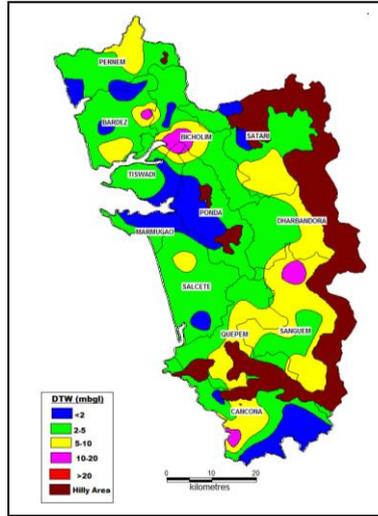


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जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
DEPT. OF WATER RESOURCES, RD & GR
केन्द्रीय भूजल बोर्ड / CENTRAL GROUND WATER BOARD

गोवा राज्य की भूजल वर्षपुस्तिका
GROUND WATER YEAR BOOK OF GOA
(2020-2021)



दक्षिण पश्चिम क्षेत्र /South Western Region
बेंगलुरु /Bangalore

CONTRIBUTORS' PAGE

PRINCIPAL AUTHORS

Smt. Rakhi U R. Jr.Hydrogeologist (Scientist-B)
Ms. D.Dhayamalar Sr. Hydrogeologist (Scientist-D)
Dr.K.Ravichandran Sr.Chemist (Scientist D)
Dr.Lubna Kouser Assistant Hydrologist

DATA COLLECTION

Dr.J.Davithuraj, Scientist -B

HYDROCHEMISTRY

Dr.K.Ravichandran Sc-D
Smt.Lalitha B.H, STA(Ch)
Dr. Sailee Bhangе, STA(Ch)

SCRUTINY & ISSUANCE

**Report Processing Section
CGWB, SWR, Bangalore**

EXECUTIVE SUMMARY

Central Ground Water Board, an apex Organization under Ministry of Water Resources, Government of India, is carrying out the monitoring of ground water levels all over the country for generating a sound database so that the changes in ground water regime could be scientifically studied, analysed and strategies for its optimal utilization can be planned.

The behaviour of ground water table during the ground water year 2020-2021 in Goa State has to be studied by monitoring a set of dug wells and purpose-built piezometers during the months of May 2020, August 2020, November 2020 and January 2021. Water level monitoring could not be carried out during May 2020 and August 2020 due to covid 19 lockdown restrictions. So last 5 years average water levels is calculated and analysed for these seasons. As of January 2021, Central Ground Water Board, South Western Region, monitors 85 dug wells and 43 piezometers to study the ground water scenario of Goa State.

The present compilation relates to the year 2020-2021. It provides information pertaining to water levels and also chemical quality of the phreatic aquifer. Thematic maps depicting the ground water scenario along with geochemical quality are furnished and discussed in this report. In addition, the fluctuations in water level and piezometric surface between different time frames have been analysed and presented. Various thematic maps presented reflect the effect of rainfall received during the period of study and the long-term behaviour of water level according to ground water recharge and draft conditions obtained in various agro-climatic zones. The data on seasonal rainfall are furnished to correlate the effect of the rainfall on water levels.

In general, the water levels are deep in the month of May and a rising trend of water levels during November (Post-monsoon period) was observed. Water level fluctuation takes place during August, November and January depending on the monsoon rainfall and level of groundwater development.

During the pre-monsoon period, the average depth to water levels of 2 -5 m bgl and 5 to 10 mbgl are more prevalent in the State during premonsoon period. Shallow water levels of less than 2 m bgl are noticed as isolated patches in Goa State. Depth to water level 10-20 m bgl is noticed in isolated pockets in some parts of the state.

During the post-monsoon period, the depth to water levels of 2 -5 m bgl and 5 to 10 mbgl are more prevalent in the State. Depth to water level of less than 2 m bgl has been recorded in 23% of wells analysed. Depth to water level more than 10 is noticed as patches in some part of Goa State.

Results of chemical analysis of water samples collected during May 2019 are also discussed for understanding the spatial variation of EC, Chloride, Fluoride and Nitrate concentration in the phreatic aquifer system of the state of Goa

GROUND WATER YEAR BOOK OF GOA STATE (2020-2021)

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 132 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 12 taluks. The taluk wise distribution of Ground water monitoring stations being monitored by the Region is given in **Table 1**.

Table 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	16
3	Pernem	251.7	15
4	Bicholim	277.2	13
5	Satari	517.7	15
6	Ponda	259.4	7
District: South Goa			
7	Sanguem	506	11
8	Cancona	352.0	15
9	Dharbandora	368.8	19
10	Quepem	318.3	4
11	Salcete	292.9	19
12	Mormugao	109.1	3

* 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 etch plain. 3. Low dissected denudation hills and table land and 4. Deeply dissected high Western Ghats denudational hills occurring all along the eastern part of Goa rising to a maximum of 832m 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 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 broadens in central midlands and become 'U' shaped in the low lands and coastal plains (**Plate I**).

Table 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		

1.4 Geological Conditions

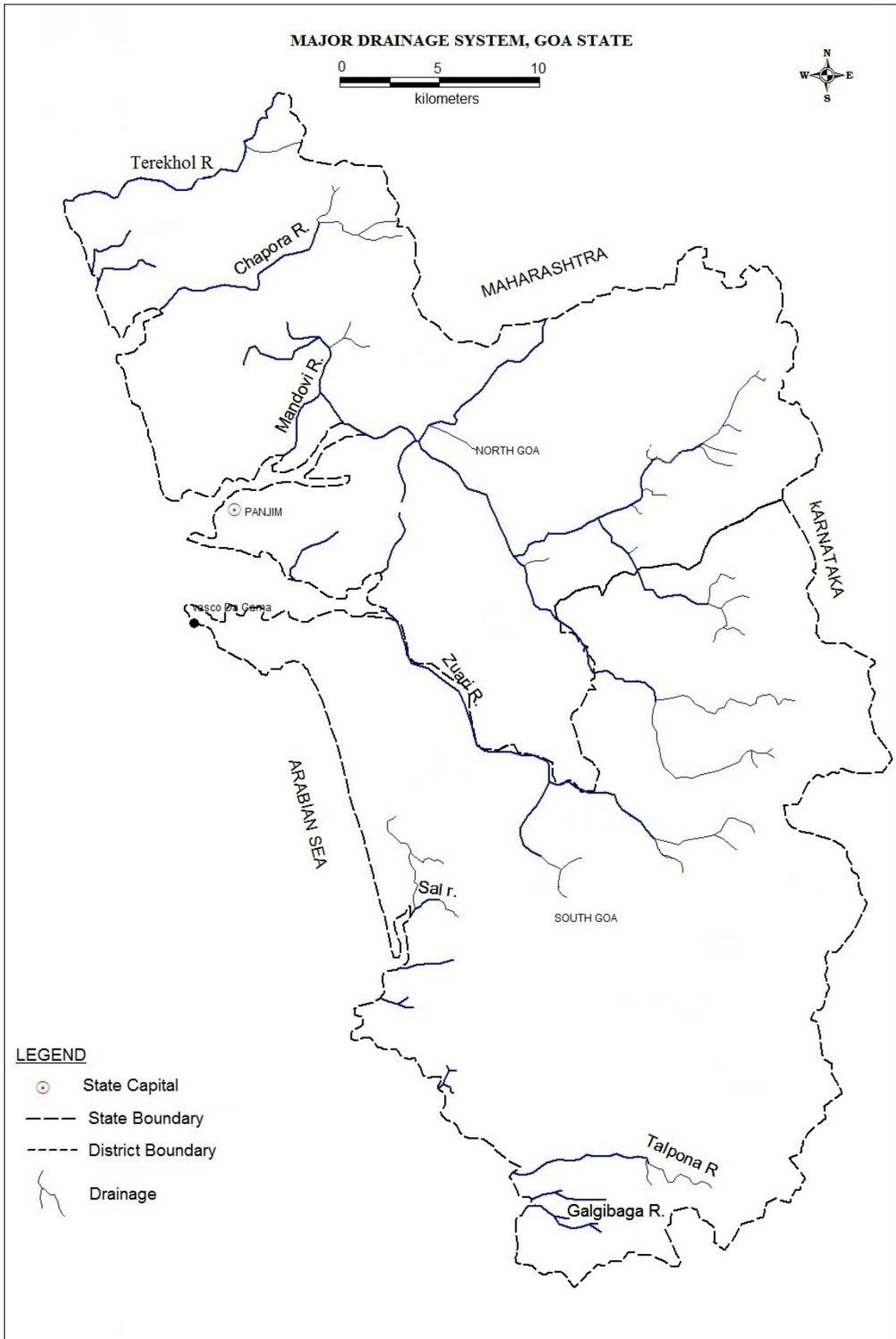
Major part of the Goa State is underlain by rocks of Precambrian age comprising of banded biotite gneisses, Meta volcanics, phyllites, biotite and chlorite schists, greywacke, conglomerate (tilloid), pink phyllites with associated banded ferruginous quartzite and chart breccia. These rocks are intruded 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 northeastern part in the high altitudes.

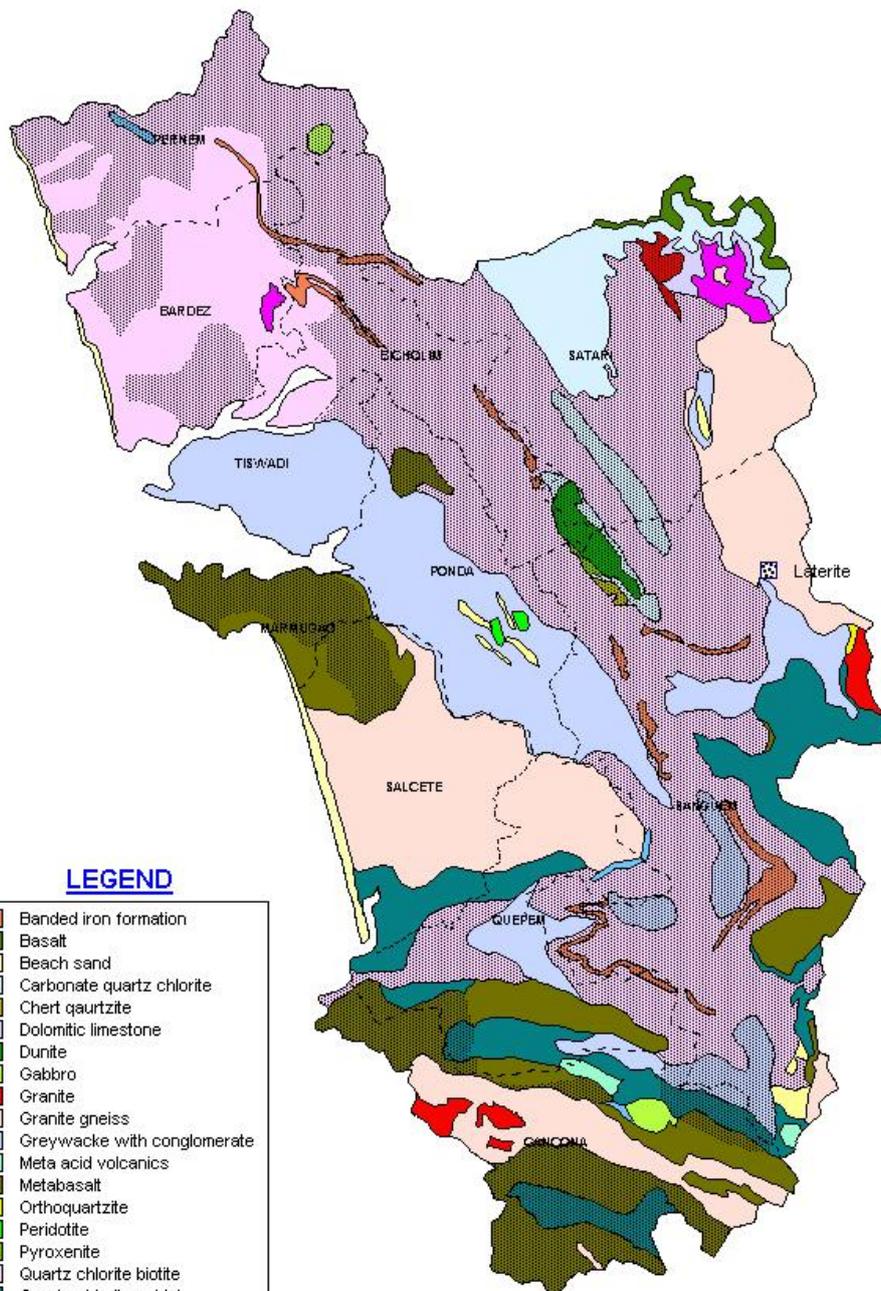
Almost all formations in the state have undergone lateritisation to various degrees depending upon the climate and rock type. The lateritisation is more pronounced in the coastal areas than in the hilly regions. Phyllites, Schists and Meta volcanics are more susceptible to lateritisation and the gneissic / 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 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 (**Plate II**).



GEOLOGICAL MAP OF GOA STATE



LEGEND

- Banded iron formation
- Basalt
- Beach sand
- Carbonate quartz chlorite
- Chert quartzite
- Dolomitic limestone
- Dunite
- Gabbro
- Granite
- Granite gneiss
- Greywacke with conglomerate
- Meta acid volcanics
- Metabasalt
- Orthoquartzite
- Peridotite
- Pyroxenite
- Quartz chlorite biotite
- Quartz chlorite schist
- quartz sericite schist
- Quartzite
- Serpentine

2. CLIMATE AND RAINFALL

The State has a tropical-maritime monsoonal type climate with distinct aerographic 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 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.

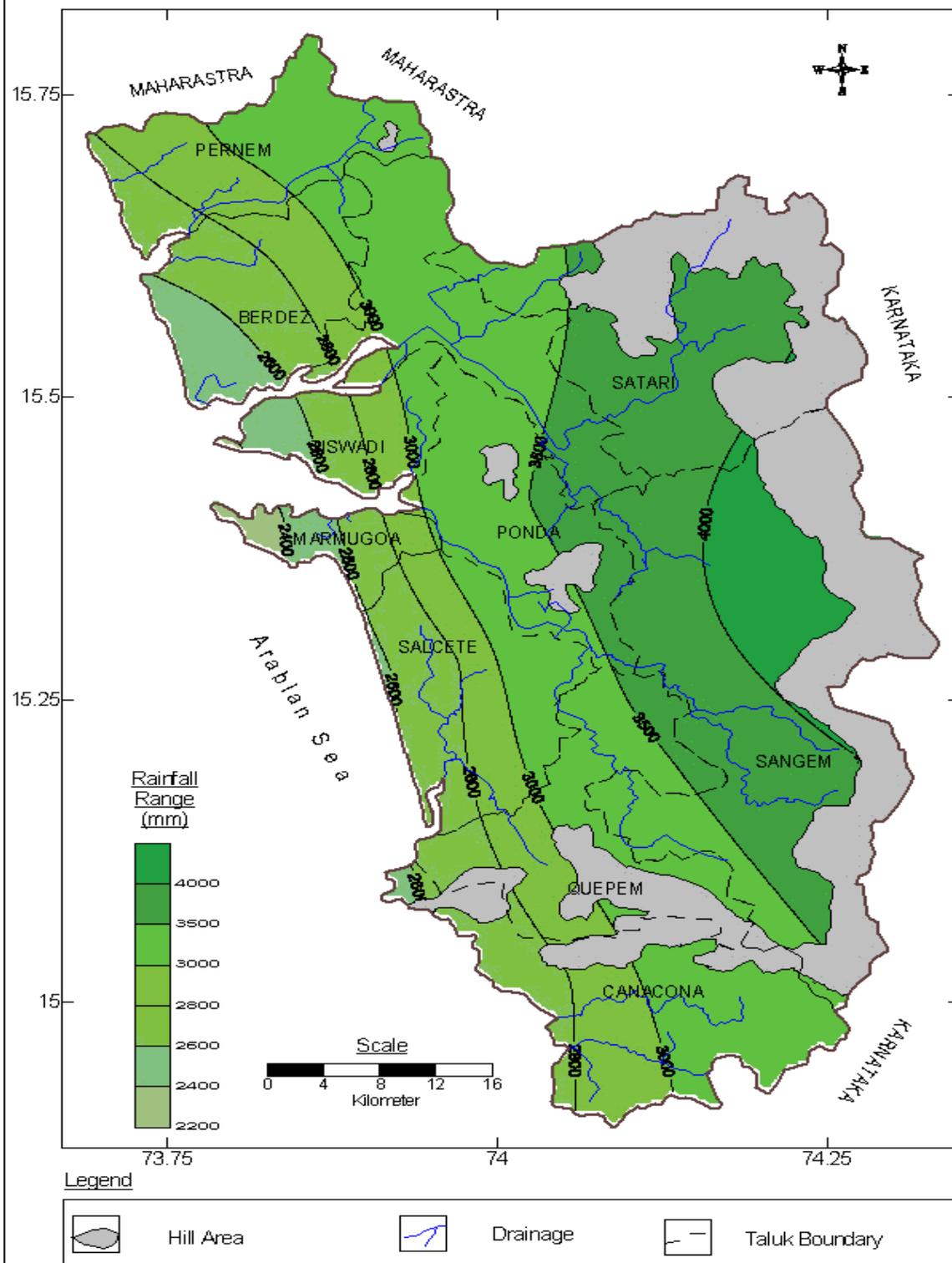
The annual normal rainfall in North Goa ranges from 2766.9 at Panaji along the west coast and highest at Valpoi in the east (Ghats section) indicating rainfall increases from west to east. Average rainfall in North Goa is 3400.1mm. Similarly in South Goa it ranged 2611.7 mm at Mormugao in west coast 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 3733.13mm.

