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Original Research Paper

Rainfall Intensity and Quantity of Groundwater Along the Coastal Area of Kanyakumari to Colachel, South Tamil Nadu Before and After Tsunami

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ABSTRACT

Rainfall intensity and groundwater quantity in Coastal area of Kanyakumari to Colachel coastal belt after Tsunami was used to assess the capacity of groundwater for determining its suitability for drinking and agricultural purposes. Physical and chemical parameters of groundwater were also analysed based on the rainfall intensity. In Kanyakumari district, the surface water resources have been fully utilized. The surface flow is more during monsoon periods. The deficient monsoon rainfall has affected the flow of surface water into reservoirs, anacuts, lakes, etc. Surface water and rainwater are widely used for irrigation. Consequently, agriculturists have to a great extent depend upon an alternate source, viz., groundwater for irrigation requirements. Groundwater in the area is generally very good, pleasant, fresh to brackish, average to very low saline and low alkaline in nature and fit both for agriculture and drinking purposes. Permissible average total hardness and TDS in all places of the study area identify the suitability of groundwater for drinking and irrigation. In the study area less groundwater extraction keeps the water table high. The elevated topography, more rainfall and limited groundwater extraction, keeps the Kanyakumari coastal belt free from sea water intrusion. Quantity of water is generally good throughout the district due to continuous rain fall in all monsoon seasons. Comparing the results of water quantity like surface water and subsurface water before and after Tsunami there is not much change in the quantity.

INTRODUCTION

Capacity of groundwater is equally important to its quantity owing to the suitability of water for various purposes. Water quantity analysis is an important issue in groundwater studies. Variation of groundwater quantity in an area is a function of intensity of rainfall, i.e., surface and subsurface flow of water. Knowledge on surface and subsurface flow of water is more important to assess the quality of groundwater for understanding its suitability for various needs.

Previous investigations in the Coastal area of Kanyakumari district in south Tamil Nadu include groundwater estimation by Ground and Surface water Resources, Water Resources Organization, Public Works Department (1970-2005) and Government of Tamilnadu, Chennai (1973 to 2004).

In order to know the interrelationship among rainfall, run-off and infiltration, the small water-sheds located in different soil types are under observation by setting up meteorological stations. There is only one meteorological station at Aralvaimozhi, which is continuously monitored and the data relating to rainfall, temperature, evaporation, wind velocity and soil moisture accumulations

etc. are collected. The data collected are helpful to establish various parameters which are useful to assess groundwater potential.

However, as groundwater in the coastal belt of Kanyakumari to Colachel area is affected by Tsunami on 26th December 2004, it is essential to assess the quantity and suitability of groundwater for drinking and agricultural uses after Tsunami. Hence, the present work has the objective of understanding the quantity of hydrogeochemical constituents of groundwater related to its suitability and quantity for agriculture and drinking use after Tsunami. Hard rock terrain with network of irrigation system and less groundwater extraction keeps the water table high in the coastal belt. The elevated topography, more rainfall and limited groundwater extraction keeps the Kanyakumari coastal belt free from shortage of groundwater quality .

MATERIALS AND METHODS

Description of the study area: Kanyakumari district covers an area of 1671.84 km^2 in which along the coastal belt 70 km length and 5 km width Kanyakumari to Colachel coastal belt is taken as study area after Tsunami in December 2004 (total study area 350 sq. km).

The average annual rainfall of the basin is about 1448 mm. The northeast monsoon from October to December contributes almost 538 mm, and the southwest monsoon from June to September almost 538 mm. During hot whether period from March to May rainfall is 326 mm, and during winter in January and February the rainfall is 45 mm in the study area (Fig. 1). Cultivation is due to river basins like Pazhayar, Valliyar and Tamiraparani.

The whole area is generally undulated with ups and downs, slopping towards different directions. All major rivers originate from the Western Ghats and flow towards southeast. Wind velocity generally reach maximum in July-August indicating the setting of monsoon over the district. The maximum wind speed of 17.74 km/hr is recorded during August, and the minimum of 5.53km/hr during December. Humidity in the area is generally high recorded during May of 95%, whereas the minimum during February of 45%.

