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Short Communication

Effect of change in ecosystem on ground water quality

K.C.B. RAJU, V. RAMESAM*, AND R.S. CHAUHAN
Central Ground Water Board, 3-6-291, Hyderguda, Hyderabad 500 029.

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Abstract

The variation in cholride and magnesium in the ground waters of Andhra Pradesh for the last half a decade was mapped and compared with the population patterns as obtained from recent census operations. It is observed that both the ions give rise to similar patterns apparently controlled by the hydrogeological setting, physiography, etc. Significant differences were, however, noted in certain areas. The influence of 1977 cyclone was clearly decipherable in coastal areas. Saline matter carried by the cyclone winds was confined to the region between Vinukonda in Guntur district and Eluru in West Godavari district.

The Coastal parts and Rayalaseema show increasing salinity in ground waters with rising population. Similar effect is not felt in Telengana area presumably because of lag in transport of salt waste into ground water.

Key words: Ecosystem, ground water, geochemistry, water quality.

The changes in industrial, economic and social fields, particularly since independence, have affected the ecosystems in Andhra Pradesh. It needs hardly any special proof to say that most of the productive activities of the second wave civilisation[1] have affected environment, upsetting natural balances. Deforestation, urbanisation, industrialisation and attendant activities reflected their impact not only on the increase but also on selective redistribution of the population. Cities have expanded and even in the rural scenario, population growth is preferentially skewed towards villages having better communication facilities. It can reasonably be expected that these shifts in the growth and redistribution of demographic patterns would leave their mark on ground water quality especially with reference to such ions which do not come through rock-weathering and are added to the ground water system through human interference.

* Present address: Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016.

Dissolved ions in ground waters taken up for study should be ubiquitous, stable through a good range of pH and temperature, highly soluble and also not affected by lapse in time of collecting the water sample and its analysis in the laboratory. Mainly chloride and to some extent magnesium satisfy these conditions and it was, therefore, decided to study the change in these ions with time in the ground waters of Andhra Pradesh.

The Central Ground Water Board (CGWB) has been monitoring a network of observation wells (existing open wells) throughout the State of Andhra Pradesh since 1969[2]. Ground

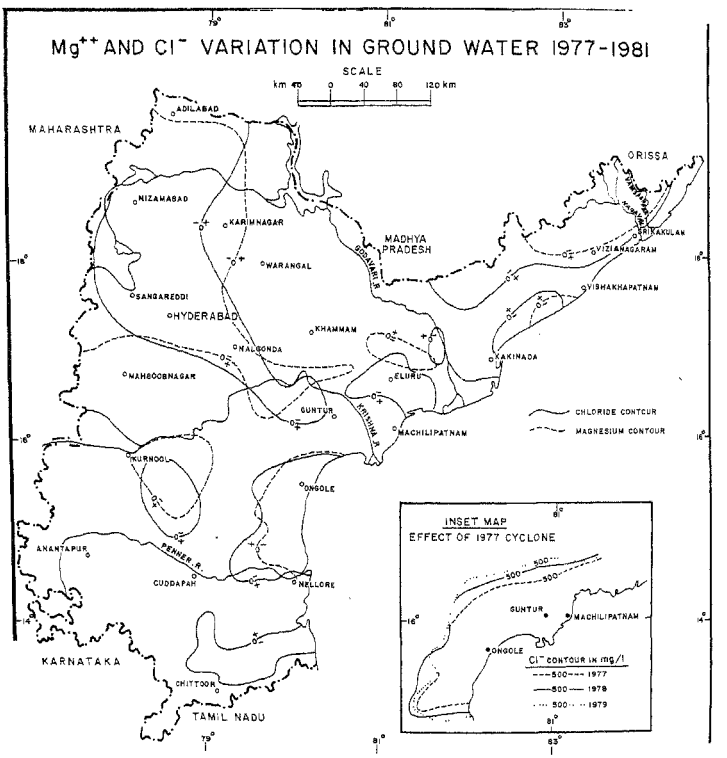

FIG. 1. Mg^{2+} and Cl^- variation in shallow ground water in Andhra Pradesh between 1977 and 1981.

water levels are measured five times a year and water quality is determined from samples collected in the pre-monsoon (April-May) season. The year 1977 has been chosen as a base year considering the availability of a fair distribution of control points in the entire State. Incidentally, it may be mentioned that 1976, the preceding year, was a year of normal rainfall in the State and thus anomalous values influenced by meteorologic conditions were avoided. The change in ground water quality in half a decade *i.e.* by 1981 was recorded as increase or decrease in the chloride and magnesium values in the water samples from the same well. The '0' contour of no change is shown in fig. 1. (+) sign indicates areas where the dissolved species have gone up and (−) sign indicates areas which have recorded a decrease.

