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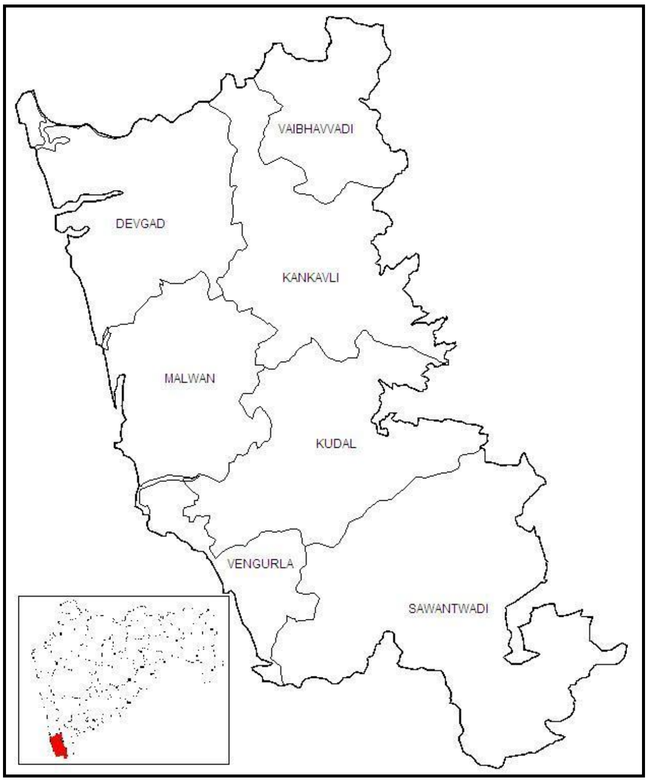
भारत सरकार
जल संसाधन मंत्रालय
केन्द्रीय भूमिजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत सिंधुदुर्ग जिले की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION SINDHUDURG DISTRICT MAHARASHTRA



By
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द्वारा
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मध्य क्षेत्र, नागपुर
CENTRAL REGION
NAGPUR
2014

SINDHUDURG DISTRICT AT A GLANCE

1. GENERAL INFORMATION		
Geographical Area	:	5207 sq. km.
Administrative Divisions	:	Taluka- 8; Sawantwadi, Vengurla, Kudal, Kankavli, Malvan, Deogad, Dodamarg and Vaibhavwadi
Villages	:	743
Population (Census 2011)	:	8,68,825
Normal Annual Rainfall	:	2300 mm to 3200 mm
2. GEOMORPHOLOGY		
Major Physiographic unit	:	5; Coastline, Estuarine plains, Lateritic plateaus, Residual hills, Scrap faces of Sahayadri.
Major Drainage	:	6; Gad, Karli, Terekhol, Tillari, Wagothan and Deogad
3. LAND USE (2010-11)		
Forest Area	:	386.43 sq. km.
Net Area Sown	:	1522.00 sq. km.
Cultivable Area	:	3222.00 sq. km.
4. SOIL TYPE		
Four types viz., Rice soil, Garden soil, Varkas soil and Alluvial soil.		
5. PRINCIPAL CROPS (2011)		
Food Grains	:	828.00 sq. km.
Pulses	:	91.00 sq. km.
Oil Seeds	:	137.00sq. km.
Sugar Cane	:	0.11 sq. km.
6. IRRIGATION BY DIFFERENT SOURCES (2010-11) **-**		
Dugwells/Tube wells	:	2263 Ha
Canal Irrigation	:	6273 Ha
Net Irrigated Area	:	14603 sq. km.
7. GROUND WATER MONITORING WELLS (As on 31/03/2011)		
Dugwells	:	38
Piezometers	:	NIL
8. GEOLOGY		
Recent to sub-Recent	:	Alluvium, beach sand
Pleistocene	:	Laterite and lateritic spread
Miocene		Shale with peat and pyrite nodules
Cretaceous to Eocene		Deccan Trap Basalt lava flows
Upper Pre-Cambrian		Kaladgi Series: quartzite, sandstone, shale and associated limestone
Dharwar Super Group		Phyllite, conglomerate, quartzite
9. HYDROGEOLOGY		
Water Bearing Formation	:	Basalt- weathered/fractured/ jointed vesicular/massive, under phreatic and semi-confined to confined conditions Laterite: GW occurs under phreatic conditions Alluvium- Sand/gravel under

		phreatic conditions
Premonsoon Depth to Water Level (May-2011)	:	1.65-18.90 m bgl
Postmonsoon Depth to Water Level (Nov.-2011)	:	1.06-14.49 m bgl
Premonsoon Water Level Trend (2002-2011)	:	Rise: 0.007-0.25 m/year Fall: 0.02-0.60 m/year
Postmonsoon Water Level Trend (2002-2011)	:	Rise: 0.001-0.29 m/year Fall: 0.08-037 m/year

10. GROUND WATER EXPLORATION (As on 31/03/11)

Wells Drilled	:	PZ-5

10. GROUND WATER QUALITY

Good and suitable for drinking and irrigation purpose.

11. DYNAMIC GROUND WATER RESOURCES- (2009)

Net Annual Ground Water Availability	:	261.96 MCM
Annual Ground Water Draft (Irrigation + Domestic)	:	72.63 MCM
Allocation for Domestic and Industrial requirement up to next 25 years	:	36.51 MCM
Stage of Ground Water Development	:	27.73 %

12. GROUND WATER CONTROL AND REGULATION

Over-Exploited Taluka	:	None
Critical Taluka	:	None
Notified Taluka	:	None

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

Even though the district receives high rainfall in the range of 2300 to 3200 mm/year, water scarcity in the non-monsoon seasons is the major issue of concern and many villages face water scarcity in the summer. The falling trend of water level in the range of 0 to 0.20 m/year is (in parts of Devgad and Kankavali talukas) and in elongated western part of the district (in parts of Malwan and Vengurla) and in southern part of the district (in parts of Sawantwadi and Dodamarg talukas). The district has a coastline of 121 km and has 14 creeks, about 76900 ha of agricultural land is reported to be saline due to sea water ingress along the coast and creeks.

Ground Water Information
Sindhudurg District

Contents

1.0 Introduction 2
2.0 Climate and Rainfall 3
3.0 Geomorphology and Soil Types 4
4.0 Ground Water Scenario 6
4.1 Hydrogeology 6
4.2 Water Level Scenario 8
4.3 Aquifer Parameters 8
4.4 Yield of Wells 12
4.5 Ground Water Resources 13
4.6 Ground Water Quality.. 14
4.7 Status of Ground Water Development 14
5.0 Ground Water Management Strategy...............................17
5.1 Ground Water Development 17
5.2 Water Conservation and Artificial Recharge....................... 18
6.0 Ground Water Related Issues and Problems 19
7.0 Areas Notified by CGWA/SGWA.......................................20
8.0 Recommendations 20

List of Figures

1. Location.
2. Hydrogeology.
3. Depth to Water Level (Premonsoon- May 2011).
4. Depth to Water Level (Postmonsoon- Nov. 2011).
5. Premonsoon Water Level Trend (May 2002-2011).
6. Ground Water Resources (2009).