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 **Plate III** Normal monthly rainfall of in respect of 12 stations of Goa state is presented in **Table 3**.

Table 3: 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

NORMAL MONSOON (JUNE - SEPTEMBER) RAINFALL (1970-2000) GOA STATE



3. DEPTH TO WATER LEVEL

Due to covid-19 lockdown water level monitoring was not carried out in the State during May 2020 and August 2020. Hence 5 years average water level from 2015 - 2019 is analysed for these two seasons.

Average Water Level May (2015 to 2019)

The statement showing the distribution of ground water monitoring wells along with average depth to water level of phreatic aquifer in different depth ranges is presented in **Table-4** and **Plate-IV** depicts the ground water scenario in May 2015 to May 2019. Salient features of the average depth to water level scenario are given below.

1. A perusal of the water level data reveals that the depth to water level ranged from 1.66 m bgl (Quepem taluk) to 19.11 m bgl (Bicholim taluk).
2. The salient feature of the analysis is that the depth to water level over major part of the State lies within 10 m bgl in 89% of wells analysed, while 11% of wells show depth to water level more than 10 m bgl.
3. Depth to water level of less than 2 m bgl has been recorded in 5% of wells analysed and noted in Bardez, Ponda, Quepem, Satari and Tiswadi taluks.
4. Depth to water level in the range of 2 to 5 m bgl has been recorded in 42% of wells analysed and noted in all the taluks except Dharbandora taluk.
5. Depth to water level in the range of 5 to 10 m bgl has been recorded in 39% of wells analysed and noted in all the taluks except Mormugao and Tiswadi taluks.
6. Depth to water level in the range of 10 to 20 m bgl has been observed in 11% of wells analysed and noted as isolated Bardez, Bicholim, Canacona, Dharbandora, Quepem Salcete and Sanguem taluks.

AVERAGE DEPTH TO PIEZOMETRIC SURFACE

Average Depth to piezometric surface has been recorded from piezometers spread all over the State in hard rock areas. The statement showing average depth to piezometric surface during May 2015 to May 2019 is given in **Table 5**. Salient features of the average depth to piezometric surface are given below;

1. The depth to piezometric surface ranged from 0.5 m bgl (Mormugao taluk) to 21.6 m bgl (Dharbandora taluk) in Goa State.

2. 63% of wells have recorded depth to piezometric surface within 10 m bgl and 37% of wells show depth to piezometric surface more than 10 m bgl.
3. Depth to piezometric surface of less than 2 m bgl has been recorded in 9% of wells analysed and this has been noted in Mormugao, Salcete and Tiswadi taluks.
4. Depth to piezometric surface in the range of 2 to 5 m bgl has been recorded in 24% of wells analysed and noted in Bardez, Pernem, Sanguem, Tiswadi and Salcete taluks.
5. Depth to piezometric surface in the range of 5 to 10 m bgl has been recorded in 30 % of wells analysed and noted in Bardez, Bicholim, Canacona, Dharbandora, Pernem, Salcete and Satari taluks.
6. Depth to piezometric surface in the range of 10 to 20 m bgl has been observed in 30% of wells analysed and noted in Bardez, Bicholim, Canacona, Dharbandora, Pernem, Ponda, Quepem and Satari taluks.
7. Depth to piezometric surface in the range of 20 to 40 m bgl has been noted in 7 % of wells analysed and noticed in Bardez, Dharbandora and Ponda taluks.

Table 4: AVERAGE DEPTH TO WATER LEVEL (MAY 2015-2019)

S.No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
1	Bardez	13	1.97	14.18	1	7.7	8	61.5	2	15.4	2	15.4	0	0	0	0
2	Bicholim	9	2.83	19.11	0	0	3	33.3	3	33.3	3	33.3	0	0	0	0
3	Cancona	10	4.16	14.87	0	0	4	40	5	50	1	10	0	0	0	0
4	Dharbandora	5	5.27	13.94	0	0	0	0	4	80	1	20	0	0	0	0
5	Mormugao	1	3.07	3.07	0	0	1	100	0	0	0	0	0	0	0	0
6	Pernem	9	2	7.46	0	0	6	66.7	3	33.3	0	0	0	0	0	0
7	Ponda	5	1.83	6.84	1	20	2	40	2	40	0	0	0	0	0	0
8	Quepem	5	1.66	15.95	1	20	2	40	1	20	1	20	0	0	0	0
9	Salcete	12	2.28	13.23	0	0	7	58.3	4	33.3	1	8.3	0	0	0	0
10	Sanguem	12	2.73	11.97	0	0	2	16.7	9	75	1	8.3	0	0	0	0
11	Satari	10	1.88	9.11	1	10	5	50	4	40	0	0	0	0	0	0
12	Tiswadi	3	1.67	4.85	1	33.3	2	66.7	0	0	0	0	0	0	0	0
	Total	94	1.66	19.11	5	5	42	45	37	39	10	11	0	0	0	0

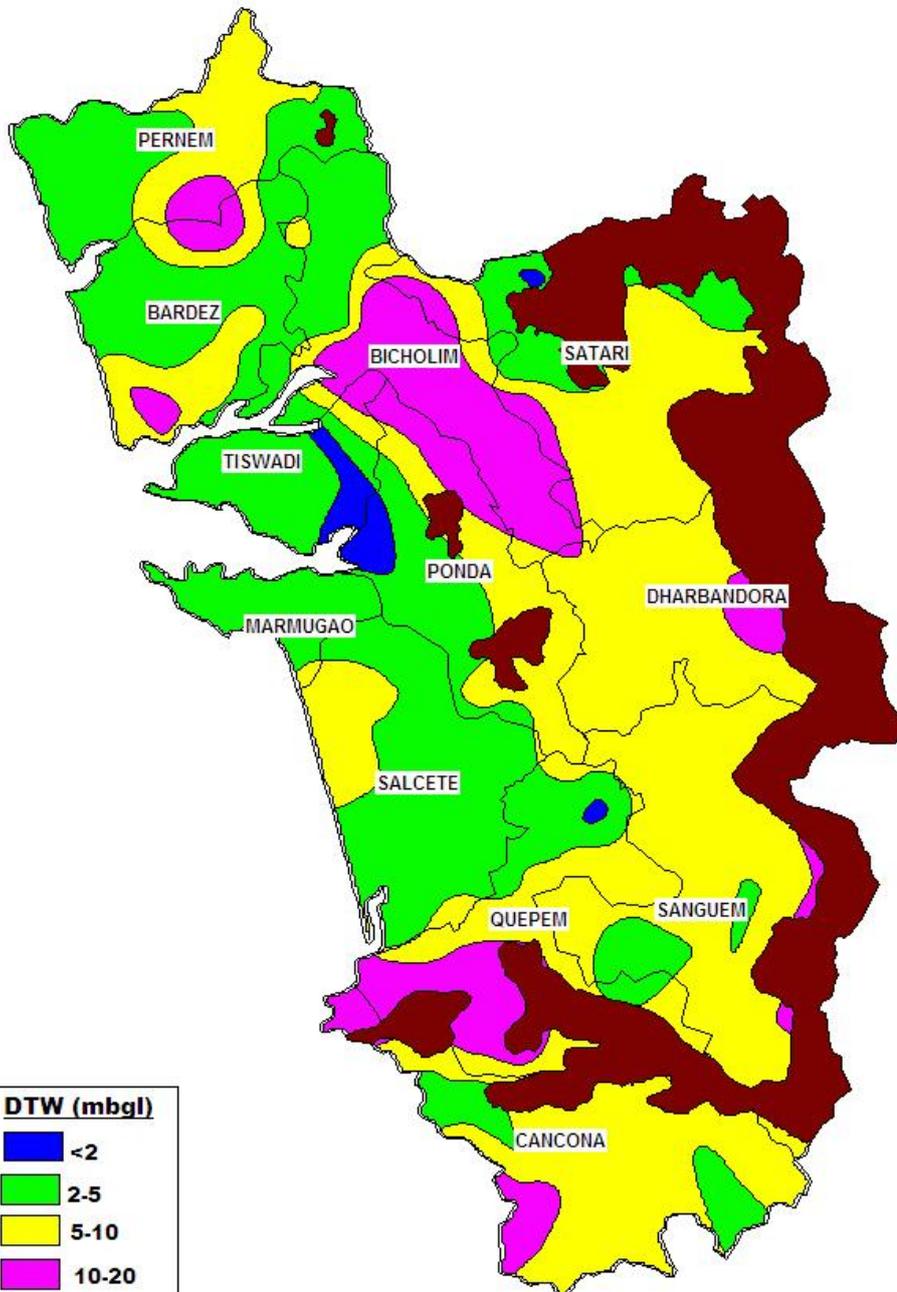
Table 5: AVERAGE DEPTH TO PIEZOMETRIC SURFACE (MAY (2015-2019))

S.No	Taluk Name	No. of Wells Analysed	Min	Max	No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
1	Bardez	5	2.78	20.8	0	0	1	20	2	40	1	20	1	20	0	0
2	Bicholim	3	5.24	12.7	0	0	0	0	2	66.7	1	33.3	0	0	0	0
3	Cancona	5	7.96	12.6	0	0	0	0	2	40	3	60	0	0	0	0
4	Dharbandora	4	6.19	21.6	0	0	0	0	2	50	1	25	1	25	0	0
5	Mormugao	1	0.5	0.5	1	100	0	0	0	0	0	0	0	0	0	0
6	Pernem	8	2.79	16.2	0	0	2	25	2	25	4	50	0	0	0	0
7	Ponda	2	16.88	21.2	0	0	0	0	0	0	1	50	1	50	0	0
8	Quepem	1	15.44	15.4	0	0	0	0	0	0	1	100	0	0	0	0
9	Salcete	8	1.97	6.69	1	12.5	5	62.5	2	25	0	0	0	0	0	0
10	Sanguem	2	4.6	4.96	0	0	2	100	0	0	0	0	0	0	0	0
11	Satari	4	5.06	19.9	0	0	0	0	2	50	2	50	0	0	0	0
12	Tiswadi	3	0.8	4.36	2	66.7	1	33.3	0	0	0	0	0	0	0	0
	Total	46	0.5	21.6	4	9	11	24	14	30	14	30	3	7	0	0

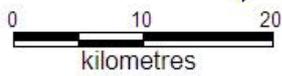
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AVERAGE DEPTH TO WATER LEVEL

(MAY 2015 to MAY 2019)



DTW (mbgl)	
	<2
	2-5
	5-10
	10-20
	>20
	Hilly Area



Average Water Level August (2015 to 2019)

The statement showing the distribution of ground water monitoring wells along with average depth to water level of phreatic aquifer in different depth ranges is presented in **Table-6** and **Plate-V** depicts the ground water scenario in August 2015 to August 2019. Salient features of the average depth to water level scenario are given below.

1. A perusal of the water level data reveals that the depth to water level ranged from 0.44 m bgl (Pernem taluk) to 14.26 m bgl (Bicholim taluk).
2. The salient feature of the analysis is that the depth to water level over major part of the State lies within 10 m bgl in 96% of wells analysed, while 4% of wells show depth to water level more than 10 m bgl.
3. Depth to water level of less than 2 m bgl has been recorded in 36% of wells analysed and noted in all taluks except Mormugao taluk.
4. Depth to water level in the range of 2 to 5 m bgl has been recorded in 40% of wells analysed and noted in all the taluks except Tiswadi taluk.
5. Depth to water level in the range of 5 to 10 m bgl has been recorded in 20% of wells analysed and noted in Bardez, Canacona, Dharbandora, Pernem, Ponda, Salcete and Sanguem taluks.
6. Depth to water level in the range of 10 to 20 m bgl has been observed in 4% of wells analysed and noted as isolated patches in Bicholim and Canacona taluks.

AVERAGE DEPTH TO PIEZOMETRIC SURFACE

Average Depth to piezometric surface has been recorded from piezometers spread all over the State in hard rock areas. The statement showing average depth to piezometric surface during August 2015 to August 2019 is given in **Table 7**. Salient features of the average depth to piezometric surface are given below;

1. The depth to piezometric surface ranged from 0.08 m bgl (Mormugao taluk) to 17.7 m bgl (Dharbandora taluk) in Goa State.
2. 70% of wells have recorded depth to piezometric surface within 10 m bgl and 30% of wells show depth to piezometric surface more than 10 m bgl.
3. Depth to piezometric surface of less than 2 m bgl has been recorded in 27% of wells analysed and this has been noted in Canacona, Dharbandora, Mormugao, Pernem, Salcete, Satari and Tiswadi taluks.
4. Depth to piezometric surface in the range of 2 to 5 m bgl has been recorded in 27% of wells analysed and noted in Bardez, Bicholim, Canacona, Dharbandora, Pernem, Salcete, Sanguem and Tiswadi taluks.

