5 mbgl water levels, 26% wells have 5 to 10 mbgl water level, and the remaining 8% 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. Depth to water level in the range of <2 mbgl, is observed as patches in almost all taluks, except Sanguem taluk. Water level more than 10 mbgl is observed as patches in of Bicholim, Tiswadi, Sanguem and Cancona taluks.

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

GROUND WATER YEAR BOOK 2016-17
OF GOA STATE

C O N T E N T S

LIST OF FIGURES

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GROUND WATER YEAR BOOK OF GOA STATE
2016-17

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 3,702 Sq. km., which is administratively divided into two districts with 11 taluks. The taluk wise distribution of Ground water monitoring stations being monitored by the Region is given in **Table 1.1.**

Table 1.1: District wise 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.Coastal plains with dominant Marine 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 aerial extent.

1.3 Drainage

The State of Goa is drained by the west flowing rivers, 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). Primarily the underlying rocks govern the drainage system in the area. The drainage pattern is generally dendritic type. The major river Zuari follows the major NW synclinal axis. The river valleys are 'V' shaped in the western high hill ranges, but broaden 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		

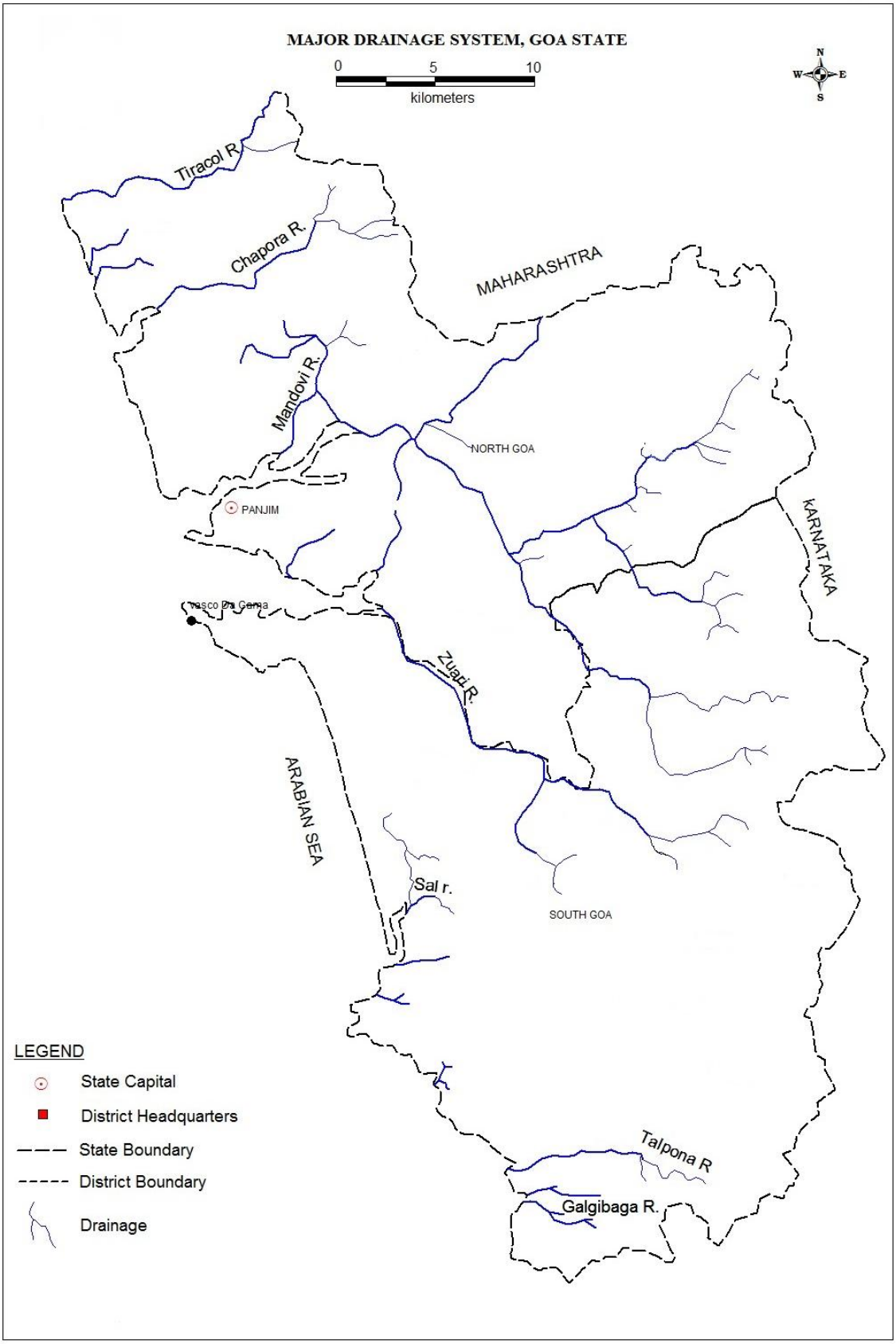


Fig 1.1: Major Drainage System of Goa State

1.4 Geology

Major part of the Goa State is underlain by rocks of Pre-cambrian age comprising of 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 north-eastern part in the high altitudes. Geological map is presented in Fig 1.2.

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 metres. 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 conditions.

Major portion of the state is occupied mainly 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.

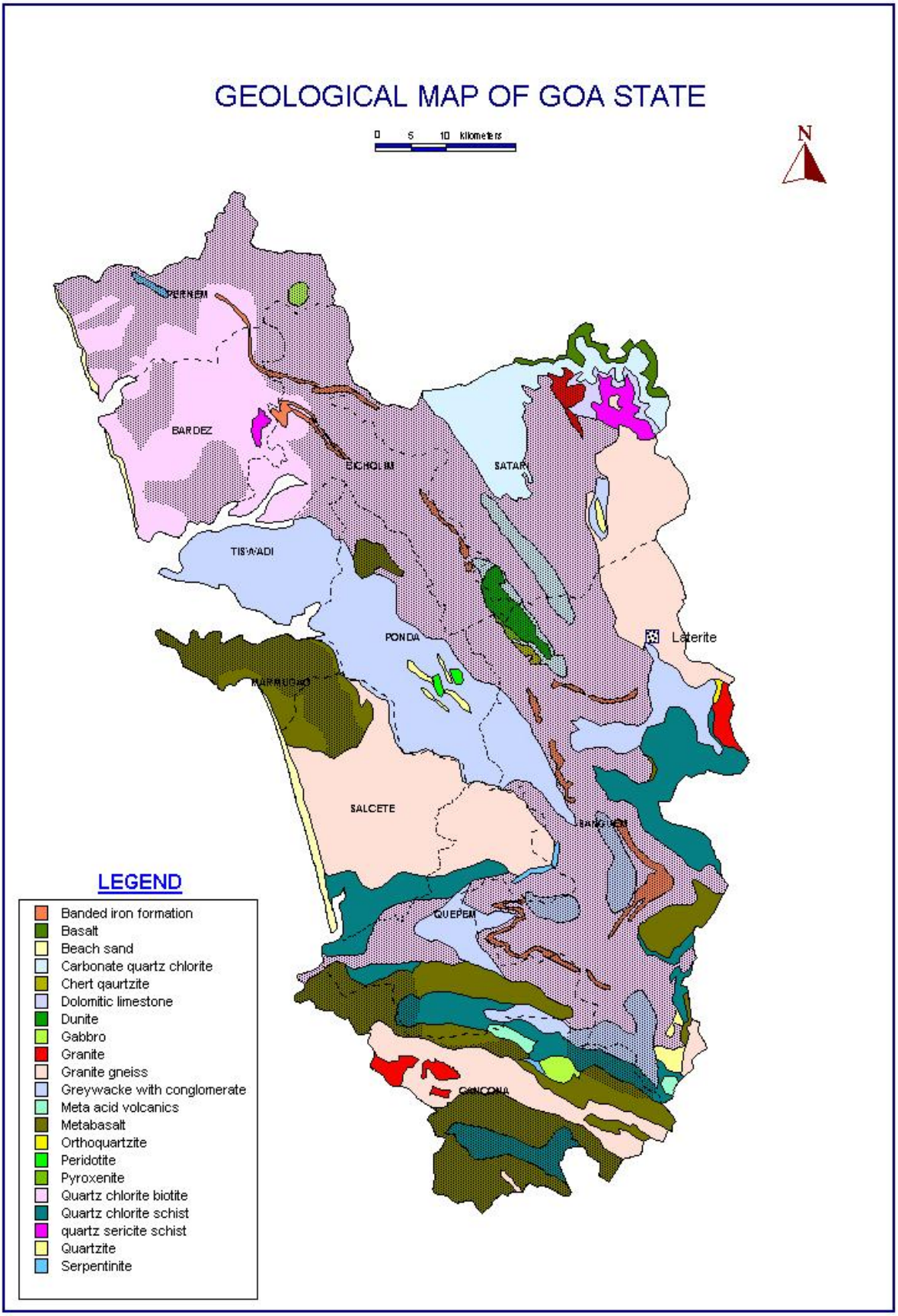


Fig 1.2: Geological Map of Goa State

2.0 Climate and Rainfall

Goa 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 the coolest month with temp 25°C

2.1 Rainfall

Rain occurs during the monsoon period from June to September. Over 90 percent of annual rainfall occurs during monsoon period. The balance of 10 percent 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 3460 mm (90% of annual rainfall), 218.1 mm (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 3483.3 mm. The minimum rainfall of 2611.7 mm is recorded at Mormugao station falls in South Goa district and maximum of 5090 mm is in Sanguem station also from South Goa district.

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 Mormugao 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 3733.13 mm.

The months of June (840.7 mm) and July (1246.9 mm) are the wettest months with around 2187.6 mm (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 in respect of 12 stations of Goa state is presented in Annexure - II.

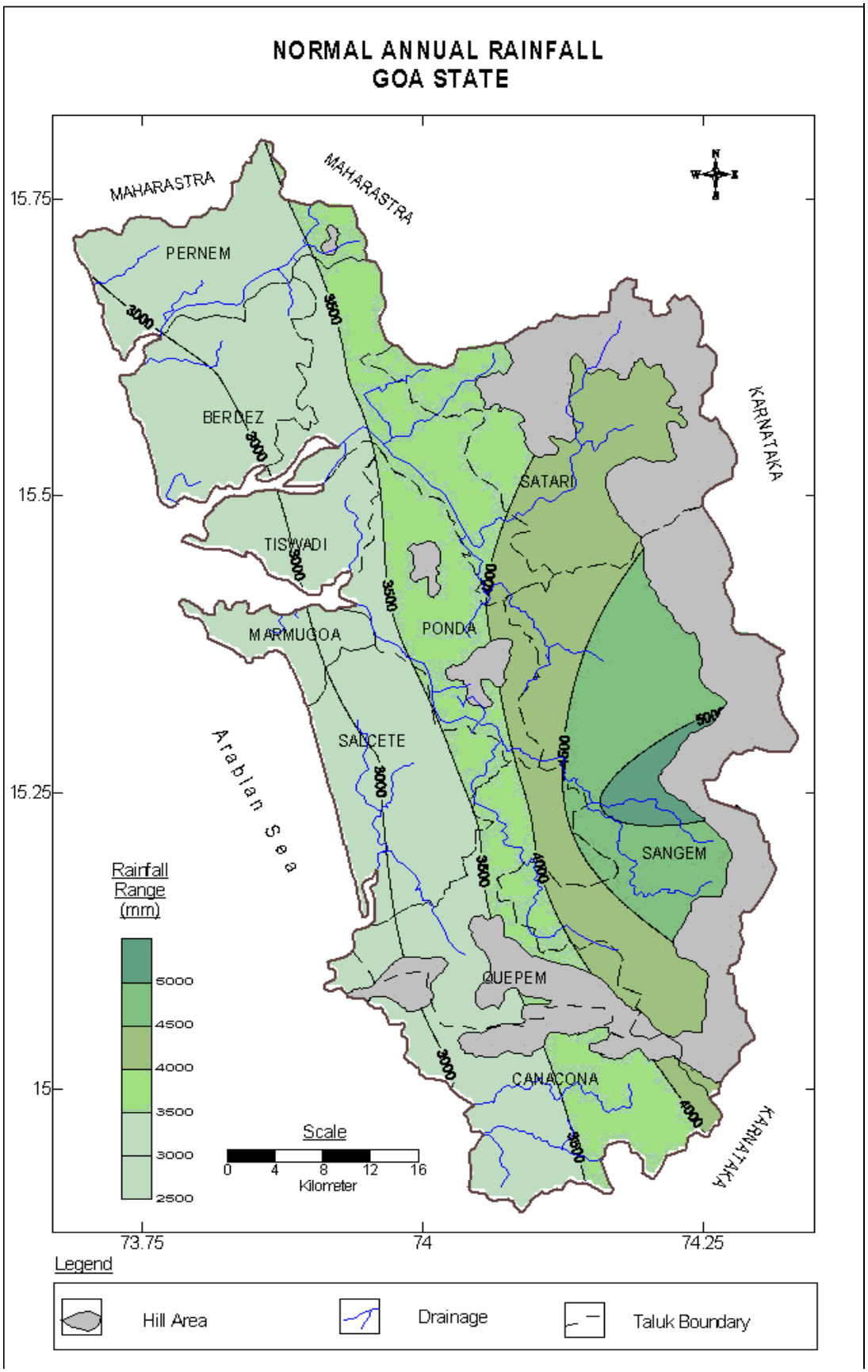


Fig 2.1: Normal Annual Rainfall (1970-2000)

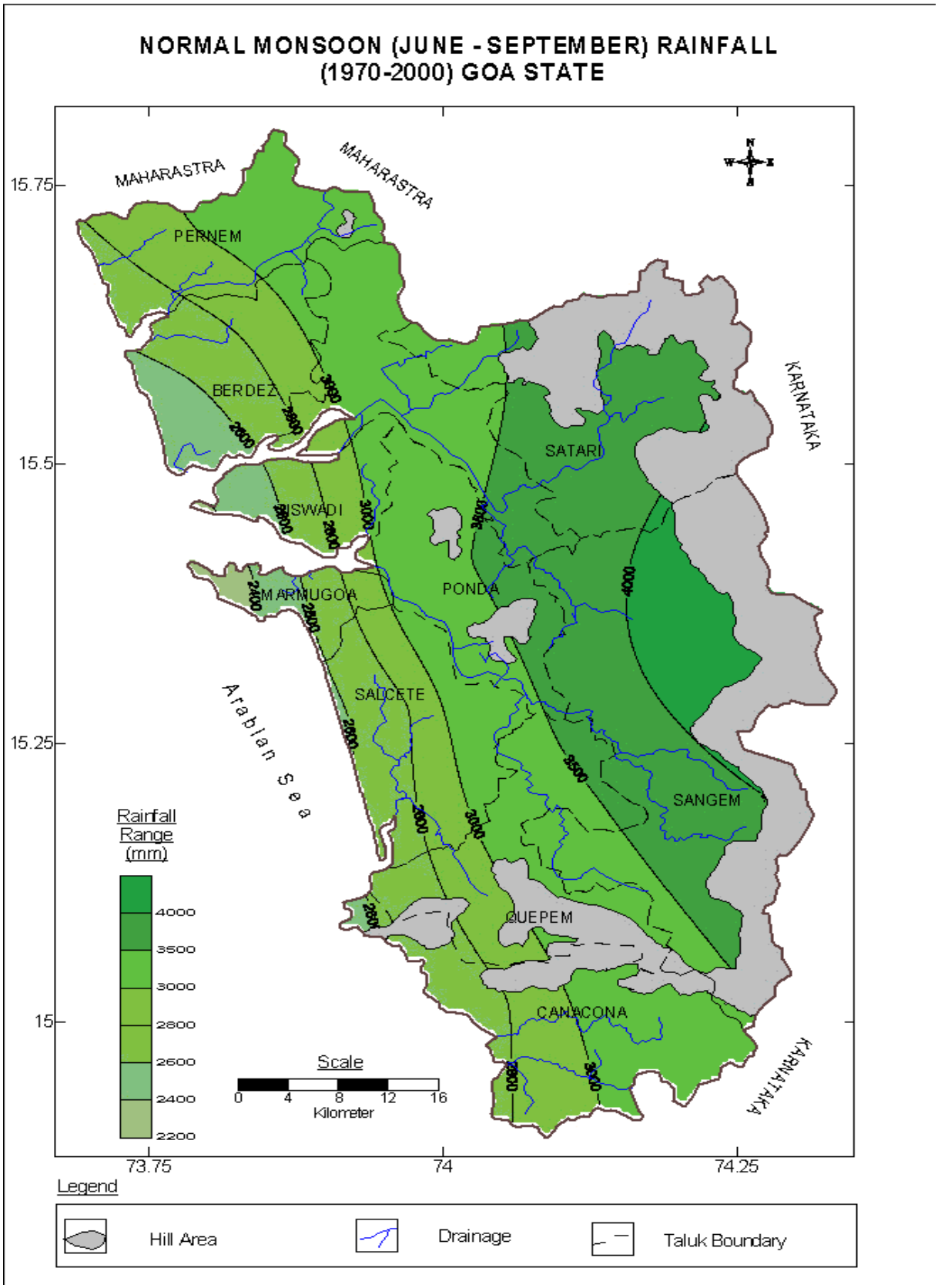


Fig 2.2: Normal Monsoon Rainfall (1970-2000)

3. GROUND WATER LEVELS IN GOA DURING WATER YEAR 2016 -17

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 of 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 2016 and January 2017. The analysis/findings are as below:

Depth to Water Level, May 2016

The depth to water level recorded in the State of Goa during May 2016 ranged from 1.7 mbgl to 18.84 mbgl. It is seen that out of 89 stations analyzed during the month, 2% wells have water level less than 2 mbgl, 42% wells have 2 to 5 mbgl water level, 46% wells have 5 to 10 mbgl water level, 10% 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 to 10 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 to 5 mbgl is observed in almost all taluks of Goa State. Water level in the range of 5 to 10 mbgl is observed in almost all taluks of Goa State and >10 mbgl is observed in parts of Berdez, Bicholim, Ponda, Salcete, Sanguem, Satari, and Cancona taluks.

Depth to Water Level, August 2016

The depth to water level recorded in the State of Goa during August 2016 ranged from 0.11 mbgl to 13.14 mbgl. It is seen that out of 85 stations analyzed during the month, 36.5% wells have water level less than 2 mbgl, 40% wells have 2 to 5 mbgl water level, 21.2% wells have 5 to 10 mbgl water level, 2.4% 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 as major portions in Canacona, Pernem, Bardez, Tiswadi, Mormugao, Salcete and Quepem taluks and as small patches in Sanguem and Satari taluks. 2 to 5 mbgl is observed in almost all taluks of

Goa State as major portion, 5 to 10 mbgl is observed in almost all taluks, except Mormugao. Water level >10 mbgl as small patches is recorded in Bicholim and Cancona taluks.

Depth to Water Level, November 2016

The depth to water level recorded in the State of Goa during November 2016 ranged from 0.61 mbgl to 14.49 mbgl. It is seen that out of 82 stations analysed during the month, 27% wells have water level less than 2 mbgl, 39% wells have 2 to 5 mbgl water level, 26% wells have 5 to 10 mbgl water level, 8% 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, Tiswadi, Sanguem and Cancona taluks.

