CHAPTER - II

REVIEW OF LITERATURE
REVIEW OF LITERATURE

Introduction

Water is essential for the survival of humans, animals and plants. Water is also home to a very wide range of microflora and microfauna, creating a fascinating environment of extreme biological importance, but which attracts too little attention.

Fresh water is emerging as one of the most critical natural resource issues facing humanity. Water is, literally, the source of life on earth. The human body is 70% water. Human beings can survive for only a few days without fresh water.

It is estimated that 31 countries, accounting for under 8% of the world population, face chronic fresh water shortages. By the year 2025, however, 48 countries are expected to face shortages, affecting more than 2.8 billion people -35% of world’s projected population. Among countries likely to run short of water in the next 25 years are Ethiopia, India, Kenya, Nigeria, and Peru. Parts of other large countries, such as China, already face chronic water problems (WHO, 1997).

In most parts of the world polluted water, improper waste disposal, and poor water management cause serious public health problems. Such water-related diseases as cholera, typhoid, and schistosomiasis harm or kill millions of people every year. Overuse and pollution of water supplies also
are taking a heavy toll on the natural environment and pose increasing risks for many species of life.

The quality as well as the quantity of water is deteriorating globally as a result of rapid urbanization, population growth and industrialization. Most countries however currently are aware of the necessity of fresh water as a requirement for survival. Fresh water needs to occupy highest priority, on the international agenda.

Moreover, the supply of the freshwater that is available to humanity is shrinking, in effect, because many fresh water resources have become increasingly polluted or dried. In some countries lakes and rivers have become receptacles for a vile assortment of wastes, including untreated or partially treated municipal sewage, toxic industrial effluents, and harmful chemicals that leached into surface and ground waters from agricultural activities. Caught between finite and increasingly polluted water supplies on one hand and rapidly rising demand from population growth and development on the other, many developing countries face uneasy choices (Crossette, 1995). The lack of freshwater is likely to be one of the major factors limiting economic development in the decades to come, warns the World Bank (Serageldin, 1995a).

Scarce and unclean water supplies are critical public health problems in much of the World. Polluted water, water shortages, and
insanitary living conditions kill over 12 million people a year (Davidson et al, 1992). Pollution is pervasive. Few countries, whether developing or industrialized, have adequately safeguarded water quality and controlled water pollution. Many countries do not have proper legislation to control water pollution adequately, while others cannot enforce water quality standards.

International development agencies are often urging the developing countries devote more attention to protecting and improving water quality. The developed world also must spend more and do more to clean up degraded waterways, or economic development will stall and the quality of life will fall (Falkenmark and Lindh, 1993).

The GEMS/WATER Programme

The Global Environmental Monitoring System (GEMS) was initiated in 1974 as a means of promoting and coordinating the collection of environmental data nationally, regionally, and globally. While GEMS aims at assisting governments to develop monitoring systems for their own use, its other objectives are to improve the validity and comparability of environmental data globally and to provide for the collection and assessment of environmental data. Within GEMS, major programs were developed for climate-related monitoring, monitoring of natural resources, monitoring of the oceans, and health-related monitoring.
As part of the latter group of projects, the global water quality monitoring project, briefly GEMS/Water, was established in 1976 jointly by WHO, UNESCO, WMO and UNEP. The objectives of the project are:

- to collaborate with Member States in the establishment of new water monitoring systems and to strengthen existing ones

- to improve the validity and comparability of water quality data within and between Member States

- to assess the incidence and long-term trends of water pollution by selected persistent hazardous substances.

The global water quality monitoring project is based on the active participation of Member States which routinely monitor the quality of the hazardous substances in water resources at selected locations and provide the data for global synthesis and dissemination. Wherever possible, the stations for the global network were selected from existing national or local networks. Where such stations did not exist, new ones were established. Priority was given to water bodies (rivers, lakes and groundwater aquifers) which are the major sources of water supply for municipalities, irrigation, livestock, and selected industries. A number of stations were also included to monitor international rivers and lakes, rivers discharging into ocean and seas, and water bodies not yet affected by man's activities (baseline stations).
The target for the first stage of the project (1977-1981) was the establishment of a skeleton network of approximately 300 monitoring stations on rivers, lakes, and on groundwater aquifers. At that time it was estimated that a total of about 1200 stations might ultimately be required to achieve representative global coverage. Measurement of water quality variables at these stations included natural as well as anthropogenic constituents.