The pattern of change in chloride and magnesium is similar in almost all parts of the State except in southern part of Chittoor district, part of West Godavari district and in the environs of Karimnagar.

Apparently regional trends in variation of these ions are controlled by physiography, rainfall, geological conditions and prevailing hydraulic gradient. The characteristics of variations noticed can be briefly summarised:

Coastal regions

1. The water quality is improving (because of better flushing of the ions) in Pleistocene and Recent formations where water table gradient is more (1 in 200).

2. The deltaic regions of Krishna, Godavari, Pennar (fig. 2) record a rise in chloride and magnesium contents because of prevailing low hydraulic gradients (1 in 2500).

3. The north-eastern part of the State where khondalites occur recorded an increase in dissolved species. Vamsadhara, Nagavali and other intermittent basins record a decrease in values because of higher rainfall (1200 mm).

Inland areas

4. Magnesium and chloride values decrease with steep hydraulic gradients.

5. There is a fall in the Cl^- and Mg^{2+} values in the Kundair and Jammalamadugu series (fig. 2).

6. Areas drained by major rivers (Krishna and Godavari) show a fall in the Mg^{2+} and Cl^- values up to their deltaic regions.

7. The Mg^{2+} and Cl^- decrease also in Gondwana formations where steeper hydraulic gradients exist (fig. 2).

8. The south-western part of the State where Archaean formations occur with low rainfall and low hydraulic gradients show enrichment in Mg^{2+} and Cl^- ions.

Influence of the November 1977 cyclone

In order to assess the effect of the unprecedented cyclone of November, 1977 along coastal Andhra Pradesh, movement of chloride front taking 500 ppm contour as reference is mapped and shown as inset in fig. 1. The area bounded by the coast in the east and the contour in the west shows increasing area of salinity from 1977 to 1979. The affected area is

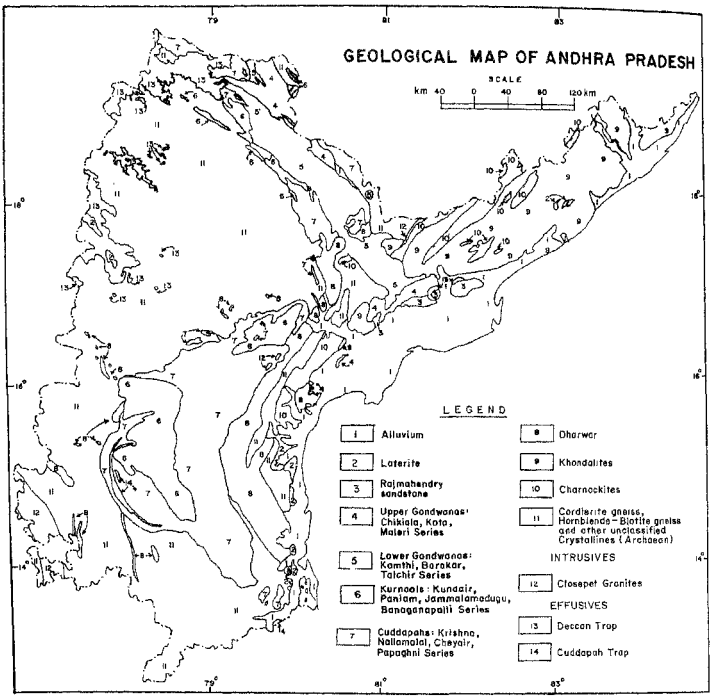

FIG 2. Geological map of Andhra Pradesh.

limited by Vinukonda in Guntur district in the south and Eluru in West Godavari district in the north. Beyond these two places, there is no significant displacement in the 500 ppm contours for the years 1977, 1978 and 1979. It is possible that the cyclone winds carried saline matter from Bay of Bengal mainly along the Krishna river valley and deposited it on the surface. Depending on the local depth to the ground water table, the rainfall of subsequent years is dissolving it and adding to the groundwater body.

