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GROUND WATER FOR RURAL DEVELOPMENT - A CASE STUDY

by K M GURAPPA, M R GAJENDRAGAD, G RAJENNA AND A N SEETHARAN

INTRODUCTION

The area under investigation lies along the west coast of Karnataka, a State in South India. It covers about 6 Sq. Km. around Karnataka Regional Engineering College, Surathkal. The National Highway No. 17 (Bombay - Kanyakumari) passess through this area. The belt lies between longitude 74°46' E and 74°48'E and latitude 13° N and 13°2' N (Fig. 1). The economic complexion of

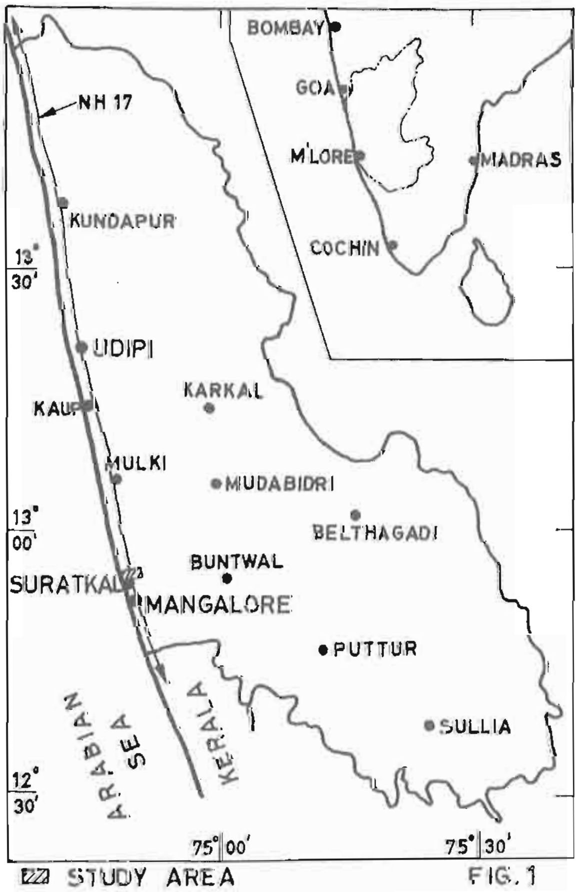

FIG. 1

this region has rapidly improved after the establishment of New Mangalore Port, Mangalore Chemicals and Fertilizers. Completion of Hassan-Mangalore railway line, near completion of Kudurenukh iron ore project and starting of small scale industries in the neighbourhood have also contributed to economic growth.

The Karnataka State Land Reforms have forced many a land owner to return to and settle down in their villages to attend to agricultural improvement. A considerable number of educated and affluent families have taken to scientific and mechanized agricultural activities. They have also started small scale ancillary industries which support fish and paddy based enterprises. All these establishments have led to rapid influx of population besides improving the economic conditions of the farm working class. Dakshina Kannada district enjoys the highest density of population in that it ranks 6th among the 19 districts in Karnataka in the matter of population while areawise it occupies the 12th place Agriculture and labour are the chief occupations of the population in the district and yet the percentage literacy here is the highest in the entire state. This speaks highly of the socio-cultural awareness among the inhabitants here. No wonder sanitary conditions maintained by the people are the best in the district and no epidemic has ever infested this district for well over a centuray. People here are familiar with modern methods of waste disposal to enrich the nutrient value of farm yard manure and yet get gobar gas as domestic fuel.

All the above factors have demanded a heavy quantum of freshwater for domestic, irrigational and industrial needs. As this belt is very close to the Arabian sea, the Pavanje river which joins the sea, is rendered so saline by the backwaters that the river water becomes unfit for use. Surface reservoirs are not practicable because this belt is a flat terrain with highly porous laterites, clay and sand. Groundwater is therefore the only dependable source of water, since it is relatively cleaner, fresher and abundantly available almost round the year.

Innumerable wells are, however, sunk indiscriminately to meet the demand for water; but many of them get polluted due to sea water intrusion during summer, resulting in shortage of freshwater.

The aim of selecting this area for investigation is to assess the groundwater potential, and to harness it without adverse effects. Such an investigation is, of necessity, multidisciplinary in nature and hence this collective effort.