List of Tables

1. Studies undertaken by CGWB.
2. Annual Rainfall Data (2002-2011).
3. Aquifer Parameters.
4. Yield of Dugwells and Borewells.
5. Ground Water Resources (2009).
6. Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003), May 2011.
7. Classification of Ground Water for Irrigation based on EC, May 2011.

Ground Water Information
Sindhudurg District

1.0 Introduction

Sindhudurg district is located in the Konkan region of Maharashtra State and covers a geographical area of 5207 sq.km. The district lies in the Survey of India degree sheets 47H, 48 E and 48 I. The district is located between north latitude 15°37' and 16° 40' and east longitude 73° 19' and 74° 13'. The district is bounded in the north by Sindhudurg district, west by Arabian Sea and in the east by Kolhapur district and in the south by Goa State and Belgaum district of Karnataka State. National Highway 17 passes through the district. The district has 7 railway stations with a 103 km. stretch of Konkan Railway line. It has good road and rail links with Goa and Mumbai. The district has a geographical area of 5207 sq. km. out of which about 386.43 sq.km. is covered by forest, whereas cultivable area is 3222 sq. km. and net sown area is 1522 sq. km.

The district headquarters is located at Oras (Kudal). The district comprises of two revenue sub-divisions viz: Sawantwadi and Kankavli. The eight taluka of the district are Sawantwadi, Vengurla, Kudal, Kankavli, Malvan, Deogad, Dodamarg and Vaibhavwadi. The population of the district as per 2001 census is 8,68,825. The district comprises of 5 towns and 743 villages.

Central Ground Water Board has taken up several studies in the district. A list of studies conducted in the district is presented in Table-1.

Table 1: Studies Undertaken by CGWB.

S. No.	Year	Officer(s)	Toposheets	Type of Survey/Study
1	1983-84,	D. B. Shetye	47- H/7, 47- H/10, 47- H/11 and 47- H/15	SHS
2	1984-85	D. B. Shetye	48- E/9, 48- E/13, 48- E/14, 47- H/8 and 47- H/12	SHS
3	1990-91	D. B. Shetye	47- H/10, 47- H/14 and 47- H/15	SHS
4	1999-2000	L.J. Balachandra	Entire District	RHS

(Here, SHS- Systematic Hydrogeological Survey, RHS- Reappraisal Hydrogeological Studies)

Shri L.J. Balachandra, Scientist-B in 1999-2000 has compiled the report entitled "Ground Water Resources and Development Potential of Sindhudurg

District, M.S." Central Ground Water Board has so far not carried out ground water exploration work in the district. However, 5 Peizometers (Pz) to monitor ground water levels have been drilled in the district. A map of the district showing the taluka boundaries, taluka headquarters, physical features and location of Peizometers and monitoring wells is presented as **Figure-1**.

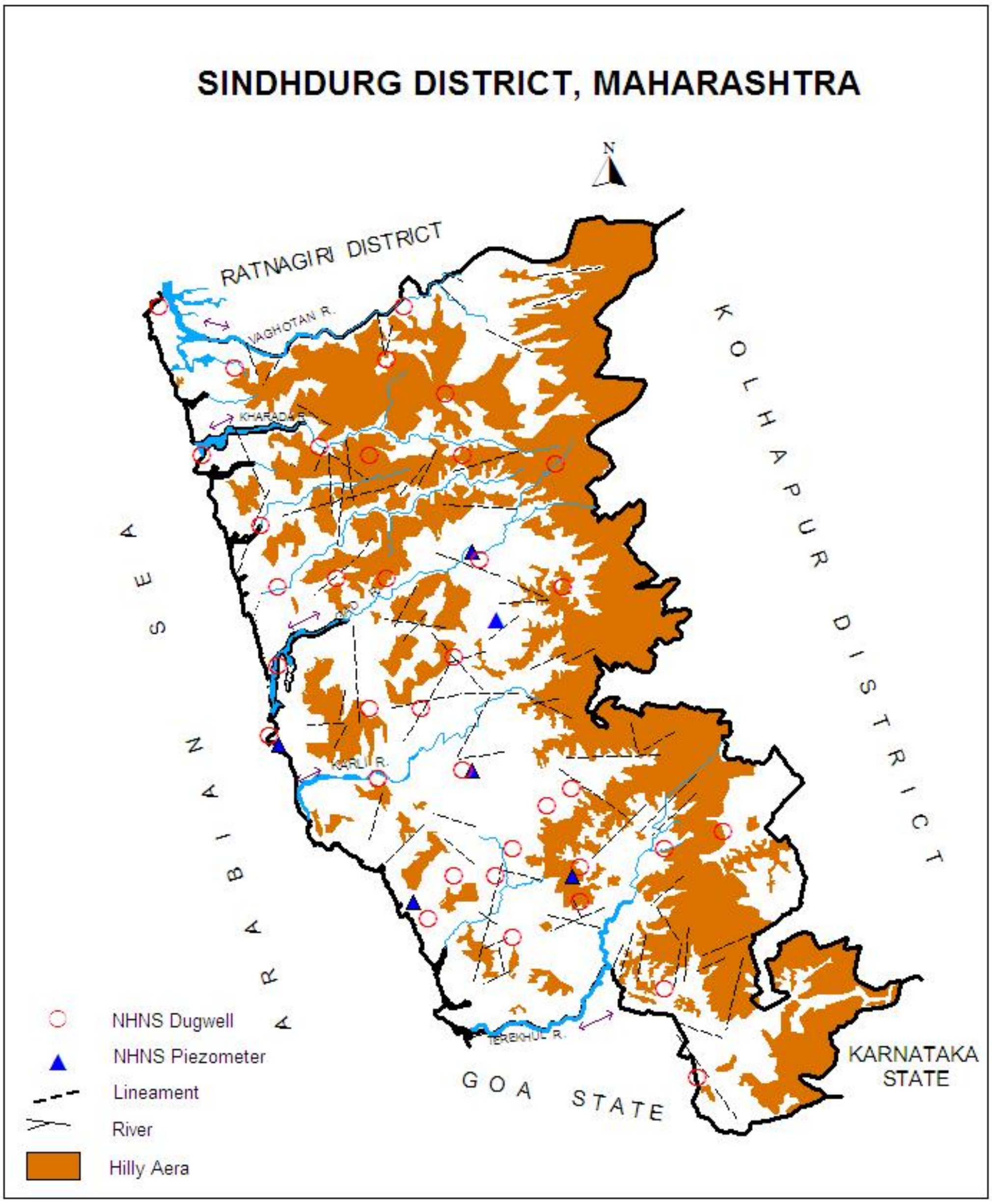

Figure-1: Location

2.0 Climate and Rainfall

Climatic conditions in the district are strongly influenced by its geographical conditions. The district falls under the 'Assured and High Rainfall zone'. The climate is generally humid. The cold season is from December to February followed by summer from March to May. June to September is the southwest monsoon, while, October and November constitute the post-monsoon season. Being a coastal district, variation in the temperature during the day and throughout the season is not large. December is the coldest month with mean daily maximum temperature at 32.7°C and the mean daily minimum temperature at 18.7°C. April is the hottest month. The relative humidity during the southwest monsoon is very high (86 to 90%). The relative humidity during winter and summer months is also above 57%.

