Chapter 2

REVIEW OF LITERATURE
Water is one of the prime necessities for the sustenance of life. Water by its unique chemical and physical properties dissociates number of chemicals at room temperature. Hence, water is very rightly referred as 'universal solvent'. The main source of water in this universe is the rainfall. Groundwater is one of the sources of drinking water to the people of this planet. However, the water resources have not maintained their earlier status in terms of quality as a consequence of increased population. The surface water bodies have become dumping sites for municipal, domestic, hospital and industrial wastes. Due to the seepage of polluted surface waters and also due to the bacterial contamination, the groundwater are polluted. Hence it is very essential to know the chemistry of water before it is used for drinking purposes.

Investigation on heavy metals in groundwater system have been carried out by many investigators including those of Burkitt et al. (1972) and Satyanarayana et al. (1992). High level of Iron and Zinc portions may be because of the rock unit and soil nature of the area. The dumping of the solid waste in the open landfill in low lying areas creates a major sources of groundwater pollution through leaching process of materials. Generally, among the trace metals iron and zinc were detected in considerable quantities. The heavy metals chelated with organic compounds and invisibly greater redox potentials might be aided in easy transportation of the heavy metals (Warrin et al., 1971; Rao and Rameshwari, 1998).

The behavior of trace elements in groundwater is complicated because it is related to source of groundwater (rain, river and sea water). Further, it is also related to many bio-geochemical processes that control macro chemical and trace elemental conditions (Edmonds, 1973; Edmonds et al., 1987; Drever, 1988; Stuyfzand, 1989).
Direct dumping of wastes into water bodies causes the transfer of pollutants to natural virgin environment thus disturbing the ecosystem. This may include the transportation of heavy metals into aquatic systems in dissolved forms. The interaction of these heavy metals with organisms and their consumption through food chain ultimately leading to metal toxicity by bio-magnification (Stern and Baccini, 1976).

Among the major nutrients, phosphorus and potassium application through agricultural activities caused high level nitrate contamination in altering the quality of groundwater (Meisinger, 1976). Higher level nitrate concentration has been reported in dug wells and shallow tube wells, penetrating the alluvial aquifers of the Indo-Gangetic plain which is intensively cropped and irrigated area (Handa, 1994). Study by Cairn et al. (1980) depicts that the frequencies of detection of volatile organic compounds and some trace elements, which were larger in groundwater underlying urban or industrial areas in comparison to undeveloped areas.

The studies on the groundwater were made in relation with the landfill pattern in the aquifers (Cherry, 1983). The disposal of huge quantities of solid wastes by open dumping leads to environmental degradation. The solid waste is dumped in low lying areas and had the contact with groundwater or rain water resulting in generation of leachate and that contains organic and inorganic substances. This also contributes to the contamination of the groundwater or nearby surface water (Nicholson et al., 1983; Jaroslave, 1985; Vogi et al., 1985; Saprykina, 1997).

The increase in nitrate concentration in groundwater over the last 20 years have been related to increased fertilizer application especially in many of the traditional agricultural regions of Europe (Hagebro et al., 1983; Robert and Marsh, 1987), thus contributing the pollution load to the globe. The hydrological
environments which are likely to be most vulnerable to the leaching of pesticides are those with shallow water tables and coarse textured soils that are low in organic matter (Chilton et al., 1995)

Hexavalent form of Chromium (Cr$^{6+}$) is more toxic than trivalent (Cr$^{3+}$) form. The Cr$^{6+}$ causes bronchial cancer in humans (Adrino, 1986). The maximum permissible limit of Chromium in drinking water as recommended by the WHO and BIS is 0.05 ppm.

The present day environmental observations reveal that most of the aquatic habitats whisper the anthropogenic activities that carelessly caused many hazards. Loss of biodiversity, pollution, frequent water borne diseases, different noxious problems of aquatic fish and semi aquatic plants and animals including fish injure the heart of the aquatic biologists (Khulbe, 1989).

Studies conducted on the chemical groundwater quality of Mangalore city in Karnataka by Narayana and Suresh (1989) also indicated that groundwater quality deteriorates due to urbanization, industrialization and anthropogenic activities. Therefore, groundwater is a vital source of water supply for domestic, agricultural and industrial purposes. Even though there are two sources of water namely surface and groundwater, which seem to be independent of each other but are definitely interrelated and use of one may effect the water available from other sources of recharge for groundwater quality. Ramesh et al. (1995) of Chennai, Tamil Nadu (India) indicated that groundwater quality has been deteriorated due to the over exploitation, anthropogenic activities and improper management of natural resources. These lead to the unequal distribution of major and trace elements in nature.