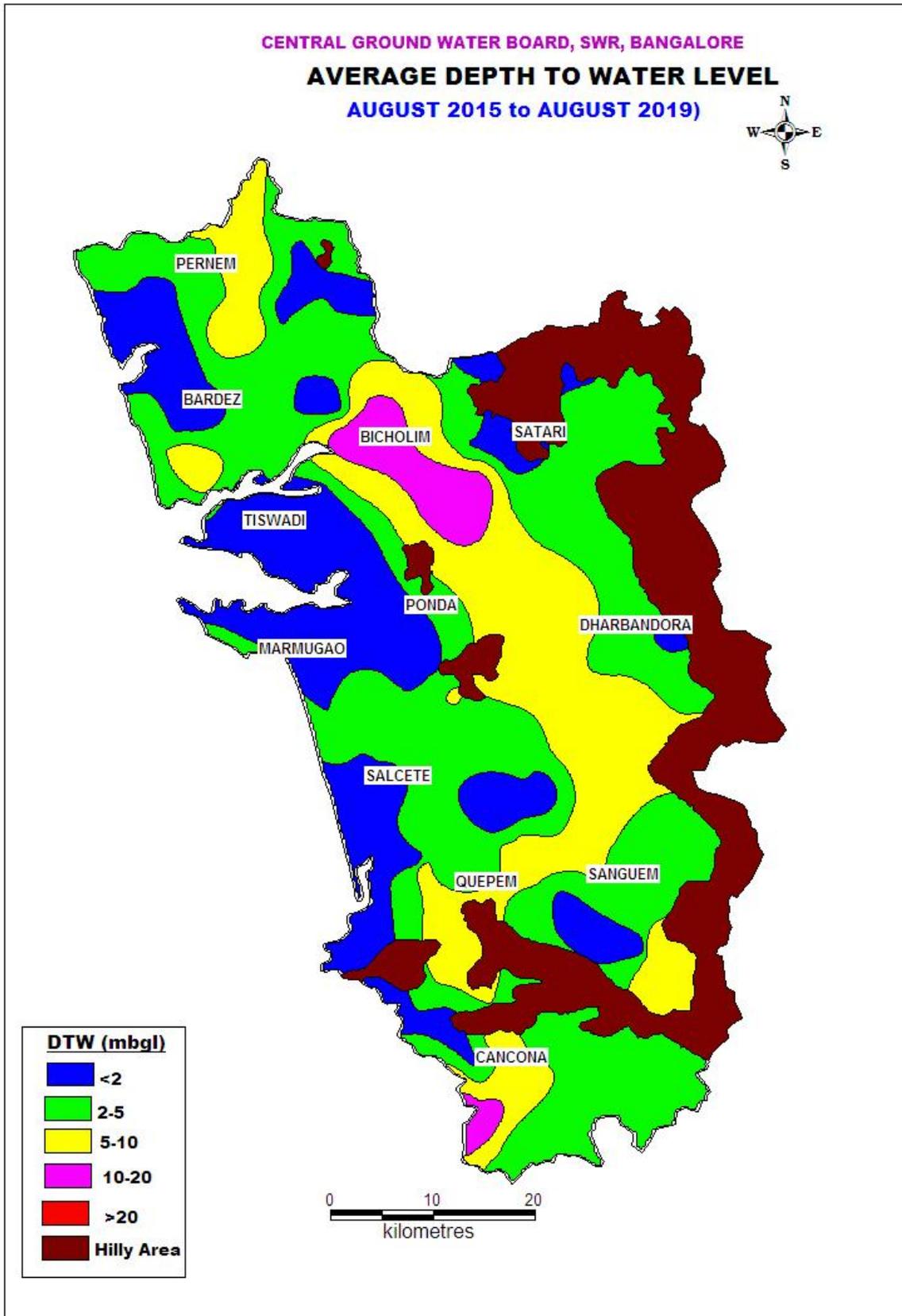
5. Depth to piezometric surface in the range of 5 to 10 m bgl has been recorded in 16 % of wells analysed and noted in Bardez, Bicholim, Canacona, Dharbandora and Satari taluks.
6. Depth to piezometric surface in the range of 10 to 20 m bgl has been observed in 30% of wells analysed and noticed in Bardez, Bicholim, Dharbandora, Pernem, Ponda, Quepem and Satari taluks.

Table 6: Average Depth to Water Level (August (2015- 2019))

S.No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
					1	Bardez	12	0.54	7.63	4	33.3	6	50	2	16.7	0
2	Bicholim	9	1.25	14.26	2	22.2	4	44.4	0	0	3	33.3	0	0	0	0
3	Canacona	10	0.95	12.98	3	30	3	30	3	30	1	10	0	0	0	0
4	Dharbandora	5	1.65	7.59	1	20	3	60	1	20	0	0	0	0	0	0
5	Mormugao	1	2.4	2.4	0	0	1	100	0	0	0	0	0	0	0	0
6	Pernem	9	0.44	7.26	3	33.3	4	44.4	2	22.2	0	0	0	0	0	0
7	Ponda	5	1.08	5.14	2	40	2	40	1	20	0	0	0	0	0	0
8	Quepem	4	0.87	3.02	2	50	2	50	0	0	0	0	0	0	0	0
9	Salcete	12	1	6.14	6	50	4	33.3	2	16.7	0	0	0	0	0	0
10	Sanguem	11	1.13	9.13	2	18.2	2	18.2	7	63.6	0	0	0	0	0	0
11	Satari	10	1	4.11	5	50	5	50	0	0	0	0	0	0	0	0
12	Tiswadi	3	0.98	1.81	3	100	0	0	0	0	0	0	0	0	0	0
	Total	91	0.44	14.26	33	36	36	40	18	20	4	4	0	0	0	0

Table 7: Average Depth to Piezometric Surface (August (2015-2019))

S.No	District	No. of Wells Analysed	Min	Max	No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
					1	Bardez	4	3.15	17.1	0	0	1	25	1	25	2
2	Bicholim	3	4.06	10.2	0	0	1	33.3	1	33.3	1	33.3	0	0	0	0
3	Canacona	5	1.85	7.12	1	20	1	20	3	60	0	0	0	0	0	0
4	Dharbandora	4	1.08	17.7	1	25	1	25	1	25	1	25	0	0	0	0
5	Marmugoa	1	0.08	0.08	1	100	0	0	0	0	0	0	0	0	0	0
6	Pernem	8	1.45	16.2	2	25	2	25	0	0	4	50	0	0	0	0
7	Ponda	2	13.6	14	0	0	0	0	0	0	2	100	0	0	0	0
8	Quepem	1	11.3	11.3	0	0	0	0	0	0	1	100	0	0	0	0
9	Salcete	8	0.11	4.06	4	50	4	50	0	0	0	0	0	0	0	0
10	Sanguem	1	2.68	2.68	0	0	1	100	0	0	0	0	0	0	0	0
11	Sattari	4	1.37	17.6	1	25	0	0	1	25	2	50	0	0	0	0
12	Tiswadi	3	0.43	2.67	2	66.7	1	33.3	0	0	0	0	0	0	0	0
	Total	44	0.08	17.7	12	27	12	27	7	16	13	30	0	0	0	0



November 2020

The statement showing the distribution of ground water monitoring wells along with depth to water level of phreatic aquifer in different depth ranges is presented in **Table 8** and **Plate-VI** depicts the ground water scenario in November 2020. Salient features of the depth to water level scenario during November 2020 are given below.

1. A perusal of the water level data reveals that the depth to water level ranged from 0.85 m bgl (Pernem taluk) to 14.49 m bgl (Bicholim taluk).
2. The salient feature of the analysis is that the depth to water level over major part of the State lies within 10 m bgl in 94% of wells analysed, while 6% of wells show depth to water level more than 10 m bgl.
3. Depth to water level of less than 2 m bgl has been recorded in 23% of wells analysed and noted in all taluks except Mormugao, Dharbandora, Quepem and Sanguem taluks.
4. Depth to water level in the range of 2 to 5 m bgl has been recorded in 46% of wells analysed and noted in all the taluks.
5. Depth to water level in the range of 5 to 10 m bgl has been recorded in 25% of wells analysed and noted in all the taluks except Mormugao, Ponda and Quepem taluks.
6. Depth to water level in the range of 10 to 20 m bgl has been observed in 6% of wells analysed and noted as isolated Bardez, Bicholim, Canacona and Sangeum taluks.

DEPTH TO PIEZOMETRIC SURFACE

Depth to piezometric surface has been recorded from piezometers spread all over the State in hard rock areas. The statement showing depth to piezometric surface is given in **Table 9**. Salient features of the depth to piezometric surface during November 2020 are given below;

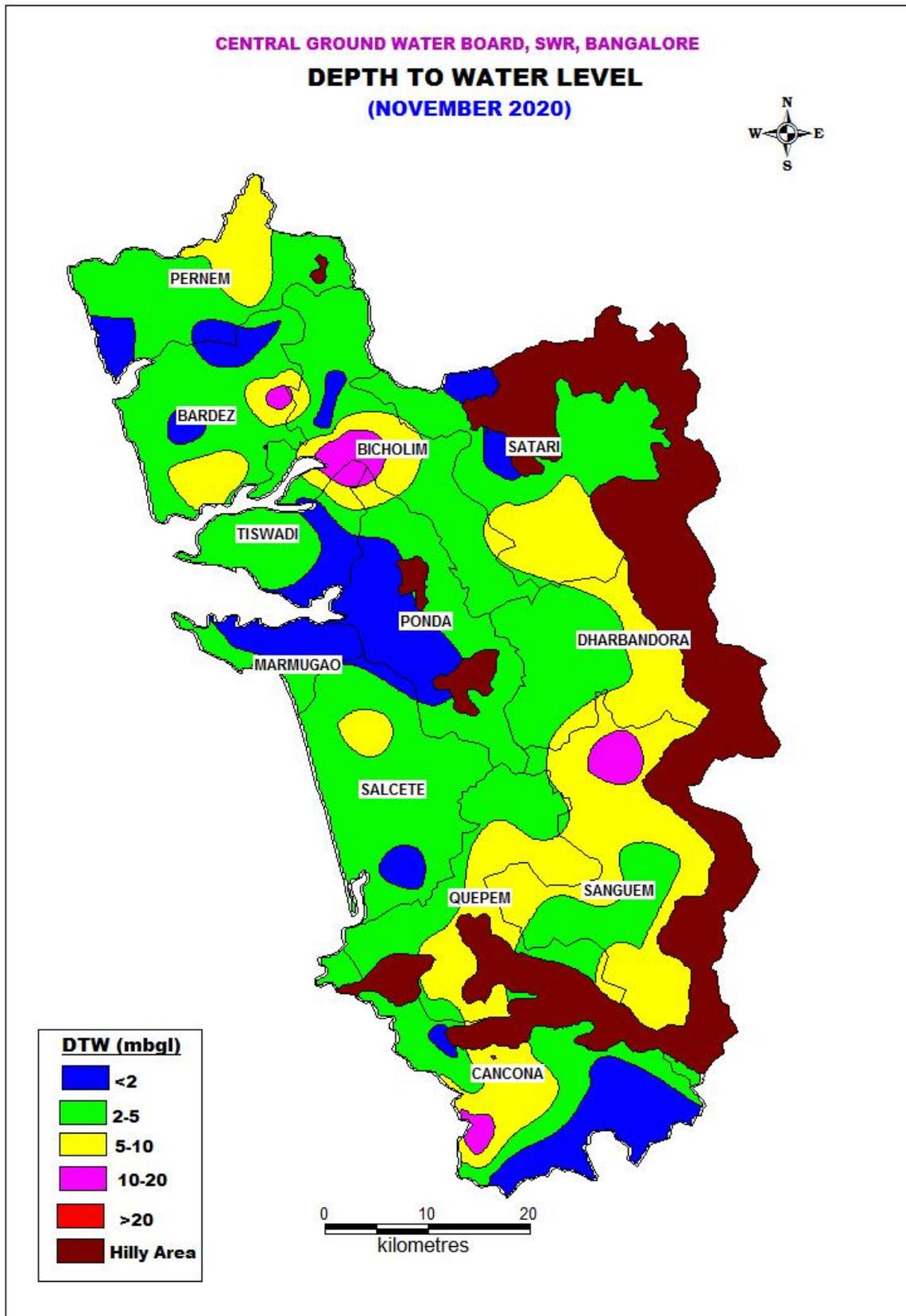
1. The depth to piezometric surface ranged from 0.21 m bgl (Bardez taluk) to 25.50 m bgl (Bicholim taluk) in Goa State.
2. 70% of wells have recorded depth to piezometric surface within 10 m bgl and 30% of wells show depth to piezometric surface more than 10 m bgl.
3. Depth to piezometric surface of less than 2 m bgl has been recorded in 23% of wells analysed and this has been noted in Bardez, Mormugao, Pernem, Salcete and Tiswadi taluks.
4. Depth to piezometric surface in the range of 2 to 5 m bgl has been recorded in 20% of wells analysed and noted in Dharbandora, Canacona, Pernem, Sangeum, Sattari and Tiswadi taluks.

5. Depth to piezometric surface in the range of 5 to 10 m bgl has been recorded in 27 % of wells analysed and noted in Bardez, Bicholim, Canacona, Dharbandora, Salcete and Sanguem taluks.
6. Depth to piezometric surface in the range of 10 to 20 m bgl has been observed in 27% of wells analysed and noted in Bardez, Dharbandora, Pernem, Ponda, Sanguem and Satari taluks.
7. Depth to piezometric surface in the range of above 20 m bgl has been observed in 3% of wells analysed and noted in Dharbandora taluk.

S. No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
					1	Bardez	12	1.11	11.43	5	41.7	5	41.7	1	8.3	1
2	Bicholim	7	1.17	14.49	2	28.6	3	42.9	1	14.3	1	14.3	0	0	0	0
3	Cancona	9	0.98	12.48	3	33.3	3	33.3	1	11.1	2	22.2	0	0	0	0
4	Dharbandora	4	3.92	7.82	0	0	1	25	3	75	0	0	0	0	0	0
5	Mormugao	1	2.85	2.85	0	0.0	1	100.0	0	0.0	0	0.0	0	0	0	0
6	Pernem	9	0.85	7.65	1	11.1	6	66.7	2	22.2	0	0.0	0	0	0	0
7	Ponda	3	1.38	3	2	66.7	1	33.3	0	0.0	0	0.0	0	0	0	0
8	Quepem	2	2.13	3.95	0	0.0	2	100.0	0	0.0	0	0.0	0	0	0	0
9	Salcete	8	1	6.08	2	25.0	4	50.0	2	25.0	0	0.0	0	0	0	0
10	Sanguem	11	2.11	10.84	0	0.0	3	27.3	7	63.6	1	9	0	0	0	0
11	Satari	8	1.43	7.40	2	25.0	4	50.0	2	25	0	0.0	0	0	0	0
12	Tiswadi	3	1.13	4.76	1	33.3	2	66.7	0	0	0	0.0	0	0	0	0
	Total	77	0.98	14.49	18	23	35	46	19	25	5	6	0	0	0	0

Table 9: Depth to Piezometric Surface (November 2020)

S.No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
1	Bardez	3	0.21	19.16	1	33.3	0	0.0	1	33.3	1	33.3	0	0.0	0	0
2	Bicholim	2	5.12	5.19	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0	0	0
3	Cancona	4	3.51	8.55	0	0.0	1	25.0	3	75.0	0	0.0	0	0.0	0	0
4	Dharbandora	4	4.54	25.5	0	0	1	25	1	25	1	25	1	25	0	0
4	Mormugao	1	0.28	0.28	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0
5	Pernem	6	1.76	13.18	1	16.7	2	33.3	0	0.0	3	50.0	0	0.0	0	0
6	Ponda	1	15.78	15.78	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0
7	Quepem	0			0	0	0	0	0	0	0	0	0	0	0	0
8	Salcete	4	0.40	5.77	3	75.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0
9	Sanguem	0			0	0.0	0	0.0	0	33.3	1	33.3	0	0.0	0	0
10	Satari	3	2.62	15.58	0	0.0	1	33.3	0	0.0	2	66.7	0	0.0	0	0
11	Tiswadi	2	0.35	3.89	1	50.0	1	50.0	0	0.0	0	0.0	0	0.0	0	0
	Total	30	0.21	25.50	7	23	6	20	8	27	8	27	1	3	0	0



January 2021

The statement showing the distribution of ground water monitoring wells along with depth to water level of phreatic aquifer in different depth ranges is presented in **Table 10** and **Plate-VII** depicts the ground water scenario in January 2021. Salient features of the depth to water level scenario during January 2021 are given below.

1. A perusal of the water level data reveals that the depth to water level ranged from 1.11 m bgl (Pernem taluk) to 15.66 m bgl (Bardez taluk).
2. The salient feature of the analysis is that the depth to water level over major part of the State lies within 10 m bgl in 90% of wells analysed, while 10% of wells show depth to water level more than 10 m bgl.
3. Depth to water level of less than 2 m bgl has been recorded in 11% of wells analysed and noted in 6 taluks such as Bardez, Pernem, Ponda, Quepem, Satari, Tiswadi and Canacona taluks
4. Depth to water level in the range of 2 to 5 m bgl has been recorded in 51% of wells analysed and noted in all the taluks except Dharbandora taluk.
5. Depth to water level in the range of 5 to 10 m bgl has been recorded in 28% of wells analysed and noted in all the taluks except Mormugao and Quepem taluks.
6. Depth to water level in the range of 10 to 20 m bgl has been observed in 10% of wells analysed and noted as isolated Bardez, Bicholim, Cancona, Dharbandora and Sanguem taluks.