Effect of population growth

The principal source of chloride in natural waters is from the sea either through transportation of saline matter by wind or by dissolution of excess chloride excreted by human and cattle population. In an earlier study[3], it was found that the per capita annual consumption of salt in Coimbatore area is as follows:

	Consumption
Cattle	: 11 kg/yr
Sheep	: 3 to 5 kg/yr
Human beings	: 7.5 kg/yr

As the various rock types that occur in the State of Andhra Pradesh are not rich in sodium chloride, it can be assumed that the chloride in the waters is derived from human and livestock interface. Thus it is logical to expect higher chloride in ground waters with increasing sodium chloride consumption and excretion due to rising population.

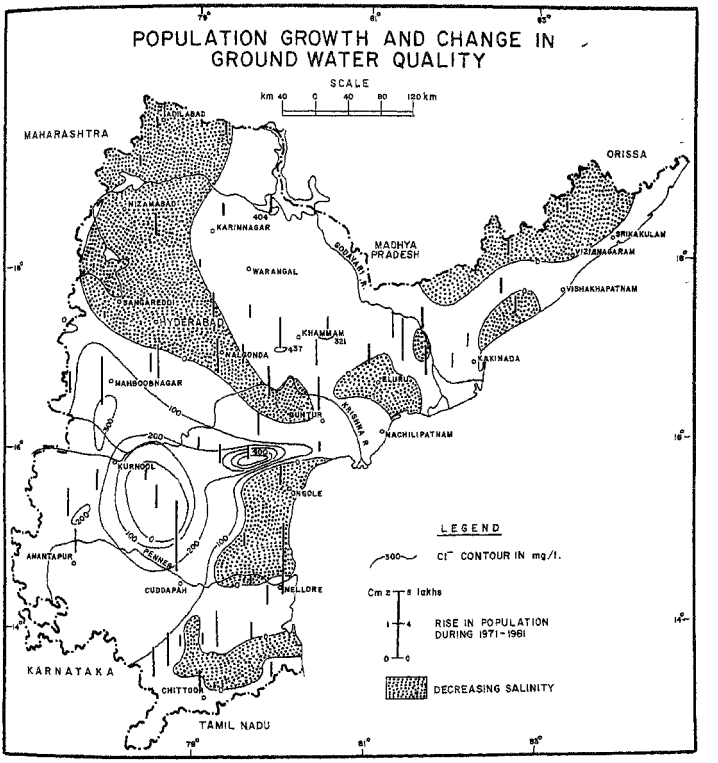

FIG. 3. Population growth and change in ground water quality in Andhra Pradesh.

Magnesium is a common element in many rock forming silicates. As ferromagnesium minerals disintegrate giving rise to Mg^{2+} (aq), groundwater is enriched in this ion. It was, however, found that the common salt consumed by the people of the State contains considerable amount of magnesium. Analyses conducted on random samples of salt obtained from the market in Hyderabad showed the following content of magnesium.

Common table salt	:	0.25% Magnesium by weight
Unrefined crystal salt	:	1.7% Magnesium by weight

In view of the high magnesium content in the common salt consumed, the biological interface modifies considerably the natural input of magnesium to the groundwater giving rise to similarity in patterns of changes in their values.

The change in chloride content of the ground waters is shown at an interval of 100 ppm in fig. 3 along with the increase in population between 1971 and 1981 projected as bars. In general, the areas of increase in salinity (chlorinity) match with the rise in population in Rayalaseema districts as well as in the coastal tracts. The rise in the population in Telengana area has not reflected its effect on ground water quality. Even though the regional trends are controlled by physiographic and hydrogeological factors, it can be seen that generally salinity increases steeply in the downstream direction of main cities/towns. The fact that the north-western part of the State still does not markedly show the effect of population rise on ground water quality goes to suggest that the phenomenon of population growth in these parts is recent and its effect is still to percolate down to the groundwater table. Further investigations, however, are needed to determine the lag effect between rise in population and change in the chemical quality of the ground waters.

Conclusions

The change in groundwater quality in the half decade ending in 1981 has been compared to population growth in Andhra Pradesh. Water quality patterns, while broadly reflecting the hydrogeological set up, also record the impact of a rise in population. The north-western part of the State has not been affected by groundwater quality, presumably due to a lag effect in the transmission of the salt into groundwater. Cities with rising populations and no proper drainage facilities show deterioration in chemical quality in the downstream direction.

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