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SALINITY INGRESS IN COASTAL PARTS OF THANE DISTRICT, MAHARASHTRA

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ABSTRACT : Economically accessible groundwater forms the largest single source of water supply even in humid areas, In coastal regions, groundwater supplies are vulnerable to contamination by salt water intrusion, especially in the rural areas near metropolitan cities such as Bombay. In these areas, there is an increasing commercialization of agriculture to meet the growing demands of the metropolis. Due to the alignment of the routeways, the area, to the north of Bombay in coastal Thane concentrated on the production of vegetables and flowers for the urban market. This led to well irrigation on a large scale in this belt and over-utilization of the ground water reserves. The area chosen for an indepth study is part of Agashi village. located to the north of Bombay. Two aspects were selected for study. The first was determination objectively of the extent of the problem through a chemical analysis of the water in 25 wells. The second aspect was a study of the awareness of the problem by the farmers and their adaptation through changes in the cropping pattern. The results of the study can be summarised as : In all but 3 of the wells the water was not suitable for drinking purposes. The community wells used for domestic purposes had become brakish and hence the village faced a seyere problem. 3 wells had become useless for irrigation due to sea water ingress. The problem of brackishness is a recent phenomenon and had become noticeable in the last 10 years. The farmers have been compelled to shift from cultivation of bananas and vegetables to that of flowers.

INTRODUCTION

Economically accessible ground water forms the largest single source of water supply even in humid areas where surface water provides a comparatively large alternative source of supply. In coastal regions, ground water supplies are vulnerable to contamination by salt water intrusion. This problem of salinity ingress in coastal areas is particularly noticeable in the rural areas near metropolitan cities like Bombay. In these areas there is an increasing commercialization of agriculture to meet the growing demands of the gigantic metropolis as, in developing countries such as India, it is the areas in the immediate vicinity of the metropolis which provide an appreciable proportion of the perishables such as milk, vegetables and flowers. Due to the alignment of the routeways it was the area to the north of Bombay in coastal Thane which was exploited by the city for its requirements. This led to well irrigation on a large scale in this belt and over-utilization of the ground water reserves.

The problem of salinity ingress is not unique to this region. Coastal Gujarat is grappling with a similar problem on a much larger scale. 1.2 million hectares of fertile land stretching between Bhavnagar and Lakhpet have turned saline; it has affected 1.33 million people in 779 villages and salinity ingress has reached 10 km. inland. (Menon, 1986, pp. 159-160). Ironically, Coastal Saurashtra's fertility contributed to this distressing state of affairs. In the mid-1960s loans were liberally granted to the farmers to install irrigation pumps and 90% of the fields had diesel pumps. The withdrawal of ground-water increased leading to a drop in the water-table and ingress of sea-water. Similar problems have been recorded in other parts of the world. In Tunisia, between 1940 and 1971, deterioration in ground-water quality took place due to salinity intrusion from the Mediterranean Sea (Dh. Bansalah et. al, 1980). A rate of advance of the saline interface by 40 metres per year was estimated from the measured aquifer parameters.

It is evident that salinity ingress in coastal areas is a man-made environmental disaster which brings in its wake severe hardships for the farmers. In coastal Gujarat it has resulted in prosperous farmers being forced to leave their fields and become menial labourers in nearby areas. It is in the above context that the present study has been undertaken of salinity ingress in the coastal parts of the Thane district of Maharashtra. The area chosen for an indepth study is part of Agashi village, located to the north of the metropolitan city of Bombay, in Thane District (Fig. 1).

Agashi is a very large village having a population of slightly over 25,000 in 1981 and covering an area of 1956 hectares; it consists of 12 hamlets. A reconnaitry survey indicated that the problem of salinity ingress was primarily experienced in the hamlets of Mukkam and Kolhapur which lie in the north-western part of Agashi. The river Vaitarna flows to the north into the Arabian sea in the west and at the time of high tide sea-water spreads in the lowlying lands adjoining the two hamlets. Two aspects were selected for study. The first was determination objectively of the extent of the problem through a chemical analysis of well water; for this purpose, a 1/2 litre sample of water was collected from each of the 25 wells in the study area. The second aspect was a study of the extent of awareness of the problem by the farmers, and their adaptation through changes in the cropping pattern. Data was collected with the help of a questionnaire from the concerned farmers.

CHEMICAL ANALYSIS OF WELL WATERS–CHOICE OF PARAMETERS

Well water usually does not contain turbidity since the surrounding mass of earth acts as a good filter medium. However the same is not true of dissolved salts. All soils are not good ion exchangers and even if the surrounding soil is essentially composed of natural zeolites with a good ion exchange capacity, this is not unlimited. Thus most of the well waters contain dissolved salts present as ions due to dissociation of electrolytes such as Sodium Chloride (NaCl). Consequently the water from wells are conducting and conductivity (expressed as siemens/cm) bears a relationship with the total dissolved solids (TDS) expressed as milligrams per litre.

