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Ground Water Flow in Virudhunagar

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Abstract
Groundwater is more vital distributed resources in the earth. Utilization and necessity of groundwater for agriculture, industries and domestic purposes are being increased in developing countries. The brochure provides detailed information about the groundwater resources in Virudhunagar district of Tamil Nadu state in India. It includes data on various aspects such as administrative divisions, population, erosion and sedimentation, land use, soil types, crops, irrigation, and groundwater quality. The report also outlines the ground water-scenario, issues and problems related to groundwater, and identifies possible solutions with regards to rainwater harvesting and artificial recharge structures in the area. The brochure is intended as a resource material for policy makers, researchers, and other stakeholders in the water resources sector.

Key words: Ground water, Well, Geohydrology, Water Conservation

Introduction
Virudhunagar District is a district (an administrative district) of Tamil Nadu state in south India. Virudhunagar is the district headquarters of Virudhunagar district. Virudhunagar district was formed by the separation of Old Ramanathapuram District G.O passed on 08,March 1985 & formed in 15,March 1985 into Ramanathapuram District, Sivagangai District and the west part as Virudhunagar District. Virudhunagar District was formerly called Karmavirer Kamarajar District. Groundwater is more vital distributed resources in the earth. Utilization and necessity of groundwater for agriculture, industries and domestic purposes are being increased in developing countries. Further, due to overgrowth of population, socio-economic development, swifting urbanization and environmental degradation, water stress has been emerged as a real threat for human lives (Kaliammal and Udayanapillai, 2016). Many places in the world have already been under severe water stress. Numerous researchers have reported their research on hydro geochemical studies of groundwater, not only in India, but also in various part of the world ((Kumaresan and Riyazuddin, 2006; Tatawat and Singh Chandel, 2007; Sadashivaiah et al., 2008; Semwal and Jangwan, 2009; Dinesh Kumar Tank and Singh Chandel, 2010; Biswajeet Pradhan and Saied Pirasteh, 2011; Senthil Kumar, et al., 2014; Shahidullah et al., 2000; Pradhan and Chandrasekharan et al., 2009; Nwankwoala and Udom 2011; Ahmed Al-ameri et al., 2012; Ghoraba and Khan et al., 2013; Ghulam Hussain, Abdullah Al-Zariah and Latif, 2014). The quality of groundwater is highly affected spatially and temporally by various factors such as lithology, aquifer chemistry, rock-water interaction and its circulation, microbial action, pollution and seawater intrusion (Udayanapillai et al, 2012). These complex processes which make various hydro geochemical characterization, occurring in wide range of lithology from the age of Archaean crystalline rock to Recent alluvium.

DISTRICT AT A GLANCE (VIRUDUNAGAR DISTRICT)

S. No.	ITEMS	STATISTICS	
1.	**GENERAL INFORMATION**		
	i. Geographical area (Sq. km)	**4243.23**	
	ii. Administrative Divisions (As on 31-3-2007) Number of Taluks Number of Blocks Number of Villages	 8 11 600	
	iii. Population (2001 Census) Total Population Male Female	 1751301 870376 880925	
	iv. Average Annual Rainfall (mm) (1901-2000)	799.8	
2.	**GEOMORPHOLOGY**		
	i. Major physiographic Units	Structural hills, Deep Burried Pediments, Shallow Burried Pediments, Bazada and Flood Plain .	
	ii. Major Drainages	Vaippar, Gundar, & Arjuna Nadhi.	
3.	**LAND USE (Sq. km) (2005-06)**		
	i. Forest area ii. Net area sown iii. Cultivable waste	264.66 1428.82 96.63	
4.	**MAJOR SOIL TYPES**	1. Deep red loam, 2. Black soil, 3. Red sandy soil.	
5.	**AREA UNDER PRINCIPAL CROPS (Ha) (2005-2006)(Figures is bracket are % to the total Geographical area of the district)**	1. Paddy -30433 (50.6%) 2. Groundnut – 467 (0.78%) 3. Pulses – 467 (0.78%) 4. Sugarcane – 3209 (5.33%)	
6.	**IRRIGATION BY DIFFERENT SOURCES (2005-06)**	**Number**	**Area irrigated (Ha)**
	i. Dug wells	36087	33765
	ii. Tube wells	0	0
	iii. Tanks	997	26423
	iv. Canals	0	0
	vi. Net irrigated area	55365 Ha	
	vii. Gross irrigated area	60188 Ha	
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.03.2007)**		
	i. Number of dug wells	12	
	ii. Number of piezometers	11	
8.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Recent Alluvium, Sandstones, Gneisses Complex, Basic metamorphic rocks, Granites and Charnockites.	
9.	**HYDROGEOLOGY**		
	i. Major water bearing formations	Sandstone, weathered & fractured granitic gneisses etc.	
	ii. Pre- monsoon depth to water level (May 2006) (m. bgl)	0.67 – 12.12	
	iii. Post- monsoon depth to water level (Jan 2007) (m. bgl)	0.49 – 8.78	
	iv. Long term water level trend in 10 years (1998-	**Annual**	