PHYSIOGRAPHY AND GEOHYDROLOGY

The area under study receives very heavy rainfall with an annual average of 4000mm, July being the month of heaviest rainfall. The temperature ranges from 37.8°C in hotter months to 16.7°C in cooler months. High humidity in monsoon and sultry weather in summer months are experienced.

A large portion of this area is covered by mounds of ferruginous laterites. The coastal belt is flat and is covered with thin layers of sand over laterites and clay. The fertile soil is suitable for paddy, coconut, arecanut and banana. Two to three crops of paddy could be raised during a year. It is rather peculiar that the eastern portion of the area is situated about 3m below the sea level. The creek that flows in the centre of the valley is contaminated with salt water during high tides. A small portion of the valley remains water-logged throughout.

The groundwater is stored in laterites and also in weathered, jointed and sheared gneisses. The water is found at a depth of 2m in regions nearer to the coast and at 4m to 5m farther from the coast.

A large number of open wells and the only dug-cum-bore well yield good water suitable for all purposes. The bore wells in the area are all abandoned either for poor yield or for acidic waters.

AQUIFER CHARACTERISTICS

Groundwater occurs under phreatic water table conditions. The open wells are sunk for domestic and irrigational purposes. They are generally shallow and vary from 3m to 13m in depth and 2m to 4m in diameter. The depth to water ranges from 2m to 5m. Wells in the valley overflow during rainy seasons. For the present study, 60 wells are inventoried in detail to assess the hydrogeological properties of the aquifer. Out of these, 6 wells are selected for pumping tests. From the test data, aquifer characteristics viz specific capacity, transmissivity, permeability and specific yield are calculated using relevant formulae (ref. 1). The results of analyses are presented in Table 1.

The pumping tests reveal the presence of a rich unconfined aquifer which can be developed and exploited without any hazardous results.

TABLE 1 : Pump Test Results

Sl. No.	Well No.	Measured Discharge 'Q' (m^3/min) $Q=C \times S_1$	Specific Capacity $C=(A/t) \times \log_e(S_1/S_2)$ (m^3/min/m) Slichter's recovery formula (ref.2)	Permeability $P = T/M$ (m/day)	Transmissivity $T= 264Q/\Delta s$ (m^2/day) Theis modified Jacob's formula (ref.4)	Specific yield $Sy=4Tt/R^2$ (%) Ramsahoye and Lang formula (ref.3)
1	24	0.149	0.11	16.59	30.7	0.719
2	28	0.085	0.12	54.43	52.8	0.962
3	29	0.102	0.11	35.29	45.52	1.897
4	33	0.02	0.03	42.90	45.91	0.56
5	39	0.02	0.03	26.69	22.96	0.13
6	41	0.446	0.638	286.31	250.52	3.09

QUALITY OF WATER AND SOIL

With a view to determining the quality of groundwater, samples are collected from all the 60 wells at regular intervals and chemical analyses are carried out by volumetric and gravimetric methods to estimate Cl^-, HCO_3^- and SO_4^{--}. The Mg^{++} and NO_3^- contents are computed from these results by conventional methods. Electrical conductivity, pH, and alkali and alkaline earth cations are determined by using conductivity bridge, pH meter and flame photometer. Almost all the inventoried wells excepting just a few, yield water with pH around 7.2, electrical conductivity around 345 micromho per cm and alkali and lime cations around 28 ppm and 50 ppm respectively. The results of analyses are plotted to get Stiff diagrams and to locate the quality of water on the Piper trilinear diagram (ref. 5).

Fertility indices are also determined for soil samples to assess the suitability of a crop to the soil and water of the area. The results of chemical analyses show that the water is quite suitable for domestic, irrigational and industrial needs. The soil is mostly either lateritic or lateritic clay. At some places the soil is acidic and that seems to be the main reason for low productivity. The farmers are therefore advised to use lime or sea shell to correct the acidity and to enhance the yield. They are also advised to use improved varieties of paddy seeds which are resistant to pests and diseases so as to reduce the risk in cultivation. Cost of manuring can be reduced to a greater extent if green manure plants like gliricidia (Gliricidia maculata) are grown along the borders of the paddy fields and their foliage used for the soil. Salt-sensitive crops like paddy may be gradually replaced by less salt-sensitive crops like groundnut, soyabean, garden-beet and barley.