The period between 1977 to 1979 was a preparatory phase during which time guidelines were prepared, specialists were trained in different regions, and national, regional and global centers were established. National institutions were identified in agreement with the governments and designated as the focal points for GEMS/WATER activities within each country. In addition, laboratories were designed to conduct the routine sampling and analysis at the selected monitoring sites.

GEMS/Water is implemented by WHO, Geneva, with the assistance of WHO Regional Offices. Technical support is provided by two WHO regional centers for environmental health. In addition, institutes have been designated as regional reference laboratories for implementing the analytical quality assurance component of the project. The Global Data Center is located at the Canada Center for Inland Waters, Burlington, Canada, which was designated as both a WHO Collaborating Center on Surface and Ground Water Quality and a UNEP GEMS Collaborating
Center for Freshwater Monitoring and Assessment. The Environmental Monitoring and Support Laboratory, Cincinnati, of the U.S. Environmental Protection Agency serves as the global center for analytical quality control. UNESCO has participated in the field of training and measurement methodology. WHO has concentrated on network design criteria and hydrological monitoring methods.

The initial phase of the project, (1977-81) has led to the completion of a basic monitoring network. Routine operations with regard to data flow were established for most stations during 1978 to 1979. The necessary technical procedures were provided through the GEMS/WATER Operational Guide which has been used in all laboratories and institutes as the principal guideline for their monitoring program.

Having achieved a certain level of routine monitoring and data reporting, it was considered timely to compile project results in the form of three publications which appeared in 1983:

2. GEMS/WATER Data Summary 1979-1981.

Nutrient Pollution

Agriculture forms the biggest contributor for water pollution even more so than industries and municipalities. Virtually in every country,
where agricultural fertilizers and pesticides are used, there are reports of contaminations of groundwater aquifers as well as surface waters. Animal wastes form another source of persistent pollution in some areas. The water that goes back into rivers and streams after being used for irrigation is often of degraded quality with excess nutrients, salinity, pathogens and sediments that often render it unfit for any further use, unless cleaned—typically at great expense—by water purification plants (Klohn and Wolter, 1998).

Europe and America confront enormous water pollution. Over 90% of Europe’s rivers have high nitrate concentrations, mostly from agrochemicals, and 5% of them have concentrations at least 200 times greater than nitrate levels that occur in unpolluted rivers (WHO, 1999).

Over half of Europe’s lakes are eutrophied from a glut of agricultural and municipal nutrients. Eutrophication is a process that occurs when excess nutrients stimulate the growth of algae, which, when they die and decay, rob the water of oxygen. In Europe eutrophication has become one of the most serious problems affecting freshwater and also near shore marine environments (Abramovitz, 1996).

Although mineral salts of low pollution relevance are the most common constituents found in ground water, some serious pollutants and pollution levels also can be detected. UNEP (1998) reported that 79% of ground water samples in Sri Lanka contain nitrate levels above the drinking water standard of 10 mg/litre.
The primary source of NO$_3$-N in ground water is leaching from soils. Shrivastva et al, (1988) and Olaniya and Saxena (1977) have reported the leaching of nitrate ions from the soil into ground water. Nitrate itself is relatively nontoxic but when ingested with food or water it may be reduced to nitrite (NO$_2$-) by bacteria present in mouth and gut. If nitrite containing water is utilized for drinking purposes (Qian-Feng et al, 1983) it can react with secondary amines present in the human body, and may form carcinogenic nitrosamines. High levels of nitrates present a health problem and can cause infant methaemoglobinemia (blue baby disease) and cancer (Aps, 1991). Nitrates affect young babies less than three months old by depriving them of oxygen.

