



स्वच्छ सुरक्षित जल – सुन्दर खुशहाल कल
CONSERVE WATER - SAVE LIFE



**GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD**

**GROUND WATER INFORMATION BOOKLET
NORTH GOA DISTRICT, GOA STATE**



**SOUTH WESTERN REGION
BANGALORE
JUNE 2010**

FOREWORD

Ground water contributes to about eighty percent of the drinking water requirements in the rural areas, fifty percent of the urban water requirements and more than fifty percent of the irrigation requirements of the nation. Central Ground Water Board has decided to bring out district level ground water information booklets highlighting the ground water scenario, its resource potential, quality aspects, recharge – discharge relationship, etc., for all the districts of the country. As part of this, Central Ground Water Board, South Western Region, Bangalore, is preparing such booklets for the 2 districts of Goa state.

The North Goa district Ground Water Information Booklet has been prepared based on the information available and data collected from various state and central government organisations by several hydro-scientists of Central Ground Water Board with utmost care and dedication. This booklet has been prepared by Sri S.Sudarshana, Superintending Hydrogeologist, under the guidance of Dr. K.Md. Najeeb, Regional Director, Central Ground Water Board, South Western Region, Bangalore. Smt. Sandhya Yadav, Scientist-C assisted in the compilation of data from various sources.

I take this opportunity to congratulate them for the diligent and careful compilation and observation in the form of this booklet, which will certainly serve as a guiding document for further work and help the planners, administrators, hydrogeologists and engineers to plan the water resources management in a better way in the district.

(T.M.HUNSE)
Regional Director

NORTH GOA DISTRICT AT A GLANCE

Sl. No.	Items	Statistics	
1.	General Information		
	(i) Geographical area (sq. km.)	1,736	
	(ii) Administrative Division (as on 2005 – 06)		
	(a) Number of Taluks	6 (Tiswadi, Bardez, Pernem, Bicholim, Satari, Ponda)	
	(b) Number of Villages	213	
	(iii) Population (as per 2001 Census)	7,58,573	
	(iv) Average Annual Rainfall (mm)	2932 mm	
2.	Geomorphology		
	(i) Major physiographic units	Coastal plain, vast etch plain towards the east, low dissected denudational hills and table land & deeply dissected high western ghat denudational hills occurring all along the eastern part.	
	(ii) Major Drainage	Principal perennial rivers are Terekhol, Chapora, Mandovi & Zuari rivers. Non-perennial river – Baga.	
3.	Land Use (sq. km.)		
	(i) Forest area (ha)	35,042 ha	
	(ii) Net area sown (ha)	83,765 ha	
4.	Major soil types	Lateritic soil, Saline soil, Alluvial soil (very thin strip along the coast line towards western part of the district).	
5.	Area under principal crops (2005 – 06)	Crops	Area (ha)
		Paddy	29605
		Cereals millets/ pulses & oil seeds	12684
		Sugarcane	240
		Coconut	11155
		Arecanut	1421
		Cashew nut	40109

6.	Irrigation by different sources (Area (ha) & Number of structures) (As per Third Census of Minor Irrigation Schemes 2000-01)	Area irrigated (ha)	Number
	(i) Dug wells	1867.91 ha	3359
	(ii) Tube wells (Shallow; Deep)	75.10 ha (23.7 ha; 51.40 ha)	71 (14; 57)
	(iii) Tanks / Ponds	-	68
	(iv) Canals	1149.40 ha	3
	(v) Other sources: (a) Lift Irrigation Schemes (b) Surface Flow irrigation	(a) 1383.54 ha (b) 3972.92 ha	(a) 417 (b) 2559
	(vi) Net irrigated area	8448.87 ha	
7.	Number of ground water monitoring wells of Central Ground Water Board (as on 31.03.2009)		
	(i) Dug wells	22	
	(ii) Piezometers	5	
8.	Predominant Geological Formations	<p>(a) Mainly formations of Goa Group, comprising: Schist (major part), Greywacke with conglomerate, Dolomitic limestone (small patch towards northeastern part), Metabasalt (small patch towards southwestern part).</p> <p>(b) Formations of Peninsular Gneissic Complex, comprising: Granite gneiss, Granite (small patch towards northeastern part).</p> <p>(c) Deccan Traps: Basalt (thin strip towards north eastern most tip)</p> <p>(d) Beach sand: (very thin strip towards north western part of the district).</p> <p>(e) Laterite: Vast portion of the rocks (viz. schist, greywacke with conglomerate, granite & metabasalts) is lateritised.</p>	

9.	Hydrogeology	
	(i) Major water bearing formation	Laterite, Alluvium, Granite, Granite Gneiss, Meta volcanics & Meta sedimentaries.
	(ii) Pre – monsoon depth to water level during May 2009 (in m bgl)	2.17 to 19.23
	(iii) Post – monsoon depth to water level during Nov. 2006 (in m bgl)	0.43 to 14.90
	(iv) Long term water level trend in 10 years (1997 – 2006) (in m/year)	
	(a) Pre – monsoon	Range from a decline of 8.43 m to rise of 2.72 m
(b) Post – monsoon	Range from a decline of 1.62 m to rise of 4.13 m	
10.	Ground water exploration by Central Ground Water Board (as on 31.03.07)	
27 Number of wells drilled		
(a) Exploratory Drilling Programme	(a)	24 EW; 8 OW; Total – 32
(b) Deposit well construction (Under Caboraj Niwas & Western Ghat Development Programme of Goa State)	(b)	12
(ii) Depth Range (m bgl)		
(a) Exploratory Drilling Programme	(a)	17.60 – 184.25 m bgl
(b) Deposit well construction (Under Caboraj Niwas & Western Ghat Development Programme of Goa State)	(b)	22.05 – 79.0 m bgl
(iii) Discharge (litres per second)		
(a) Exploratory Drilling Programme	(a)	0.05 – 13.50 lps
(b) Deposit well construction (Under Caboraj Niwas & Western Ghat Development Programme of Goa State)	(b)	1.00 – 25.00 lps
(iv) Sp. Capacity (m ³ /day/m)		
(a) Exploratory Drilling Programme	(a)	0.47 – 988.47
(a) Deposit well construction (Under Caboraj Niwas & Western Ghat Development Programme of Goa State)	(b)	– Not computed
(v) Transmissivity (m ² /day)		
(a) Exploratory Drilling Programme	(a)	0.12 – 346.10
(b) Deposit well construction (Under Caboraj Niwas & Western Ghat Development Programme of Goa State)	(b)	– Not computed -