Depth to Water Level, January 2017

The depth to water level recorded in the State of Goa during January 2017 ranged between 1.04 to 15.80 mbgl. It is seen that out of 81 stations monitored during the month, 14% wells have less than 2 mbgl water levels, 48% wells have 2 to 5 mbgl water levels, 27% wells have 5 to 10 mbgl water level, and the remaining 11% have 10 to 20 mbgl 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, Berdez, Ponda, Marmugao, Salcete, Canacona, Tiswadi, Satari and Bicholim taluks. Depth to water level in the range of 2 to 5 mbgl and 5 to 10 mbgl is observed in major part of the state covering almost all the taluks in the State. Depth to water level more than 10 mbgl is noticed as small patches in Pernem, Bardez, Bicholim, Sanquem, Quepem 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 2016 are compared with water levels during August 2016, November 2016 and January 2017 to know the Seasonal Fluctuation. 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 2016 to August 2016

Water levels from 80 stations were compared to know the change in groundwater level in August 2016 as compared with May 2016 in the State of Goa. It is seen that out of 80 stations analyzed during the month which shows all the stations have shown rise in water level except two stations in fall category. Rise of water level in the range 0 to 2 m is observed in 34 wells accounting for 42.5% of the analyzed wells. Rise in water level in the range of 2 to 4 m and > 4m is recorded in 29 wells (36.3%) and 15 wells (18.8%) respectively. Fall in water level in the range of 0 to 2 m is recorded in 1 station accounting for 1.3% and 2 to 4 m is recorded in 1 station accounting for 1.3% in Goa State (Table 3.5).

A map depicting the change in groundwater level in August 2016 as compared to May 2016, 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 and 2 to 4 m is the general trend of the Goa State and is observed in almost all the taluks. More than 4 m rise is observed in parts of Tiswadi, Satari, Sanguem and Quepem taluks. Fall in water level of 0 to 2 m is observed in parts of Salcete, Canacona and Sanguem taluks.

Change in Groundwater Level: May 2016 to November 2016

Water levels from 77 stations were compared to know the change in groundwater level in November 2016 as compared with May 2016 in the State of Goa. Amongst the 77 analysed 67 wells (87%) have a recorded rise in water level and 10 wells (13%) have fall in water level during November 2016 as compared to May 2016. Rise of water level in the range 0 to 2 m is observed in 39 wells accounting for 51% of the analysed wells. Rise in water level in the range of 2 to 4 m and >4m is recorded in 21 wells (27%) and 7 wells (9%) respectively. Fall in water level of 0 to 2 m is noticed in 8 wells accounting for 10% of the analysed wells. Fall in water level in the range of 2 to 4 m and >4m is recorded in 1 well (1%) each (Table 3.6).

A map depicting the change in groundwater level in November 2016 as compared to May 2016, 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 parts of Canacona, Bardez, Tiswadi, Quepem and Sanguem taluks. Fall in water level in the range of 0 to 2 m is observed in parts of Bicholim, Pernem, Quepem, Sanguem and Sattari. Fall in water level in the range of 2 to 4 m and >4 m is observed as isolated patches in Quepem and Canacona, taluks.

Change in Groundwater Level: May 2016 to January 2017

Water levels from 75 stations were compared to know the change in groundwater level in January 2017 as compared with May 2016 in the State of Goa. On the whole 61 wells accounting for 81% of the analysed wells have recorded a rise in water level during January 2017 as compared with the period May 2016. The remaining 14 wells (19%) have recorded fall in water level. In the rise category, the rise of water level in the range 0 to 2 m is observed in 47 wells accounting for 63% of the analyzed wells. Rise in water level in the range of 2 to 4 m is recorded in 12 wells (16%) and more than 4 m is recorded in 2 wells (3%) respectively. In the fall category, 12 wells (17%) have recorded a fall in the range of 0 to 2 m. Fall in water level in the range of 2 to 4 and more than 4 m is recorded in 1 well (1%) each (Table 3.7).

A map showing the change in groundwater level in January 2017 as compared to May 2016, 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 showing rise in water level in the range of 0 to 2 m and 2 to 4 m of rise is observed in parts of Bardez, Pernem, Tiswadi, Salcete, Ponda, Satari, Sangem Canacona and Quepem taluks of Goa State. Rise in water level of >4 m is observed in parts of Bardez and Tiswadi taluks. Fall in water level in the range of 0 to 2 m is observed as patches in parts of Bardez, Tiswadi, Bicholim, Pernem, Ponda, Sangem, Quepem and Canacona taluks. Fall in water level in the range of 2 to 4 m and more than 4 m is noticed in parts of Canacona taluk.

Change in Groundwater Level: May 2015 to May 2016

Water levels from 84 stations were compared to know the change in groundwater level in May 2016 as compared with May 2015 in the State of Goa. It is seen from the table that 43% of the stations monitored have recorded a rise in water level during May 2016 as compared to May 2014 and 57% have shown fall in water level. Rise in water level in the range of 0 to 2 m is observed in 34 wells accounting for 41% and more than 4 m is observed in 2 wells accounting for 2% of the analysed wells. Fall in water level in the range of 0 to 2 m is recorded in 42 wells accounting for 50%, 2 to 4 m in 2 wells accounting for 2% and more than 4 m is recorded in 2 wells accounting for 5% (Table 3.8).

A map depicting the change in groundwater level in May 2016 as compared to May 2015, 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 to 2 m is observed in almost all parts of Goa State. Rise in water level in the range of >2 m is observed in parts of Quepem, Canacona and Sanguem taluks. Fall in water level in the range of <2 m is observed in almost all parts of Goa state. Fall in water level of 2 to 4 m is observed in parts of Ponda, Berdez and Satari taluks and >4 m is observed in parts of Berdez taluk.

Change in Groundwater Level: August 2015 to August 2016

Water levels from 82 stations were compared to know the change in groundwater level in August 2015 as compared with August 2015 in the State of Goa. It is seen from the table that 67% of the stations monitored have recorded a rise in water level during August 2016 as compared to August 2015 and 33% have shown fall in water level. Rise in water level in the range of 0 to 2 m is observed in 49 wells accounting for 59.8%, 2 to 4 m is observed in 4 wells accounting for 4.9% and more than 2 m is observed in 2 wells accounting for 2.4%. Fall in water level in the range of 0 to 2 m is recorded in 26 wells accounting for 31.7% and more than 4 m is recorded in 1 well accounting for 1.2% of the analysed wells (Table 3.9).

A map depicting the change in groundwater level in August 2016 as compared to August 2015, 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 all taluks in Goa State. Rise in water level in the range of >2 m is observed as isolated patches in Bicholim, Tiswadi, Satari, Sanguem, Quepem and Canacona taluks. Fall in water level in the range of 0 to 2 m is observed as isolated patches in almost all taluks of Goa State. Fall in water level of >2 m is observed in parts of Sanguem and Canacona taluks of the Goa State. Fall in water level of >4 m is observed in parts of Canacona taluk of Goa State.

Change in Groundwater Level: November 2015 to November 2016

Water levels from 80 stations were compared to know the change in groundwater level in November 2016 as compared with November 2015 in the State of Goa. It is seen from the table that 53% of the stations monitored have recorded a rise in water level during November 2016 as compared to November 2015 and 47% have shown fall in water level. Rise in water level in the range of 0 to 2 m is observed in 38 wells accounting for 48% and 2 to 4 m is observed in 4 wells accounting for 5%. Fall in water level in the range of 0 to 2 m is recorded in 37 wells accounting for 46%, 2 to 4 m is recorded in 1 well accounting for 1% of the analysed wells (Table 3.10).

A map depicting the change in groundwater level in November 2016 as compared to November 2015, 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 to 2 m is observed as major portion in almost all taluks of Goa State. Water level rise in the range of 2 to 4 and >4 is noticed as isolated patch in Satari and Salcete taluk. Fall in water level in the range of 0 to 2 m is observed in major portion of the Goa State. Fall in water level in the range of 2 to 4 m is observed in parts of Sanguem taluk.

Change in Groundwater Level: January 2016 to January 2017

Water levels from 74 stations were compared to know the annual change in groundwater level in January 2017 as compared to January 2016 in the State of Goa. On the whole 41 wells accounting for 56% of the analysed wells have recorded a rise in water level during January 2017 as compared with the period January 2016. The remaining 33 wells (44%) have recorded fall in water level. It is seen from the data that out of 74 stations, 38 wells have rise in water level in the range of 0 to 2 m accounting for 52% , while rise in water level in the range of 2 to 4 m is recorded in 3 wells (4%). Fall in water level in the range of 0 to 2 m is recorded in 29 wells accounting for 39%. Fall in the range of 2 to 4 m and >4 m is observed in 3 wells (4%) and 1 well (1%) respectively (Table 3.11).

A map showing the change in groundwater level in January 2017 as compared to January 2016, showing rise/fall in the ranges of 0 to 2 m, 2 to 4 m and > 4 m is enclosed as Fig 3.11. Major part of the state shows rise in water level in the range of 0 to 2 m. Rise in water level of 2 to 4 m is recorded in parts of Bardez and Salcete taluks. Fall in water level in the range of 0 to 2 m is observed in almost all parts of Goa State. Fall in water levels in the range of 2 to 4 m is recorded in parts of Berdez, Bicholim, Ponda, Satari and Canacona taluks and more than 4 m fall is noticed in parts of Satari and Bicholim taluk.

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

Mean groundwater level for the period May 2006 to May 2015 was compared with the groundwater level in May 2016 in the State of Goa. It is seen that out of the 39 stations compared, 18 stations accounting for 46% of analyzed wells, have shown a rise and 21 wells accounting for 54% of analyzed wells have shown a fall in water level. In the rise category, 18 wells accounting for 46% of the analysed wells are in the range of 0 to 2 m. In the fall category, 20 wells accounting for 51% of the wells have recorded a range of 0 to 2 m and 1 well accounting for 3% are in the range of 2 to 4 m water level fluctuation during May 2016 as compared to preceding decadal mean (Table 3.12).

A map showing the change in water levels, with rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m is enclosed as Fig 3.12. Rise in water levels of 0 to 2 m is observed in parts of Sanguem, Quepem, Cancona, Salcete, Satari, Bicholim and Pernem and Berdez taluks. Fall in water level of 0 to 2 m is observed in almost all taluks.

Change in Water Level: Mean (August 2006 to August 2015) – August 2016

Mean groundwater level for the period August 2006 to August 2015 was compared with the groundwater level in August 2016 in the State of Goa. It is seen that out of the 38 stations compared, 16 stations have shown a rise in water level accounting for 42% of analyzed wells and 22 wells accounting for 58% of analyzed wells have shown a fall in water level In the

rise category, 16 wells accounting for 42.1% of the analyzed wells are in the range of 0 to 2 m. In the fall category, 22 wells accounting for 57.9% of the wells have recorded a range of 0 to 2 m water level fluctuation during August 2016, as compared to proceeding decadal mean (Table 3.13).

A map showing the change in water levels, with rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m is enclosed as Fig 3.13. Rise in water levels of 0 to 2 m is observed in almost all parts of Goa State. Fall in water level of 0 to 2 m is observed dominating in all taluks of Goa State.

Change in Water Level: Mean (November 2006 to November 2015) – November 2016

Mean groundwater level for the period November 2006 to November 2015 was compared with the groundwater level in November 2016 in the State of Goa. It is seen that out of the 36 stations compared, 13 stations accounting for 36% of analyzed wells, have shown a rise in water level. The remaining 23 wells accounting for 64%, have shown a fall in water level. Rise of water level in the range 0 to 2 m is observed in 11 wells accounting for 30% and 2 to 4 m is observed in 1 well accounting for 3% and >4 m is observed in 1 well accounting for 3% of the analysed wells. Fall in water level of 0 to 2 m is noticed in 22 wells accounting for 61% and 2 to 4 m is observed in 1 well accounting for 3% of analyzed wells (Table 3.14).

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 to 2 m, 2 to 4m and >4m is enclosed as Fig 3.14. Rise in water levels of 0 to 2 m is observed almost all taluks. Rise in water levels of 2 to 4 m is observed in almost all taluks except Pernem and above 4 m is observed in parts of Satari and Salcete taluks of Goa State. Fall in water level in the range of 0 to 2 m is observed in major portion of the Goa State. Fall in water level in the range of 2 to 4 m is observed in parts of Sanguem taluk.

Change in Groundwater Level: Mean (Jan 2007 to Jan 2016) – Jan 2017

Mean groundwater level for the period January 2007 to January 2016 (decadal mean water level) was compared with the groundwater level in January 2017 in the State of Goa. It is seen that out of the 36 stations compared, 17 wells accounting for 47% of analysed wells have shown a rise in the range of 0 to 2 m and 2 to 4 m water level rise is observed in 1 station (3%). 16 wells accounting for 44% of the analysed wells, shown a fall in water level in the range of 0 to 2 m, 1 wells (3%) shows fall of 2 to 4 m and 1 well (3%) shows a fall of more than 4 m 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 to 2 m and 2 to 4 m and >4 m is enclosed as Fig 3.15. Rise in water level in the range of 0 to 2 m is observed almost in all taluks of Goa State. Rise in the range of 2 to 4 m is observed in parts of Salcete

taluk of Goa State. Major part of the State shows fall in water level in the range of 0 to 2 m. Fall in water level of 2 to 4 m is observed in parts of Quepem and Canacona taluks and more than 4m fall is observed in parts of Canacona taluk of Goa State.

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 2016-17 is given in Annexure - V. However the piezometers water levels are not incorporated in the preparation of water level and fluctuation maps discussed above.

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, 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 samples analyzed 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 distribution of pH values in Goa State varies from 7.0 to 8.2 which indicate acidic 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, the greater its electrical conductivity. BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/L (corresponding to about EC of 750 µS/cm at 25°C) that can be extended to a TDS of 2000mg/L (corresponding to about 3000 µS/cm at 25°C) in case of no alternate source. Water having TDS more than 2000 mg/litre are not suitable for drinking purpose.

The 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.

The 98% of the samples collected all over the state 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 the desirable and permissible limit of nitrate is 45 mg/L.

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 exhibited wide variations from 0.02 mg/L to 0.61 mg/L. All the samples are in well within permissible limit as per the drinking water standards.

4.6 Distribution of Calcium

It is a natural 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 limit is 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 be within the permissible limits.

5. CONCLUSIONS

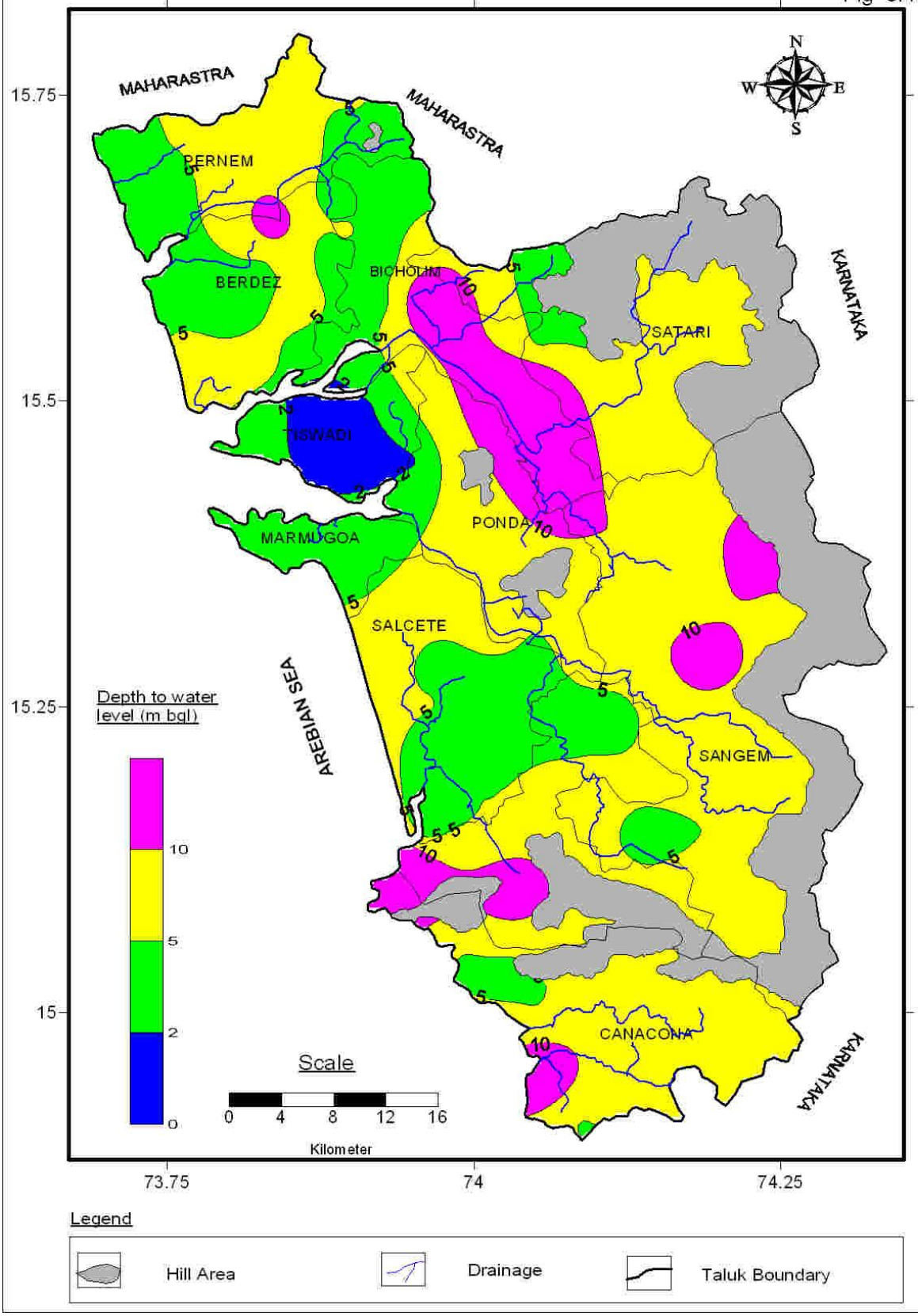
The present report includes results of a study on the behavior of the Ground Water Regime in the State of Goa through a network of 103 National Ground Water Monitoring Stations tapping the phreatic aquifer.

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 Greywack, Carbonate quartz chlorite and recent alluvium.

The data of depth to water levels shows that during the pre-monsoon period of 2016 about 90% of the analysed wells have water levels within 10 mbgl. Moderately deep water levels of 10 to 20 mbgl are seen in about 10% wells. No well shows deep water levels >20 mbgl. The depth to water level during August 2016 ranged from 0.11 mbgl to 13.14 mbgl, about 37% of analysed wells have less than 2 mbgl water levels, 40% wells have 2 to 5 mbgl water level, 21% wells have 5 to 10 mbgl water level, and the remaining 2% wells have 10 to 20 mbgl water level. During post-monsoon period of 2016, about 92% of the analysed wells have water level within 10 mbgl. Moderately deep water levels of 10 to 20 mbgl are seen in 8% of the wells. The depth to water level during January 2017 ranged from 1.04 mbgl to 15.80 mbgl, about 14% analysed wells have less than 2 mbgl water levels, 48% wells have 2 to 5 mbgl water levels, 27% wells have 5 to 10 mbgl water level, and the remaining 1% wells have 10 to 20 mbgl water level. The chemical quality of ground water collected from 65 water level monitoring stations representing the shallow aquifers during May 2015 indicate, that 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.