Health problems due to nitrates present in water sources have attained a serious state almost in every country. In over 150 countries nitrates from fertilizers have seeped into water wells, fouling the drinking water (Maywald, et al 1988). Excessive concentrations of nitrates cause blood disorders (Bowman, 1994). They are also found to cause digestive tract cancers (Linda Nash, 1993). High levels of nitrates and phosphates in water encourage growth of blue green algae, leading to deoxygenation (eutrophication). Oxygen is required for the metabolism of the organisms that serve as purifiers which break down organic matter polluting the water. Therefore the amount of oxygen contained in water forms a key indicator of water quality.
The use of agricultural chemicals (nitrate –nitrogen fertilisers and pesticides) and their occurrence in groundwater is examined by Goodrich (1991). The concern over the toxicological hazards caused due to pesticides is growing over the last three decades. The extent of groundwater contamination from both nitrate – nitrogen and from a range of pesticides is discussed based on numerous surveys throughout U.S.A. Technologies available for removing these chemicals, to acceptable drinking water levels are outlined. Several different drinking water treatment methods, involving both centralised treatment and individual household point of entry devices, were evaluated through case studies and field – scale research projects in Suffolk country, New York, and in California. Processes available for the removal of nitrate from drinking water were reviewed presenting their strengths and weaknesses (Burke, 1991). The processes were ion exchange, reverse osmosis, electrolysis and biological denitrification. A combination of biological denitrification and electrodialysis is available offering such benefits as conversion of nitrates to nitrogen in continuous operation. It is suitable for flows above 300 m$^3$ per day and with a nitrate concentration of 50 – 100 mg/l.

**Ground water Pollution**

In many areas of the world groundwater is the primary drinking water source. Ground water quality is affected by many factors such as physico chemical characters of the rocks through which the water is
circulating, geology of the location, climate of the area, role of microorganisms that operate for the oxidative and reductive biodegradation of organic matter, intrusion of saline waters as in coastal areas etc.

Ground water constitutes an important component of many water resource systems, supplying water for domestic use, for industry and for agriculture. At present, nearly one-fifth of all water used in the world is obtained from groundwater resources. Some 15% of world’s crop land is irrigated by groundwater. The present irrigated area in India is 60 million hectares (Mha) of which about 40% is from groundwater (Raghunath, 1987).

Groundwater acts as a reservoir by virtue of large pore space in earth materials, as a conduit that can transport water over a long distance, and as a mechanical filter that improves water quality by removing suspended solids and bacterial contamination (Sharma, 1996).

In Europe the problem of groundwater pollution is worsening. Within 50 years some 60,000 square kilometers of groundwater aquifers in western and central Europe are calculated to be contaminated with pesticides and fertilizers (Niemczynowicz, 1996). Of Hungary’s 1,600 field wells tapping groundwater, 600 of them are already contaminated, mostly with agricultural chemicals (Havas-Szilagyi, et al 1998). In the Czech Republic 70% of all surface waters are heavily polluted, mostly with municipal and industrial wastes. Some 30% of the country’s rivers are so
fouled with pollutants that no fish survived (Nash, 1993). In US, 40% of all surface waters are unfit for bathing or fishing, and 48% of all lakes are eutrophied (US EPA, 1998).

Germany has accorded high priority to ground water protection where over 80 per cent of the public water supply was taken from groundwater, including artificial recharge and bank infiltration. However despite legislation, groundwater pollution was increasing, particularly in agricultural areas. Hence limits have been introduced for pesticides levels and new rules have been introduced governing dumping and storage.

River Pollution

More than half of the Worlds major rivers are being seriously depleted and polluted, degrading the surrounding ecosystem, thus threatening the health and livelihood of the people who depend upon them for irrigation, drinking and industry. As per the World Commission on water for the 21st century, 25 million people fled their homes in 1998 because of the depletion, pollution, degradation and poisoning of rivers, outnumbering the war related refugees for the first time in history (Reuters, 1999).

Pollution is a vexing problem in developing countries where the population is growing rapidly, development demands are increasing, and governments have different investment priorities. In developing countries, on an average, 90% to 95% of all domestic sewage and 75% of all industrial
waste are discharged into surface waters without any treatment (Carty, 1991; Allaoui, 1998).

In Thailand and Malaysia water pollution is so heavy that rivers often contain 30 to 100 times more pathogens, heavy metals, and chemicals from industry and agriculture than is permitted by government health standards (Niemczynowicz, 1996). Over three-quarters of China’s 50,000 kilometers of major rivers are so filled with pollutants and sediment that they no longer support fish life. In 1992 China’s industries discharged 36 billion metric tons of untreated or partially treated effluents into rivers, streams, and coastal waters (UNEP, 1998). In 1986, along the Liao River, which flows through a heavily industrialized part of northern China, almost every aquatic organism within 100 kilometers was killed when over 1 billion tons of industrial wastes were dumped into the river in a period of three months (Hinrichsen, 1998a).

