**Review Of Literature**

**WATER RESOURCES**

Water: water is required for the development of irrigation, navingation, generation of hydro-electricity and for meeting the domestic and industrial needs. Water resources are to be exploited judiciously for meeting demands, sometimes competitive, from all quarters. The inter-state river water disputes on the utilization of water resources stand in the way of full utilization of these invaluable resources.

A large proportion of India’s water resources are located in the zones with an annual rainfall of 125 centimetres and above. But need for irrigation is particularly the greatest in the zones of medium to low rainfall. Underground water is brackish in large parts of west Rajasthan and many of our rivers are facing the danger of pollution by discharge of urban and industrial wastes. On the other hand, the scarcity of drinking water is being felt more acutely in our major cities because of the increasing size of their population. A large number of our rural areas are still without safe and reliable supply of potable water throughout the years. In Madras the scarcity of water for meeting the domestic and industrial needs was so acute a few years back in summer months that there was talk about desalination of sea water in spite of the high cost of this process.

Water is an important resource like land. An important use of water in our country is for irrigation. Through irrigation we have not for only been able to extend the area under cultivation but also raise agricultural productivity. Besides, water is required in large amounts for industrial and domestic consumption.

Unlike land, the availability of water varies from place to place and time to time. Being a monsoon land, the bulk of rainfall in confined to a brief part of the country lacks surface water supply for a greater part of the year. Even places like Cherrapunji and Konkan receiving dry months.
Due to unequal distribution of rainfall, the country faces the problems of flood and famine in some parts of the country every year.

Our ground water resources are abundant only in the northern and coastal plains. In other parts of the country, its supply is not adequate. In fact, at places the ground water is obtained from a depth of more than 15 metres. So far as safe drinking water is concerned, we have not yet been able to provide it to all villages. In many parts people have to walk for more than a kilometer to fetch water. Thus in most parts of the country, the availability of water for agricultural and other purposes in inadequate and irregular. We therefore, need to plan the use of available water. Let us have a look at our national water budget.

**Our Water Budget**

Suppose there is a level piece of land, one hectare in area i.e. 10,000 sq. metres. On this piece of land if one metre deep water is allowed to stand, it would be 10,000 cubic metres or simply one hectare metre.

Taking into account the average annual rainfall for the entire country and its total area, it has been found that our total water resources are of the order of 167 million hectare-metres. Again, it has been further worked out that only 66 million hectare-metres of water can be utilized by us for irrigation. Keeping in view in the limitations of our financial and technological resources we have planned to use it in a phased manner fully only by 2010 A.D.

Before the commencement of the planning era i.e. in 1973 only 9.7 million hectare-metres of water was used for irrigation. By 1973, as much as 18.4 million hectare-metre of water was being used for irrigation.

If we take up the land area as a unit, the position could be stated a little differently. In 1951 only 22.6 million hectares of land was under irrigation. By 1984-85, the land under irrigation almost tripled to 67.5 million hectares. By 1990 another 13 million hectares were to be brought under irrigation, making the total to 80 million hectares. This may be adjudged against the total potential of 113 million hectares by 2010 A.D.
This is the gross sown area and not the net sown area as the former is bound to be larger than the letter. Currently 28 per cent of the net sown area is under irrigation i.e. 45 million hectares even though the gross irrigated area is about 80 million hectares. Not more than 50 per cent of the net sown area will ultimately be brought under irrigation. This estimated potential takes into account even the ground water resources that are recharged every year by the normal rains. These usable ground water resources are estimated to be around 40 million hectaremetres. Of this, only a fourth i.e 10 million hectare-metres are now being utilized. The remaining 30 million hectare-metres are yet to be utilized. This is the overview of our potential and developed water resources.

**Type of Water Resources**

The water resources can be classified into three categories, depending on the source. Of the various types of resources, water resources play the most important part in our lives. Most of the earth’s surface (about 3/4ths) is covered by water. Of this about 97% is found in the seas and oceans as a dilute saline solution. Of the remainder 2.4% is trapped in the polar ice so only a miniscule amount is available for use by the various life forms. Because fresh water is so scarce, good management of this resource becomes vital for the survival of life on this planet. The unique properties of water allow it to play a vital role in shaping the landscape and in creating special habitats for all organisms.

**Rainwater** in one of the purest sources of water available. Its quality almost always exceeds that of ground or surface water. It does not come nor does it come into or rocks where it can dissolve minerals and salts nor does it come contact with many of the pollutants that are often discharged into local surface waters or contaminate ground water supplies. However, rainwater quality is influenced by the ambience of the place where it falls. Rainfall in areas where heavy industry or crop dusting is prevalent may not have the same purity as rain falling in other areas.
Rainwater is soft. It can significantly lower the quantity of detergents and soaps needed for cleaning. Soap scum and hardness deposits do not occur. There is no need for a water softener as there often is with well water. Water heaters and pipes are free of the deposits caused by hard water and should last longer.

We get a lot of rain, yet we do not have enough water. Even Cherrapunji, which receives about 11,000 mm of rainfall annually, suffers from acute shortage of drinking water. This is because the rainwater is not conserved but allowed to drain away. Thus it does not matter how much rain we get, if we don’t capture or harvest it.

**Surface water** is found in the form of lakes, ponds and rivers. A lake is a large body of water found in natural depressions. These lakes may be fed by rain water or by springs. Ponds are man made bodies of water and are much smaller than lakes. Rivers are the principal source of surface water. Most large cities and towns depend on rivers for their water supply. Surface water is most often polluted as it serves as a receptacle for sewage and industrial effluents.

**Groundwater** contains dissolved minerals from the soil through which it passes. This source of water is utilized by man from springs, shallow wells and deep wells. The quality of spring water depends on the geographical location and the topography of the region. Shallow wells are dug in the uppermost layer of the earth’s surface and usually supply a limited amount of water. These wells are also susceptible to pollution due to seepage. The deep wells are dug much more minerals than the other forms of groundwater.

**Hydrosphere:** The total water present on the earth in solid, liquid and gaseous phases constitutes the **hydrosphere**. Water covers 71% of the total surface of the earth. Earth is sometimes called a water planet. Hydrosphere includes all types of water resources such as oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar ice caps and ground
water (i.e., water below earth’s surface). Approximately 97.3% of the world’s vast supply of water is in oceans. Polar ice caps and glaciers provide 2% water while underground fresh water is hardly 0.6%. Fresh water lakes and rivers account for less than 0.01% of the total. Yet they, nevertheless, contain enormous amount of water \((1.26 \times 10^{14} \text{ m}^3)\). In vapour form, water is present only to the extent of 0.001%.

Water is essential to all forms of life. A man, on an average, consumes about 2.2 liter of water daily. More than 70% of the human’s body mass is made of water. Plants cannot survive without water. Water is required for domestic uses, industrial cooling, power generation, transportation and waste disposal besides for drinking and agriculture and agriculture (irrigation). The conservation and keeping up of a good supply of water is, thus, very essential.

**Sea water** is unfit for drinking or agriculture because each kilogram contains 35g of dissolved salts. Most of the dissolved salts in sea water is sodium chloride, but more than 60 different elements are present in small amounts. Sea water contains a number of dissolved gases. principally nitrogen, oxygen, carbon dioxide and noble gases, Nitrogen and noble gases are not utilized in any biological process. However, oxygen and carbon dioxide play important roles in marine environment. The sea plants photosynthesize and respire both. This process only occurs near the sea surface. The oxygen content decreases with depth. A minima occurs in the 2001000 m depth range. Dissolved phosphates and nitrates act as fertilizers for **phytoplanktons** and other marine plants.

**Snow** and **ice** represent both a valuable asset and a menacing hazard. Snow is the principal source of water not only in many of the world’s mountainous areas, but also in the densely settled plains and valleys. Moreover, in the critical dry years, snow and ice are more dependable than other sources of water. The most detrimental effect of snowfall lies in the disruption of communication systems. Glaciers cause rock erosion
also. In recent times, the ice caps of polar regions and glaciers have been
greatly affected on account of the global warming.

Water for use in homes, agriculture and industry is generally
obtained from lakes, rivers or underground sources. The water which we
use for drinking purposes must be first purified to remove solid particles,
colloidal particles, bacteria and other harmful impurities. Important steps
for purification include preliminary filtration, sedimentation, sand
filtration, aeration and sterilisation. The purified water still contains up to
0.5 g/L of inorganic ions such as Na\(^+\), K\(^+\), Mg\(^{2+}\), Ca\(^{2+}\), Cl\(^-\), SO\(_4\)^{2-}\), F and
HCO\(_3\) but in such low concentration these ions are not harmful. The
circulation of water between hydrosphere, atmosphere, lithosphere and
biosphere is called the **hydrological cycle**.

Water is an excellent solvent for many of the chemicals that make
up our bodies, as well as for a wide variety of other substances. The
importance of water as a solvent in living organisms and in the
environment is given in the following points:

(i) Blood plasma is an aqueous solution containing a variety of life-
supporting substances. Inhaled oxygen dissolves in blood plasma in
the lungs where O\(_2\) combines with haemoglobin. Blood carries
dissolved CO\(_2\) to lungs to be exhaled from the body.

(ii) Water transports nutrients into all cells and organs of our body.

(iii) Water helps to maintain a chemical balance in the body by
flushing waste products out.

(iv) By dilution, water reduces the concentration of pollutants to
safe levels or by carrying them away.

(v) Plants take up nutrients from soil with the help of water. Water
transports these materials into various parts of the plant.

(vi) Rain water carries substances from atmosphere down to earth.
The Hydrological cycle

The small percentage of water which is available for man’s use is constantly renewed by a hydrological cycle.

Water is not lost in undergoing various processes of hydrological cycle namely, evaporation, condensation, rainfall, stream-flow etc., but gets converted from one from to another.

This cycle has been sufficient for the needs of the entire human and animal population throughout the ages. However, over the last 150 to 200 years, man’s activities threaten to disrupt this age-old cycle of renewal and replenishment.

Man has made tremendous advances in the field of science during this period. This has been accompanied by increased levels of industrialization. These developments have made significant contributions to the quality of human life. Our lives are more comfortable, the incidences of diseases and epidemics have been controlled so we live much longer than our grandfathers did, and so on. However, all this progress comes at a price. The negative effects of technological advances are being felt all over the globe, and it is only now that we have begun to realize their far-reaching effects.
India is blessed with an abundance of water resources, the problem in India lies in the fact that these water resources are not evenly distributed throughout the even where there is water available it is not found in sufficient quantities throughout the year.

**NATIONAL WATER RESOURCES AT A GLANCE**

Annual Precipitation Volume (Including snowfall) 4000
Average Annual Potential flow in Rivers 1869
Per Capita Water Availability (1997) 1967
Estimated Utilizable Water Resources 1122
(i) Surface Water Resources 690
(ii) Ground Water Resources 432

**WATER RESOURCE LIMITATION**

It is estimated that out of total available water, 97.3 per cent is contained in the oceans and the remaining 2.7 per cent is fresh water which is mostly found in solid form. Goethe rightly said, ‘Everything originated in the water and everything is sustained by water.’ Thus we see that it is most important for us to manage our water resources for human benefit.

This can be achieved by keeping in mind its quality and controlling its depletion and degradation, and developing it in view of the present and the future needs. Water, like forests is a multipurpose resource and it a important to see that its various uses should not be at conflict with and other and that it can be enjoyed in its totality by man and other organisms. Thus, its right allocation and its quantitative and qualitative conservation are the primary tasks before water managers.

The qualitative degradation of water is also in a way quantitative depletion of usable resources. Therefore recycling of waste water after due treatment would relieve the water scarcity to a great extent. The demand for usable water is increasing like any other resource, with the continuous rise in population and continuous increase in per capita demand linked with more sewage disposal and transport, prolific use of water-using gadgets and increased recreational activities.
Water has multiple uses and must be managed in an integrated manner; therefore, it involves overall participation to the lowest possible level. The problem of equitable distribution of usable water must be well managed. Positive must be formulated to address the needs of women and to work towards their empowerment, so that the problems they face at the domestic end is simplified for them. Most important of all, water must be treated as an economic commodity and used judiciously. Protection of potential of fresh water resources is an important step towards sustainability coupled with judicious use. Sound and sustained water management will not only meet the needs of a growing population but will also benefit the economy of a country.

ROLE OF NATIONAL AND INTERNATIONAL AGENCIES

INTRODUCTION
The non-governmental organizations (NGOs) play a significant role in the field of environment and development, much of the work documented in the NGO sector has formed the basis of government policies and programmes. The Ministry of Environment and Forests extends support to NGO activities and conducts many of its own programmes through them.

The range and diversity of NGO activities is immense. Some important examples are the Aga Khan Rural Support Programme (AKRSP), India, set up in 1983 to serve as a catalyst for rural development in India, with special emphasis on income generation and better management of resources. As a funding organization, it provides direct support to village institutions in the area of soil and water conservation. The Vikram Sarabhai Centre for Development and Interaction (VIKSAT), an activity of the Nehru Foundation for Development, Ahmedabad has grown into an interactive institution with programmes in the field of urban development, rural technology, nature education and social forestry. VIKSAT documents development experiences and shares them through publications and audio visual materials.
Bharatiya Agro Industries Foundation (BAIF), a major multifaceted NGO, is involved in the regeneration of degraded resources such as land, livestock, water vegetation and manpower. BAIF supports local leadership by providing technical know how, research and management. It is active in the areas of cross breeding of plants and animals, tribal rehabilitation. Community health, water-shed development, and bioenergy generation.

The Ministry of Environment and Forests acts as nodal agency in the country for United Nations Environment programme (UNEP), Nairobi, South Asia Cooperative Environment programme (SACEP), Colombo, International Union for Conservation of Nature and Natural Resources (IUCN) and European Union (EU). Annual financial contributions when needed, are made to these organizations. The Ministry also functions as the nodal agency and participates actively in international agreements relating to environment such as the Convention on International Trade in Endangered Species, Convention on Wetlands of International importance, especially as waterfowl habitat, Convention on the Conservation of Migratory Species of Wild Animal, Vienna, Convention for the Protection of the Ozone layer, Convention on Biological Diversity and Climate Change, the Basel Convention on Transboundary Movement of Hazardous Substances, etc.

The Ministry also handles bilateral issues and matters, pertaining to multilateral bodies such as the Commission on Sustainable Development, UNEP, Environment Support Programme of UNDP and the regional bodies like ESCAP, SAARC and SACE. In addition, the Ministry also handles the work relation to the National Environmental Council and the India Canada Environment Facility.

COMMISSION ON SUSTAINABLE DEVELOPMENT (CSD)

Commission on Sustainable Development was set up in 1993 under Economic and Social Council (ECOSOC) of the UN for the purpose of review in progress of implementation of Agenda 21. CSD meetings are held every year in New York. The Ministry of External Affairs is the nodal ministry for the CSD matters. However, this Ministry plays an important role in providing technical support for implementation of Agenda 21. For each session, every country has to present its National Report on progress achieved on the themes selected for the session.

WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT

World Summit on Sustainable Development was held in Johannesburg in 2002 South Africa to mark the tenth year post UNCED held in Rio in 1992. the summit reviewed the progress towards sustainable development and the commitments made ten years ago in Rio.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

The United Nations Environment programme has established an open minded Inter-government Group of Ministers of their representatives to undertake a comprehensive policy oriented assessment of existing institutional weaknesses as well as future needs and options to strengthen international environmental governance.

GLOBAL ENVIRONMENT FACILITY (GEF)

The Global Environment Facility is a financial mechanism to meet the agreed environmental costs of measures to developing countries to help them carry out programmes to relieve pressures on global ecosystems. The GEF was created to fulfil a unique niche for providing finance for programmes and projects to achieve global environmental benefits in the focal areas of biodiversity, climate change, international waters and land degradation. The facility supports International Environmental Management and transfer of technologies which are environment friendly. It is a cooperative venture among national governments, the World Bank, the United Nations Development Programme, and the United Nations Environment Programme in specific areas of concern.
The Global Environment Cell (GEC) with UNDP assistance has been set up to provide technical and scientific inputs into the process of project formulation including those of GEF assistance.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)
The Ministry has signed the Programmed Support Document under the Country Cooperation Framework (CCF-1), with the UNDP to enhance cooperation between the government of India and the UNDP in the environment sector. The CCF-1 strategy places emphasis on technology upgradation, poverty eradication and environmental preservation, etc. The four thrust areas of the environment programme are:
Management of natural resources.
Strengthening decision making capacity.
Management of development.
Spread of information, advocacy and participation.
To recommend, implement and monitor these projects under this programme, a Programme Management Board (PMB) has been constituted in the ministry with representatives of UNDP and four NGOs.

INDIA CANADA ENVIRONMENT FACILITY (ICEF)
The India Canada Environment Facility is a joint initiative of the government of India and the government of Canada created by the signing of a Memorandum of Understanding (MoU) between the two government in October 1992 for the purpose of undertaking projects related to the environment.

MONTREAL PROTOCOL
India acceded to the Montreal Protocol in 1987, to strengthen global efforts for the protection of ozone layer. The protocol recognizes the difficulties of the developing countries in phasing out ozone depletion substances and has, therefore, established a multilateral fund to promote financial and technological cooperation including the transfer of technologies to help this process. A country programme has been prepared to implement the protocol in India. Voluntary agreement with
enterprises will be used along with fiscal incentives, information campaigns, legislation and regulation, to achieve the phasing out of ozone depleting substances.

The forest policy adopted in 1988 contains the key elements that were negotiated in Rio in the UNCED Conference. India hosted the first Ministerial Conference of the Forest Forum for developing countries in September 1993. The Delhi Declaration on Forests, issued at the end of this conference, highlighted the priorities of the developing countries with reference to the forestry sector. India and the United Kingdom have entered into a Memorandum of Understanding on the forestry principles. India along with 170 other countries, signed the Convention on Biological Diversity during the Earth Summit held in Rio in June 1992. The Convention came into force on 29 December 1993. India ratified the Convention in February 1994. The Convention establishes commitments on conservation, access to genetic resources, transfer of technology, biotechnology and bio-safety, benefit sharing and finance and affirms sovereign rights of states on their biological resources. India ratified the Framework Convention on Climate Change in November 1993. The Framework which came into force in 1994 recognizes that the fulfilment of commitments by the developing countries would be contingent on transfer of technology and financial assistance. India has taken several initiatives to develop its own renewable resources and has initiated many research projects related to the phenomenon of climate change.

Several bilateral and multilateral programmes are underway in various environmental areas, with assistance from Germany, Canada, Sweden, Japan, Netherlands, Norway, UK and the USA, on a bilateral basis. Several UN and multilateral agencies like UNDP, the World Bank, the Asian Development Bank and the Nordic found are assisting programmes both on loan and grant terms.
ENVIRONMENTAL MANAGEMENT CAPACITY BUILDING (EMCB) PROJECT

With the view of improving environmental appraisal process and incorporate compliance of the already approved projects in decision making, the ministry has undertaken capacity building programme in the areas of environmental clearance of projects, development of manuals and guides for preparation of Environmental Impact Assessment (EIA). Environmental Management plan (EMP) and related matters are assisted by the EMCB projects under the World Bank.

IMPACT OF AGROCHEMICALS ON ENVIRONMENT

Modern agricultural techniques which are geared towards bumper crop production to meet the ever growing demands of a rapidly increasing population are exploring new ways and means to feed the masses. In the process of discovering new techniques more and more agrochemicals which are being used in agriculture may result in grave consequences in the future.

According to Michael McKenry, the average chemical inputs per irrigable acre in California in 1980 were 13 pounds of pesticides, 140 pounds of nitrogen and 42 pounds of phosphates. In 1978 the total amount of pesticides used in United States was about 800 million pounds. In 1981, the total fertilizers used, including substantial off farm use was 77 million tons. We see that with the extensive use of agrochemicals in modern agriculture, the world is heading towards a complex array of environmental problems more severe than ever before.

Worldwide, numerous studies have shown that use of pesticides and nitrate fertilizers concentrations are strongly correlated with the pollution of groundwater. In the Big Spring Basin, Iowa, a long term study of the entire groundwater basin was undertaken for a period of 25 years, between 1958 and 1983. This study revealed a three fold increase in nitrate concentration in the groundwater. The only major change in nitrogen sources in the basin during this period was the three fold
increase in the nitrogen fertilizers applied to the farm land. As fertilizer application increased, so did groundwater contamination.

By the mid 1980s, the nitrogen fertilizer called the miracle drug of farming was detected as one of the major culprits of pollution. Numerous studies have shown that nitrate concentration in groundwater is strongly correlated with overlying land use. As crops are overloaded with nitrogen fertilizers the capacity of ecosystems to put nitrogen to use is soon exceeded. The soil organisms, process the excess into soluble nitrate, which gravity carries down below the root zone by a process called leaching. Nitrogen is usually quite stable below the root zone because biological activity is minimal there. Once the soil’s natural safety filter is overloaded, serious pollution problem begins to develop. The degree of groundwater contamination is often closely related to excess of nitrogen fertilizer applied. Part of the problem is in timing of application. If fertilizer application is timed to coincide with the crop’s active growing and flowering period, crops will use fertilizers more quickly and completely.

A great deal of nitrate gets through the farm land sub soil for the primary reason that farmers have a notion that the more fertilizer they apply the better it will be for the crops. In fact, on an average, about half the fertilizer supplied in most of the developed countries is not used by the crops. Carefully planned crop rotations can minimize leaching.

The issue of nitrates is a serious one, since it is toxic to infants and we do not realize that something useful as a fertilizer can also be harmful. High concentrations of nitrates cause the blue baby syndrome in infants, due to contamination of water. Wherever modern agricultural methods based on intensive inorganic nitrogenous fertilizers or intensive animal husbandry has been employed, nitrate pollution of groundwater has followed.

It is technically and economically impractical to decontaminate the groundwater. Thus, the only way for this is by natural recharge which takes place very slowly for example a naturally slow movement of
groundwater enough for the recovery of nitrate that leached during growth of shallow-rooted crops by growing a deep rooted crop will take a completes season. even though crop rotation can solve the problem to some extent, overloading the system year with after year with excess nitrogen will only increase the time taken for decontamination and make it harder to regain a healthy ecosystem.

