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SPATIAL ANALYSIS OF HIGH NITRATE CONCENTRATION IN THE GROUNDWATERS OF KAVERI DELTA & ITS IMPLICATIONS

P. H. ANAND , Kumbakonam

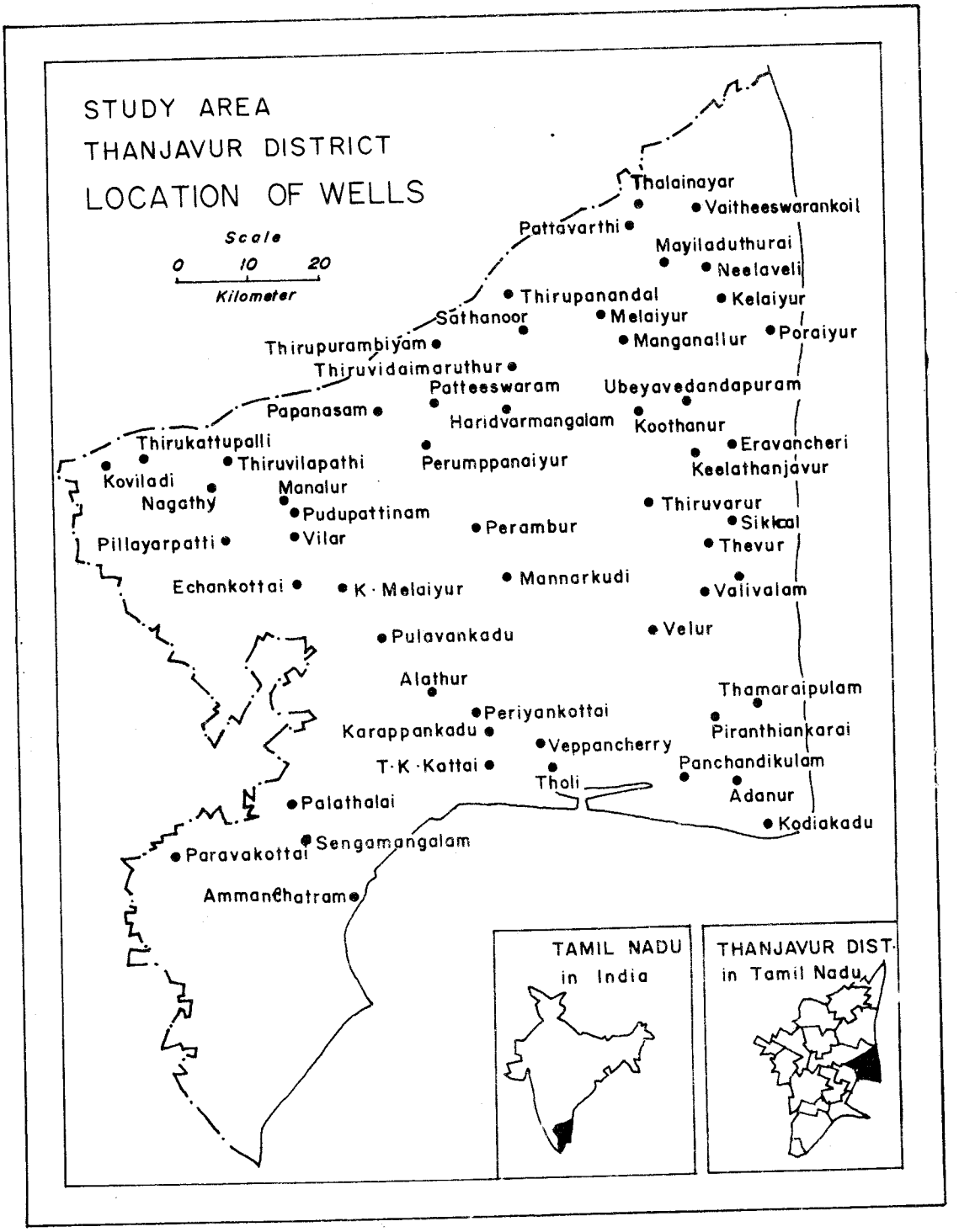
ABSTRACT : Nitrate is a health affecting constituent. It may be present in significant levels in bore wells where constant fertilizer usage is in vogue. The WHO categorised, nitrate and fluorite as health affecting constituents, Nitrate reacts with the oxygen-carrying pigment in blood. Infants constitute the most vulnerable group and lower acidity in their stomach allows the growth of certain microbes that contain enzymes capable of reducing nitrates to nitrites. Nitrates can react with amines and amides to form nitrosamines and nitrosamides. In the light of recent studies, the nitrates are converted to nitrosamines in the body and produce tumours. The major issue of nitrate pollution is due to intensive use of synthetic nitrogen fertilizers, mis-use of organic manures for agriculture and effluent from industries. Nitrate concentrations in drinking water originating from land supporting intensive agriculture have been continuously increasing over the past twenty years. The Kaveri delta is the rice bowl of Tamil Nadu and continuous use of fertiliser is in practice, resulting in some of the wells having high nitrate concentration. To analyse the space in relation to the nitrate concentrations 71 bore well samples were collected and analysed as per the usual procedures. The results were further mapped to analyse the spatial spread of nitrate concentrations and its source & implications were also studied.