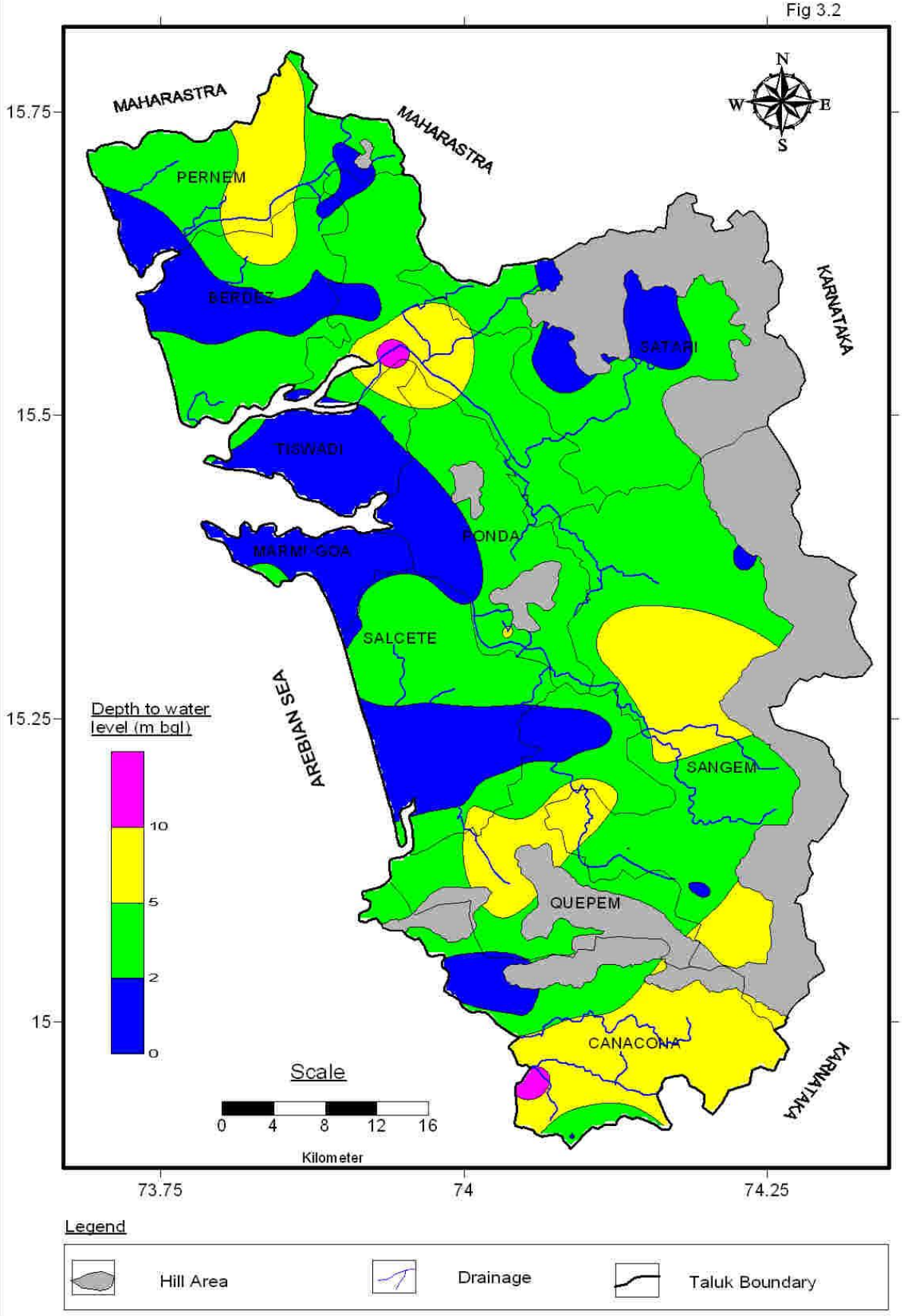
DEPTH TO WATER LEVEL - MAY 2016, GOA STATE

Fig 3.1



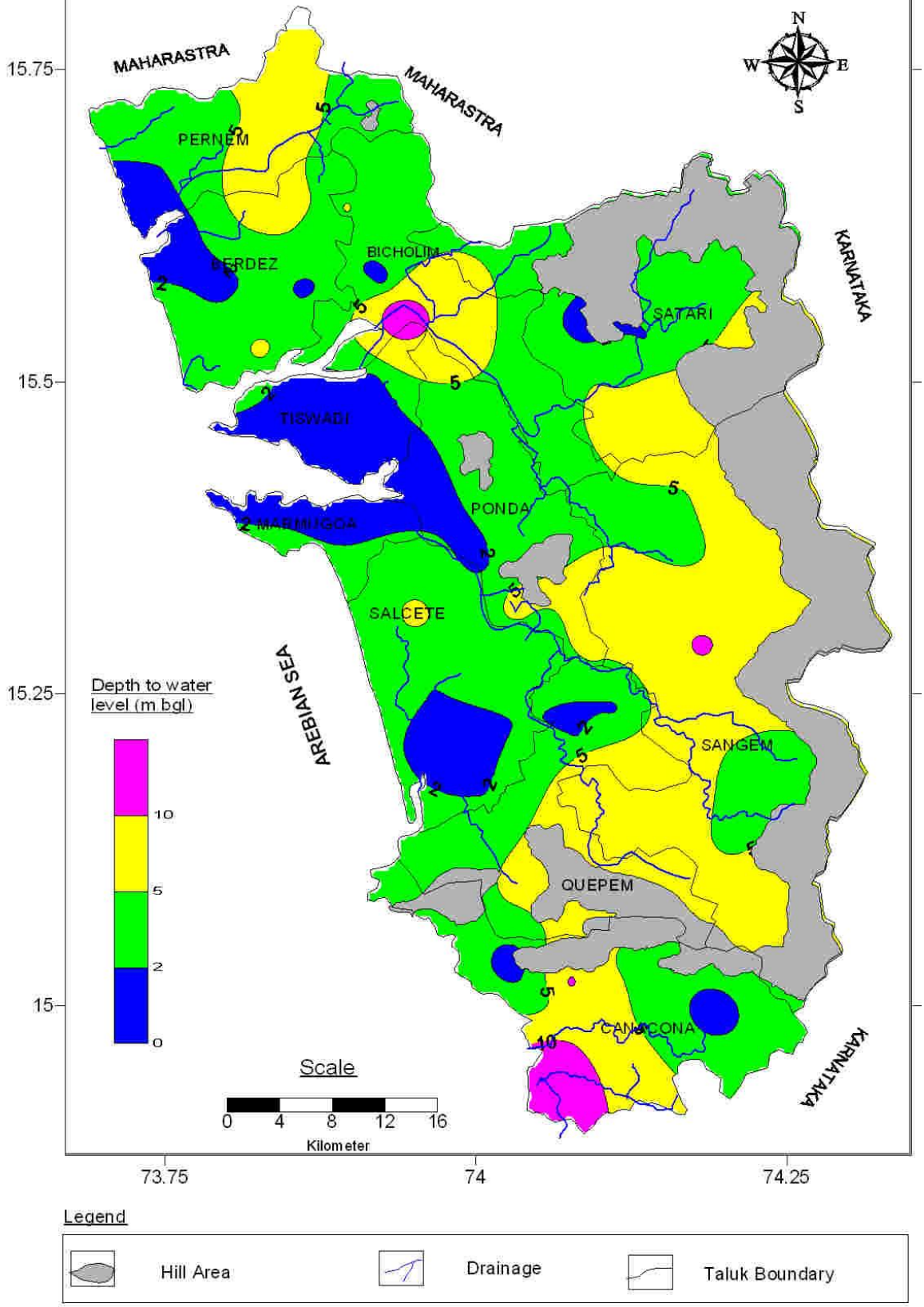
DEPTH TO WATER LEVEL - AUG 2016, GOA STATE

Fig 3.2



DEPTH TO WATER LEVEL - NOVEMBER 2016
GOA STATE

Fig 3.3

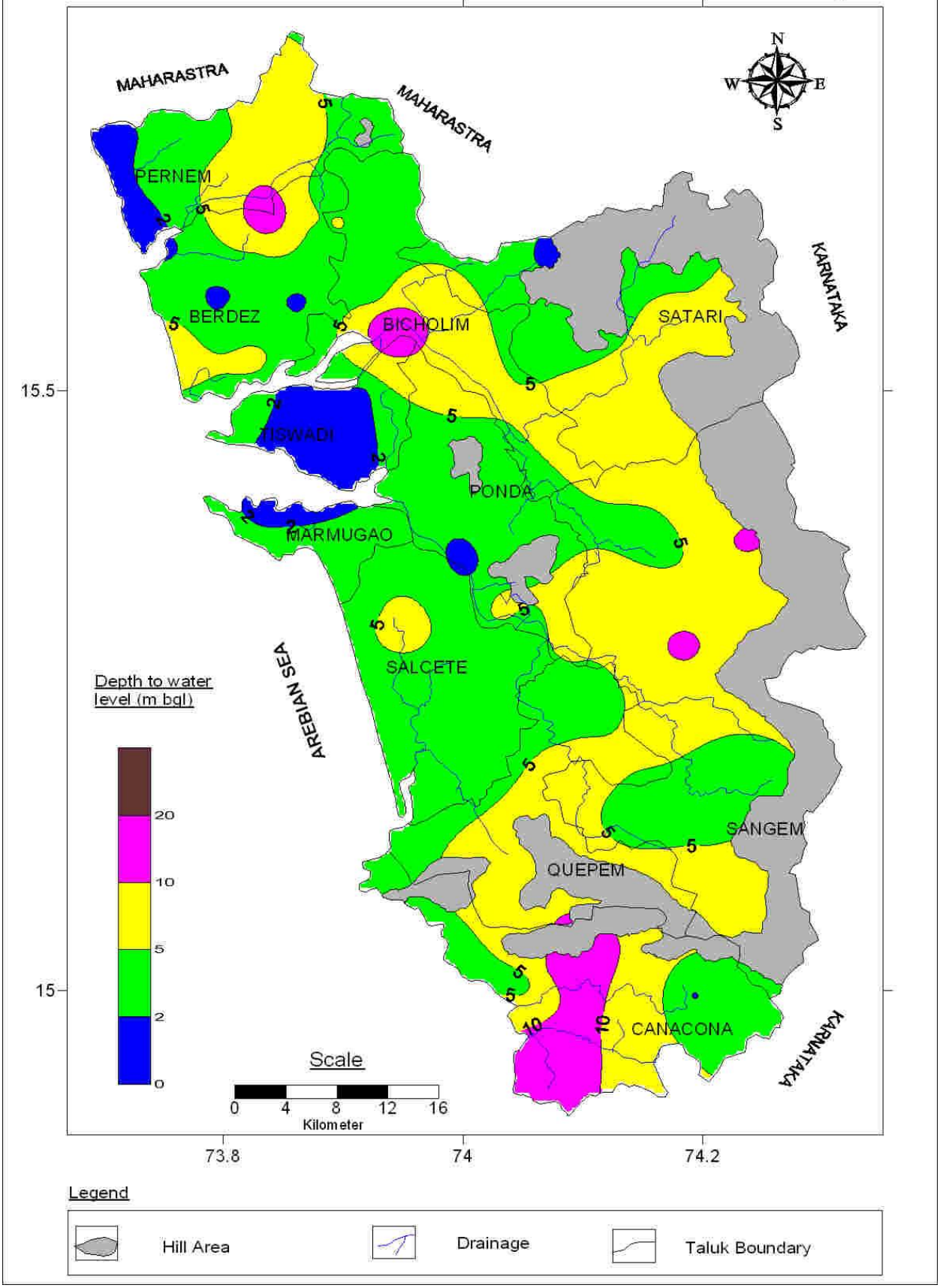


Legend

Hill Area | Drainage | Taluk Boundary

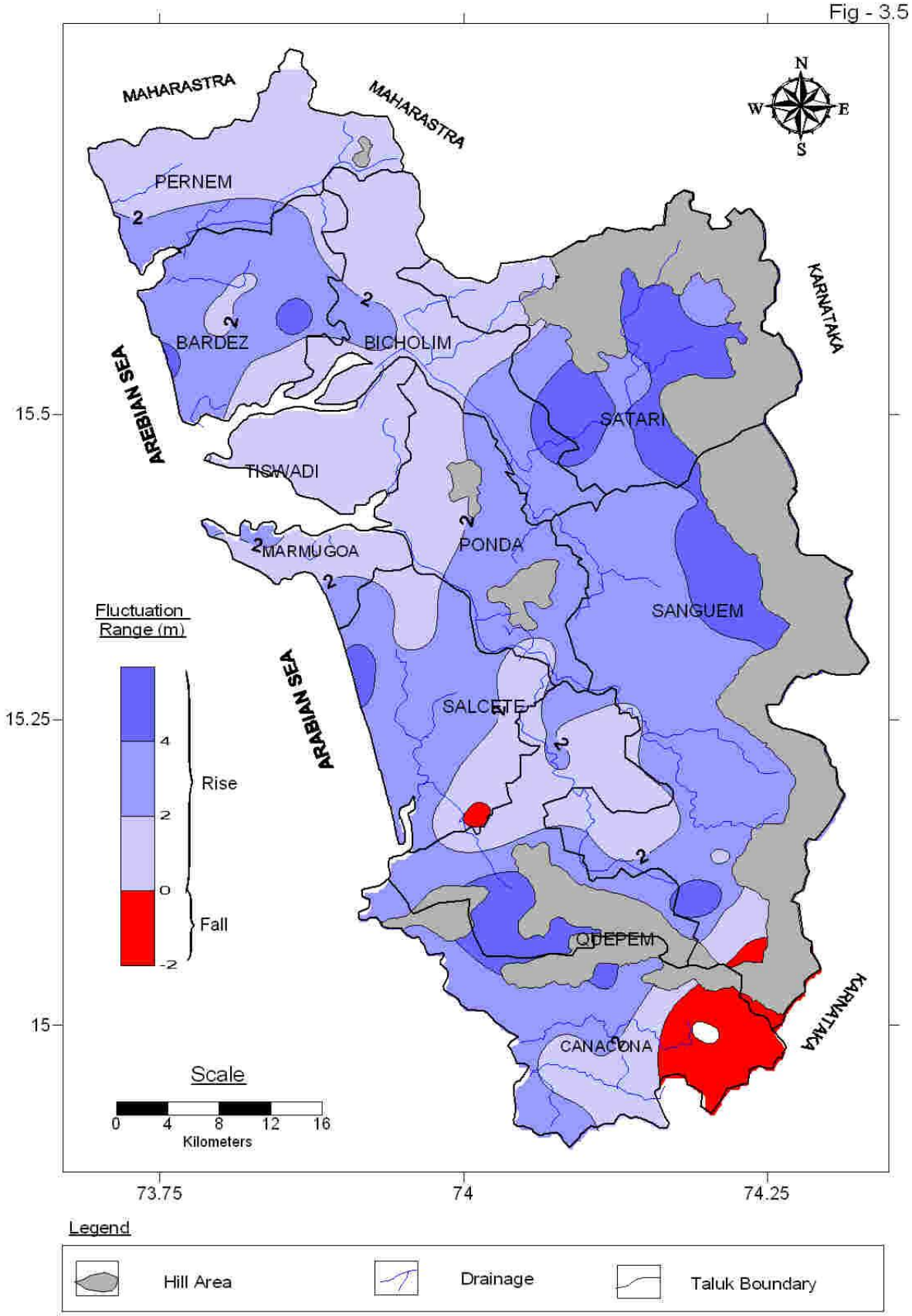
DEPTH TO WATER LEVEL MAP - JANUARY 2017
GOA STATE

Fig - 3.4



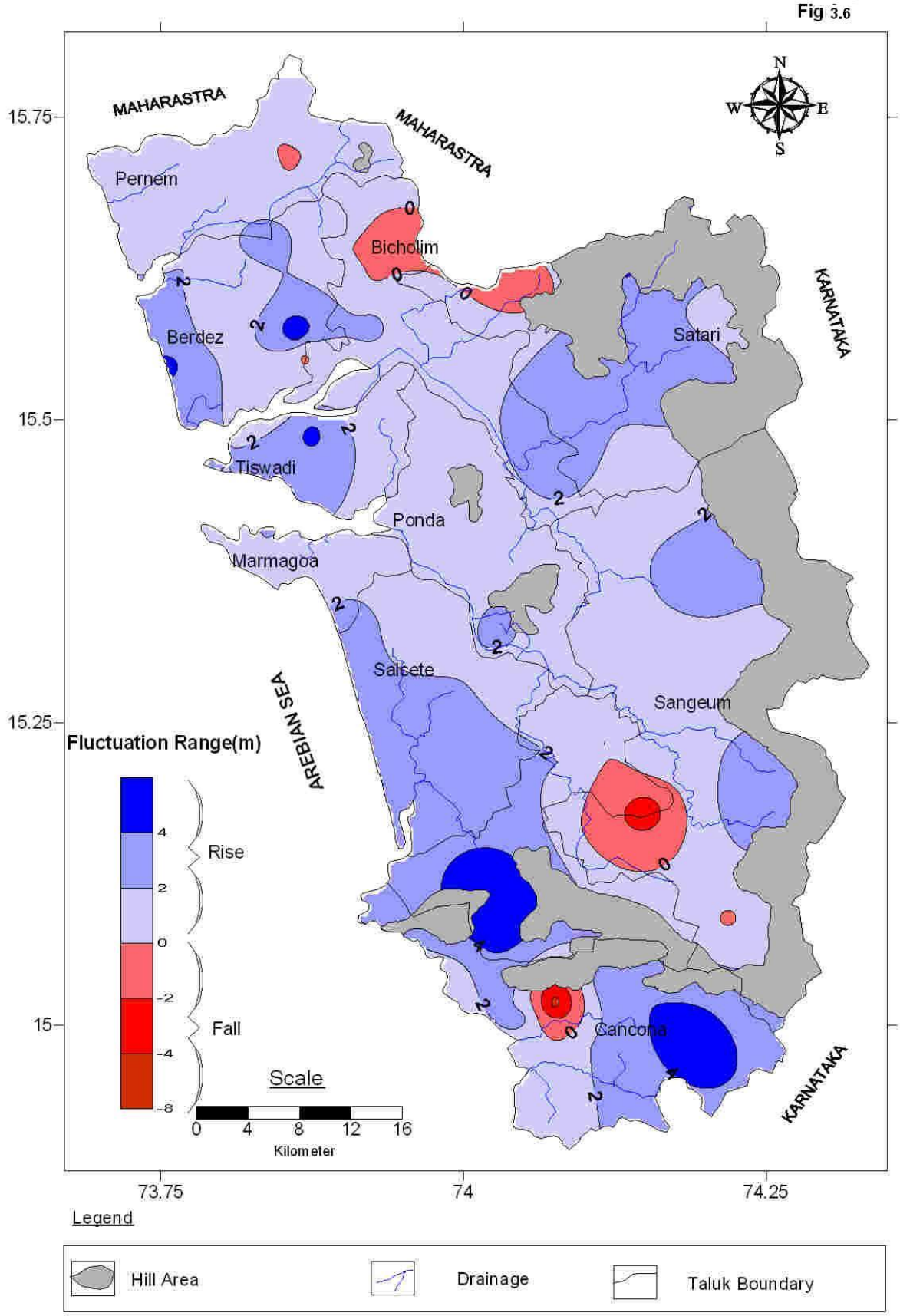
WATER LEVEL FLUCTUATION (MAY 2016 - AUGUST 2016)
GOA STATE

Fig - 3.5



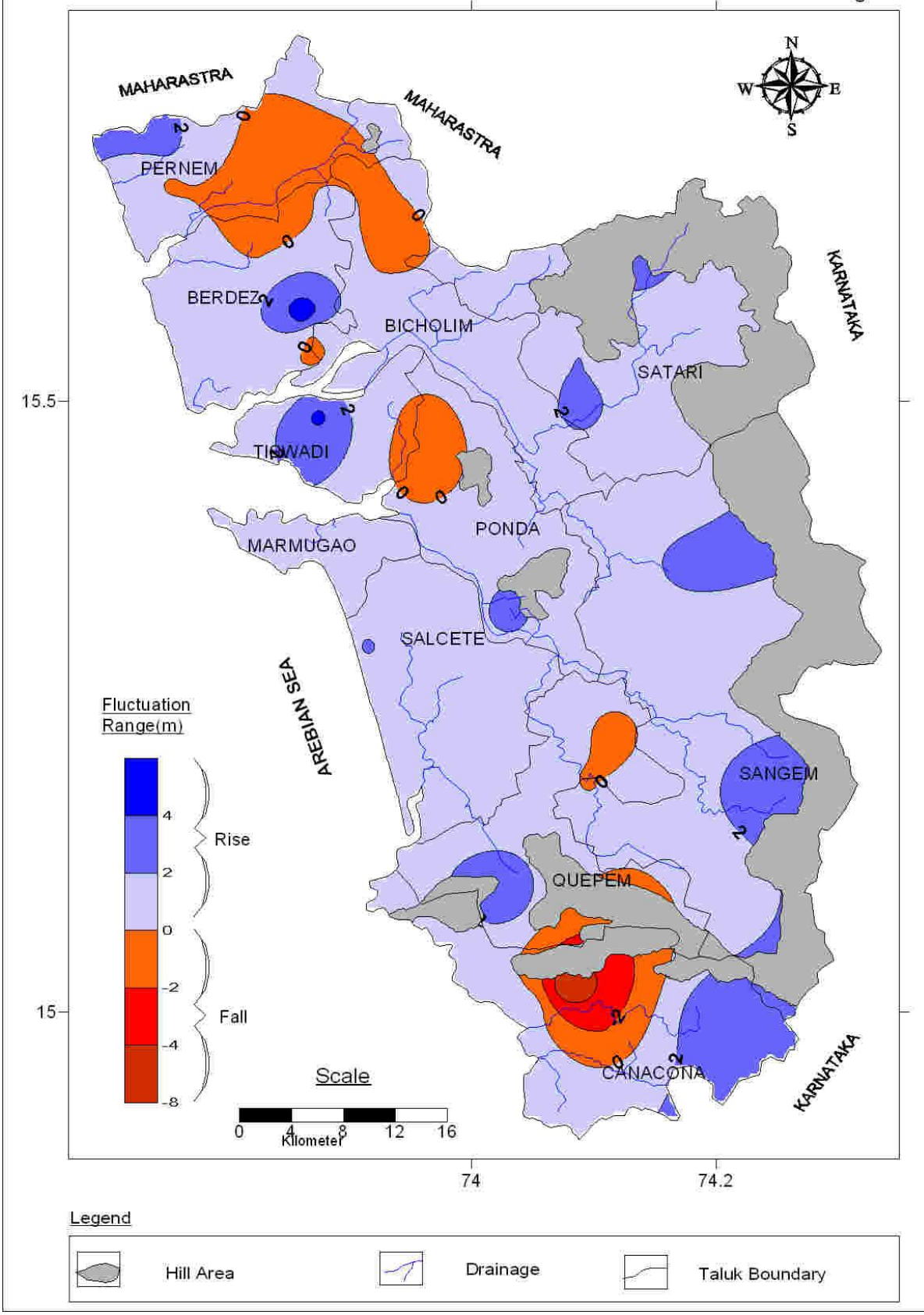