Some fertilizer formulae acidify the soil and deplete their nutrients. The also disrupt the natural cycles of the soil leading gradually to its degradation or total dependence on chemicals. The farmer’s synthetic fertilizers hinder the activities of nitrogen fixing organisms and detritivores within the soil because biological nitrogen fixation is favoured only where soil nitrogen fertility is fairly low. Open nutrient cycles are essentially one way nutrients enter from one side of the farm and then leave the system, with little internal cycling. Where legumes are not part of crop rotation nitrogen enters the system as applied fertilizer usually as anhydrous ammonia. The ammonium is oxidized quickly to nitrate with the accompanying loss of hydrogen ions. Over the time accumulation of these hydrogen ions can acidify the soil greatly. Excess nitrate is not held well by negatively charged soil particles and so tends to leach downward entering the groundwater and contaminating it. Nitrogen fertilizers favour decomposition and oxidation of soil carbon. Erosion of the surface layers of soil also results over time in the net loss of carbon. Phosphorous and potassium are also commonly applied to inorganic fertilizers. These nutrients are subject to the same losses via erosion that takes place in the case of nitrogen and carbon. Agricultural soils are loaded with stored excessive nitrogen which can slowly leach into groundwater and remain there for a long time. The average time needed for nitrate to seep from the soil surface to a depth of 15 meters takes 10 years according to a study in California. It could take another 40 years to see the full extent of deep groundwater contamination from current agricultural practices, according to computer simulations. Groundwater
decontamination is usually technically and economically not practical and can take place only by natural recharge, this happens very slowly. In 1984, Chris Lecos reported in ‘Pesticides and Food: Public Worry No. 1’ that pesticides on foods, particularly imported foods, were consumers’ number-1 concern about food safety. One of the drawbacks of pesticides and other agrochemicals is that they are often hard to get rid off once applied to food crops. This may prove fatal tough little concern to raises public emotion, like the knowledge that, foods have traces of toxic chemicals. The Food and Drug Administration (FDA) of the United States admits that pesticides do not show up frequently in our food, but by the time the foods are prepared and actually reach the consumers tables the residues are consistently well below permissible levels of intake. It must be realized that this conclusion is based on surveys using small sizes.

The long-lived pesticides such as DDT are most likely to leave persistent residues. Even though they are banned in most developed countries they still show up frequently on foods. Other pesticides tend to break down so rapidly that they are unlikely to show up in food unless applied to crops very close to harvest time. It takes a much smaller does of these chemicals to make them extremely toxic.

In the late 1980s, pesticides were discovered in the groundwater supplies. Organic pesticides, the modern replacement for arsenic-based chemicals, grew out of industries that worked on chemical warfare. Organic pesticides, which are chlorinated hydrocarbons are usually persistent containing low level toxins and have the quality of bio-concentration. They accumulate within the tissues and system of organisms, these pesticides enter the food chain and increase in levels of toxicity from each trophic level due to biological magnifications, they prove to be extremely fatal especially to the organisms at the end of the food chain. Examples of such pesticides are DDT, which is a typical chlorinated hydrocarbon. These pesticides were finally banned in 1969 in most of the developed
countries, though residues of them are still present all over the planet and in all populations, even after 20 years of their extensive use.

In 1979, a new variety of pesticides was linked to groundwater contamination, it was the aldicarb, which was marketed under the name Temik. This pesticide was found to have leached through the sandy soil in the potato fields of Long Island, New York. Aldicarb affects the nervous system, causing temporary cholinesterase depression. This pesticide is sub-lethal and is acutely toxic to humans. It was applied to soil to kill insects and nematodes. Aldicarb contaminated more than a thousand wells. Finally the manufacture of Temik was stopped and the product was quickly removed from the market.

Pesticides contaminate surface waters also such as reservoirs, lakes and streams. Sometimes they can sustain intense exposure particularly during heavy rains that follow field applications. In heavily irrigated areas like central Asia, 74 per cent of water samples contained organophosphates and phenoxy herbicides. While pesticides to these toxins are not rise. In the case of agricultural chemicals, the instability is shown as a major health hazard to people not necessarily involved in agriculture, whereas with regards to effects on erosion it manifests as destruction of agriculture’s living capital, the soil. Farmers, field labourers, green house and nursery employees and pesticide applicators that are routinely exposed to pesticides in their daily work are vulnerable to pesticide hazards. Estimates from emergency care clinics in Culiacan in Mexico show an average of 10 to 12 cases of pesticide poisoning per month, or is ironic for agriculture, which ought to the whole population, to be engaged in poisoning field workers. This irony extends to another aspect of pesticide hazards – the issue of food safety.

In less developed countries, especially in tropical regions the use of agrochemicals is not regulated as carefully as in developed countries. Labelling is poor and often in the native language, advisory services are usually unavailable and proper usage unknown. This is the reason why a
number of pesticides are still being used in the less developed countries are still being used in the less developed parts of the world. This makes the environment and its inhabitants more vulnerable to these agrochemicals. The issue of food is of serious concern along with contamination of water supplies and hazards to applicators and field workers.

Herbicide tolerance in crops is probably the most well-known and extensive application of genetic engineering in agriculture. Researchers have transferred genes imparting resistance to herbicides to the genome of commercial crops. Currently efforts are being made to impart herbicide resistance to 15 major crops including tobacco, wheat, rice, maize potato and vegetables. Genetic pollution may be caused when copied genes from one species inserted into another may spread to other organisms if it escapes. Thus herbicide resistant crops and produce herbicide-resistant super weeds. This is another example of a similar impact on the environment, as the one discussed in the chapter on Crop Protection, the creation of super pests. Therefore the use of herbicide-resistant crop will increase rather than decrease the use of herbicides.

Thus, with new varieties of crops new problems are to be faced in the future, because an increases in the productivity of crops ,leads to a greater dependency on the agrochemicals .increased crops productivity would reduce further expansion of agricultural land leading to further exploitation of uncultivated areas. It is good business, when chemical companies own the seed companies, to produce varieties that thrive with heavy fertilizer applications and pesticides. But farmlands and farmers would be better off with varieties that thrive in soils rich in organic matter, are competitive against weeds, and are mixture of breeds with the variety of resistance so that use of pesticides could be minimized.

**Environment Pollution**

The term environment as far as pollution is concerned, includes the air, the water and the land (soil). The pollution of our environment is one of
the biggest hazard that humanity faces today. Pollution is a gift of industrial civilization. Progress in agriculture and industry have resulted into unlimited exploitation of every bit of natural resource. Such activities of man have adverse effect on all forms of living organisms in the biosphere. The unfavourable conditions created by man himself has threatened the survival not only of man himself but also of other living organisms, For the smooth growth had development of all living organisms, a balanced or natural environment is required which has been provided by nature. In balanced environment the various components are present in a definite ratio and proportion. When the ratio of one or more components or human activities, it is sad that the environment has been polluted.

Thus, any undesirable change of the physical, chemical or biological characteristics in the air, water and land which is harmful to man directly or indirectly through his animals, plants, industrial units or raw materials is termed environment pollution.

Pollution may be natural or man-made (artificial) pollution

(i) **Natural pollution:** It originates from natural processes. A few examples of natural sources of pollution are:

(a) Volcanic eruptions; (b) Forest fires and coal mines fire;
(c) Bacterial decomposition of agricultural matter; (d) Pollen grains of flowers; (e) Excreta of animals; (f) Floods; (g) Radioactive substances.

(ii) **Artificial pollution:** It originates from the activities of man. Environment deterioration by man is attributable to three major factors: (i) over-population (ii) urbanisation and (iii) industrialisation. The increasing amount of wastes generated by these three phenomena undoubtedly degrades the quality of land, air, water and food. When the waste products are not efficiently assimilated or decomposed or otherwise removed by the natural, biological and physical processes of the biosphere, adverse effects may result as the materials responsible for
pollution accumulate or are converted to more, toxic substances. Anything, if present in the environment in excess of permissible limits, causes pollution. The problem of pollution is very complex as one type of pollution will disturb and cause pollution in other systems also.

**Pollution**, thus, means:

(i) The presence of anything in the environment in excess of required amount.

(ii) Anything put into the environment which was not there in its natural state.

(iii) Direct or indirect changes in one or more components of the ecosystem which are harmful to living organisms.

(iv) Intentional or unintentional release of any chemical or geochemical substance in the environment with adverse, harmful or unpleasant effects.

Today everything is polluted. The air we breathe is polluted by automobile exhausts, industries, thermal power plants, etc. The fruits and vegetables are polluted due to the use of pesticides and insecticides and water in lakes and rivers has been polluted by wastes from chemical and other factories, by sewage due to uncontrolled population and use of plastic materials.

Although pollution is as old man himself, but his awareness about it is only very recent. Concern over the state of environment has grown over since the sixties. The catastrophic events like the Bhopal gas tragedy, the Chernobyl nuclear reactor breakdown, etc, have given us a warning about the dangers of pollution. It is, thus, the duty of every citizen, every nation and every government to take concrete steps to minimise and control pollution.

**Pollutants**

**Pollutants are chemical, biological or physical agents that exert undesirable effects on living organisms including human health, environment or belongings.** According to “The Indian environment
(protection) Act 1986,” a pollutant has been defined as any solid, liquid or gaseous substance present in such concentration as may tend to be injurious to the environment. In a very simple way, a pollutant can be defined as a substance or an agent which causes pollution.

Various types of pollutants are listed below:

(i) Chemical agents:
Gases and particulates; Heavy metals; Pesticides; petroleum;

(ii) Physical agents:
Heat; Odour; Noise; Radiation

(iii) Biological agents:
Micro-organisms; Population

Odum, in 1971, gave a different classification of pollutants. He divided them into two basic types from an ecosystem point of view.

(a) Non-degradable pollutants: These are poisons like mercuric salts, aluminium cans, lead compounds, long chain phenolic chemicals, pesticides, etc., Which either do not degrade or degrade very slowly in the ecosystem naturally. These are not recycled in the natural environment. These substances are harmful even in low concentrations.

(ii) Bio-degradable pollutants: These are domestic wastes which can be rapidly decomposed under natural processes by micro-organisms. However, when accumulation of these occurs, i.e., complete degradation does not take place, then these pollute the biosphere and created problems.

The various principal environmental pollutants are:
(i) Deposited matter- Soot, smoke, tar, dust, grit, etc.
(ii) Gases- Oxides of nitrogen (NO, NO₂), sulphur dioxide (SO₂), carbon monoxide, halogens, etc.
(iii) Fluorides
(iv) Acid droplets: Sulphuric acid (H₂SO₄), nitric acid (HNO₃), etc.
(v) Metals: Mercury, lead, iron, chromium, zinc, cadmium, nickel, tin, etc.
(vi) Agrochemicals: Pesticides, herbicides, fungicides, bactericides, insecticides, weedicides and fertilizers, etc.
(vii) Photochemical oxidants: Peroxyacetyl nitrate (PAN), per oxybenzoyl nitrate (PBN), aldehydes, ethylene, ozone, photochemical smog, etc.
(viii) Petroleum and complex organic compounds.
(ix) Sewage due to uncontrolled population and faulty urban planning.
(x) Radioactive waste.
(xi) Noise and heat.

SOME COMMONLY USED TERMS IN ENVIRONMENTAL POLLUTION

1. **Contaminant**: A substance which does not exist in nature but is introduced by human activity into the environment is called contaminant. It may or not be harmful to the living organisms or non-living materials. The contaminant becomes pollutant when it has harmful effects. For example, methyl isocyanate vapours leaked from a defective tank killed many persons and caused respiratory, lung, eyes and throat problems to others in Bhopal can be called contaminant as it does not occur in the atmosphere but in can be termed pollutant also as it has dangerous effects. Generally, highly toxic materials are considered as pollutants.

2. **Source**: The site from which the pollutants or contaminants originate is called source. The knowledge about the source is important because it helps to devise the methods to eliminate or minimize the pollutant.

3. **Sink**: The material or medium which removes or interacts with a long-lived pollutant is called sink. For example, oceans act as sink for atmosphere carbon dioxide and other water-soluble gases. Limestone minerals act as sink for oxides of sulphur and sulphuric acid (acid rain).
\[ \text{CaCO}_3 + \text{SO}_2 \rightarrow \text{CaSO}_3 + \text{CO}_2 \]
\[ \text{CaCO}_3 + \text{SO}_3 \rightarrow \text{CaSO}_4 + \text{CO}_2 \]
\[ \text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{CO}_2 + \text{H}_2\text{O} \]

4- **Receptor:** Anything that is affected or spoiled by pollutants is called receptor. For example, marble structures are receptors of acid rain. Human beings are receptors of photochemical smog which causes irritation in the eyes and brings breathing problems.

5- **Threshold Limit Value (TLV):** The permissible limit of a pollutant in the atmosphere to which if a healthy person is exposed for 8 hour a day or 40 hours a week for life time, there is no adverse effect on him, is called threshold limit value. For example, TLV of CO is 40 ppm while that of CO\(_2\) is 5000 ppm.

**ACID RAIN**

The term acid rain is used to describe all precipitations – rain, snow, fog, dew – which are more acidic than normal. The normal rain is slightly acidic having a pH of about 5.6 as carbon dioxide gas reacts with it to form a weak carbonic acid.

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \text{ (Carbonic acid ----- weak acid)} \]

As carbon dioxide is present in unpolluted air in traces the acidity is extremely mild and may be regarded as natural. **Acid rain, thus, refers to any precipitation which has pH less than 5.6.** The pH of the acid rain can range between 5.6 and 3.5 and in some cases even lower upto 2.

**Chemistry of acid rain:** Acid rain results from the presence of two strong in polluted air: H\(_2\)SO\(_4\), and to a lesser extent, HNO\(_3\). Nitric acid comes largely from a three step process. The first step involves the formation of NO from the elements by high temperature combustion, as in automobile engines or lightning in the atmosphere during the rainy season. This is then oxidations. NO\(_2\) at normal atmospheric conditions. NO\(_2\) combines with water to form a mixture of nitrous and nitric acids.
N_2 + O_2 \rightarrow 2NO

2NO + O_2 \rightarrow 2NO_2

2NO_2 + H_2O \rightarrow HNO_3 + HNO_2

Coal, used in power plants, contains up to 40% sulphur, mostly in the form of minerals such as pyrite, FeS_2. The combustion of coal forms sulphur dioxide. Petroleum products also on combustion release sulphur dioxide.

4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2

S + O_2 \rightarrow SO_2

Large quantities of SO_2 are also produced in the metallurgical processes used to treat sulphide ores.

2NiS + 3O_2 \rightarrow 2NiO + 2SO_2

Natural processes such as volcanic eruptions, forest fires and bacterial decomposition of organic matter can produce the oxides of sulphur and nitrogen.

SO_2

, when it comes in contact with water, forms sulphurous acid

H_2SO_3.

SO_2 + H_2O \rightarrow H_2SO_3 \quad \text{(Sulphurous acid)}

SO_2 is partly and slowly converted into sulphur trioxide by molecular oxygen in presence of dust particles

2SO_2 + O_2 \rightarrow \text{Dust particles} \quad 2SO_3

SO_2 is also oxidised to SO_3 by ozone

SO_2 + O_3 \rightarrow SO_3 + O_2

SO_3 thus formed readily combines with and produces sulphuric acid as tiny droplets high in the atmosphere. These may be carried by the prevailing winds as far as 1500 km.

SO_3 + H_2O \rightarrow H_2SO_4 \quad \text{(Sulphuric acid)}

The sulphuric acid and nitric acid, thus formed remain as vapour under high temperature and begin to condense slowly as the temperature falls.
These acids mix with rain or snow, i.e., rain water gets acidified on its way down to the earth. The acidified rain water eventually mixes with the already existing water on the earth. The resulting pH of the aquatic environment.

Consequences of acid rain

(i) **Damage to animals:** Acid rain causes lakes and rivers to become acidic and drop in pH can destroy the ecological balance. Most aquatic animals cannot survive when the pH is less than 4. Some species of fish such as salmon die even when the pH is less than 5.5. Certain species of algae and zooplankton are eliminated at pH less than 6. A reduction in the zooplankton and bottom fauna will affect the food availability for the fish population.

(ii) **Damage to plants:** Acidic water is dangerous for plants. Leaf pigments are decolourised, i.e., chlorophyll is affected and agricultural productivity is decreased. Several non-woody plants (such as barley, cotton) and fruit trees (such as apple, pear) are among the most susceptible to acid rain.

Many soils contain limestone and have natural buffering properties, but without this the acidified soil means plant nutrients are leached from the soil. Aluminium is released damaging root systems, seeds stop germinating, helpful soil organisms are killed.

\[ \text{Al(OH)}_3 + 3\text{H}^+ \rightarrow \text{Al}^{3+} + 3\text{H}_2\text{O} \]

Insoluble Soluble

(Toxic in nature)

(iii) **Material damage:** Metallic surfaces exposed to acid rain are readily corroded. Textile fabrics, paper and leather products lose their material strength or disintegrate by the acid rain.

Building materials (limestone, marble, dolomite, mortar and slate especially) are weakened on reaction with acid rain as water-soluble compounds are formed. Thus, acid rain is dangerous for historical monuments.
CaCO$_3$ + H$_2$SO$_4$ → CaSO$_4$ + H$_2$O + CO$_2$

The big industries emitting sulphur dioxide should not be established in urban areas and near the historical monuments.

(iv) **Effect on human beings:** Acid rain also affects human beings directly. The release of toxic metals held in rocks, especially aluminium, mercury and cadmium into water sources by acid rain can cause poisonous levels of mercury to build in the fish which we eat. Acidic drinking water reacts with our water ducts and metal concentration can cause damage to the kidneys and liver and diarrhoea in young children.

**Ways to minimise the formation of acid rain**

To reduce acid rain, sulphur dioxide emission from power plants and smelters must be brought under control. The most direct approach is to remove sulphur from fossil fuels before combustion, but this is technically difficult to accomplish. A cheaper method is to remove SO$_2$ as it is formed. For example, in one process, powdered limestone is injected into the power plant furnace along with coal (Fig. 18.8.) At high temperature, the following decomposition occurs:

\[
\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2
\]

Limestone        Quicklime

The quicklime reacts with SO2 to form calcium sulphide and some calcium sulphate.

\[
\text{CaO} + \text{SO}_2 \rightarrow \text{CaSO}_3
\]

\[
2\text{CaO} + 2\text{SO}_2 + \text{O}_2 \rightarrow \text{Ca}_4\text{SO}_4
\]

To remove the remaining SO2, an aqueous suspension of quicklime is injected into a purification chamber prior to the escape of gases through the smokestack.

\[
\text{Ca(OH)}_2 + \text{SO}_2 + (1/2)\text{O}_2 \rightarrow \text{Ca}_4\text{SO}_4 + \text{H}_2\text{O}
\]

One problem with this approach is that it produces large quantities of solid calcium sulphate as a waste product.

Quicklime is also added to lakes and soils affected by acid rain. This process is called liming.
Installing of a sulphuric acid plant near a metal ore smelting site is also an effective way to cut sulphur dioxide emission. To do away with acid rain, an international programme, involving all the countries in order to take concrete measures to minimise sulphur dioxide pollution which travels very fast in atmosphere, is the need of the hour.

**Water pollution**

Next to air, water is the important constituent of life-support systems. Water is the most important natural resource. 80% of the earth’s area is occupied by water. However, hardly 2.5% makes up the total word’s supply of fresh water including the frozen water in the polar ice caps and glaciers. Water is needed for irrigation, industry, domestic needs, shipping and keeping up of a good supply of water is thus very essential. Man has, however, polluted much of this limited supply of water by industrial wastes, sewage and a number of synthetic chemicals. Many rivers of the word receive heavy flux of sewage, domestic waste, industrial effluents, agricultural wastes, etc., which contain substances varying from simple nutrients to highly toxic materials. In our country, all the major rivers have been polluted. These have actually become an unending sewer fit only to carry urban liquid waste, half burnt dead bodies, pesticides and other wastes. Many of our lakes have become dark with foul smell. Moreover, the rainfall on its way down to the earth brings down the air pollutants. polluted water is the water which has more negative qualities it has positive ones, i.e., it is no longer fit for any use.

**Water pollution is the presence of any foreign substance (organic, inorganic, radioactive or biological) in water which tends to degrade the quality so as to constitute a hazard or impair the usefulness of water.**

The common water pollutants are:

(i) Oxygen-demanding wastes
(ii) Disease causing agents
(iii) Synthetic organic compounds  
(iv) Plant nutrients  
(v) Inorganic chemicals and minerals.  
(vi) Suspended solids.  
(vii) Radioactive substances  
(viii) Thermal discharges  
(ix) Oil  

**i) Oxygen-demanding wastes:** Dissolved oxygen (DO) is essential for sustaining animal and plant life in any aquatic system. If the DO level in water decreases, the aquatic organisms may not survive. The wastes such as domestic, industrial and biodegradable organic compounds are oxygen demanding wastes. These are decomposed by the bacterial population which in turn decreases the oxygen from water.

BOD (biochemical oxygen demand) is a measure of the oxygen utilized by micro-organisms during oxidation of organic materials. It is the most widely known measure for assessing the water pollution potential of a given organic waste. BOD is directly proportional to the amount of organic waste which is to be broken down.

The determination of BOD of a sample of water requires 20-30 days for the complete decomposition of organic waste present in the sample. This is too long time for obtaining data. Therefore, the time has been fixed as five days, i.e., BOD is the amount of oxygen consumed in five days. The measurement is done at 20 C. The sample of water is saturated with oxygen. It is then incubated for five days at 20 C. Micro-organisms utilise oxygen to oxidise the waste during this period. The remaining oxygen is measured and subtracted from the amount of oxygen originally present to get the BOD Value. It is expressed in ppm.
BOD is a real measure of water quality. Clean water has a BOD value of less than 5 ppm. The polluted river water could have a BOD value of 17 ppm or more. The untreated municipal sewage has BOD value of 100-400 ppm.

**Chemical oxygen demand (COD):** It is another important water quality parameter. It is an index of the waste (organic and inorganic) of water which can be oxidised by a strong oxidizing agent usually acidified potassium dichromate, $K_2Cr_2O_7$. This regent oxidises most of the substances present in water including those which are not oxidised by micro-organisms. The water sample is treated with a known amount of acidic potassium dichromate solution. The unreacted potassium dichromate is determined by back titration with a suitable reducing agent like Mohr’s salt. From the amount of $K_2Cr_2O_7$ consumed, the amount of oxygen utilised in the oxidation of water sample can be calculated, with the help of following oxygen.

$$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$$
COD is also expressed in ppm. COD value do not necessarily match the BOD values. Textile wastes, paper mill wastes, etc., with high cellulose content have COD values as cellulose in not readily attacked by dissolved oxygen.

(i) **Disease causing agents:** These are the various pathogenic micro-organisms which may enter the water along with sewage or other wastes. These microbes, mainly bacteria and viruses, can cause various diseases such as cholera, typhoid, dysentery, gastroenteritis, polio, hepatitis, etc.

(ii) **Synthetic organic compounds:** These include pesticides, detergents and other industrial chemicals. These chemicals when present in water can act as toxic poisons for plants, animals and humans. These chemicals enter the hydrosphere either by losses during their transport and usage or by accidental or intentional disposal of wastes from manufacturing units.