INTRODUCTION

Ground water, in general, is clean and fresh. Due to ecological factors, either natural or man-made, certain variations in their quality are common. Ground water moves through varied geological environments and during its flow many chemical compounds will be dissolved enriching the ground water. The modern civilisation, industrialisation and urbanisation have led to fast degradation of ground water resources and hence the protection and management of ground water quality is emerging as a great concern.

NITRATE : A HEALTH AFFECTING CONSTITUENT

According to the WHO, Nitrate and Fluoride are health affecting constituents, Nitrates are sometimes present in significant quantity in wells and borewells, where consistent fertilizer usage is in vogue. Nitrate reacts with oxygen-carrying pigment in blood, heamoglobin, to produce a compound which is less effective oxygen transporter and may produce serious physiololgical effects known as 'Methaemoglobinaemia' or blue baby. Infants constitute the most vulnerable group for the following reasons : (a) lower acidity in their stomach allows the growth of certain microbes that contain enzymes capable of reducing nitrates to nitrites, (b) Fatal haemoglobin may be more methaemoglobin by the action of nitrates. It is evident from the recent studies, that nitrates are converted to



Map No.1 : Study area Thanjavur District, Location of Wells

nitrosamis in the body to produce tumours. The desirable and minimum permissable limits prescribed by WHO and ISI are : Nitrate as No_3: 45 mg/1 ; Fluoride as F: 0.6 (ISI), 1.5 mg/ 1 (WHO).

PROBLEM DESCRIPTION AND OBJECTIVE

The major issues of nitrate pollution is due to intensive use of synthetic nitrogen fertilizers, misuse of organic manures for agriculture and effluent from industries. Nitrate concentration in drinking water originates from land supporting intensive agriculture which has been continuously increasing over the past twenty years. Nitrate standards of drinking water are being exceeded by an increasing number of sources in various countries and there is growing concern over the potential health aspects of increasing nitrate intake by populations. In most of the studies, nitrate contamination of water, especially in aquifers are the major concern as it affects the quality of drinking water resources and it is also expected to become a major environmental problem for years to come. The present study attempts to evaluate the extent of Nitrate concentration in the ground water of Kaveri delta area consisting of Thanjavur and Nagai Quaid-E-milleth districts, the once rice bowl of Tamil Nadu.