11.	Ground water quality	
	(i) Presence of chemical constituents more than permissible limit	Saline due to sea water ingress in inland aquifers along tidal river courses. Ground water in general is of good quality.
	(ii) Type of water	Calcium – Bicarbonate Type
12.	Dynamic ground water resource (2004)	
	(i) Net ground water availability (ham)	17354.51
	(ii) Total Annual Ground Water Draft (ham)	4756.21
	(iii) Projected demand for domestic & industrial uses upto 2025 (ham)	2413.84
	(iv) Stage of ground water development (%)	27 % (SAFE)
13	Awareness & Training activity	
	(i) Mass awareness programmes organized	2 (i) Ground water management (ii) On “Hydrological Information System” – under Hydrology Project – II.
	(a) Date	(i) 18.03.02; (ii) 12.03.08;
	(b) Place	(i) Panaji, (ii) Panaji
	(ii) Water management Training Programmes (WMTP) organized	2 (i) WMTP on 29.03.04 at Goa Science Centre, Marine Highway, Miramar, Panaji, North Goa. (ii) “Hydrological Information System” – under Hydrology Project – II, on 12.03.08, Panjim, North Goa.
14.	Artificial recharge & rainwater harvesting	
	(i) Projects completed by CGWB (No. & amount spent)	Nil
15.	Ground water control & Regulation	
	(i) Number of OE blocks	Nil
	(ii) Number of Critical blocks	Nil
	(iii) Number of blocks notified	Nil

16.	Major ground water problems & issues	<ul style="list-style-type: none">• Ground water in dug wells & borewells in areas around Baga & along Chapora river is brackish to saline due to seawater ingress.• Ground water in areas adjacent to stream course in NE of Panjim is polluted due to domestic sewage.• Scarcity of ground water during summer months due to high sub – surface run off in hilly topography and highly permeable nature of phreatic aquifer. This results in lowering of water level or drying of wells during summer months.
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Fig-1



1.0 Introduction

1.1 Location

Goa state lies along the west coast of India. The state is sub – divided into two districts, North & South Goa district. North Goa district lies in the northern part of Goa state. The geographical area of the district is 1,736 sq.km, and is situated between north latitudes 15° 16' 30" & 15° 48' 15" and between east longitudes 73° 40' 30" & 74° 17' 15". The district is bounded by Sindhudurg district of Maharashtra in the north, Belgaum district of Karnataka in the north – east, Uttara Kannada district of Karnataka in the east, South Goa district in the south and in the west by the Arabian Sea.

1.2 Administrative set up

Panaji is the district headquarters of North Goa district. The district comprises of 6 taluks namely, Tiswadi, Bardez, Pernem, Bicholim, Satari and Ponda (**Figure 1**). There are 213 villages and 27 towns, out of which, 7 are Municipal towns.

1.3 Population

Population of the district (as per 2001 Census) is 7,58,573 with a population density of 437 per sq. km.

1.4 Physiography & Drainage

Physiographically North Goa district can be broadly divided onto four distinct morphological units from west to east namely,

- (i) coastal plain with marine land forms on the west,
- (ii) vast stretch of plains adjoining the coastal plain,
- (iii) low dissected denudational hills & tablelands towards the east, and
- (iv) deeply dissected high Western Ghats denudational hills along the eastern most part of the district.

Principal perennial rivers draining through the district are, Terekhol, Chapora, Mandovi & Zuari and non – perennial (seasonal) river Baga. The river basin of all these westerly flowing short rivers originate from Western Ghats and drain in the Arabian Sea in the west under estuarine environment. 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.

1.5 Crops & Irrigation practices

Agriculture is one of the important economic activities in the district. Rice is the staple food and paddy is the principal agricultural crop. Gross cropped area under paddy in 2005 – 06 was 29605 ha, accounting for nearly 27.82% of the Gross Cropped Area (106413 ha). Other crops grown are cereals, millets, pulses & oil seeds, which constitute an area of 12684 ha (11.92%), sugarcane 240 ha (0.22%), coconut 11155 ha (10.48%), arecanut 1421 ha (1.33%) and cashew nut 40109 ha (37.69%).

Irrigation potential created as on March 2000 by the Anjunem Irrigation Project was 2100 ha in Satari and Bicholim taluks of North Goa district. Irrigation by different sources, as per Third Census of Minor Irrigation Schemes 2000 – 01 is illustrated in Table 1.

Table 1: Irrigation by different sources (As per Third Census of Minor Irrigation Schemes 2000 – 01)

Sl. No.	Irrigation source	No. of schemes	Area irrigated (ha)
1.	Dug wells	3359	1867.91
2.	Shallow tube wells	14	23.70
3.	Deep tube wells	57	51.40
4.	Lift irrigation schemes	417	1383.54
5.	Surface flow irrigation	2559	3972.92
TOTAL		6406	7299.47

1.6 Activities carried out by Central Ground Water Board (CGWB)

Twenty four deposit wells were constructed in Goa State for Caboraj Niwas and Western Ghat Development Programme, by CGWB, during the Field Season Programme (1984 – 86). Out of 24 deposit wells, 12 nos. were constructed in North Goa district, 5 nos. in Tiswadi and 7 nos. in Satari taluks respectively.

Under Exploratory Drilling Programme of CGWB, 24 exploratory wells & 8 observation wells were drilled to study the hydrogeological conditions, aquifer parameters and update ground water regime & quality in the district.

Monitoring of spatial and temporal change in ground water level in the district is being done by CGWB, South Western Region, four times annually (viz. May, September, November & January), through an established network of 27 monitoring stations (22 dug wells and 5 piezometers).

Under the aegis of activities of Central Ground Water Authority, one Mass Awareness Programme and one Water Management Training Programme

was organized in the district in the year 2002 and 2004 respectively.

