CHAPTER VIII

ENVIRONMENTAL ASPECTS AND SOME REMEDIAL MEASURES
During the last few decades, disposal without proper treatment of sewage wastes from urban areas and of effluents from industries have been the cause of deterioration in the quality of groundwater adversely affecting water supplies for municipal, domestic, industrial and agricultural use. The increasing use of pesticides in raising agricultural production has resulted in an incipient degradation of groundwater quality in rural areas. It may be noticed that in spite of the technological advancement that man has achieved, there is hardly a phase of his activity that does not pollute or contaminate the environment he lives in.

The process of induction into groundwater of objectionable matter or property, arising from human activity, and thereby so changing its physical, chemical or other property as to render it unfit or less fit for drinking, agricultural, irrigation or other use, is called groundwater pollution (McKee and Wolf, 1963). The word contamination is often synonymously used when groundwater of less desirable quality pollutes groundwater of better quality when the natural equilibrium is disturbed, such as sea water intrusion due to heavy pumping in coastal area. Freeze and Cherry (1979) reserve the term pollution for situations where degradation of quality attain levels that are considered objectionable. According to Hem (1970), although some polluted surface waters can be restored to reasonable quality levels and
pollution of groundwater may be slow in recovering from the polluted condition that it becomes necessary to think of the pollution of aquifers as almost irreversible, once it occurred.

8.1 SOURCES OF POLLUTION

For definition to be of practical use, it should be based on the limiting values of water quality. Thus Matther (1972) proposed the following definition: an anthropogenically polluted groundwater is groundwater in which the total dissolved and suspended solids caused directly or indirectly by man is higher than the maximum permissible concentrations relative to the limiting values that are laid down in National and International guidelines for potable and industrial water.

The major sources of pollution in the study area are mainly the manmade factors (Agricultural, Industrial disposal and sewage wastes). A mention is made with reference to incidence of pollution in India, as gleaned from literature available on the subject (Baweja and Karanth, 1980).

8.1.1 AGRICULTURAL WASTES

In keeping with improved agricultural practices, irrigated fields are applied with fertilizers like phosphates and nitrates pesticides like aldrin, agroxone, melathon and gamexine. These may accumulate in the soil and get
dissolved in groundwater. Many of the pesticides and herbicides are cumulative poisons, their ill-effects manifesting themselves only after prolonged use of the water containing them. Progressive increase in the mineral content of groundwater, resulting from the lack of drainage and return circulation of water in irrigated areas, is well recognised. Extensive deterioration in quality of groundwater is observed in the study area.

8.1.2 SEWAGE DISPOSAL

Among the various natural resources, water is the major resource that gets affected as a result of unhealthy urban growth (Dunne and Leopold, 1978). Disposal, without adequate treatment, of sewage, municipal and domestic waste is witnessed in ill planned Chittoor urban and Yadamari towns of the study area. Bacteria, Nitrate and Phosphate contents are derived from the decaying urban vegetables and animal wastes. The use of detergent soaps, and other wastes from commercial and industrial establishments contribute to the municipal sewage. Septic tanks and polluting water derived from wells owned by individual house holds are also giving polluting effects to groundwater of the study area.
8.1.3 INDUSTRIAL WASTE DISPOSAL

Industrialisation brings with it the attendant problem of waste disposal. The effluents discharged from the industries like distillery, Sugar factory and Dairy etc., variously introducing undesirable colour, taste and dissolved salts which may include high values of Electrical conductivity, chlorides and nitrates.

The effluents from the distillery in the study area, are discharged into fields, ditches and river bed (Figs. 8.1 & 8.2). The groundwater is altogether unfit for drinking and even irrigation, polluting upto distances of a few kilometres i.e. upto the outskirts of the Chittoor town.

The dairy waste is discharged into a nearby pond without any treatment. The Sugar factory effluents are discharged directly into the river course, after sending into a pond near to the stream course (Fig. 8.3).

Pollution impact on the surface and subsurface waters (Fig. 8.4, 8.5 & 8.6) of the study area is due to the inadequate treatment and planning of Agricultural, Industrial and Municipal wastes.