WATER LEVEL FLUCTUATION , MAY 2016 - NOVEMBER 2016, GOA STATE

Fig 3.6



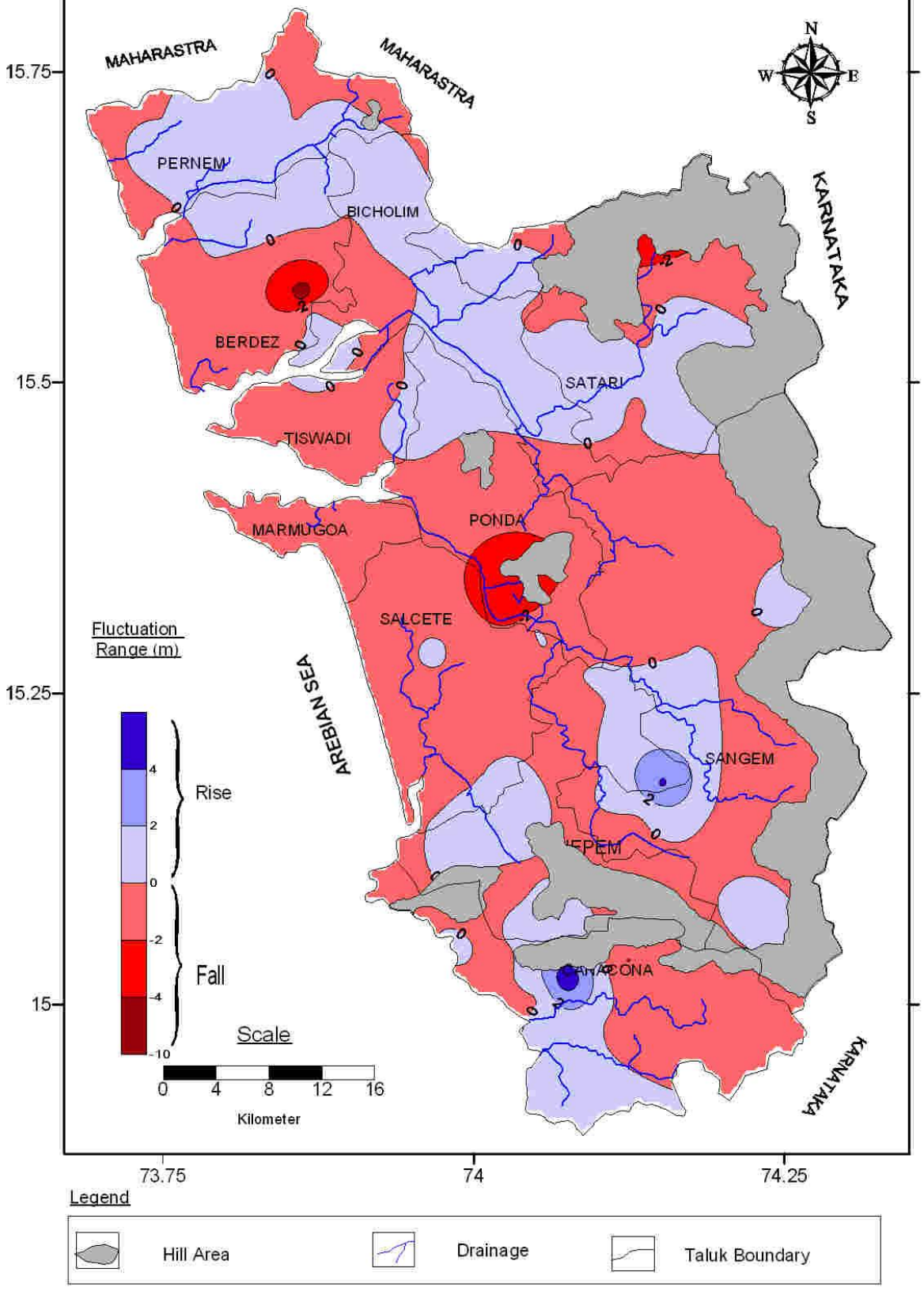
WATER LEVEL FLUCTUATION MAP, MAY 2016- JANUARY 2017, GOA STATE

Fig - 3.7



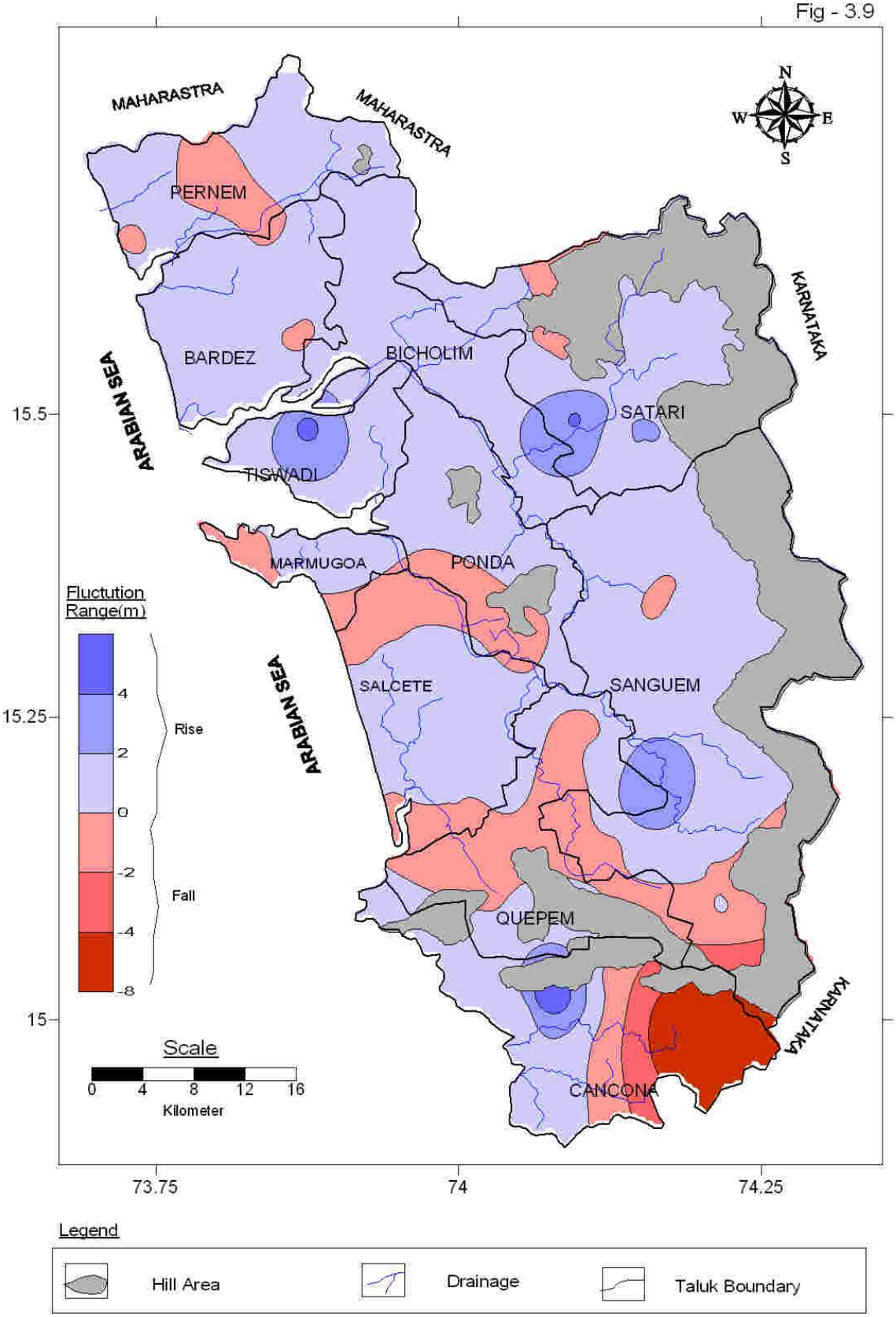
WATER LEVEL FLUCTUATION, MAY 2015 - MAY 2016, GOA STATE

Fig 3.8



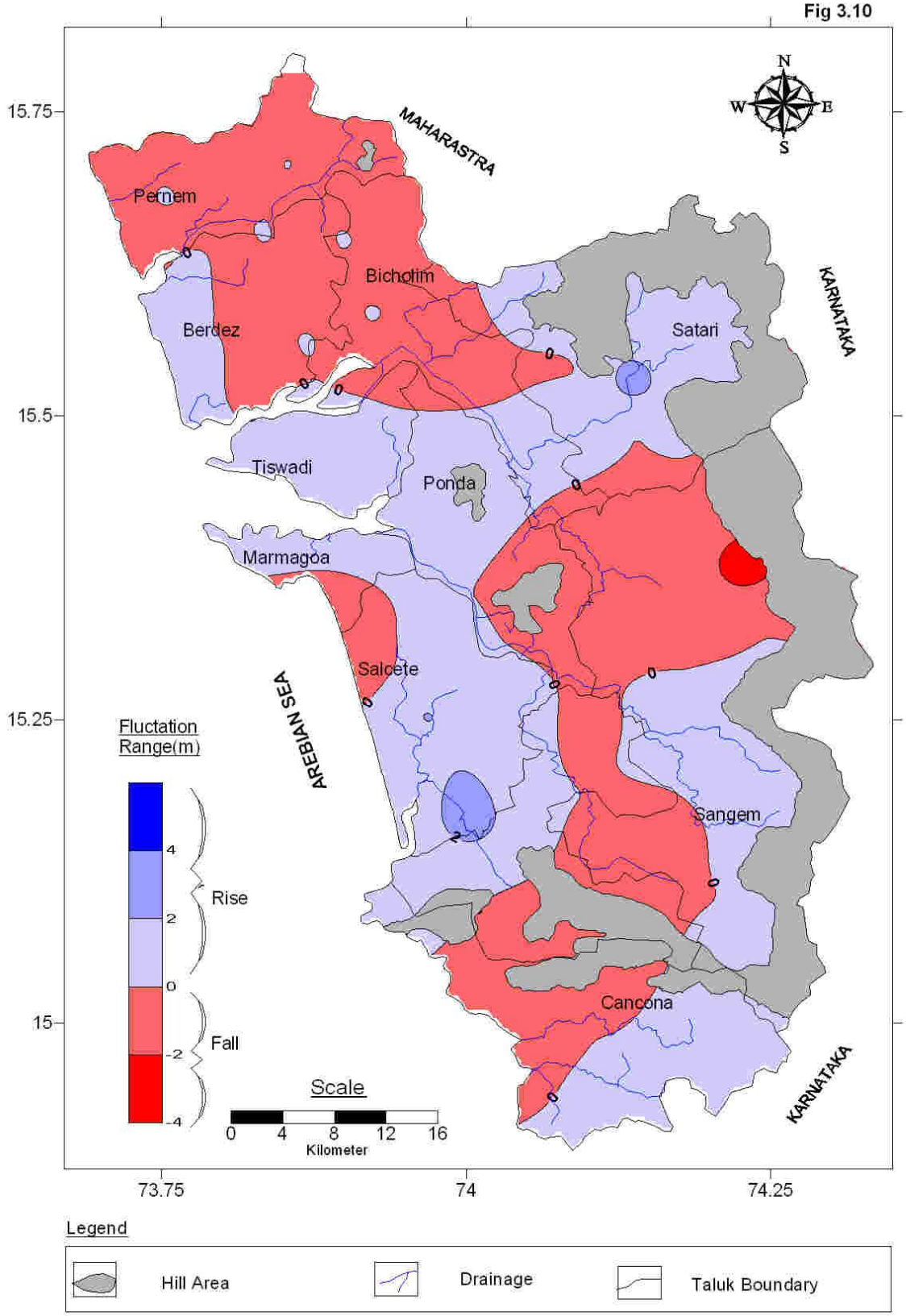
WATER LEVEL FLUCTUATION (AUG 2015 - AUG 2016)
GOA STATE

Fig - 3.9



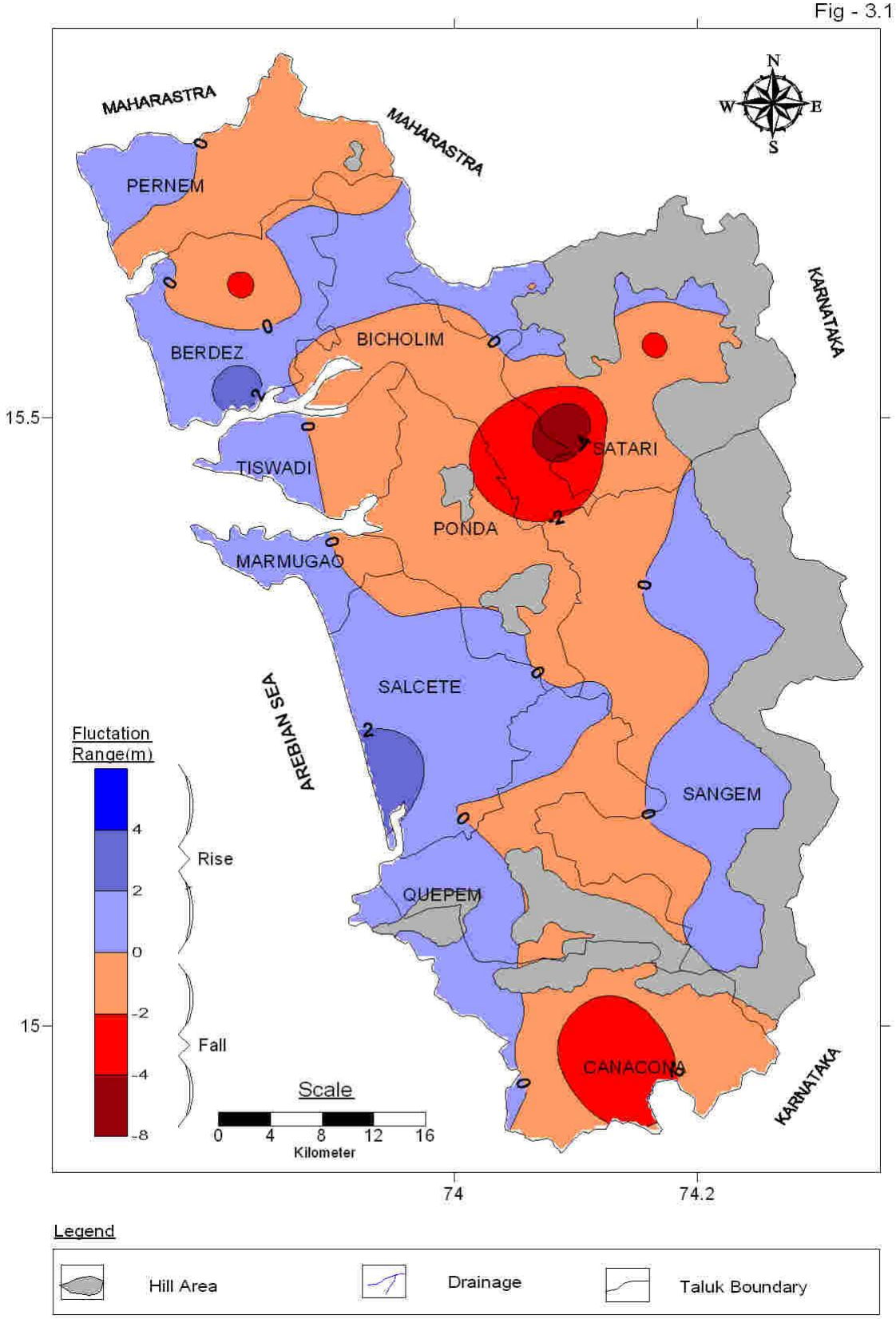
WATER LEVEL FLUCTUATION NOVEMBER 2015 - NOVEMBER 2016, GOA STATE

Fig 3.10



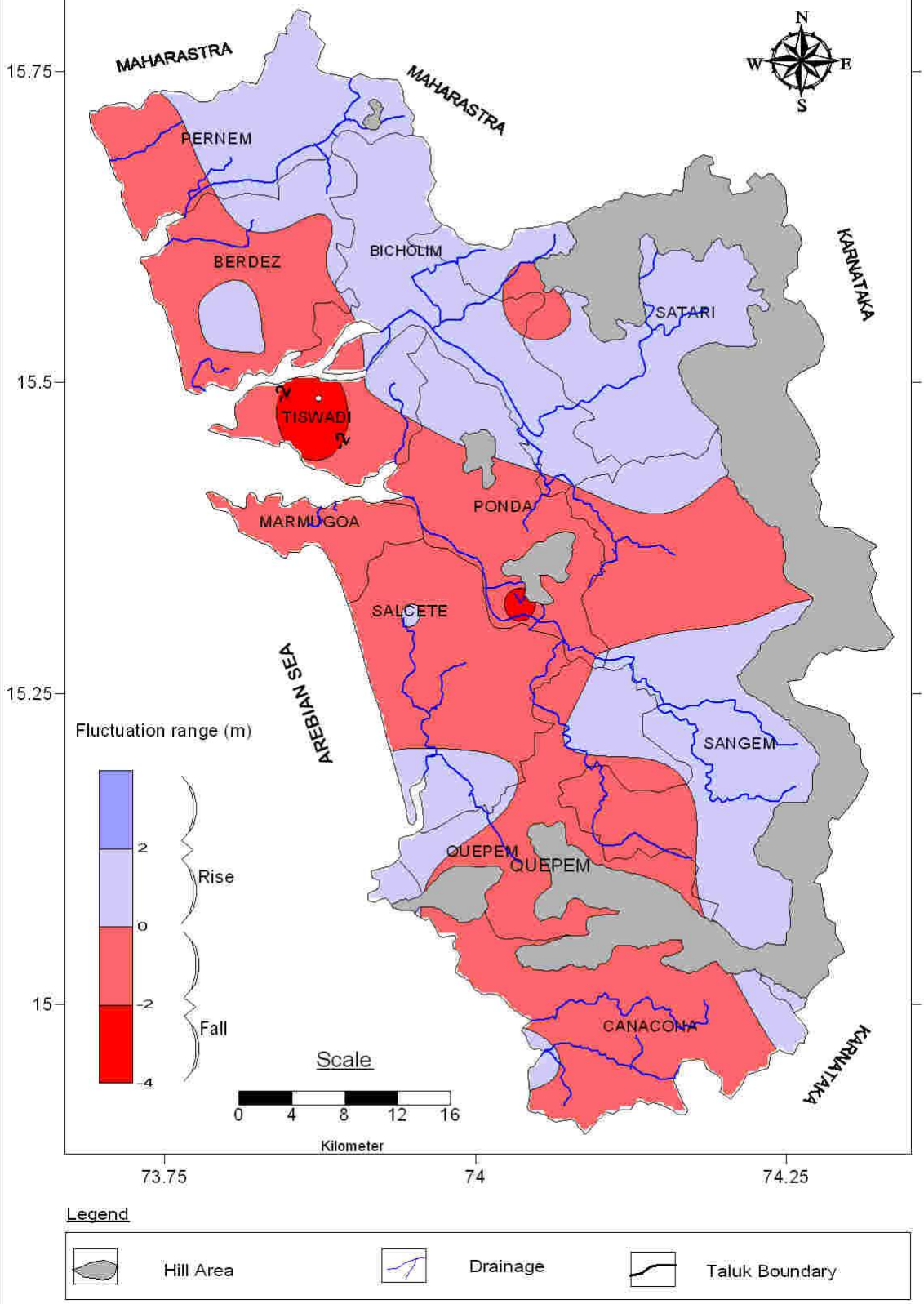
WATER LEVEL FLUCTUATION JANUARY 2016 - JANUARY 2017, GOA STATE