Iron in surface water is generally present in ferric state. Concentrations of ferric greater than 1ppm have been reported in groundwater (Dara, 1993). The
average daily requirement of iron is considered to be 10 mg. Manganese plays a key role in the proper functioning of flavor-proteins and in the synthesis of sulfated muco-polysaccharides, cholesterol hemoglobin and in many other metabolic processes (National Research Council (NRC), 1973). Copper in public water supplies enhances corrosion of aluminum and zinc utensils and fittings even when concentration in water exceeds 1ppm. The concentration of zinc in groundwater is usually higher than that in the surface water owing to the leaching of Zinc containing particles. Many nickel salts are water soluble and therefore contamination of groundwater takes place. The levels of nickel generally found in food and water are considered to be a serious health hazard (Underwood, 1971). Because of low solubility of chromium the levels found in water are usually low. The concentration of lead in fresh water is generally lower than water source since lead is partially removed by conventional water treatment processes. The levels of lead in drinking water, however, can be much higher, owing to the use of lead in service pipes and lead linked storage tanks (NRC, 1997). The sources of accumulation of Cadmium in drinking water are fishes (Kataria, 1995) hence generally cadmium is not found in groundwater. It has been particularly prevalent among children in slum areas (Patri and Pande, 1987; Sharma et al., 1998; Singh et al., 1988; Sawanth et al., 2000; Mohan et al., 1998).

Fluoride is considered as a mineral nutrient. The farmers in Andhra Pradesh state, first detected fluorosis in India among the cattle, during early 1930s. Among the Indian union states, a high level of fluoride of 5.2 ppm in Medak district of Andhra Pradesh (Srikanth et al., 1994), 15 ppm in Nawabganj block of Uttar Pradesh (Mukherjee et al., 1995) and 18 ppm in Jaipur of Rajasthan (Agarwal et al., 1991) as been reported as against its critical limit of 1.5 ppm in drinking water (BIS, 1998). The fluoride levels mentioned above by various regions pose serious health hazards to human and irreversible damage to plants. High profile of fluoride in shallow zone groundwater is due to geo-chemical deposition in the
vicinity of groundwater extraction structures. High ambient temperature, alkalinity, calcium and magnesium contents in the drinking water influences Toxicity of fluoride (Singhal et al., 1994).

Baruni (1995) conducted a study in Tripoli, Libya and noted that over exploitation of groundwater of the Miocene-Quaternary aquifer to meet the Tripoli water supplies invited the problem of chemical contamination and thereby the TDS content has increased to about 10,000 ppm.

Tripathi and Srivastava (1996) have carried out chemical analysis for salts in groundwater samples, in and around the salt pan, situated on the adjacent part of Chilka lake in Orissa (India). The study showed that the groundwater has been polluted due to increase in the salt concentration which flows through the soil by percolation and reaches the aquifer through the surrounding salt pan regions. Adhikari et al. (1997) of West Bengal (India) have studied the raw sewage effluent discharge from Dhapa chemical plant, with respect to its long term effect on application on the composition of groundwater. The study revealed the effect of raw sewage fed in this area has little impact on the chemical composition of groundwater. Janardhana Raju et al. (1998) have also conducted study on chemical quality and ecological aspects of groundwater in Nandyal taluk of Andhra Pradesh. The investigation made indicated that the chemical quality is characterized by the high salinity with non-carbonate alkalinity.