8.2 HOW GEOLOGY IS FAVOURABLE TO POLLUTION

The study area is occupied by granites, gneisses and alluvium. As discussed in the Groundwater Exploration
LEGEND FOR FIGURES

Fig. 8.1 Figure shows the Distillery effluents discharge through a canal

Fig. 8.2 Figure shows the accumulation of Distillery effluents in a pond near the industry
LEGEND FOR FIGURES

Fig. 8.3 Figure shows the storage pond for the sugar factory effluents near the Doddipalli village.

Fig. 8.4 Figure shows the combined effluent runoff both from the distillery and sugar factory.
LEGEND FOR FIGURES

Fig. 8.5  Figure shows the effluent runoff through Niva river from the Distillery

Fig. 8.6  Figure shows swimming by the public causing skin diseases
(Chapter 4.7) the depth to basement is very shallow in Chittoor town, and thus the discharged effluents are not having sufficient infiltration to recover from the polluted condition. The discharged effluents are ceaselessly released year after year, the clogging of the solid salts in the pores of the weathered layer is occurring due to this the infiltration is not taking place.

The fractures, along which main stream flow, are also favourable for pollution in the downstream direction and northern portion of the stream course. Alluvial zone, which is thick along the stream course, is constituted of varying proportions of clay, silt and sand. The movement of groundwater due to the presence of clay becomes sluggish at places and it dissolves more salts there. On account of this, the discharged effluents which have high values of salts, subsurface flow in the stream course and groundwater is getting polluted.

8.3 NITRATE POLLUTION AND EFFECTS ON HUMAN BEINGS

For identification of pollution, the most unequivocal criteria possible are required. In this respect, the commonly determined inorganic dissolved solids are only suitable. Raised high values of bicarbonate, chloride and nitrate serve as indicators of pollution (Georg Matthey, 1982). However, it is to be proved at any given time and
place that these indicators are not attributable to geological origins (Luning & Heinsen, 1934, and Keller, 1942).

In the study area, the high values of Nitrates indicate water pollution. The nitrogen compounds go into surface water mainly through the introduction of the communal, agricultural and industrial waste waters, through the rainwater and also through the washing away of agriculturally used surface and built areas (Subhra chakravarthy, 1987). Specified limit of nitrate in drinking water will be around 45 mg/l as stipulated by WHO and ISI.

The following diagram fortifies the global nitrogen cycle.

Air Nitrogen

Urea Ammonia ←→ Soil Nitrate ←→ Plants

Animals

The nitrate compounds present in soil, help the plants in the synthesis of their substance. It is the nitrogen compound with highest stage of oxidation. It occurs due to the mineralisation of organic manure and subsequent
bacterial nitrification. Discharge also occurs during thunder storm by means of electric nitrate present in the atmosphere, which is the largest reservoir of nitrogen. Nitrate in groundwater is usually derived from:

--- the geochemical composition of groundwater
--- the thunder storm
--- manure
--- the organic pool of the soil
--- the infiltration of the surface runoff.

Nitrogen compounds are transformed by biological processes. In the presence of oxygen, organically bound nitrogen is oxidized via amino acids and ammonia to nitrite and finally to nitrate.

Plants extract nitrogen as the nitrate from the soil root nodule bacteria (Stainer et al., 1976). Other bacteria as well as algae can raise the nitrate supply by oxidation of atmospheric nitrogen. Any excess is available for leaching, as in the nitrate released by leaf fall or death of the plant. Fertilizer application, animal husbandry, and liquid and solid wastes can locally increase the supply of soluble nitrogen compounds.

George and Hastings (1951) found in numerous cases in Texas groundwater abnormally high nitrate content (three water samples contained 1440, 1610 & 1950 mg/l), which only in some cases could have been caused by fertilizers or man-
made pollution. Many investigators have reported nitrate contamination in groundwaters (Soren, 1977, Pande et al., 1979, Matisoff et al., 1982, Spruill, 1983, William et al., 1984 etc.).