The normal annual rainfall over the district varies from 2300 mm (Malvan) to about 3205 mm (Kudal). It is minimum in the western part of the district along the coast and gradually increases towards east and reaches maximum along Western Ghats. The average annual rainfall for the period 2002-2011 ranges from 2752.19 mm (Devgadh) to 3980.19 mm (Vaibhawadi). The annual rainfall data of all talukas is given in Table 2. Perusal of rainfall data from above table reveals that during last decade (year 2002-2011) also reveals that lowest rainfall amounting 2261.1 mm was observed during year-2002 in the district, whereas maximum rainfall 4668.8 mm was recorded in year-2010 in the district.

Table 2: Annual Rainfall Data (2002-2011) (mm)

Taluka	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Decadal Avg.**
Devgad	2033.9	2132	2091	2535.4	2889	3316.2	2391	2846.4	3796	3491	**2752.19**
Malvan	2048.9	2415	2535	2484	2299.2	2836	3291	4209	5568	4303	**3198.91**
Samantwadi	2962	3570	2503.4	3939.8	4761.4	4103.9	3838	4062.5	5036	4632.6	**3940.96**
Vengurla	2166.3	2578.1	2525.6	3055.8	2774.5	3479.3	2555.1	3723.1	4362.5	3485.2	**3070.55**
Kankavali	2116	2066.8	2404	2692	3381	3331	3106.8	3515	5093	4619	**3232.46**
Kudal	1977.8	2540	2712	3059	2531	3342	3273	3875	4442	4189	**3194.08**
Vaibhavadi	2799.9	3152	3339.6	4421	4823.4	4692.2	3916.2	3695.6	4179	4783	**3980.19**
Dodamarg	2784	3053	2751	3600	3826.6	4160.1	3801.6	3625.4	4874.1	4393	**3686.88**
Dist Av.	**2361.1**	**2688.3**	**2607.7**	**3223.3**	**3410.7**	**3657.5**	**3271.5**	**3694.0**	**4668.8**	**4236.9**	

3.0 Geomorphology and Soil Types

The outstanding feature in the relief of the district is its highly uneven nature and very narrow riverine plains that fringe the coastline. About 40 to 50% of the area in the district is hilly. The district has three major physiographic divisions from east to west. (i) The eastern part close to the Western Ghats, is highly dissected with deep valleys. (ii) The middle part of the district is occupied by flat-topped hills with undulating plateau with elevations up to 300 meter above mean sea level (m amsl) covered by Laterite. (iii) The coastal plain in the western part with elevations of 100 to 150 m amsl. The physiograhic features have given rise to five characteristic landforms viz. (i) The coast line (ii) The estuarine alluvial plains (iii) The Lateritic plateau (iv) Highly eroded remnant hills (v) Scarp faces of Sahayadri hill ranges. The drainage system of the major rivers in the district is mostly of sub-parallel type and the tributaries drainage pattern tends to be sub-rectangular type. Major joints in the Basalt control the drainage pattern. The river systems are young with a small drainage area and westerly seasonal regime. During monsoon the rivers carry heavy load of water having tremendous headward eroding capacity and ultimately drain in the Arabian Sea. All the major rivers originate in the Sahayadri Hill ranges. The five major rivers in the district are Gad (Length- 84km.), Karli (92km.), Terekhol (69km.), Tillari (53 km.), Deogad (48km.) and Wagothan (24km.). All these rivers form part of the westerly flowing river system originating from Sahayadri hill ranges and debouching in Arabian Sea.

The soil formation in the district in the district is controlled mainly by climate. Most of the soils are derived from Lateritic rocks. The soils are classified based on physical characteristics into four types viz., Rice soil, Garden soil, Varkas soil and Alluvial soil. The Rice soils are termed as ‘Mali soils’ when situated in higher levels, ‘Kuryat soils’ in lower levels and ‘Panthar or Vaigam’ when situated near water courses. Varkas soils are reddish brown to yellowish red in colour and are situated on hill slopes. These soils are poor in fertility, shallow in depth and coarse in texture. Garden soils are of mixed origin, yellow red to brown in color and are located in the valley portions. These soils are light, well drained and fairly fertile. Coastal Alluvial soils are recent deposits found along the coastal tracts and constitute deep loam. Due to inundation of sea, part of the coastal soils has become salty. In the Deogad, Malwan and Vengurla talukas practically entire strip is salty.

4.0 Ground Water Scenario

4.1 Hydrogeology

Dharwarian metasediments (Archean), Kaladgi formation (Precambrian), Deccan Trap lava flows (Upper Cretaceous to Lower Eocene age), , Laterite (Pleistocene) and Alluvial deposits (Recent to Sub-Recent) are the water bearing formations observed in Sindhudurg district. However Kaladgi formation occurs in very limited patches and does not form potential aquifer in the district. The Alluviums also has limited areal extent found mainly along the coast. A map depicting the hydrogeological features is shown in **Figure-2**.

4.1.1 Hard Rock Areas

4.1.1.1 Dharwarian Metasediments

The Dharwarian metasediments and intrusions are devoid of primary porosity and permeability. The major aquifer formations are Granitic Gneisses and Granites, which are banded or jointed, locally sheared and weathered that facilitates movement and storage of water. The secondary porosity and permeability thus developed gives rise to moderately yielding aquifers. Granulites are dense and compact and hence not suitable for storage or transmission of ground water. The unconfined aquifer is developed down to depth of 15 metres below ground level (m bgl) and the yield of the wells tapping such aquifer varies form 2 to 3 m^3/day. Borewells generally tap deeper aquifer down to the depth of 70 m bgl and their yield varies between 500 and 7770 litres/hr.

4.1.1.2 Kaladgi

The Kaladgi rocks are mainly represented by orthoquartzite, sandstone and shales. They are jointed in diverse directions and this along with weathered portion controls the water bearing properties. The unconfined aquifer is developed down to depth of 10-12 m bgl and the yield of the wells tapping such aquifer varies form 2 to 5 m^3/day. Borewells generally tap deeper aquifer down to the depth of 60 m bgl and their yield varies between 500 and 9315 litres/hr.