	2007) in (m/year)	**Rise**	**Fall**
		Min : 0.0009 Max :0.3944	Min : 0.0635 Max :0. 2693
10	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2007)**		
	i. Number of Exploratory wells ii. Number of Observation wells iii. Number of Piezometers under Hydrology Project.	26 5 11	
	iv. Depth range (m bgl)	120 – 200	
	v. Discharge (lps)	0.004 – 1.142	
	vi. Storativity (S)	3.41×10^{-5} -0.7×10^{-2}	
	vii. Transmissivity (m^2/day)	1 – 518.3	
11	**GROUND WATER QUALITY(As on MAY 2006)**		
	i. Presence of chemical constituents more than permissible limit	Cl , F & TH as $CaCO_3$ & NO_3.	
	ii. Type of water	Ca-Cl , NaCl & Ca-HCO_3	
12	**DYNAMIC GROUND WATER RESOURCES (As on 31.03.2004) in MCM**		
	i. Annual Replenishable Ground Water Resources	469.78	
	ii. Total Annul Ground Water Draft for all purposes	312.51	
	iii. Projected demand for Domestic and Industrial Uses up to 2029	271	
	iv. Stage of Ground Water Development	67 %	
13.	**AWARENESS AND TRAINING ACTIVITY**		
	i. Mass Awareness Programmes Organized		
	Year	2002-03	
	Place	Rajapalayam.	
	Number of Participants	300	
	ii. Water Management Training Organized		
	Year	2002-03	
	Place	Rajapalayam.	
	Number of Participants	30	
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	Technical Guidance were provided as when sought	
	i. Projects completed by CGWB Number of structures ii Amount spent	Vadapatti in Sivakasi Block. Rs 6.510 (Lakhs)	
15.	**GROUND WATER CONTROL AND REGULATION**		
	i. Number of OE Blocks	1	
	ii. Number of Critical Blocks	1	
	iii. Number of Blocks Notified	**Nil**	
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	i) Virudhunagar district is characterised by relatively high level of ground water development in both hard rock and sedimentary aquifers. ii) Presence of Black Clayey Soils has resulted in reduced natural recharge to groundwater system iii) It has also resulted in water quality problem iv) Water scarcity in part of the district due to unfavorable hydrogeological set up.	

Administrative Details

Virudhunagar district is divided into 8 taluks. The taluks are further divided into 11 blocks (Plate-I), which further divided into 600 villages.

Table 2 Taluk and village of the district

S. No.	Taluk	No. of Villages	Block	No. of Villages
1	Srivilliputtur	54	Srivalliputtur	31
			Watrap	23
2	Rajapalayam	35	Rajapalayam	35
3	Virudhunagar	59	Virudhunagar	59
4	Sattur	47	Sattur	47
5	Aruppukottai	40	Aruppukottai	40
6	Thiruchuli	192	Thiruchuli	100
			Narikudi	92
7	Kariyapatti	108	Kariyapatti	108
8	Sivakasi	65	Sivakasi	29
			Vembakottai	36
	Total	**600**		**600**

Basin and sub-basin

The district is part of the composite east flowing river basin, "Between Gundar and Vaippar" as per the Irrigation Atlas of India. Vaippar, Arjuna River, Gundar, and Deviar, Nichibanadhi, Kovilur and Periyar are the important Sub-basins/Watersheds.