DEPTH TO PIEZOMETRIC SURFACE

Depth to piezometric surface has been recorded from piezometers spread all over the State in hard rock areas. The statement showing depth to piezometric surface is given in **Table 11**. Salient features of the depth to piezometric surface during January 2021 are given below;

1. The depth to piezometric surface ranged from 0.36 m bgl (Mormugao taluk) to 26.06 m bgl (Bicholim taluk) in Goa State.
2. 67% of wells have recorded depth to piezometric surface within 10 m bgl and 33% of wells show depth to piezometric surface more than 10 m bgl.
3. Depth to piezometric surface of less than 2 m bgl has been recorded in 22% of wells analysed and this has been observed in Bardez, Mormugao, Pernem, Salcete and Tiswadi taluks.

4. Depth to piezometric surface in the range of 2 to 5 m bgl has been recorded in 22% of of wells analysed and this has been observed in Bardez, Cancona, Pernem, Salcete, Satari and Tiswadi taluks.
5. Depth to piezometric surface in the range of 5 to 10 m bgl has been recorded in 24 % of wells analysed and observed in Bicholim, Canacona, Dharbandora, Satari and Tiswadi taluks.
6. Depth to piezometric surface in the range of 10 to 20 m bgl has been observed in 24% of wells analysed and noted in Bardez, Bicholim, Canacona, Pernem, Ponda, Dharbandora and Satari taluks.
7. Depth to piezometric surface in the range of above 20 m bgl has been observed in 81% of wells analysed and noted 3 taluks such as Bardez, Bicholim and Ponda.

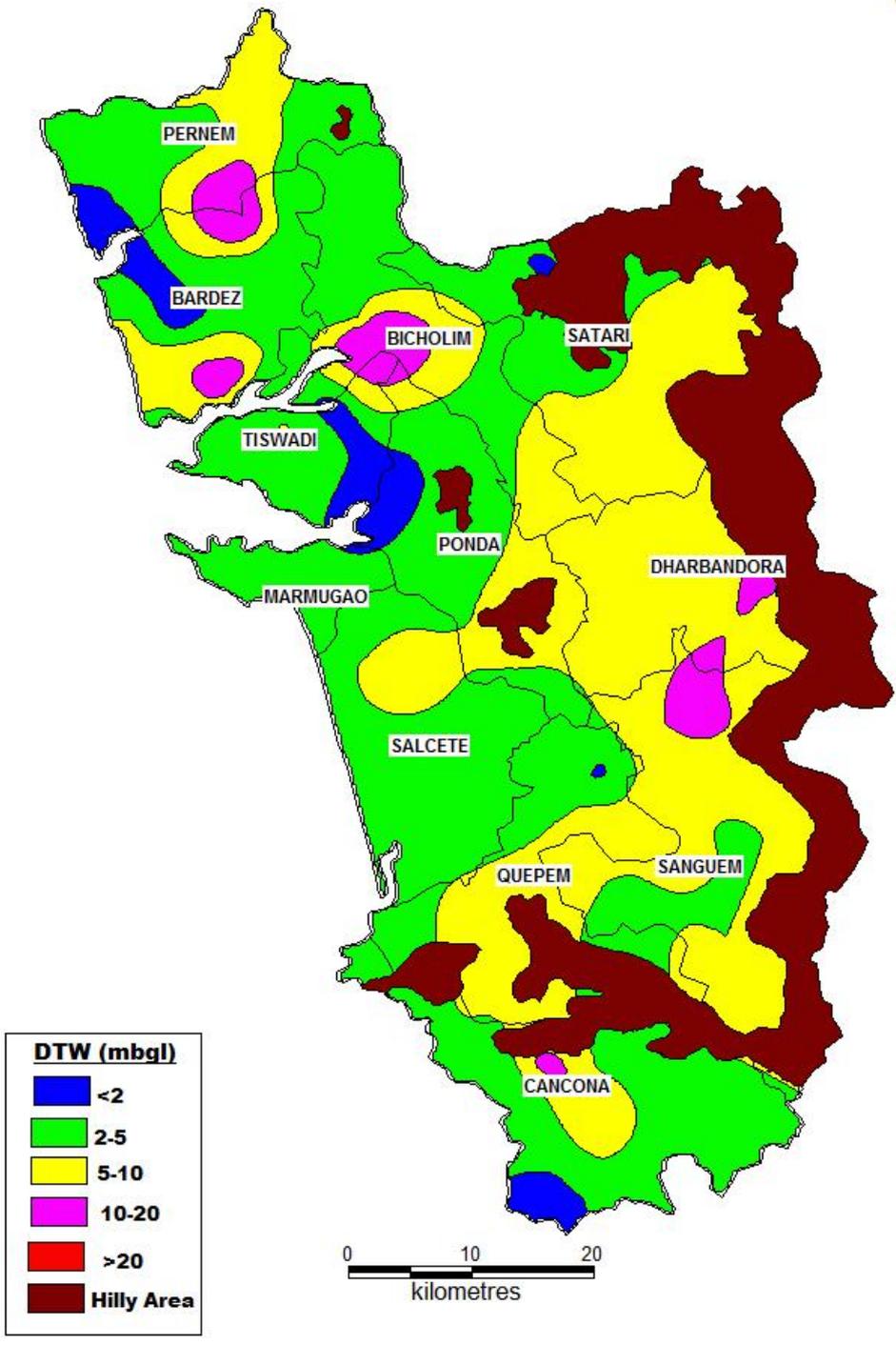
Table 10: Depth to Water Level (January 2021)

S.No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
1	Bardez	11	1.32	15.66	2	18.2	5	45.5	1	9.1	3	27.3	0	0	0	0
2	Bicholim	7	2.61	14.71	0	0.0	5	71.4	1	14.3	1	14.3	0	0	0	0
3	Cancona	8	1.58	10.88	1	12.5	5	62.5	1	12.5	1	12.5	0	0	0	0
4	Dharbandora	3	5.98	10.4	0	0	0	0	2	66.7	1	33.3	0	0	0	0
5	Mormugao	1	2.95	2.95	0	0.0	1	100.0	0	0.0	0	0.0	0	0	0	0
6	Pernem	8	1.11	7.29	1	12.5	5	62.5	2	25.0	0	0.0	0	0	0	0
7	Ponda	4	1.63	6.45	1	25.0	2	50.0	1	25.0	0	0.0	0	0	0	0
8	Quepem	3	1.91	4.10	1	33.3	2	66.7	0	0.0	0	0.0	0	0	0	0
9	Salcete	7	2.63	8.73	0	0.0	5	71.4	2	28.6	0	0.0	0	0	0	0
10	Sanguem	11	2.49	10.60	0	0.0	3	27.3	7	63.6	1	9.1	0	0	0	0
11	Satari	8	1.90	7.76	1	12.5	4	50.0	3	37.5	0	0.0	0	0	0	0
12	Tiswadi	3	1.15	5.06	1	33.3	1	33.3	1	33.3	0	0.0	0	0	0	0
	Total	74	1.11	15.66	8	11	38	51	21	28	7	10	0	0	0	0

Table 11: Depth to Piezometric Surface (January 2021)

S.No	Taluk Name	No of Wells analysed	Min	Max	No/Percentage of Wells showing Depth to water table (mbgl) in the range of											
					0-2	%	2-5	%	5-10	%	10-20	%	20-40	%	>40	%
1	Bardez	5	0.80	21.78	1	20.0	1	33.3	0	20.0	1	20.0	1	25	0	0
2	Bicholim	3	5.90	12.92	0	0.0	0	0	2	66.6	1	33.3	0	0	0	0
3	Cancona	5	4.82	10.01	0	0.0	1	0.0	2	60.0	1	20.0	0	0	0	0
4	Dharbandora	4	5.62	26.06	0	0	0	0	2	50	1	25	1	25	0	0
5	Mormugao	1	0.36	0.36	1	100	0	40.0	0	0.0	0	0.0	0	0	0	0
6	Pernem	6	1.67	14.09	1	16.7	2	0.0	0	0.0	3	50.0	0	0	0	0
7	Ponda	2	16.88	20.35	0	0.0	0	33.3	0	0.0	1	50.0	1	50	0	0
8	Quepem	0			0	0	0	0	0	0	0	0	0	0	0	0
9	Salcete	5	1.05	4.74	3	60.0	2	0.0	0	0.0	0	0.0	0	0	0	0
10	Sanguem	0			0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0
11	Satari	3	3.58	19.48	0	0.0	1	0.0	2	33.3	1	33.3	0	0	0	0
12	Tiswadi	3	0.80	4.39	2	66.7	1	20.0	1	0.0	0	0.0	0	0	0	0
	Total	37	0.36	26.06	8	22	8	22	9	24	9	24	3	8	0	0

CENTRAL GROUND WATER BOARD, SWR, BANGALORE
DEPTH TO WATER LEVEL
(JANUARY 2021)



4. FLUCTUATION OF WATER LEVEL

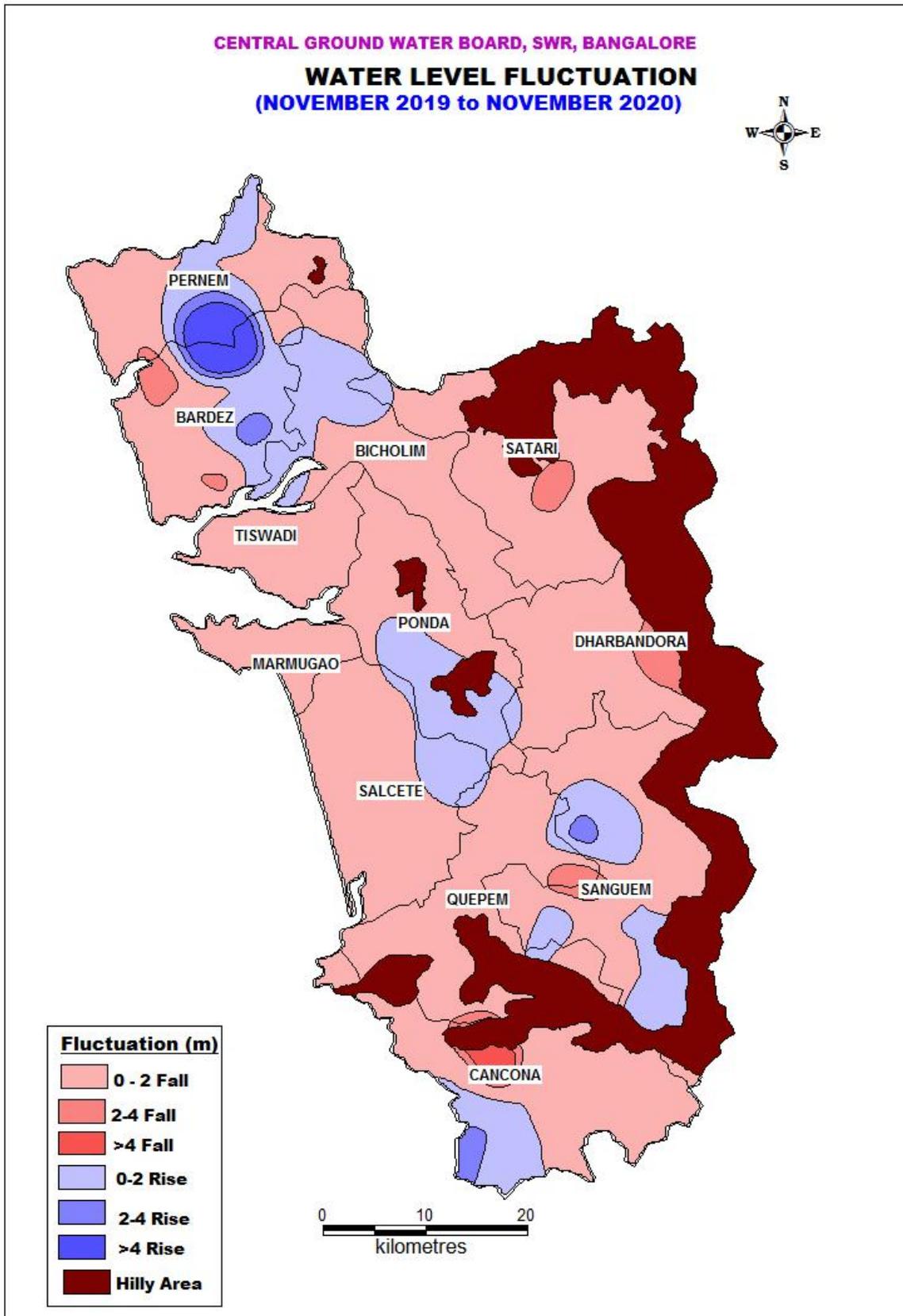
November 2019 & November 2020

The statement showing the distribution of ground water monitoring wells falling in different ranges of fluctuation is presented in **Table 12**. A comparison of water level shows that a rise in the water level is recorded in 85% of wells analysed, while 15% recorded fall. The fluctuation in water level has been plotted in **Plate VIII**. A perusal of the plate shows that a general fall in the range of 0 – 2 m is noticed in major part of the area, followed by a rise of 0 – 2 m.

1. Rise in the water level in the range of 0-2 m has been observed in 76% of wells analysed and observed in almost all taluks.
2. Rise in the water level in the range of 2-4 m has been observed in 5% of wells analysed and observed in Bardez, Bicholim, Sanguem and Satari taluks.
3. Rise in the water level in the range of >4 m has been observed in 4% of wells analysed and observed Canacon, Ponda and Sanguem taluks.
4. The fall in water level in the range of 0-2 m has been observed in 13% of wells analysed and noted in Bardez, Pernem, Sanguem and Satari taluks.
5. The fall in water level in the range of 2-4 m has been observed in 1% of wells analysed and noted in Bardez taluk.
6. The fall in water level more than 4 m has been observed in 1% of wells analysed and noted in Sanguem taluk.

Table 12: District wise categorisation of water level fluctuation (Nov 2019-Nov 2020)

S.No	District Name	No of wells analysed	Rise_Range of Fluctuation (m)						Fall_Range of Fluctuation (m)						Rise	Fall
			0-2		2-4		>4		0-2		2-4		>4			
			No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%		
1	Bardez	11	2	18.2	0	0.0	1	9.1	6	54.5	2	18.2	0	0.0	3	8
2	Bicholim	7	2	28.6	1	14.3	0	0	4	57.1	0	0	0	0.0	3	4
3	Canacona	7	0	0.0	1	14.3	0	0	5	71.4	0	0	1	14.3	1	6
	Dharbandora	4	0	0	0	0	0	0	4	100	0	0	0	0	0	4
4	Mormugoa	1	0	0.0	0	0.0	0	0	1	100.0	0	0	0	0	0	1
5	Pernem	9	2	22.2	0	0.0	0	0	7	77.8	0	0	0	0	2	7
6	Ponda	3	2	66.7	0	0.0	0	0	1	33.3	0	0	0	0	2	1
7	Quepem	2	0	0.0	0	0.0	0	0	2	100.0	0	0	0	0	0	2
8	Salcete	8	0	0.0	0	0.0	0	0	8	100.0	0	0	0	0	0	8
9	Sanguem	11	3	27.3	1	9.1	0	0	5	45.5	2	18.2	0	0	4	9
10	Sattari	8	1	12.5	0	0.0	0	0	6	75	1	12.5	0	0	1	7
11	Tiswadi	2	0	0.0	0	0.0	0	0	2	100	0	0.0	0	0	0	3
	Total	73	12	17	3	4	1	1	51	70	5	7	1	1	16	57