4.1.1.3 Deccan Trap Basalt

The primary porosity is negligent in the Deccan trap basalts. The secondary porosity imparted due to jointing, fracturing plays an important role in ground water circulation. In the basaltic terrain ground water occurs under unconfined conditions in the phreatic zone up to a depth of 15 meters in the weathered zone, fractures and joints in the massive unit and weathered/fractured vesicular units. The basalts occupying higher elevations do not form good aquifers however the basalts occupying lower elevations give rise to good aquifers. The unconfined aquifer is developed due to the weathering and jointing of upper flow in Basalt down to depth of 15-20 m bgl and the yield of the wells tapping such aquifer varies form 0.50 to 4.00 m^3/day. Borewells are not common in the district and they tap deeper aquifer in generally down to the depth of 90 m bgl their yield varies between 500 and 770 litres/hr.

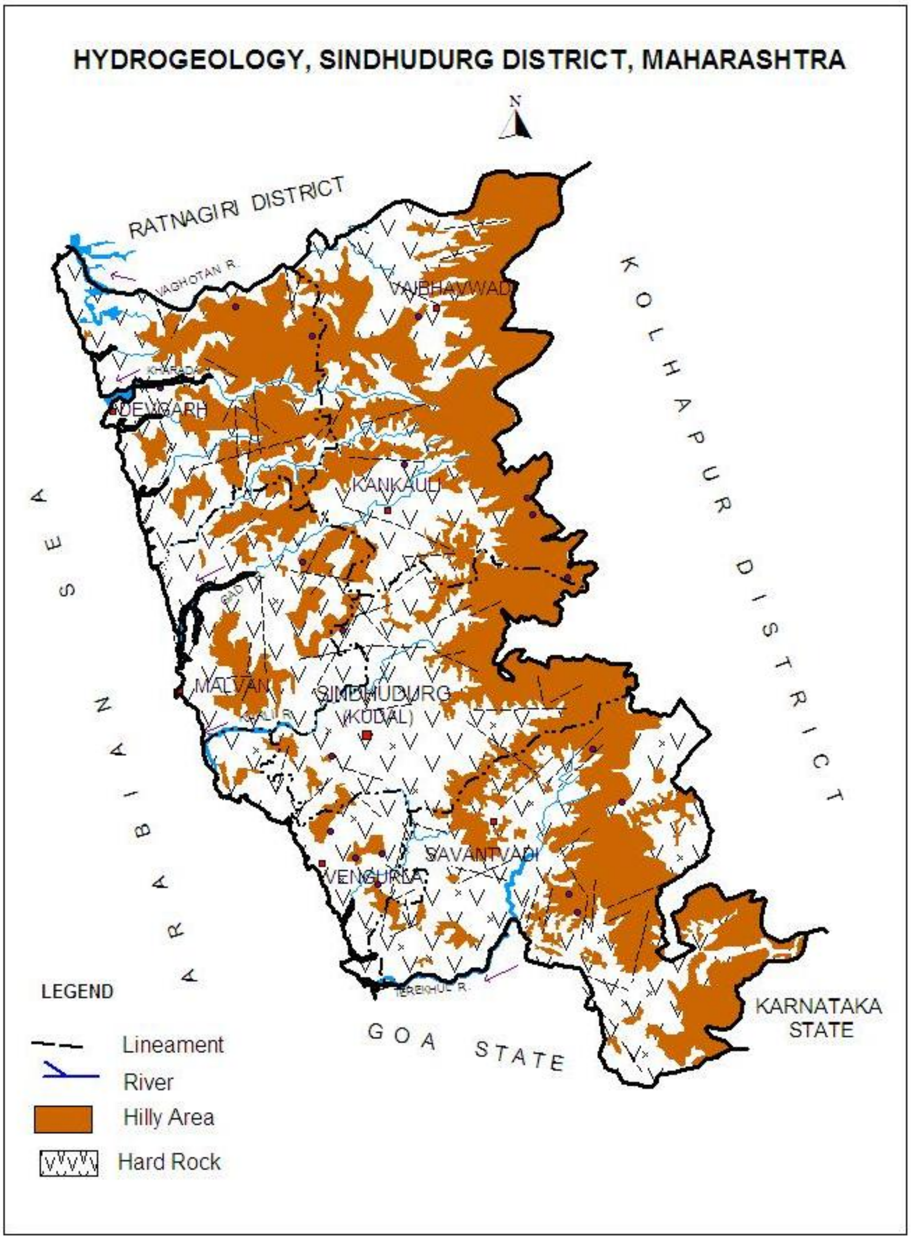

Figure-2: Hydrogeology

4.1.1.4 Laterite

Laterite has better porosity due to intricate network of sinuous conduits making it porous formation. The ground water circulates through a network of voids and conduits, joints and fractures. The local water table aquifer develops in the topmost layer down to the depth of 20 m bgl under unconfined conditions. The wells in these areas show rapid decline in water levels during post monsoon season and go dry in peak summer due to lateral movement at lithomarge/laterite contact and through spring discharge. Only dugwells are found in this formation.

4.1.2 Soft Rock Areas

4.1.2.1 Beach Sand/Alluvium

The Alluvial deposits are found along the coastal areas in few isolated patches having limited areal extent and limited thickness as Beach Sand. The ground water occurs in inter-granular pore spaces of sands, gravels and silts. The ground water occurs under phreatic/unconfined aquifer at relatively shallow depths of 2-10 m bgl and their yield ranges from about 2 to 5 m^3/day.

4.2 Water Level Scenario

Central Ground Water Board periodically monitors 38 National Hydrograph Network Stations (NHNS) stations in Sindhudurg district, four times a year i.e., in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Premonsoon (May-2011)

The depth to water levels in the district during May 2011 ranges between 1.65 (Amboli) and 18.90 m bgl (Achra). Depth to water levels during premonsoon (May 2011) has been depicted in **Figure-3**. The shallow water levels within 2 m bgl are observed in small area around Amboli in eastern part of the district. Major part of the district is showing water level in the range 5 to 10 m bgl in north-south section. Deeper water levels of more than 10 m bgl are observed in northern part of the district.

4.2.2 Depth to Water Level – Postmonsoon (Nov.-2011)

The depth to water levels during Nov. 2011 ranges between 1.06 m bgl at few NHNS (Amboli and Vados) and 14.49 m bgl (Achra). Spatial variation in postmonsoon depth to water levels is shown in **Figure-4**. The shallow water levels within 2 m bgl are observed in small area in eastern part of the district (parts of Sawantwadi and Kudal). The water levels of 2 to 5 m bgl are the most dominant range observed in southern part of the district. The water levels in the range of 5 to 10 m bgl are observed in patches in northern and western coastal areas. The deeper water levels of more than 10 m bgl are observed n small patches in northern part.