World Bank aided Hydrology Project for Peninsular States started during 1995 – 96, with a mandate to bring together all departments dealing with water under one umbrella. The sole objective of the Project was to deliver a reliable and functional Hydrological Information System. The Project is implemented in Karnataka, with CGWB, South Western Region, identified as one of the member and nodal agency dealing with ground water related issues.

Under Phase – II of Hydrology Project, various activities have been taken up by CGWB in the state of Goa and in the district as well. The activities comprise, preliminary field investigations, interactive sessions of central with state agencies, establishment of ground water monitoring stations in consultation with state agencies, finalization of sites for piezometer construction, data compilation & digitization of relevant maps and meetings of the expert committee constituted for the project. 2 nos. of ground water monitoring stations have been established in Divar islands for water level and quality monitoring in Tiswadi taluk, North Goa district. One mass awareness and one training programme have been organized on “Hydrological Information System”, in the district.

2.0 Climate & Rainfall

Due to maritime influence, the diurnal range of temperature during the day is not large. The diurnal range is the least being 4 to 6° C during monsoon season and increases to the maximum of 10 to 20°C during December & January. May is the hottest month where the mean daily temperature increases to 30°C. January is the coolest with mean daily temperature of about 23°C. It is noted that the day temperature is the lowest in monsoon months of July and August and not in the cool winter months of December and January. The temperature is highest (around 33°C) in pre – monsoon months of April & May and again in post monsoon months of November & January. Due to proximity to the Arabian Sea, humidity throughout the year is more than 60% with range from 80 to 90% during monsoon period.

As a result of orographic influence, rainfall increases towards the Western Ghats, with average annual rainfall (1971 – 2001) 2828.70 mm (in Bardez taluk) to 3948.30 mm (in Satari taluk). Over 90% of annual rainfall occurs during monsoon months of June to September. About 32% of the annual rainfall is received during July.

3.0 Soil Types

Soils of the district can be classified into 3 types namely (i) Laterite soil (ii) Saline soil and (iii) Alluvial soil:

- (i) Lateritic soil is the major soil type in the district. It is highly porous & permeable, slightly acidic with low pH values, low in organic matter, Calcium and Phosphorus.
- (ii) Saline soil in the district occurs in the flood plains of Zuari and Mandovi rivers in Tiswadi, Bardez and Ponda taluks. It also occurs in Pernem taluk. The soil is deep, poorly drained and less permeable. It is saline, high in pH and contains humus and organic matter.
- (iii) Alluvial soil occurs as very thin strip along the coastline towards western part of the district. It is reddish brown to yellowish, coarse grained and confined to narrow valleys of rivers. It is well drained, acidic with low pH and organic content.

4.0 Geology

4.1 Stratigraphy

The stratigraphic succession of rocks in North Goa district is given in Table 2 below.

4.2 Distribution of rock types

North Goa district is dominantly covered by the formation of Goa Group belonging to Dharwar Super Group of Archaean to Proterozoic age. Deccan Trap of Upper Cretaceous occupies a narrow strip along the northeastern corner to Lower Eocene age.

The Goa Group comprises of metamorphic rocks of green schist facies, and is divided into Barcem, Sanvordem, Bicholim and Vageri formation in the ascending order of superposition. The Goa Group of rocks has been intruded by granite gneiss, feldspathic gneiss, hornblende gneiss and porphyritic granite, followed by basic intrusive.

During the Sub – Recent and Recent times, the rocks have been subjected to lateritisation of varying thickness. Thus, laterite occurs extensively covering almost all the formations in North Goa district.

Coastal alluvium occurring along the coastal plains consists of fine to coarse sands with intercalations of sandy loam, silt and clay.

4.3 Structural geology

The Goa group of rocks is disposed in a general NW – SE direction. The rock types indicate three cycles of folding. The straight coastline suggests the major fault along the west coast. Associated with this fault a number of weak planes have developed. Along these weak planes Terekhol, Chapora, Mandovi and Zuari rivers flow to meet the Arabian Sea. Western Ghats, which extends in NS to NNW – SSE direction represent a prominent fault zone. Even though the rock types of Goa Group have suffered considerable faulting, all the faults are not exposed on surface owing to the extensive cover of laterite.

Table 2: Stratigraphy Of North Goa District

AGE	GROUP	FORMATION	ROCK TYPE
Quaternary			Beach Sand
Genozoic			Laterites
Upper Cretaceous to Eocene	Deccan Trap		Basalt
Lower Proterozoic	Clospet Granite		Granite
		Peridotite, Gabbro, Norite	Pyroxenite, Peridotite, Serpentinite, Gabbro
Archaean to Lower Proterozoic	Goa Group	Vageri Formation	Carbonate-quartz-chlorite schist with Greywacke
		Bicholim Formation	Dolomitic limestone
			Quartz- Sericite schist
			Banded iron formation
			Chert and quartzite
			Quartz-chlorite-biotite schist with layers of chert, iron oxide, carbonate, meta-basalt and meta gabbro
			Greywacke with conglomerate
		Sanvordem Formation	Quartzite
		Barcem Formation	Quartz-chlorite schist
			Meta-acid volcanics
Meta-basalt			
		Orthoquartzite	
Archaean	Peninsular Gneissic complex		Granite Gneiss, Migmatites and Granites

5.0 Ground water scenario

5.1 Hydrogeology

Occurrence and movement of ground water depends upon the type of rock formation, structure, topography, rainfall, recharge etc. Ground water in

the district occurs in rocks having primary porosity & permeability or in those having secondary porosity acquired due to weathering, leaking, tectonics, solutions etc.

Ground water bearing formations in the district are laterite, alluvium, granite, granite gneiss, metavolcanics and metasedimentaries. Hydrogeological map is illustrated in **Figure-2**.