Fig - 3.11



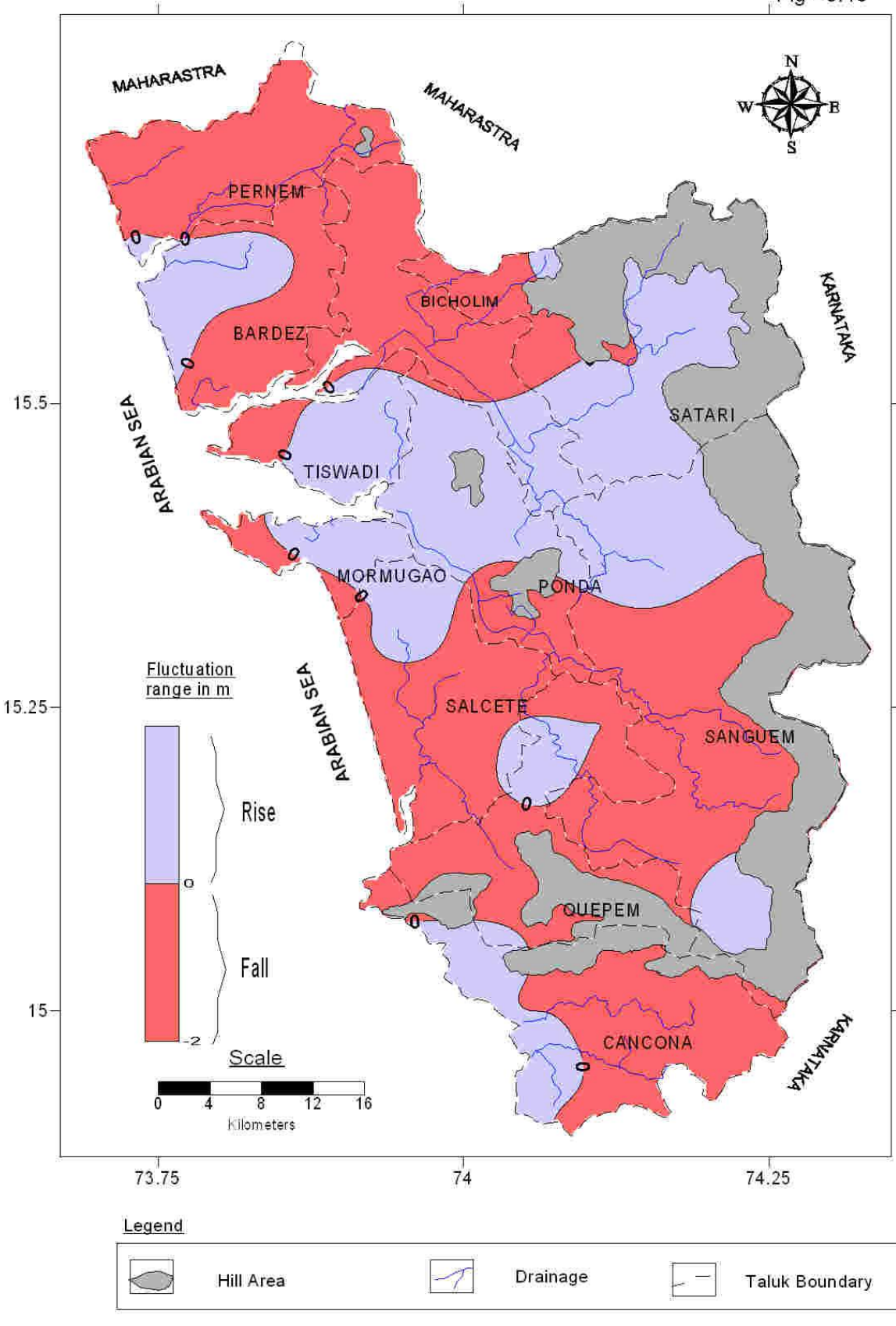
WATER LEVEL FLUCTUATION, DECADAL MEAN (MAY 2006- MAY 2015) - MAY 2016, GOA STATE

Fig 3.12



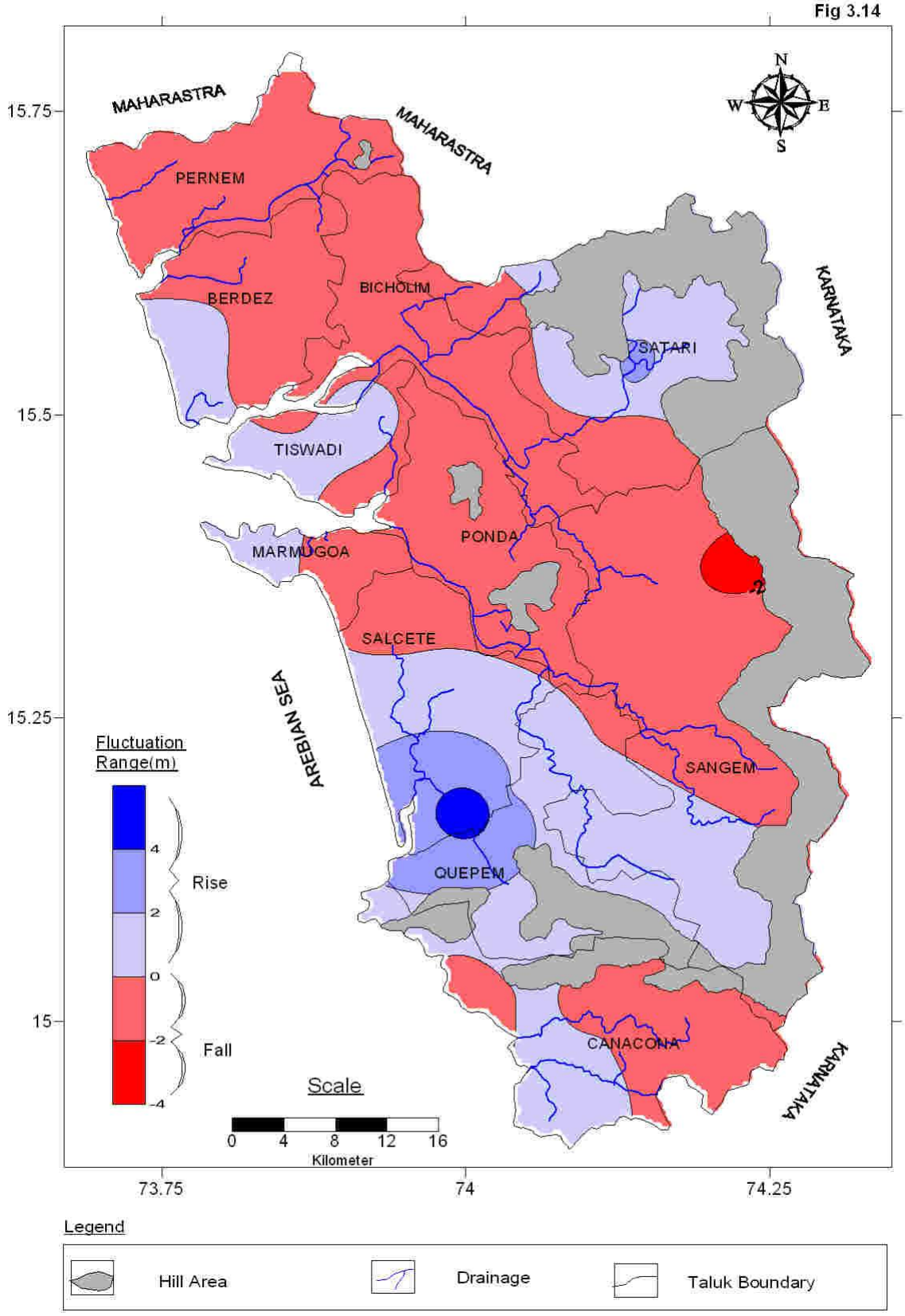
WATER LEVEL FLUCTUATION
MEAN (AUG 2006 TO AUG 2015) - AUG 2016 GOA STATE

Fig - 3.13



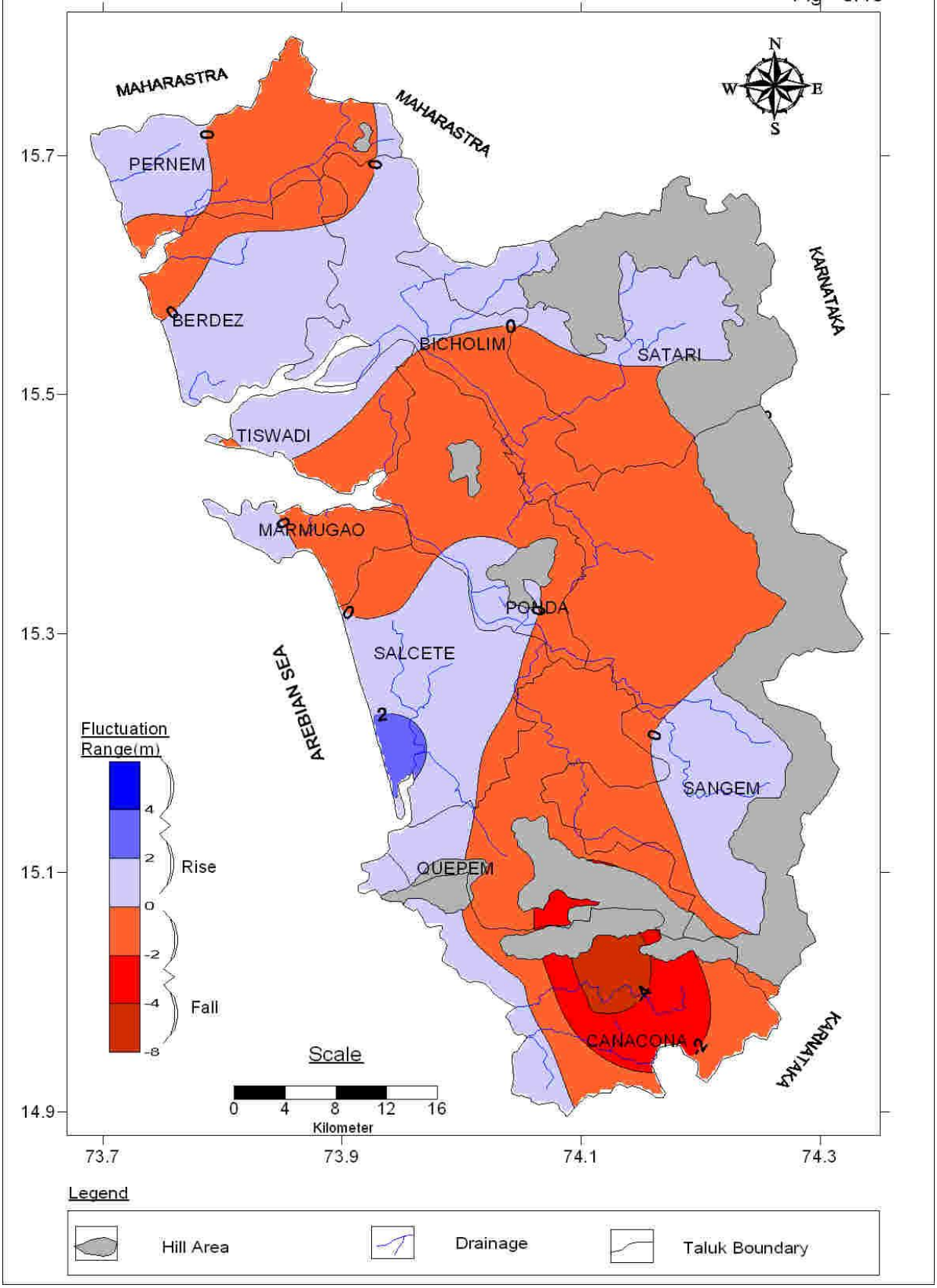
WATER LEVEL FLUCTUATION, DECADAL MEAN (NOV 2006- NOV 2015) - NOV 2016, GOA STATE

Fig 3.14



WATER LEVEL FLUCTUATION, DECADAL MEAN (JAN 2007- JAN 2016 - JANUARY 2017, GOA STATE

Fig - 3.15



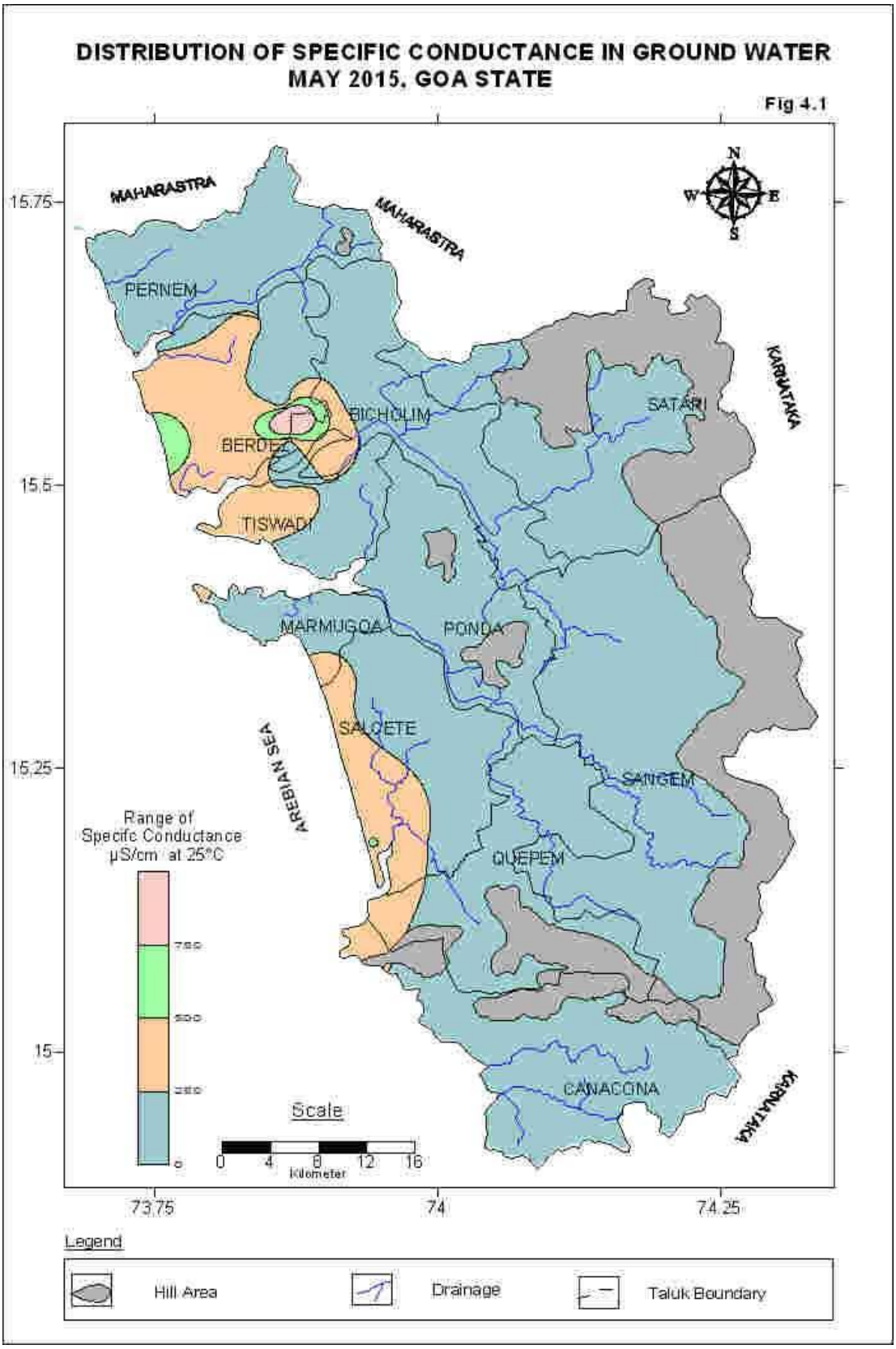


Fig 4.1: Distribution of Electrical Conductance (May 2015)