Polychlorinated biphenyls (PCBs), having high stabilities, are relatively new additions to the list of pollutants of water. They are used as fluids in transformers and capacitors. The presence of these PCBs in water causes skin disorders in humans. These act as carcinogenic.

(iv) **Plant nutrients:** Nitrogen and phosphorus fertilizers which are drained from agricultural lands or from other sources into water bodies may stimulate the growth of algae and aquatic weeds. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. The anaerobic conditions created by the rotting algae can present a health hazard for birds, fish and other aquatic species. During the decomposition of aquatic plants by micro-organisms, the amount of dissolved oxygen decreases which proves fatal for aquatic species.

(v) **Inorganic chemicals and minerals:** These include various metals and metallic compounds released from human activities or from
natural minerals. These pollutants enter the water bodies from municipal and industrial waste water and mine runoff. The acid-rain consisting of sulphate and nitrate ions makes the water acidic. Most of these inorganic compounds, particularly of heavy metals, are toxic and capable of killing living organisms in water bodies. Most of these substances produce physiological poisoning by becoming attached to the tissues of aquatic organisms and accumulate. The metals of concern are cadmium, lead, mercury and silver. Alkalies discharged by industries such as textiles, tanneries paper, etc., can also destroy aquatic life. The main constituents of mine drainage are sulphuric acid and iron compounds. These cause corrosion of metals and concrete and are fatal to fish.

Recently the level of fluorides in the drinking water has considerably increased in different parts of India, causing fluorosis (an incurable bone disease).

(iv) Suspended solids: Suspended solids in water are mainly of sand, silt and minerals eroded from the land. Solid particles settle in reservoirs and dams and thus reduce their water storage capacity. The suspended particles in water bodies also block the sunlight required for the photosynthesis by bottom vegetation and thus reduce the availability of food to fish.

(vii) Radioactive substances: The refining of uranium ore is an important source of radioactive waste producing radioactive materials containing radium, bismuth, etc., which are a hazard in drinking waters. Certain marine organisms have the capacity for accumulating radio nucleides from water. These may cause radioactivity in living organisms. Radioactive substances can enter humans through food and water. These may get accumulated in blood and certain vital organs such as liver, thyroid gland, bone and muscular tissues.

(viii) Thermal discharges: Power plants and industries use large quantities of water for cooling purposes. Used water is usually discharged
directly into water bodies. The temperature of water bodies thus increases. This brings down the DO level which is harmful for microorganisms. An increase in temperature also increases the toxicity of some chemical pollutants. Poisons are more toxic in summer months.

(ix) Oil: Oil and oil wastes enter rivers and other water bodies from several sources like oil refineries, storage tanks, automobile waste oil, petro-chemical plants and industrial effluents. Normal tanker operations and spillage from oil taker accidents cause marine pollution and shore contamination.

Since oil is insoluble in water, it floats and spreads rapidly into a thin layer. At sea, the oil layer is responsible for the death of bird. The oil penetrates the birds’ feathers thereby affecting their insulation and buoyancy. The bird experience difficulty in floating and flying. The oil layer on the surface of water reduces the DO levels in water as oxygen transfer from atmosphere is prevented. Oil may be driven to shores through wind and tides where it is accumulated and poses aesthetic problems.

The pollution of natural waters by both biological and chemical contaminants is a worldwide problem. The level of purity required for water depends on its use. Surface water, as seem in rivers and lakes, can be

List of commonly found water pollutants.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Sources</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen-demanding</td>
<td>Natural runoff from land, human sewage, animal wastes</td>
<td>Decomposition by consuming bacteria depletes dissolved oxygen in water, decaying plant life, fishes die or migrate away; industrial waste (from oil refineries, paper mills, food processing)</td>
</tr>
</tbody>
</table>
Disease-causing agent

Inorganic chemicals and minerals

Acids

Salts

Lead

Mercury

Plant nutrients
cetera), urban storm runoff.

Domestic sewage animal wastes.

Mine drainage; industrial wastes; acid deposition.

Natural runoff from land; irrigation; mining; industrial wastes; oilfields; urban storm runoff; deicing of roads with salts.

Leaded gasoline; some pesticides; smelting of lead.

Natural evaporation and dissolving; industrial wastes; fungicides.

Outbreaks of water-borne diseases, such as typhoid, infectious hepatitis, cholera and dysentery; infected livestock.

Kills some organisms; increases solubility of some harmful minerals.

Kills fresh water organisms; causes salinity buildup in soil; makes water unfit for domestic use, irrigation and many industrial uses.

Toxic to many organisms; including humans.

Highly toxic to humans (especially methyl mercury, which causes minamata disease).

Algal blooms and excessive aquatic growth; kills fish
<table>
<thead>
<tr>
<th><strong>Sediments</strong></th>
<th><strong>Natural runoff from land; agricultural runoff; mining, domestic sewage; industrial wastes; inadequate waste water treatment; food processing industries; phosphates in detergents.</strong></th>
</tr>
</thead>
<tbody>
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<td><strong>Radioactive substances</strong></td>
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</tr>
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<td><strong>Heat</strong></td>
<td><strong>Natural sources (rock and solids); uranium mining and processing; nuclear power generation; unclear weapons testing.</strong></td>
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<td><strong>Organic chemicals oil and grease</strong></td>
<td><strong>Cooling water from industrial electric and nuclear power plants.</strong></td>
</tr>
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Pesticides and herbicides wastes; pipeline wastes; offshore oil well blowouts; natural ocean seepages; tanker spills; and cleaning operation. agriculture; forestry; mosquito control. toxic or harmful to some fish, selfish; predatory birds and animals, concentrates in human fat; some compounds toxic to humans; possible birth and genetic defects and cancer.

Plastics homes and industries. Toxic or harmful to some fish, selfish; predatory birds and animals, concentrates in human fat; some compounds toxic to humans; possible birth and genetic defects and cancer.

Detergents (phosphates) Home and industries. Kills fish; effects mostly unknown. Encourages growth of algae and aquatic weeds; kills fish and causes foul odours as dissolved oxygen is depleted. Sometimes fatal to plankton and fish; foul tastes and odours; possible cancer in humans.

Chlorine compounds water disinfection with chlorine; paper and other industries (bleaching) cleaned up relatively more easily than groundwater, which is out of sight since it is present under the surface of Earth. A large variety of contaminants are seen in water. Depending on their nature, we have chemical, physical, biological contaminants. Some common water pollutants along with their sources and effects are listed in Table 1. We discuss some typical water contaminants from industrial wastes.
Heavy Metals

Among the natural substances that man concentrates in his immediate environment metals are the most ubiquitous metals can neither be degraded nor metabolised; they are an example of ultimate persistence. Metals enter the living organisms as inorganic salts or as organometallic derivatives. Among the heavy metals, mercury, lead and cadmium have severely affected the environment. These metals react with -SH group of a large number of enzymes inhibiting catalysis of general metabolic reactions.

A significant portion of these metals present in soil is leached into water bodies. Similarly, components of heavy metals are largely rained down into natural water courses. Thus, the effect of heavy metals are best studied from the point of view of water pollution.

Mercury is present naturally in some minerals in igneous rocks (basalt and granite) and volcanoes. Human activities such as mining operation, use of pesticides, use as catalysts, in thermometers, barometers, et cetera have elevated the mercury content released in the aquatic systems. In water, mercury is transferred as (CH$_3$Hg$^+$) methyl mercury, that is highly toxic and hazardous to humans.

Moreover, the methyl mercury gets biomagnified, in the food chains (bioamplification), in the tissues of aquatic organisms particularly fishes. One of the most visible tragedies caused by methyl mercury poisoning is Minamata disease. Several Japanese were killed and hundreds permanently paralysed with new born sustaining congenital defects as a result of eating fishes contaminated with mercury. Mercury, in general, causes neurological disorder by affecting the brain and damaging cells of the nervous system. Mercury not only cross the blood-brain barrier causing mental retardation, convulsion et cetera in infants born of mothers exposed to large amounts of methyl mercury.

As in the case of mercury, man-made sources of lead have played havoc with the environment. Lead has been mined and used by man for
millennia-in acid storage batteries, ammunition, solder and casting materials, glazing pottery, paints and additives in gasoline.

Lead poisoning, also called plumbism or saturnism, has proved to be more dangerous to the children than the adults. Lead impairs kidney functions by concentrating in the proximal renal tubular lining. Lead poisoning affects the central nervous system as well. Pregnant women exposed to large amounts of lead are likely to have abnormality in their brain.

Cadmium used extensively in electroplating, plastics, pigments, photovoltaic cells, et cetera cause adverse effects in bones, gradually leading to their disintegration. In 1946, on the west coast of Japan incidences of this extremely painful disease called 'itai itai due to Cd poisoning were seen. Cadmium also damages the kidneys to a large extent.

Detergents and Fertilisers

Detergents contain phosphorus-based additives that improve their cleansing performance across a wide range of use conditions. The most popular and useful P-based additive are sodium tripolyphosphate (Na₅P₃O₁₀), Potassium pyrophosphate (K₄P₂O₇) and sodium trimetaphosphate (Na₃P₃O₉). When these phosphates are released into stream and lakes, they act as fertiliser to the plants and encourage the formation of algae. This reduces the dissolved oxygen content of water. This process, called eutrophocation, creates difficulties in the development of higher life forms in the water bodies.

Acid mine drainage

Water quality severely deteriorates in areas having mines. The problem is mainly due to acid drainage from coal mines. Sulphuric acid is formed, when water and air along with microbes oxidise sulphur-bearing minerals (FeS₂, mainly pyrite) associated with coal. Microbial oxidation of discarded waste material at mine site is also prevalent. This acid then enters streams either from ground water or surface runoff. The resulting
acidic conditions, with pH as low as 3 or below, kills fishes and most plant life and can make the water virtually useless.

Polychlorinated Biphenyls
These are a class of aromatic organic compounds, which find applications in paints, printing inks, capacitors and most particularly in transformers where their high thermal stability and low electrical conductivity makes them ideal as heat transfer media.

As many as 209 different structures are available with 1 to 10 chlorine atoms substituted in various position on the aromatic rings. Polychlorinated biphenyls (PCB) are significantly volatile and have a tendency to escape into the atmosphere and deposit on particulates. These return to the ground by rains. Also, these are absorbed by the waxy cuticle on plants. These processes lead to PCB contamination of soil and surface waters. PCBs are reported to be carcinogenic and cause skin disorders. Their disposal, by high temperature heating, if done incorrectly, give even more toxic derivatives.

**International Standards for Drinking Water**

Setting of water quality standard involves the attachment of a numerical criteria with the limits for each pollutant by a scientific rationale. The international standard for drinking water cover all aspects such as colour, odour, taste, hardness, conductance, biochemical oxygen demand (BOD), microorganisms etc. Some such standards, that have to be obeyed, they are:-

**Fluoride**
Soluble fluorides are often added to water as they are good for strengthening the teeth. However, the permissible limit of F⁻ ions is 1ppm (1mg dm⁻³). At levels>1.5 ppm mottling of tooth enamel occurs and in extensive cases (10 ppm or more) teeth and even bones get damaged leading to bone sclerosis.
**Lead**
The permissible limit is 50 ppb (50 gdm⁻³). The metal is highly toxic. Corrosion of water pipes, contamination of water.

**pH**
pH should be between 5.5 and 9.5. Lower pH increases solubility of metals.

**Other Metals**
Maximum permissible limits of common metals in drinking water are given below:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Max. allowable conc. (ppm or mg/dm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn</td>
<td>5.0</td>
</tr>
<tr>
<td>Fe</td>
<td>0.2</td>
</tr>
<tr>
<td>Mn</td>
<td>0.05</td>
</tr>
<tr>
<td>Cu</td>
<td>3.0</td>
</tr>
<tr>
<td>Cd</td>
<td>0.005</td>
</tr>
<tr>
<td>Ac</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Sulphate**
Reasonable amount of SO²⁻₄ are harmless. Excessive sulphate (>500 ppm) has a laxative effect.

**Nitrate**
Excess nitrate may cause methhmaglobinemia (‘blue baby’syndrome) in infants. Here, the nitrate ions in the digestive system get converted to nitrate ions-a conversion that takes place only in infants since their gastric juices are less acidic than those of adults. Nitrite ions pass into the bloodstream and form complex with haemoglobin thereby making it ineffective to carry O₂. As a result the child suffocates. Nitrite ions can cause stomach cancer. Maximum allowed limit of 50 ppm has been set for nitrate ions.
Dissolved Oxygen in Water

The amount of dissolved oxygen (DO) in water is an important parameter of water quality and support of aquatic life. Fish, for example, requires certain minimum amounts of DO depending on their species, stage of development, level of activity and the water temperature. The recommended DO level is 5 ppm for at least 16 h and not less than 3 ppm for the remaining 8 h, for a warm water fish population.

There are four processes which affect the amount of oxygen in the DO level in the water:

The process wherein oxygen enters the water through the contact that the water surface makes with the atmosphere is called Peanalas. The solubility of oxygen in fresh water, at 1 atm pressure, decreases with increase in temperature. By increasing the surface area in contact with the atmosphere the transfer of oxygen is increased, so a bubbling stream picks up oxygen easier than a stagnant pond through photosynthesis aquatic plants liberate O₂ with the help of sunlight. This phenomenon occurs only during daylight hours and increases effectively. If however, during dark hours, photosynthesis stops but respiration continues. Thus, there is a continuous removal of oxygen from water via respiration. The fourth process, which affects the amount of oxygen in water is the oxidation of wastes. Organic wastes are used as food by the microorganisms, especially bacteria and in the process break down the complex organics and into the simple organic and inorganic materials.

\[ [CH_2O]_n + \text{bacteria} + O_2 \rightarrow CO_2 + H_2O + \text{new bacterial cells} \]

This decomposition may occur in the presence of oxygen (aerobic decomposition), which contributes to deoxygenation of water and hence, drops in DO. If too much organic matter must be decomposed, the DO supply in water may fall to zero. This will lead to the killing of oxygen dependant aquatic life.

Other sources of consumption of O₂ are bio-oxidation of nitrogenous material;
\[
\text{NH}_4^+ (aq) + 2O_2 (aq) \rightarrow 2H^+ (aq) + NO_3^- (aq) + H_2O (l)
\]

And the chemical or biochemical oxidation of chemical reducing agents.

\[
4\text{Fe}^{2+} (aq) + O_2 (aq) + 10H_2O (l) \rightarrow 4\text{Fe} (OH)_3 (s) + 8H^+ (aq)
\]

\[
2\text{SO}_3^- (aq) + O_2 (aq) \rightarrow 2\text{SO}_4^{2-} (aq)
\]

**Biochemical oxygen demand (BOD) and chemical oxygen demand (COD)**

Biochemical oxygen demand or BOD is a standard measure of the amount of oxygen that would be needed by the microorganisms to cause biodegradation of a part of the organic and inorganic pollutants in water. The organic matters like starch and sugar are consumed by microorganisms as food. The inorganic constituents like sulphides, sulphates and ferrous ions are attacked by oxygen in presence of microorganisms. Ultimately, these pollutants get transformed to simple, non-hazardous compounds. Dissolved oxygen is consumed in this process.

In order to elucidate BOD, a water sample is taken and saturated with oxygen. It is then incubated at a constant temperature, usually 20°C for five days. This allows time for microorganisms in the waste water to mediate oxidation of pollutants. The remaining amount of DO is determined and BOD is obtained by subtraction.

BOD is an indicator of the degree of pollution. If the pollution extent is large, then greater amounts of DO shall be consumed and BOD indicates relatively pure water. For drinking water BOD should be in the range 0.75 to 1.5 ppm.

Biochemical oxygen demand is a measure of contamination caused by the totality of these compounds, which can be oxidised in the presence of microorganisms (and not contamination caused by any specific chemical). A large, number of compounds are, however, resistant to microbial oxidation. Therefore, they do not contribute to the biochemical oxygen demand, yet their presence makes water unfit for consumption.
BOD does not always give an accurate assessment of pollution load, e.g. some detergents are resistant to microbial degradation even cellulose is slow oxidising. Thus, the five-day period of determination of BOD may be insufficient for the complete oxidation of rich material. Moreover, the five-day period itself is a long one to assess water quality. In order to avoid the problems associated with BOD test, another analytical method called chemical oxygen demand or COD, is sometimes performed. In this case, water sample is treated with a known quantity of an oxidising agent usually potassium dichromate in acidic medium. This reagent oxidizes most of the polluting substances, including those which are resistant to microbial oxidation. the remaining $K_2Cr_2O_7$ is determined by back titration with a suitable reducing agent like mohr salt. The amount of $K_2Cr_2O_7$ consumed is determined by subtraction. From here, amount of $O_2$ used in the oxidation may be calculated from the following chemical equations.

$$K_2Cr_2O_7 (aq) + 4H_2SO_4(aq) \rightarrow K_2SO_4 (aq) + Cr_2 (SO_4)_3 (aq) + 4H_2O (l) + 3(O)(aq)$$

The result are expressed in terms of amount of oxygen, in ppm, that would be required to oxidise the contaminants.

Control of Water Pollution

(i) **Septic tanks should be used for each house. This will reduce the flow of municipal sewage and human excreta towards river, lake or pool.**

(ii) Rivers, lakes, etc., should not be used for bathing and washing purposes. In this way, water sources are not polluted with detergents and germs.

(iii) Too much use of pesticides which are not degradable should be avoided. These are highly toxic substances.

(iv) Efforts should be made to increase the use of low grade or polluted water. Treatment of domestic sewage for industrial cooling is a good example of efficient use. Water reuse has a special significance in mining
and similar industries where the water availability is less. These efforts will save fresh water from being polluted.

(v) Waste water treatment techniques should be applied before the polluted water enters a river, lake or pool. Available waste water treatment processes can be physical, chemical or biological. Physical processes comprise screening, sedimentation, floatation and filtration. Commonly used chemical processes are precipitation, coagulation and disinfection while biological processes are biological filtration and the activated sludge process. In particular cases, the processes such as carbon adsorption, oxidation and reduction, ion-exchange, reverse osmosis, electrodialysis, etc., are also used.

B.O. Atolaye, M.O. Aremu, D. Shagye and G.R.I. Pennap (2006), An investigation into the concentrations and distributions of lead, magnesium, zinc, chromium, iron, manganese and copper in the soil sediment, river water and the organs of Clarias gariepinus and Tilapia quineensis was undertaken with a view to evaluating the interplay of these inorganic minerals in the various matrices. The fishes were of variable sizes while the organs investigated in them were head, intestine, gills and flesh. The lead, magnesium, zinc, chromium, iron, manganese and copper values were lower in fish organs than in the water and soil, thereby showing a low level of bioconcentration. The trace metals determined were below the deleterious level however there is a need for further monitoring.

Brajesh K. Shrivastava and Masood Alam (2006) assessed Ground-water quality of Raigarh city in Chattisgarh state for drinking water purpose based on physico-chemicals, heavy metals & bacteriological (Coliform) parameters. The samples were analysed as per methods specified by Bureau of Indian Standards/standard methods. Physico-chemical analysis reveals that fluoride, nitrate and iron are higher than BIS specified limit at some sampling sites. The samples with high
Iron content & other heavy metals pollution was found in groundwater located near sponge iron plant indicating possible metal leaching into groundwater. Bacteriological analysis reveals that coliform organisms were found absent at 5 locations while at 13 sampling locations, they were found in less than BIS specified limit. Four sampling stations were found heavily contaminated by coliform organisms with maximum coliform organisms were found 86/100ml of water sample.

R.K. Biswas and R.A. Banu (2006), The paper present the physiochemical characteristics and suitability of the ground water body as potable water sources occurring around Dhalai beel area adjacent to Dhaka Export Processing Zone (DEPZ), Savar, Bangladesh. Several parameters including Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Total Hardness, Total Dissolved Solids, Total Alkalinity and quantity of dissolved anions Hardness, Total Dissolved Solids, Total Alkalinity of Dissolved Solids, Total Alkalinity and quantity of dissolved anions viz, Cl, PO4, SO4 and cations viz. K, Na, Ca, Mg, Fe, Cu, Zn, Mn, As, Pb, Cd are studied. The study reveals that the concentration of PO4, K, Na, Fe and Pb exceed the standard permissible limit prescribed by WHO and USPHS.

Jaipal garg and Gita Seth (2006) assess physico-chemical characteristics of ground water samples from the bore wells and dug wells of different 22 locations of Pali district in Rajasthan. Totally 18 parameters were analysed. In many locations maximum parameters within the permissible limit and about 59% samples sites showed higher concentration of fluoride content than the permissible limit and 36% of the water samples showed higher range of total dissolved solids than the permissible limit. The hydro-chemical facts of ground water of this area were found to be dominated by sodium bicarbonate and sodium chloride.

Weqar Ahmad Siddiqi and Javed Hasan (2006) studied the impact of rainwater harvesting on the amounts of heavy metals in ground
water has been studied by collecting water samples from these selected sites in the months before and after the rain. In study the difference between the values of some of the heavy metals in ground water, collected before and after rain, has been found. The present study reveals that the rainwater harvesting suitably reduced the amounts of heavy metals in under ground water and has improved the quality of ground water.

M. C. Shah, P. G. Shilpkar, V. R. Patel, D. N. Upadhyay, H. K. Patel and J. C. Kansara (2006) study water quality parameters of ground water of North, Central and South regions of Kalol Taluka in Gandhinagar district of Gujarat state, India during May-2006. The observed values of various physico-chemical parameters of water samples were compared with standard recommended by World Health Organization (WHO). The analysis of variance (ANOVA) and t-test have been applied for the comparative study of water quality parameters among various regions of Kalol Taluka. The variance was found significant at 1% level of significance in case of Electrical Conductivity, Magnesium Hardness, Chloride Content and at 5% level of significance in case of pH, Total Dissolved Solids, Total Hardness, Chemical Oxygen Demand among the water samples of above three regions of Kalol Taluka.

Vandana Magarde, S.A. Iqbal and SumaN Malik (2006) studied water quality of Upper Lake of Bhopal with respect to the parameters like temp, total dissolved solids (TDS), conductivity, pH, hardness (Carbonate & Bicarbonate), alkalinity, BOD, COD, DO and heavy and toxic metals. The study reveals that the water of Upper Lake is partly polluted and requires suitable majors to check it.

A. Behbahaninia (Iran) (2006) studied physico-chemical properties and its pollutant situation of Jajrood River. This research has been carried out to determine the water quality, pollutant situation, heavy metals of Jajrood River, and comparison of the results with global standards. In
water samples, pH, EC, DO, BOD, COD, some cations and anions, and heavy metals determined in lab. The results indicated that in the each agricultural, industrial, and human affected region, the properties have variations especially in low-water regimes. Heavy metals concentrations in the stations along main branch are insignificant.