5.1.1 Occurrence of ground water and aquifer characteristics of various formations

Laterites

Laterites are the important water bearing formations. Laterites are of two types, viz. *insitu*, occurring in plateau areas or of detrital origin generally occupying valley portions. Besides inherent porosity, the laterites are highly jointed and fractured, which control their water bearing capacity. The topographic settings of laterites control its ground water potential. The thickness of laterites extends up to 30 m. Ground water occurs under water table condition in lateritic formation. In the plateau area and high grounds, depth of wells range from 9.40 to 26.60 m bgl and depth to water level varies between 8.20 – 21.90 m bgl, whereas wells located in topographic lows range in depth from 3.10 – 11.95 m bgl and depth to water level varies from 1.5 – 8.40 m bgl. Specific capacities varies between 1.73 to 3205 m³/day/m. Promising ground water bearing areas are located near Malpen and Tuem in Pernem taluk, Advalpal and Mayem in Bicholim Taluk.

Alluvium

Alluvium constitutes good aquifers and is restricted to banks of rivers, viz. Zuari and Mandovi. Thickness of the coastal alluvium varies from 5 – 22 m, and comprise of fine to coarse sand with intercalations of sandy loam, silt and clay. Depth range of 1.42 to 7.7 m bgl is being tapped by dug wells. Exploratory tube wells constructed in alluvium vary in depth from 15.50 – 22m. Depth to water level in these formations varies from 1.4 to 5.85 m bgl. The discharges recorded from these aquifers are between 1.88 – 3 lps. Specific capacities vary between 27.10 & 200.78 m³/day/m and transmissivity varies from 25.44 – 177.50 m²/day.

Granite and Granite Gneiss

Ground water occurs under unconfined, semi – confined and confined conditions in weathered and fractured zones of granite and granite gneiss. Depth to water level in these formations in open wells varies from 3.8 to 6.25 m bgl, and specific capacities between 14.4 to 77.30 m³/day/m. Exploratory bore holes drilled in granite and granitic gneiss are in the

depth range of 70.70 to 124 m bgl. Discharge recorded is between 0.77 to 8.8 lps. Specific capacities in exploratory wells recorded, vary from 2.27 to 43 m³/day/m and transmissivity from 0.87 to 34.60 m²/day.

Metavolcanics

In unaltered state, metavolcanics are very poor in ground water. However, ground water is found to occur in zones having secondary porosity and permeability imparted due to weathering, joints and fractures. Ground water occurs both under water table and confined conditions. Water bearing zones extend up to depth of 40 to 100 m.

Irrigation dug wells having diameter from 2.2 to 6.1 m are found to tap the weathered zone up to 9.25 m bgl. Depth to water level in dug wells varies from 1.48 to 6.26 m bgl. Specific capacity varies from 10.60 to 228.70 m³/day/m.

Exploratory wells and deposit wells drilled by CGWB in this formation range in depth from 37.20 to 200.75 m bgl and the discharges recorded range from 0.18 to 25 lps. Productive zones were encountered even up to 119 m bgl. Specific capacities recorded from boreholes tested varied from 0.46 to 988.47 m³/day/m and transmissivity varied from 0.25 to 346.10 m²/day.

Studies have indicated that bore holes drilled in metavolcanics with thick lateritic cover in the plateau areas and close to lineaments have yields ranging from 2 to 5 lps.

Metasedimentaries

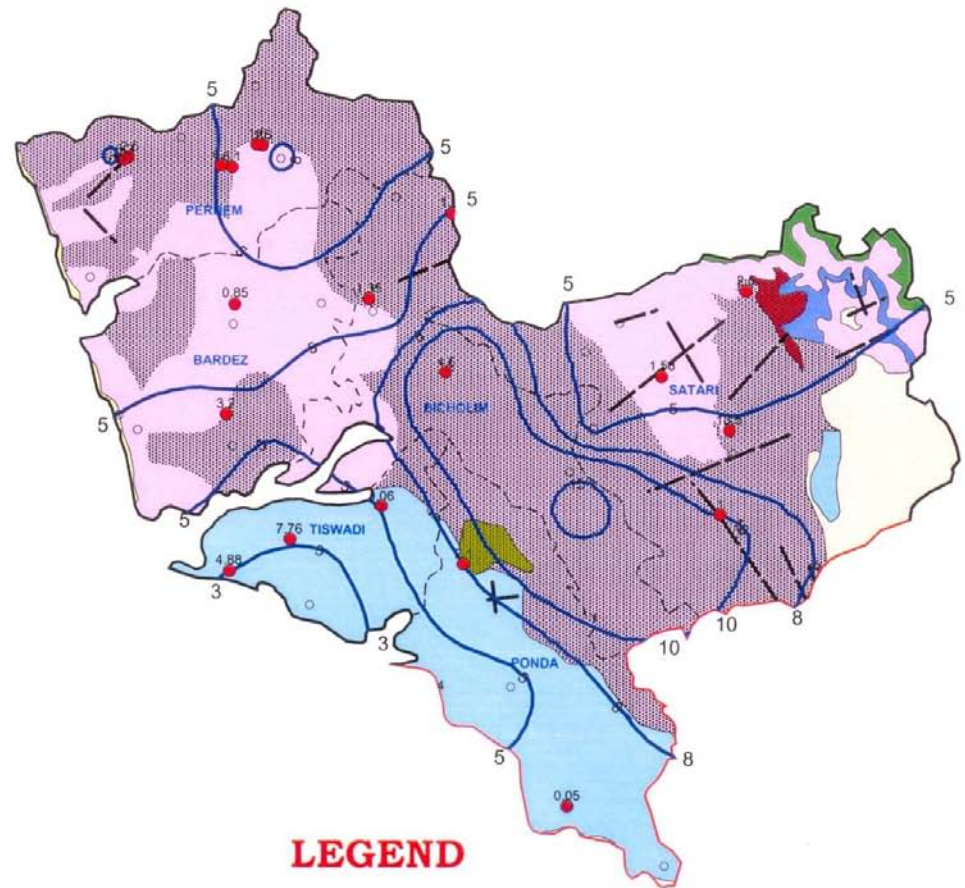
Metasedimentaries comprise shales, phyllites, schists, metagreywackes, argillites and quartzites. The irrigation dug wells tapping weathered zones extending from 8.5 to 19.85 m bgl in these rock units with varying well diameters from 2.2 to 6.1 m. Depth to water level during post and pre – monsoon periods are recorded respectively in the range between 0.48 to 12.06 m bgl and 1.79 to 14.88 m bgl with fluctuations between 0.86 to 8.0 m. Specific capacities vary from 0.85 to 82.80 m³/day/m.