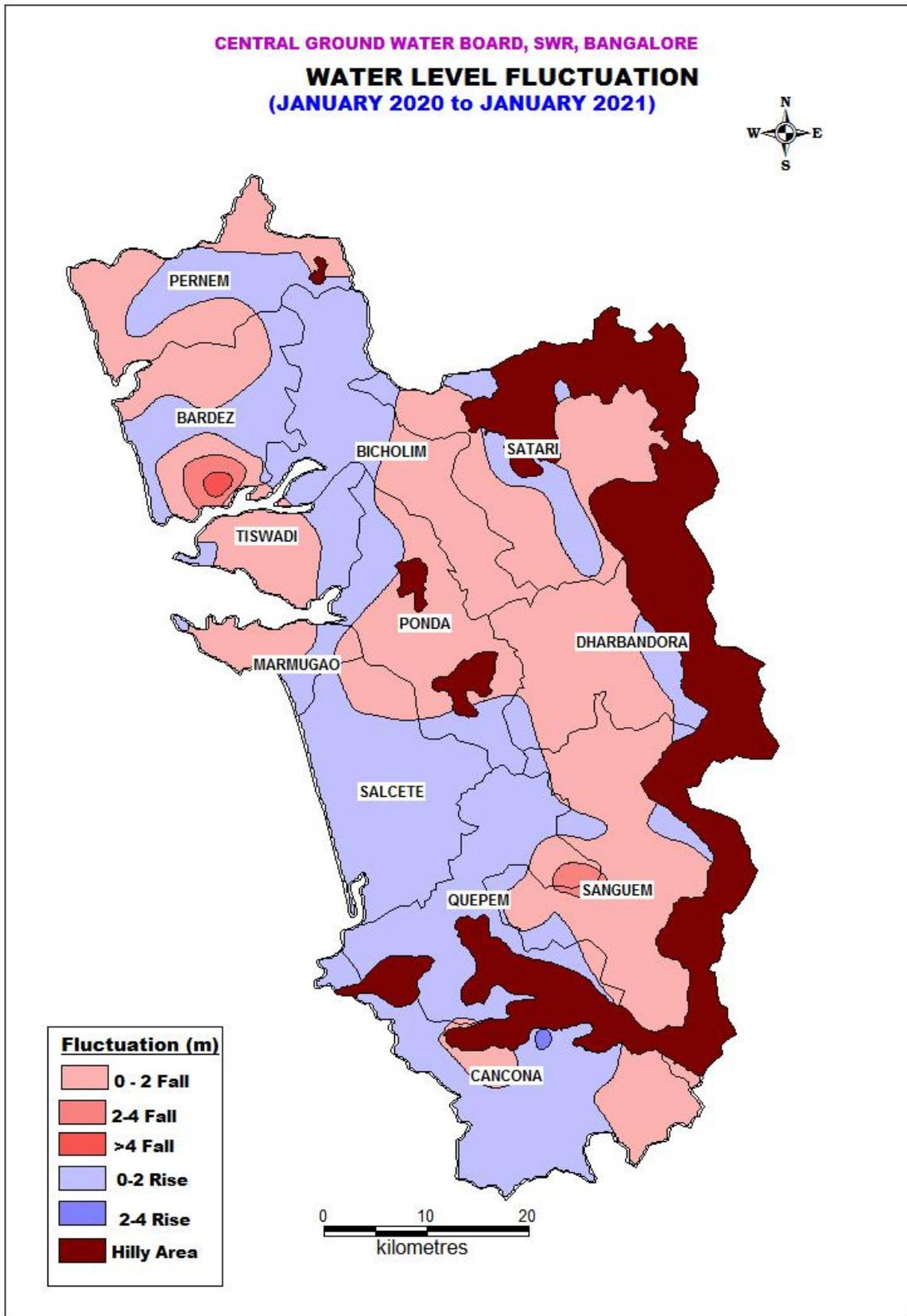


January 2020 & January 2021

The statement showing the distribution of ground water monitoring wells falling in different ranges of fluctuation is presented in **Table 13**. A comparison of water level shows that a rise in the water level is recorded in 79% of wells analysed, while 21% recorded fall. The fluctuation in water level has been plotted in **Plate IX**. A perusal of the plate shows that a general fall in the range of 0 – 2 m is noticed in major part of the area, followed by a rise of 0 – 2 m.

1. Rise in the water level in the range of 0-2 m has been observed in 72% of wells analysed and observed in all taluks except Mormugao taluks.
2. Rise in the water level in the range of 2-4 m has been observed in 6% of wells analysed and observed in Bardez, Bicholim, Salcete and Tiswadi taluks.
3. Rise in the water level in the range of >4 m has been observed in 1% of wells analysed and observed in Sanguem taluk.
4. The fall in water level in the range of 0-2 m has been observed in 20% of wells analysed and noted in almost all taluks except Tiswadi taluk.
5. Fall in the water level in the range of 2-4 m has been observed in 1% of wells analysed and observed in Sanguem taluk.

Table 13: District wise categorisation of water level fluctuation (Jan 2020-Jan 2021)																
S. No	District Name	No of wells analysed	Rise_Range of Fluctuation (m)						Fall_Range of Fluctuation (m)						Rise	Fall
			0-2		2-4		>4		0-2		2-4		>4			
			No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%		
1	Bardez	11	4	36.4	1	9.1	0	0.0	5	45.5	1	9.1	0	0.0	5	6
2	Bicholim	7	4	57.1	0	0.0	0	0.0	3	42.9	0	0.0	0	0.0	4	3
3	Canacona	8	6	75.0	0	0.0	0	0.0	2	25	0	0.0	0	0	6	2
4	Dharbandora	3	2	66.7	0	0	0	0	1	33.3	0	0	0	0	2	1
5	Mormugoa	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	1
6	Pernem	8	7	87.5	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	7	1
7	Ponda	4	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0	3	1
8	Quepem	3	3	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0
9	Salcete	7	2	28.6	0	0.0	0	0.0	5	71.4	0	0.0	0	0.0	2	5
10	Sanguem	11	1	9.1	0	0.0	0	0.0	9	81.8	0	0.0	1	9.1	1	10
11	Sattari	8	4	50.0	0	0.0	0	0.0	4	50.0	0	0.0	0	0.0	4	4
12	Tiswadi	3	1	33.3	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0	1	2
	Total	74	37	50	1	1	0	0.0	34	47	1	1	1	1	38	36



FLUCTUATION BETWEEN DECADAL MEAN WATER LEVEL & WATER LEVEL

The fluctuation of water level recorded during the particular period with respect to decadal means indicate the impact of ground water development and ground water recharge during the decade. Positive fluctuation indicates improved recharge over and above ground water development and negative fluctuation indicates increased ground water development over and above the recharge.

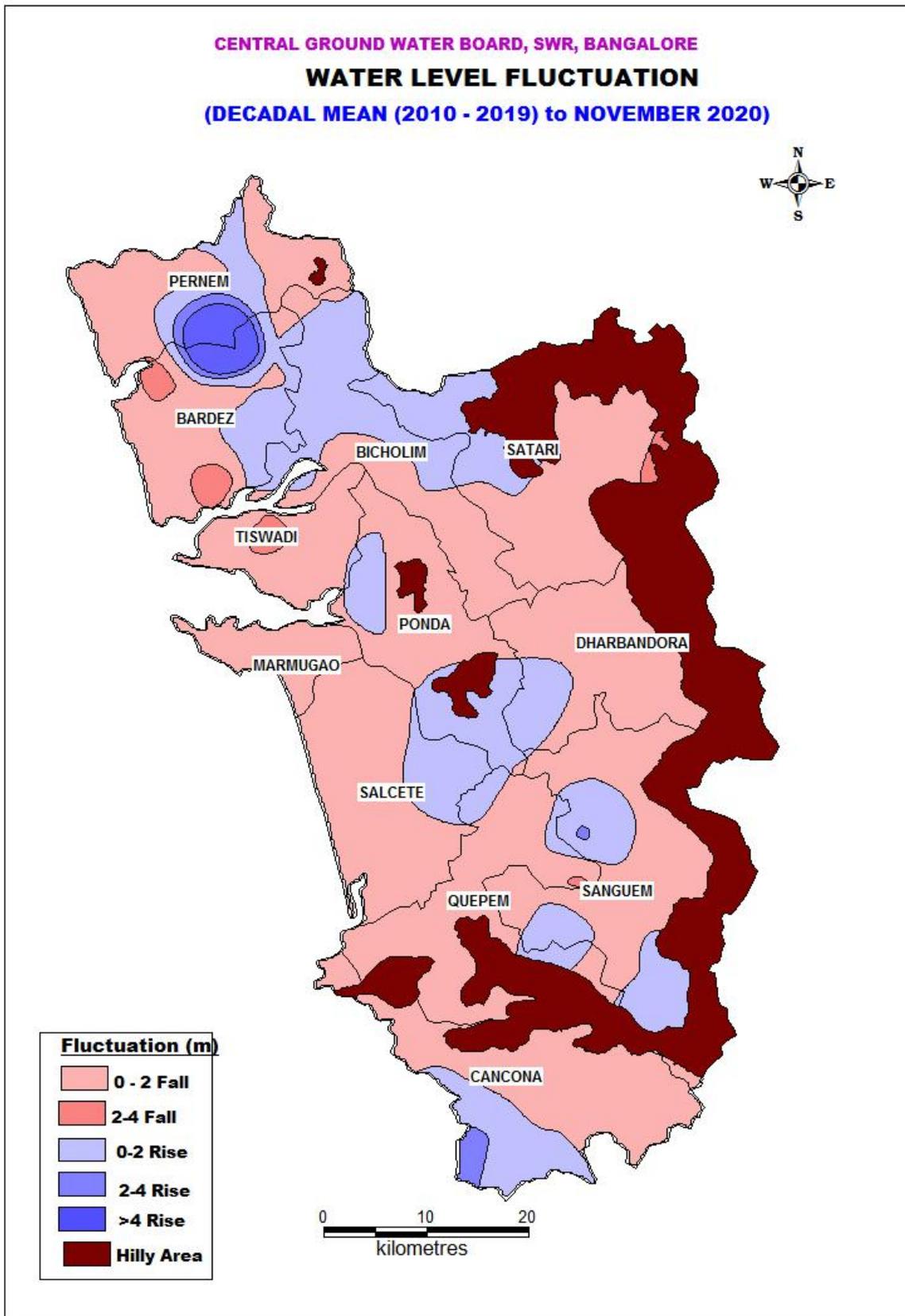
Mean Water Levels for the Period November 2010-2019 & November 2020:

The statement showing the distribution of ground water monitoring wells falling in different ranges of fluctuation is presented in **Table 14**. The fluctuation in water level has been plotted in **Plate X**. A comparison of water level shows that a rise in the water level is recorded in 24% of wells analysed, while 76% recorded fall. Salient features of the comparison of water levels are given below.

1. Rise in the water level in the range of 0-2 m has been observed in 20% of wells analysed, noted in Bardez, Bicholim, Pernem, Ponda, Salcete, Sanguem and Sattari taluks.
2. Rise in the water level in the range of 2-4 m has been observed in 3% of wells analysed, noted in Canacona and Sangeum taluk.
3. Rise in the water level in the range of >4 m has been observed in 1% of wells analysed and observed in Bardez taluk.
4. The fall in water level in the range of 0-2 m has been observed in 69% of wells analysed and noted in all taluks.
5. The fall in water level in the range of 2-4 m has been observed in 7% of wells analysed and noted in Bardez, Sangeum and Tiswadi taluks.

Table 14: District wise categorisation of water level fluctuation (Decadal mean 2010-2019 & Nov 2020)

S. No	Taluk Name	No of wells analysed	Rise_Range of Fluctuation (m)						Fall_Range of Fluctuation (m)						Rise	Fall
			0-2		2-4		>4		0-2		2-4		>4			
			No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%		
1	Bardez	11	1	9.1	0	0.0	1	9.1	6	54.5	3	27.3	0	0.0	2	9
2	Bicholim	6	4	66.7	0	0.0	0	0	2	33.3	0	0.0	0	0.0	4	2
3	Cancona	8	0	0.0	1	12.5	0	0	7	87.5	0	0.0	0	0.0	1	7
4	Dharbandora	4	0	0	0	0	0	0	4	100	0	0	0	0	0	4
5	Mormugao	1	0	0.0	0	0.0	0	0	1	100	0	0.0	0	0.0	0	1
6	Pernem	9	2	22.2	0	0.0	0	0	7	77.8	0	0.0	0	0.0	2	7
7	Ponda	3	2	66.7	0	0.0	0	0	1	33.3	0	0.0	0	0.0	2	1
8	Quepem	2	0	0.0	0	0.0	0	0	2	100	0	0.0	0	0.0	0	2
9	Salcete	8	1	12.5	0	0.0	0	0	7	87.5	0	0.0	0	0.0	1	7
10	Sanguem	11	2	18.2	1	9.1	0	0	7	63.6	1	9.1	0	0.0	3	8
11	Satari	8	3	37.5	0	0.0	0	0	5	62.5	0	0.0	0	0.0	3	5
12	Tiswadi	3	0	0.0	0	0.0	0	0	2	66.7	1	33.3	0	0.0	0	3
	Total	74	15	20	2	3	1	1	51	69	5	7	0	0.0	18	56



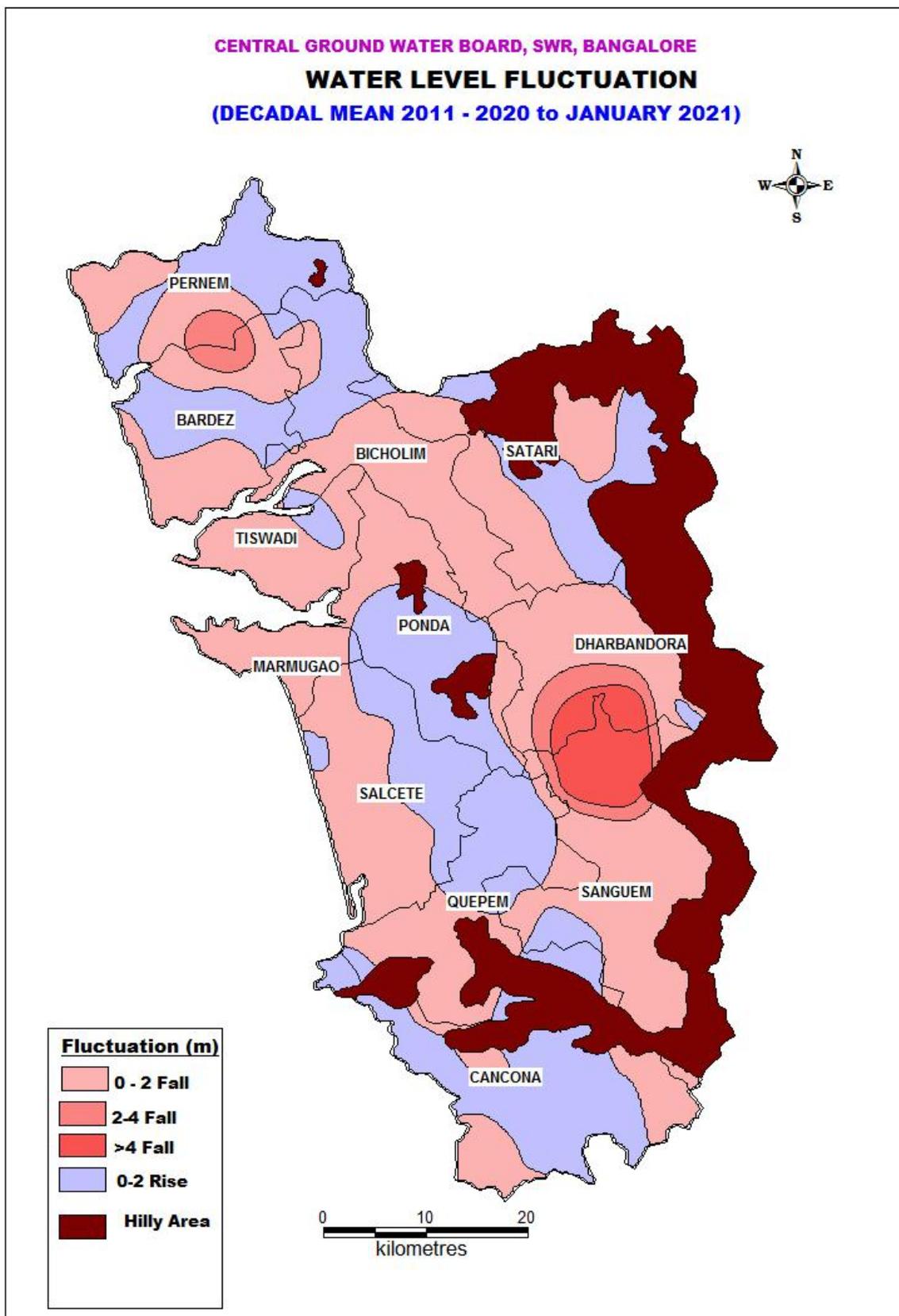
Mean Water Levels for the Period January 2011-2020 & January 2021:

The statement showing the distribution of ground water monitoring wells falling in different ranges of fluctuation is presented in **Table 15**. The fluctuation in water level has been plotted in **Plate XI**. A comparison of water level shows that a rise in the water level is recorded in 60% of wells analysed, while 40% recorded fall. Salient features of the comparison of water levels are given below.