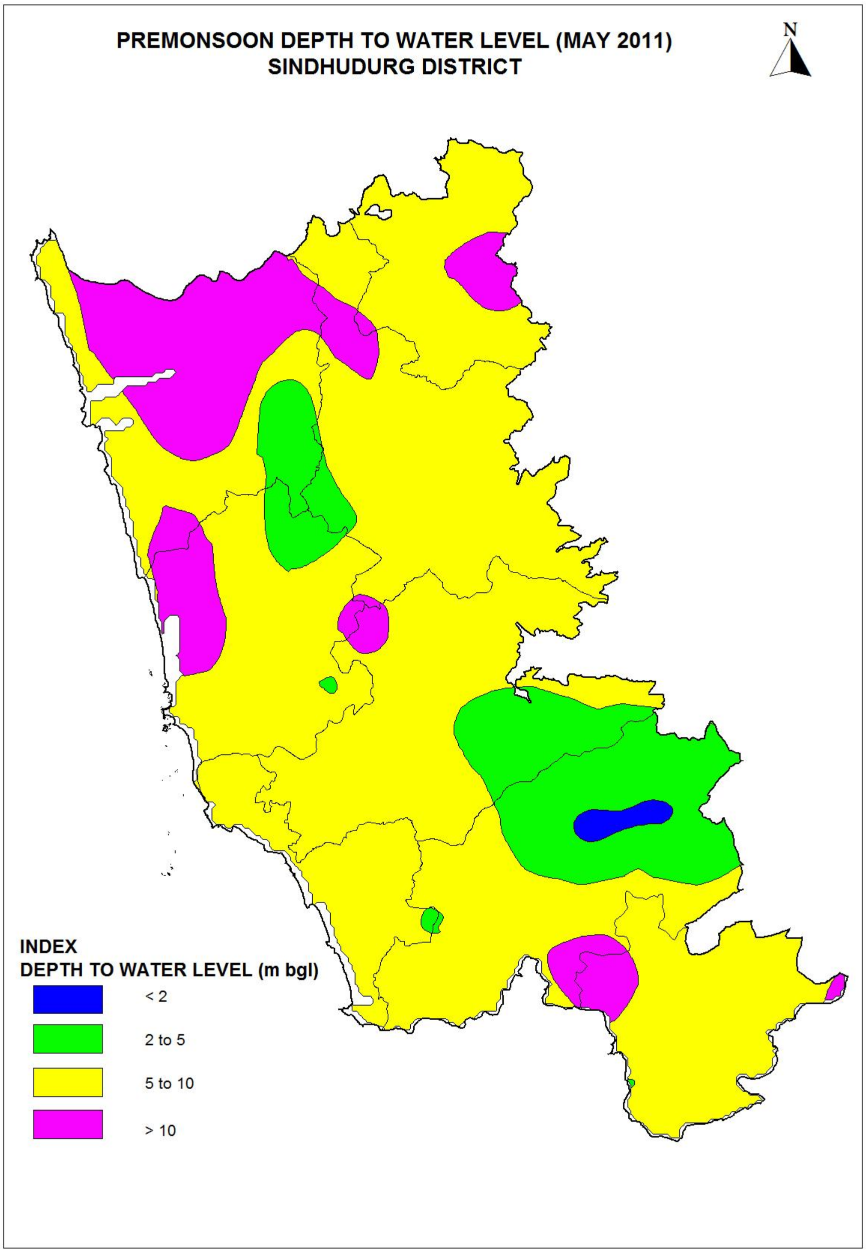

Figure-3: Premonsoon Depth to Water Level (May 2011)

4.2.3 Seasonal Water Level Fluctuation– (May to Nov. 2011)

The rise in water levels in the range of 0.06 m (Ramgarh) to 8.85 m (Wareri) has been observed. Major part of the district show rise of water level up to 4 m. Rise above 4 m was observed in few patches in north western coastal part and in southern part of Savantwadi taluka.

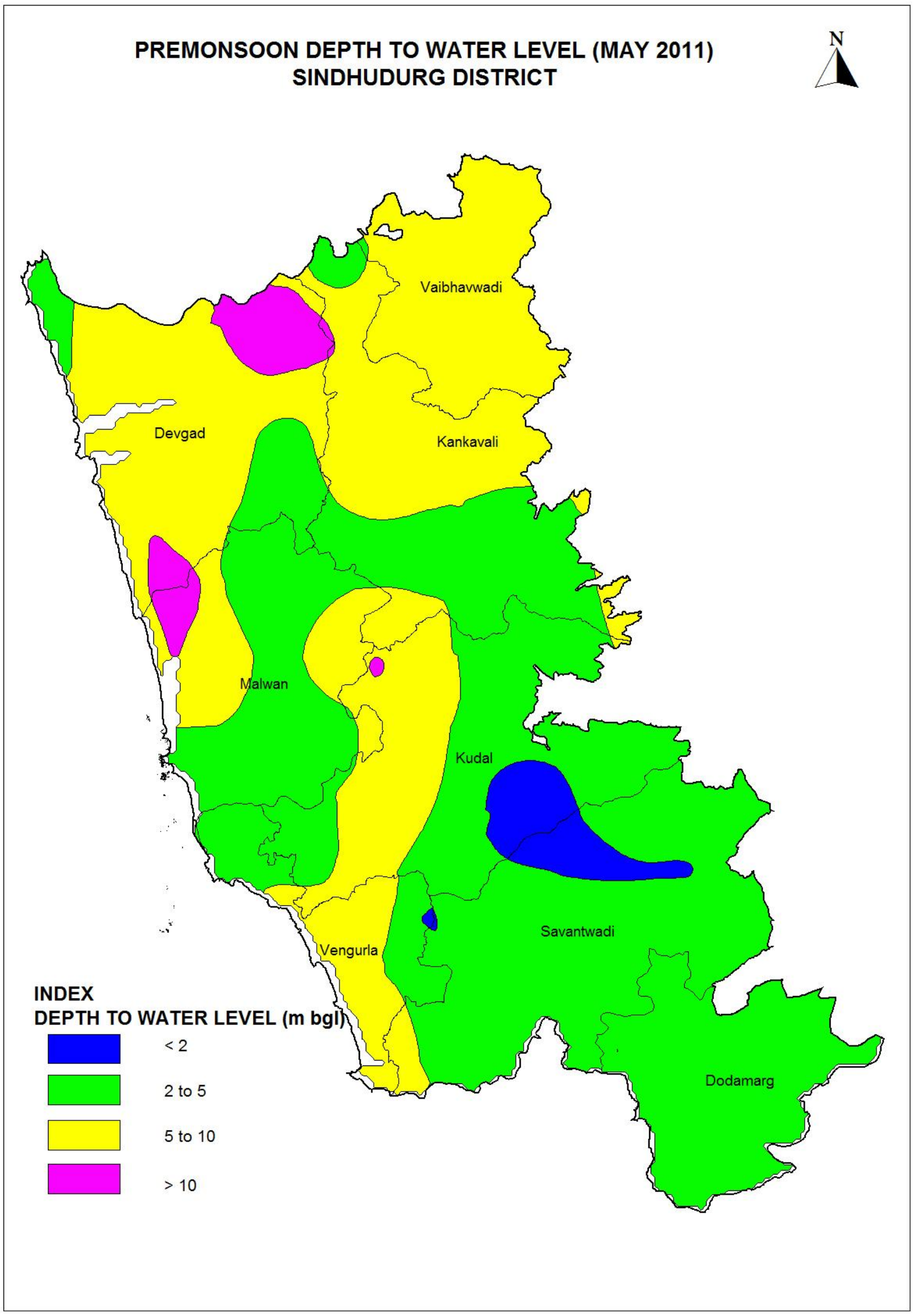

Figure-4: Depth to Water Level (Postmonsoon- Nov.2011)