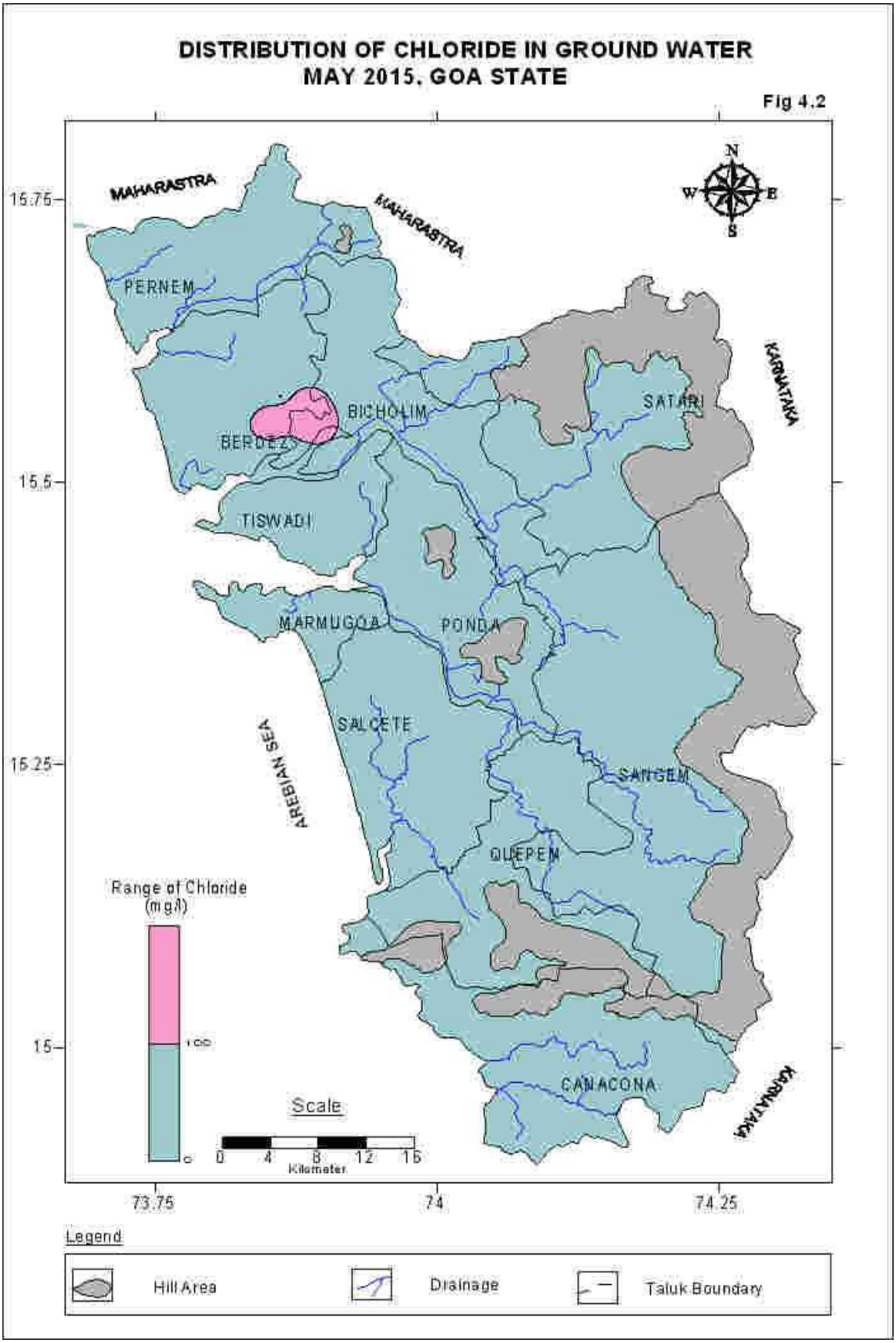


Fig 4.2: Distribution of Chloride (May 2015)

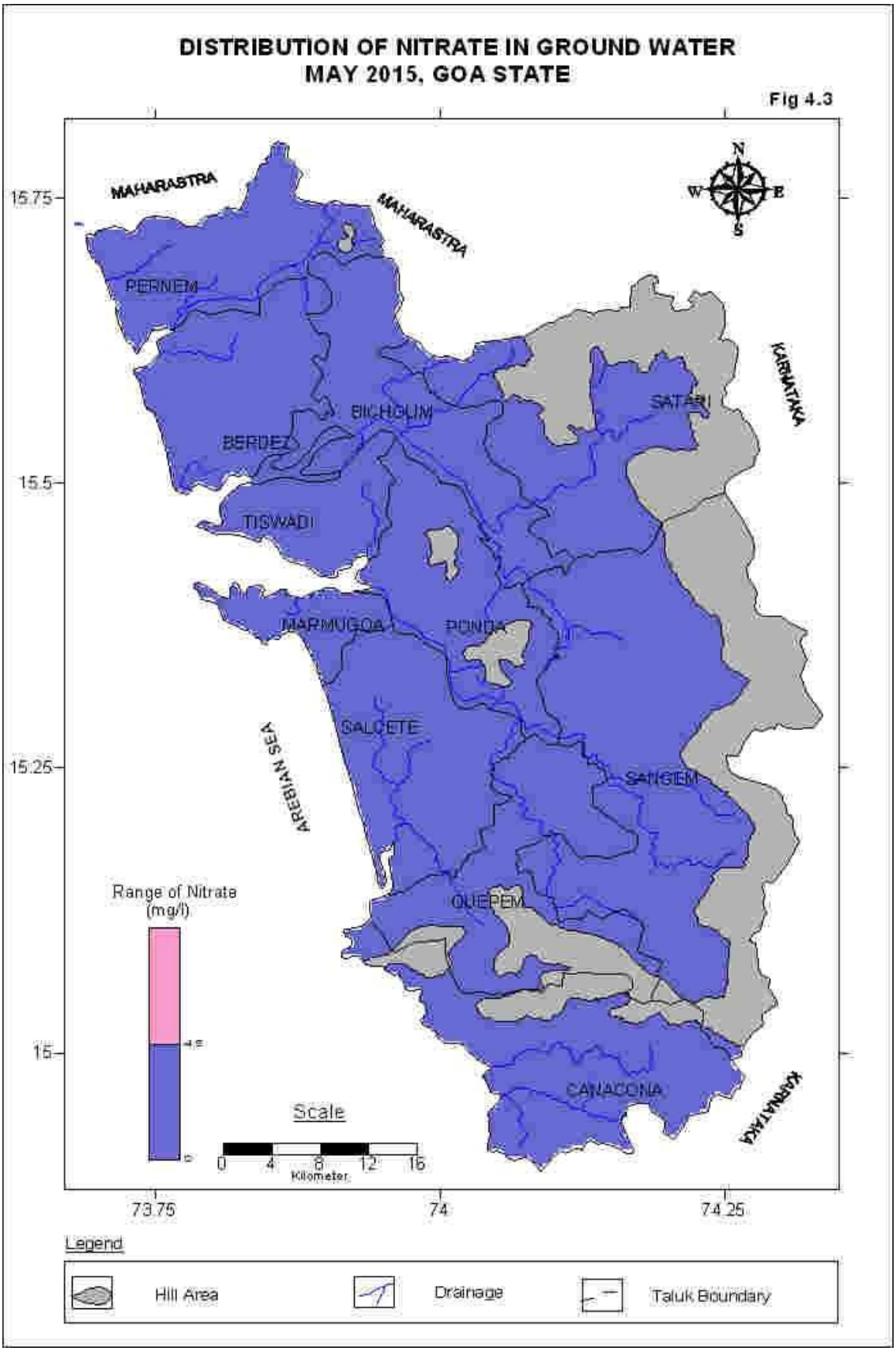


Fig 4.3: Distribution of Nitrate (May 2015)

Table 3.1

Talukwise Well Frequency for Different Ranges of Depth to Water Level

Month / Year :May-2016

Taluk	No of WL measured	D.T.W. (m bgl) Min.	Max.	0 - 2 (m) No.	%	2 - 5(m) No.	%	5 - 10(m) No.	%	10 - 20(m) No.	%	>20 (m) No.	%
Tiswadi	4	2.08	9.00	0	0.0	2	50.0	2	50.0	0	0.0	0	0.0
Sattari	10	2.56	8.76	0	0.0	3	30.0	7	70.0	0	0.0	0	0.0
Sangeum	15	3.00	14.20	0	0.0	1	6.7	11	73.3	3	20.0	0	0.0
Salcete	12	2.37	13.00	0	0.0	7	58.3	4	33.3	1	8.3	0	0.0
Quepem	4	1.70	15.81	1	25.0	1	25.0	1	25.0	1	25.0	0	0.0
Ponda	4	1.87	8.90	1	25.0	1	25.0	2	50.0	0	0.0	0	0.0
Pernem	8	2.33	7.63	0	0.0	5	62.5	3	37.5	0	0.0	0	0.0
Marmugoa	1	3.05	3.05	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	10	3.94	14.70	0	0.0	4	40.0	5	50.0	1	10.0	0	0.0
Bicholim	8	2.86	18.84	0	0.0	3	37.5	3	37.5	2	25.0	0	0.0
Bardez	12	2.10	13.10	0	0.0	9	75.0	2	16.7	1	8.3	0	0.0
Total	88			2	2.3	37	42.0	40	45.5	9	10.2	0	0.0

Table 3.2

Talukwise Well Frequency for Different Ranges of Depth to Water Level

Month /Year: August-2016

Taluk	No of WL	D.T.W. (m bgl)		0 - 2 (m)		2 -5 (m)		5 -10 (m)		10 - 20 (m)		> 20 (m)	
measured	Min.	Max.		No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	0.62	4.35	3	75.0	1	25.0	0	0.0	0	0.0	0	0.0
Sattari	10	0.58	4.59	4	40.0	6	60.0	0	0.0	0	0.0	0	0.0
Sangeum	14	1.55	9.57	3	21.4	5	35.7	6	42.9	0	0.0	0	0.0
Salcete	10	0.63	6.10	4	40.0	3	30.0	3	30.0	0	0.0	0	0.0
Quepem	4	1.02	3.02	2	50.0	2	50.0	0	0.0	0	0.0	0	0.0
Ponda	5	1.24	5.47	2	40.0	2	40.0	1	20.0	0	0.0	0	0.0
Pernem	8	0.17	7.21	2	25.0	4	50.0	2	25.0	0	0.0	0	0.0
Marmugoa	1	2.47	2.47	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	10	0.11	12.49	4	40.0	2	20.0	3	30.0	1	10.0	0	0.0
Bicholim	7	1.02	13.14	2	28.6	4	57.1	0	0.0	1	14.3	0	0.0
Bardez	12	0.51	9.65	5	41.7	4	33.3	3	25.0	0	0.0	0	0.0
Total	85			31	36.5	34	40.0	18	21.2	2	2.4	0	0.0

Table: 3.3
Taluk wise Well Frequency for Different Ranges of Depth to Water Level

Month /Year: Nov-2016

Taluk	No of WL Measured	D.T.W. (m bgl) Min.	Max.	0 - 2 (m) No.	%	2 - 5 (m) No.	%	5 -10 (m) No.	%	10 - 20 (m) No.	%	>20 (m) No.	%
Tiswadi	4	0.94	7.93	3	75.0	0	0.0	1	25.0	0	0.0	0	0.0
Sattari	10	1.44	7.24	3	30.0	5	50.0	2	20.0	0	0.0	0	0.0
Sangeum	13	2.32	10.65	0	0.0	3	23.1	7	53.8	3	23.1	0	0.0
Salcete	9	1.20	5.92	3	33.3	4	44.4	2	22.2	0	0.0	0	0.0
Quepem	4	1.76	3.95	2	50.0	2	50.0	0	0.0	0	0.0	0	0.0
Ponda	5	1.37	6.57	2	40.0	1	20.0	2	40.0	0	0.0	0	0.0
Pernem	9	0.83	7.73	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Marmugoa	1	2.78	2.78	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	8	0.61	14.61	2	25.0	3	37.5	1	12.5	2	25.0	0	0.0
Bicholim	7	1.36	14.45	2	28.6	2	28.6	2	28.6	1	14.3	0	0.0
Bardez	12	1.26	10.07	4	33.3	5	41.7	2	16.7	1	8.3	0	0.0
Total	82			22	26.8	32	39.0	21	25.6	7	8.5	0	0.0

Table 3.4
Taluk Wise Well Frequency for Different Ranges of Depth to Water Level

Month / Year Jan-2017

Taluk	No of WL measured	D.T.W. (m bgl Min.		0 - 2 (m)		2 - 5 (m)		5 -10 (m)		10 - 20 (m)		20 (m)	
				No.	%	No.	%	No.	%	No.	%	No.	%
Tiswadi	4	1.40	8.56	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0
Sattari	10	1.76	7.67	1	10.0	5	50.0	4	40.0	0	0.0	0	0.0
Sangeum	13	2.47	10.95	0	0.0	4	30.8	7	53.8	2	15.4	0	0.0
Salcete	9	1.40	9.51	2	22.2	5	55.6	2	22.2	0	0.0	0	0.0
Quepem	4	2.17	4.20	0	0.0	4	100.0	0	0.0	0	0.0	0	0.0
Ponda	5	1.22	6.93	1	20.0	2	40.0	2	40.0	0	0.0	0	0.0
Pernem	9	1.04	8.43	1	11.1	6	66.7	2	22.2	0	0.0	0	0.0
Marmugoa	1	2.85	2.85	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0
Canacona	7	1.70	13.10	1	14.3	2	28.6	0	0.0	4	57.1	0	0.0
Bicholim	7	1.52	15.80	1	14.3	3	42.9	2	28.6	1	14.3	0	0.0
Bardez	12	1.50	14.15	2	16.7	6	50.0	2	16.7	2	16.7	0	0.0
Total	81			11	13.6	39	48.1	22	27.2	9	11.1	0	0.0

Table 3.5
Talukwise Categorisation of Water Level Fluctuation
(May-2016 to August-2016)

Taluk	Number of Station Analysed	Fall						Rise					
		0 -2 (m)	%	2 -4 (m)	%	>4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%
Bardez	11	0	0.0	0	0.0	0	0.0	7	63.6	3	27.3	1	9.1
Bicholim	6	0	0.0	0	0.0	0	0.0	3	50.0	1	16.7	2	33.3
Canacona	10	0	0.0	1	10.0	0	0.0	1	10.0	7	70.0	1	10.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	7	0	0.0	0	0.0	0	0.0	6	85.7	1	14.3	0	0.0
Ponda	4	0	0.0	0	0.0	0	0.0	2	50.0	2	50.0	0	0.0
Quepem	3	0	0.0	0	0.0	0	0.0	1	33.3	2	66.7	0	0.0
Salcete	10	1	10.0	0	0.0	0	0.0	3	30.0	4	40.0	2	20.0
Sangeum	14	0	0.0	0	0.0	0	0.0	6	42.9	5	35.7	3	21.4
Sattari	10	0	0.0	0	0.0	0	0.0	2	20.0	4	40.0	4	40.0
Tiswadi	4	0	0.0	0	0.0	0	0.0	2	50.0	0	0.0	2	50.0
Total	**80**	**1**	**1.3**	**1**	**1.3**	**0**	**0.0**	**34**	**42.5**	**29**	**36.3**	**15**	**18.8**

Table 3.6
Talukwise Categorisation of Water Level Fluctuation
(May-2016 to November-2016)

Taluk	Number of Station Analysed	Fall						Rise					
		0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%
Bardez	11	0	0.0	0	0.0	0	0.0	8	72.7	2	18.2	1	9.1
Bicholim	6	1	16.7	0	0.0	0	0.0	2	33.3	2	33.3	1	16.7
Canacona	8	0	0.0	0	0.0	1	12.5	2	25.0	4	50.0	1	12.5
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
Pernem	8	2	25.0	0	0.0	0	0.0	6	75.0	0	0.0	0	0.0
Ponda	4	0	0.0	0	0.0	0	0.0	3	75.0	1	25.0	0	0.0
Quepem	3	1	33.3	0	0.0	0	0.0	1	33.3	1	33.3	0	0.0
Salcete	9	0	0.0	0	0.0	0	0.0	3	33.3	5	55.6	1	11.1
Sangeum	13	2	15.4	1	7.7	0	0.0	6	46.2	3	23.1	1	7.7
Sattari	10	2	20.0	0	0.0	0	0.0	4	40.0	3	30.0	1	10.0
Tiswadi	4	0	0.0	0	0.0	0	0.0	3	75.0	0	0.0	1	25.0
Total	77	8	10.4	1	1.3	1	1.3	39	50.6	21	27.3	7	9.1

Table 3.7
Taluk wise Categorisation of Water Level Fluctuation
(May-2016 toJanuary-2017)

Taluk	Number of Station Analysed	Fall						Rise					
		0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	4 (m)	%
Bardez	11	2	18.2	0	0.0	0	0.0	9	81.8	0	0.0	0	0.0
Bicholim	6	2	33.3	0	0.0	0	0.0	2	33.3	1	16.7	1	16.7
Canacona	7	1	14.3	1	14.3	1	14.3	3	42.9	1	14.3	0	0.0
Marmugoa	1	0	0.0	0	0.0	0	0.0	1	100.	0	0.0	0	0.0
Pernem	8	4	50.0	0	0.0	0	0.0	3	37.5	1	12.5	0	0.0
Ponda	4	1	25.0	0	0.0	0	0.0	2	50.0	1	25.0	0	0.0
Quepem	3	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Salcete	8	0	0.0	0	0.0	0	0.0	6	75.0	2	25.0	0	0.0
Sangeum	13	1	7.7	0	0.0	0	0.0	8	61.5	4	30.8	0	0.0
Sattari	10	0	0.0	0	0.0	0	0.0	8	80.0	2	20.0	0	0.0
Tiswadi	4	0	0.0	0	0.0	0	0.0	3	75.0	0	0.0	1	25.0
Total	75	12	16.0	1	1.3	1	1.3	47	62.7	12	16.0	2	2.7

Table 3.8
Talukwise Categorisation of Water Level Fluctuation
(May 2015 to May 2016)

Taluk	Number of Station Analysed	Fall in m						Rise in m					
		0- 2	%	2 - 4	%	>4	%	0 - 2	%	2-4	%	>4	%
Bardez	11	6	54.5	0	0.0	0	0.0	5	45.5	0	0.0	0	0.0
Bicholim	8	1	12.5	0	0.0	1	12.5	6	75.0	0	0.0	0	0.0
Canacona	9	4	44.4	1	11.1	0	0.0	3	33.3	0	0.0	1	11.1
Marmugoa	1	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pernem	8	3	37.5	0	0.0	0	0.0	5	62.5	0	0.0	0	0.0
Ponda	4	1	25.0	0	0.0	1	25.0	2	50.0	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	12	10	83.3	0	0.0	0	0.0	2	16.7	0	0.0	0	0.0
Sangeum	14	8	57.1	1	7.1	0	0.0	4	28.6	0	0.0	1	7.1
Sattari	10	5	50.0	0	0.0	1	10.0	4	40.0	0	0.0	0	0.0
Tiswadi	4	2	50.0	0	0.0	1	25.0	1	25.0	0	0.0	0	0.0
Total	84	42	50.0	2	2.4	4	4.8	34	40.5	0	0.0	2	2.4

Table 3.9
Talukwise Categorisation of Water Level Fluctuation
(August-2015 to August-2016)

Taluk	Number of Station Analysed	Fall						Rise					
		0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%
Bardez	12	3	25.0	0	0.0	0	0.0	9	75.0	0	0.0	0	0.0
Bicholim	7	1	14.3	0	0.0	0	0.0	5	71.4	0	0.0	1	14.3
Canacona	9	1	11.1	0	0.0	1	11.1	6	66.7	0	0.0	1	11.1
Marmugoa	1	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pernem	8	2	25.0	0	0.0	0	0.0	6	75.0	0	0.0	0	0.0
Ponda	5	3	60.0	0	0.0	0	0.0	2	40.0	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	7	70.0	0	0.0	0	0.0	2	20.0	1	10.0	0	0.0
Sangeum	14	6	42.9	0	0.0	0	0.0	6	42.9	2	14.3	0	0.0
Sattari	9	1	11.1	0	0.0	0	0.0	7	77.8	1	11.1	0	0.0
Tiswadi	4	0	0.0	0	0.0	0	0.0	4	100.0	0	0.0	0	0.0
Total	**82**	**26**	**31.7**	**0**	**0.0**	**1**	**1.2**	**49**	**59.8**	**4**	**4.9**	**2**	**2.4**

Table 3.10
Taluk wise Categorisation of Water Level Fluctuation
(November-2015 to November-2016)