In greater Sao Paulo, Brazil, 300 metric tons of untreated effluents from 1,200 industries are dumped into the Tiete River every day as it flows through the city. As a result, the river flows with high concentrations of lead, cadmium, and other heavy metals. The city also dumps some 1,000 metric tons of sewage into the river each day, of which only 12% is estimated as treated (WHO, 1992).

Karachi, Pakistan’s largest city, has completely overwhelmed the capacity of its outdated sewage treatment plants. Because of frequent
breakdowns and clogged sewage pipes, these plants often operate at no more than 15% of capacity. Majority of all sewage water leaks out into the surrounding soil, contaminating the wells used by city residents for drinking water (Rahman, 1995).

Furthermore, pollutants such as sulfur dioxide and oxides of nitrogen, which combine in the atmosphere to form acid rain, have had pervasive effects on both freshwater and land ecosystems. Acid rain lowers the pH of rivers and streams. Unless buffered by calcium (as contained in limestone), acidified waters kill many acid-sensitive fish, including salmon and trout. In the soil, acids can release heavy metals, such as lead, mercury, and cadmium, that percolate into waterways (Hinrichsen, 1998b).

Some of the worst pollutants are synthetic chemicals. Some 70,000 different chemical substances are in regular use throughout the world (Pullen and Hurst, 1993). Every year an estimated 1,000 new compounds are introduced (World resources Institute, 1987). Many of them find their way into rivers, lakes, and groundwater aquifers. In the US alone, more than 700 chemicals have been detected in drinking water, 129 of them considered highly toxic (Maywald et al, 1988).

A number of synthetic chemicals, particularly the group known as persistent organic pollutants (POPs), which includes halogenated hydrocarbons, dioxins, and organochlorines such as DDT and PCBs, are long-lived and highly toxic in the environment (World Bank, 1993). They
do not break down easily under natural processes and thus tend to accumulate in the biological food chain, until they pose risks to human health. For example, Beluga whales swimming in the highly polluted St. Lawrence River, which connects the Atlantic Ocean to North America’s Great Lakes, have such high levels of PCBs in their blubber that, under Canadian law, they now qualify as “toxic waste dumps” (Pullen and Hurst, 1993). Indigenous communities that once hunted these whales no longer are permitted to take any because of the health risks.

**Microbial Pollution**

Epidemics arising from waterborne diseases are a global health problem. Faecal contamination of drinking water is the main cause of these outbreaks. According to WHO (1996) for drinking water to be classified as safe, no coliform bacteria should be present in a 100ml water. Water-related diseases present a human tragedy, killing millions of people each year, preventing millions more from leading healthy lives, and undermining development efforts (Olshansky et al, 1997). About 2.3 billion people in the world suffer from diseases that are linked to contaminated water (Kristof, 1997).

Some 60% of all infant mortality is linked to infectious and parasitic diseases, most of them water-related (Rowley, 1996). In some countries water-related diseases make up a high proportion of all illnesses among both adults and children. In Bangladesh, for example, an estimated
three-quarters of all diseases are related to unsafe water and inadequate sanitation facilities. In Pakistan one-quarter of the people attending hospitals are sick only due to water-related diseases (Ali, 1992).

While water-related diseases vary substantially in their nature, transmission effects and adverse health effects related to water can be organized into three categories: water-borne diseases, including those caused by both faecal-oral organisms and those caused by toxic substances; water-based diseases; and water-related vector diseases (Bradley, 1994). Another category—water-scarce (also called water-washed) diseases—consist of diseases that develop where clean freshwater is scarce (Kjellen and McGranahan, 1997).

Water-borne diseases are “dirty-water” diseases—ie those caused by water that has been contaminated by human, animal, or chemical wastes. Worldwide, the lack of sanitary waste disposal and the lack of clean water for drinking, cooking, and washing is the cause for over 12 million deaths a year (USAID, 1990).

Water-borne diseases include cholera, typhoid, shigellosis, polio, meningitis, and hepatitis A and E. Human beings and animals act as hosts to the bacterial, viral, or protozoal organisms that cause these diseases. Millions of people have little access to sanitary waste disposal or to clean water for personal hygiene. Over 1.2 billion people are at risk because they lack access to safe freshwater (Khan, 1997).
Where ever proper sanitation facilities are lacking, water-borne diseases can spread rapidly. The extent to which disease organisms occur in specific freshwater sources depends on the amount of human and animal excreta that they contain (Bowman, 1994).