Drainage

The major part of Virudhunagar district falls in Vaippar - Gundar river basin. Vaippar, Arjuna River, Gundar and Deviar are the important rivers. The drainage pattern, in general, is dendritic. All the rivers are seasonal and carry substantial flows during monsoon period. Vaippar, which is one of the important rivers of the district, flow and drain in the Vembakkam and Sattur blocks. The Arjuna river, flowing in the central part of the district, has its origin from the Sattur Watrap Hills and is formed by Kovillar, periyar and Chittar rivers. The Gundar river originates at an altitude of 500 m. amsl near Kottaimalai of Saptur reserve forest in Varushanadu hills in Madurai district

1. 4. Irrigation Practices

The nine-fold lands use classification (2005-06) for the district is given below.

Table 3 Irrigation practices in district

S. No.	Classification	Area (Ha)
1	Forests	26466
2	Barren & Uncultivable Lands	4525
3	Land put to non agricultural uses	70286
4	Cultivable Waste	9663
5	Permanent Pastures & other grazing lands	804
6	Groves not included in the area sown	6568
7	Current Fallows	3063
8	Other Fallow Lands	160066
9	Net Area sown	142882
	Total	**424323**

(Source: Department of Economics & Statistics, Govt. of Tamil Nadu)

The chief irrigation sources in the area are the tanks, wells and tube/bore wells. Reservoirs and Tank irrigation is highest in Srivalliputtur, Thiruchuli and Kariyapatti blocks followed by Aruppukottai, Rajapalayam, Sivakasi, Sattur, and Virudhunagar blocks.

The block-wise and source- wise net area irrigated (2005-06) (in Ha) is given below

S. No.	Block	Net area irrigated by					Total Net Area irrigated
		Canals	**Tanks**	**Tube/ Bore wells**	**Ordinary wells**	**Other Sources**	
1	Srivilliputtur	0	1056	4211	439	0	5706
2	Watrap	0	1259	1983	4017	0	7259
3	Rajapalayam	32	2581	2794	1848	15	7270
4	Virudhunagar	98	289	6517	4679	0	11583
5	Sattur	0	650	1417	881	0	2948
6	Aruppukottai	7	481	764	3192	0	4444
7	Thiruchuli	20	1307	769	4678	0	6774
8	Narikudi	253	275	2881	1006	0	4415
9	Kariyapatti	313	1822	484	407	813	3839
10	Sivakasi	28	4756	7797	721	358	13660
11	Vembakottai	0	315	1716	542	93	2666
	Total	**751**	**14791**	**31333**	**22410**	**1279**	**70564**

(Source: Department of Economics & Statistics, Govt. of Tamil Nadu)

Central Ground Water Board carried out the Systematic hydrogeological surveys in the district during the period of 1976 - 80, Reappraisal hydrogeological surveys were conducted during the period of 1990 - 95, Detailed exploration were carried out in Vaippar and Gundar basin down to a depth of 200 m bgl to assess the ground water resources of the area. The exploratory drilling of boreholes (26 Nos.) was revealed that the weathered and fracture zone is limited to 25 to 35 m below ground level. The fracture encountered at deeper depths are not productive due to poor yield with higher draw downs. In the sedimentary area of this district the thickness of Alluvial and Tertiary formation ranges from 35 to 50 m.

CGWB is monitoring the groundwater regime for the changes in water levels and water quality through 12 dug wells and 11 piezometers. The monitoring of water levels are carried out during May (Pre monsoon), August (Middle of south west monsoon), November (Post south west monsoon) and January (Post northeast monsoon) to study the impact of rainfall on groundwater regime. Water samples are collected during May for determining the changes in chemical quality of groundwater.

GROUND WATER SCENARIO

Hydrogeology: The district is underlain by both porous and fissured formations (Plate-II). Unconsolidated & Semi-consolidated formations and Weathered, Fissured and Fractured crystalline rocks constitute the important aquifer systems in the district. The porous formations in the district include sandstones and clays of Recent to subrecent and Tertiary age (Quaternary).The alluvial formations comprising mainly sands, clays and gravels are confined to major drainage courses in the district. The maximum thickness of alluvium is 35.0 m. whereas the average thickness is about 25.0 m. Ground water occurs under phreatic to semi-confined conditions in these formations and is being developed by means of dug wells and filter points. Alluvium, which forms a good aquifer system along the Vaippar and Gundar river bed, which is one of the major sources of water supply to the villages.