S.K. Das and D. Chakrabarty studied diurnal variations of some physico-chemical parameters as well as primary productivity of phytoplankton in Jalangi River at Krishnagar, West Bengal, India. Well mark dial variations have been recorded in respect of some of the factors analyzed. The river is almost free from pollution and anthropogenic hazards.

M. Reda Fishar in the paper examines the distribution of benthic macroinvertebrates in relation to physico-chemical conditions along 1035 km of the River Nile from Aswan High Dam to Al Kanater Barrage, Cairo. Total Dissolved Salts and several individual chemical variables showed positive linear regression with distance from Aswan. Changes in taxon richness appear to be influenced by either pollution and/or sedimentation. Sites downstream of the Kema Factory and downstream of organic discharge from Etsa Drain from Minia city show severe pollution. It is concluded that the low ionic concentrations resulting from the Aswan High Dam construction, localised pollution, and the occurrence of sediment are the main factors governing macroinvertebrate taxon richness.

T.V. Otokunefor, C. Obiukwu (2005) investigated the physicochemical qualities of a refinery effluent and water and sediment of an effluent receiving water body. The treated refinery effluent contained very high concentrations of phenol (11.06 mg/l), oil and grease (7.52 mg/l), ammonia (8.52 mg/l), COD (91.76 mg/l), TDS (390.6 mg/l) and phosphate (6.2 mg/l), but low in sulphide, nickel, lead, copper and chromium, which were undetectable. High concentrations of phenol (5.13–16.38 mg/l), oil and grease (10.56–15.23 mg/l), and ammonia
(4.31–13.17 mg/l) were observed in water and sediment samples respectively, at the point of effluent impact. A high concentration of sulphide (3.74 mg/l) was accumulated in the sediment at the point of impact of the refinery effluent, though it was undetectable in the effluent itself or water sample. The concentrations of these parameters as well as of phosphate, nitrate, zinc and COD declined progressively with distance from the point of impact.

Monica Tolotti and Hansjörg investigated limnochemistry of Piburger See, (Austria), 28 years after the beginning of lake restoration. Although long-term data of the lake show a declining trend in total phosphorus concentrations, long-term water chemistry and phytoplankton data were checked against local weather data in order to explain the delay in the re-oligotrophication process of Piburger See. However, no clear relationship could be detected between the trends observed in the lake and weather conditions during the past 30 years.

Psenner et al. (1994, 1998, 2000) studied the physico-chemical characteristics of Piburger See in 1998 were in accordance with the results of monitoring activities carried out at the lake. Conductivity and major ion concentrations reflect the geochemical characteristics of the catchment.

G. J. Chakrapani1, and Jan Veizer (2005) in their study show that dissolved inorganic carbon (DIC) is a major component of river waters and is derived from atmospheric CO2, from reactions for silicate and carbonate rock weathering and biological activities such as photosynthesis and respiration. DIC in water samples. From the measurements made on these rivers in India through the present study, we find that the river waters have highly depleted DIC.

A study was conducted in an eutrophic body of water with special reference to physicochemical conditions prevailing in the benthic environment. The study revealed mud habitat as less disturbed and more stable, and so the population density of the dominant taxa varied very
little. Benthic organisms have been found to be associated with rich organic pollution indicating higher rate of eutrophication in the pond.

The studies on physicochemical and biological examination of the water of Nacharam lake were carried out with reference to phytoplankton population. It has been concluded that the raw water supply from this source is fit for industrial as well as irrigation purposes, but it cannot serve as a scarcity alternative to Hyderabad water supply.

Seasonal changes of some limnological factors in the river Damodar were studied from December 1991 to November, 1992. The water was more polluted in upper than in lower Damodar. The water of upper Damodar showed acidic pH whereas it was alkaline in lower Damodar though, the velocity of water in upper Damodar was higher compared to that of lower Damodar.

Paper deals with the adverse effects of effluents from textile mills on physicochemical characteristios of at fresh water lake situated at Kishangarh in Rajasthan. Study reveals a marked deviation in the physicochemical characteristic. The water body was also highly polluted. Interrelationships between various parameters are also reported.

The analyses and monitoring were conducted to evaluate the impact of different types of chemical, electroplating, textile and dyeing industry waste water on the river and ground water. Water samples from the localities located on the side of Yamuna river and other areas in Delhi and industrial effluents of different types of industries were collected and analysed. Water quality parameters were very poor, except the samples collected from upstream.

Paper deals with the analysis of physico-chemical parameters of a reservoir, called Loco tank in Asansol. The sewage from the surrounding areas continuously mixes with the waterbody. The effluents from various
small-scale industries are also dumped into this reservoir. A significant level of variation was found in respect to these parameters. The results clearly indicate that the water of the reservoir is severely degraded.

To ensure that the intake water derived from surface and ground water is clear and suitable for drinking the final water quality at Delhi have been evaluated. The final water supply of four treatment plants and 80 tubewells at Delhi were surveyed for heavy metals. The levels of manganese, copper, selenium and cadmium were found marginally above the Indian Standards (IS) specification regulated for drinking water. The data was used to assess the final water quality supplied at Delhi.

Investigation is aimed to calculate Water Quality Index (WQI) of ground water and to assess the impact of pollutants due to agriculture and human activities on its quality. Ten physico-chemical parameters were monitored for calculation of WQI. The results varied from 35.338-224.358 mg/L indicating level of nutrient load and pollution in the hand pumps. The existing results revealed that waters of the study area was not safe for human use.

Water pollution by surfactants in detergent formulation has become an environmental problem. Surfactant levels in waste water, surface water and subsurface water in and the surrounding areas of Tirupati, a famous pilgrim town in South India, has been studied. Results showed the presence of anionic alkylbenzene sulfonate (LAS) surfactants in appreciable amount in sub-surface water.

Heavy metal pollution in the water of major canals originating from the river Yamuna in Haryana was studied. All these metals except Zn were found to be present in the Western Yamuna Canal (WYC) exceeding the maximum permissible limits. Concentrations of the metals were, however, relatively less in the highly eutrophicated waters of Agra.
canal and Gurgaon canal as compared to that in WYC but Fe concentration were much higher.

A hydrochemical study has been carried out on the fresh groundwater resources of Potharlanka, Krishna Delta, India. Extremely low HCO$_3}$/Cl and variable high Mg/Ca (molar ratios) indicated the transformation of the fresh groundwater aquifer systems to saline. A high percentage of the mixed water types indicates the possibility of simultaneous fresh groundwater dilution activity along with a seawater ingestion/intrusion process. Low rainfall and excessive withdrawal of groundwater has caused the increase the saline water intrusion.

Attempt has been made to ascertain the present water quality condition of river Ami in relation to paper mill effluent discharge. The samples were collected from the upstream and downstream of the flow-path of the river from point source of pollution by the mill. The high degree of water quality degradation is reflected by the changes in values of BOD, COD, DO, nitrogen contents and chlorides etc in downstream.

Paper deals with the concentration of heavy metals in the highly polluted Hussainsagar Lake. Surface water samples from six spots were collected throughout the lake and heavy metals analysed were manganese, chromium, zinc, molybdenum, lead, cobalt, cadmium and iron. The results have shown that the concentration of iron, zinc, and cobalt is high as compared to WHO and ICMR. The values of other heavy metals are found within permissible limits.

Hydrogeochemical investigation were carried out in the south-eastern part of the Ranga Reddy district, Hyderabad, India, to assess the quality of groundwater for its suitability for domestic and irrigation purposes. The results showed that the concentrations of these ions are above the permissible limits for drinking and irrigation purposes. The
pollution with respect to NO₃⁻, Cl⁻, and F is mainly attributed to the extensive use of fertilizers and large-scale discharge of municipal wastes into the open drainage system of the area.

A high seasonal variability of biological parameters caused varying relations with erosion resistance grain size, total organic carbon (TOC), cationexchange coefficient (CEC), carbohydrates and proteins.

Rafalina Korol, Agnieszka Kolanek, Marzenna Stronska undergo an analysis of water quality variations in the transboundary river Odra in the time span of 1973–2003. For the years 1993–2003, the trends in water quality variations are calculated and the rates of variation are analysed a notable decline in riverine water quality, which should be attributed to the industrial development in those days.

Extensive investigations of trace metals concentrations in water, suspended particulate matter (SPM) and bottom sediments significant levels of metal contamination were found. Median concentrations (Cd, Pb, Cu, Zn and As) in the SPM and sediments were (mg kg⁻¹) 7.1 and 8.9 Cd, 128 and 146 Pb, 81 and 119 Cu, 1198 and 1204 Zn, 48 and 54 As, respectively. The highest metal pollution of the Odra River solids was found with cadmium, zinc, lead and arsenic, showing high similarity in their frequency distributions in both SPM and sediments.

Helios Rybiacka, 1996 studies of the Odra River in 1989–1993 showed that the bottom sediments were contaminated mainly with Zn, Cu, Pb and Cd. The highest contents of all studied metals were found at the Lubin–Legnica Cumining and smelting region, e.g. Cd up to 16, Pb up to 3954, Cu up to 1784 and Zn up to 6685 (mg kg⁻¹).

Bojakowska & Sokołowska, 1993 undergo a study on river Odra and showed that the mean values of Zn and particularly of Pb and Cu in the 0.63 mm fraction of bottom sediments were significantly higher compared with the results obtained within the framework of National Environmental Monitoring, from 1990 to 1992.
The metal concentrations compared with bulk sediment samples varied in wide ranges and were significantly higher in the fraction o20 mm. The median values were as high as (mg kg⁻¹): 1078 of Zn, 142 of Pb, 96 of Cu, 67 of Cr, 5.0 of Cd, 24 of Co, 43 of Ni and 1.1 of Hg. Obtained results have shown that in general, both the flood sediment bulksamples and their o20 mm size fraction contained high metal concentrations, but still lower ones if compared with the Odra River bottom sediments examined earlier.


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Weqar Ahmad Siddiqi and Javed Hasan (2006) In the present study water samples, from various societies of East Zone of Dwarka subcity of New Delhi have been collected where rainwater-harvesting systems are installed. The impact of rainwater harvesting on the amounts of heavy metals in ground water has been studied by collecting water samples from these selected sites in the months before and after the rain. In study the difference between the values of some of the heavy metals in ground water, collected before and after rain, has been found. The present study reveals that the rainwater harvesting suitably reduced the amounts of heavy metals in under ground water and has improved the quality of ground water.

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regions of Kalol Taluka. Established order of water quality of various regions of Kalol Taluka is North Kalol>Central Kalol>South Kalol.

Magarde, S.A. Iqbal and SumaN Malik Upper Lake of Bhopal is among the biggest lakes of India and is a major source of drinking water for citizens of Bhopal. In the present study, water quality assessment was carried out with respect to the parameters like temp, total dissolved solids (TDS), conductivity, pH, hardness (Carbonate & Bicarbonate), alkalinity, BOD, COD, DO and heavy and toxic metals. The study reveals that the water of Upper Lake is partly polluted and requires suitable majors to check it.

B.O. Atolaye1, M.O. Aremu1, D. Shagye1 and G.R.I. Pennap(2006) An investigation into the concentrations and distributions of lead, magnesium, zinc, chromium, iron, manganese and copper in the soil sediment, river water and the organs of Clarias gariepinus and Tilapia quineensis was undertaken with a view to evaluating the interplay of these inorganic minerals in the various matrices. The fishes were of variable sizes while the organs investigated in them were head, intestine, gills and flesh. The lead, magnesium, zinc, chromium, iron, manganese and copper values were lower in fish organs than in the water and soil, thereby showing a low level of bioconcentration. The trace metals determined were below the deleterious level however there is a need for further monitoring.

Bieluonwu A Uzoukwu, CF Eze, PO Ordu, (2005) studied the physico-chemical profile study carried out on Ulasi river course from Ezinifite to Ogwu-Aniocha in Anambra State of Nigeria shows that the water body has a fairly constant temperature that is in the 26–27°C range. The mean pH values of the top level of the river is always higher than that of the bottom. The mean Fe concentration along the course of the river falls in the 0.6–2.5 mg/L for the top and 0.8–4.9 mg/L for the bottom levels of the river and are above the 0.2 mg/L guiding limit set by
WHO for potable water Low levels of inorganic $\text{PO}_4^{3-}$ and $\text{NO}_3^-$ nutrients were reported for the river

Mohammed Aslam, M.A.; Balasubramanian, A.; Kondoh, A.; Rokhmatuloh; Mustafa,A.J.Geoscience(2003), Hydrogeomorphological units have been mapped using the IRS-1C, LISS III False Color Composite (FCC). The satellite images characteristics have been identified and assessed. The study area which belongs to the parts of Cauvery river basin around Manchanahalli, Karnatakaastate, India, exhibits diverse hydrogeomorphological conditions where the ground water regime is controlled mainly by topography and geology. The main hydrogeomoropphic units found in the area are alluvial plain, Pedi plain, pediment, valley fill, meander scar and water bodies. Groundwater in this hard rock terrain with remnants of palaeochannels is multivariate in nature because of its relation to topography, depth and extent of weathered material overlying bed rock and interconnection of joints and faults.

Abubacker MN, Kannan V, Sridharan VT, Chandramohan M, Rajavelu S(1996) underwent the physico-chemical and biological investigation of water from Uyyakondan Canal of Cauvery river indicated high levels of chlorides and calcium which made the water unsuitable for human use. Diatoms, Melosira granulata, M. sulcambam, Cyclotella meneghiniana, Pleurosigma angulatum were the dominant pollution-tolerant species recorded under these conditions. The study assumes significance as some of these diatoms and fungi can be used as bio-indicators of water pollution.

The data was collected to study the distribution of organic matter in two fresh water lakes lying in the vicinity of Hyderabad. In both the water bodies the NO3 peak preceeded the COD peak in winter season that clearly indicated that ambient Dissolved Oxygen (DO) levels were sufficient to oxidise both organic carbon and oxygen.
The various physico-chemical parameters which control the environmental conditions in different Indian estuaries are given in this review. This is an attempt to increase the understanding of the factors that control the spatio-temporal variability of plankton and productivity in these systems and to develop workable models for the growth and distribution of plankton population.

Seasonal, spatial and diurnal variation in chemical constituents in the snow, ice and melt water is reported here. The study was carried out during post-ablation period November, 1994. Calcium and nitrate appear as dominant cation and anion, respectively in snow indicating significant contribution of terrestrial and anthropogenic sources. Ice has higher concentration of all cations and anions than snow.

Fourteen physico-chemical parameters of two community ponds (Amarnath and Tilaknagar ponds) of Rourkela Industrial Complex were monitored, for 2 year. The water quality index calculated from 10 physico-chemical parameters varied from 118-427 in the year 94-95 and 125-483 in the year 95-96 indicating level of nutrient load and pollution in the ponds. The water is not safe for human consumption unless it is treated and disinfected.

Paper draws a distinction between the waters of Dal Lake in its floating garden area and those in its open, virtually undisturbed area. Several pollution indicator species have been recorded in floating garden waters. These waters are more enriched, eutrophic and polluted as is evident by higher levels of chloride, nitrate and phosphorus; higher population density values of Bacillarophyceae and Cyanophyceae and rich and varied macrophytic flora.

Present study reports bacteriological quality of river Godawari water before and after treatment studied for one year. The coliform concentration in raw water varied from 175 to 900 org/100 mL while in
municipal (treated) water it ranged from nil to 25 being absent only on three occasions out of 24 observations.

Bacteriological profile indicates a very high B.O.D., M.P.N. and the presence of bacteria like E. coli, Salmonella, Shigella, in both the sources. Surface water show a very high contents of total dissolved solid, total alkalinity, total hardness, Ca, Mg, NO3, SO4 during March to June. In ground water most variations occurred from October to March. PH, electrical conductivity, total dissolved solid, total alkalinity, total hardness, Ca, Mg, SO4, NO3, and coliform showed a downward trend from April to June. It is observed that values of several parameters exceeded the permissible limits pointing out the necessity of proper treatment disposal and management of wastes discharged into the rivers and on an open land.

Heavy metal concentrations in the river Yamuna flowing along the state of Haryana through Delhi have been reported selecting 16 stations covering the upstream and downstream stations for major industrial complexes of the state. While Fe, Ni and Co concentrations exceeded the maximum permissible limits prescribed for drinking all along the river, the Cd concentrations crossed the acceptable standards in Delhi downstream. The Pb concentrations declined in the eutrophicated Delhi downstream while Zn concentrations remained within desirable limits throughout.

Successive studies on the physico-chemical parameters of water were carried out over a period of two months at 19 different sites in the Jaipur city, India. Analysis revealed that there has been a certain change in the concentration of various constituents. pH varied from (7.7-8.1) and rise in chloride and TDS in some water samples is observed. There have been changes in fluoride concentration (0.2-0.3 mg/l). An important fact that has been emerged in the study is about the rise in nitrate concentration.
The surface waters from the Osman sagar lake and the ground waters from the surrounding areas of this lake has been analysed for the water quality. All the parameters are well with in the desirable limits of drinking water standards. There is no presence of carbonates in both surface and ground waters. The surface waters have shown a little content of B.O.D.

Ramganga river for a stretch of 36 km at Moradabad has been studied for pollution in surface water, sediments and ground waters in river width area. The pollution is mainly caused by the untreated effluent of nearly 450 electroplating plants and the entire brass and stainless steel industry apart from the domestic wastewaters. The physical, chemical and biological parameters are determined

The physiochemical characteristics of water of river Hindon and Narmada have been studied. Various ostracods have also been reported in these rivers. Water of river Hindon was found to be more polluted than river Narmada.

Bastacola (non-fire zone) and Lodna (fire zone) areas are situated in southern part of Jharia Coalfield, District Dhanbad (Bihar). A systematic on the physico-chemical characteristics of surface and subsurface waters from 18 samples of non-fire and fire zone has been carried out to assess the impact of coal seam fire on the quality of water. It was observed that the coal seam fire does not only damages valuable resource of nation, but it also degrade/deteriorate the quality of water, which can produce adverse effects on the inhabitants residing in and around fire zone area.

Patricia M. Castañé, María G. Rovedatti, Mirta L. Topalián and Alfredo Salibián(2006) collected samples monthly from 5 sites of the river Reconquista; some 18–20 physicochemical parameters were determined in each sample. Analyses revealed significant differences in
the degree of deterioration between sites. Two of them, close to the source of the river (Cascallares-S1 and Paso del Rey-S2) resulted less polluted than the two points located close to the mouth of the river (San Martin-S4 and Bancalari-S5). The worsening of the water quality in S4–S5 was attributed to the discharges of the Moron stream.

Cheung KC, Poon BH, Lan CY, Wang MH (2003) studied the effects of anthropogenic activities, industrialization and urbanization on the accumulation of heavy metals and nutrients in sediments and water of rivers in the Pearl River Delta region were examined. Most sediments were seriously contaminated with Cd, Pb, and Zn in accordance with the classification by Hong Kong Environmental Protection Department. Total phosphorus (P) and nitrogen (N) concentrations in sediments ranged from 0.02% to 0.12% and 0.06% to 0.64%, respectively. High carbon (C), N, P and sulphur (S) levels at Yuen Long Creek were related to the discharge of industrial effluents along the river. The enrichment of P and ammoniacal-nitrogen (NH4+-N) in water were obvious. For most sites, the P concentration exceeded 0.1 mg/l, which is the recommended concentration in flowing water to encourage excessive growth of aquatic plants. Nine out of the 16 sites studied had NH4+-N concentration over 2 mg/l. The rivers in the south of Deep Bay (Hong Kong) had high nutrient exports compared with the rivers in the east region and western oceanic water. The concentrations of nitrate-nitrogen NO3--N in surface water were under the maximum contaminant level in public drinking water supplies (10 mg/l) except for one site. Although the concentrations of heavy metals in overlying water were low, their accumulations were significant. High contents of nickel (Ni) and zinc (Zn) in water were found at certain locations, suggesting the occurrence of some local contamination. These preliminary results indicated that river and sediment transported pollutants is likely one of the factors for the water quality degradation of Deep Bay water.
G. P. Mishra and A. K. Yadav (1977) The present paper deals with a comparative study of the physico-chemical characteristics of river and lake waters in Central India. The surface water has been analysed for pH, turbidity, conductivity, alkalinity, dissolved oxygen and chlorides. The results of analyses of river water have been compared with those from lake water.

The study reveals that the lake water is highly turbid, rich in organic matter, contains more of chlorides and has a higher pH value as compared to river water.

Jain, C. K. and Sharma, M. K. (2001). The distribution of trace metals (Cu, Zn, Fe, Mn, Cd, Cr, Pb and Ni) in water, suspended and bed sediments of the river Hindon, a highly polluted river in western Uttar Pradesh (India) has been studied. The river is polluted by municipal, industrial and agricultural effluents, and flows through the city of Saharanpur, Muzaffarnagar and Ghaziabad districts. The heavy metal concentrations in water were observed to depend largely on the amount of flowing water and are negatively correlated with flow. Sediment analysis indicates that the large amount of heavy metals is associated with organic matter, the fine-grained sediment fraction and Fe/Mn hydrous oxides. A high positive correlation of most of the metal ions in sediments with iron, manganese and organic matter indicate that these constituents play a major role in transport of metal ions. The heavy metal concentrations generally increased with the decreasing particle size of the sediments. Lower metal concentrations in bed sediments during post-monsoon season established that monsoon had a slight effect on status of metals in sediments by causing renewal and mobilization of metals from the sediments.

Imran Ali and C. K. Jain (2001). The water quality of river Yamuna at Delhi has been studied with reference to toxic metals.
during pre-monsoon and post-monsoon seasons. The various metals analysed include cadmium, cobalt, chromium, copper, iron, manganese, lead and zinc. The quality of river water has deteriorated due to the continuous discharge of municipal and industrial effluents from various drains. The metal load discharged by various drains is quite high. It is apparent from the results that maximum load of metal ions was transported from Najafgarh, Barapullah and Shahdara drains. Most of the metal ions show higher concentrations in the post-monsoon season. The main sources of metal pollution in river Yamuna include municipal and industrial effluents. The river water is not safe due to the higher levels of toxic metals. The presence of toxic metals in groundwater indicates contamination in ground water, however the impact is not well pronounced. The water supply for domestic purpose from the river Yamuna should be treated for toxic metal ions and immediate action should be taken to control the quality of the river water.