Diarrhoeal disease, the major water-borne disease, is prevalent in those countries where there is inadequate sewage treatment. An estimated 4 billion cases of diarrhoeal diseases occur every year, causing 3 million to 4 million deaths, mostly among children (Olshansky et al 1997).

Using contaminated sewage as fertilizer has resulted in epidemics of diseases like cholera. In the early 1990s, for example, raw sewage water that was used to fertilize vegetable fields caused outbreaks of cholera in Chile and Peru (Misch, 1991). In Buenos Aires, Argentina, a slum neighborhood faced continual outbreaks of cholera, hepatitis, and meningitis because only 4% of homes had either water mains or proper toilets. Besides poor diets and little access to medical services aggravated the health problems (Ainstein, 1996).

Toxic substances that find their way into freshwater are another cause of water-borne diseases. Increasingly, agricultural chemicals, fertilizers, pesticides, and industrial wastes are being found in freshwater supplies. Such chemicals, even in low concentrations, can build up over time and, eventually, can cause chronic diseases such as cancers among people that use the water (Silfverberg, 1994).
Pesticides such as DDT and heptachlor, which are used in agriculture, often flow into the irrigation waters. In Dhaka, Bangladesh, heptachlor residues in water sources have reached as high as 0.789 micrograms per litre—more than 25 times the WHO-recommended maximum of 0.03 micrograms per liter (Xinhua Chinese News Agency, 1998). Similarly, a study of irrigation waters collected during the rainy season in Venezuela found that the water was contaminated with a number of pesticides.

The seepage of toxic pollutants into ground and surface water reservoirs utilised for drinking and household use caused health problems in industrialised countries as well. In Europe and Russia the health of some 500 million people is at risk from water pollution. For example, in northern Russia half a million people on the Kola Peninsula, consume water contaminated with heavy metals, a practice that helps to explain high infant mortality rates and endemic diarrhoeal and intestinal diseases reported there (Edwards, 1997).

Twelve water quality variables from upstream and downstream locations in the Hanford reach, Columbia river, Washington, were examined for the time periods 1951-1953 and 1963-1988 to identify any significant changes that might have occurred over a 35 year interval. During the 1951-1953 period higher downstream beta radioactivity and water temperatures were observed arising from 5 single-purpose production
reactors which operated until 1971. Dissolved oxygen (DO) and sulphates were also significantly lower downstream during the early period. The beta-radioactivity and water temperatures were similar upstream and downstream during the 1986-1988 period, but nitrate nitrogen had become significantly higher downstream. Phosphates had decreased significantly over the 35 year interval, while BOD, DO and nitrate nitrogen had increased by a small degree.

**Water Quality Problems of India**

Water is one of the major means of transport of arsenic in the environment. Arsenic in the aquatic environment is predominant in places with high geothermal activities. Industrial effluents are the added source of arsenic to the environment. Arsenic and arsenical compounds are found in effluents from the metallurgical industry, glassware and ceramic industries, dye and pesticide manufacturing industries, petroleum refining, rare earth industry and other organic and inorganic chemical industries. United States currently has set 50 µg/l as the maximum contaminant level for arsenic in drinking water. Because of the cancer risks involved, Canada has already lowered the maximum contaminant level to 25µg/l; the United States Environmental Protection Agency is reviewing the current allowable level for arsenic with a view of lowering it significantly. Various treatments methods have been adopted to remove arsenic from drinking water (Viraraghavan et al., 1999).
Arsenic in groundwater has been found above the maximum permissible limit (0.05mg/l) in six districts of West Bengal, India; these six districts have an area of 34,000 km\(^2\) with a population of 30 million (Chatterjee et al; 1993 Das et al; 1995). Based on a survey of these affected districts it was estimated that at least 800,000 people could be drinking water high in arsenic with more than 175,000 people showing arsenical skin lesions which are the advanced stages in the manifestation of arsenic toxicity. Major source of arsenic is geological. Most of the water samples contained a mixture of arsenite and arsenate and in none of them was methylarsonic or dimethylarsinic acid detected.