High concentration of nitrates in drinking water is toxic and its toxicity in humanity was first reported by Comly (1945). Excessive nitrate or nitrite concentrations in drinking water pose a potential health hazard to infants (Vigil et al., 1965). The nitrate itself has no effect on health, but nitrate gets reduced to nitrite, which has a definite toxic effect at the concentration of 0.1 mg/l. The nitrite oxidises the red colouring matter (hemoglobin) of blood to methamoglobin, in which case the blood colouring matter is not in a position to transport oxygen. In case large rates of conversions are involved, inner suffocation may occur which can be recognised by the grey blue colouring of skin and mucous membrane. In case of infants, the conversion of hemoglobin can occur faster as they are more susceptible to methemoglobinemia (which is ineffective as an oxygen carrier). At higher nitrate levels, young infants (generally less than 4 months old) could die from this methemoglobinemia or blue baby disease. This methemoglobin, produces the anoxemia, symptomised by greyish or brownish-blue discoloration of the skin and can lead to death by asphyxia. Older infants and adults can
tolerate higher levels in drinking water and food because their stomach pH is too low for nitrate-reducing bacteria. However, high concentration of nitrates in drinking water cause gastric carcinomas (Gilli et al., 1984) and possible development of Cancer from Nitrosamines (U.S. Env. Protection Agency, 1976). This led the World Health Organisation to recommend a tentative limit of 45 mg/l of nitrate in public water supplies.

8.4 SUMMARY OF POLLUTION ASPECTS

From the above discussion, the study area is considered to be polluted, by the industries like distillery, Sugar and Dairy and by Agricultural and municipal sewage wastes. The variation of pollution by the nitrate is shown in Figure 7.6 a & b for both pre and postmonsoon.

Figures 7.4 (a & b) and 7.5 (a & b) of the electrical conductivity and chlorides distribution maps reveal the rate of pollution increasing and decreasing variation in the study area. The self purification of polluted rivers is brought about by distance of flow (Adeney, 1928), fast flow of the river (Klein, 1957). In the study area river water is not so much selfpurifying, because the sufficient fast flow or the quantum of water are not available in any season. Only the discharged effluents will flow in the stream.
course, and because of these effects the groundwater of the Chittoor town of the study area is highly polluted.

From all the types of analyses and observations in the field, the study area is delineated as the polluted and non-polluted areas. Hence, the surface water of the Niva river is not good enough for drinking purposes. Local people report their apprehension that they are afflicted with gastric, lung problems, cholera and laxative diseases, when surface waters of the river and polluted groundwaters are consumed.

8.5 REMEDIAL MEASURES TO CONTROL POLLUTION

Every need is felt to take remedial measures to control the pollution of waters in the study area.

First of all, the effluents of the industries must be treated as per the WHO and ISI standards, before they are released into the open ditches or ponds and/or stream courses.

Secondly, the Chittoor town must be planned in such a way to build the underground drainage system which should be treated and reused for irrigation purposes.

The following remedial measures for reducing the nitrates have to be taken into consideration.
If feasible, reduction by mixing with nitrate free water is often recommended in this regard. As nitrates are often associated with high total dissolved solids, chlorides, and electrical conductivity, the standard technologies applied for desalination viz., reverse osmosis and electrodialysis can also provide the elimination of the nitrates.

The method of natural decomposition of nitrates by bacteria can successfully be applied for the removal of nitrates. The prerequisites for the course of denitrification are the partly oxidised conditions, optimum pH value and temperature and sufficient supply of reduction agent for the extinction of micro organisms. Depending on the type of micro-organism used, either hydrogen (Autotrophic bacteria) or an organic carbon compound (heterotrophic bacteria) are added as reduction agent. For denitrification within a short time, highly concentrated bacteria on a suitable carrier is used. As an after treatment, aeration for enriching oxygen, active coal filtration for removing the residue substrata and disinfection of the nitrate free water is carried out (Subhra chakravarthy, 1987). The advantage of this method is that only nitrate compounds are converted into nitrogen gas, keeping the other properties of water unaltered. No separation nor pretreatment is required. But the disadvantage, the carbonate hardness of water is increased and extensive checking for complete
removal of nitrate is required.

For supply of water with reduced nitrate content for drinking purposes the following alternative measures are suggested.

Source development

---Procurement of water from other sources totally

---New tapping of groundwater with low nitrate content by construction of new wells in nitrate free zone, widening of flat wells or tapping of water from greater depths.

The above discussed cumulative measures would go a long way to save the posterity of the area concerned from all the health hazards and hence, the urgent need for their adoption and implementation on war footing.