Imran Ali and C. K. Jain, 2001. The pollution potential of pesticides in Hindon river (India) has been studied. The different pesticides monitored include lindane, malathion, BHC, p,p'-DDD, o,p'-DDT and methoxychlor. The water and sediment samples were collected during pre- and post-monsoon seasons. The concentrations of pesticides were found quite high in sediments compared to the associated water column. It has been observed that the agricultural runoff is the main source of pesticide pollution.

Abhay Kumar Singh *, S. I. Hasnain (2002) An analytical study of major cations and anions of the proglacial streams of Garhwal Himalaya has been carried out to assess the weathering and geochemical processes in high altitude river basins. Calcium and magnesium are the major cations, and bicarbonate and sulphate are the most dominant anions in these waters. A high correlation among HCO$_3^-$, Ca and Mg, a relatively
high contribution of (Ca+Mg) to the total cations (TZ$^+$) and high (Ca+Mg&sol;Na+K) ratio indicate carbonate weathering could be the primary source of the dissolved ions. Carbonic acid weathering is the major proton-producing reaction in the Alaknanda River, while in the Bhagirathi River it is the coupled reaction which controls the solute acquisition processes. To know the geochemical factors controlling the chemical nature of water, R-mode factor analysis on major ion data from Ganga headwater streams has been performed. Factor 1 in the Alaknanda River is explicitly a bicarbonate factor showing strong loading of EC, Ca, Mg, HCO$_3$ and TDS. In the Bhagirathi River Factor 1 explains the sulphide dissolution and silicate weathering and Factor 2 explains carbonate weathering. Wide downstream variations are observed in the total dissolved solids (TDS) and total suspended matter (TSM) in the headwater streams of the Ganga. Quartz and feldspar are the common detrital minerals, and kaolinite and illite the common clay minerals in the suspended sediment.

Satya P. Mohapatra$^1$, Vijay T. Gajbhiye$^1$, Narendra P. Agnihotri$^1$ and Manju Raina$^{1(1995)}$ Rivers are the main source of water in India, and are particularly used for agricultural irrigation and drinking water supply. As most of the rivers pass through agricultural fields, they are subject to contamination with the different insecticides used for crop protection. Residues of persistent organochlorines, which are still used in large quantities in India, are found in water from many Indian rivers. In certain rivers, the concentrations of DDT, aldrin and heptachlor are often present in excess of their guideline limits. Although the concentration level of gamma-HCH is well below the guideline limit, the accumulation of the carcinogenic beta isomer is a matter of great concern. A few organophosphorus insecticides have also been detected in river water. Recently, some organochlorine insecticides have been banned from use in India. The use of new, readily biodegradable insecticides and biocides in agriculture and public health programmes offers some optimism.
lake conducted between 1896 and 1981, lead to a 10-year limnological study to evaluate any potential degradation of water quality. No long-term variations in water quality were observed that could be attributed to anthropogenic activity. Building on the success of this study, a permanent limnological program has been established with a long-term monitoring program to insure a reliable data base for use in the future. Of equal importance, this program serves as a research platform to develop and communicate to the public a better understanding of the coupled biological, physical, and geochemical processes in the lake and its surrounding environment. This special volume represents our current state of knowledge of the status of this pristine ecosystem including its special optical properties, algal nutrient limitations, pelagic bacteria, and models of the inter-relationships of thermal properties, nutrients, phytoplankton, deep-water mixing, and water budgets.

Shu-Rong Zhang, Xi Xi Lu, David Laurence Higgitt, Chen-Tung Arthur Chen2, Hui-Guo Sun, Jing-Tai Han studied the temporal and spatial variations of major ions in the Zhujiang (Pearl River) were analyzed using long-term water chemistry data of major dissolved ions (Ca$^{2+}$, Mg$^{2+}$, the sum of Na$^+$ and K$^+$, HCO$_3^-$, SO$_4^{2-}$, Cl$^-$), and dissolved silica (SiO$_2^-$) from 75 hydrological stations (1958-2002). The total dissolved solids (TDS) within the Zhujiang basin varies from 34.0 mg/l to 416.1 mg/l generally decreasing from upstream to downstream along the main stem of the Zhujiang. Rock weathering is the dominant controlling factor for the water chemistry of the Zhujiang, and more specifically, on average 68% (22-92%) of total dissolved load comes from carbonate weathering, 22% (2-68%) from silicate weathering, and 10% (3-24%) from evaporite weathering respectively. The flux calculations indicate that in total about 41.8 $\times 10^6$ tonnes/year of TDS are transported out of the Zhujiang (excluding the Delta Region), averaged for the period 1958-2002. Changes in water chemistry can be observed from long-term trend
analysis, notably for $\text{SO}_4^{2-}$ and $\text{Cl}^-$, as a result of anthropogenic influences, such as acid deposition, domestic and industrial wastewater discharge, and basin water resource development. An intense reforestation policy coupled with rapid reservoir development in the Zhujiang Basin would trigger more significant anthropogenic impacts on water chemistry in the future.

N. Semwal* and P. Akolkar(2006) in their study deals with water quality assessment of rivers in Uttaranchal, in view of their religious importance and ecological sustainability. Based on bio-monitoring assessment, biological water quality criteria have been evolved for rivers of Uttaranchal, indicating various beneficial uses of water quality and their respective levels of characteristics. The physico-chemical water quality in most of the rivers of Uttaranchal remained unchanged except of total dissolved solids, which ranged from 90.23 to 121.33 mg/l, total suspended solids varying from 126.5 to 236.5 mg/l and total alkalinity of 37.0 to 96.0 mg/l. Religious places have contributed significant levels of sulphates to water quality (1.66 to 20.0 mg/l). Traces of iron, zinc and copper metals in water and sediments have been observed in clean water quality stretches. Agricultural practices on the river bank may have considerable impact on contribution of pesticide residues such as total Endosulfan, Dieldrin and DDT. Open defecation is the most common activity on river banks, which has significant contribution towards the aesthetic water quality of rivers.

Khwaja A.R.; Singh R.; Tandon S.N.(2001) The present article discusses the influence of the wastes on the physicochemical characteristics of the Ganga water and sediments. Two sampling sites have been chosen at Kanpur, the first before and the second after the point where tanneries are located. The same physicochemical parameters which have been determined in the wastes have been monitored at these two sites for two seasons. The results reveal that most parameters
increase as the river traverses between these two points. The increase in values of parameters such as BOD, COD, Cl-, and total solids could be due to the domestic wastes just as much as to the tannery wastes. Phenols and sulfides, can also come from other sources, but their probability of coming from tanneries is higher. However, chromium is one parameter which can primarily be identified to originate from the tanneries. The speciation of the sediments for chromium reveals that the leakage of chromium into the Ganga is taking place at the second site. There is almost a ten fold increase in chromium at the second site as compared to the first. At the first site the surface chromium is primarily in the residual fraction while at the second site it is in the Fe–Mn oxide fractions.

A study of the water quality parameters, total metal and metal speciation of the Yamuna river waters from Dakpathar to Agra has been undertaken. An attempt has been made to expound their temporal and spatial variations. The studies indicate that pollutional load increases along its route downstream the river. A larger percentage of cadmium, copper and zinc are in the bound form (particulate and dissolved) while lead is more bioavailable.

Analysis of six tube well water which are the source of drinking water in Roorkee city of Hardwar district was carried out along with physicochemical and biotic analysis. Presence of bacterial community in relation to biotic factors is sought.

The results of the amount of BHC isomers ( occurring in Ganga water from a selected stretch of the river obtained for the first time in West Bengal are discussed. The water samples were collected from both the banks of the Ganga and also from canals linking the Ganga. N-Hexane was used as partitioning solvent for extraction of BHC residues from water samples. It was found that out of the 36 samples so far analysed the BHC residues ranged from 0.0010. 002 ppm in 21 samples.
Analytical results of trace metals namely, Fe, Cu, Zn, Ni, Co, Pb and Cd in soil sediments and associated water bodies of the districts of Western Uttarakhand Pradesh reveal that the levels of Cu, Zn, Co, Pb, and Cd are well within the permissible limits as recommended by various organisations, whereas concentrations of Cr, Fe, Mn and Ni exceed much above the recommended values in both water as well as soil sediments of districts Meerut, Ghaziabad, and Saharanpur. Respiratory illness, neurological disorders are common symptoms associated with higher Mn uptake in the districts of Saharanpur and Muzaffarnagar. Development of dermatitis in some workers engaged in electroplating polishing, paint and pigment industries in Saharanpur may be caused by Ni poisoning. Lead in human body may affect skin, gastrointestinal tract, lungs and central nervous system and several cases of these damages are noticed to be reported daily in various hospitals of Meerut district. The symptoms of Cd poisoning such as vomiting, abdominal cramps, headaches and shortness of breath are common among the human beings of districts Meerut and Ghaziabad.

Physicochemical characteristics of water of Karwan river, Agra, U.P, India, were studied at various sampling stations in the stretch of 15 Km towards upstream from its merger into Yamuna to assess the magnitude of pollution. The parameters showed that the river was highly polluted at station III in all the seasons due to the discharge of domestic and industrial effluents into it.

The hydrographic factors of Kali estuary varied spatially and temporally but the impact of the latter on the biotic community was conspicuous. Change in the weather condition was noticed according to the seasons at this latitude with heavy rainfall, high percentage of relative humidity during the southwest monsoon season. Surface water temperature and salinity registered low and maximum during these seasons.
Present investigation deals with analysis of organic compounds in Brahmani river near Rourkela industrial complex and quality of drinking water. Presence of acidic compounds like benzoic acid, toluic acid, naphthoic acids, phenols and aresols are reported near Deogaon site. Whereas upstream samples did not show such impurities. Presence of nitrogenous organic compounds has been detected in all sites during all seasons. Method to purify these impurities is suggested.

BOD contamination in Kali river due to discharge of sewage from Bulandsahar city and effluents of industries of Meerut and Muzaffarnagar cities has become a serious problem of water pollution. The high concentration of BOD and lower DO in Kali river is posing the main problem for survival of aquatic life. A study has been undertaken for 3 seasons in a year with respect to colour, pH, turbidity, DO and BOD of the river and it was found that BOD is quite high in the river and presence of low DO forced the aquatic lives to go away. Turbidity is much more than the permissible limit. The pH is also making the water unusable for various uses.

This study was made on the macrophytic biomass production of Kawar lake during the period January 1988 to December 1989 in relation to its effects on the water chemistry. This maximum biomass of submerged macrophytic community was recorded in April and minimum in September. The emergent macrophytic biomass was observed higher in September and the minimum biomass was recorded in January.

The waters of Visakhapatnam harbour were found to be highly turbid with an-euphotic zone of 0.80 to 2.63 m depth. The BOD and dissolved oxygen contents varied in different stations. Extremely high levels of nitrate, phosphate and silicate ranging from 1.37 to 4.61 mg/l were observed in Station I and the concentration of nutrients decreased gradually from Station II to Station VI. The low nutrient levels observed in Station VI were 2 to 16 times greater than the clear open waters of
Visakhapatnam and the concentrations of trace metals in the harbour were higher than those of coastal waters. These hydrographical characteristics indicate that the degree of pollution from sewage and industrial wastes and the eutrophic conditions of water vary from Stations I to VI in the harbour.

Physicochemical and biological parameters of the river Alaknanda were monitored. The quality of water was assessed by comparing with the existing standards for important parameters. The dissolved oxygen exhibited positive relationship with the temperature. The turbidity, total alkalinity, hardness, free carbon dioxide, chloride concentration total dissolved solids, zooplankton and phytoplankton showed marked variation during monsoon and winter seasons.

The Varanasi city sewage discharged into the river Ganga at six sites, was analysed for its physicochemical properties. An analysis of variance reveals significant variation in most of the parameters with respect to months as well as sites. Furthermore, at Rajghat, sewage was most concentrated with the highest pollution load, whereas sewage at Assi ghat was the least concentrated. The correlation among various parameters is reported.

Veer Bhadra Mishra studied that the biochemical oxygen demand is as high as 20 mg/l and faecal coliform counts is around 1.5 million/100 ml at downstream end of the city.

Korfali SI, Davies BE(2005), Although Lebanon has abundant water, its rivers are polluted and aquifer water mismanaged. Effective river water usage requires an understanding of the geochemistry of polluting metals in catchments. Climate is "Mediterranean": wet winters and dry summers. Active sediment flushing is restricted to winter high discharge episodes. Except in winter, water column pollutants are removed by precipitation or sorption to the surface of static bed
sediments. Hence (1) does winter flushing of contaminated sediment and replacement by clean sediment favour self purification? (2) does the distribution of metals between extractable fractions change seasonally and thereby affect metal bioavailability? Results on the distribution of metals are reported for Fe, Pb, Zn, Cu and Cd in bed sediments from Nahr Ibrahim (a karstic river) for summer and winter. A Tessier-like sequential extraction scheme was applied to samples (< 75 microm) for five locations along a 13 km stretch to the sea. Water pH was above 8.2 at all locations implying a very low solubility for Fe. Sediment was derived from catchment soils and limestone. Total sediment Fe increased in winter at all sites following deposition of eroded soil from upstream. Cadmium, Cu and Pb derived from polluting sources; the sources of Zn were more complex. Dilution by clean sediment explained winter reductions in total Cd, Cu and Pb; Zn changes were less consistent. Iron occurred mostly (> 77 sum of fractions) in the residual fraction compared with 6-31 for pollutants; residual Cu and Zn showed a small increase in winter whereas Cd and Pb did not change. All readily exchangeable metals decreased in winter and the carbonate bound forms predominated in both seasons. Nahr Ibrahim has a high capacity for self purification and metal resolubilization from sediment will be limited by the solubility of carbonate forms.

Mao ZP, Yin CQ, Shan BQ, (2004) studied the spatial and temporal variability of nutrients and suspended solids were investigated for two years in a 1.8 km agricultural headwater stream, located by Chaohu Lake, southeastern China. The stream form was greatly modified by human activities into channelized, pond and estuary shapes. The stream could be divided into 4 channelized reaches (1.3 km), a pond reach (0.15 km) and 3 estuary reaches (0.36 km). It was found that nutrients and TSS concentrations in the stream showed temporal variability, and higher concentrations occurred in months with high precipitation and intensive agricultural activities. And, retention of total nitrogen (TN), nitrate
(NO(3-)-N), ammonium(NH4+-N) and total suspended solids (TSS) predominantly occurred in the pond reach and estuary reaches with larger width and low current velocity. Pollutants retained in these reaches accounted for more than 50% of those retained in whole stream. The retention mostly happened in the rain-runoff events and it was 7 to 27 times than that in base flow. The results showed that the channelized reach was the most important source for pollutants release under either runoff or base flow, and its release accounted for more than 90% of whole stream release. There was a high spatial variability of nutrients retention in different channelized reaches. The channelized reach directly discharging into the pond did always retain nutrients and TSS under base flow and runoff conditions, whereas the other channelized reaches performed differently in different hydrological conditions. The high spatial and temporal variability of nutrients and TSS in the stream indicated that anthropogenic disturbance of the agricultural headwater stream, such as channelization and excavation, would be expected to decrease the capacity of nutrients retention in the stream.

Abdul Malik, Shafat A. Qadri, Javed Musarrat, Masood Ahmad (2006) studied the comprehensive water quality studies on the River Ganga were undertaken at Fatehgarh and Kannauj (U.P.) during 1987-1990. The data revealed significant seasonal variations in the physicochemical and bacteriological properties of the river water. The remarkably high level of coliforms, fecal coliforms, and fecal streptococci reflects the poor quality of the water. Some of the Escherichia coli isolates from the test stretch also exhibited multiple drug resistance. These pollutants render the water unfit for drinking and bathing and may pose serious problems related to public health.

Singh VK, Singh KP, Mohan D, (2005) The concentrations of cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc in water and bed sediments of river Gomti have been studied in a fairly long stretch of 500 km from Neemsar to Jaunpur. Grab samples of water
(October 2002-March 2003) and bed sediments (December 2002 and March 2003) were collected from 10 different locations following the standard methods. The river water and sediment samples were processed and analyzed for heavy metals viz., Cd, Cr, Cu, Fe, Pb, Mn, Ni, and Zn, and using ICP-AES. The heavy metals found in the river water were in the range: Cd (0.0001-0.0005 mg/L); Cr (0.0015-0.0688 mg/L); Cu (0.0013-0.0.0043 mg/L); Fe (0.0791-0.3190 mg/L); Mn (0.0038-0.0.0973 mg/L); Ni (0.0066-0.011 mg/L); Pb (0.0158-0.0276 mg/L); and Zn (0.0144-0.0298 mg/L) respectively. In the sediments the same were found in the range: Cd (0.70-7.90 /microg/g); Cr (6.105-20.595 microg/g); Cu (3.735-35.68 microg/g); Fe (5051.485-8291.485 micorg/g); Mn (134.915-320.45 microg/g); Ni (13.905-37.370 microg/g); Pb (21.25-92.15 microg/g); and Zn (1 5.72-99.35 microg/g) of dry weight respectively.

Some physico-chemical parameters viz., pH, total solids, total dissolved solids, total suspended solids, dissolved oxygen, biological oxygen demand, chemical oxygen demand, hardness etc. were estimated as these have direct or indirect influence on the incidence, transport and speciation of the heavy metals. Based on the geoaccumulation indices, the Gomti river sediments from Neemsar to Jaunpur are considered to be unpolluted with respect to Cr, Cu, Fe, Mn, and Zn. It is unpolluted to moderately polluted with Pb. In case of Cd it varies from moderately polluted to highly polluted. As far as Ni is concerned the sediment is very highly polluted at Barabanki and Jaunpur D/s. No correlation was found between enrichment factor and geoaccumulation index.

Shakan S, Grzetic I, Dordavic D.( 2007) in this work studied the sediments of the River Tisa (Tisza) are studied to assess their environmental pollution levels for some major heavy metals, as well as to predict the investigated elements' mobility on the basis of their association type with the substrate. The Tisa River catchments area is a subbasin of the River Danube. Part of this river, 166 km long, belongs to the Serbian province of Vojvodina, before it flows into the Danube. It has
been chosen for our investigation, because it has been exposed to intense pollution in the last decades. An assessment of metal pollution levels in Tisa River sediments was made by comparing mean values for obtained results for the Tisa River sediments with the freshwater sediment's Quality Guidelines as published by US EPA, Environment Canada and soil standards for Serbia. The concentration levels of Pb, Ni, Cu and Cr in Tisa River sediments are safe when compared with Serbian MAQ (Maximum Allowed Quantity) standards for soils, but they are unsafe in the case of Zn and Cd. Recommendations and Outlook. The quality of sediments in the Tisa River was on the border line between potentially polluted and polluted.

The physico-chemical and biological investigation of water from Uyyakondan Canal of Cauvery river indicated high levels of chlorides and calcium which made the water unsuitable for human use. Diatoms, Melosira granulata, M. sulcabam, Cyclotella meneghiniana, Pleurosigma angulatum were the dominant pollution-tolerant species recorded under these conditions. The study assumes significance as some of these diatoms and fungi can be used as bio-indicators of water pollution.

The seasonal variation of calcium and magnesium concentration in the surface waters of Gopalpur Creek were studied. Calcium and magnesium concentration increased from the upper reaches of the creek towards the mouth and varied linearly with chlorinity value. Premonsoon period recorded higher values than other seasons, whereas monsoon period encountered lower value.

The surface waters from the Osman sagar lake and the ground waters from the surrounding areas of this lake has been analysed for the water quality. All the parameters are well within the desirable limits of drinking water standards. There is no presence of carbonates in both surface and ground waters. The surface waters have shown a little content of B.O.D.
Ramganga river for a stretch of 36 km at Moradabad has been studied for pollution in surface water, sediments and ground waters in river width area. The pollution is mainly caused by the untreated effluent of nearly 450 electroplating plants and the entire brass and stainless steel industry apart from the domestic wastewaters. The physical, chemical and biological parameters are determined

A. Behbahaninia (Iran) (2006) studied physico-chemical properties and its pollutant situation of Jajrood River. This research has been carried out to determine the water quality, pollutant situation, heavy metals of Jajrood River, and comparison of the results with global standards. In water samples, pH, EC, DO, BOD, COD, some cations and anions, and heavy metals determined in lab. The results indicated that in the each agricultural, industrial, and human affected region, the properties have variations especially in low-water regimes. Heavy metals concentrations in the stations along main branch are insignificant.

S.K. Das and D. Chakrabarty studied diurnal variations of some physico-chemical parameters as well as primary productivity of phytoplankton in Jalangi River at Krishnagar, West Bengal, India. Well mark dial variations have been recorded in respect of some of the factors analyzed. The river is almost free from pollution and anthropogenic hazards.

M. Reda Fishar in there paper examines the distribution of benthic macroinvertebrates in relation to physico-chemical conditions along 1035 km of the River Nile from Aswan High Dam to Al Kanater Barrage, Cairo. Total Dissolved Salts and several individual chemical variables showed positive linear regression with distance from Aswan. Changes in taxon richness appear to be influenced by either pollution and/or sedimentation. Sites downstream of the Kema Factory and downstream of organic discharge from Etsa Drain from Minia city show severe pollution. It is concluded that the low ionic concentrations resulting from the Aswan
High Dam construction, localised pollution, and the occurrence of sediment are the main factors governing macroinvertebrate taxon richness.

T.V. Otokunefor, C. Obiukwu (2005) investigated the physicochemical qualities of a refinery effluent and water and sediment of an effluent receiving water body. The treated refinery effluent contained very high concentrations of phenol (11.06 mg/l), oil and grease (7.52 mg/l), ammonia (8.52 mg/l), COD (91.76 mg/l), TDS (390.6 mg/l) and phosphate (6.2 mg/l), but low in sulphide, nickel, lead, copper and chromium, which were undetectable. High concentrations of phenol (5.13–16.38 mg/l), oil and grease (10.56–15.23 mg/l), and ammonia (4.31–13.17 mg/l) were observed in water and sediment samples respectively, at the point of effluent impact. A high concentration of sulphide (3.74 mg/l) was accumulated in the sediment at the point of impact of the refinery effluent, though it was undetectable in the effluent itself or water sample. The concentrations of these parameters as well as of phosphate, nitrate, zinc and COD declined progressively with distance from the point of impact.

Monica Tolotti and Hansjörg investigated limnochemistry of Piburger See, (Austria), 28 years after the beginning of lake restoration. Although long-term data of the lake show a declining trend in total phosphorus concentrations, long-term water chemistry and phytoplankton data were checked against local weather data in order to explain the delay in the re-oligotrophication process of Piburger See. However, no clear relationship could be detected between the trends observed in the lake and weather conditions during the past 30 years.