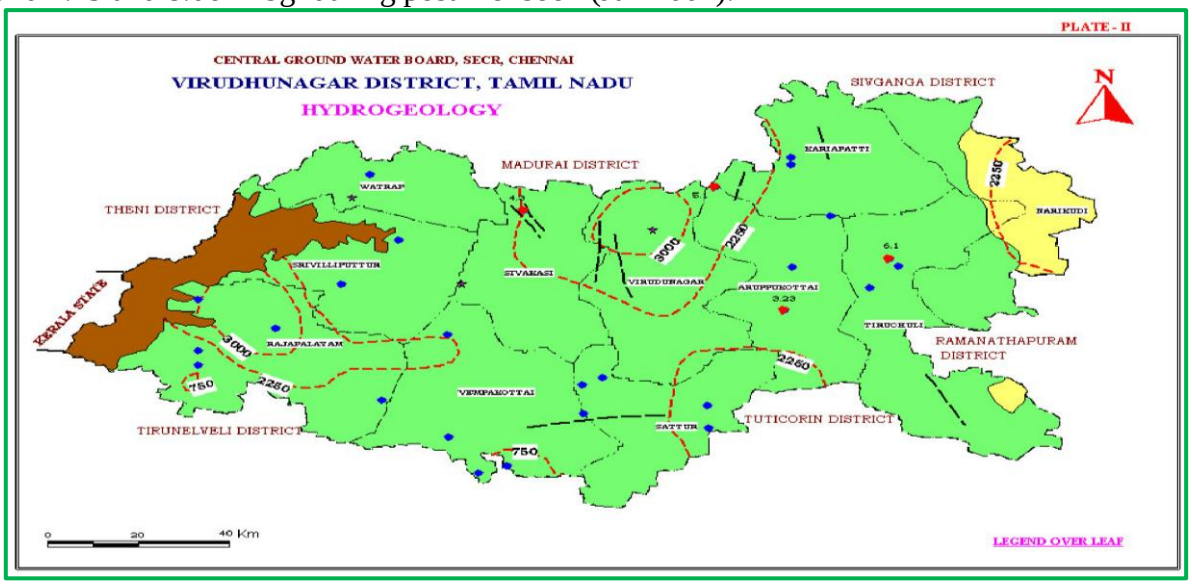
The water-bearing properties of crystalline formations, which lack primary porosity, depend on the extent of development of secondary intergranular porosity . The occurrence and movement of ground water in these rocks are generally confined to such spaces. These

aquifers are highly heterogeneous in nature due to variation in lithology, texture and structural features even within short distances. Ground water generally occurs under phreatic conditions in the weathered mantle and under semiconfined conditions in the fissured and fractured zones at deeper levels.

The thickness of weathered zone in the district is in the range of 4 to 15 m. The depth of dug wells ranged from 10 to 15 m bgl. The yield of large diameter wells in the district, tapping the weathered mantle of crystalline rocks ranges from 40 to 110 lpm and are able to sustain pumping for 2 to 6 hours per day. The Specific capacity of large diameter wells tested in crystalline rocks ranges from 6.26 to 183.8 lpm / m. of drawdown. The yield characteristics of wells vary considerably depending on the topographic set-up, lithology and nature of weathering.

The yield of bore wells drilled down to a depth of 40 to 70 m, by various state agencies mainly for domestic purposes ranged from 10 to 250 lpm. The yield of successful bore wells ranged up to 6 lps for the drawdown varying between 5.76 and 17.56 m and drilled down to a depth of 200 m bgl during the ground water exploration programme of Central Ground Water Board..

The depth to water level in the district varied between 0.67 and 12.12 m bgl during pre-monsoon (May 2006) and varied between 0.49 and 8.78 m bgl during post monsoon (Jan 2007). The seasonal fluctuation shows a rise in water level which ranges from 0.35 to 2.8 m. The piezometric head varied between 3.49 and 16.23 m bgl during pre monsoon (May 2006) and 1.29 and 8.06 m bgl during post monsoon (Jan 2007).



Hydrogeology of Virudhunagar district (Department of Economics & Statistics, Govt. of Tamil Nadu)

Long Term Fluctuation (1998-2007): The long term water level fluctuation for the period 1998-2007 is indicates rise in water level in the range of 0.0009 - 0.3944 m/year. The fall in water level ranging between 0.0635 and 0.2693 m/year.