Rao and Rameswari (1998) studied the groundwater quality and classified Vishakapatnam region as industrially polluted and non-polluted groundwater zone. Sharma and Swamy (1986) investigated the water quality in the same region and observed different pollution viz., industrial effluents, natural pollutants, geological formations, irrigation and urban pollutants.
Weathering of rocks contribute carbonate and bicarbonate salts. In areas of non-carbonates rocks the HCO$_3$ and CO$_3$ originates entirely from the atmosphere and soil CO$_2$, whereas in areas of carbonate rocks, the rock itself contributes approximately 50% of the carbonate and bicarbonate presence (Chapmann, 1998). Dissolution of calcium and bicarbonates is active in the recharge area, such that Ca$^{2+}$ is saturated with respect due to calcite (Edmunds, 1973). Calcium and magnesium are essential for normal human growth. It has been found in several epidemiological investigations in the USA and European countries that drinking water hardness i.e., concentration of calcium and magnesium is inversely associated to cardiovascular mortality in particular and adult mortality in general (Schroedar, 1960; Crawford et al., 1968; CEC, 1976 and Sonnebome et al., 1983). These investigations have revealed the presence of calcium and magnesium in the drinking water supplies might prove beneficial to humans. Magnesium is common in natural water as Mg$^{2+}$ and along with calcium, contributing to water hardness. Magnesium arise principally from the weathering of rocks containing Ferro magnesium minerals and from some carbonates rocks. Magnesium occurs in many organo-metallic compounds and in organic matter since it is an essential element for living organisms (Sawyer et al., 1978; Kannan, 1991).

Evaluation of drinking water quality in Tiruchirapalli, Tamil Nadu was carried out by Jameel (1998) with regard to the determination of suitability of water for drinking and domestic purposes. The analytical data showed all the waterbodies have high levels of organic salts and total hardness, with high electrical conductivity. Since they are unsuitable for drinking purposes, methods to improve the water quality has been suggested. Jain et al. (1996) have succeeded in assessing the groundwater quality in western Uttar Pradesh for the post and pre monsoon seasons, to evaluate the suitability of water for irrigation and domestic uses. It was observed that the quality of groundwater of the study area is suitable for both the uses. The values of sodium adsorption ratio indicate that majority of samples fall under the category of low sodium hazards.
Further, Davina Gonsalves and Joe D’Souza (1999) have conducted the study on the groundwater in Goa city in order to assess the impact of tourism industry on the quality of groundwater with respect to physico-chemical and microbial parameters. Srivastava (1997) investigated the status of water pollution in and around Hazaribagh township in South Bihar region. The analytical work was made during the pre and post monsoon season, the report obtained during the study revealed the presence of high levels of hardness, iron and biochemical oxygen demand content than the standard limits of drinking water. Therefore, the treatment of water prior to use for domestic purpose from the pollution control point of view was suggested.

High profile of fluoride in groundwater has been observed in 4.6% of geographical area in Karnataka (Sumalatha et al., 1999). Sporadic incidence of high fluoride content in groundwater has been reported from India, China, Sri Lanka, West Indies, Spain, Holland, Italy, Mexico, North and South American countries. In India its occurrence in top aquifer system is endemic to many places in Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Rajasthan, Punjab, Haryana, Bihar and Kerala (Sumalatha and Ambica, 1999).

A case study on groundwater water pollution due to improper treatment and disposal arrangement by Maharashtra distilleries was conducted by Biradar et al. (1999). They have arrived at the conclusion that among the various physico-chemical parameters analyzed, few parameters viz., dissolved oxygen, alkalinity, BOD were affected by percolation of distillery effluent stored in Katcha lagoon and thereby the water quality was made unsuitable for drinking, domestic and irrigation purpose.

Mercury is rather a scarce element in the earth’s crust but its industrial use is wide spread and it is easily found in the aquatic environment around most of the big cities. All forms of mercury are not equally toxic and in nature, they change
their form, due to different kinds of reactions. Methyl mercury is worst toxic form, which is soluble in nature. The ‘Minamata’ disease was found to be due to the consumption of fishes containing methyl mercury (Sawant et al., 2000).

Chandrashekar et al. (2000) have succeeded in assessing the groundwater pollution potential through remote sensing and GIS techniques for Anekal taluk of Bangalore urban district of Karnataka. The main objective of remote sensing technique used was to protect groundwater quality from every activity of the society, which causes pollution and to determine groundwater pollution potential.

A study on fluoride hazard in groundwater of Orissa has been carried out by Das et al. (2000) and observed that 81.3% of groundwater samples from shallow aquifers contain less than 1.0 mg/l, 7.86% are with 1.5 mg/l and 10.83% are above 1.5 mg/l. Rao and Venkateshwaralu (2000) have suggested that the groundwater of Chirla town is not suitable for drinking purposes without a proper treatment. The electrical conductivity values are very high in that water and few of them possess high values of total hardness, magnesium and sulphate contents. In some areas, excess fluoride concentration is also observed.