G. J. Chakrapani1, and Jan Veizer (2005) in their study show that Dissolved inorganic carbon (DIC) is a major component of river waters
and is derived from atmospheric CO2, from reactions for silicate and carbonate rock weathering and biological activities such as photosynthesis and respiration. DIC in water samples. From the measurements made on these rivers in India through the present study, we find that the river waters have highly depleted DIC,

A study was conducted in an eutrophic body of water with special reference to physicochemical conditions prevailing in the benthic environment. The study revealed mud habitat as less disturbed and more stable, and so the population density of the dominant taxa varied very little. Benthic organisms have been found to be associated with rich organic pollution indicating higher rate of eutrophication in the pond.

The studies on physicochemical and biological examination of the water of Nacharam lake were carried out with reference to phytoplankton population. It has been concluded that the raw water supply from this source is fit for industrial as well as irrigation purposes, but it cannot serve as a scarcity alternative to Hyderabad water supply.

Seasonal changes of some limnological factors in the river Damodar were studied from December 1991 to November, 1992. The water was more polluted in upper than in lower Damodar. The water of upper Damodar showed acidic pH whereas it was alkaline in lower Damodar though, the velocity of water in upper Damodar was higher compared to that of lower Damodar.

Paper deals with the adverse effects of effluents from textile mills on physicochemical characteristics of a freshwater lake situated at Kishangarh in Rajasthan. Study reveals a marked deviation in the physicochemical characteristic. The water body was also highly polluted. Interrelationships between various parameters are also reported.
The analyses and monitoring were conducted to evaluate the impact of different types of chemical, electroplating, textile and dyeing industry waste water on the river and ground water. Water samples from the localities located on the side of Yamuna river and other areas in Delhi and industrial effluents of different types of industries were collected and analysed. Water quality parameters were very poor, except the samples collected from upstream.

Paper deals with the analysis of physico-chemical parameters of a reservoir, called Loco tank in Asansol. The sewage from the surrounding areas continuously mixes with the waterbody. The effluents from various small-scale industries are also dumped into this reservoir. A significant level of variation was found in respect to these parameters. The results clearly indicate that the water of the reservoir is severely degraded.

To ensure that the intake water derived from surface and ground water is clear and suitable for drinking the final water quality at Delhi have been evaluated. The final water supply of four treatment plants and 80 tubewells at Delhi were surveyed for heavy metals. The levels of manganese, copper, selenium and cadmium were found marginally above the Indian Standards (IS) specification regulated for drinking water. The data was used to assess the final water quality supplied at Delhi.

Investigation is aimed to calculate Water Quality Index (WQI) of ground water and to assess the impact of pollutants due to agriculture and human activities on its quality. Ten physico-chemical parameters were monitored for calculation of WQI. The results varied from 35.338-224.358 mg/L indicating level of nutrient load and pollution in the hand pumps. The existing results revealed that waters of the study area was not safe for human use.
Water pollution by surfactants in detergent formulation has become an environmental problem. Surfactant levels in waste water, surface water and subsurface water in and the surrounding areas of Tirupati, a famous pilgrim town in South India, has been studied. Results showed the presence of anionic alkylbenzene sulfonate (LAS) surfactants in appreciable amount in sub-surface water.

Heavy metal pollution in the water of major canals originating from the river Yamuna in Haryana was studied. All these metals except Zn were found to be present in the Western Yamuna Canal (WYC) exceeding the maximum permissible limits. Concentrations of the metals were, however, relatively less in the highly eutrophicated waters of Agra canal and Gurgaon canal as compared to that in WYC but Fe concentration were much higher.

A hydrochemical study has been carried out on the fresh groundwater resources of Potharlanka, Krishna Delta, India. Extremely low HCO$_3$/Cl and variable high Mg/Ca (molar ratios) indicated the transformation of the fresh groundwater aquifer systems to saline. A high percentage of the mixed water types indicates the possibility of simultaneous fresh groundwater dilution activity along with a seawater ingress/or/intrusion process. Low rainfall and excessive withdrawal of groundwater has caused the increase the saline water intrusion.

Attempt has been made to ascertain the present water quality condition of river Ami in relation to paper mill effluent discharge. The samples were collected from the upstream and downstream of the flow-path of the river from point source of pollution by the mill. The high degree of water quality degradation is reflected by the changes in values of BOD, COD, DO, nitrogen contents and chlorides etc in downstream.
Paper deals with the concentration of heavy metals in the highly polluted Hussainsagar Lake. Surface water samples from six spots were collected throughout the lake and heavy metals analysed were manganese, chromium, zinc, molybdenum, lead, cobalt, cadmium and iron. The results have shown that the concentration of iron, zinc, and cobalt is high as compared to WHO and ICMR. The values of other heavy metals are found within permissible limits.

Hydrogeochemical investigation were carried out in the south-eastern part of the Ranga Reddy district, Hyderabad, India, to assess the quality of groundwater for its suitability for domestic and irrigation purposes. The results showed that the concentrations of these ions are above the permissible limits for drinking and irrigation purposes. The pollution with respect to NO$_3^-$, Cl$^-$, and F is mainly attributed to the extensive use of fertilizers and large-scale discharge of municipal wastes into the open drainage system of the area.

A high seasonal variability of biological parameters caused varying relations with erosion resistance grain size, total organic carbon (TOC), cation exchange coefficient (CEC), carbohydrates and proteins.

Rafalina Korol, Agnieszka Kolanek_, Marzenna Stron´ ska undergo an analysis of water quality variations in the transboundary river Odra in the time span of 1973–2003. For the years 1993–2003, the trends in water quality variations are calculated and the rates of variation are analysed a notable decline in river ine water quality, which should be attributed to the industrial development in those days.

Extensive investigations of trace metals concentrations in water, suspended particulate matter (SPM) and bottom significant levels of metal contamination were found. Median concentrations (Cd,Pb,Cu,Zn and As) in the SPM and sediments were (mg kg$^{-1}$) 7.1 and 8.9 Cd,128
and 146 Pb, 81 and 119 Cu, 1198 and 1204 Zn, 48 and 54 As, respectively. The highest metal pollution of the Odra River solids was found with cadmium, zinc, lead and arsenic, showing high similarity in their frequency distributions in both SPM and sediments.

Helios Rybicka, 1996 studies of the Odra River in 1989–1993 showed that the bottom sediments were contaminated mainly with Zn, Cu, Pb and Cd. The highest contents of all studied metals were found at the Lubin–Legnica Cumining and smelting region, e.g. Cd up to 16, Pb up to 3954, Cu up to 1784 and Zn up to 6685 (mg kg\(^{-1}\))

Bojakowska & Sokowksa, 1993 undergo a study on river Odra and showed that the mean values of Zn and particularly of Pb and Cu in the 0.63 mm fraction of bottom sediments were significantly higher compared with the results obtained within the framework of National Environmental Monitoring, from 1990 to 1992.

Helios Rybicka, 1996; Helios Rybicka & Strzebonska, 1999 studied flood sediments of Odra river collected immediately after the flood in August ’97, showed high metal content. The metal concentrations compared with bulk sediment samples varied in wide ranges and were significantly higher in the fraction 020 mm. The median values were as high as (mg kg\(^{-1}\)): 1078 of Zn, 14.2 of Pb, 96 of Cu, 67 of Cr, 5.0 of Cd, 24 of Co, 43 of Ni and 1.1 of Hg. Obtained results have shown that in general, both the flood sediment bulk samples and their 020 mm size fraction contained high metal concentrations, but still lower ones if compared with the Odra River bottom sediments examined earlier.

Brajesh K. Shrivastava and Masood Alam (2006) studied groundwater quality of Raigarh city in Chattisgarh state was assessed for drinking water purpose based on physico-chemicals, heavy metals & bacteriological (Coliform) parameters. The samples were analysed as per methods specified by Bureau of Indian Standards/standard methods. Physico-chemical analysis reveals that fluoride, nitrate and iron are higher than BIS specified limit at some sampling sites. The samples with high
Iron content & other heavy metals pollution was found in groundwater located near sponge iron plant indicating possible metal leaching into groundwater. Bacteriological analysis reveals that coliform organisms were found absent at 5 locations while at 13 sampling locations, they were found in less than BIS specified limit. Four sampling stations were found heavily contaminated by coliform organisms with maximum coliform organisms were found 86/100ml of water sample.

Jaipal garg and Gita Seth (2006) An assessment of physico-chemical characteristics of ground water samples from the bore wells and dug wells of different 22 locations of Pali district in Rajasthan. Totally 18 parameters were analysed. In many locations maximum parameters within the permissible limit and about 59% samples sites showed higher concentration of fluoride content than the permissible limit and 36% of the water samples showed higher range of total dissolved solids than the permissible limit. The hydro-chemical facts of ground water of this area were found to be dominated by sodium bicarbonate and sodium chloride.

Weqar Ahmad Siddiqi and Javed Hasan (2006) In the present study water samples, from various societies of East Zone of Dwarka subcity of New Delhi have been collected where rainwater-harvesting systems are installed. The impact of rainwater harvesting on the amounts of heavy metals in ground water has been studied by collecting water samples from these selected sites in the months before and after the rain. In study the difference between the values of some of the heavy metals in ground water, collected before and after rain, has been found. The present study reveals that the rainwater harvesting suitably reduced the amounts of heavy metals in under ground water and has improved the quality of ground water.

Gandhinagar district of Gujarat state, India have been carried out during May-2006. The observed values of various physico-chemical parameters of water samples were compared with standard recommended by World Health Organization (WHO). The analysis of variance (ANOVA) and t-test have been applied for the comparative study of water quality parameters among various regions of Kalol Taluka. The variance was found significant at 1% level of significance in case of Electrical Conductivity, Magnesium Hardness, Chloride Content and at 5% level of significance in case of pH, Total Dissolved Solids, Total Hardness, Chemical Oxygen Demand among the water samples of above three regions of Kalol Taluka. Established order of water quality of various regions of Kalol Taluka is North Kalol>Central Kalol>South Kalol.

Magarde, S.A. Iqbal and SumaN Malik Upper Lake of Bhopal is among the biggest lakes of India and is a major source of drinking water for citizens of Bhopal. In the present study, water quality assessment was carried out with respect to the parameters like temp, total dissolved solids (TDS), conductivity, pH, hardness (Carbonate & Bicarbonate), alkalinity, BOD, COD, DO and heavy and toxic metals. The study reveals that the water of Upper Lake is partly polluted and requires suitable majors to check it.

B.O. Atolaye1, M.O. Aremu1, D. Shagye1 and G.R.I. Pennap(2006) An investigation into the concentrations and distributions of lead, magnesium, zinc, chromium, iron, manganese and copper in the soil sediment, river water and the organs of Clarias gariepinus and Tilapia quineensis was undertaken with a view to evaluating the interplay of these inorganic minerals in the various matrices. The fishes were of variable sizes while the organs investigated in them were head, intestine, gills and flesh. The lead, magnesium, zinc, chromium, iron, manganese and copper values were lower in fish organs than in the water and soil, thereby showing a low level of bioconcentration. The trace metals
determined were below the deleterious level however there is a need for further monitoring.

Bieluonwu A Uzoukwu, CF Eze, PO Ordu, (2005) studied the physico-chemical profile study carried out on Ulasi river course from Ezinifite to Ogwu-Aniocha in Anambra State of Nigeria shows that the water body has a fairly constant temperature that is in the 26–27°C range. The mean pH values of the top level of the river is always higher than that of the bottom. The mean Fe concentration along the course of the river falls in the 0.6–2.5 mg/L for the top and 0.8–4.9 mg/L for the bottom levels of the river and are above the 0.2 mg/L guiding limit set by WHO for potable water. Low levels of inorganic $\text{PO}_4^{3-}$ and $\text{NO}_3^-$ nutrients were reported for the river.

Mohammed Aslam, M.A.; Balasubramanian, A.; Kondoh, A.; Rokhmatuloh; Mustafa, A.J. Geoscience (2003), Hydrogeomorphological units have been mapped using the IRS-1C, LISS III False Color Composite (FCC). The satellite images characteristics have been identified and assessed. The study area which belongs to the parts of Cauvery river basin around Manchanahalli, Karnataka state, India, exhibits diverse hydrogeomorphological conditions where the ground water regime is controlled mainly by topography and geology. The main hydrogeomorphie units found in the area are alluvial plain, Pedi plain, pediment, valley fill, meander scar and water bodies. Groundwater in this hard rock terrain with remnants of palaeochannels is multivariate in nature because of its relation to topography, depth and extent of weathered material overlying bed rock and interconnection of joints and faults.

Abubacker MN, Kannan V, Sridharan VT, Chandramohan M, Rajavelu S (1996) underga the physico-chemical and biological investigation of water from Uyyakondan Canal of Cauvery river indicated high levels of chlorides and calcium which made the water unsuitable for
human use. Diatoms, Melosira granulata, M. sulcaba, Cyclotella meneghiniana, Pleurosigma angulatum were the dominant pollution-tolerant species recorded under these conditions. The study assumes significance as some of these diatoms and fungi can be used as bio-indicators of water pollution.

The data was collected to study the distribution of organic matter in two fresh water lakes lying in the vicinity of Hyderabad. In both the water bodies the NO3 peak preceded the COD peak in winter season that clearly indicated that ambient Dissolved Oxygen (DO) levels were sufficient to oxidise both organic carbon and oxygen.

The various physico-chemical parameters which control the environmental conditions in different Indian estuaries are given in this review. This is an attempt to increase the understanding of the factors that control the spatio-temporal variability of plankton and productivity in these systems and to develop workable models for the growth and distribution of plankton population.

Seasonal, spatial and diurnal variation in chemical constituents in the snow, ice and melt water is reported here. The study was carried out during post-ablation period November, 1994. Calcium and nitrate appear as dominant cation and anion, respectively in snow indicating significant contribution of terrestrial and anthropogenic sources. Ice has higher concentration of all cations and anions than snow.

Fourteen physico-chemical parameters of two community ponds (Amarnath and Tilaknagar ponds) of Rourkela Industrial Complex were monitored, for 2 year. The water quality index calculated from 10 physico-chemical parameters varied from 118-427 in the year 94-95 and 125-483 in the year 95-96 indicating level of nutrient load and pollution in the ponds. The water is not safe for human consumption unless it is treated and disinfected.
Paper draws a distinction between the waters of Dal Lake in its floating garden area and those in its open, virtually undisturbed area. Several pollution indicator species have been recorded in floating garden waters. These waters are more enriched, eutrophic and polluted as is evident by higher levels of chloride, nitrate and phosphorus; higher population density values of Bacillarophyceae and Cyanophyceae and rich and varied macrophytic flora.

Present study reports bacteriological quality of river Godawari water before and after treatment studied for one year. The coliform concentration in raw water varied from 175 to 900 org/100 mL while in municipal (treated) water it ranged from nil to 25 being absent only on three occasions out of 24 observations.

Bacteriological profile indicates a very high B.O.D., M.P.N. and the presence of bacteria like E. coli, Salmonella, Shigella, in both the sources. Surface water show a very high contents of total dissolved solid, total alkalinity, total hardness, Ca, Mg, NO3, SO4 during March to June. In ground water most variations occurred from October to March. PH, electrical conductivity, total dissolved solid, total alkalinity, total hardness, Ca, Mg, SO4, NO3, and coliform showed a downward trend from April to June. It is observed that values of several parameters exceeded the permissible limits pointing out the necessity of proper treatment disposal and management of wastes discharged into the rivers and on an open land.

Heavy metal concentrations in the river Yamuna flowing along the state of Haryana through Delhi have been reported selecting 16 stations covering the upstream and downstream stations for major industrial complexes of the state. While Fe, Ni and Co concentrations exceeded the maximum permissible limits prescribed for drinking all along the river, the Cd concentrations crossed the acceptable standards in Delhi downstream. The Pb concentrations declined in the eutrophicated Delhi
downstream while Zn concentrations remained within desirable limits throughout.

Successive studies on the physico-chemical parameters of water were carried out over a period of two months at 19 different sites in the Jaipur city, India. Analysis revealed that there has been a certain change in the concentration of various constituents. pH varied from (7.7-8.1) and rise in chloride and TDS in some water samples is observed. There have been changes in fluoride concentration (0.2-0.3 mg/l). An important fact that has been emerged in the study is about the rise in nitrate concentration.

The surface waters from the Osman sagar lake and the ground waters from the surrounding areas of this lake has been analysed for the water quality. All the parameters are well with in the desirable limits of drinking water standards. There is no presence of carbonates in both surface and ground waters. The surface waters have shown a little content of B.O.D.

Ramganga river for a stretch of 36 km at Moradabad has been studied for pollution in surface water, sediments and ground waters in river width area. The pollution is mainly caused by the untreated effluent of nearly 450 electroplating plants and the entire brass and stainless steel industry apart from the domestic wastewaters. The physical, chemical and biological parameters are determined.

The physiochemical characteristics of water of river Hindon and Narmada have been studied. Various ostracods have also been reported in these rivers. Water of river Hindon was found to be more polluted than river Narmada.

Bastacola (non-fire zone) and Lodna (fire zone) areas are situated in southerner part of Jharia Coalfield, District Dhanbad (Bihar). A
systematic on the physico-chemical characteristics of surface and subsurface waters from 18 samples of non-fire and fire zone has been carried out to assess the impact of coal seam fire on the quality of water. It was observed that the coal seam fire does not only damages valuable resource of nation, but it also degrade/deteriorate the quality of water, which can produce adverse effects on the inhabitants residing in and around fire zone area.

Patricia M. Castañé, María G. Rovedatti, Mirta L. Topalián and Alfredo Salibián (2006) collected samples monthly from 5 sites of the river Reconquista; some 18–20 physicochemical parameters were determined in each sample. Analyses revealed significant differences in the degree of deterioration between sites. Two of them, close to the source of the river (Cascallares-S$_1$ and Paso del Rey-S$_2$) resulted less polluted than the two points located close to the mouth of the river (San Martin-S$_4$ and Bancalari-S$_5$). The worsening of the water quality in S$_4$–S$_5$ was attributed to the discharges of the Moron stream.

Cheung KC, Poon BH, Lan CY, Wang MH (2003) studied the effects of anthropogenic activities, industrialization and urbanization on the accumulation of heavy metals and nutrients in sediments and water of rivers in the Pearl River Delta region were examined. Most sediments were seriously contaminated with Cd, Pb, and Zn in accordance with the classification by Hong Kong Environmental Protection Department. Total phosphorus (P) and nitrogen (N) concentrations in sediments ranged from 0.02% to 0.12% and 0.06% to 0.64%, respectively. High carbon (C), N, P and sulphur (S) levels at Yuen Long Creek were related to the discharge of industrial effluents along the river. The enrichment of P and ammoniacal-nitrogen (NH4+-N) in water were obvious. For most sites, the P concentration exceeded 0.1 mg/l, which is the recommended concentration in flowing water to encourage excessive growth of aquatic plants. Nine out of the 16 sites studied had NH4+-N concentration over 2
mg/l. The rivers in the south of Deep Bay (Hong Kong) had high nutrient exports compared with the rivers in the east region and western oceanic water. The concentrations of nitrate-nitrogen NO₃--N in surface water were under the maximum contaminant level in public drinking water supplies (10 mg/l) except for one site. Although the concentrations of heavy metals in overlying water were low, their accumulations were significant. High contents of nickel (Ni) and zinc (Zn) in water were found at certain locations, suggesting the occurrence of some local contamination. These preliminary results indicated that river and sediment transported pollutants is likely one of the factors for the water quality degradation of Deep Bay water.

G. P. Mishra and A. K. Yadav(1977) The present paper deals with a comparative study of the physico-chemical characteristics of river and lake waters in Central India. The surface water has been analysed for pH, turbidity, conductivity, alkalinity, dissolved oxygen and chlorides. The results of analyses of river water have been compared with those from lake water.

The study reveals that the lake water is highly turbid, rich in organic matter, contains more of chlorides and has a higher pH value as compared to river water.

Jain, C. K. and Sharma, M. K2001.. The distribution of trace metals (Cu, Zn, Fe, Mn, Cd, Cr, Pb. and Ni) in water, suspended and bed sediments of the river Hindon, a highly polluted river in western Uttar Pradesh (India) has been studied. The river is polluted by municipal, industrial and agricultural effluents, and flows through the city of Saharanpur, Muzaffarnagar and Ghaziabad districts. The heavy metal concentrations in water were observed to depend largely on the amount of flowing water and are negatively correlated with flow. Sediment analysis indicates that the large amount of heavy metals is associated with organic
matter, the fine-grained sediment fraction and Fe/Mn hydrous oxides. A high positive correlation of most of the metal ions in sediments with iron, manganese and organic mater indicate that these constituents play a major role in transport of metal ions. The heavy metal concentrations generally increased with the decreasing particle size of the sediments. Lower metal concentrations in bed sediments during post-monsoon season established that monsoon had a slight effect on status of metals in sediments by causing renewal and mobilization of metals from the sediments.

Imran Ali and C. K. Jain 2001. The water quality of river Yamuna at Delhi has been studied with reference to toxic metals during pre-monsoon and post-monsoon seasons. The various metals analysed include cadmium, cobalt, chromium, copper, iron, manganese, lead and zinc. The quality of river water has deteriorated due to the continuous discharge of municipal and industrial effluents from various drains. The metal load discharged by various drains is quite high. It is apparent from the results that maximum load of metal ions was transported from Najafgarh, Barapullah and Shahdara drains. Most of the metal ions show higher concentrations in the post-monsoon season. The main sources of metal pollution in river Yamuna include municipal and industrial effluents. The river water is not safe due to the higher levels of toxic metals. The presence of toxic metals in groundwater indicates contamination in ground water, however the impact is not well pronounced. The water supply for domestic purpose from the river Yamuna should be treated for toxic metal ions and immediate action should be taken to control the quality of the river water.

Imran Ali and C. K. Jain, 2001. The pollution potential of pesticides in Hindon river (India) has been studied. The different pesticides monitored include lindane, malathion, BHC, p,p'-DDD, o,p'-DDT and methoxychlor. The water and sediment samples were collected during pre- and post-monsoon seasons. The concentrations of pesticides
were found quite high in sediments compared to the associated water column. It has been observed that the agricultural runoff is the main source of pesticide pollution.

