

GROUNDWATER QUALITY STUDIES FOR IRRIGATION IN ANDHRA PRADESH, INDIA

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ABSTRACT

Groundwater samples from seven districts are analysed with the aid of a digital computer. The waters are classified based on the predominant ions. Range and averages of cations, anions, EC and pH are computed districtwise. Similar statistics are computed for each lithological unit. The discussions relate to possible indication of the ranges and predominance of ions and ion ratios, presence of rock forming minerals and influence of sea water. About 100 samples of granitic terrain under irrigation were subjected to regression analysis and correlation of individual ions namely Cl, SO₄, HCO₃ and TH with EC is established.

INTRODUCTION

In this paper a study is made of the available analytical data collected from seven districts of Andhra Pradesh State representing different agro-climatic regions and hydrogeological formations, and the regional groundwater samples are classified. Analyses of 2230 groundwater samples are analysed by deploying EC 2640 Robotron Digital Computer, after developing a programme in COBOL. The input record has 80 bytes and comprises of well-code-number, date, EC, CO₃, HCO₃, Cl, F, Na, K, Ca, Mg, TH, depth of sample collection, geology-code, pH and NO₃. Using the input data, percent reacting values, Mg/Ca ratio, SAR, RSC, Percent Sodium, Eaton classification, USSL Classification, F-Code and Cl/HCO₃ ratio are computed. USSL Classification(1954) and Eaton Classification(1950) indicate the suitability of water for irrigation use. Statistics pertaining to number of samples, range (maximum and minimum), mean for the constituents are obtained for each district. Bar-charts portraying the percentage of samples falling in the given percentage ranges of each of the cations and anions are prepared for identifying the predominant anions and cations and classification of the type of water. Identical analysis is repeated for each geology code for studying the relationship of groundwater quality with lithology of the aquifer.

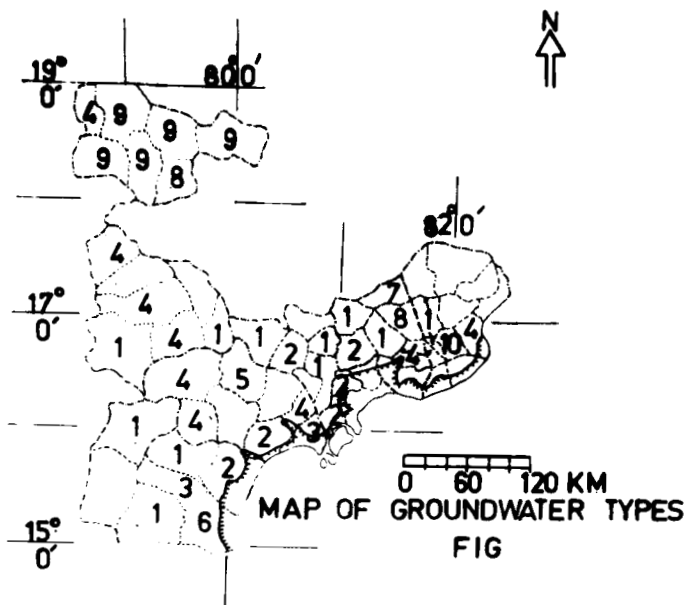
RESULTS AND DISCUSSIONS

The districtwise distribution of groundwater composition shows that large variation exists in electrical conductivity (EC) in water of the same type as well as of various lithological formations. The EC is maximum (12 to 25 m.mhos/cm) in the coastal districts of West Godavari and East Godavari; these high values are associated with the chloride content 121 to 276 epm. The high chloride concentration, high Mg/Ca ratio (Hem, 1970), and high chloride-bicarbonate ratio (Revelle, 1941) indicate seawater intrusion into the coastal alluvial aquifers. Figure shows the saline groundwater zone, which is topographically low-lying and sub-mersible tract of the Delta on the East Coast. The sediments of this area include intercalations of sand and clay with tongues of gravel extending along stream courses. In some of the patches in these sediments brackish water is found attributable to certain hydrogeological processes. Tidal incursions are observed. However, the occurrence of fresh water in the coastal belt is not ruled out due to the hydraulic gradient of groundwater being above mean sea level (Ghyben, 1889 and Hertzberg, 1901); but deep aquifers are found to yield brackish to saline water unfit for irrigation.