Pushpa Bharathi and Meera Rao (2000) have made investigation pertaining to fluoride content of groundwater and its diets on adults from fluorotic villages in Mundaragi taluk of Gadag district, Karnataka. Further, they focused on the content of fluoride in groundwater diets of adults from six fluoritic villages and one non fluorotic village of Mundagiri taluk of the study area. The report indicated that a maximum of 13.5 ppm fluoride in the fluorotic village and a minimum of 0.8 ppm from non fluorotic village. They have also conducted a study on preventive measures of fluorotic village in Mundaragi taluk of Gadag district in order to get information on the existing measures for prevention of fluorosis through personnel interview. Even though some practicing methods such as consumption of milk, Green leaf vegetable, use of plastic and soil pots for storage of eatables, the
authors failed to remove excess fluoride from drinking waters in the study locality. Pushpa Bharathi et al. (2000) suggested a chemical treatment for defluoridation using alum as a defluoridator at domestic level. The experiment conducted revealed that, alum at a concentration of 2.5 ppm for the contact of 18 hours reduces the fluoride to permissible limit of 1.5 ppm.

Aurangabadkar et al. (2001) assessed the groundwater quality around municipal solid waste dump site at Chennai. The study revealed that the quality of groundwater does not confirm to the drinking water quality standards. Concentration of iron and manganese were exceeded the permissible limits for drinking water. Sharma (2001) carried out the analysis of the groundwater in an industrial town, Bhilwara of Rajasthan and established a significant positive correlation between electrical conductivity and physico-chemical parameters like chloride, magnesium, nitrate and total dissolved solids and suggested to detect the level of electrical conductivity and total hardness periodically, which serve as valid parameters for monitoring the groundwater quality in industrial towns instead of complete water analysis as such key parameters also give insights into hydrochemistry and geology of the area concerned.

Mishra and Patel (2002) studied the water quality of Sundergarh town of Orissa and reported unbalanced concentration of nitrate in different localities. Kaushik et al. (2002) worked on water quality of urban groundwater of Hisar and Panipat in Haryana and observed the greater impact of urban activities on underground water quality in Hisar city as compared to Panipat. Thangavel et al. (2003) assessed the quality of groundwater and soil nearby tanneries in Walajah area and established a significant negative correlation between the distance from the point of disposal of tannery effluent.

Garg (2003) studied the groundwater quality of Chitrakoot region and stated that the water is fit for drinking and irrigation purposes. Garg et al. (2004)
analysed the physico-chemical characteristics of Bangalore and stated that 40% of the total samples were turbid, 66% of total samples were hard water, 47% of total water samples were iron content, 87% of the total samples with sodium and 10% of the samples with potassium contents

The identification of potential groundwater zones in Baghmundi block of Purulia district of West Bengal using remote sensing and GIS was studied by Chakraborty and Paul (2004) and stated that morphometric analysis of groundwater is required

Centindag and Unsal (2004) and Elango et al (2004) have studied the hydro geochemistry and made quality evolution along the groundwater path in Hankendi Plain at Turkey and found that chemically the groundwater is potable and suitable for both domestic and agricultural purposes

Shashidhar and Devata (2004) have reported pH, electrical conductivity, sulphates in groundwater of Bolaram, India According to them most of the parameters exceeded the permissible limits Thriveni et al (2004) assessed the quality of groundwater in Channagiri taluk, Karnataka The results revealed that some of the parameters like hardness, electrical conductivity, total dissolved solids, and alkalinity exceed the permissible limits The seasonal study of nutrient status of the groundwater of Honnali taluk in Karnataka was done by Basavarajappa et al (2004) The seasonal studies made by Kumar et al (2004) had revealed the ionic relationship provides the groundwater quality management

Recent contributions to the field of groundwater chemistry include those of Anisa B Khan and Sapna (2005) who conducted a case study on groundwater salination in different aquifers in and around Pondicherry region and found groundwater samples of the southern region are highly contaminated with sea water Further, they have stated that legal enactments and strict implementation of
legislation are to be taken to prevent indiscriminate pumping of groundwater and alternative technology to increase the natural recharge potential of the groundwater bodies/surface reservoirs.

Recently, Harish Babu et al. (2006) worked on groundwater quality of Tarikere town, Karnataka state and analyzed for the assessment of the physico-chemical parameters with reference to BIS standards for drinking water.