Aquifer Parameters

Formation	Transmissivity (m^2/day)	Storativity		Specific Yield (%)
Weathered Crystallines	-	-		<2
Fractured Crystallines	1-548	$3.41X10^{-5}$	to	-
		$7.0X10^{-3}$		

Ground Water Resources: The ground water resources have been computed jointly by Central Ground Water Board and State Ground & Surface Water Resources and Data Centre

(PWD, WRO, Government of Tamil Nadu) as on 31st March 2004. The salient features of the computations are furnished below. The computation of ground water resources available in the district has been done using GEC 1997 methodology.

Block	Net Groundwater Availability (M.Cu.m)	Existing Gross Draft for Irrigation (M.Cu.m)	Existing Gross Draft for Domestic and industrial water supply (M.Cu.m)	Existing Gross Draft for all uses (M.Cu.m)	Allocation for Domestic and Industrial Requirement supply upto next 25 years (2029) (M.Cu.m)	Net groundwatre Availability for future Irrigations Development (M.Cu.m)	Stage of Groundwater Development (%)	Category of Block
Srivilliputtur	45.30	36.89	20.40	38.93	23.3	62.8	86	Semi Critical
Watrap	52.27	49.03	25.80	51.6	26.8	0.55	99	Critical
Rajapalayam	67.37	65.48	20.2	67.5	21.1	-0.22	100	Over Exploited
Virudhunagar	36.17	14.20	30.4	17.24	31.7	18.80	48	Safe
Sattur	26.13	87.60	19.30	10.69	20.1	15.36	41	Safe
Aruppukottai	26.33	86.30	18.00	10.43	18.8	15.82	40	Safe
Thiruchuli	47.35	19.87	18.00	21.66	18.7	25.61	46	Safe
Narikudi	59.86	25.94	16.8	27.62	17.5	32.16	46	Safe
Kariyapatti	50.36	25.93	19.1	27.84	20.0	22.43	55	Safe
Sivakasi	31.82	18.85	46.30	23.48	48.3	8.14	74	Semi Critical
Vembakottai	26.82	13.14	23.7	15.51	24.7	11.22	58	Safe
Total	**469.78**	**443.23**	**258.00**	**312.5**	**271.00**	**212.67**	**66.52**	

Ground Water Quality: The chemical characteristics of ground water in the phreatic zone in Virudhunagar district has been studied using the analytical data of ground water samples collected from Ground water monitoring wells of Central Ground Water Board. The study of quality of ground water in deeper aquifers in the district has been attempted using the data collected from exploratory bore/tube wells constructed in the district. Ground water in phreatic aquifers in Virudhunagar district, in general, is colourless, odorless and slightly alkaline in nature. The specific electrical conductance of ground water in phreatic zone (in Micro Seimens at 25° C) during May 2006 was in the range of 409 to 4350 in the district. It is between 750 and 2250 µS/Cm at 25° C in the major part of the district. Conductance below 750 µS/Cm at 25° C have been observed in ground water in parts of Sattur and Watrap blocks, whereas conductance exceeding 2250 µS/Cm at 25° C have been observed in part of Rajapalayam and Virudhunagar blocks. It is observed that the ground water is suitable for drinking and domestic uses in respect of all the constituents except Total Hardness and Nitrate. Total Hardness as $CaCO_3$ is observed to be in excess of permissible limits of treating water standard of BU in about 49 percent of samples analyzed whereas Nitrate is found in excess of 45 mg/l in about 30 percent samples analyzed. The incidence of high Total Hardness is attributed to the composition of lithounits constituting the aquifers in the district.

Whereas the Nitrate pollution is most likely due to the use of pesticides and fertilizers for agriculture. With regard to irrigation suitability based on specific electrical conductance and Sodium Absorption Ratio (SAR), it is observed that ground water in the phreatic zone may cause high to very high salinity hazard and medium to high alkali hazard when used for irrigation. Proper soil management strategies are to be adopted in the major part of the district while using ground water for irrigation.