1. Rise in the water level in the range of 0-2 m has been observed in 56% of wells analysed, noted in almost all taluks.
2. Rise in the water level in the range of 2-4 m has been observed in 1% of wells analysed, noted in Bardez taluk.
3. Rise in the water level more than 4 m has been observed in 3% of wells analysed, noted in Salcete and Sanguem taluks.
4. The fall in water level in the range of 0-2 m has been observed in 36% of wells analysed and noted in all taluks except Mormugao and Ponda taluks.
5. The fall in water level in the range of 2-4 m is observed in 4% of wells analysed and noted in Ponda taluk.

Table 15: District wise categorisation of water level fluctuation (Decadal mean 2011-2020 & Jan 2021)

S.No	Taluk Name	No of wells analysed	Rise Range of Fluctuation (m)						Fall Range of Fluctuation (m)						Rise	Fall
			0-2		2-4		>4		0-2		2-4		>4			
			No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%		
1	Bardez	11	7	63.6	0	0.0	0	0.0	3	27.3	0	0.0	1	9.1	7	4
2	Bicholim	5	4	80.0	0	0.0	0	0.0	1	20.0	0	0.0	0	0.0	4	1
3	Cancona	8	4	50	1	12.5	0	0.0	3	37.5	0	0.0	0	0	5	3
4	Dharbandora	3	2	66.7	0	0	0	0	1	33.3	0	0	0	0	2	1
5	Mormugao	1	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	1
6	Pernem	8	4	50.0	0	0.0	0	0.0	4	50.0	0	0.0	0	0.0	4	4
7	Ponda	4	3	75.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0	3	1
8	Quepem	3	3	100	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0
9	Salcete	7	6	85.7	0	0.0	0	0.0	1	14.3	0	0.0	0	0.0	6	1
10	Sanguem	11	4	36.4	0	0.0	0	0.0	6	54.5	1	9.1	0	0.0	4	7
11	Satari	8	5	62.5	0	0.0	0	0.0	3	37.5	0	0.0	0	0.0	5	3
12	Tiswadi	3	2	66.7	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0	2	1
	Total	72	44	62	1	1	0	0.0	25	35	1	1	1	1	45	27



5. HYDROCHEMISTRY

The quality of shallow groundwater in Goa state has been evaluated by sampling and analysis of water sample collected from Groundwater Monitoring wells. About 71 Groundwater Monitoring wells were monitored for water quality during May 2019 representing pre-monsoon water quality. The district-wise chemical analysis data of the samples are given in the **Annexure - II**. The summarized results of groundwater quality ranges are given in **Table - 16**.

Table – 16: Summarized results of groundwater quality ranges, (May 2019)

S. No.	Parameters		Range	No. of sample	Percentage
1	Electrical Conductivity μs/cm at 25°C	Fresh	< 750	70	98.5
		Moderate	751- 2250	01	1.5
		Slightly mineralized	2251- 3000	NIL	0.0
		Highly mineralized	> 3000	NIL	0.0
2	Chloride mg/L	Desirable limit	< 250	71	100.00
		Permissible limit	251-1000	NIL	0.00
		Beyond permissible limit	> 1000	NIL	0.00
3	Fluoride mg/L	Desirable limit	< 1.0	71	100
		Permissible limit	1.1- 1.5	NIL	0.00
		Beyond permissible limit	>1.5	NIL	0.00
4	Nitrate mg/L	Permissible limit	<45	67	93.00
		Beyond permissible limit	> 45	04	7.00

4.1 PH

pH is the measure of hydrogen or hydroxyl ion concentration in water. The pH scale is used to predict whether the water is acidic or basic in nature. The pH scale ranges from 0 to 14, the midpoint 7 is taken as neutral and waters having pH < 7 is called acidic, and having pH > 7 is called basic. pH is an important parameter in water chemistry, because geochemical reactions such as oxidation-reduction, dissolution-precipitation are pH dependent. For example, mineral solubility is enhanced under acidic pH, whereas high pH leads to precipitation of minerals such as calcite. Consequently, water having acidic pH would be more corrosive and alkaline pH would lead to the deposition of minerals (encrustation).

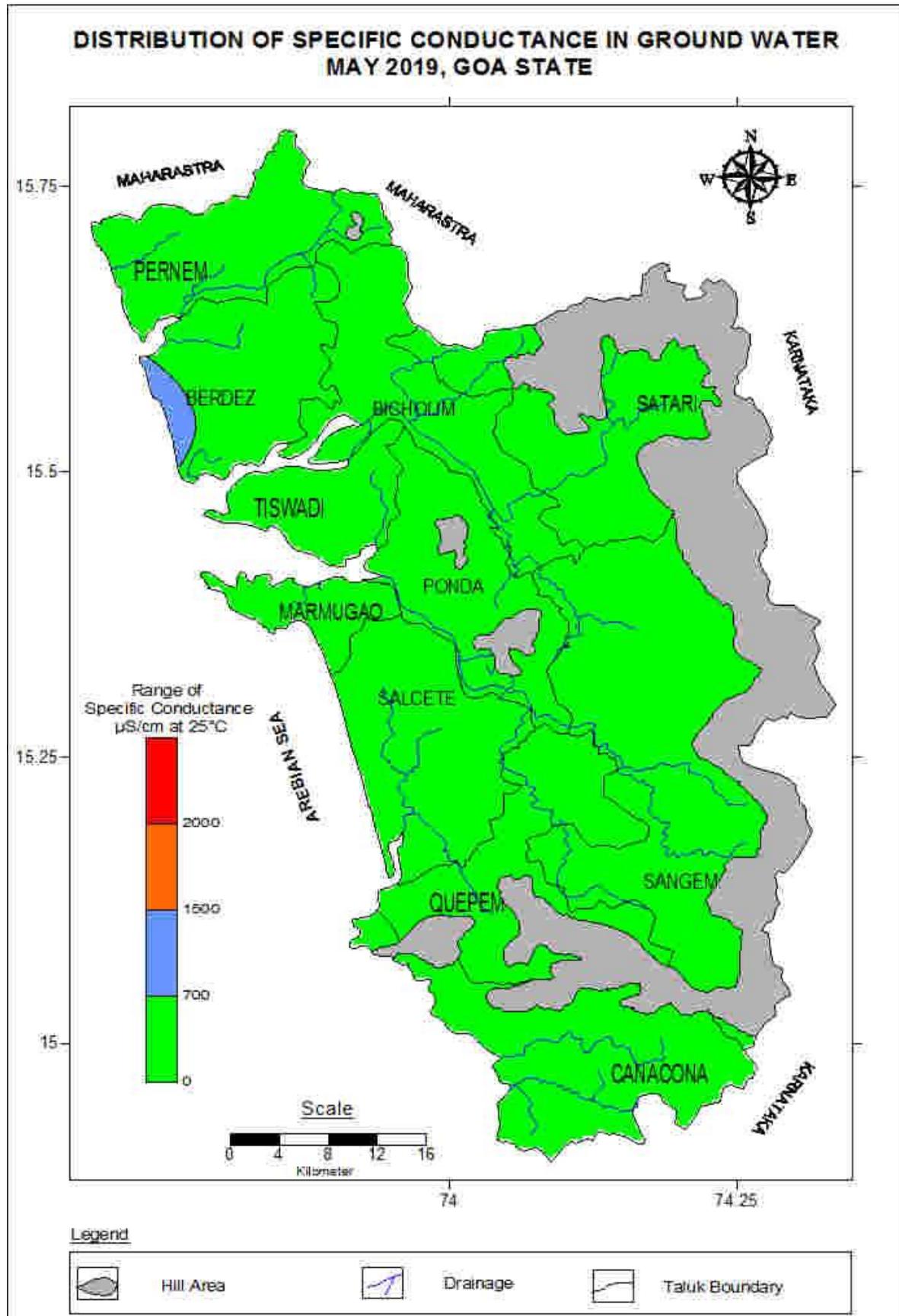
In the shallow groundwater of the state, the pH ranged between 6.72 and 9.73. Analysis of the data shows that a major part of state has pH 7 to 8.3. Based on the NHS 2019 data, in about 8%

of the area the groundwater pH is between 8.3 and 9.60. The occurrence of pH <7 are sporadic and is insignificant. No pattern of spatial variation is observed with respect to the distribution of pH. In recharge areas, where fresh rainwater gets recharged, groundwater without much dissolution is characterized by low EC values. It increases along groundwater flow path, because of the utilization of H⁺ ions for mineral dissolution leading to the formation of bicarbonate ions with increase of alkalinity.

4.2 Electrical Conductivity

Electrical conductivity (EC) is the indicator of the total mineral content of water and hence it indicates the total dissolved solids (TDS) present in water. TDS of water determines its usefulness to various uses of water. Generally water having TDS <500 mg/L is good for drinking and other domestic uses. However, in the absence of alternative sources TDS up to 2000 mg/L may be used for drinking purposes, however with TDS > 2000 mg/L, palatability decreases. The distribution of EC in the shallow groundwater of Goa state is shown in **Plate XII**.

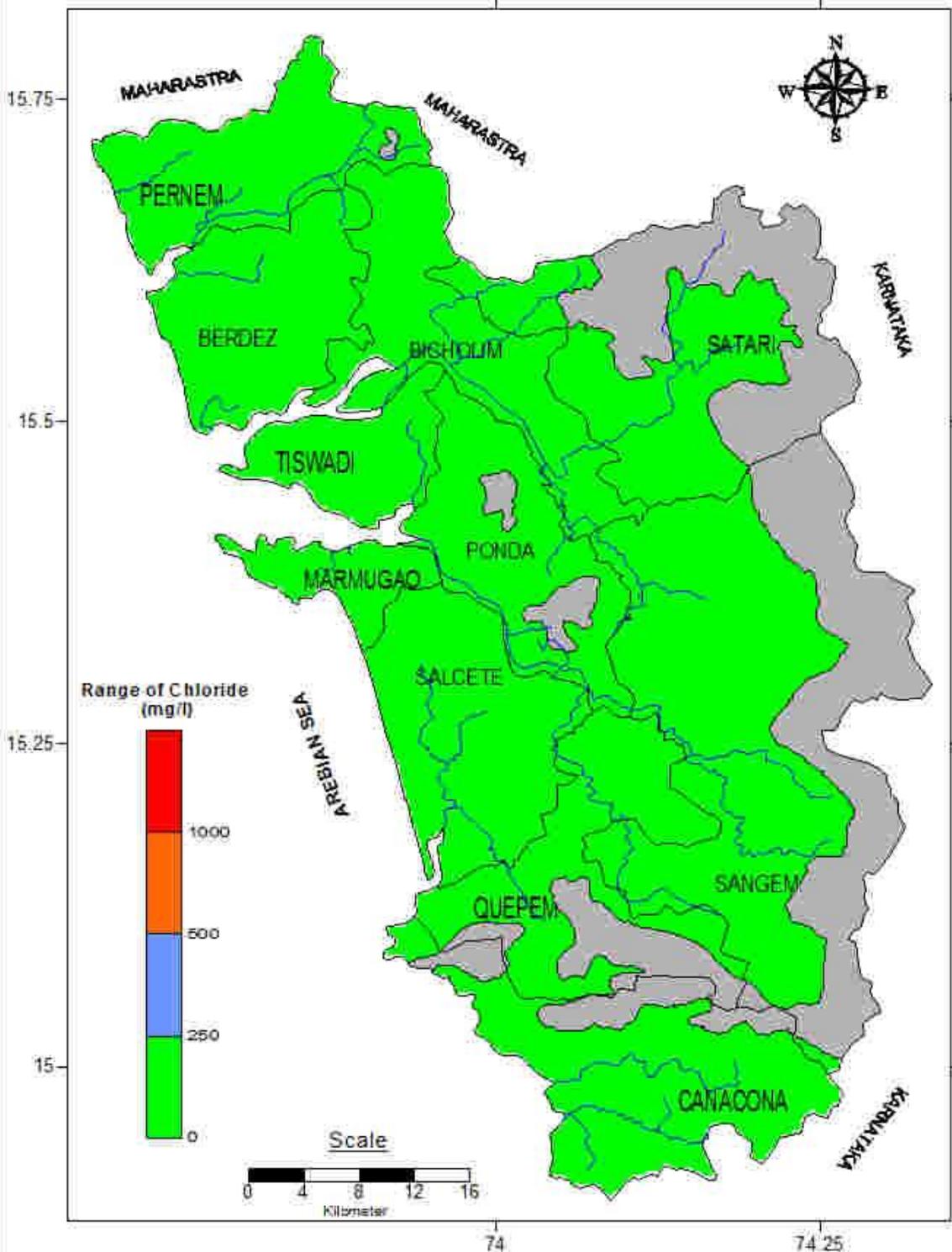
Electrical conductivity ranged between 121 and 930 $\mu\text{s}/\text{cm}$ at 25°C with an average of 317 $\mu\text{s}/\text{cm}$ at 25°C during May 2019. In general, the groundwater quality in the state is fresh in about 98.5 % of the Groundwater Monitoring wells as indicated by the EC value less than 750 $\mu\text{s}/\text{cm}$ at 25°C. In about 1.5 % of the Groundwater Monitoring wells, the EC is between 751-2250 $\mu\text{s}/\text{cm}$ at 25°C indicating that the groundwater is moderate quality.



4.3 Chloride

Chloride is one of the major anion in groundwater. The high mobility of the ion and the high solubility of chloride salts make the chloride ions present in waters. Moreover, chloride ions do not take part in any of the geochemical (or) biochemical reactions, hence it can be used as a good indicator of groundwater pollution. Over 500 mg/L it imports saline taste to drinking water. BIS specified 250 mg/L as the desirable and 1000 mg/L as the permissible limit in the absence of alternate sources for drinking water. Chloride concentration ranged between 11 and 99 mg/l with an average concentration of 24 mg/l during May 2019. The chloride content is less than the desirable limit of 250 mg/L in the entire sample analyzed. The spatial distribution of chloride concentration in groundwater of Goa state is shown in **Plate XIII**.