A recent study of ground water samples collected in an area of about 270 km\(^2\) from Madras city, India, showed that the arsenic levels exceeded the maximum permissible limit over the entire city and a positive correlation of arsenic with other toxic metals showed all these toxic elements to be anthropogenic in origin (Ramesh et al., 1995).

Poor management and negligence has compelled villagers in several districts of West Bengal to drink water contaminated with arsenic even 18 years after the calamity was first discovered. People are suffering clinically and subclinically, with more and more cancer cases cropping up in the affected villages. The status of the arsenic calamity in West Bengal by January, 1999 had 1000 villages affected in 9 districts (including southern part of Calcutta). It was also identified that in these 9 districts
more than 4.5 million people are drinking contaminated water with arsenic above 0.05 mg/l and that about 300,000 people have arsenical skin lesions. About 10,000 of hair, nail, urine samples were examined and revealed that, on an average, 80% of the people had arsenic in the body above normal level. Therefore it may be assumed that a large number of people are subclinically affected (Chakraborti, 1999).

A team of scientists from the Central Soil Salinity Research Institute found arsenic in the groundwater of Gohana block in Sonepat district of Haryana. The peak concentration of arsenic found in three villages out of the five tested was more than 27 mg/l. The WHO prescribed norms allow 0.05 mg/l of arsenic in drinking water and those of FAO was only 0.10 mg/l in waters used for irrigation purposes (Down to Earth, 2002).

In India more than 25 million people of 15 States are consuming high fluoride (2 to 20 mg/l) contaminated water and are under severe threat of fluorosis. In rural India, ground water remains the main source of drinking water. The contents of fluoride in ground water is increasing due to heavy withdrawal and poor recharging of aquifers. Medically it is advised that water used for human consumption should not contain fluoride beyond 1.0 mg/l (WHO, 1984). Hydro fluorosis caused by intake of drinking water containing excessive amounts of fluoride has been reported from all five inhabited continents of the world (WHO, 1970).
Fluoride content in drinking ground waters and endemic fluorosis in 15 States of India including Rajasthan have also been reported (Susheela, 1993). In the state of Rajasthan the fluoride content in drinking waters monitored, were found to contain higher in 27 out of 32 districts (Gupta et al 1993) and a few sporadic studies on fluorosis have been reported. As per the survey carried out by the Public Health Engineering Department, Rajasthan in the year 1991-93, on the status of water supply in villages/habitations, nearly 16560 (about 20% of the total) villages/habitations were found to be affected by excess fluoride (more than 1.5 mg/l), out of which 5461 villages/habitations had fluoride higher than 3mg/l. The WHO standards permit only 1mg/l fluoride in drinking water as a safe limit for human consumption (WHO, 1970, 1984). As per the manual on Water Supply and Treatment, Central Public Health and Environmental Engineering Organisation (CPHEEO, 1991) the permissible limit of fluoride in drinking water is 1.0-1.5 mg/l and the U.S Public Health Service Drinking Water Standards allow fluoride concentration in drinking water from 0.8 to 1.7mg/l (USPHS, 1962).

The latest information shows that fluorosis is endemic in at least 25 countries across the globe. The total number of people affected is not known, but a conservative estimate would number in tens of millions. In 1993, 15 of India's 32 states were identified as endemic for fluorosis (RGNDWM, 1993). In Mexico, 5 million people (about 6% of the population) are affected by fluoride in groundwater. Fluorosis is prevalent
in some parts of central and western China, and caused not only by fluoride in groundwater but also by breathing airborne fluoride released from the burning of fluoride-laden coal. Worldwide, such instances of industrial fluorosis are on the rise.

Some governments are not yet fully aware of the fluoride problem or convinced of its adverse impact on their populations. Efforts are therefore needed to support more research on the subject and promote systematic policy responses by governments. Since some fluoride compounds in the earth’s upper crust are soluble in water, fluoride is found in both surface waters and groundwater. In surface freshwater, however, fluoride concentrations are usually low around 0.01 ppm to 0.3 ppm.

In groundwater, the natural concentration of fluoride depends on the geological, chemical and physical characteristics of the aquifer, the porosity and acidity of the soil and rocks, the temperature, the action of other chemical elements, and the depth of wells. Because of the large number of variables, the fluoride concentrations in groundwater can range from well under 1 ppm to more than 35 ppm. In Kenya and South Africa, the levels can exceed 25 ppm. In India, concentrations up to 38.5 ppm have been reported.