Terrain and topography details: Catchment area of the watershed is surrounded by hills on the western side of Nagercoil-Tirunelveli Road. Run-off gauge posts were installed at the inlet and outlet of the watershed. An automatic water level recorder was installed at the outlet of the water shed to record run-off during flood hours automatically.

The basement of the study area consists of charnockite, granite gneiss, leptinite, leptinite gneiss, peninsular gneiss, laterite, warkalai sandstone, variegated clay, and river alluvium, etc.

Time of observation: All the observations were recorded, both at 8.30 a.m and 5.30 p.m., daily and charts were changed every day morning at 8.30 a.m. in rain gauge, sunshine recorder and actinography. Weekly charts were changed in automatic water level recorder, thermograph and hygrograph. The soil moisture content was found on all days of the year.

RESULTS AND DISCUSSION

Water level study: Monitoring groundwater levels form an important component of groundwater survey. The water level fluctuations reflect the change in groundwater storage. For this purpose, 172 wells spread over the entire coastal area of Kanyakumari to Colachel are under observation during the first week of every month. The study of water level fluctuation helps to assess the gravity of situation in times of drought and also to take appropriate remedial measures (Freeze & Cherry 1979).

Weathered zone thickness of the study area generally ranges from 10 m to 35 m below ground level. The groundwater of the area occurs under unconfined conditions. Rainfall infiltration and seepage of water from surface water bodies are responsible for groundwater actuation. Most of the wells used for irrigation are shallow and partially penetrating because once a considerable depth of water column is reached, farmers stop further deepening of wells.

Hydrographs indicate that the groundwater table tends to rise during October and December to reach peak and starts receding from February onwards to the end of August to September. However, a slight raising trend is seen during July because of southwest monsoon rain. The average annual rainfall of this district, 70 years is 1448.6 mm. The seasonwise rainfall at selected rain gauge stations is given in Table 1. There are 22 rain gauge stations spread over the district of which 12 rain gauge stations are selected as 70 year rainfall data are available. A general over all view of rainfall pattern recorded in the different rainfall stations indicate that the precipitation varies from 764.30 mm to 208.30 mm. Most of the rainfall occurs during NE and SE monsoon periods. The seasonal normal rainfall for selected rain gauge stations are given in Table 2, which reveals that the quantum of precipitation during the southwest and northeast monsoon is more or less equal. The contribution of southwest monsoon and northeast monsoon is 37.16 and 37.18 percent of the annual rainfall respectively.

Analysis of seasonal and annual rainfall data for 70 years (1973-2002) indicates that the coefficient of variation of annual rainfall is in the range of 764.3 to 2083.3 percent. The variability of seasonal rainfall is comparatively much higher. As per meteorological standards, deviation of plus 20 percent or more is excess, minus 19 percent or plus 19 percent is normal, minus 20 percent to minus 60 percent is deficient, and less than minus 60 percent is scanty. Between the period considered from 1971 to 1980 in excess rainfall recorded in different stations, but between 1982 to 1990 excess rainfall is not recorded. The annual rainfall of the above stations varies from 764.30 mm to 2083.30 mm (Rammohan 1984).

Field data: Groundwater levels were studied from 172 representative open wells and 3 PWD wells during July 2005 , July 2006 and July 2007 at regular intervals.

Groundwater occurs in almost all the geological formations in the district namely crystalline rocks, sedimentary formations, quaternary alluvium and beach sands and is developed by dug wells, dug-cum-bore wells and bore wells. The entire Kanyakumari district is covered by hard rock forma-

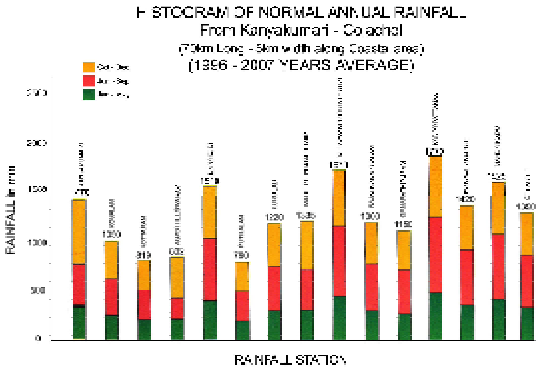

Fig.1: Normal annual rain fall.