Taluk	Number of Station Analysed	Fall						Rise					
		0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	>4 (m)	%
Bardez	12	5	41.7	0	0.0	0	0.0	6	50.0	1	8.3	0	0.0
Bicholim	7	4	57.1	0	0.0	0	0.0	3	42.9	0	0.0	0	0.0
Canacona	8	5	62.5	0	0.0	0	0.0	3	37.5	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	7	77.8	0	0.0	0	0.0	2	22.2	0	0.0	0	0.0
Ponda	5	3	60.0	0	0.0	0	0.0	2	40.0	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	3	33.3	0	0.0	0	0.0	4	44.4	2	22.2	0	0.0
Sangeum	13	5	38.5	1	7.7	0	0.0	7	53.8	0	0.0	0	0.0
Sattari	9	2	22.2	0	0.0	0	0.0	6	66.7	1	11.1	0	0.0
Tiswadi	4	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Total	80	37	46.3	1	1.3	0	0.0	38	47.5	4	5.0	0	0.0

Table 3.11
Talukwise Categorisation of Water Level Fluctuation
(January-2016 to January-2017)

Taluk	Number of Station Analysed	Fall						Rise					
		0 - 2 (m)	%	2 - 4 (m)	%	> 4 (m)	%	0 - 2 (m)	%	2 - 4 (m)	%	4 (m)	%
Bardez	12	3	25.0	1	8.3	0	0.0	7	58.3	1	8.3	0	0.0
Bicholim	5	1	20.0	0	0.0	1	20.0	3	60.0	0	0.0	0	0.0
Canacona	6	1	16.7	1	16.7	0	0.0	4	66.7	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
Pernem	9	7	77.8	0	0.0	0	0.0	2	22.2	0	0.0	0	0.0
Ponda	5	3	60.0	0	0.0	0	0.0	2	40.0	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	7	1	14.3	0	0.0	0	0.0	5	71.4	1	14.3	0	0.0
Sangeum	12	5	41.7	0	0.0	0	0.0	7	58.3	0	0.0	0	0.0
Sattari	10	6	60.0	1	10.0	0	0.0	2	20.0	1	10.0	0	0.0
Tiswadi	4	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Total	74	29	39.2	3	4.1	1	1.4	38	51.4	3	4.1	0	0.0

Table 3.12
Talukwise Categorisation of Change in Water Level
10 Yrs Mean (May 2006 - May 2015) to May-2016

		Range in m				Rise in m						Fall in m					
	Number of Station	Rise		Fall		0 - 2		2 - 4		>4		0 - 2		2 - 4		>4	
Taluk	Analysed	Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	5	0.04	0.04	0.00	0.09	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Bicholim	4	0.11	0.87			4	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Canacona	7	0.19	0.19	0.08	1.54	1	14.3	0	0.0	0	0.0	6	85.7	0	0.0	0	0.0
Pernem	4	0.32	1.09	0.15	0.41	2	50.0	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0
Ponda	2			0.01	2.42	0	0.0	0	0.0	0	0.0	1	50.0	1	50.0	0	0.0
Quepem	2	0.07	0.35			2	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Salcete	3	0.17	0.19	0.58	0.58	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Sangeum	4	0.07	0.89	0.54	0.66	2	50.0	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0
Sattari	5	0.07	1.57	0.17	0.44	3	60.0	0	0.0	0	0.0	2	40.0	0	0.0	0	0.0
Tiswadi	3	0.64	0.64	0.06	0.33	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Total	39					18	46.2	0	0.0	0	0.0	20	51.3	1	2.6	0	0.0

Table 3.13
Talukwise Categorisation of Change in Water Level
10 Yrs Mean (August 2006 - August 2015) - August 2016

Taluk	Number of Station Analysed	Range in m				Rise						Fall					
		Rise		Fall		0 - 2(m)		2 - 4(m)		> 4 (m)		0 -2 (m)		2 - 4 (m)		> 4(m)	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	4	0.33	0.38	0.10	1.15	2	50.0	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0
Bicholim	2			0.36	0.63	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Canacona	7	0.41	1.95	0.16	0.51	3	42.9	0	0.0	0	0.0	4	57.1	0	0.0	0	0.0
Pernem	5	0.02	0.02	0.01	1.05	1	20.0	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0
Ponda	2			0.32	0.44	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Quepem	3	0.00	0.56			3	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Salcete	3	0.38	0.38	0.11	1.69	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Sangeum	4	0.05	1.44	0.66	0.66	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0
Sattari	5	0.25	1.13	0.04	0.46	2	40.0	0	0.0	0	0.0	3	60.0	0	0.0	0	0.0
Tiswadi	3	0.31	0.31	0.14	0.57	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Total	**38**					**16**	**42.1**	**0**	**0.0**	**0**	**0.0**	**22**	**57.9**	**0**	**0.0**	**0**	**0.0**

Table 3.14
Talukwise Categorisation of Change in Water Level
10 Yrs Mean (November 2006 - November 2015) to November 2016

Taluk	Number of Station Analysed	Range in m Rise Min	Rise Max	Fall Min	Fall Max	Rise 0 - 2 (m) No	%	Rise 2 -4 (m) No	%	Rise >4 (m) No	%	Fall 0 -2 (m) No	%	Fall 2 -4 (m) No	%	Fall >4 (m) No	%
Bardez	4	0.65	0.65	0.08	0.44	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Bicholim	2			0.15	0.38	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Canacona	6	0.02	0.13	0.43	0.58	4	66.7	0	0.0	0	0.0	2	33.3	0	0.0	0	0.0
Pernem	5			0.17	0.96	0	0.0	0	0.0	0	0.0	5	100.	0	0.0	0	0.0
Ponda	2			0.37	0.46	0	0.0	0	0.0	0	0.0	2	100.	0	0.0	0	0.0
Quepem	3	1.10	1.90	0.23	0.23	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Salcete	3	5.15	5.15	0.32	0.46	0	0.0	0	0.0	1	33.3	2	66.7	0	0.0	0	0.0
Sangeum	3	0.22	0.22	0.58	3.36	1	33.3	0	0.0	0	0.0	1	33.3	1	33.3	0	0.0
Sattari	5	0.67	2.40	0.14	1.08	1	20.0	1	20.0	0	0.0	3	60.0	0	0.0	0	0.0
Tiswadi	3	0.25	0.44	0.54	0.54	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0
Total	36					11	30.6	1	2.8	1	2.8	22	61.1	1	2.8	0	0.0

Table 3.15

Talukwise Categorisation of Change in Water Level

10 Yrs Mean (January 2007 - January 2016) to January 2017

Taluk	Number of Station Analysed	Range in m				Rise						Fall					
		Rise		Fall		0 -2(m)		2-4(m)		4(m)		0 -2(m)		2 -4 (m)		4(m)	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Bardez	4	0.05	0.53			4	100.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bicholim	2	0.14	0.14	0.00	0.00	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0
Canacona	5	0.14	1.50	3.97	6.15	3	60.0	0	0.0	0	0.0	0	0.0	1	20.0	1	20.0
Pernem	5	0.08	1.48	0.33	0.53	2	40.0	0	0.0	0	0.0	3	60.0	0	0.0	0	0.0
Ponda	2	0.64	0.64	0.94	0.94	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0
Quepem	3			0.12	0.90	0	0.0	0	0.0	0	0.0	3	100.	0	0.0	0	0.0
Salcete	3	0.05	2.80	0.26	0.26	1	33.3	1	33.3	0	0.0	1	33.3	0	0.0	0	0.0
Sangeum	4	1.22	1.22	0.25	0.56	1	25.0	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0
Sattari	5	0.14	1.44	0.21	0.64	3	60.0	0	0.0	0	0.0	2	40.0	0	0.0	0	0.0
Tiswadi	3	0.03	0.03	0.03	0.18	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
Total	36					17	47.2	1	2.8	0	0.0	16	44.4	1	2.8	1	2.8

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
MEA I	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 2016-2017
SOUTH WESTERN REGION, GOA

S.No	Well No	District	Location	Depth to water level (mbgl)				Decadal mean water level (mbgl)			
				May-16	Aug-16	Nov-16	Jan-17	May-16	Aug-16	Nov-16	Jan-17
1	GAJY1307	North Goa	Adavapal	5.57	4.51	5.46	5.39	5.57	4.51	5.46	5.39
2	48I4D3	South Goa	Agonda Desaiwada	3.98	1.45	3.34	3.48	3.98	1.45	3.34	3.48
3	48I4A5	South Goa	Akamol Ambavalli	-	2.7	2.9	3.8	-	2.7	2.9	3.8
4	48E2D12	North Goa	Alto Betim Porvorim	6.73	5.13	5.85	6.23	6.73	5.13	5.85	6.23
5		North Goa	Amberem	7.1	6.42	7.05	7.4	7.1	6.42	7.05	7.4
6	GAJY1302	North Goa	Anjuna Beach	-	7.1	7.94	11.83		7.13	7.94	11.83
7	48E2D10	North Goa	Baga	2.77	-	2.78	-	2.77	-	-	-
8		South Goa	Bagmola	3.05	2.47	-	2.85	3.05	2.47	2.78	2.85
9	48E3D6	South Goa	Ballynuvhen	6.48	5.04	5.85	6.16	6.48	5.04	5.85	6.16
10	Jy13117	South Goa	Barodi Velni (betul)	2.37	-	-	-	2.37	-	-	-
11	48I2A2	North Goa	Bayalwadikeri(querim)	2.56	1.7	3.19	1.76	2.56	1.7	3.19	1.76
12	Jy13116	South Goa	Betalbatti	6.87	2.4	3.54	4.77	6.87	2.4	3.54	4.77
13	GAJY1303	North Goa	Bhamber(Nanoda Cross)	5.82	2.83	4.25	4.79	5.82	2.83	4.25	4.79
14	Jy13114	South Goa	Bhati	5.29	2.11	2.32	2.47	5.29	2.11	2.32	2.47
15	GAJY1311	North Goa	Bhujpal	5.38	1.1	1.44	3.36	5.38	1.1	1.44	3.36
16		North Goa	Bicholim	-	-	-	-	-	-	-	-
17	48E2D9	North Goa	Bicholim(pz)	15.75	-	-	-	15.75	-	-	-
18	48I3A2	South Goa	Bolkharnem	6.88	2.94	5.25	6.05	6.88	2.94	5.25	6.05
19	GAJY1310	North Goa	Bori		1.24	1.37	1.22		1.24	1.37	1.22
20		North Goa	Britona	2.1	1.71	1.77	1.94	2.1	1.71	1.77	1.94
21	48E2D11	North Goa	Calangute	8.15	3.57	3.77	6.35	8.15	3.57	3.77	6.35
22	48I4A12	South Goa	Canacona	4.85	1.79	2.53	3.56	4.85	1.79	2.53	3.56
23	48E4D1	South Goa	Carmona	-	-	-	2.67	-	-	-	2.67
24	GAJY1312	North Goa	Charayode	6.24	0.58	1.88	3.08	6.24	0.58	1.88	3.08
25	Jy1306	South Goa	Chikalim	3.13	0.63	1.2	1.4	3.13	0.63	1.2	1.4

26		North Goa	Collem(kolamba)	9	4.35	7.93	8.56	9	4.35	7.93	8.56
27		North Goa	Colval	13.1	9.65	10.07	14.15	13.1	9.65	10.07	14.15
28	Jy13118	South Goa	Cuncalim	2.48	1.15	1.74	2	2.48	1.15	-	2
29	48I4A6	South Goa	Cuncalim(pz)	4.8	6.1	-	-	4.8	6.1	1.74	
30	48J1A2	South Goa	Daptamol Lolien	14.7	12.49	14.61	13.1	14.7	12.49	14.61	13.1
31	48I3A3	South Goa	Darbandahra(pz)	9.86	-	-	-	9.86	-	-	-
32	48I4A7	South Goa	Deulwada Kolamba	3	1.93		2.6	3	1.93	-	2.6
33		North Goa	Devulawada Narve	-	13.14	14.45	15.8		13.14	14.45	15.8
34		North Goa	Dhatwad Vante	9.15	2.84	5.21	6.56	9.15	2.84	5.21	6.56
35		South Goa	Fathorda Margao(pz)	3.6	-	-	-	3.6	-	-	-
36		North Goa	Gauli Mola	-	-	-	-	-	-	-	-
37	GAJY1305	North Goa	Gavalebhat Chimbel(kirl)	5.94	1.01	1.32	1.4	5.94	1.01	1.32	1.4
38	48I4A1	South Goa	Ghadiawada	1.7	1.02	1.76	2.17	1.7	1.02	1.76	2.17
39	48E3D3	North Goa	Goa Velha	-	-	-	-	-	-	-	-
40	Jy1312	South Goa	Guddemal	12	7.22	8.03	9.45	12	7.22	8.03	9.45
41	48I4A11	South Goa	Gulem Velipwada	3.94	0.11	0.67		3.94	0.11	0.67	-
42		North Goa	Hasapur	5.16	3.53	3.91	3.65	5.16	3.53	3.91	3.65
43		North Goa	Hasaravanni Vaipal	3.4	1.54	3.3	4.4	3.4	1.54	3.3	4.4
44	48J1A1	South Goa	Hattipal Poinguinem	8.64	6.02	6.31	10.51	8.64	6.02	6.31	10.51
45		North Goa	Hivre Budruk	-	-	-	-	-	-	-	-
46	48I2A4	North Goa	Honda	4.42	2.15	2.53	3.36	4.42	2.15	2.53	3.36
47	Jy13120	South Goa	Jambavli	9.1	7.6	8.7	9.25	9.1	7.6	8.7	9.25
48		North Goa	Jambhul Bhatt	3.75	1.02	1.36	2.61	3.75	1.02	1.36	2.61
49	Jy1311	South Goa	Kalay	11.79	9.57	10.65	10.95	11.79	9.57	10.65	10.95
50	48E4D2	South Goa	Kanagini(pz)	15.81	-	-	-	15.81	-	-	-
51		South Goa	Kapsa	6.08	3.02	3.95	4.2	6.08	3.02	3.95	4.2
52	48E3D2	North Goa	Karanjhalen	3.35	1.68	1.39	2.6	3.35	1.68	1.39	2.6
53	Jy1305	South Goa	Kaveslium	4.55	1.46	2.04	-	4.55	1.46	2.04	-
54	48I3A1	North Goa	Khadki(harijanwada)	8.76	2.91	7.24	7.67	8.76	2.91	7.24	7.67
55	GAJY1313	North Goa	Khotodem	6.73	4.59	5.91	6.33	6.73	4.59	5.91	6.33
56	48E2D3	North Goa	Korgaon	4.94	3.52	3.98	2.25	4.94	3.52	3.98	2.25

57		North Goa	Kundel Dassolwada	1.87	1.42	1.56	2.95	1.87	1.42	1.56	2.95
58	48E3D5	South Goa	Majorda Bpada Curilo	5.53	2.02	2.66	3.84	5.53	2.02	2.66	3.84
59	Jy1301	South Goa	Malkarnem	5.8	4.54	8.93		5.8	4.54	8.93	
60	GAJY1309	North Goa	Mankem	4.05	2.98	3.67	3.65	4.05	2.98	3.67	3.65
61	48E2D7	North Goa	Mapuca	3.88	2.15	3.45	3.6	3.88	2.15	3.45	3.6
62		South Goa	Marmagoa	-	-	-	-	-	-	-	-
63	Jy1309	South Goa	Mashe	4.52	3.11	3.47	3.79	4.52	3.11	3.47	3.79
64	48I3A5	South Goa	Molem	14.2	1.75	10.05	10.5	14.2	1.75	10.05	10.5
65	48E2C1	North Goa	Morji	2.33	0.17	0.83	1.04	2.33	0.17	0.83	1.04
66	48I2A3	North Goa	Morlem	3.59	3.17	3.8	2.9	3.59	3.17	3.8	2.9
67	48E2D6	North Goa	Mulgaon Shivalkherwad	2.89	2.36	2.95	3.31	2.89	2.36	2.95	3.31
68	GAJY1304	North Goa	Nagargoan	7.29	0.82	3.85	5.86	7.29	0.82	3.85	5.86
69	48E2D2	North Goa	Nagjhar	7.63	7.21	7.73	8.43	7.63	7.21	7.73	8.43
70	Jy13115	South Goa	Navelim	5.14	1.57	2	4.12	5.14	1.57	2	4.12
71	48I4A9	South Goa	Netrolim	9.74	8.92	10.14	8.79	9.74	8.92	10.14	8.79
72		North Goa	Olaulim	7.36	1.48	1.56	1.52	7.36	1.48	1.56	1.52
73	Jy13119	South Goa	Padi	13	5.77	5.92	9.51	13	5.77	5.92	9.51
74	48I3A8	North Goa	Panchawadi(pz)	7.1	4.41	6.57	6.93	7.1	4.41	6.57	6.93
75	GAJY1301	North Goa	Parra	2.43	0.82	1.26	1.5	2.43	0.82	1.26	1.5
76	48E2D1	North Goa	Pernem		3.32	3.54	3.74		3.32	3.54	3.74
77		North Goa	Pirna	3.19	1.45	1.9	2.85	3.19	1.45	1.9	2.85
78	48J1A3	South Goa	Polem(polen)	4.79	1.88			4.79	1.88		
79		North Goa	Pomburpa Palmar	3.36	3.07	3.31	3.01	3.36	3.07	3.31	3.01
80	48I3A4	North Goa	Ponda(pz)	-	-	-	-	-	-	-	-
81	Jy1308	South Goa	Ponquini	8.99	8.19	-	-	8.99	8.19	-	-
82	48I4A4	South Goa	Quepem	3.79	1.55	1.82	3.4	3.79	1.55	1.82	3.4
83	Jy13121	South Goa	Revona	7.49	5.64	8.24	6.77	7.49	5.64	8.24	6.77
84	48E2D4	North Goa	Sal	2.86	2.08	2.71	2.91	2.86	2.08	2.71	2.91
85		North Goa	Salwardhar Dumun	2.78	2.33	2.75	3.25	2.78	2.33	2.75	3.25
86	GAJY1306	North Goa	Sawanthwada(mandrem)	3.01		2.28	3.27	3.01		2.28	3.27
87	48I3A7	North Goa	Shiroda	8.9	5.47	6.36	6.12	8.9	5.47	6.36	6.12

88	GAJY1308	North Goa	Shivoli (brahmanwada)	3.42	0.51	1.36	2.18	3.42	0.51	1.36	2.18
89		South Goa	Shrishtal Gaondongar	8.1	3.79	4.19	11.2	8.1	3.79	4.19	11.2
90	48E2D5	North Goa	Sirsaim	4.27	1.93	3.12	3.65	4.27	1.93	3.12	3.65
91	Jy1307	South Goa	Sristal	5.78	3.14	10.78	11.48	5.78	3.14	10.78	11.48
92	Jy1310	South Goa	Suktali (molem)	6.34	3.46	3.96	3.94	6.34	3.46	3.96	3.94
93	48I2A6	North Goa	Surla(pz)	18.84	-	-	-	18.84	-	-	-
94	Jy13113	South Goa	Themchewada	7.73	5.08	6.3	7.28	7.73	5.08	6.3	7.28
95		South Goa	Ugem(pz)	-	-	-	-	-	2.8	3.6	-
96	48E1D1	North Goa	Uguem(ugawe)	3.3	2.8	3.6	3.05	3.3	-	--	3.05
97	Jy1303	South Goa	Vadam	5.4	3.55	3.85	3.93	5.4	3.55	3.85	3.93
98		South Goa	Valkinim	-	-	-	-	-	-	-	-
99	48I2A5	North Goa	Valpoi	5.47	3.05	1.96	5.3	5.47	3.05	1.96	5.3
100	48E3D1	North Goa	Velha Goa	2.08	0.62	0.94	1.48	2.08	0.62	0.94	1.48
101	Jy1302	South Goa	Vichundrem	7.8	1.55	6.7	7	7.8	1.55	6.7	7
102		South Goa	Waddem(pz)	-	-	-	-	-	-	-	-
103	Jy1304	South Goa	Yedda	5.39	7.64	0.61	1.7	5.39	7.64	0.61	1.7