STUDY AREA PROFILE

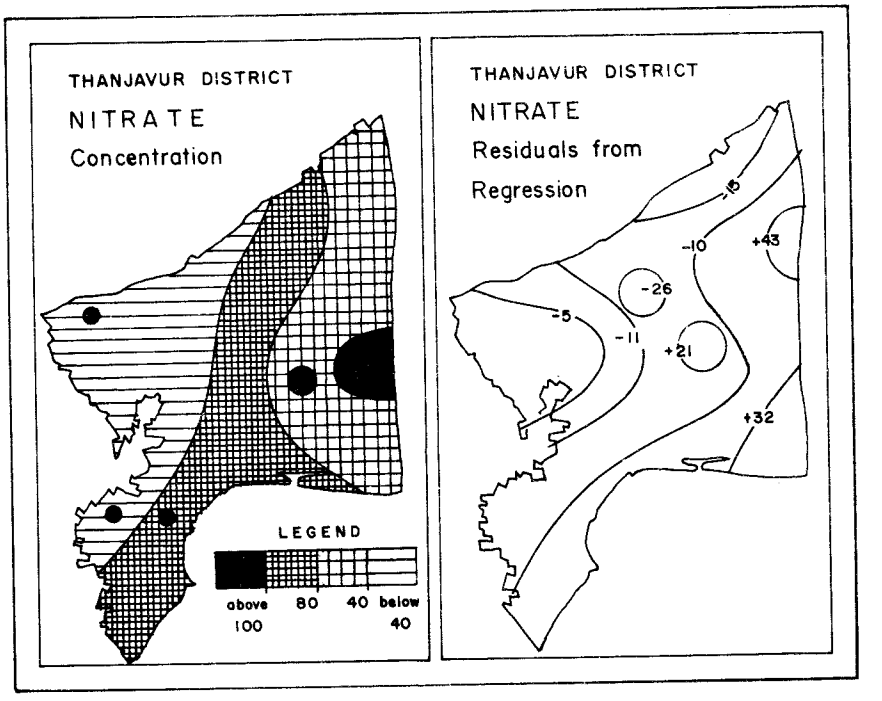
Kaveri delta, comprising Thanjavur and Nagai Quaid-E-Milleth districts, predominantly an agricultural region, lies in the central eastern part of Tamil Nadu with an area of 8212 Sq. km.Kaveri is the main river which spreads its distributaries in all directions and also forms the major source of irrigation water in the area. Ground water as a source of water supply is of primary importance besides other factors such as the amount of rainfall nature of soil and subsoil and the physical and structural features of the rocks. In the Kaveri delta region. water table is highest during November-December just after the north-east monsoon period. Water table lies at a depth of 10 and 15 metres in the taluks of western upland and it is much higher in coastal taluks, sometimes even reachaing 10m below the surface.

SAMPLING AND ANALYSIS

To identify the Nitrate concentration zones in the study area, water samples were collected from 79 borewells located in different parts of the deltaic region of the study area. Samples of about one liter from each site were collected in polythene cans and were analysed in the laboratory, following normal procedures, described by Handa (1984). The following Geochemical parameters were determined through the scientific measurements. They are : pH, EC, TDS, Calcium & Magnesium, Iron, Sodium, Potassium, Total Hardness, Fluoride, Chloride, Nitrate and Sulphate. The results of these analysis indicate that out of the 79 samples, Poraiyar well water was having the maximum nitrate content of 175 mg/1 and the minimum of 1 mg/1 was found in the Mazhavarayanallur and Mangaimandapam. The mean value was 16.3 mg/1. Eleven bore well samples were free of nitrate content and seven wells had exceeded the WHO normal limits of 45 mg/1.

STATISTICAL SIGNIFICANCE

In order to study the statistical significance of the nitrate, with other geochemical variables, the Multiple Correlation and Regression Analysis have been applied. This analysis will explain the variation in one dependent variable (nitrate in this case) via variations in the explanatory or independent variables. Similarly, the Correlation techniques extend such analysis to examine interdependence between two main groups of variables, predictor and criterion variables.