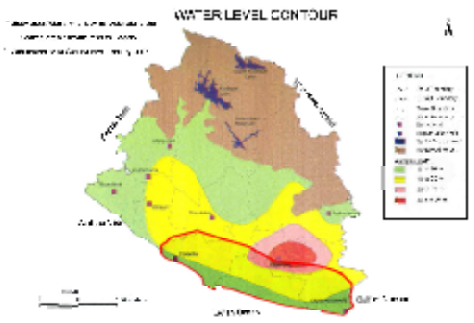

Fig. 2: Water level contour.

tion like charnockite and gneisses. The groundwater occurrence is limited to only weathered mantle of the hard rock. The weathered thickness ranges generally from 10 m to 35 m below ground level. The groundwater occurrence is also limited 10 m to 30 m below ground level. Weathering is quiet higher in granite gneissic rock rather than charnockite. Hence, the groundwater occurrence is also higher in gneiss than charnockite. The groundwater occurs under water-table conditions in valley-fill sediment area. These bajada and valley-fill area have alluvial deposit for a depth of 10 to 15 m followed by highly weathered formation up to 20 to 30 m below groundwater level. The water table is very shallow. In alluvial formation, the groundwater occur under water table conditions (Figs. 3a, 3b). These formations are highly porous and permeable. However, the thickness of alluvium is very shallow.

Table 1: Seasonwise normal rainfall (70 Years) at selected rain gauge stations in Kanyakumari to Colachel coastal area.

Seasons	Period	Rainfall in mm	Percentage
Winter	Jan. and Feb.	45.4	3.13
Hot weather period	Mar. to May	326.3	22.53
South-west monsoon	June to Sept.	538.3	37.16
North-east monsoon	Oct. to Dec.	538.6	37.18
	Total	1448.6	100.00

Water table fluctuation: By establishing a network of observing wells spread-over the district, the fluctuation in groundwater level is monitored every month. The groundwater level reached the lowest level in hottest periods after which it starts rising to reach highest peak, a little after the end of rainy season. The rise and fall depends upon the amount, duration and intensity of precipitation, depth of weathering, specific yield of the formation, etc.

A general overall view of the water level fluctuation suggests that the water level tends to rise during October to December to reach the peak and starts receding from February onwards to the end of August to September. However, a slight raising trend is seen during July because of southwest monsoon rain.

Water table contours are shown indicating water level conditions (Fig. 2). In general, water level conditions are improved in the month of January, i.e., in post-monsoon period. However, general water level conditions during past 10 years are in safe and more than sufficient (Fig. 4).

Table 2: Seasonal normal rainfall for selected rain gauge stations in Kanyakumari to Colachel coastal area.

Sl.No	Raingauge Stations	Jan to Feb	Mar to May	June to Sep	Oct to Dec	Normal Rainfall Annual	Average Years
1.	Kanyakumari	55.6	185.1	298.9	454.8	994.4	70
2.	Agastheeswaram	34.0	282.7	466.1	468.4	1251.2	70
3.	Manakudi	47.0	391.0	636.6	623.3	1697.9	70
4.	Kottaram	35.1	161.0	196.0	372.2	764.3	70
5.	Kurusadi	32.8	320.8	563.7	465.4	1382.7	70
6.	Rajakamankalam	46.7	354.0	621.2	599.1	1621.0	70
7.	Madusudanapuram	40.5	342.1	546.4	540.6	1469.6	70
8.	Nagercoil	37.7	251.3	381.0	450.9	1120.9	70
9.	Ethamozhi	65.5	481.8	852.5	683.5	2083.3	70
10.	Monday market	54.4	438.3	741.8	667.2	1901.7	70
11.	Mondaikaddu	46.1	366.5	662.6	589.7	1664.9	70
12.	Colachel	49.4	341.2	493.6	548.1	1432.3	70
	Average	45.4	326.3	538.3	538.6	1448.6	
	Total	544.8	3915.8	6460.4	6463.2	17384.2	

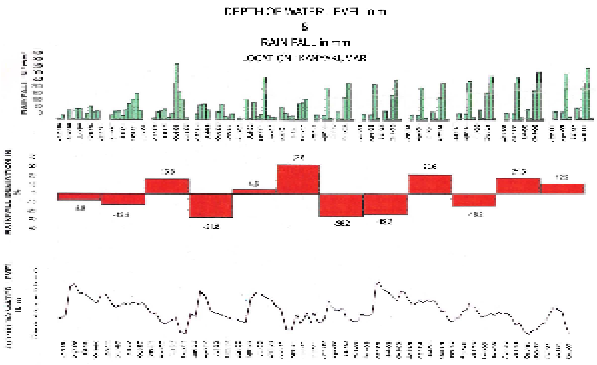

Fig. 3(a): Depth of water levels.