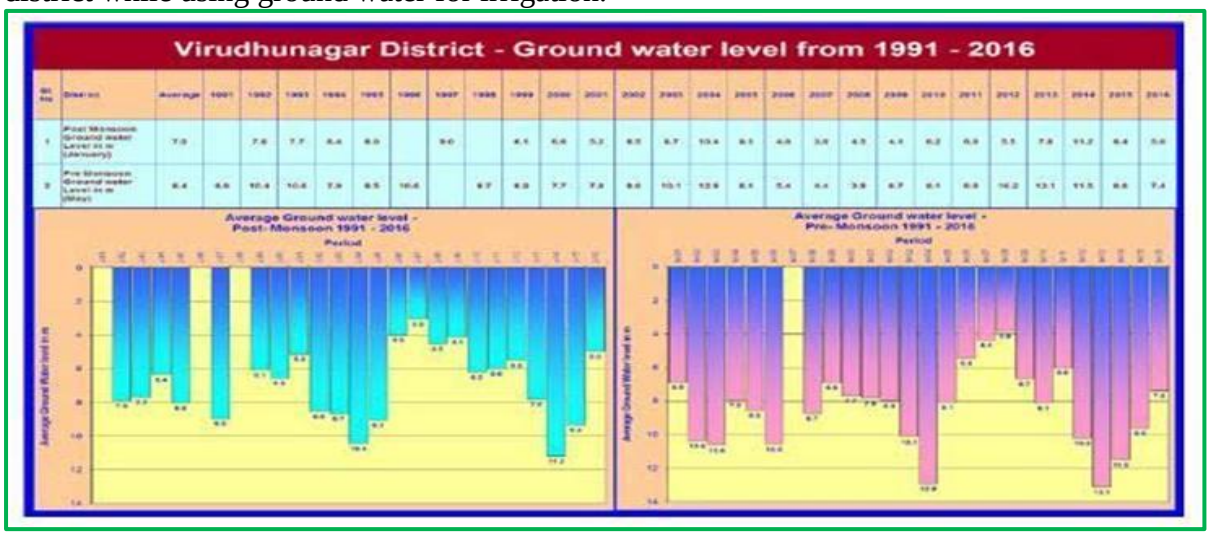
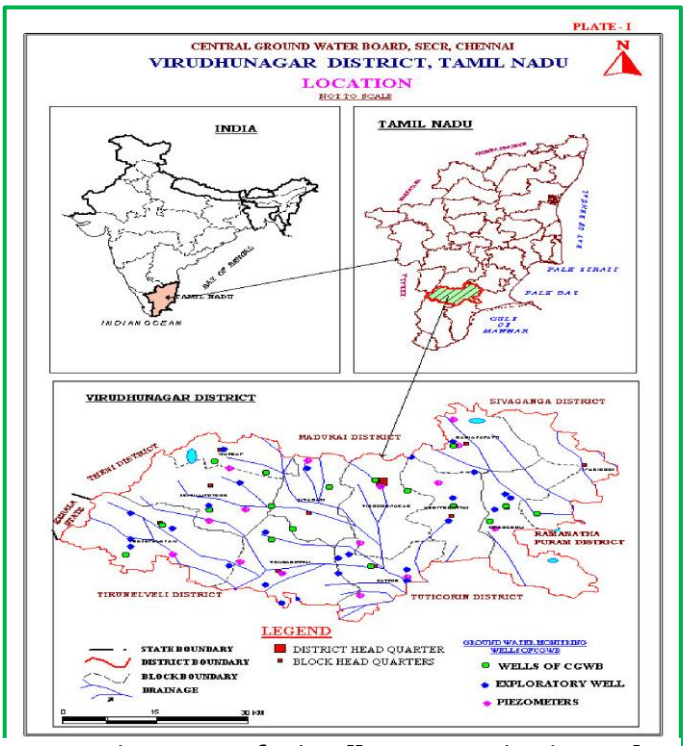


Fig 1.2 Ground water level of Virudhunagar district

Status of Ground Water Development

The estimation of groundwater resources of the district shows that one block is over exploited and one block is under "critical" category. The shallow alluvial aquifers along Vaippar and Gundar rivers serve as an important source of drinking water and irrigation development of Virudhunagar district. Dug wells are the most common ground water abstraction structures used for irrigation in the district. The yield of dug wells range from <50 to 200 m^3/day in weathered crystalline rocks, 20 to 100 m^3/day in Tertiary formations and upto 400 m^3/day in Recent alluvial formations along major drainage courses. The dug wells in hard rock terrain tapping the entire weathered residuum are capable of yieldin6 – 7 lps, requiring the installation of 5 HP centrifugal pumps for extraction of ground water.