5.1.2 Depth to water level

i) Pre-Monsoon of 2009:

The Depth to water level ranged from 0.43 to 14.90 m bgl. A map showing the dept to water level in the range of <2, 2 to 5, 5 to 10 and 10 to 20 m bgl is given in **Figure-3**. The map shows water level is in the range of less than 2 to 20 m bgl. Water level in the range of 10 to 20 m bgl is seen as one big pocket in Bicholim, Sattari and Ponda taluks.

HYDROGEOLOGY NORTH GOA DISTRICT GOA STATE



LEGEND

- | | | |
|-----------------------------|------|--|
| Laterite | 4.06 | Exploratory bore well location with discharge in lps |
| Beach Sand | | Ground water monitoring well location |
| Basalt | | Decadal mean water level in mbgl (1995-2004) |
| Granite | | Lineament |
| Granite gneiss | | State boundary |
| Metabasalt | | District boundary |
| Dolomitic limestone | | Taluk boundary |
| Greywacke with conglomerate | | |
| Schist | | |

Fig-3

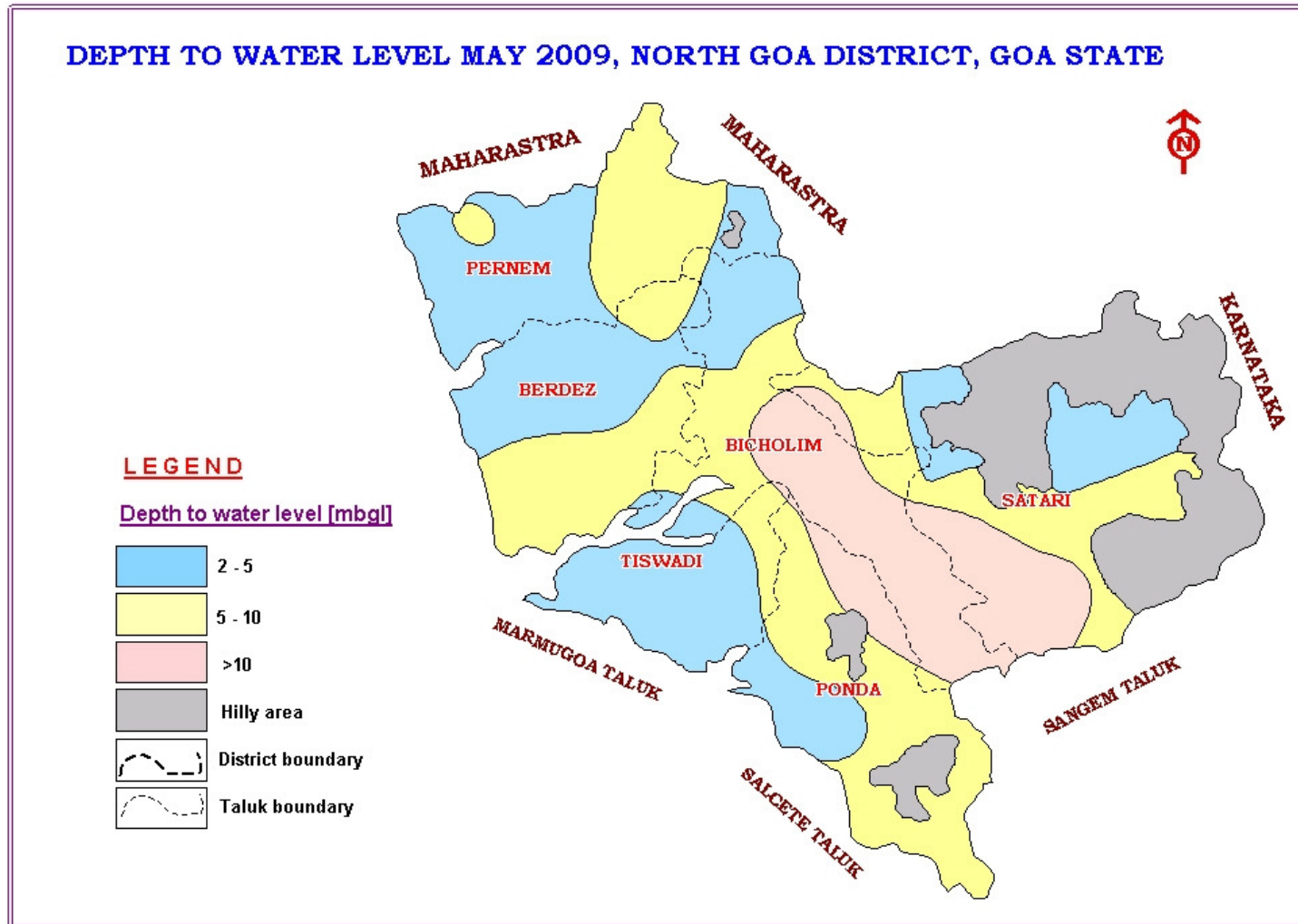
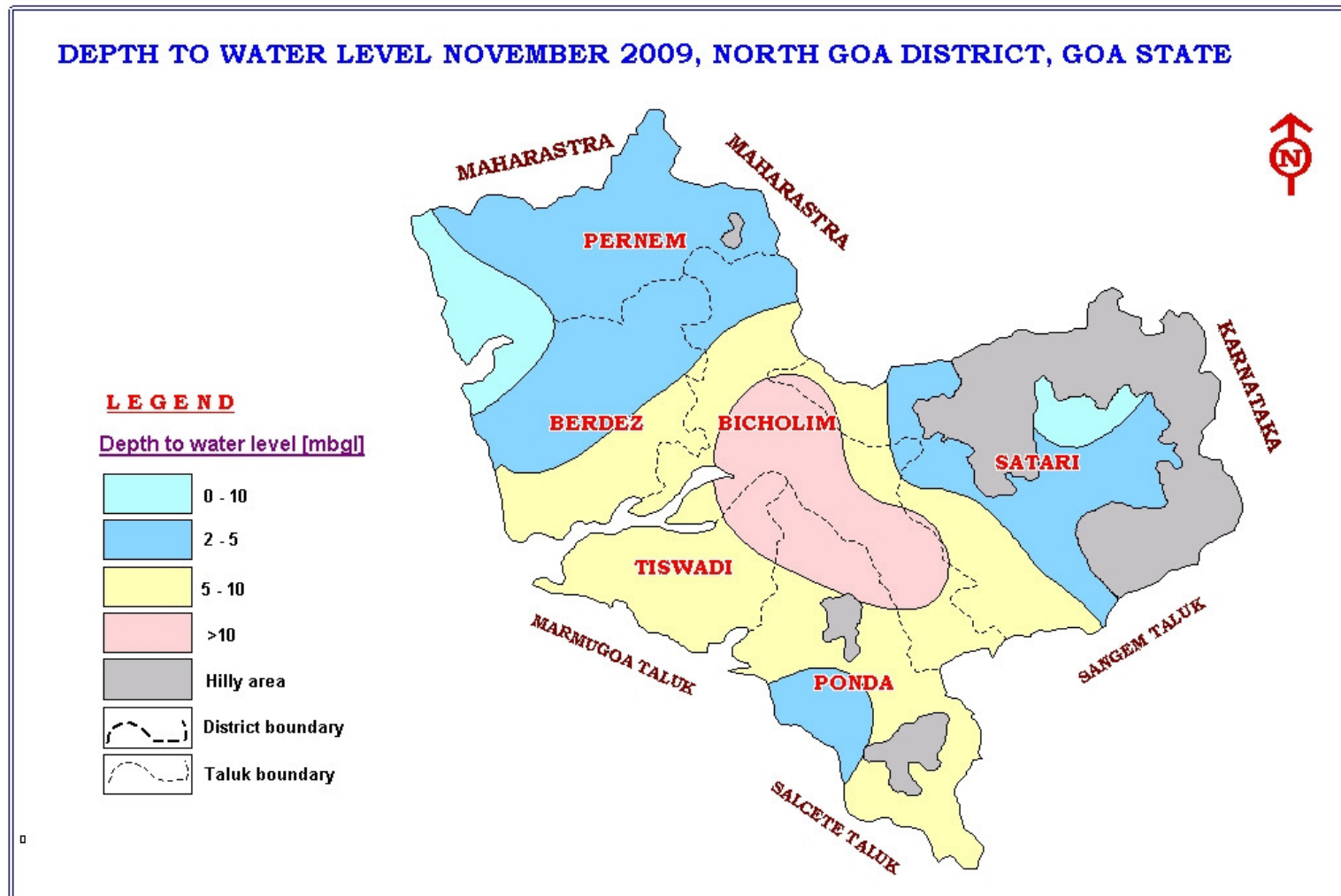