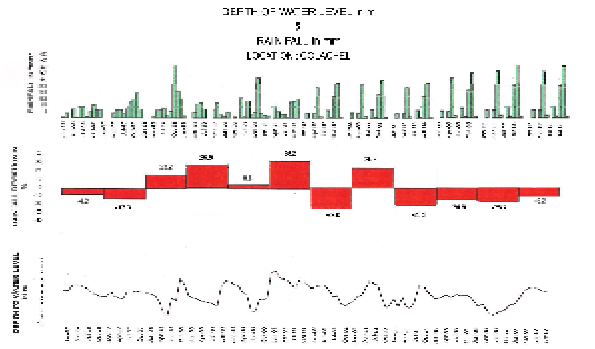

Fig. 3(b): Depth of water levels.

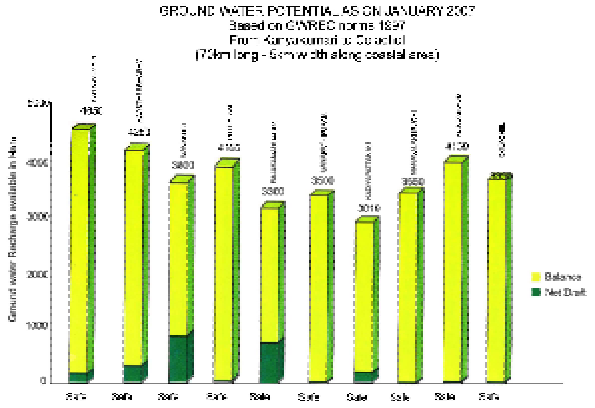

Fig. 4: Groundwater potential.

CONCLUSION

Several aspects related to groundwater as discussed give a general scenario of groundwater condition prevailing in Kanyakumari to Colachel coastal area of Kanyakumari district. Unlike other natural resources groundwater is dynamic in nature and its occurrence and movement vary with time and space. The quality of groundwater also changes depending upon the geological environment and water table fluctuation pattern. The water table fluctuation is again depending upon the behaviour of monsoon and groundwater development activities.

The monitoring of groundwater levels in the observation wells in Kanyakumari district indicates that, generally water level tends to rise during monsoon, indicating good recuperation irrespectively of the quantity of extraction. The artificial recharge of groundwater can improve the water table condition so as to avoid deterioration of water quality and it further helps to sustain the groundwater potential during non-monsoon periods.

Quantitative assessment of groundwater potential in the hard rock terrain is relatively a more complex task due to diversity in terrain conditions and aquifer complexity. Attempts have been made to quantify the groundwater potential by adopting uniform parameters, empirically chosen to represent the condition in each block, and the groundwater potential is assessed and blocks are categorized as overexploited, critical, semi-critical and safe depending upon the extraction.

For better management of available resources, conjunctive use of surface and groundwater in major command area is to be evolved.

The State Groundwater and surface water resources data centre of Public Works Department have interpreted the satellite imageries and aerial photographs. With this, land use geomorphologic and

structural maps have been prepared for each taluk of the district. Based on these maps, high, moderate and low potential areas have been demarcated. These maps give an overall view of probable favourable zones for groundwater development. These areas are favourable locations either for drilling tube wells or for sinking dug wells. As the groundwater resource is precious and scarce commodity, it has to be utilized judiciously by adopting water conservation techniques like sprinkler and drip irrigation wherever the water level has gone down due to heavy pumping. Thus, the groundwater can be utilized in proper manner and large area can be brought under groundwater irrigation. In general, studying the observation of field data, water level in the coastal area of Kanyakumari to Colachel coastal belt is good due to continuous seasonal monsoon and less groundwater extraction.

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