The one salt whose presence in large amounts distinguishes sea water is Sodium Chloride (NaCl). The concept of salinity is very useful and it can be empirically extrapolated from the measured values of conductivity and is given by the relation :

$$\text{Salinity} = m \times \text{Conductivity}.$$

In this case the values of ' m ' determined for the range was 0.58.

Internationally accepted reference values of salinity define one of the parameters of water quality. If salinity is greater than 600 the water is not fit for use as drinking water while if it is greater than 2000 the water is not fit for irrigation. An associated parameter is the measured value for Chloride content of water. This acts as a cross check on the measured value of conductivity and the salinity exptrapolated from it.

Since the dissolved salts like NaCl are neutral in character, pH of natural water is usually in the neutral region (approximately 7.0). However if carbonate content is a little on the higher side, the pH value tends to be close to 8 as in the case of sea water. Given the above background the intrusion of sea water into wells in a coastal belt can

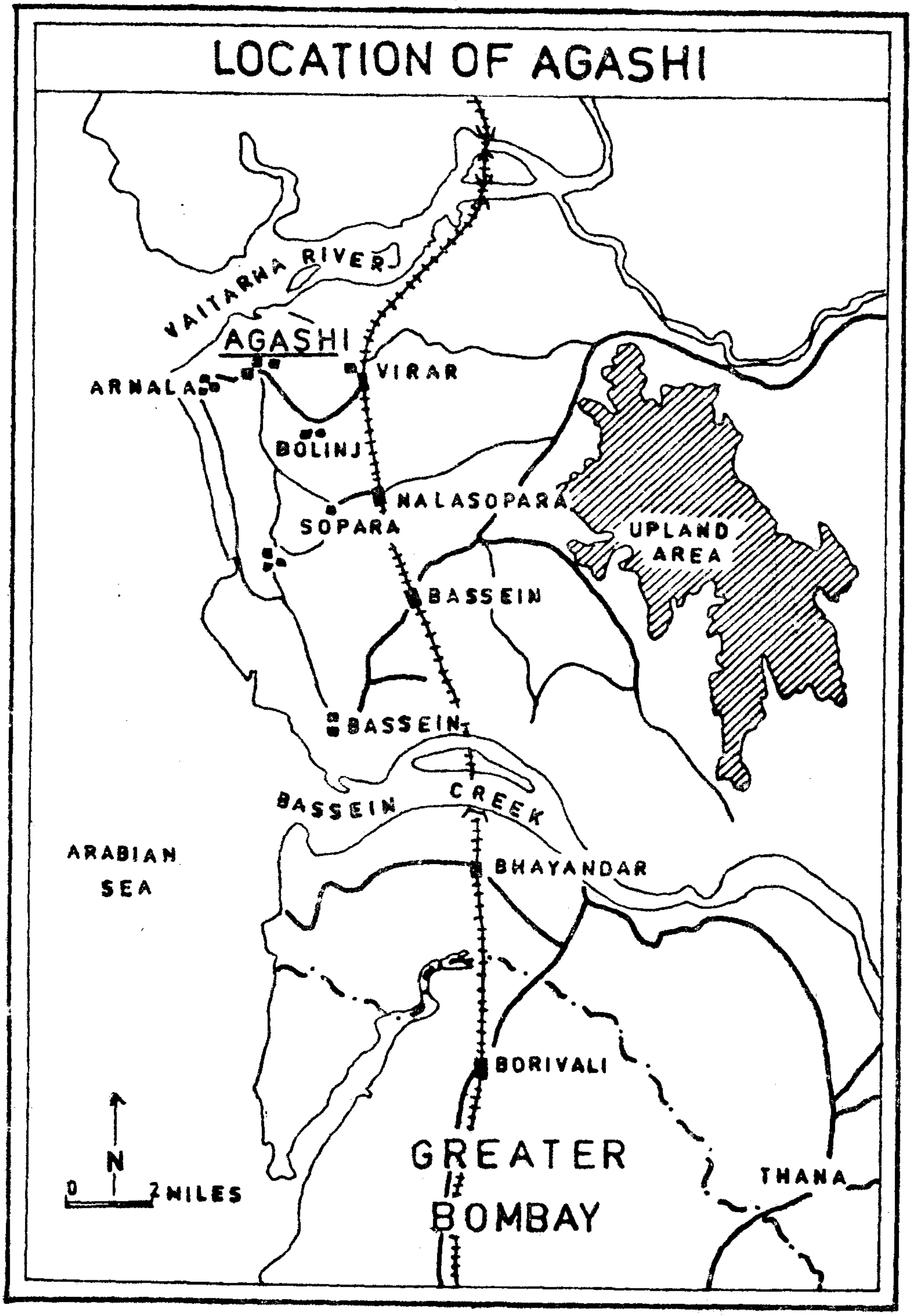
LOCATION OF AGASHI
VAITARNA RIVER
AGASHI
ARNALA
VIRAR
BOLINJ
NALASOPARA
SOPARA
UPLAND AREA
BASSEIN
BASSEIN
BASSEIN CREEK
ARABIAN SEA
BHAYANDAR
BORIVALI
N
0 2 MILES
GREATER BOMBAY
THANA

Fig. 1

be gauged by the measurement of conductivity, chloride and to a lesser extent pH. Extrapolated salinity values can be used to infer the extent of sea water intrusion into the coastal belt.