DRAFT AND EFFECTS

Two small land holders deepened their wells nearer to the sea shore in order to get larger supply of water for irrigation. Although the yield increased, the water was found contaminated due to salt water intrusion and so was rendered unfit for any use. As a result, wells which yielded freshwater earlier had to be abandoned and the small land holders who ventured to deepen the wells have found their efforts counter-productive.

In a similar way indiscrimiate sinking of wells unmindful of requisite spacing between wells has also proved unproductive; for, close spacing results in severe interference particularly during pumping. This has induced farmers to resort to starting their pumps much earlier than their neighbours in order to tap maximum quantity of water. Such an unhealthy competetion among farmers resulting in overdraft is indeed deterimental to their overall interest.

Yet another factor which deserves consideration is that the Government of Karnataka have modified their power tariff to help the farmers. Power charges are levied on the basis of capacity of the pump rather than the actual power consumption. This, too, has indirectly encouraged the farmers to pump out more water than what the crops really need. Due to all these factors depletion of groundwater levels and ruinous over-draft are the consequences. In turn scarcity of freshwater is experienced well before the onset of summer.

As aforesaid, the land in the eastern portion of the belt is below the sea level and a creek is flowing towards the sea. During high tides, back-water flows into the creek thus spilling salt water into the adjoining paddy fields. To prevent the spill-over, two earthen bunds of 2m height are constructed on either bank of the creek. This has mitigated the salt water encroachment.

WELL DIMENSIONS AND SPACING

Depth, diameter and well spacing are important factors for efficient management of groundwater regime. The main criteria for realising optimum yield are :

(i) pumping rate commensurate with irrigation requirement of crops

(ii) transmissivity of the aquifer and

(iii) radius of influence.

The groundwater potential of the belt is enriched by the annual rainfall, seepage from the river and return flow from irrigation. The annual recharge to the groundwater regime is estimated on the basis of seasonal fluctuation of water level in wells and specific yield of the aquifer. This is of the order of 9,67,500m^3 from all sources as against an annual draft of 7,20,000m^3. This leaves a groundwater balance of 2,47,500m^3, which can safely accommodate 20 additional wells and cater to the needs of small scale industries as well as irrigation.

To be economically viable, an open well should yield 12,000m^3/year. Taking into account the extent of irrigable area, type of crop and crop-water requirements, one can deduce that 80% of the existing wells in the area under investigation can yield enough water to irrigate 1.6 ha for three crops of paddy. If one or two of the crops of paddy are replaced by less water-requiring crops like groundnut, millets and/or pulses, much larger area can be catered to by the same amount of water. Hydrogeological data indicates that 2m of saturated thickness of water can be tapped during the peak period of crop-water requirement. The study of seasonal water level fluctuation suggests a minimum depth of 8m for a well so as to tap 2m at a time conveniently. However, in the vicinity of the coast, the depth should not exceed 6m in order to prevent salt water intrusion.

Based on the formation constants, the optimum diameter of a well works out to be 6m with a spacing of 60m between adjacent wells.

CONCLUSIONS

This small belt is selected as a representative of the coastal area so as to carry out a micro-scale study. The investigations reveal the presence of a potential unconfined aquifer which can be economically exploited as a dependable source of freshwater.

None of the wells contain water contaminated with organic pollutants or excessive inorganic salts. The water is therefore quite suitable for all civic and commercial needs. The slight acidity, in some cases, can be readily corrected with requisite additions of lime.

The farmers normally cultivate paddy repeatedly. As a result, the soil nutrients are not properly utilised and the yield of paddy gradually depletes. Introduction of rotation of crops with high yielding and salt-tolerant crops is therefore recommended. These recommendations have been tried by farmers with encouraging results. Such developmental activities would certainly increase food production, create job opportunities to the rural labour, overcome freshwater scarcity during summer months and safeguard the interest of farmers.

Suggestions regarding optimum depth, diameter and spacing of wells have also been followed by farmers. Their experiences show that these measures are indeed rewarding.

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