Fig.4



ii) Post-Monsoon of 2009:

The Depth to water level ranged from 2.17 to 19.23 m bgl. A map showing the dept to water level in the range of <2, 2 to 5, 5 to 10 and 10 to 20 m bgl is given in **Figure-4**. The map shows water level is in the range of 2 to 20 m bgl. Water level in the range of 10 to 20 m bgl is seen as one big pocket in Bicholim, Sattari and Ponda taluks.

5.1.3 Seasonal ground water level fluctuation

Water levels from 19 stations were compared to know the change in water level between pre-monsoon and post monsoon of 2009. While 16 stations recorded rise in water levels 3 stations recorded fall in water level.

5.1.4 Long – term water level trend

i) Pre-monsoon:

Water levels from 25 stations were compared to know the decadal change in water level during pre monsoon 2009. While 6 stations recorded rise in water levels 19 stations recorded fall in water level

ii) Post monsoon:

Water levels from 19 stations were compared to know the decadal change in water level during post monsoon 2009. While 15 stations recorded rise in water levels 4 stations recorded fall in water level

5.2 Aquifer system encountered in the district

Under ground water exploration programme of CGWB, in North Goa district, attempt has been made to study aquifer geometry & parameters through drilling of exploratory bore wells. The selection of sites of all such bore wells was done based on detailed hydrogeological investigations and geophysical surveys.

The major aquifers encountered in the district during exploratory drilling are in granite, granite gneiss, metabasalts, metasedimentaries and alluvium. Formation wise aquifer parameters recorded during exploratory drilling in the district is illustrated in Table 3.

Table 3: Formation wise aquifer parameters in North Goa district

Formation/Aquifers	Yield (lps)	Drawdown (m)	Sp. Capacity (m ³ /d/m)	Transmissivity (m ² /day)
1. Granites & Gneisses	0.34 – 8.8	17.68 – 34.61	0.27 – 43.00	0.2 – 30.6
2. Metabasalts	0.18 – 9.9	1.9 – 33.78	0.46 – 141.20	0.2 – 232
3. Metasedimentaries	0.22 – 10	1.32 – 34.40	0.47 – 159.60	0.12 – 346
4. Alluvium	1.8 – 2.5	0.87 – 9.1	27 - 200	21 - 1776

Fig-5



5.3 Ground water resources

Taluk wise ground water resource potential of the district estimated by CGWB, South Western Region, Bangalore and Water Resources Department of Goa, based on the recommendations of Ground Water Resources Estimation Methodology – 97 (as on March 2004) is mentioned in Table 4.