Samples from 30 rivers in northern and north-eastern hilly states of India were analysed for total coliforms, thermo tolerant faecal coliforms, temperature, pH, conductivity, total solids, turbidity, hardness, alkalinity,
chlorides, sulphates, fluorides, nitrates, calcium, magnesium, various heavy metals besides pesticide residues. It was found that 34.5 per cent of samples had above 50 coliforms per 100 ml while 24 per cent of samples demonstrated levels above 50 faecal coliforms per 100 ml. Iron was above maximum permissible limit only in the rivers of Tripura and some northern states. The levels of heavy metals, pesticide residues and other physicochemical parameters were close to their maximum permissible limits.

Environmental impact of the rapid growth in the Indian tanning industry with the increased use of chemicals is examined. Factors contributing to this growth and to the general neglect of environmental damage are discussed with reference to the specific water pollution problems in Tamil Nadu. The naturally sweet and potable water of the Kudavanar river was completely polluted and extremely salty down to depths of 200 ft, with the soil offering little resistance to the percolation and seepage of effluents. The tanneries situated along both the banks of the river requiring large quantities of water, not only depleted groundwater resources but also discharged effluents into the river beds.

Rivers, though most important water resources of the world are being polluted by indiscriminate disposal of sewage, industrial wastes and a plethora of human activities. Pollution of rivers first affecting its physicochemical quality systematically destroys the biotic community disrupting
the delicate food web. River pollution has several dimensions and the effective monitoring and the control of river pollution requires the expertise from various disciplines (Koshy and Nayer, 1999). There are fourteen major rivers in India and the reports of Saxena and Chauhan (1993) and those of CPCB (1996-97) indicate that majority of them are polluted. The river Yamuna, once a river of mythical status, today breeds malaria, cholera and jaundice diseases which claim the lives of thousands of living beings. Environmentalists bewail the degradation of the 1367 km of Yamuna- the largest tributary of Indias holy river, the Ganges that originates from 6387 meters high glacier in the Himalayas (Reuters, 1999). The environmental degradation gained momentum due to rapid industrialization, poor sanitation and unscientific waste disposal procedures which have absolutely no concern for the environment.

India consumes around 86311 tonnes of technical grade insecticides each year to cover 182.5 million hectares of cultivated lands. Some of these compounds, such as DDT, have been banned from agricultural use, but are still used for vector control under public health programmes. The insecticide concentrations in the river water are, therefore, dependent on agricultural practices. According to the IARI study, residues of persistent organochlorines, which are still used in large quantities in India, are found in many rivers, including the Yamuna (Anil Agarwal, 1997).
The Central Pollution Control Board in monitoring water quality at 340 locations on various rivers has conducted detailed river basin studies and has identified 18 grossly polluted stretches, 14 less polluted stretches along 22 rivers based on the designated best use of primary water quality criteria. It is seen that grossly polluted stretches fall in ‘D’ and ‘E’ categories where water is not suitable for drinking even after conventional treatment and is almost not suitable for bathing, 6 stretches of less grossly polluted are of category ‘D’ which is only fit for propagation of wild life and fisheries.

Industrial production globally has grown more than 50 fold over the past century. This rapid industrialization has a profound impact on the environment especially on water resources. Severe water pollution coupled with depletion of ground water reserves is a serious and immediate environmental challenge in India. For example, in India industries relating to Tanning, Paper and Pulp, Fertilizer, Oil refineries, steel and Fermentation generate about 850 to 1300 million cubic meters of effluents per year. The total pollutant load levels from these sectors are estimated at 24594 tons/day BOD, 34759.22 ton/day COD excluding fertilizer Industry. Though the country has made appreciable progress in conventional wastewater treatment technologies, the access to advanced/sophisticated technologies pertaining to specialized physico chemical and biological treatment of wastewater, floatation technologies, absorption and adsorption technologies etc. are limited. India has initiated wastewater treatment of
highly organic wastewaters from distilleries, food processing units, diary, pulp and paper units and the like. In the small scale industry, the need is more of state-of-the-art, technologies that are practical i.e. with less operational problems and also treat most obvious pollutants cost effectively coupled with energy generation.