DISTRIBUTION OF CHLORIDE IN GROUND WATER MAY 2019, GOA STATE



4.4 Nitrate (NO₃)

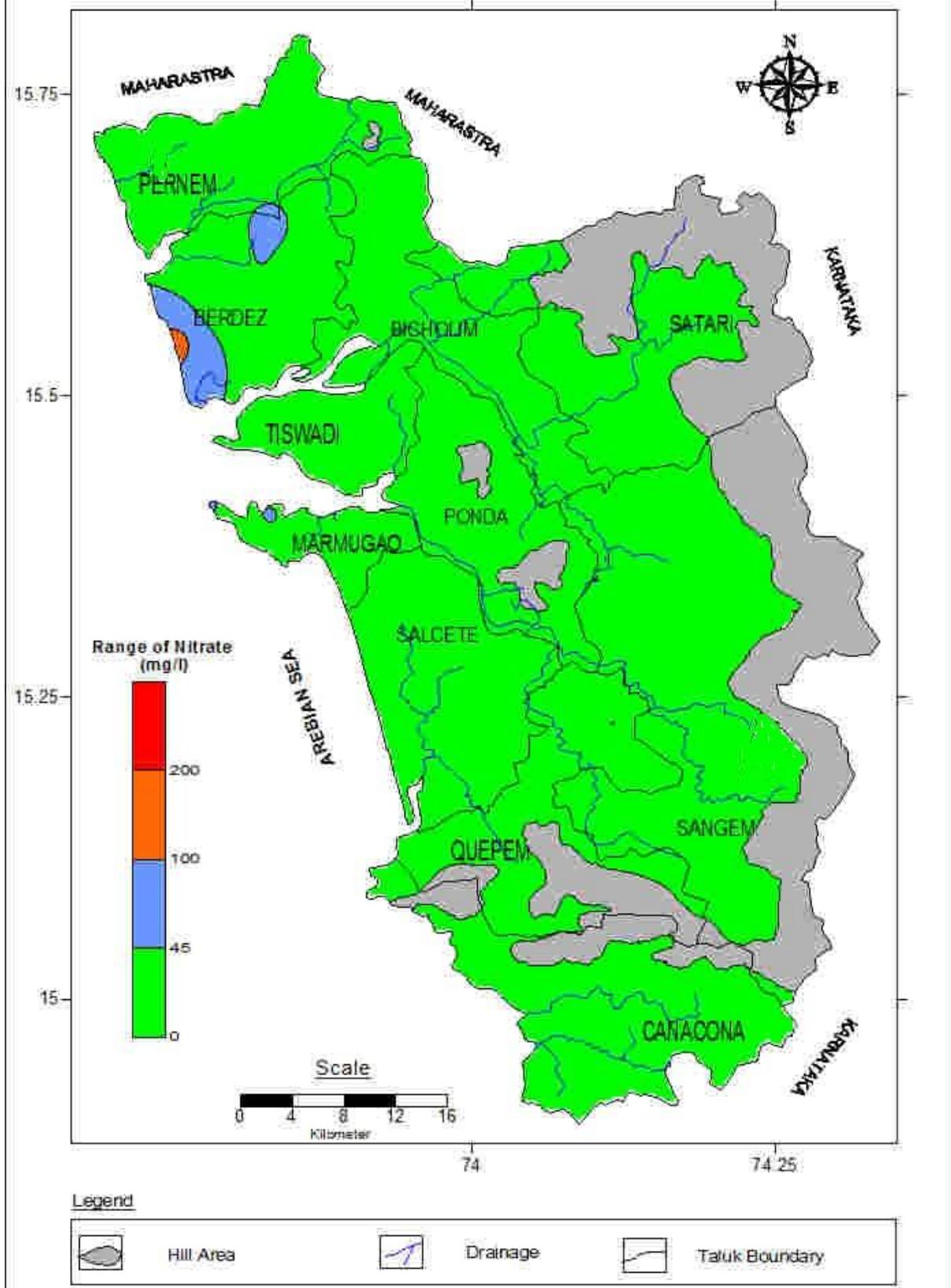
Nitrate is one of the major indicators of anthropogenic sources of pollution. The negative charge and high mobility favors its persistence in nature and transport along the groundwater flow path. Nitrate is the ultimate oxidized product of all nitrogen containing matter and its occurrence in groundwater can be fairly attributed to infiltration of water through soils containing animal waste and fertilizer. A large proportion of this nitrogen gets converted into nitrate which, being soluble in water and not retained by soils, gets leached into water bodies. As the lithogenic sources of nitrogen are very rare, its presence in groundwater is almost due to anthropogenic activity.

NO₃ is an oxidizing agent and is readily oxidizes haemoglobin (Hb) in to methaemoglobin (MeHb) a blue coloured pigment and gets reduced to NO₂. The oxidized Hb impairs seriously the oxygen carrying capacity of the blood and thus causes hypoxia, which may have fatal consequences in anaemic individuals and infants under 8 weeks of age. The MeHb formed in the infant blood gives a characteristic bluish to the skin and mucous membrane, thus giving the name “Blue Baby Syndrome”. This condition is particularly important in the case of infants because the infant and the foetal – Hb, which is $\alpha_2\gamma_2$ type has greater affinity for oxygen (O₂) than adult Hb which is $\alpha_2\beta_2$ type. Thus the Me-Hb formed in the foetal blood severely impairs the oxygen carrying capacity of the blood in infants, causing the blue baby disease.

In addition to methemoglobinemia, excess nitrate may cause oral cancer, cancer of the colon, rectum and other gastrointestinal cancers, Alzheimer’s disease, vascular dementia, absorptive, secretive functional disorders of the intestinal mucosa, changes in the maturation, differentiation and apoptosis in intestinal crypts, multiple sclerosis, reduced casein digestion, development of tolerance (lowering of response) to nitrate drugs and recurrent stomatitis in human beings. Nitrate may gets reduced to Nitrite (NO₂) in the intestinal tracts, which may further react with amino acids to form nitrosoamines which are potential carcinogens. Consumption of high nitrate containing water may cause adverse effect on the cardiovascular system and central nervous system. BIS specified 45mg/L as the as the permissible limit for drinking water.

Nitrate concentration ranged between 0 and 122 mg/l with an average concentration of 9 mg/L during May 2019. The Nitrate content is less than 45mg/L in about 93 % of the sample analyzed and and 7 % of sample shows more than 45 mg/L which are from North Goa district. The distribution of nitrate in shallow groundwater is shown as contour map in **Plate XIV**.

DISTRIBUTION OF NITRATE IN GROUND WATER MAY 2019, GOA STATE



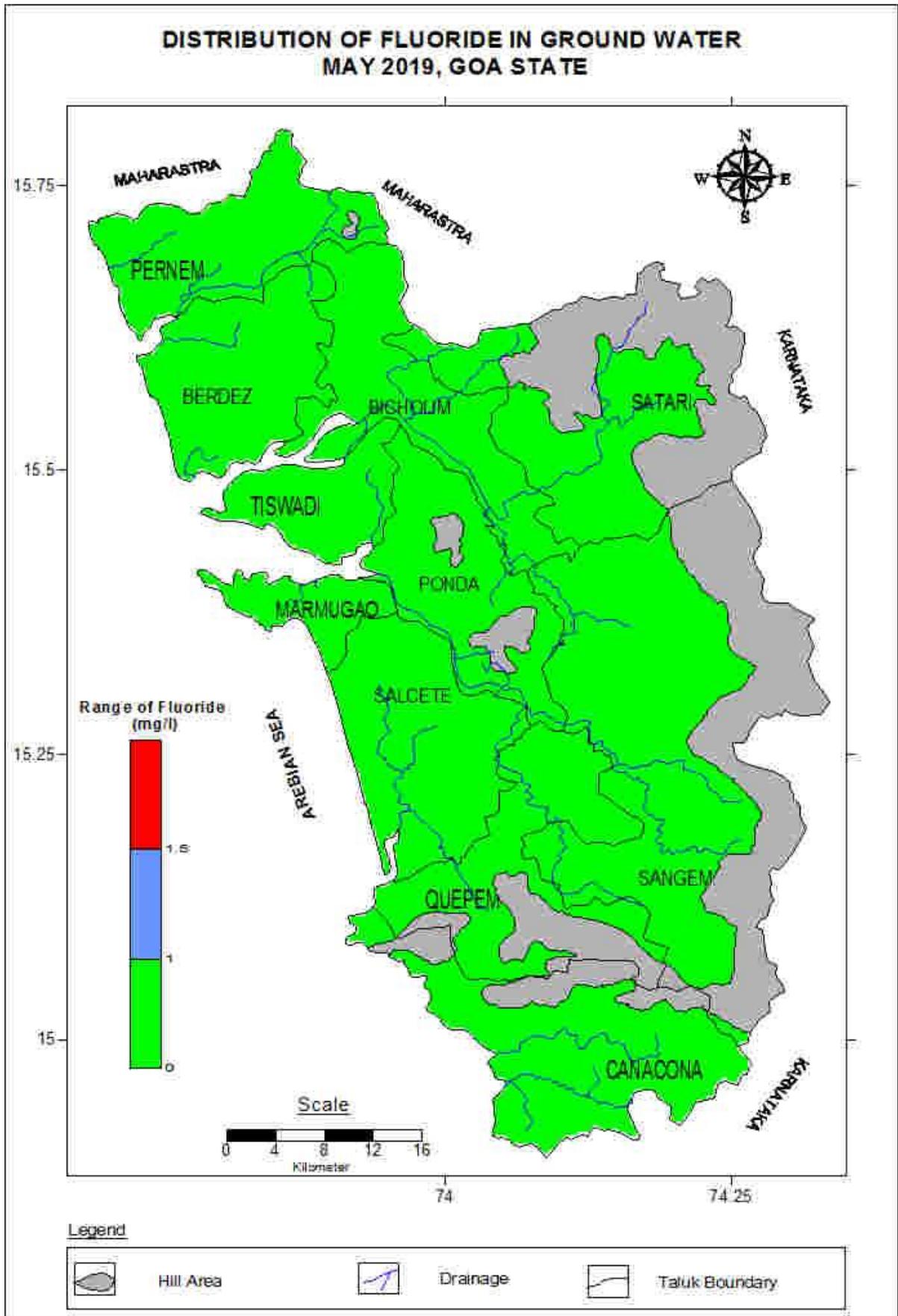
4.5 Fluoride

Fluorine is the most electronegative element and highly reactive, thus combining with all other elements to form covalent fluorides. Fluoride exists naturally in all waters derived from the dissolution of fluoride containing minerals. Surface water generally has low fluoride while groundwater may have high concentrations of fluoride as has been found in many parts of the world.

The formation of high fluoride groundwaters is principally governed by climate, composition of bedrock and hydrogeology. Areas with semi arid climate, crystalline, igneous bedrock, and alkaline soils are the most affected. The common fluoride bearing minerals are Fluorspar (CaF_2), Cryolite (Na_3AlF_6), Fluorapatite ($\text{Ca}_{10}\text{F}_2(\text{PO}_4)_6$), Amphiboles such as hornblende. Fluoride is an impurity commonly found in phosphatic fertilizers used in the agriculture. Accumulation of fluoride in the soils eventually results in leaching by percolation into the groundwater aquifer and thereby increases the concentration of fluoride level.

It is generally accepted that minor amounts of fluoride is beneficial for teeth and bones. Around 1.0 mg/L greatly reduces the incidence of dental carries. At a levels over 1.5 mg/L, fluoride can cause a mottled discolouring and malformation of teeth. Very high concentration of fluoride can produce skeletal change. Hence, BIS specified 1.0 mg/L as the desirable limit and 1.5 mg/L as the permissible limit in the absence of alternate sources for drinking water.

Fluoride concentration ranged between 0.01 and 0.88 mg/L with an average concentration of 0.51 mg/L during May 2019. The Fluoride content is less than 1.5 mg/L in all the 71 samples collected from National Hydrograph stations. Distribution of fluoride is shown in **Plate XV**.



V. CONCLUSIONS

The behaviour of ground water table during May 2020 to January 2021 in Goa State has been studied by monitoring the dug wells tapping phreatic aquifers. As water level is not monitored during May and August average water level of 5 years is calculated and analysed. The data on water levels was analysed in detail and salient features are as under.

1. 89% of wells have recorded depth to water level within 10 m bgl during premonsoon period (May 2015 to 2019), whereas during post-monsoon period (November 2020), about 94% of wells recorded water level less than 10 m bgl.
2. 96% of wells have recorded depth to water level within 10m bgl during August (2015 to 2019) and 90% during January 2021.
3. 85% of wells have recorded rise in water levels and 15% of wells recorded fall in water levels during November 2020 in comparison to November 2019.
4. 24% of wells have recorded rise in water levels and 76 % of wells have recorded fall in water level during November 2020 with respect to respective decadal means.
5. Fall in water levels may be due to localised over extraction of ground water.
6. In general the groundwater quality in the state is fresh in about 98.5 % of the Groundwater Monitoring wells as indicated by the EC value less than 750 $\mu\text{s}/\text{cm}$ at 25°C. In about 1.5 % of the Groundwater Monitoring wells, the EC is more than 3000 $\mu\text{s}/\text{cm}$ at 25°C indicating that the groundwater is highly mineralized.
7. The chloride content is less than 250 mg/L in the entire sample analyzed.
8. The Fluoride content is less than 1.5 mg/L in all the 71 samples collected from Ground Water Level Monitoring stations.
9. The Nitrate content is less than 45mg/L in about 93 % of the sample analyzed and and 7 % of sample shows more than 45 mg/L which are from North Goa district.

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Annexure I: Water level data of Goa State

District	Site Type	Site Name	Average WL May (2015-2019)	Average WL Aug (2015-2019)	Nov 2020	Jan 2021
North Goa	Bore Well	Adavapal	5.46	3.15	5.75	4.74
North Goa	Bore Well	Ajosi	4.36	2.67	3.89	4.39
North Goa	Bore Well	Aldona	15.92	11.29	-	15.55
North Goa	Bore Well	Asapur	6.04	4.29	-	-
North Goa	Bore Well	Betki	16.88	13.56	-	16.88
North Goa	Bore Well	Colvale	15.43	10.18	12.26	13.58
North Goa	Bore Well	Kasar Pal	9.47	7.33	5.12	9.68
North Goa	Bore Well	Kirl Pirna	9.35	5.65	-	7.19
North Goa	Bore Well	Korgoan	11.35	10.28	10.34	10.54
North Goa	Bore Well	Krilwada	1.54	1.01	-	1.14
North Goa	Bore Well	Madakai	21.18	14.01	15.78	20.35
North Goa	Bore Well	Mayam	5.24	4.06	5.19	5.90
North Goa	Bore Well	Mola	0.80	0.43	0.35	0.80
North Goa	Bore Well	Morjum	2.79	1.45	1.76	1.67
North Goa	Bore Well	Narve	12.67	10.16	-	12.92
North Goa	Bore Well	Parsekarwada	16.21	16.20	-	-
North Goa	Bore Well	Sanqulim	21.63	17.66	25.50	26.06
North Goa	Bore Well	Sawantwada	4.95	1.87	3.95	4.76
North Goa	Bore Well	Silolieum	5.14	2.67	3.94	4.67
North Goa	Bore Well	Tivim	20.79	17.06	19.16	21.78
North Goa	Bore Well	Varkhand	14.88	11.45	13.18	14.09
North Goa	Dug Well	Adavapal	5.58	4.54	4.27	4.89
North Goa	Dug Well	Alto Betim Porvorim	7.93	4.75	8.63	12.03
North Goa	Dug Well	Amberem	7.19	6.46	6.59	6.88
North Goa	Dug Well	Anjuna Beach	11.72	7.63	11.43	11.67
North Goa	Dug Well	Bayalwadikeri(querim)	1.88	1.53	1.90	1.90
North Goa	Dug Well	Bhamber(Nanoda Cross)	4.89	2.83	-	-
North Goa	Dug Well	Bhujpal	4.72	1.05	1.43	3.01
North Goa	Dug Well	Bicholim(pz)	15.76	10.44	-	-
North Goa	Dug Well	Bori	2.63	1.08	1.38	4.58
North Goa	Dug Well	Britona	1.97	1.47	1.89	1.96
North Goa	Dug Well	Calangute	8.32	3.97	4.62	6.22
North Goa	Dug Well	Charayode	4.62	1.00	2.15	2.89
North Goa	Dug Well	Colval	14.18	9.99	1.11	15.66
North Goa	Dug Well	Devulawada Narve	16.65	12.11	14.49	14.71
North Goa	Dug Well	Dhatwado Vante	8.01	3.43	5.48	5.80
North Goa	Dug Well	Gavalebhat, Chimbhel(kirl)	4.85	1.81	4.76	5.06
North Goa	Dug Well	Hasaravanni Vaipal	2.73	1.66	2.80	2.20
North Goa	Dug Well	Haspur	5.18	3.21	4.29	4.60
North Goa	Dug Well	Honda	3.67	1.98	2.39	3.85
North Goa	Dug Well	Jambhul Batt(mayam Lake)	3.19	1.25	1.17	2.31