Abhay Kumar Singh*, S. I. Hasnain (2002) An analytical study of major cations and anions of the proglacial streams of Garhwal Himalaya has been carried out to assess the weathering and geochemical processes in high altitude river basins. Calcium and magnesium are the major cations, and bicarbonate and sulphate are the most dominant anions in these waters. A high correlation among HCO$_3^-$, Ca and Mg, a relatively high contribution of (Ca+Mg) to the total cations (TZ$^+$) and high (Ca+Mg&sol;Na+K) ratio indicate carbonate weathering could be the primary source of the dissolved ions. Carbonic acid weathering is the major proton-producing reaction in the Alaknanda River, while in the Bhagirathi River it is the coupled reaction which controls the solute acquisition processes. To know the geochemical factors controlling the chemical nature of water, R-mode factor analysis on major ion data from Ganga headwater streams has been performed. Factor 1 in the Alaknanda River is explicitly a bicarbonate factor showing strong loading of EC, Ca, Mg, HCO$_3^-$ and TDS. In the Bhagirathi River Factor 1 explains the sulphide dissolution and silicate weathering and Factor 2 explains carbonate weathering. Wide downstream variations are observed in the total dissolved solids (TDS) and total suspended matter (TSM) in the headwater streams of the Ganga. Quartz and feldspar are the common detrital minerals, and kaolinite and illite the common clay minerals in the suspended sediment.

Satya P. Mohapatra¹, Vijay T. Gajbhiye¹, Narendra P. Agnihotri¹ and Manju Raina¹(1995) Rivers are the main source of water in India, and are particularly used for agricultural irrigation and drinking water supply. As most of the rivers pass through agricultural fields, they are subject to contamination with the different insecticides used for crop protection.
Residues of persistent organochlorines, which are still used in large quantities in India, are found in water from many Indian rivers. In certain rivers, the concentrations of DDT, aldrin and heptachlor are often present in excess of their guideline limits. Although the concentration level of gamma-HCH is well below the guideline limit, the accumulation of the carcinogenic beta isomer is a matter of great concern. A few organophosphorus insecticides have also been detected in river water. Recently, some organochlorine insecticides have been banned from use in India. The use of new, readily biodegradable insecticides and biocides in agriculture and public health programmes offers some optimism.

Gary L. Larson, Robert Collier, Mark, W. Buktenica, (2007) studied Crater Lake located in the caldera of Mount Mazama in Crater Lake National ark, Oregon. The lake has a surface area of about 53 km2 at an elevation of 1882 m and a maximum depth of 594 m. Limited studies of this ultraoligotrophic lake conducted between 1896 and 1981 lead to a 10-year limnological study to evaluate any potential degradation of water quality. No long-term variations in water quality were observed that could be attributed to anthropogenic activity. Building on the success of this study, a permanent limnological program has been established with a long-term monitoring program to insure a reliable data base for use in the future. Of equal importance, this program serves as a research platform to develop and communicate to the public a better understanding of the coupled biological, physical, and geochemical processes in the lake and its surrounding environment. This special volume represents our current state of knowledge of the status of this pristine ecosystem including its special optical properties, algal nutrient limitations, pelagic bacteria, and models of the inter-relationships of thermal properties, nutrients, phytoplankton, deep-water mixing, and water budgets.
Shu-Rong Zhang, Xi Xi Lu, David Laurence Higgitt, Chen-Tung Arthur Chen, Hui-Guo Sun, Jing-Tai Han studied the temporal and spatial variations of major ions in the Zhujiang (Pearl River) were analyzed using long-term water chemistry data of major dissolved ions (Ca$^{2+}$, Mg$^{2+}$, the sum of Na$^{+}$ and K$^{+}$, HCO$_3^-$, SO$_4^{2-}$, Cl$^-$), and dissolved silica (SiO$_2$) from 75 hydrological stations (1958-2002). The total dissolved solids (TDS) within the Zhujiang basin varies from 34.0 mg/l to 416.1 mg/l generally decreasing from upstream to downstream along the main stem of the Zhujiang. Rock weathering is the dominant controlling factor for the water chemistry of the Zhujiang, and more specifically, on average 68% (22-92%) of total dissolved load comes from carbonate weathering, 22% (2-68%) from silicate weathering, and 10% (3-24%) from evaporite weathering respectively. The flux calculations indicate that in total about $41.8 \times 10^6$ tonnes/year of TDS are transported out of the Zhujiang (excluding the Delta Region), averaged for the period 1958-2002. Changes in water chemistry can be observed from long-term trend analysis, notably for SO$_4^{2-}$ and Cl$^-$, as a result of anthropogenic influences, such as acid deposition, domestic and industrial wastewater discharge, and basin water resource development. An intense reforestation policy coupled with rapid reservoir development in the Zhujiang Basin would trigger more significant anthropogenic impacts on water chemistry in the future.

N. Semwal* and P. Akolkar(2006) in their study deals with water quality assessment of rivers in Uttaranchal, in view of their religious importance and ecological sustainability. Based on bio-monitoring assessment, biological water quality criteria have been evolved for rivers of Uttaranchal, indicating various beneficial uses of water quality and their respective levels of characteristics. The physico-chemical water quality in most of the rivers of Uttaranchal remained unchanged.
except of total dissolved solids, which ranged from 90.23 to 121.33 mg/l, total suspended solids varying from 126.5 to 236.5 mg/l and total alkalinity of 37.0 to 96.0 mg/l. Religious places have contributed significant levels of sulphates to water quality (1.66 to 20.0 mg/l). Traces of iron, zinc and copper metals in water and sediments have been observed in clean water quality stretches. Agricultural practices on the river bank may have considerable impact on contribution of pesticide residues such as total Endosulfan, Dieldrin and DDT. Open defecation is the most common activity on river banks, which has significant contribution towards the aesthetic water quality of rivers.

Khwaja A.R.; Singh R.; Tandon S.N. (2001) The present article discusses the influence of the wastes on the physicochemical characteristics of the Ganga water and sediments. Two sampling sites have been chosen at Kanpur, the first before and the second after the point where tanneries are located. The same physicochemical parameters which have been determined in the wastes have been monitored at these two sites for two seasons. The results reveal that most parameters increase as the river traverses between these two points. The increase in values of parameters such as BOD, COD, Cl-, and total solids could be due to the domestic wastes just as much as to the tannery wastes. Phenols and sulfides, can also come from other sources, but their probability of coming from tanneries is higher. However, chromium is one parameter which can primarily be identified to originate from the tanneries. The speciation of the sediments for chromium reveals that the leakage of chromium into the Ganga is taking place at the second site. There is almost a ten fold increase in chromium at the second site as compared to the first. At the first site the surface chromium is primarily in the residual fraction while at the second site it is in the Fe–Mn oxide fractions.

A study of the water quality parameters, total metal and metal speciation of the Yamuna river waters from Dakpathar to Agra has been undertaken. An attempt has been made to expound their temporal and
spatial variations. The studies indicate that pollutional load increases along its route downstream the river. A larger percentage of cadmium, copper and zinc are in the bound form (particulate and dissolved) while lead is more bioavailable.

Analysis of six tube well water which are the source of drinking water in Roorkee city of Hardwar district was carried out along with physicochemical and biotic analysis. Presence of bacterial community in relation to biotic factors is sought.

The results of the amount of BHC isomers (residual occurring in Ganga water from a selected stretch of the river obtained for the first time in West Bengal are discussed. The water samples were collected from both the banks of the Ganga and also from canals linking the Ganga. N-Hexane was used as partitioning solvent for extraction of BHC residues from water samples. It was found that out of the 36 samples so far analysed the BHC residues ranged from 0, 0010. 002 ppm in 21 samples.

Analytical results of trace metals namely, Fe, Cu, Zn, Ni, Co, Pb and Cd in soil sediments and associated water bodies of the districts of Western Uttar Pradesh reveal that the levels of Cu, Zn, Co, Pb, and Cd are well within the permissible limits as recommended by various organisations, whereas concentrations of Cr, Fe, Mn and Ni exceed much above the recommended values in both water as well as soil sediments of districts Meerut, Ghaziabad, and Saharanpur. Respiratory illness, neurological disorders are common symptoms associated with higher Mn uptake in the districts of Saharanpur and Muzaffarnagar. Development of dermatitis in some workers engaged in electroplating polishing, paint and pigment industries in Saharanpur may be caused by Ni poisoning. Lead in human body may affect skin, gastrointestinal tract, lungs and central nervous system and several cases of these damages are noticed to be reported daily in various hospitals of Meerut district. The symptoms of Cd poisoning such as vomiting abdominal cramps, headaches and
shortness of breath are common among the human beings of districts Meerut and Ghaziabad.

Physicochemical characteristics of water of Karwan river, Agra, U.P, India, were studied at various sampling stations in the stretch of 15 Km towards upstream from its merger into Yamuna to assess the magnitude of pollution. The parameters showed that the river was highly polluted at station III in all the seasons due to the discharge of domestic and industrial effluents into it.

The hydrographic factors of Kali estuary varied spatially and temporally but the impact of the latter on the biotic community was conspicuous. Change in the weather condition was noticed according to the seasons at this latitude with heavy rainfall, high percentage of relative humidity during the southwest monsoon season. Surface water temperature and salinity registered low and maximum during these seasons.

Present investigation deals with analysis of organic compounds in Brahmani river near Rourkela industrial complex and quality of drinking water Presence of acidic compounds like benzoic acid, toluic acid, napthoic acids, phenols and aresols are reported near Deogaon site. Whereas upstream samples did not show such impurities. Presence of nitrogenous organic compounds has been detected in all sites during all seasons. Method to purify these impurities is suggested.

BOD contamination in Kali river due to discharge of sewage from Bulandsahar city and effluents of industries of Meerut and Muzaffarnagar cities has become a serious problem of water pollution. The high concentration of BOD and lower DO in Kali river is posing the main problem for survival of aquatic life. A study has been undertaken for 3 seasons in a year with respect to colour, pH, turbidity, DO and BOD of the river and it was found that BOD is quite high in the river and presence
of low DO forced the aquatic lives to go away. Turbidity is much more than the permissible limit. The pH is also making the water unusable for various uses.

This study was made on the macrophytic biomass production of Kawar lake during the period January 1988 to December 1989 in relation to its effects on the water chemistry. This maximum biomass of submerged macrophytic community was recorded in April and minimum in September. The emergent macrophytic biomass was observed higher in September and the minimum biomass was recorded in January.

The waters of Visakhapatnam harbour were found to be highly turbid with an euphotic zone of 0.80 to 2.63 m depth. The BOD and dissolved oxygen contents varied in different stations. Extremely high levels of nitrate, phosphate and silicate ranging from 1.37 to 4.61 mg/l were observed in Station I and the concentration of nutrients decreased gradually from Station II to Station VI. The low nutrient levels observed in Station VI were 2 to 16 times greater than the clear open waters of Visakhapatnam and the concentrations of trace metals in the harbour were higher than those of coastal waters. These hydrographical characteristics indicate that the degree of pollution from sewage and industrial wastes and the eutrophic conditions of water vary from Stations I to VI in the harbour.

Physicochemical and biological parameters of the river Alaknanda were monitored. The quality of water was assessed by comparing with the existing standards for important parameters. The dissolved oxygen exhibited positive relationship with the temperature. The turbidity, total alkalinity, hardness, free carbondioxide, chloride concentration total dissolved solids, zooplankton and phytoplankton showed marked variation during monsoon and winter seasons.
The Varanasi city sewage discharged into the river Ganga at six sites, was analysed for its physicochemical properties. An analysis of variance reveals significant variation in most of the parameters with respect to months as well as sites. Furthermore, at Rajghat, sewage was most concentrated with the highest pollution load, whereas sewage at Assi ghat was the least concentrated. The correlation among various parameters is reported.

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reductions in total Cd, Cu and Pb; Zn changes were less consistent. Iron occurred mostly (> 77 sum of fractions) in the residual fraction compared with 6- 31 for pollutants; residual Cu and Zn showed a small increase in winter whereas Cd and Pb did not change. All readily exchangeable metals decreased in winter and the carbonate bound forms predominated in both seasons. Nahr Ibrahim has a high capacity for self purification and metal resolubilization from sediment will be limited by the solubility of carbonate forms.

Mao ZP, Yin CQ, Shan BQ,(2004) studied the spatial and temporal variability of nutrients and suspended solids were investigated for two years in a 1.8 km agricultural headwater stream, located by Chaohu Lake, southeastern China. The stream form was greatly modified by human activities into channelized, pond and estuary shapes. The stream could be divided into 4 channelized reaches(1.3 km), a pond reach(0.15 km) and 3 estuary reaches(0.36 km). It was found that nutrients and TSS concentrations in the stream showed temporal variability, and higher concentrations occurred in months with high precipitation and intensive agricultural activities. And, retention of total nitrogen (TN), nitrate (NO(3-)N), ammonium(NH4+-N) and total suspended solids (TSS) predominantly occurred in the pond reach and estuary reaches with larger width and low current velocity. Pollutants retained in these reaches accounted for more than 50% of those retained in whole stream. The retention mostly happened in the rain-runoff events and it was 7 to 27 times than that in base flow. The results showed that the channelized reach was the most important source for pollutants release under either runoff or base flow, and its release accounted for more than 90% of whole stream release. There was a high spatial variability of nutrients retention in different channelized reaches. The channelized reach directly discharging into the pond did always retain nutrients and TSS under base flow and runoff conditions, whereas the other channelized reaches performed differently in different hydrological conditions. The high
spatial and temporal variability of nutrients and TSS in the stream indicated that anthropogenic disturbance of the agricultural headwater stream, such as channelization and excavation, would be expected to decrease the capacity of nutrients retention in the stream.

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Singh VK, Singh KP, Mohan D, (2005) The concentrations of cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc in water and bed sediments of river Gomti have been studied in a fairly long stretch of 500 km from Neemsar to Jaunpur. Grab samples of water (October 2002-March 2003) and bed sediments (December 2002 and March 2003) were collected from 10 different locations following the standard methods. The river water and sediment samples were processed and analyzed for heavy metals viz., Cd, Cr, Cu, Fe, Pb, Mn, Ni, and Zn, and using ICP-AES. The heavy metals found in the river water were in the range: Cd (0.0001-0.0005 mg/L); Cr (0.0015-0.0688 mg/L); Cu (0.0013-0.0.0043 mg/L); Fe (0.0791-0.3190 mg/L); Mn (0.0038-0.0.0973 mg/L); Ni (0.0066-0.011 mg/L); Pb (0.0158-0.0276 mg/L); and Zn (0.0144-0.0298 mg/L) respectively. In the sediments the same were found in the range: Cd (0.70-7.90 /microg/g); Cr (6.105-20.595 microg/g); Cu (3.735-35.68 microg/g); Fe (5051.485-8291.485 micorg/g); Mn (134.915-320.45 microg/g); Ni (13.905-37.370 microg/g); Pb (21.25-92.15
microg/g); and Zn (1.57-99.35 microg/g) of dry weight respectively. Some physico-chemical parameters viz., pH, total solids, total dissolved solids, total suspended solids, dissolved oxygen, biological oxygen demand, chemical oxygen demand, hardness etc. were estimated as these have direct or indirect influence on the incidence, transport and speciation of the heavy metals. Based on the geoaccumulation indices, the Gomti river sediments from Neemsar to Jaunpur are considered to be unpolluted with respect to Cr, Cu, Fe, Mn, and Zn. It is unpolluted to moderately polluted with Pb. In case of Cd it varies from moderately polluted to highly polluted. As far as Ni is concerned the sediment is very highly polluted at Barabanki and Jaunpur D/s. No correlation was found between enrichment factor and geoaccumulation index.

Shakan S, Grzetic I, Dordavic D. (2007) in this work studied the sediments of the River Tisa (Tisza) are studied to assess their environmental pollution levels for some major heavy metals, as well as to predict the investigated elements' mobility on the basis of their association type with the substrate. The Tisa River catchments area is a subbasin of the River Danube. Part of this river, 166 km long, belongs to the Serbian province of Vojvodina, before it flows into the Danube. It has been chosen for our investigation, because it has been exposed to intense pollution in the last decades. An assessment of metal pollution levels in Tisa River sediments was made by comparing mean values for obtained results for the Tisa River sediments with the freshwater sediment's Quality Guidelines as published by US EPA, Environment Canada and soil standards for Serbia. The concentration levels of Pb, Ni, Cu and Cr in Tisa River sediments are safe when compared with Serbian MAQ (Maximum Allowed Quantity) standards for soils, but they are unsafe in the case of Zn and Cd. Recommendations and Outlook. The quality of sediments in the Tisa River was on the border line between potentially polluted and polluted.
The physico-chemical and biological investigation of water from Uyyakondan Canal of Cauvery river indicated high levels of chlorides and calcium which made the water unsuitable for human use. Diatoms, Melosira granulata, M. sulcabam, Cyclotella meneghiniana, Pleurosigma angulatum were the dominant pollution-tolerant species recorded under these conditions. The study assumes significance as some of these diatoms and fungi can be used as bio-indicators of water pollution.

The seasonal variation of calcium and magnesium concentration in the surface waters of Gopalpur Creek were studied. Calcium and magnesium concentration increased from the upper reaches of the creek towards the mouth and varied linearly with chlorinity value. Premonsoon period recorded higher values than other seasons, whereas monsoon period encountered lower value.

The surface waters from the Osman sagar lake and the ground waters from the surrounding areas of this lake has been analysed for the water quality. All the parameters are well within the desirable limits of drinking water standards. There is no presence of carbonates in both surface and ground waters. The surface waters have shown a little content of B.O.D.

Ramganga river for a stretch of 36 km at Moradabad has been studied for pollution in surface water, sediments and ground waters in river width area. The pollution is mainly caused by the untreated effluent of nearly 450 electroplating plants and the entire brass and stainless steel industry apart from the domestic wastewaters. The physical, chemical and biological parameters are determined.

The present paper deals with a comparative study of physicochemical characteristics of a river and a lake in Central India. It has been observed that the lake water is highly turbid, rich in organic
matter, contains more chlorides, and shows a higher pH and lower bicarbonate concentration as compared to river water. The higher values of bicarbonate have been recorded in December and January when the temperature was low.

An apparent inverse correlation between dissolved oxygen and water temperature was noticed. There seems to be a positive correlation between the chloride concentration and conductivity.

Saksena & Adoni (1973) studied the physicochemical characteristics and some planktonic populations of Sagar Lake in this region they found that pH of surface water was found to be alkaline in both habitats. Variation in pH showed no relationship with dissolved oxygen. No definite correlation could be observed between pH and temperature. (cf. Verma, 1967).

The temporal and spatial variations of major ions in the Zhujiang (Pearl River) were analyzed using long-term water chemistry data of major dissolved ions (Ca2+, Mg2+, the sum of Na+ and K+, HCO3-, SO42-, Cl-), and dissolved silica (SiO2) from 75 hydrological stations (1958-2002). The total dissolved solids (TDS) within the Zhujiang basin varies from 34.0 mg/l to 416.1 mg/l generally decreasing from upstream to downstream along the main stem of the Zhujiang. Rock weathering is the dominant controlling factor for the water chemistry of the Zhujiang, and more specifically, on average 68% (22-92%) of total dissolved load comes from carbonate weathering, 22% (2-68%) from silicate weathering, and 10% (3-24%) from evaporite weathering respectively. The flux calculations indicate that in total about 41.8 ×106 tonnes/year of TDS are transported out of the Zhujiang (excluding the Delta Region), averaged for the period 1958-2002. Changes in water chemistry can be observed from long-term trend analysis, notably for SO42- and Cl-, as a result of anthropogenic influences, such as acid deposition, domestic and industrial wastewater discharge, and basin water resource development. An intense reforestation policy coupled with rapid reservoir development
in the Zhujiang Basin would trigger more significant anthropogenic impacts on water chemistry in the future. Keywords: Zhujiang (Pearl River); water chemistry; major dissolved ions, total dissolved solids, sediment load; human impacts on river basins.

The pioneering efforts in collating and updating river geochemistry databases [Clarke, 1916; Livingstone, 1963; Degens, 1989], studies of dissolved major ions in river waters have been carried out in more systematic and holistic approaches. The most notable cases include the Amazon [Richey et al., 1991; Stallard and Edmond, 1981; 1983; 1987], the Orinoco [Vegas-Vilarrubia and Paolini, 1985; Edmond et al., 1996], the Ganges-Brahmaputra [Sarin and Krishnaswami, 1984; Sarin et al., 1989; Galy and France-Lanord, 1999], and the Congo [Nkounkou and Probst, 1987; Probst et al., 1992].


The present study deals with water quality assessment of rivers in Uttarakhand, in view of their religious importance and ecological sustainability. Based on bio-monitoring assessment, biological water quality criteria have been evolved for rivers of Uttarakhand, indicating various beneficial uses of water quality and their respective levels of characteristics. Out of 60 stretches of 19 rivers, 41 stretches indicated clean water quality of Class ‘A’, five stretches were slightly polluted (class ‘B’), six were moderately polluted (class ‘C’), one stretch was highly polluted (class ‘D’) and there were altogether seven severely polluted (class ‘E’) stretches. The physico-chemical water quality in most of the rivers of Uttarakhand remained unchanged except of total dissolved solids, which ranged from 90.23 to 121.33 mg/l, total suspended solids varying from 126.5 to 236.5 mg/l and total alkalinity of 37.0 to 96.0 mg/l. Religious places have contributed significant levels of sulphates to water quality (1.66 to 20.0 mg/l). Traces of iron, zinc and copper metals in water and sediments have been observed in clean water quality stretches. Agricultural practices on the river bank may have considerable impact on contribution of pesticide residues such as total Endosulfan, Dieldrin and DDT. Open defecation is the most common activity on river banks, which has significant contribution towards the aesthetic water quality of rivers.

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Water quality of forty two randomly selected open wells along Malappuram coast (Kozhikode) was studied during post monsoon. The compliance of the individual parameters as well as overall water quality was estimated with reference to international drinking water quality standards. The studies reveal that pertability of the majority of the wells (90.6%) is below permissible levels as per the ICMR and WHO standards.

Water quality of shallow tube wells (15-18 m depth) around few well sites and two group gathering stations of RDS field Assam, India have been assessed. Water quality around well sites and group gathering stations do not indicate any significant change. Vertical migration of saline formation water to water table is not indicated. Water is nearly neutral and Mg-Ca-HCO type. Although its low EC, TDS, Cl, NO3 and heavy metal content conform to ISI limits and WHO guidelines, high
concentrations of Fe, Mn and sometimes, Mg, along with its decomposing odour makes this water unsuitable for drinking purpose.

Monitoring of river Ramganga waters of Bareilly was carried during Gangasnan (mass bathing) period on physicochemical characteristics. Higher values of EC alkalinity hardness, calcium, magnesium, BOD, during Gangasnan and post Gangasnan are suggestive of greater pollution load.

Heavy metals which are of significant importance in potable water were determined. Among various metals analysed, the iron and manganese were found to be present above the permissible limit of drinking water. Copper, zinc and lead were observed to be present much below the concentration permitted for drinking water. However, chromium was found to exceed the permissible limit at some instances. The probability of presence of these metals is expected due to geological strata, decay and decomposition of vegetation in and around the area.