Location Map of Virudhunagar District and Ground water monitoring of district

GROUNDWATER MANAGEMENT STRATEGY

Groundwater Development: In view of the presence of balck top soil in the major parts of the district, the recharge potentials are very low an dit has also resulted in quality problem. Hence, it is necessary to exercise causion while planning further devlopment of available groundwater resources in the district. The yields of dug wells in crystalline and Tertiary

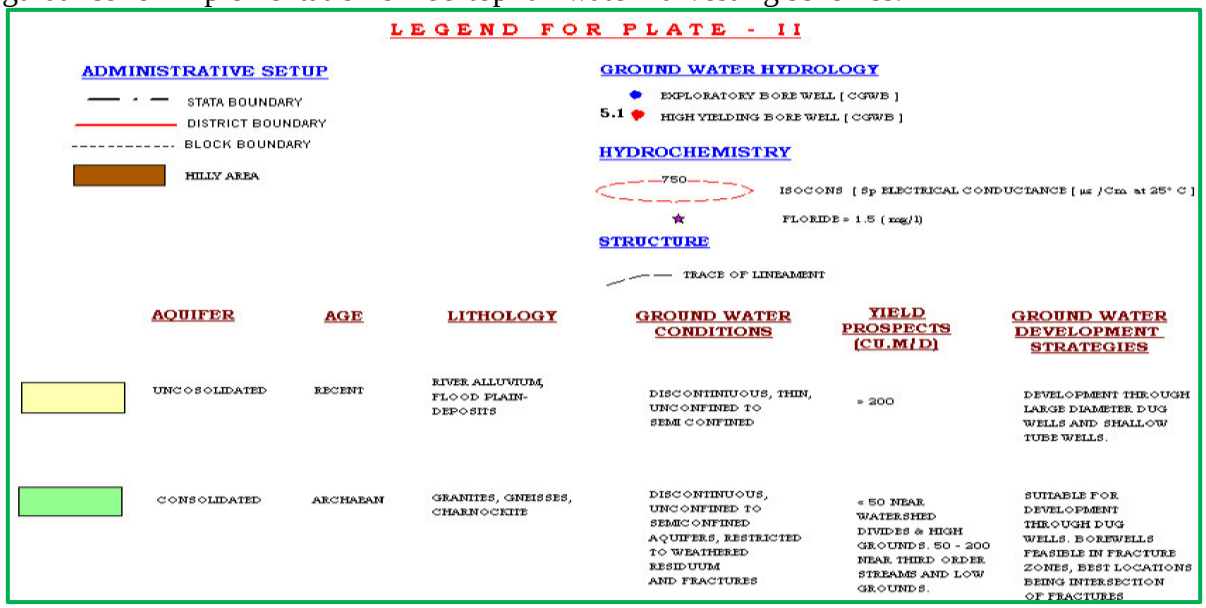
formations can be improved at favorable locations by construction of extension bores and radial arms respectively to a length of 20-30 m. In recent years, farmers for irrigation purposes have also drilled a large number of bore wells.The development of ground water for irrigation in the district is mainly through dug wells tapping the weathered residuum or recent alluvial deposits. Bore wells have also become popular as the source for irrigation in the district in recent years. Dug wells with extension bores wherever necessary is ideal for hard rock areas whereas large diameter dug wells with radials is suitable for alluvial areas.

The map showing the development prospects for the district is shown in Plate- VI.

Water Conservation and Artificial Recharge: CGWB had prepared a master plan to augment groundwater potential by saturating the shallow aquifer taking into consideration the available unsaturated space during post monsoon and available uncommitted surplus run off. Subsequently, computations have been made for Drought Prone Area Program (DPAP) for over exploited and critical blocks in the districts warranting immediate attention. Institute of Remote Sensing, Anna University had prepared block wise maps demarcating potential zones for artificial recharge for the State of Tamil Nadu. Subsequently, State Government agencies have constructed artificial recharge structures with their own fund or with fund from Central Government, dovetailing various government programs.

Ministry of Water Resources, Government of India has initiated Dug Well Recharge Scheme in the State. The scheme is being implemented by the Nodal Department (SG&SWRDC, PWD, WRO, Government of Tamil Nadu) with the technical guidance of CGWB. The subsidy of Rs. 4000/- for small and marginal farmers and Rs. 2000/- for the other farmers is credited to the beneficiaries' bank account through NABARD. The scheme after implementation will prove to be beneficial to the irrigation sector. The available uncommitted surplus run off has to be recomputed, taking into consideration the quantum of recharge effected through existing irrigation dug wells also. The existing structures and uncommitted surplus flow should be considered for further planning of artificial recharge program.