RESULTS OF THE CHEMICAL ANALYSIS

The results of the chemical analysis are summarised in Table I.

It is seen from the extrapolated values for salinity as expressed as total dissolved solids, that only 3 wells i.e. 1, 16, and 25 fall below the limit of salinity of 600; hence all the rest are not suitable for drinking water. However this statement may be slightly qualified since well nos. 2 and 22 have salinity values of just a little above 600. Given experimental errors, it is possible that these wells can also be classified as suitable for drinking water, particularly in areas of water shortage. It is worth noting that the 3 wells belonging to the Gram Panchayat which are community wells used for drinking and domestic purposes have become brackish and hence the village is faced with a severe problem in terms of drinking water.

Well nos. 7, 9, 12, 17 fall above the salinity limit of 2000. Hence the yare unfit for irrigation. Here again well nos. 7 and 12 are borderline cases since thesalinity values are 2088, just above the defined limit. The pH of well no. 7 indicates that the high salinity is not necessarily due to sea water ingress, since even pure sea water rarely exceeds a pH of 8.0. There appears to be an independent pH increasing source such as high carbonate content in the soil around this well. Thus in reality only 3 wells can be classified as having become useless for irrigation due to sea water ingress. An analysis was carried out to see if any relationship could be established between chloride content and distance from the sea. No relationship emerged probably due to the fact that the entire study area lies within two miles of the sea and hence the whole area is susceptible to ingress of salinity.

TABLE I

Results of Chemical Analysis of Well Water Samples

Sample Nnmber	Observed Conductivity (siemens/cm)	Total Dissolved Solids (mg/l)	Chloride	pH Measured
1	800	464	114	7.71
2	1100	638	178	7.82
3	3000	1740	880	8.17
4	1500	870	383	7.58
5	2200	1276	604	7.41
6	1250	725	249	7.53
7	3600	2088	909	8.49
8	3000	1740	831	7.67
9	3800	2204	1130	7.58
10	3000	1740	916	7.42
11	2150	1247	479	7.49
12	3600	2088	1065	7.52
13	3000	1740	710	7 78
14	Broken	—	—	—
15	1950	1131	426	7.49
16	900	522	213	7.69
17	5400	3132	1782	7.49
18	3200	1850	1001	7.93
19	1600	928	355	8.16
20	2400	1392	639	7.61
21	1350	783	273	7.41
22	1150	667	199	7.69
23	2900	1682	887	7.42
24	1750	1015	426	7.29
25	1000	580	149	7.86

RELATIONSHIP OF CONDUCTIVITY AND CHLORIDE LEVEL

As mentioned earlier the conductivity is the result of dissolved solids and could be due to the presence of several salts of sodium, potassium, calcium, magneisum etc. The common anion can be chloride, sulphate, carbonate, nitrate etc. The intrusion of sea water into well water will effectively alter the chloride levels. Hence in the study the chloride levels were independently measured. A correlation analysis was carried out between the conductivity and chloride (both being experimentally determined values). The coefficient of correlation was found to be 0.98. Such a high degree of correlation clearly indicates that the increase in conductivity of the well waters in question is essentially due to the ingress of high chloride levels, in other words, sea water. This analytical approach has given further confidence to the points made earlier that the well waters have been made brackish by the intrusion of salinity, which has resulted in some of the wells becoming useless even for agricultural purposes.

FARMERS RESPONSE TO SALINITY INGRESS

Most of the farmers were of the view that the problem of brackishness was a recent phenomenon and had become noticeable in the last 10 years. This is natural as it was only after the introduction of electrification in 1959 that all the wells were fitted with electric motors. The farmers are mainly dependent on market gardening and wells are the major source of irrigation. All the wells are jointly owned resulting in heavy-withdrawal of water. The farmers perception of the problem is fairly accurate except in borderline cases; for e.g., in the case of wells with a salinity between 600–800 they are generally not aware of the problem.

The problem is thus related to commercialisation of agriculture and greater withdrawal of groundwater. The farmers have been compelled to change the crops and it is interesting to note that the tendency has been to shift from cultivation of bananas and vegetables to that of flowers; the specific flowers cultivated are those having a higher degree of tolerance to high salinity. The shift was partly due to incidence of diseases in the banana plantations.

CONCLUSIONS

It is clear from the study that the problem of salinity ingress in coastal Thane is related to introduction of electrification and increase in withdrawal of ground water. The problem is not as yet as severe as it is reported to be in coastal Gujarat. However it is clear that the process has been set in motion and unless steps are taken to monitor the salinity levels in wells and start measures to check it, this prosperous agricultural area will be faced with a major environmental disaster. If proper steps are not taken immediately the cost involved for control of salinity will also become exorbitant. The repercusion of this problem will affect not only the area itself but also the city of Bombay which will then have to depend on areas much further for its requirements of vegetables and flowers.

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