The frequency distribution of each of the major anionic and cationic constituents is studied for each of the taluks and the types of groundwater is classified based on the predominant cation and anion groups, the predominance indicated in decreasing order i.e., HCO_3 -Cl- SO_4 /Na-Ca-Mg (figure). It is found that all the above ions are more than 25 per cent of reacting values.

Similar frequency analysis is carried out for each of the major lithological units. It is observed that HCO_3 is predominant in shallow aquifers of granite, shale, sandstone and alluvium; 32 to 60 per cent of the samples analysed falling beyond 50 per cent of reacting values. Sodium is predominant of all cations, being more than 50 per cent of reacting values in 20 to 60 per cent of samples. Groundwater in Gondwana sandstones and Rajahmundry sandstones (tertiary) shows EC between 0.2 to 11 m.mhos/cm; and chloride content in 30 per cent of the samples is above 50 per cent of reacting values.

Concentrations of fluoride in groundwater of districts of Karimnagar and Prakasam were observed to vary from 0.2 to 8 mg/l, whereas, in Nalgonda district the variation is 0.2 to 6 mg/l. Shale, granite and alluvium are found to contain higher amounts of fluoride (0.2 to 8 mg/l) whereas, concentrations upto 4 mg/l are noticed in sandstone and schist. Fluoride bearing granites have been reported in Sivannagudem area and Devarakonda-Mallepally areas in Nalgonda District, Kanigiri-Podili-Darsi of Prakasam district and Huzurabad area in Karimnagar District. Fluorosis is prevalent in some of these areas (Indian Academy of Geo-Science, 1977). Incidence of fluoride in these waters may be due to the fact that fluorine absorption is more in minerals like gibbsite, kaolinite, halleyite and precipitated $\text{Al}(\text{OH})_3$ than in goethite, montmorillonite and vermiculite, (Bower and Hatcher, 1967). The role of fluorine in plant nutrition is not well established. Paliwal (1969) observed that irrigation



TYPE OF WATER ANION/CATION
(Based on predominant ions, in the
order indicated.)

$\text{HCO}_3\text{-Cl-SO}_4$ / Na - Mg - Ca	1
/ Na - Ca - Mg	4
/ Mg - Ca - Na	7
/ Mg - Na - Ca	10
/ Ca - Na - Mg	8
/ Ca - Mg - Na	9
$\text{HCO}_3\text{-SO}_4\text{-Cl}$ / Na - Mg - Ca	3
$\text{Cl-SO}_4\text{-HCO}_3$ / Na - Mg - Ca	5
$\text{Cl-HCO}_3\text{-SO}_4$ / Na - Mg - Ca	2
/ Na - Ca - Mg	6

SALINE ZONE

$\text{EC} \times 10^6 > 3000$

AREA NOT COVERED



water having an average of 7 mg/l of fluorine and an EC value of 6000 micro-siemens/cm was found detrimental to the growth of wheat.

The relationship of specific conductance to hardness and ion concentrations (Cl, HCO₃, SO₄) using 100 analyses from Sreeramsagar Project Command Area underlain by granites is indicated by the following linear regression models:-

			Correlation Co-efficient
EC	=	471.85 + 129 Cl	0.90
EC	=	26.12 + 2.85 TH	0.86
EC	=	161.82 + 146.42 HCO ₃	0.66
EC	=	711.43 + 132.08 SO ₄	0.43

Well defined relationships exist for Cl and TH, whereas the HCO₃ and SO₄ ion concentrations are less closely related. It is evident that a record of EC at a station can be used to compute the other chemical characteristics of the water. The sampling and analysis can be directed towards determination of constituents which did not correlate with EC.

REFERENCE

1. J.D.Hem, Study and Interpretation of the Chemical Characteristics of Natural Waters. U.S.G.S. Water Supply Paper, 1473, 1970.