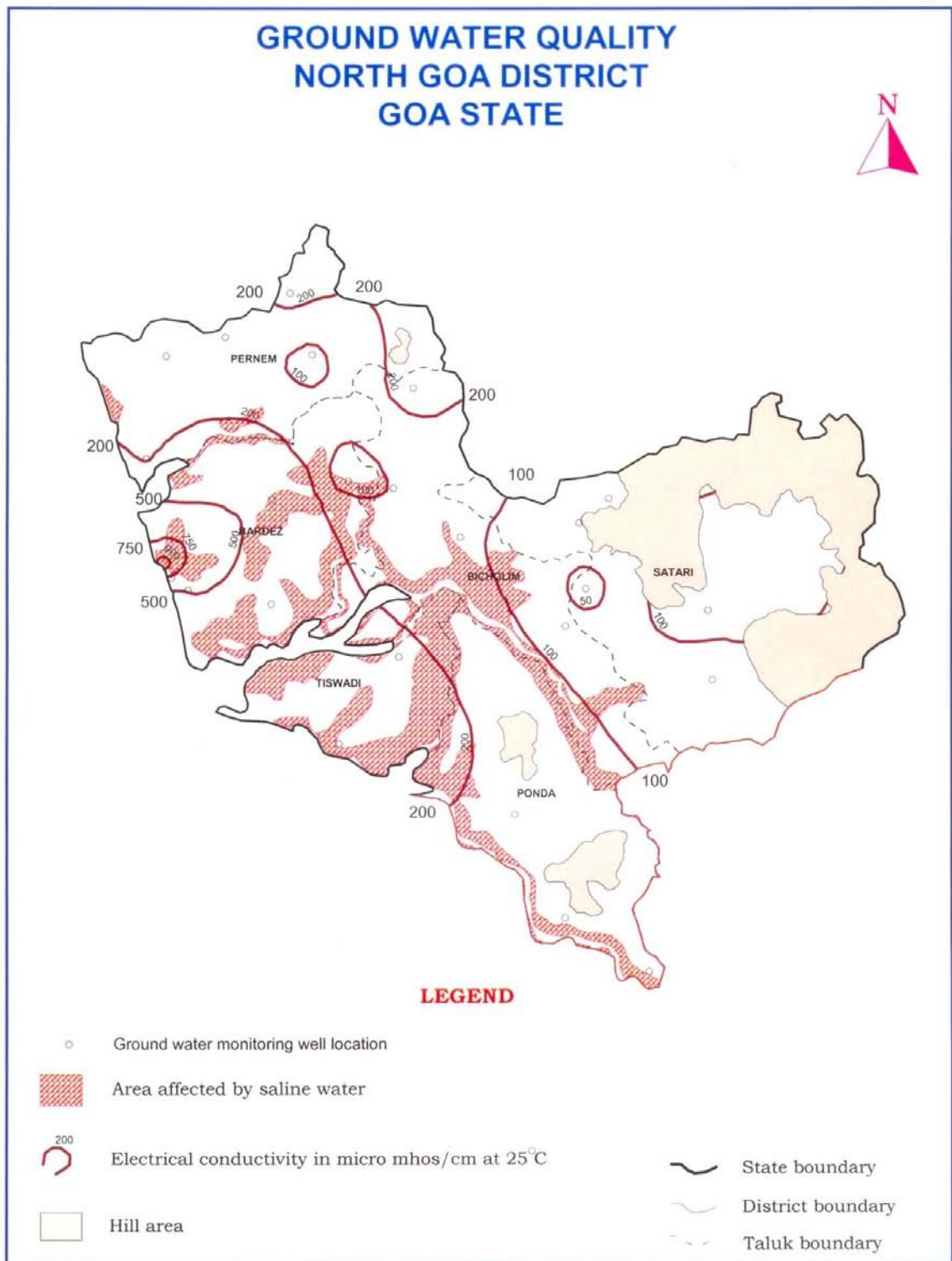
Table 4: Taluk wise ground water resource potential of North Goa district, Goa.

GROUND WATER RESOURCES OF NORTH GOA DISTRICT AS ON MARCH 2004											
TALUK	Net Ground water Availability (HAM)	Irrigation draft (HAM)	Domestic and industrial draft (HAM)	Total annual ground water draft (HAM)	Projected domestic and industrial draft 2025 (HAM)	Ground water availability for future irrigation** (HAM)	Average Stage of development (%)	STAGE OF DEVELOPMENT AS ON MARCH 2004			
								Safe Area (%)	Semi-Critical Area (%)	Critical Area (%)	OE Area (%)
Tiswadi	1585.95	385.56	388.08	773.64	509.42	690.97	49	SAFE			
Bardez	3568.84	695.52	551.95	1247.47	724.54	2148.78	35	SAFE			
Pernem	3712.95	243.45	174.53	417.98	229.11	3240.40	11	SAFE			
Bicholim	4053.07	593.75	219.95	813.70	288.72	3170.60	20	SAFE			
Satari	1644.12	475.65	142.08	617.73	186.51	981.97	38	SAFE			
Ponda	2789.57	523.43	362.26	885.69	475.53	1790.60	32	SAFE			
TOTAL	17354.51	2917.36	1838.85	4756.21	2413.84	12023.31	27	SAFE			

As illustrated in Table 4 and Map (**Figure-5**), there is good scope of ground water exploitation in all the 6 taluks of North Goa district. All the 6 taluks are 100% SAFE for ground water exploitation. However, there are pockets of declining water level in Bardez, Bicholim, Satari and Ponda taluks of North Goa district. On the basis of long term water level trend (1995 – 2005) considered for computation of ground water resource, Pre – monsoon trend of 40% of the observation wells in Bicholim and 16% in Satari taluks have recorded declining trend. Hence, ground water development may be regulated in such pockets.

Declining long term post – monsoon trend has been observed in 40% of observation wells falling in Bardez, 40% in Bicholim, 50% in Satari and 40% in Ponda taluks of North Goa. However, rest of the wells has shown rising trend.

Fig-6



Ground water of the district is free from fluoride, nitrate and alkali hazards.

5.4 Ground water quality

In general the quality is good and potable. However, high electrical conductivity and chloride indicating brackish to saline nature of ground water has been reported around Baga. This can be attributed to seawater ingress in inland aquifers along tidal river courses. The spatial distribution of saline water is given in **Figure-6**.

5.5 Status of groundwater development

Dug wells are mainly the ground water abstraction structure in use for irrigation purposes in all the taluks. Shallow and deep tube wells are not much in use for irrigation purposes. Surface water irrigation is found to be extensively used in all the taluks of the district. Lift irrigation schemes are also being executed in Pernem, Bicholim, Satari and Ponda taluks respectively. The details of ground water abstraction structures constructed under various minor irrigation schemes in North Goa district are mentioned in Table 5.