4.2.4 Water Level Trend (2002-2011)

Trend of water levels for premonsoon and postmonsoon period for last ten years (2002-2011) have been computed for 37 NHNS. Analysis of long term water level trend indicates that during premonsoon period, rise in water levels has been recorded at 25 stations and it ranges between 0.007 m/year (Shergaon-Shirgaon) to 0.25 m/year (Adeli-Banderwadi). Fall in water levels has been observed at 12 stations in the range of 0.02 m/year (Deogarh) to 0.60 m/year (Vagothan).

During postmonsoon period, rise in water levels has been recorded at 14 stations and it ranges from 0.001 m/year (Matond-Ghodemukh) to 0.29 m/year (Wareri), fall in water levels ranging between 0.08 m/year (Insuli) and 0.37 m/year (Kudal) is observed.

The premonsoon water level trend map was also prepared for the period May 2002-2011 and the same is presented in **Figure- 5**. A perusal of the map indicates that in major part of the district the rising trend of water level in the range 0 to 0.20 m/year is observed. The falling trend of water level in the range of 0 to 0.20 m/year is (in parts of Devgad and Kankavali talukas) and in elongated western part of the district (in parts of Malwan and Vengurla) and in southern part of the district (in parts of Sawantwadi and Dodamarg talukas).

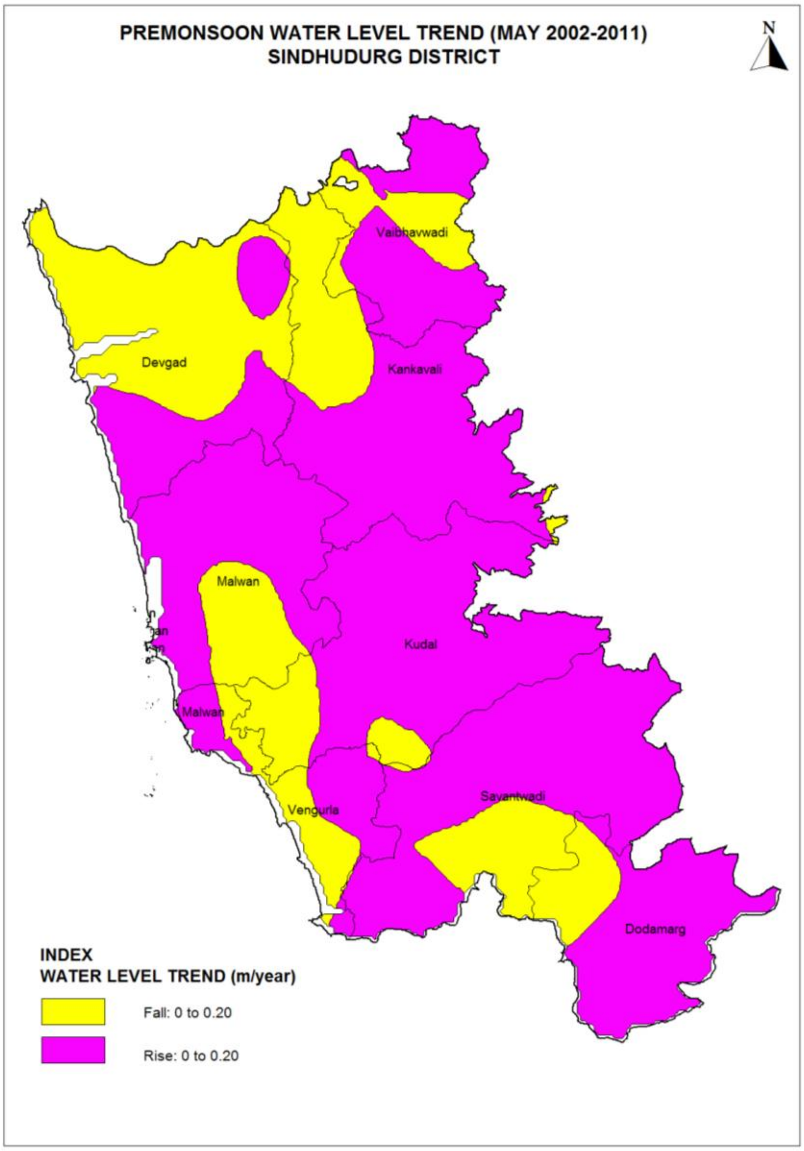

Figure-5: Premonsoon Water Level Trend (May 2002-2011)

4.3 Aquifer Parameters

As mentioned earlier, CGWB has not carried out any deep exploratory drilling in Sindhudurg district and as such no data is available on aquifer parameters of deeper aquifer. The aquifer parameters are available from dugwell pumping tests conducted during previous studies by CGWB. The summarised results of pumping test are given in Table-3. The specific capacity ranges from 3.38 to 424.57 lpm/m of drawdown, transmissivity ranges form 5.58 to 375.22 m^2/day, whereas permeability varies from 4.28 to 425.22 m/day.

Table-3: Aquifer Parameters.

S. No.	Aquifer	Specific Capacity (lpm/m of dd)	Transmissivity (m^2/day)	Permeability (m/day)
1	Laterite	79.10 to 424.57	46.59 to 375.22	7.40 to 425.22
2	Fractured Basalt	3.38 to 51.44	5.58 to 28.95	4.28 to 24.85

4.4 Yield of Wells

The yields of the wells are the functions of the permeability and transmissivity of aquifer encountered and vary with thickness of the aquifer zone encountered, location, diameter and depth etc. Ground water in the area is being developed by two type of abstraction structures i.e., borewells and dugwells. However dugwells are the main ground water abstraction structures in the district. Majority of dugwells in the district are basically used for domestic purpose. Some of the dugwells with good yield are fitted with centrifugal pumps which are used for irrigation purpose and some with submersible pumps for piped water supply schemes. Generally dugwells with rope and pulley as well as Persian wheel are used for domestic purpose.