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

SOUTH WESTERN REGION, GOA STATE

l.No.	Well NO.	District	Location	Seasonal Water Level Fluctuation			Annual Water Level Fluctuation				Water Level Fluctuation with respect to decadal mean water level (m)			
				May 16-Aug 16	May 16-Nov 16	May 16-Jan 16	May 15-May 16	Aug 15-Aug 16	Nov 15-Nov 16	Jan 16-Jan 17	Mean May(2006-2015) to 01-05-2016	Mean Aug(2006-2015) to 01-08-2016	Mean Nov(2006-2015) to 01-11-2016	Mean Jan(2007-2016) to 01-01-2017
1	GAJY1307	North Goa	Adavapal	1.06	0.11	0.18	0.04	0.59	0.05	0.15	-	-	-	-
2	48I4D3	South Goa	Agonda Desaiwada	2.53	0.64	0.5	0.09	1.02	.	0.62	-0.079	0.526	-0.581	0.338
3	48I4A5	South Goa	Akamol Ambavalli	-	-	-		0.65	0.55	0.56		0.561	1.902	-0.904
4	48E2D12	North Goa	Alto Betim Porvorim	1.6	0.88	0.5	-0.57	0.86	-0.8	-0.78	0.037	-1.154	-0.409	0.528
5		North Goa	Amberem	0.68	0.05	-0.3	0.18	0.48	-0.2	-2.3	-	-	-	-
6	GAJY1302	North Goa	Anjuna Beach	-	-	-		0.35	2.56	-1.93		-	-	-
7	48E2D10	North Goa	Baga			0.2	-			0.12	-0.003			
8		South Goa	Bagmola	0.58	0.27	0.32	-0.07	-0.04	0.02	-0.05	-	-	-	-
9	48E3D6	South Goa	Ballynuvhen	1.44	0.63	0.8	-0.67	-0.04	0.18	0.17	0.166	0.377	-0.319	0.051
10	Jy13117	South Goa	Barodi Velni (betul)	0.86		2.1	-0.04	-0.14		-0.28	-	0.249		
11	48I2A2	North Goa	Bayalwadikeri(querim)		-0.63	1.03	-0.22		0.3	-1.31	1.2		0.673	1.436
12	Jy13116	South Goa	Betalbatti	4.47	3.33	2.82	-0.66	-0.14	-1.06	0.23	-	-	-	-
13	GAJY1303	North Goa	Bhamber(Nanoda Cross)	2.99	1.57	2.02	-0.84	0.62	0.16	-0.32	-	-	-	-
14	Jy13114	South Goa	Bhati	3.18	2.97	0.83	-2	0.47	0.76	-0.13	-	-	-	-
15	GAJY1311	North Goa	Bhujpal	4.28	3.94	-	0.25	0.06	-0.08	-0.1	-	-	-	-
16		North Goa	Bicholim			0.16				-0.01				

17	48E2D9	North Goa	Bicholim(pz)			1.8	0.02			-0.35	0.803			
18	48I3A2	South Goa	Bolkharnem	3.94	1.63	1.29	-0.22	1.82	-0.28	-0.05	0.068	1.445	-0.582	-0.249
19	GAJY1310	North Goa	Bori	-	-	-		-0.26	0.01	-		-	-	-
20		North Goa	Britona	0.39	0.33	3.16	-0.02	-0.24	0.16	-1.55	-	-	-	-
21	48E2D11	North Goa	Calangute	4.58	4.38	1.73	-0.47	0.63	1.5	-0.2	-0.09	0.333	0.647	0.049
22	48I4A12	South Goa	Canacona	3.06	2.32	0.44	-0.06	0.14	-0.07	-0.78	-0.217	-0.165	0.083	0.141
23	48E4D1	South Goa	Carmona			-1.05				-0.35				2.803
24	GAJY1312	North Goa	Charayode	5.66	4.36	0.48	-4.68	-	-	0.02	-	-	-	-
25	Jy1306	South Goa	Chikalim	2.5	1.93	1.6	-0.82	-0.1	0.28	1.85	-	-	-	-
26		North Goa	Collem(kolamba)	4.65	1.07	0.4	0.31	1.19	-0.2	-0.33	-0.06	-0.573	-0.543	-0.18
27		North Goa	Colval	3.45	3.03	-	1.72	-0.12	0.02	-0.85	-	-	-	-
28	Jy13118	South Goa	Cuncalim	1.33		2.59	-0.5	0.05		-2.68	-	-	5.154	-
29	48I4A6	South Goa	Cuncalim(pz)	-1.3	3.06	4.54	1.18	-0.54	3.42	0.13	0.189	-1.69		
30	48J1A2	South Goa	Daptamol Lolien	2.21	0.09	-0.47	0.36	1.67	-0.06	-0.4	0.185	1.946	0.13	1.505
31	48I3A3	South Goa	Darbandahra(pz)				-				-	-0.657		
32	48I4A7	South Goa	Deulwada Kolamba	1.07		2.55	-0.33	-0.08		-0.51	-0.655			-0.563
33		North Goa	Devulawada Narve	-	-	-1		1.21	-1.17	-1.42		-	-	-
34		North Goa	Dhatwad Vante	6.31	3.94	1.51	1.46	4.52	0.64	0.55	-	-	-	-
35		South Goa	Fathorda Margao(pz)				0.3				-			
36		North Goa	Gauli Mola											
37	GAJY1305	North Goa	Gavalebhat Chimbel(kirl)	4.93	4.62	-1.87	-4.26	0.17	0.1	-3.98	-	-	-	-
38	48I4A1	South Goa	Ghadiawada	0.68	-0.06	1.06	0.07	-0.15	-0.6	-0.73	0.353	0.003	-0.231	-0.123
39	48E3D3	North Goa	Goa Velha			-0.15	-0.3			-0.4				
40	Jy1312	South Goa	Guddemal	4.78	3.97	1.14		-0.35	-0.01	-0.16	-	-	-	-
41	48I4A11	South Goa	Gulem Velipwada	3.83	3.27		-0.15	0.15	-0.24		-0.49	0.414	0.019	
42		North Goa	Hasapur	1.63	1.25	0.84	-0.47	0.14	-0.21	-0.35	-	-	-	-
43		North Goa	Hasaravanni Vaipal	1.86	0.1		0.18	0.85	-0.75		-	-	-	-
44	48J1A1	South Goa	Hattipal Poinguinem	2.62	2.33	1.88	-0.28	0.14	0.05	0.2	-0.411	-0.513	0.036	-3.968
45		North Goa	Hivre Budruk											
46	48I2A4	North Goa	Honda	2.27	1.89	0.75	-0.15	0.15	-0.03	-0.08	-0.437	-0.317	-0.138	-0.206
47	Jy13120	South Goa	Jambavli	1.5	0.4	1.09	-0.29	-0.8	0.01	0.03	-	-	-	-
48		North Goa	Jambhul Bhatt	2.73	2.39	0.4	-0.22	0.18	0.08	-0.14	-	-	-	-
49	Jy1311	South Goa	Kalay	2.22	1.14	2.69	0.01	0.12	0.06	2.11	-	-	-	-
50	48E4D2	South Goa	Kanagini(pz)				-				-			
51		South Goa	Kapsa	3.06	2.13	-1.08	0.12	0.19	-0.08	-1.34	-	-	-	-
52	48E3D2	North Goa	Karanjhalen	1.67	1.96	1.69	-0.53	0.06	0.17	-0.38	-0.333	-0.14	0.442	-0.032
53	Jy1305	South Goa	Kaveslium	3.09	2.51		-0.68	-0.06	0.14		-	-	-	

54	48I3A1	North Goa	Khadki(harijanwada)	5.85	1.52	0.4	1.19	2.33	0.05	-0.07	1.57	1.135	-1.082	-0.644
55	GAJY1313	North Goa	Khotodem	2.14	0.82	0.28	-0.48	0.14	0.08	0.25	-	-	-	-
56	48E2D3	North Goa	Korgaon	1.42	0.96	0.73	0.02	0.15	-0.19	0.06	-0.149	-0.904	-0.689	1.483
57		North Goa	Kundel Dassolwada	0.45	0.31	3.7	0.26	0.05	0.77	-0.21	-	-	-	-
58	48E3D5	South Goa	Majorda Bpada Curilo	3.51	2.87	1.29	-0.25	-0.08	-0.41	-0.66	-0.575	-0.108	-0.456	-0.264
59	Jy1301	South Goa	Malkarnem	1.26	-3.13		4.51	4	-1.41		-	-	-	
60	GAJY1309	North Goa	Mankem	1.07	0.38	0.69	0.05	-0.31	-0.03	0.08	-	-	-	-
61	48E2D7	North Goa	Mapuca	1.73	0.43	-0.42	-0.01	0.85	-0.31	0.17	-0.03	0.379	-0.081	0.21
62		South Goa	Marmagoa											
63	Jy1309	South Goa	Mashe	1.41	1.05	1.43	-0.14	0.07	0.1	-0.36	-	-	-	-
64	48I3A5	South Goa	Molem	12.45	4.15	-0.8	-0.37	1.53	-2.98	-1.14	-0.539	0.051	-3.362	-0.259
65	48E2C1	North Goa	Morji	2.16	1.5	1.02	-0.61	-0.04	-0.48	-0.33	-0.413	0.024	-0.534	-0.326
66	48I2A3	North Goa	Morlem	0.42	-0.21	0.95	0.2	0.26	0.3	0.95	-0.169	-0.46	-0.251	0.644
67	48E2D6	North Goa	Mulgaon Shivalkherwad	0.53	-0.06	5.84	0.24	0.17	-0.15	1.68	0.45	-0.626	-0.381	0.139
68	GAJY1304	North Goa	Nagargoan	6.47	3.44	3.49	0.48	0.68	0.03	-2.92	-	-	-	-
69	48E2D2	North Goa	Nagjhar	0.42	-0.1	0.17	-0.02	0.27	0.01	-0.57	1.092	-0.739	-0.369	-0.528
70	Jy13115	South Goa	Navelim	3.57	3.14	0.93	-0.26	2.02	2.08	0.02	-	-	-	-
71	48I4A9	South Goa	Netrolim	0.82	-0.4	-	0.79	0.12	0.86	-0.32	0.891	0.288	0.223	1.215
72		North Goa	Olaulim	5.88	5.8	0.34	-5.22	-0.04	-0.01	-0.82	-	-	-	-
73	Jy13119	South Goa	Padi	7.23	7.08	0.35	-0.24	-0.07	-0.51	0.26	-	-	-	-
74	48I3A8	North Goa	Panchawadi(pz)	2.69	0.53	0.39	-0.35	0.5	-0.1	-0.79	-0.014	-0.316	-0.37	-0.944
75	GAJY1301	North Goa	Parra	1.61	1.17	0.72	-0.05	0.22	-0.01	0.84	-	-	-	-
76	48E2D1	North Goa	Pernem	-	-	-0.05		-0.3	-0.42	-0.19		-1.051	-0.962	-0.502
77		North Goa	Pirna	1.74	1.29	-0.47	0.38	0.05	0.01	-0.4	-	-	-	-
78	48J1A3	South Goa	Polem(polen)	2.91			1.09	1.08			-0.667	-0.502		
79		North Goa	Pomburpa Palmar	0.29	0.05	-0.26	0.13	-0.51	0.05	-1.62	-	-	-	-
80	48I3A4	North Goa	Ponda(pz)											
81	Jy1308	South Goa	Ponquini	0.8			-	-			-	-		
82	48I4A4	South Goa	Quepem	2.24	1.97	2.78	-0.48	-	-	0.38	0.072	0.111	1.105	-0.244
83	Jy13121	South Goa	Revona	1.85	-0.75	1.24	0.24	0	-0.41	-0.2	-	-	-	-
84	48E2D4	North Goa	Sal	0.78	0.15	-3.1	0.31	0.17	-0.3	-6.75	0.105	-0.357	-0.146	-0.001

85		North Goa	Salwardhar Dumun	0.45	0.03	0.62	0.2	1.22	-0.02	-0.1	-	-	-	-
86	GAJY1306	North Goa	Sawanthwada(mandrem)		0.73	-5.7	0.78		0.07	-1.14	-		-	-
87	48I3A7	North Goa	Shiroda	3.43	2.54	2.4	-4.23	-0.17	-0.13	0.12	-2.423	-0.437	-0.457	0.644
88	GAJY1308	North Goa	Shivoli (brahmanwada)	2.91	2.06	0.45	-0.18	0.37	0.12	-	-	-	-	-
89		South Goa	Shrishtal Gaondongar	4.31	3.91	0.25	-2.13	-0.11	-0.33	0.08	-1.541	-0.222	-0.431	-6.152
90	48E2D5	North Goa	Sirsaim	2.34	1.15	1.47	0.16	0.25	-0.63	-0.38	-0.086	-0.098	-0.44	0.086
91	Jy1307	South Goa	Sristal	2.64	-5	0.17	5.7	6.84	-0.64	-0.08	-	-	-	-
92	Jy1310	South Goa	Suktali (molem)	2.88	2.38	0.6	-1.38	-0.1	.	-	-	-	-	-
93	48I2A6	North Goa	Surla(pz)				0.55				0.867			
94	Jy13113	South Goa	Themchewada	2.65	1.43	0.8	0.97	2.72	1.82	0.03	-	-	-	-
95		South Goa	Ugem(pz)		-0.3	3.69			-0.31	1.16	0.322	-0.013	-0.167	
96	48E1D1	North Goa	Uguem(ugawe)	0.5	1.55	-	0.05	0.54	0.2	-				0.081
97	Jy1303	South Goa	Vadam	1.85		-	-1.25	-0.01		-	-	-	-	-
98		South Goa	Valkinim	2.42		-		0.97		-	0.074			
99	48I2A5	North Goa	Valpoi	1.46	3.51	-	-0.14	1.06	3.04	-		-0.042	2.401	0.141
100	48E3D1	North Goa	Velha Goa		1.14	-	-0.25		0.34	-	0.637	0.313	0.254	0.032
101	Jy1302	South Goa	Vichundrem	6.25	1.1	-	-0.26	-0.12	-0.1	-	-	-	-	-
102		South Goa	Waddem(pz)			-				-				
103	Jy1304	South Goa	Yedda	-2.25	4.78	-	-0.54	-7.32	0.36	-	-	-	-	-

ANNEXURE - V

Depth to Water Level of Piezometers in Goa State during 2016-17

Sl.No	District	Taluk	Location	Depth to Water Level			
				May-16	Aug-16	Nov-16	Jan-17
1	North Goa	Bardez	Adavapal	5.78	1.7	4.2	4.7
2	North Goa	Tiswadi	Ajosi	4.43	3.06	3.85	4.22
3	North Goa	Bardez	Aldona	16.3	-	-	13.9
4	North Goa	Bardez	Aropora	2.9	-	-0.03	1.28
5	South Goa	Canacona	Aven	-	7.36	7.84	8.1
6	North Goa	Ponda	Betki	16.98	-	15.11	
7	South Goa	Mormugao	Bogmola	0.42		0.4	0.49
8	South Goa	Salcete	Canabonulim	5.91	3.21	3.61	4.45
9	South Goa	Salcete	Chandvar	2.63			2.38
10	South Goa	Salcete	Chinchinim	2.45	0.24	0.54	1.1
11	South Goa	Sanquem	Collem	-	-	6.25	5.66
12	North Goa	Pernem	Colvale	14.1			
13	South Goa	Canacona	Dabel	-	7.54	9.1	10.4
14	South Goa	Sanquem	Dhat Farm	-	-	-	-
15	South Goa	Salcete	Dovorlim	5.25	4.21	4.72	4.87
16	North Goa	Pernem	Hassapur	-	-	-	-
17	South Goa	Sanquem	Kalay	5	-	3.23	4
18	South Goa	Salcete	Karmona	-	-	-	-
19	North Goa	Bicholim	Kasar Pal	9.55	7.96	9.04	9.35
20	South Goa	Salcete	Kavelosim	-	-	-	-
21	North Goa	Bardez	Kirl Pirna	-	5.07	6.85	7.9
22	North Goa	Pernem	Korgoan	10.83	9.89	10.51	10.8
23	North Goa	Tiswadi	Krilwada	1.6	1.03	1.21	1.35
24	South Goa	Canacona	Kuske	-	-	-	-
25	North Goa	Ponda	Madakai	21.3	-	-	-
26	South Goa	Salcete	Manora Rai	5.35	4.14	5.15	5.41
27	North Goa	Bicholim	Mayam	6.05	4.06	5.29	5.83
28	South Goa	Sanquem	Meidawada	-	6.58	10.23	10.95
29	North Goa	Tiswadi	Mola	0.46	0.49	0.51	0.34
30	South Goa	Sanquem	Molem	9.27	1.28	4.14	6.67
31	North Goa	Pernem	Morjum	2.9	1.47	1.6	2.23
32	North Goa	Satari	Morlem	-	1.56	2.7	3.56
33	North Goa	Satari	Nanoda	19.65	17.54	18.02	18.28
34	North Goa	Bicholim	Narve	12.3	-	-	-
35	South Goa	Sanquem	Natravlim	-	-	-	-
36	North Goa	Pernem	Parsekarwada	18.7	13.9	18.05	17.9
37	South Goa	Canacona	Patnem	7.9	2.15	3.3	4.5
38	South Goa	Canacona	Ponquini	9.15	8.35	8.51	8.7
39	South Goa	Quepem	Quiescond	14.77	-	-	-
40	North Goa	Bicholim	Sanqulim	27.75	17.89	24.12	27.6
41	North Goa	Satari	Sanvordam	-	-	-	-
42	North Goa	Pernem	Sawanthwada	5.2	1.86	4.3	4.6

43	North Goa	Pernem	Silolium	5.3	2.56	12.48	4.6
44	North Goa	Satari	Thane	9.84	5.5	4.33	-
45	North Goa	Bardez	Tivim	20.7	17.02	6.29	20.3
46	North Goa	Pernem	Tuem	-	-	19.95	-
47	North Goa	Pernem	Varkhand	14.9	11.56	13.23	14.4
48	South Goa	Salcete	Verna	1.94	-0.23	1.45	1.66
49	South Goa	Canacona	Yedda	10.3	4.79	10.95	8.2

ANNEXURE - VI

HYDROCHEMICAL DATA OF GROUND WATER MONITORING STATIONS, GOA STATE

S.NO.	Location	pH	Specific Conduct. in µS/cm at 25°C	C0	HC0	Cl	N0	S0	F	PO	Ca	Mg	TH	Na	K	PO	
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	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.	20	14	0.36	0.15	0.006
59	Malkarnem	7.5	130	0	24	28	2	2	0.04	-	8	2.	30	15	0.6	0.18	0.004
60	Kalya	7.7	50	0	12	7.	1.	1	0.05	-	2	1.	10	6	0.4	0.1	0.002
61	Collem	7.3	90	0	18	18	1	1	0.06	-	6	3.	30	4.	0.8	0.11	0.001
62	Molem	7.4	160	0	30	36	1	3	0.07	-	1	5	50	12	1.30	0.06	ND
63	Bolkarnem	7.1	70	0	12	14	0.	4	0.10	-	4	2.	20	6.	0.08	0.12	0.008
64	Marcel	7.1	50	0	12	7	1.	2	0.05	-	4	2.	20	1.	0.4	0.08	0.014
65	Keri	7.0	60	0	12	7	2.	4	0.05	-	4	2.	20	2.	0.4	0.11	0.001