Table 5: Taluk wise ground water abstraction structures constructed under various minor irrigation schemes in North Goa district.

Sl. No.	Taluk	Dug wells	Shallow tube wells	Deep tube wells	Surface flow irrigation	Lift irrigation
1	Tiswadi	595	-	-	23	-
2	Bardez	966	-	-	1272	-
3	Pernem	316	-	-	155	77
4	Bicholim	487	-	-	111	54
5	Satari	372	9	57	242	207
6	Ponda	623	5	-	756	79
	TOTAL	3559	14	57	2559	417

Source: IIIrd Census of Minor Irrigation Schemes 2000 – 01

6.0 Ground water management strategy

6.1 Ground water development

Stage of ground water development in the district is 27% as a whole and the district falls in SAFE category. There is lot of Scope for further development of ground water resource.

Due to complexities of formations, structure and morphological control, bore wells have to be properly located with respect to lineaments. The areas having pre - monsoon water levels less than 9 m and fluctuations less than 6 m have been recommended for dug well development and in areas having greater than 9m pre – monsoon water levels and greater

than 6m fluctuations, bore wells have been suggested for resource development

Bore wells of 150 to 200 mm dia may be drilled upto a depth of 45 to 150 m depending upon local hydrogeological conditions.

Deeper ground water abstraction structures should be at least 0.5 km away from creeks and 400m away from coastline in low-lying areas to avoid quality problems.

6.2 Water conservation & Artificial recharge

Due to thin soil cover and highly rugged topography, in spite of heavy rainfall, the drainage system tends to be lean during summer months. Likewise due to steep hydraulic gradient and highly permeable phreatic aquifers, the dynamic ground water resource also gets depleted quickly rendering scarcity even for drinking water during summer months. Therefore, there is need for augmenting recharge by construction of water harvesting structures like bhandaras, sub – surface dykes, percolation ponds etc., so that these surface water bodies will help in augmenting ground water resources.

In this regard, Department of Water Resources, Govt. of Goa, has taken up various projects pertaining to inter linking of rivers in the district and post – monsoon water harvesting. The State Govt. has endeavored in inter linking of Zuari River with Kalay River in Mandovi basin through canal and Chapora River with Assonora River in Mandovi basin. Series of bhandaras have also been constructed in Khandepar and Assonora (Sub – basin of Madei basin).

7.0 Ground water related issues & problems

Ground water occurring in dug wells as well as bore wells is brackish to saline in areas around Baga and those along river Chapora, due to sea water ingress in inland aquifers along tidal river courses. Salinity is more pronounced during May when fresh water flow is minimum and maximum seawater ingress takes place.

Investigations have revealed that ground water adjacent to stream course in the NE of Panjim is also polluted due to domestic sewage in addition to salinity problem.

Scarcity of ground water is observed during summer months as a result of high sub – surface and surface run off due to hilly topography and highly permeable nature of phreatic aquifer system. This results in lowering of water levels or drying of wells in some areas in summer months.

8.0 Awareness & Training Activity

8.1 Mass Awareness Programme (MAP) & Awareness Programme on “Hydrological Information System” under Hydrology Project, organized by Central Ground Water Board

Central Ground Water Authority (CGWA) organized MAP on the theme “Conservation & Protection of ground water”, on 18.03.2002 at International Centre, Panaji, North Goa. Representatives of Central & State agencies and general public attended the programme. An interaction session was held on the themes, viz. water conservation, artificial recharge, ground water legislation and ground water authority.

Awareness Programme on “Hydrological Information System”, was organized under Hydrology Project – II, on 12.03.2008 at Panaji, North Goa. The representatives of State Govt. departments and members of Hydrology Project user group attended the programme.

8.2 Water Management Training Programme (WMTP) & Training Programme on “Hydrological Information System” under Hydrology Project, organized by Central Ground Water Board

One day ‘Water Management Training Programme’ was organized by CGWA in association with Govt. of Goa on 29.03.2004 at Goa Science Centre, Marine Highway, Miramar, Panaji.. Representatives from State Govt. departments, Watershed Development Society, Gram Vikas Kendra, educational & research institutes attended the programme.

Training programme on “Hydrological Information System”, was organized under Hydrology Project – II, on 12.03.2008, at Panaji, North Goa. Basic objective of the training programme was to train the members of Hydrology Project user group on the modules of Hydrological Information System developed under Hydrology Project.

8.3 Presentations and lectures delivered in public forum

Lectures on various aspects of ground water development, management and “Hydrological Information System”, were delivered by the scientists of CGWB on occasions of mass awareness and training programmes, organized at different venues in North Goa district.

9.0 Areas Notified by Central Ground Water Authority (CGWA)

Based on status of ground water utilization and available ground water resource, the entire district is categorized as SAFE from the point of view of ground water development. Therefore, no area has been considered for notification by CGWA.

10.0 Recommendations

- (i) Due to thin soil cover and highly rugged topography, in spite of heavy rainfall, the drainage system tends to be lean during summer months. Likewise due to steep hydraulic gradient and highly permeable phreatic aquifers, the dynamic ground water resource also gets depleted quickly rendering scarcity even for drinking water during summer months. Therefore, there is need for augmenting recharge by construction of water harvesting structures like bhandaras, sub – surface dykes, percolation ponds etc., so that these surface water bodies will help in augmenting ground water resources.
- (ii) Investigations have revealed that ground water adjacent to stream course in the NE of Panjim is also polluted due to domestic sewage in addition to salinity problem. Hence, indiscriminate sewage disposal should be regulated.
- (iii) Due to complexities of formations, structure and morphological control, bore wells have to be properly located with respect to lineaments. The areas having pre - monsoon water levels less than 9 m and fluctuations less than 6 m have been recommended for dug well development and in areas having greater than 9m pre – monsoon water levels and greater than 6m fluctuations, bore wells have been suggested for resource development
- (iv) Bore wells of 150 to 200 mm dia may be drilled upto a depth of 45 to 150 m depending upon local hydrogeological conditions.
- (v) Deeper ground water abstraction structures should be at least 0.5 km away from creeks and 400m away from coastline in low-lying areas to avoid quality problems.

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