The yield of dugwells in Coastal Alluvium ranges from 2 to 5 m^3/day, in Deccan Trap it varies from 0.50 to 4.00 m^3/day, in Kaladgis it varies between 2 and 5 m^3/day, whereas in Metamorphics it ranges between 2 and 3 m^3/day. The depth of the dugwells in all the formations is shallow up to 13 m bgl. The wells located in topographic lows have better yield than located elsewhere. However, the yield of the dugwells is more during post-monsoon period and declines with the approach of summer.

The borewells are mainly constructed for rural water supply. The successful borewells are fitted with hand pumps and those with high yield are fitted with power pumps. The yield of the borewells drilled by Groundwater Survey and Development Agency (GSDA) ranges between 500 to 9315 lph, whereas the depths of the borewells range between 45 and 70 m bgl. The formation-wise depth and yield of dugwells and borewells are given in Table-4.

Table-4: Yield of Dugwells and Borewells.

S. No.	Formation	Dugwells		Borewells	
		Depth (m bgl)	Yield (m^3/day)	Depth (m bgl)	Yield (lph)
1	Coastal Alluvium	2.00 to 11.80	2 to 5	---	--
2	Deccan Trap	8.00 to 13.50	0.5 to 4	45 to 65	500 - 770
3	Kaladgis	3.80 to 10.00	2 to 5	50 to 60	500 - 9315
4	Metamorphics	3.00 to 11.50	2 to 3	50 to 70	500 – 7770

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) of Maharastra State have jointly carried out Taluka and Watershed wise estimation of ground water resources of Sindhudurg district for base year 2008-09 according to GEC methodology- 1997.Ground Water Resource Estimation figures as a whole for Sindhudurg district indicates that Net Ground Water Availability is 26196.06 ha-m and Existing Ground Water Draft for all uses is 7262.86 ha-m. After making provision for Domestic and Industrial Supply for next 25 Years as 3651.19 ha-m, Ground Water Availability for future Irrigation is 17107.6 ha-m. Over all Stage of Ground Water development of the district is 27.73%. indicating there is ample scope for ground water development in the district. All Talukas of Sindhudurg district are categorized under “Safe Category”. Taluka wise ground water resources figures of Sindhudurg district are given below in **Table-5**. Taluka wise figures of ground water resources are reveling that stage of ground water development in the district is varying from 14.94% at Sawantwadi Taluka to 35.055 at Kudal Taluka and all Taluka are categorized under “Safe Category” where there are scope for future development of ground water resources in Sindhudurg district.

Table-5: Ground Water Resources (2009).

Taluka	Net G.W. Availability (ha-m)	Existing G.W. Draft for all Uses (ha-m)	Provision for Domestic & Industrial Requirement for Next 25 Years (ha-m)	G.W. Availability for Future Irrigation (ha-m)	Stage of G.W. Develop-ment (%)	Category
Devgad	3898.80	1252.44	618.01	2337.35	32.12	Safe
Doudamarg	755.35	228.41	127.45	466.62	30.24	Safe
Kankavali	5016.23	1206.00	582.25	3497.02	24.04	Safe
Kudal	5464.73	1915.17	661.13	3134.80	35.05	Safe
Malwan	4052.71	1219.37	496.69	2671.03	30.09	Safe
Sawantwadi	3363.62	502.43	608.26	2543.66	14.94	Safe
Vaibhavadi	1676.95	399.58	282.01	1136.36	23.83	Safe
Vengurla	1967.67	539.45	275.50	1320.76	27.42	Safe
District Total	**26196.06**	**7262.86**	**3651.19**	**17107.6**	**27.73**	**Safe**

4.6 Ground Water Quality

CGWB is monitoring the ground water quality of the Sindhudurg district since the last four decades through its established monitoring wells. The objectives behind the monitoring are to develop an overall picture of the ground water quality of the district. During the year 2011, the Board has carried out the ground water quality monitoring of 31 monitoring wells. These wells mainly consist of the dug wells representing the shallow aquifer. The sampling of ground water from these wells was carried out in the month of May 2011 (pre-monsoon period). The water samples after collection were immediately subjected to the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analyzed, include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F). The sample collection, preservation, storage, transportation and analysis were carried out as per the standard methods given in the manual of American Public Health

Association for the Examination of Water and Wastewater (APHA, 1998). The ground water quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of ground water quality in the district in the year 2011.

Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TH, NO_3 and F prescribed in the standards and is given in **Table-6**.

Table-6: Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003), May 2011

Parameters	**DL**	**MPL**	**Samples with conc. < DL**	**Samples with conc. in DL-MPL**	**Samples with conc. >MPL**
TH (mg/L)	300	600	29	2	-
NO_3 (mg/L)	45	No relaxation	30	-	1
F (mg/L)	1.0	1.5	29	2	-

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit)

The perusal of **Table-6** shows that the concentrations of all the parameters except nitrate in most of the samples are the maximum permissible limit of the within BIS standards Overall, it can be concluded that the ground water quality in the wells monitored in the district is safe for drinking purpose.

Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

Electrical Conductivity (EC)

The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows.

Low Salinity Water (EC: 100-250 µS/cm): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop.

Medium Salinity Water (EC: 250 – 750 µS/cm): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High Salinity Water (EC: 750 – 2250 µS/cm): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very High Salinity Water (EC: >2250 µS/cm): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected.

The classification of ground water samples collected from monitoring wells for was carried out irrigation purpose and given below in **Table-7**.

It is clear from the **Table-7** that maximum number of samples (74%) falls under the category of low salinity water while nearly 19% of samples fall in medium salinity water category. This shows that the ground water in the pre-monsoon season from shallow aquifer in the district should be used for irrigation with proper soil and crop management practices.

Table-7: Classification of Ground Water for Irrigation based on EC (May 2011.

Type	**EC (µS/cm)**	**No. of Samples**	**% of Samples**
Low Salinity Water	<250	23	74
Medium Salinity Water	250-750	6	19
High Salinity Water	750-2250	2	7
Very High Salinity Water	>2250	-	-
Total		**31**	**100.0**

4.7 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area. Ground water is predominantly used for irrigation, as it is the major ground water utilising sector. As per the Minor Irrigation Census data available for year 2006-07, area irrigated by ground water is about 74.19 sq.km., whereas surface water accounts for 85.35 sq.km. The district had 7439 irrigation dugwells, which create an irrigation potential of 73.32 sq.km., out of which 71.92 sq.km., of irrigation potential is utilised. There are 89 bore wells which have created irrigation potential of 0.87 ham and potential utilised is 0.85 sq km.

State Government agencies have drilled number of borewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all till March 2007, GSDA, Government of Maharashtra was successfully operating 2653 borewells for rural water supply under various schemes in the district, out of which 297 are fitted with electric pumps and 2356 are fitted with hand pumps.

5.0 Ground Water Management Strategy

Agricultural development in the district mainly depends on rainfall. The ground water development is on the higher side. The district also faces water scarcity during summer months in spite of heavy rainfall. There is thus a need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation and rainwater conservation to provide sustainability to ground water development.