Map No. 2

The multiple correlation analysis was initially performed for the dependent variable (nitrate) with the eleven independent variables such as pH, EC, TDS, Calcium, Magnesium, Sodium, Potassium, Iron, Total Hardness, Chloride and Sulphate, to derive some of the originally related variables, which has an exact impact on high nitrate concentration. As per the inter-correlation matrix the highly positive variables are selected and they are Calcium, Total hardness, Chloride. These three variables indicate that they are highly correlated with the nitrate when compared with the omitted insignificant variables, and they are further subjected to the multiple regression analysis and derived the following equation :

$$Y = 0.38\ (a) + 0.066\ (x_1) + 0.042\ (x_2) + 0.051\ (x_3)$$

Where x_1 is Calcium, x_2 is Total Hardness and x_3 is Chloride and Y is the Nitrate. Using this equation, it can be estimated that the level of nitrate contamination in the study area in relation to the above three variables. The co-efficient 0.066 shows that an increase in nitrate for each change in Calcium with the proportion of the Total Hardness. Similarly, if the Calcium (x_1) is held constant, the co-efficient 0.066 shows the increase in nitrate concentration resulting from a change in the Chloride.

RESIDUAL MAPPING

The difference between the observed value (nitrate) and its estimated value has been calculated for the 79 samples. The residuals are meaningful indicators which explain the actual and intensity of operations of the factors in determining y and the other independent

variable. The Residual map, indicates the spatial patterns in terms of their positive and negative values (in percentage). From the map two positive zones of more than 75 per cent have been identified in the central eastern and western parts of the district. On the contrary the north and south eastern parts are loaded with the negative residuals.

HIGH NITRATE CONCENTRATION : A DISCUSSION

Application return flow is believed to be a major source of groundwater degradation. Application rates of irrigation water and precipitation generally exceeds the crop consumption use. Leaching of nitrate from 30% to 50% of the applied water below the root is common. In many areas such return flow is the major source of ground water recharge. Two primary groups of potential pollutants are found in agricultural use. They are fertilizers and pesticides. Commercial inorganic fertilizers contain variable concentrations of nitrogen, phosphourous and potassium. Nitrogen is the most serious ground water pollutant, particularly under agricultural lands. shallow ground water can also become contaminated as a result of leaching of nitrate from land application of livestock and poultry wastes. This is often due to poorly constructed wells that make it easy for leaching to reach the groundwater. In the present study nitrate content was found high in some wells. They are generally very deep and the water source is shallow aquifer. These aquifers are reacharged by the runoff waters and they bring sufficient amount of nitrate from the cropland which was applied as fertilizers and pesticides to the contaminated aquifer. It is further identified that high nitrate contamination is found to a greater extent in the rural areas, where the aggriculture is the major and use. Eleven out of 79 bore wells did not contain nitrate at all the it is evident that the deeper aquifers are not polluted by the agricultural waste. But the deep wells of Poraiyar and Thiruvarur recorded very high concentration of nitrate and this could be substantiated on the basis of the fact that, these locations are near the Municipal solid waste disposal sites and the continuous discharge might be the possible reason.

REFERENCE

Ayers. R.S. and R.L. Bronson (1976) *Abatement of Nitrate Pollution in a public supply well by analysis of Hydrologic characteristis, Ground Water Journal.*

Handa B.K. (1984) *Effects of fertilizer use of Ground water quality in India, Ground water in Water Resources Planning.*

Hem. J.D. (1970), *Study and Interpretation of the chemical characteristics of natural water, 2nd edition,* U.S. Geological Survey Water Supply Paper 1473, 363 pp

White D.E. (1963), *Data of Geochemistry-Chemical Composition of subsurface waters,* 6th ed. U.S. Geological Survey Prof. Paper 440-F, 67 pp

Dr. P. H. Anand, Senior Lecturer, Department of Geography, Government College (Men-Autonomous), Kumbakonam, 612 001.