On the basis of experimental studies, it has been found that de-silting of existing tanks followed by percolation pond with recharge wells, recharge shafts are economical. There is considerable scope for implementation of roof – top rainwater harvesting in the district. Recharge pits / Shafts / trenches of suitable design are ideal structures for rainwater harvesting in such areas. Central Ground Water Board is also providing free technical guidance for implementation of rooftop rainwater harvesting schemes.



Ground water hydrology of Virudhunagar district

GROUND WATER RELATED ISSUES & PROBLEMS

In view of the top black soil in the major parts of the district, the recharge potentials are very low and it has also resulted in water quality problems.

AWARENESS & TRAINING ACTIVITY

Mass Awareness Campaign (MAP) & Water Management Training Programme (WMTP) by CGWB: One Mass Awareness Campaign on "Ground Water Management, Regulation & Conservation" was organized at Rajapalayam, Virudhunagar district during the period 2002-03 . One WMTP was organized on "Rain Water Harvesting Training" at the meeting hall of District Collectorate complex, Rajapalayam in Virudhunagar district during the period 2002-03.

AREA NOTIFIED BY CGWA/SGWA

Central Ground Water Authority has not notified any area in the district. Government of Tamil Nadu vide G.O. No. 53 has banned groundwater development for irrigation in the over exploited blocks of Tamil Nadu. The over exploited block in this district is Rajapalayam

RECOMMENDATIONS

In view of the top black soil in the major parts of the district, the recharge potentials are very low and it has also resulted in water quality problems. In order to increase the recharge, tanks, percolation ponds may be provided with the recharge wells/recharge shafts penetrating this impervious layer to make it more effective in recharging the aquifer. Waste land development program and micro irrigation system area to be implemented for increasing the agricultural produces to attain more food and income per drop of water in view of the limited water resources in the districts.

DISTRICT – VIRUDUNAGAR OVERVIEW

		Wells Feasible	Rigs Suitable	Depth of Well (mbgl)	Discharge (LPM)	Suitable Artificial Recharge Structures
Soft Rock Aqu	ifer	Dug Well	Manual	10-15	10 - 60	Percolation Ponds With Recharge Shaft
Hard Rock Aqu	ifer	Dug Well	Manual	10-15	10 - 60	Check Dams/ Percolation Ponds With Recharge Shaft
Hard Rock Aqu	ifer	Dug Well Dug Cum Bore Well Bore Well	Manual Manual + DTH DTH	10-15 10 - 15+40 60-90	60 - 180	Check Dams/ Percolation Ponds With Recharge Shaft
District Boundary				Block Boundary		
District Headquarter				Block Headquarters		
5		Water Level-Pre-Monsoon (Decadal Mean 1993-2002) Mbgl		1250		Ec in Microsiemens / Cm at 25° C
River				Lineament		
Hilly Area				Nitrate Greater Than Maximum Permissible Limit (45 mg/l)		

OTHER INFORMATION

Geographical Area	4243.23 Sq. Km.
Number of Blocks	11
Major Drainage	Vaipar Gundar & Arjuna Nadhi
Population (2001)	17,51,301
Average Annual Rainfall	799.8 Mm
Annual Range of Temperature	24 –40° C
Regional Geology	**Soft Rocks: Clay, Sandstone & Shale** **Hard Rocks:** Granites & Gneisses
Net Ground Water Availability for Future Irrigation	212.67 MCM/Yr
Stage Of Ground Water Development As on January 2003	66.52 %
Name of Blocks Showing Intensive Ground Water Development ☆	**Over Exploited** Rajapalayam **Critical**: Watrap

Conclusion

The article concludes that the groundwater resources in Virudhunagar district face significant challenges, including water quality problems, over-exploitation, and low recharge potential due to the presence of black soil. The report suggests solutions such as rainwater harvesting and artificial recharge structures to address these challenges. Proper groundwater management strategies should be adopted in the area to ensure sustainable utilization of the available resources. The brochure provides information that can help policy makers, re searchers, and other stakeholders in the water resources sector to analyze the situation and identify further areas for study and action.

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