North Goa	Dug Well	Karanjhalen	3.00	1.52	2.15	2.44
North Goa	Dug Well	Khadki(harijanwada)	9.11	3.61	7.40	7.76
North Goa	Dug Well	Khotodem	5.75	3.27	5.71	-
North Goa	Dug Well	Korgaon	4.61	3.47	3.93	4.06
North Goa	Dug Well	Kundel Dassolwada	1.83	1.24	1.50	1.63
North Goa	Dug Well	Mankem	4.14	2.44	3.00	3.20
North Goa	Dug Well	Mapuca	3.61	2.36	3.46	3.60
North Goa	Dug Well	Morji	2.00	0.44	0.85	1.11
North Goa	Dug Well	Morlem	3.57	3.09	-	3.80
North Goa	Dug Well	Mulgaon Shivalkherwad	3.08	2.24	1.95	2.53
North Goa	Dug Well	Nagargoan	7.05	4.11	3.88	6.23
North Goa	Dug Well	Nagjhar	7.46	7.26	7.65	7.21
North Goa	Dug Well	Olaulim	5.44	2.64	3.24	3.02
North Goa	Dug Well	Panchawadi(pz)	6.84	4.62	-	-
North Goa	Dug Well	Parra	2.22	0.74	1.19	1.32
North Goa	Dug Well	Pernem	3.14	3.43	3.75	2.29
North Goa	Dug Well	Pirna	3.45	1.43	1.98	2.68
North Goa	Dug Well	Pomburpa Palmar	2.90	2.75	1.96	3.14
North Goa	Dug Well	Sal	2.83	1.89	2.59	2.53
North Goa	Dug Well	Salwardhar Dumun	2.87	2.24	2.65	2.76
North Goa	Dug Well	Sawanthwada(mandrem)	3.48	0.93	2.20	3.26
North Goa	Dug Well	Shiroda	6.05	5.14	-	6.45
North Goa	Dug Well	Shivoli (brahmanwada)	3.30	0.54	4.02	-
North Goa	Dug Well	Sirsaim	3.81	2.07	2.89	3.47
North Goa	Dug Well	Surla(pz)	19.11	14.26	-	-
North Goa	Dug Well	Uguem(ugawe)	3.40	2.82	3.44	-
North Goa	Dug Well	Valpoi	5.16	2.70	4.99	5.30
North Goa	Dug Well	Velha Goa	1.67	0.98	1.13	1.15
South Goa	Bore Well	Aven	10.25	6.02	7.66	8.19
South Goa	Bore Well	Bogmola	0.50	0.08	0.28	0.36
South Goa	Bore Well	Canabonulim	5.07	3.13	-	4.28
South Goa	Bore Well	Carmona	6.69	4.06	-	-
South Goa	Bore Well	Cavelosim	3.58	0.53	-	-
South Goa	Bore Well	Chandavar	4.45	1.38	1.64	1.93
South Goa	Bore Well	Chinchinim	2.68	0.11	0.40	1.05
South Goa	Bore Well	Collem	6.19	3.03	5.40	5.62
South Goa	Bore Well	Dabel	12.64	7.12	-	10.01
South Goa	Bore Well	Dovorlim	4.83	3.91	-	-
South Goa	Bore Well	Kalay	4.96	2.68	-	-
South Goa	Bore Well	Manora Rai	4.85	3.54	5.77	4.74
South Goa	Bore Well	Meidawada	11.80	5.91	10.34	10.69
South Goa	Bore Well	Molem	9.39	1.08	4.54	6.80
South Goa	Bore Well	Morlem	5.06	1.37	2.62	3.58
South Goa	Bore Well	Nanoda	19.93	17.58	19.48	19.48
South Goa	Bore Well	Paddi Quiescend	15.44	11.30	-	-
South Goa	Bore Well	Patnem	7.96	1.85	3.51	4.82
South Goa	Bore Well	Ponquini	9.40	6.77	8.55	8.85

South Goa	Bore Well	Severdem	14.82	10.84	14.01	-
South Goa	Bore Well	Thane	9.79	5.16	-	8.21
South Goa	Bore Well	Verna	1.97	0.32	1.27	1.56
South Goa	Bore Well	Yedda	10.44	4.26	7.54	8.56
South Goa	Dug Well	Agonda Desaiwada	4.16	1.81	3.20	3.40
South Goa	Dug Well	Akamol Ambavalli	4.34	3.02	-	-
South Goa	Dug Well	Bagmola	3.07	2.40	2.85	2.95
South Goa	Dug Well	Ballynuvhen	6.25	4.76	5.98	6.32
South Goa	Dug Well	Barodi Velni (betul)	3.40	1.45	-	-
South Goa	Dug Well	Betalbatti	6.51	2.17	3.42	4.47
South Goa	Dug Well	Bhati	4.90	2.40	3.50	4.41
South Goa	Dug Well	Bolkharnem	6.75	4.16	5.25	5.98
South Goa	Dug Well	Canacona	4.73	1.67	2.51	3.67
South Goa	Dug Well	Chikalim	2.28	1.00	1.00	2.63
South Goa	Dug Well	Collem(kolamba)	8.80	3.88	7.82	8.30
South Goa	Dug Well	Cuncalim	2.87	1.03	1.74	-
South Goa	Dug Well	Cuncalim(pz)	5.33	5.26	-	-
South Goa	Dug Well	Daptamol Lolien	14.87	12.98	12.48	-
South Goa	Dug Well	Darbandahra(pz)	9.69	7.59	-	-
South Goa	Dug Well	Deulwada Kolamba	2.73	1.74	2.11	2.49
South Goa	Dug Well	Fathorda Margao(pz)	3.75	2.41	-	-
South Goa	Dug Well	Ghadiawada	1.66	0.87	2.13	1.91
South Goa	Dug Well	Guddemal	11.97	6.29	8.00	9.40
South Goa	Dug Well	Gulem Velipwada	3.88	0.95	1.27	2.61
South Goa	Dug Well	Hattipal Poinguinem	8.43	5.65	6.61	6.65
South Goa	Dug Well	Jambavli	9.14	6.47	8.66	8.86
South Goa	Dug Well	Kalay	9.86	9.13	10.84	10.60
South Goa	Dug Well	Kapsa	6.15	2.85	3.95	4.10
South Goa	Dug Well	Kaveslium	3.54	1.25	2.16	2.75
South Goa	Dug Well	Majorda Bpada Curilo	5.58	1.76	2.58	3.76
South Goa	Dug Well	Malkarnem	7.26	5.41	8.02	9.58
South Goa	Dug Well	Mashe	4.39	2.73	3.36	3.73
South Goa	Dug Well	Molem	13.94	1.65	7.24	10.40
South Goa	Dug Well	Navelim	4.70	1.80	-	-
South Goa	Dug Well	Netrolim	9.94	8.15	9.32	9.54
South Goa	Dug Well	Padi	13.23	6.14	6.08	8.73
South Goa	Dug Well	Polem(polen)	5.34	2.42	0.98	1.58
South Goa	Dug Well	Ponquini	8.99	8.19	-	-
South Goa	Dug Well	Quepem	2.98	1.32	-	2.64
South Goa	Dug Well	Revona	8.01	5.33	8.07	7.84
South Goa	Dug Well	Shrishtal Gaondongar	7.26	3.68	4.18	3.72
South Goa	Dug Well	Sristal	7.23	5.85	10.04	10.88
South Goa	Dug Well	Suktali (molem)	5.27	4.34	3.92	-
South Goa	Dug Well	Themchewada	8.70	6.62	6.20	7.44
South Goa	Dug Well	Vadam	5.03	3.51	3.80	3.72
South Goa	Dug Well	Vichundrem	7.59	1.13	6.58	7.20
South Goa	Dug Well	Yedda	4.96	2.14	1.17	2.88

HYDROCHEMICAL DATA OF NATIONAL HYDROGRAPH STATIONS (NHS), GOA, MAY-2019

SL No	SITE_NAME	DISTRICT_NAME	Date of Collection	PH	EC	TH	Ca	Mg	Na	K	CO ₃	HCO ₃	Cl	SO ₄	NO ₃	F
					μS/cm	<.....mg/L.....>										
1	Keri	North Goa	01-06-2019	7.78	199	30	10	1	26	2	0	12	18	41	19	0.27
2	Morlem	North Goa	01-06-2019	8.03	191	25	6	2	24	1	0	31	18	33	1	0.43
3	Honda	North Goa	01-06-2019	7.14	186	33	6	4	29	1	0	31	18	49	0	0.62
4	Bhujpal	North Goa	01-06-2019	7.71	381	38	8	4	42	1	0	46	21	61	2	0.49
5	Charayode	North Goa	01-06-2019	7.78	446	65	16	6	52	2	0	76	21	93	3	0.25
6	Nagargoan	North Goa	01-06-2019	7.93	283	35	6	5	31	1	0	24	18	58	3	0.28
7	Bhamber(Nanoda Cross)	North Goa	01-06-2019	8.03	198	45	6	7	23	0	0	43	14	45	0	0.54
8	Khadki(harijanwada)	North Goa	01-06-2019	7.85	189	40	6	6	20	1	0	31	18	38	0	0.78
9	Khotodem	North Goa	01-06-2019	7.91	331	45	4	9	37	0	0	27	14	68	4	0.59
10	Dhatwado Vante	North Goa	01-06-2019	7.83	295	35	6	5	35	1	0	46	18	54	1	0.65
11	Jambhul Batt(mayam Lake)	North Goa	04-06-2019	7.52	337	45	10	5	27	3	0	37	18	44	7	0.74
12	Mulgaon Shivalkherwad	North Goa	04-06-2019	8.15	236	35	10	2	26	1	0	31	18	44	1	0.20
13	Parra	North Goa	02-06-2019	7.85	501	125	28	13	39	7	0	128	46	58	3	0.56
14	Calangute (Kalangot Beach)	North Goa	02-06-2019	7.69	930	200	42	23	85	10	0	85	99	113	122	0.37
15	Anjuna Beach	North Goa	02-06-2019	8.01	260	50	8	7	26	1	0	37	25	39	6	0.59
16	Silolium	North Goa	02-06-2019	7.83	504	120	28	12	46	5	0	140	25	87	1	0.42
17	Morji	North Goa	02-06-2019	7.79	626	70	12	10	57	2	0	49	28	120	2	0.20

18	Sawanthwada(mandrem)	North Goa	02-06-2019	8.15	201	35	8	4	21	1	0	37	18	33	0	0.01
19	Korgaon	North Goa	02-06-2019	8.19	198	35	6	5	21	1	0	31	18	36	0	0.33
20	Pernem	North Goa	02-06-2019	7.59	453	75	18	7	38	4	0	73	21	71	11	0.51
21	Uguem(ugawe)	North Goa	02-06-2019	8.20	227	30	8	2	22	3	0	24	21	29	5	0.77
22	Amberem	North Goa	02-06-2019	7.81	305	55	16	4	20	11	0	49	18	43	3	0.21
23	Nagjhar	North Goa	02-06-2019	8.24	342	40	4	7	32	2	0	24	21	58	11	0.54
24	Valpoi	North Goa	02-06-2019	7.89	264	25	8	1	31	1	0	18	18	54	1	0.30
25	Haspur	North Goa	02-06-2019	8.57	468	90	28	5	48	11	12	55	39	90	6	0.71
26	Colval	North Goa	03-06-2019	6.72	522	135	30	15	58	5	0	110	36	94	62	0.38
27	Pirna	North Goa	03-06-2019	6.95	121	20	4	2	15	1	0	18	14	20	1	0.54
28	Adavapal	North Goa	03-06-2019	7.75	231	35	6	5	21	1	0	31	14	38	4	0.17
29	Sal	North Goa	03-06-2019	7.93	227	35	10	2	20	8	0	24	18	46	3	0.32
30	Sirsaim	North Goa	03-06-2019	8.23	236	30	8	2	25	1	0	31	18	40	1	0.27
31	Mapuca	North Goa	03-06-2019	8.25	612	90	14	13	58	5	0	49	43	95	47	0.06
32	Olaulim	North Goa	03-06-2019	8.23	301	35	6	5	34	1	0	31	21	60	1	0.31
33	Pomburpa Palmar	North Goa	03-06-2019	8.24	396	50	8	7	46	1	0	37	32	72	13	0.55
34	Salwardhar Dumun	North Goa	03-06-2019	8.19	253	45	8	6	32	1	0	37	18	61	1	0.38
35	Britona	North Goa	03-06-2019	7.91	182	50	14	4	15	1	0	49	18	19	0	0.82
36	Gavalebhat, Chimbel(kirl)	North Goa	03-06-2019	8.24	243	40	6	6	25	2	0	31	25	33	6	0.57

37	Velha Goa	North Goa	03-06-2019	8.82	492	85	22	7	29	1	12	61	25	50	0	0.49
38	Karanjhalen	North Goa	03-06-2019	9.73	438	90	16	12	40	5	18	18	46	59	29	0.34
39	Chikalim	South Goa	05-06-2019	8.22	386	85	20	9	38	3	0	43	43	44	48	0.54
40	Bagmola	South Goa	05-06-2019	7.80	269	60	14	6	28	2	0	49	28	34	22	0.46
41	Ballynuvhen	South Goa	05-06-2019	7.75	234	50	14	4	28	1	0	67	25	25	6	0.54
42	Betalbatti	South Goa	05-06-2019	7.35	390	45	14	2	57	2	0	18	32	81	29	0.49
43	Cavellosim	South Goa	05-06-2019	8.10	367	65	24	1	43	2	0	61	43	57	9	0.88
44	Cuncalim	South Goa	05-06-2019	9.02	438	45	14	2	63	2	24	12	28	99	7	0.71
45	Agonda Desaiwada	South Goa	05-06-2019	7.70	479	50	18	1	68	6	0	55	28	98	7	0.55
46	Canacona	South Goa	05-06-2019	7.48	312	60	14	6	36	2	0	79	28	38	4	0.54
47	Padi	South Goa	05-06-2019	7.54	204	60	12	7	24	1	0	55	14	37	0	0.63
48	Sristal	South Goa	05-06-2019	7.76	331	60	18	4	43	1	0	79	18	71	1	0.64
49	Mashe	South Goa	01-06-2019	7.71	241	20	6	1	42	1	0	24	21	65	0	0.64
50	Polem(polen)	South Goa	06-06-2019	8.31	443	140	22	21	38	4	24	122	39	30	1	0.42
51	Daptamol Lolien	South Goa	06-06-2019	7.71	285	25	6	2	42	0	0	24	18	66	1	0.72
52	Shrishtal Gaondongar	South Goa	06-06-2019	7.68	375	40	12	2	58	1	0	67	14	96	6	0.65
53	Netrolim	South Goa	06-06-2019	7.57	325	80	20	7	36	4	0	92	14	66	1	0.48
54	Vadam	South Goa	06-06-2019	8.27	253	30	6	4	42	0	0	12	14	76	4	0.72
55	Bhati	South Goa	06-06-2019	8.11	222	10	4	0	40	0	0	24	11	68	0	0.64
56	Deulwada Kolamba	South Goa	06-06-2019	7.57	274	50	8	7	36	2	0	55	14	57	1	0.67

57	Revona	South Goa	06-06-2019	7.74	269	50	12	5	30	4	0	37	25	41	15	0.52
58	Jambavli	South Goa	06-06-2019	7.53	264	35	8	4	42	1	0	31	14	66	2	0.51
59	Quepem	South Goa	06-06-2019	7.81	406	45	12	4	61	2	0	49	18	102	1	0.77
60	Ghadiawada	South Goa	07-06-2019	7.95	240	30	8	2	25	6	0	24	25	36	0	0.61
61	Kalay	South Goa	07-06-2019	8.27	251	30	8	2	31	1	0	31	25	36	2	0.52
62	Kapsa	South Goa	07-06-2019	7.97	479	85	18	10	54	9	0	61	39	71	23	0.69
63	Panchawadi(pz)	North Goa	07-06-2019	8.21	185	25	6	2	26	2	0	37	18	30	1	0.60
64	Guddemal	South Goa	07-06-2019	7.37	228	45	10	5	30	2	0	49	18	37	6	0.66
65	Shiroda	North Goa	07-06-2019	7.94	243	50	12	5	30	3	0	43	25	40	14	0.61
66	Mankem	North Goa	07-06-2019	7.83	270	45	6	7	40	4	0	37	25	58	0	0.67
67	Bori	North Goa	07-06-2019	7.83	279	30	8	2	46	1	0	37	18	66	7	0.55
68	Sukkal	North Goa	07-06-2019	7.94	214	20	4	2	37	1	0	37	14	52	1	0.58
69	Bolkharnem	South Goa	07-06-2019	7.59	176	30	6	4	23	2	0	31	14	36	5	0.64
70	Collem(kolamba)	South Goa	07-06-2019	8.27	194	20	6	1	32	1	0	37	14	45	0	0.47
71	Kundel Dassolwada	North Goa	07-06-2019	8.19	189	20	4	2	30	1	0	37	18	36	2	0.40

**जल बचाओ
और
जलसंरक्षण करना**

**SAVE WATER
AND
CONSERVE WATER**