It is a common sight to see large number of people easing themselves along the banks of rivers, streams and nallas which finally flow in the rivers. Dumping dead bodies and half burnt bodies is another cause of river contamination No data of these pollutants is available. However, there is no doubt that these pollutants contribute to substantial organic as well as bacterial pollution. But there is a need to address these issues, wherever any river cleaning programme is under taken.

Water quality Problems of Kerala

Kerala is facing health hazards based on water quality problems in many parts. Clean water in Kerala has become a precious commodity and the quality is threatened by activities such as agricultural discharges, domestic sewage and industrial effluents. The ground water contamination in many places is caused by mineralogical origin. The water quality problems in the coastal areas are mainly because of the presence of excess of chloride. The chloride concentration>250mg/l was detected in the well water samples of Azhikode, Kakkathuruthi, Kadalundi, Anjengo, Chellanum, Nallalam, Mankombu and Harippad. The wells at Aiyur (near
Mahe River), Payyoli and Chaliyam have high concentrations of iron and TDS. The bore well samples in Kozhikode city have high concentrations of chloride (20200mg/l), iron (0.40-0.90mg/l), total hardness (9000-10600mg/l), and sulphate (2200-2300mg/l).

In Trichur, the concentration of fluoride, iron and chloride were found to be higher in the case of few bore well samples. Also 52% of the wells were found to be bacteriologically contaminated. (Remani and Harikumar, 1998). In the midlands of Thiruvananthapuram, Kottayam, Muvattupuzha, Kannur and Kasargode the water quality problems are mainly associated with pH and iron. In the highlands, the water samples analyzed from Myladumpara of Idukki district indicated a high concentration of iron and coliforms (0.84-1.15mg/l Fe and 450MPN coliforms) (Harikumar, 1998).

Water quality studies of major rivers of Kerala indicated that the quality of water in all the rivers is not in good condition. The water quality of Bharatapuzha indicated the presence of mineral oil and high concentration of iron (0.69mg/l). Organochlorine pesticides like hexachlorohexane (14ng/l) was also detected in Bharatapuzha.

Regular monitoring of the quality of 12 major rivers and a couple of lakes in the State by the Kerala State Pollution Control Board (KSPCB, 2000) shows that they have a high level of faecal pollution as indicated by
the high count of coliform bacteria. According to KSPCB lack of adequate sanitary facilities in urban centers for collection and treatment of sewage and the practice of open defecation in rural areas are seen as the cause for the abnormally high coliform counts in the natural water bodies.

The KSPCB studies show that faecal pollution at the upper zone of the rivers far exceeds the levels specified for using the river as a drinking water source. The upper zone implies the upstream portion of a river including its tributaries and roughly about two-thirds of the length of the river from the point of origin and it is a fact that the river water from this zone is a direct source of drinking water for large sections of people. The rivers monitored by the State Pollution Control Board authorities for the study are the Karamana, Kallada, Achenkovil, Pamba, Manimala, Meenachil, Muvattupuzha, Periyar, Chalakudy, Bharathapuzha, Chaliyar and Vallapattanam. Some of these rivers are the main source of drinking water for cities and a couple of other major rural drinking water supply schemes. While the high faecal count may not have any immediate or apparent consequence on the prevailing water use practices at all the three zones, remedial measures will have to be adopted for keeping the system under control as there could be a potential for contagious diseases to spread if continued to be neglected.

The faecal pollution problem plagues the major lakes in the State too. The Ashtamudi Vembanad and Sasthamcotta lakes have alarmingly
high coliform bacterial counts. Of these only the Sasthamcotta Lake has fresh water and the water from this lake is subjected to disinfection before distribution for Kollam city by the water supply authorities.

Water quality monitoring of all the natural water bodies in the State is carried out by the KSPCB primarily under the national and international schemes, Monitoring of Indian National Aquatic Resources (MINAR) and the Global Environmental Monitoring Scheme (GEMS), respectively. Samples are taken regularly each month from marked water sampling stations along the rivers and lakes for studies (Ignatius Pereira, 2002).

Providing clean supplies of water and ensuring proper sanitation facilities would save millions of lives by reducing the prevalence of water-related diseases. Thus, finding solutions to these problems should become a high priority for developing countries and assistance agencies.