5.1 Ground Water Development

Major part of the district is covered by Basalt and Laterite. The Kaladgis and Dharwarian Metamorphics occupy comparatively less area, whereas Alluvium mainly occurs along the coast as beach sand at shallow depths. In all these formations dugwells are the most feasible structures for ground water development. The borewells sites need to be selected only after proper scientific investigation. The borewells generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation. Apart from dugwells and borewells springs also serve as a dependable source for drinking and irrigation needs as observed from study around Nadhawade and Kolusra villages. The spring water could be harnessed for the problematic villages. If one spring does not give sufficient water, water of two or more springs should be harnessed and used for water supply or co-operative based irrigation purposes. As far as possible excess spring water should not be allowed to flow in long open channels/drains instead it should be arrested and conserved through check dams/bandharas etc., so as to bring more area under irrigation. The ground water quality of springs is also suitable for domestic and irrigation purposes.

Major parts of Sindhudurg district are covered by hilly areas. In these areas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development. The overall stage of ground water development is 27.73%, thus the scope of ground water development exists in worthy areas. Further ground water development should be coupled with artificial recharge and water conservation measures, wherever feasible so as to augment the ground water resources and adoption of ground water management practices, so that the sustainable development is achieved.

5.2 Water Conservation and Artificial Recharge

A large number of water conservation structures in the form of check dams, percolation tanks and KT weirs have been constructed in the district. Till 2006, 698 Nala bunds, 221 cement bunds, 548 farm ponds and 1168 Vanrai Bandharas have been constructed in the district. The contour bunding has been carried out in 6996 hectares of land.

In hard rock area, the artificial recharge structures feasible are check dams, gully plugs, percolation tanks, nalla bunds, etc. The structures like gully plugs, contour bunds are most favourable in the hilly areas. In the highland area and wide Lateritic plateau areas, contour trenching should be carried out to arrest the surface runoff and ensure recharge of rainfall runoff into the ground water reservoir. Existing dugwells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells. These sites need to be located where the hydrogeological conditions are favourable, i.e., where sufficient thickness of unsaturated/de-saturated aquifer exists and water levels are deeper than 5 m. Occurrence of such areas are limited in the district as seen from postmonsoon water level map.

It is also observed that sufficient water is available in the rivers and streams in the post-monsoon period, hence lift irrigation schemes may be encouraged using small check dams.

6.0 Ground Water Related Issues and Problems

Even though the district receives high rainfall in the range of 2300 to 3200 mm/year, water scarcity in the non-monsoon seasons is the major issue of concern and many villages face water scarcity in the summer. In such areas in the basaltic terrain, attempts may be made to increase recharge and create additional storage spaces by employing unconventional methods like hydro-fracturing, bore blast technique, horizontal bores in dugwells along the plane of weakness etc., and artificial recharge structures. Small schemes of water conservations like storage tanks on hill tops/plateau needs to encouraged for mitigating the water scarcity situation.

The falling trend of water level in the range of 0 to 0.20 m/year is (in parts of Devgad and Kankavali talukas) and in elongated western part of the district (in parts of Malwan and Vengurla) and in southern part of the district (in parts of Sawantwadi and Dodamarg talukas).

There is a lack of efforts to harness and harvest the rain water in the region. Mass awareness programmes should be organized in large scale by district administration. Such programmes are necessary so as to educate the user regarding yielding capacity of aquifer, benefits of small water conservation schemes/efforts, appropriate crop planning and irrigation practices etc.

The district has a coastline of 121 km and has 14 creeks, about 76900 ha of agricultural land is reported to be saline due to sea water ingress along the coast and creeks. CGWB has carried out a study on sea water ingress in Mithibhao creek area of the district. About 15 ground water samples were collected from areas adjacent to the Mithibhao creek and it is observed that only 4 samples collected from 3 wadis viz., Jatewadi, Kondwadi and Yeshwantwadi which are located very close to the incomplete bund of Kharland Development Board show sea water contamination. To avoid ground water quality deterioration the existing damaged bunds/bandharas needs to be repaired in time and incomplete bunds needs to be completed by Kharland Development Board on priority basis.

7.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas fall under “Safe” category, hence till March 2009 the area has not been notified either by CGWA or SGWA.

8.0 Recommendations

1 The major part of the district is underlain by hard rocks i.e., Deccan Trap Basalt, Laterite, Dharwarian Metamorphics and Kaladgis where only dugwells are most feasible structures for ground water development.

2 The sites for borewell need to be selected only after proper scientific investigation. The borewells generally tap deeper fractures, which may not be sustainable and are not recommended for irrigation purpose. However, to cater to the drinking water requirements the borewells can be used by installing the hand pumps.

3 The falling trend of water level in the range of 0 to 0.20 m/year is (in parts of Devgad and Kankavali talukas) and in elongated western part of the district (in parts of Malwan and Vengurla) and in southern part of the district (in parts of Sawantwadi and Dodamarg talukas). In such areas dual approach of ground water development coupled with augmentation needs to be practised.

4 The spring water should be harnessed for the problematic villages especially in hilly areas. If one spring does not give sufficient water, water of two or more springs should be harnessed and used for water supply or co-operative based irrigation purposes. As far as possible excess spring water should not be allowed to flow in long open channels/drains instead it should be arrested and conserved through check dams/bandharas etc., so as to bring more area under irrigation.

5 The overall stage of ground water development is about 27.73%, thus the scope of ground water development exists in worthy areas. Further ground water development should be coupled with artificial recharge and water

conservation measures, wherever feasible so as to augment the ground water resources and adoption of ground water management practices, so that the sustainable development is achieved.

6 In spite of heavy rainfall over the area, many villages face water scarcity in the summer. In such areas, attempts may be made to increase recharge and create additional storage spaces by employing unconventional methods like hydro-fracturing, bore blast technique, horizontal bores in dugwells along the plane of weakness etc., and artificial recharge structures. Small schemes of water conservations like storage tanks on hill tops/plateau needs to encouraged in mitigating the water scarcity situation.

7 The scope exists for construction of suitable artificial recharge structures in the district in limited areas. The structures recommended for the hilly areas are: contour bunds, gully plugs, nala bunds and check dams. For other hard rock areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.

8 As sufficient water is available in the rivers and streams in the post-monsoon period for 2-3 months, lift irrigation schemes may be encouraged using small check dams.

9 The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.

10 About 76900 ha of agricultural land is reported to be saline due to sea water ingress along the coast and creeks. To avoid ground water quality deterioration by sea water ingress the existing damaged bunds/bandharas constructed along the creeks needs to be repaired in time and incomplete bunds needs to be completed by Kharland Development Board on priority basis.

11 Mass awareness programmes should be organized in large scale by district administration. Such programmes are necessary to educate the user regarding yielding capacity of aquifer, benefits of small water conservation schemes/efforts, appropriate crop planning and irrigation practices etc.