Attempt has been made to quantify the solute load of a river in a small forested catchment. The elemental distribution pattern has also been constructed in various reaches of the reservoir water, receiving the river discharge. The concentration of total suspended matter (TSM) decreases with an increase in TDS. A similar inverse relationship has been observed for turbidity. A positive correlation exists between TDS and secchi depth (SD).

The physicochemical characters of the river water were analysed. The river water showed high concentrations of sulphates and nitrates. IJ1 all ten genera of phytoplanktons were observed while the zooplanktons were represented by Notholoca sp., Nauphus sp., Micronaupius sp., Karatella sp., Keretella sp. The river water was found polluted in specific periods of a year.
The water of Khalldepar has been used for irrigation and for domestic supply. As the river passes through the mining belts the effluents get mixed with it. The mixing of the domestic sewage, transport of mining ores by the barges, industrial wastes deteriorate the water quality. The Khandepar river showed peak alkalinity in January and peak chlorinity in April and the water was very hard in summer. The water was acidic throughout the study period.

Present work evaluates the WQI of a lentic water body (Hanumantal lake) of Jabalpur. The average value of water quality index for all the seasons were recorded for two stations (opposite Jain temple and Ghora Nakkas site). WQI of lake was recorded as 84.4 which indicates that lake water is not suitable for direct consumption and is not in the permissible level. It belongs to the slight pollution category.

Lucknow water works uses Gomti river as raw water source. The water is subjected to alum coagulation, flocculation, sedimentation, filtration and disinfection. This treatment was observed to be effective in the removal of copper, cadmium, chromium, lead, nickel and zinc to blow their prescribed limits. The treatment was also effective in the removal of iron to a considerable extent, however, manganese was not observed to be removed to the level conforming to Bureau of Indian Standards. It is suggested that the water works either incorporated prechlorination or prepotassium permanganate treatment to reduce manganese to the desired level.

Attempt was made to assess the pollution load with respect to the concentration of certain heavy metals in the water of the Halali reservoir (Vidisha, M.P.). Atomic Absorption Spectrophotometer was used for spectral analysis. The results showed higher concentration of iron and manganese, winereas, cobalt, nickel, copper and chromium were found to have insignificant concentrations as compared to limits prescribed by Bureau of Indian Standards.
Pollution monitoring of five Rivers Sabarmati, Khari, Vatrak and Shedhy were carried out by analysing physicochemical parameters for two years near Kheda region of Gujarat. Many fold increase of pollution was observed at the second site due to confluence of polluted river Khari, while the third site showed slight improvement due to merger of Vatrak and Shedhy rivers.

Based on chemical analysis of water samples from 66 observation wells in the Vellar basin, the ground water chemical behaviour and quality were demonstrated by six spatial distribution maps. Planners and administrators can use these maps while explorations is done for new well sites in this basin. The quality of water in the proposed site can also be assessed. These maps can also be used for preliminary for casting of water quality of the basin.

Turbidity makes the water unfit for domestic purposes. Turbidity measurement is important from the aesthetic point of view. Turbidity is an expression of certain light scattering and light absorbing properties of the water samples. Turbidity represents non specific measurement of suspended solid constituents. In the present study turbidity was absorbed in a range of 2 to 102 N. T. U. in bore wells water of Bhopal city.

Storage capacity of lower lake is depleted due to regular siltation and discharge of domestic waste and sewage. Study assesses the heavy metals seasonal concentration by Atomic Absorption Spectrophotometer (AAS). Cu, Zn, Mn, Fe Ni. Cd and Cr were analysed and these trace elements ranged from 10-30, 20-32, 50-75, 15-45, BDL-16, BDL-9 and BDL p g/L respectively at different sampling stations.

The monitoring of river water has been done seasonally near Rampur. The samples were collected from the upstream and downstream of the flowpath of the river at six points. Water temperature, sulphate and turbidity were found higher in summer season, pH nitrate, chloride,
fluoride, alkalinity, total hardness and B. O. D. were found higher in monsoon season. Iron and D.O. showed higher values in winter season. The study is aimed to assess the degree of pollution of Kubza river water and water quality status.

Impact of coconut husk retting on water quality of EdavaNadayara backwater has been studied. The water quality has been assessed by measuring various parameters. A significantly feature associated with retting is the complete depletion of oxygen in the retting zone and H2S, COD and BOD were significantly higher than in nonretting zone. The high contents of NO-N during monsoon was contributed by land drainage and high values of pO!P during premonsoon possibly caused by regeneration from sediment surface. Silicate behaves conservatively at all seasons in Paravur backwater system.

The concentration of Cu, Fe, Mn, Zn, Co, Ni, Cd and Pb present in the Cochin harbour waters was studied at monthly intervals. The average concentration of all the elements except Zn and Cd were highest in the monsoon period. The mean values for Zn increased from pre-monsoon to post-monsoon period, but the reverse was found for Cd. No interdependancy could be noticed for the presence of trace elements for the period studied.

Surface and bottom water sample were collected from the barmouth of Cochin harbour for a semidiurnal period and analysed for Cu, Zn, Cd, and Pb. The results indicated that dissolved metals are removed from the water column under the influence of salinity, PH and alkalinity. The results are compared with the values reported from other marine environment

The data revealed significant seasonal variations in the physicochemical and bacteriological properties of river water. The remarkably high level of coliforms, fecal coliforms and fecal streptococci
reflects the poor quality of water. Some of the E. coli isolated from the test stretch also exhibited multiple drug resistance which makes the water unfit for drinking and bathing and may pose serious problems related to public health.

Water quality characteristics of aquatic environments arise from a magnitude of physical, chemical and biological interaction. Water bodies, rivers, lakes and estuaries are continuously subjected to a dynamic state of change with respect to their geological age and geochemical characteristics. These are influenced by the activities of living things. The dynamic balance in the aquatic ecosystem is upset by human activities resulting in water pollution. Sometimes biological decomposition of organic matters consumes all the dissolved oxygen, which can not be made up.

Diel fluctuations of some water quality parameters of the Ganga river from Rishikesh to Kanpur were studied just before the rainy season. Air temperature, water temperature, pH, conductivity, total dissolved solids, dissolved oxygen and free carbon dioxide were shown a selective pattern of variation. Although the pH, free carbon dioxide, bicarbonates and hardness exceed the permissible limit in some places occasionally, the increase is not much harmful. The low dissolved oxygen (0.60-1.70) at Kanpur throughout the study is harmful for aquatic life and other purposes.

Water samples collected at an interval of three hours for twenty four hours from eight different stations in the Ganga river during winter were analysed on the spot for some physicochemical parameters like air temperature, water temperature, pH conductivity, total dissolved solids, free carbon dioxide and dissolved oxygen. Air temperature, water temperature, free carbon dioxide and dissolved oxygen show a selective pattern of variation. There 7-1 M of E & F/ND/97 is no such selective
variation in conductivity and total dissolved solids which are disturbed by several factors.

Levels of physicochemical parameters along with Na, K, Ca & Mg in pond/stagnant water bodies around a few selected well sites and two group gathering stations of RDS field, have been investigated. Results show marked seasonal variations and extent of lateral spread out of contaminants is not significant. The extent of degradation around production as well as abandoned wells was however found to be less. Continuous monitoring of the surface water around group gathering stations is therefore needed.

Water Quality Indices for some Indian rivers have been worked out based on published data of Central Pollution Control Board, New Delhi using modified Delphi Method. Water quality models have proved to be powerful tools in water resources management as they can incorporate the complexity of the relevant processes in the water body into a utilitarian form for management consideration.

Paper discusses a bacteriological study of river Varuna. The concentration of coliform bacteria is used as an index of civic pollution which varies with the season, water current, depth and physicochemical characteristics of water. Some coliform are faecal in nature and these reach the terrestrial and aquatic ecosystems via alimentary canal of herbivorous animals.

The water of the river Ganga was monitored for DO, BOD, Eh rH2 and sulfatereducing bacterial population (SRB) in order to test the comparative efficiency of these parameters as pollution indicators, to assess the pollutional states of the river and to evaluate the impact of pollutants on the river water. This study revealed that rH2 was an efficient pollution indicator. All the indicators showed that the river stretch receiving rayon factory effluents and untreated sewage was in a
highly polluted state, and the river was found to be more polluted in its deeper layers.

The main source of Ami river pollution is disposal of industrial effluents from M/s. Sanjai Paper & Chemical Industries Ltd. and M/s. Raina Paper and Board Industries which are situated on right bank of river Ami at Khaliabad. The effluents from both industries are directly discharged without adequate treatment leading to deteriorating the quality of river water. River flows from more or less densely inhabited areas and ultimately disappears into Rapti river near Kauri Ram, GoralVhpur, U.P., India.

An examination of the water quality of the river Ganga at Phaphamau (Allahabad) was carried out at the Mahakumbh festival. It was concluded from the results that mass bathing causes significant changes in the river’s water quality. The study indicated that the water at Phaphamau was not fit for drinking or bathing purposes. The presence of fecal coliforms in the water also indicated the potential presence of pathogenic microorganisms, which might cause waterborne diseases.

The physicochemical characteristics of Kangimi reservoir were investigated monthly at two stations of the reservoir between July 1998 and September 1999. This was done to determine if acceptable water quality standards are being maintained in the reservoir and to assess if the water could maintain a thriving fishery. All the physicochemical parameters investigated fell within the range of allowable standards for potable waters according to the World Health Organization (WHO, 1993). Alkalinity, conductivity, nitrate-nitrogen and phosphate phosphorus showed significantly higher ($P < 0.05$) values during the rains, which was associated with surface runoff, whereas dissolved oxygen, hardness, transparency and chlorophyll-a showed significantly higher values ($P < 0.05$) during the dry season. The reservoir was
indicated to be oligotrophic. The biological significance of these findings are discussed

Impoundment of rivers affects the mayfly (Ephemeroptera) fauna inhabiting such water bodies, especially with respect to their distribution and abundance. A two-year study of the mayfly fauna and some of the physicochemical parameters of the Opa stream–reservoir revealed that there are two mayfly genera inhabiting it, *Cloeon* and *Caenis*. The number of *Cloeon* larvae collected was 10,930 while the number of *Caenis* larvae was 450. It was observed that although both genera occurred at all the sampling stations, their numbers were reduced in the stream below the dam due to increased water current velocity. There were significant differences in the abundance of *Cloeon* among the stations, but none for *Caenis*. Submerged aquatic plants and water current velocity were found to be the major factors responsible for the significant differences. There were significant correlations between the number of *Cloeon* larvae and pH as well as between dissolved oxygen concentration and *Caenis*. These findings are discussed with reference to inter-specific differences in patterns of response to environmental parameters. A species-specific approach is suggested for studies on the strategies that enable mayfly species maintain their populations in stressed and unstable aquatic ecosystems.

A comprehensive comparison was made between the performances of Pd, Pd–ascorbic acid and Pd–Mg(NO$_3$)$_2$ for the determination of Ag, As, Au, Bi, Cd, Ga, Ge, Hg, In, Mn, Pb, Sb, Se, Sn, Te and Tl in terms of charring temperatures available, characteristic mass values, background absorption, permissible interference range, capability of improving the atomization signal shapes and relative standard deviations of the determinations of trace elements in real samples. Generally, the performances of Pd, Pd–ascorbic acid and Pd–Mg are similar, except that the background absorption of the Pd–Mg modifier is 1–2 orders of
magnitude greater than that of the Pd and Pd–ascorbic acid modifiers. Therefore, the need for the addition of ascorbic acid appears to be matrix-dependent, while the addition of Mg(NO₃)₂ is not recommended.

This paper proposes a mathematical model for the prediction of different ion concentration in soil water used for irrigational purposes in Niger State of Nigeria. The various ions considered are sodium (Na⁺), potassium (K⁺), calcium (Ca²⁺), nitrogen in form of nitrate (NO₃⁻), and phosphorus in form of phosphate (PO₄³⁻). The model was simulated for different concentration readings using different adsorption fractions. The results obtained compared favourably with that of the experimental, though with slight variations which were attributed to some of the basic assumptions used during the process of model development.

Jackson and Sherman, 1953; Lasaga, 1981a; Nahon, 1991 studied that sedimentary rocks are more soluble than igneous rocks (the important mineral in sedimentary rocks are feldspar, gypsum and forms of calcium carbonate). Because of their high solubility, combined with their great abundance in the earth crust, they supply a major portion of the soluble constituent to ground water. Sodium (Na) and calcium (Ca) are commonly added cations, bicarbonate and sulphate are corresponding anions, chloride occurs to only a limited extent under normal conditions. The important sources of chloride however are from sewage and intruded sea water. Occasionally nitrate is an important natural constituent, high concentration may indicate sources of part or present pollution. In limestone terrains, calcium and bicarbonate, ions are added to the ground water by solution.

Schott and Petit, 1987; Nahon, 1991 studied that the water passing through igneous rocks dissolves only very small quantities of mineral matter because of the relative insolubility of the rock composition percolating rainwater contain carbon dioxide (CO₂) derived from the atmosphere, which increases the solvent action of water. The silicate
mineral of igneous rocks result in silica being added to the ground. Pyroxenes are solid solution of great complexity all of which have the basic formula $XY [(Si, Al)O_3]_2$ where X maybe Na$^+$, Ca$^{2+}$, Mn$^{2+}$, Fe$^{2+}$, and Li$^+$ and Y maybe Mn$^{2+}$, Fe$^{2+}$, Mg$^{2+}$, Fe$^{3+}$, Al$^{3+}$, Cr$^{3+}$, and Ti$^{4+}$

Durfor, C.J. and Becker, E (1972). Water from areas rich in magnesium-containing rocks may contain magnesium in the concentration range 10 to 50 mg/L. The sulphates and chlorides of magnesium are very soluble, and water in contact with such deposits may contain several hundred milligrams of magnesium per litre. (5) Industrial effluents may contain similarly high levels of magnesium per litre; (5) loadings of magnesium in Lake Superior and Lake Huron during the period 1973 to 1975 were 3146 and 650 tonnes/year, respectively. (6) In surveys of surface water quality in Canada, it was found that magnesium levels vary greatly with location and often with season. Concentrations were usually below 25 mg/L, although concentrations as high as 168 mg/L have been found.


Hem and others, 1990, Berner, 1971 studied that a wide range of human activities adds chemicals to rivers. The use of common salt, sodium chloride, to deice highways has contributed to the chloride concentration in rivers. Burning fossil fuels creates sulfur compounds that are major sources of sulfate for river water (Hem and others, 1990). In fact, the contribution of sulfur to rivers from anthropogenic sources may now be about one-half as much as from natural sources (Berner, 1971).
Spreading fertilizers consisting of phosphate, nitrite, and nitrate compounds on cropland eventually adds to the total concentration of these chemicals in rivers as do other human activities such as the disposal of sewage effluents from metropolitan areas. Wastes from livestock production also add nitrogen compounds.

Muhammad Ali, Abdus Salam, Nadeem Ahmed, Khan, B. Y. A., Khokhar, 2004 studied the monthly variation in physico-chemical parameters of Indus River at Ghazi Ghat, Muzaffargarh (Pakistan) for a period of ten months from March to December 2001. Water samples were collected on monthly basis and were analysed for estimation of water temperature, light penetration, surface tension, density, specific gravity, viscosity, boiling point, turbidity, pH, DO, free CO₂, alkalinity, acidity, electric conductivity, carbonates, bicarbonates, total solids, total volatile solids, total dissolved solids, total volatile dissolved solid and metal contents. The significant monthly variations were observed in all the parameters studied. These parameters were compared with standard water quality indicators to indicate probable pollution in river water. The overall water quality of the study site remained within the safe limits throughout the study period. The water quality of two banks was also compared which was found similar.

Investigations were carried out for the determination of some metallic parameters in drinking waters collected from eight different sources in the vicinity of Rajgangpur Railway Station. The results of these analyses were within the maximum permissible limit recommended by the United States Public Health, WHO, ISI and ICMR. The correlation coefficients amongst different cations and anions (analysed from the experimental water samples), and some significant regression equations have been worked out.

Bacteriological profile indicates a very high B.O.D., M.P.N. and the presence of bacteria like *E. coli, Salmonella, Shigella*, in both the
sources. Surface water show a very high contents of total dissolved solid, total alkalinity, total hardness, Ca, Mg, NO3, SO4 during March to June. In ground water most variations occurred from October to March. PH, electrical conductivity, total dissolved solid, total alkalinity, total hardness, Ca, Mg, SO4, NO3, and coliform showed a downward trend from April to June. It is observed that values of several parameters exceeded the permissible limits pointing out the necessity of proper treatment disposal and management of wastes discharged into the rivers and on an open land.

Paper presents design of an *in-situ* purification system based on the effect of the variation of flow on the water quality parameters for stagnant water bodies. The important parameter of this purification system is the longitudinal dispersion coefficient. This coefficient combines the effect of diffusion and dispersion. A case study pertaining to a stagnant water body in the campus has been performed and analysis on the effectiveness of changes in volumetric flow rate on some of the pollutant concentrations in water has been carried out. It can be concluded from the study that the variation of volumetric flow rate has a definite effect on the concentration of water quality parameters.

Heavy metal concentrations in the river Yamuna flowing along the state of Haryana through Delhi have been reported selecting 16 stations covering the upstream and downstream stations for major industrial complexes of the state. While Fe, Ni and Co concentrations exceeded the maximum permissible limits prescribed for drinking all along the river, the Cd concentrations crossed the acceptable standards in Delhi downstream. The Pb concentrations declined in the eutrophicated Delhi downstream while Zn concentrations remained within desirable limits throughout.

Successive studies on the physico-chemical parameters of water were carried out over a period of two months at 19 different sites in the
Jaipur city, India. Analysis revealed that there has been a certain change in the concentration of various constituents. pH varied from (7.7-8.1) and rise in chloride and TDS in some water samples is observed. There have been changes in fluoride concentration (0.2-0.3 mg/l). An important fact that has been emerged in the study is about the rise in nitrate concentration.

The seasonal variation of calcium and magnesium concentration in the surface waters of Gopalpur Creek were studied. Calcium and magnesium concentration increased from the upper reaches of the creek towards the mouth and varied linearly with chlorinity value. Premonsoon period recorded higher values than other seasons, whereas monsoon period encountered lower value.

The surface waters from the Osman sagar lake and the ground waters from the surrounding areas of this lake has been analysed for the water quality. All the parameters are well within the desirable limits of drinking water standards. There is no presence of carbonates in both surface and ground waters. The surface waters have shown a little content of B.O.D.

Ramganga river for a stretch of 36 km at Moradabad has been studied for pollution in surface water, sediments and ground waters in river width area. The pollution is mainly caused by the untreated effluent of nearly 450 electroplating plants and the entire brass and stainless steel industry apart from the domestic wastewaters. The physical, chemical and biological parameters are determined.

The impact of marble slurry on sub-surface water quality was studied. The quality parameters were compared with standards laid by WHO and ISI for drinking water quality. It is significant to note that the level for all physico-chemical parameters of the ground water sources exceeded the permissible level prescribed by the BIS (1993) and WHO.
(1992) standards for drinking water. The raw effluent released from the industry is highly hazardous both from salinity and sodicity consideration.

The physiochemical characteristics of water of river Hindon and Narmada have been studied. Various ostracods have also been reported in these rivers. Water of river Hindon was found to be more polluted than river Narmada.

Bastacola (non-fire zone) and Lodna (fire zone) areas are situated in southern part of Jharia Coalfield, District Dhanbad (Bihar). A systematic on the physico-chemical characteristics of surface and subsurface waters from 18 samples of non-fire and fire zone has been carried out to assess the impact of coal seam fire on the quality of water. It was observed that the coal seam fire does not only damages valuable resource of nation, but it also degrade/deteriorate the quality of water, which can produce adverse effects on the inhabitants residing in and around fire zone area.

The physico-chemical and biological investigation of water from Uyyakondan Canal of Cauvery river indicated high levels of chlorides and calcium which made the water unsuitable for human use. Diatoms, Melosira granulata, M. sulcabaam, Cyclotella meneghiniana, Pleurosigma angulatum were the dominant pollution-tolerant species recorded under these conditions. The study assumes significance as some of these diatoms and fungi can be used as bio-indicators of water pollution.

The various physico-chemical parameters which control the environmental conditions in different Indian estuaries are given in this review. This is an attempt to increase the understanding of the factors that control the spatio-temporal variability of plankton and productivity in these systems and to develop workable models for the growth and distribution of plankton population.
Fourteen physico-chemical parameters of two community ponds (Amarnath and Tilak Nagar ponds) of Rourkela Industrial Complex were monitored, for 2 years. The water quality index calculated from 10 physico-chemical parameters varied from 118-427 in the year 94-95 and 125-483 in the year 95-96 indicating level of nutrient load and pollution in the ponds. The water is not safe for human consumption unless it is treated and disinfected.

Abstract: Stromatolitic limestone and calcareous shale belonging to Chattisgarh Supergroup of Proterozoic age dominate the upper part of the Mahanadi river basin. X-ray diffractogram (XRD) of limestone rocks show presence of a significant amount of calcite, dolomite and ankerite. Shales of various colours contain calcite and dolomite. It is observed that congruent dissolution of carbonate minerals in the Charmuria pure limestone has given rise to a typical karst topography. On the other hand, limestones are also seen to support red and black soil profiles. This indicates that the limestone bedrock undergoes a parallel congruent weathering, which leaves a residue of decomposed rock. The XRD analyses reveal that the limestone soils thus formed contain an assemblage of quartz, clays and Fe-oxides. It is likely that the silicate component trapped during deposition of the stromatolitic limestone weathers incongruently resulting in diverse soil profiles. Carbonate and silicate mineral weathering schemes have been worked out to explain the soil formation, fixation of Al in clay minerals, and Fe in goethite. The water quality parameters such as Ca, Mg and HCO3 in the river water suggest under saturation with respect to calcite and dolomite. The mineral stability diagrams indicate that kaolinite and Ca-smectite are stable in the river water environment, hence they occur in suspended sediments and soils. The dominant influence of carbonate weathering on the water quality is observed even in the downstream part of the river outside the limestone terrain.
Present investigation showed that not only the insect orders but also the different species of insects of the same order fluctuates seasonally. The fluctuation of the population of Hemipteran and Odonatan insects in three different study area of the river Damodar showed no clear corelations within a season or month and has been discussed in relation to different chemical parameters.

Seasonal changes of some limnological factors in the river Damodar were studied from December 1991 to November, 1992. The water was more polluted in upper than in lower Damodar. The water of upper Damodar showed acidic pH whereas it was alkaline in lower Damodar though, the velocity of water in upper Damodar was higher compared to that of lower Damodar. The insect population fluctuated throughout the year with a peak of hemipteran population during Marchapril whereas the diptera population showed its climax during December, March and April.

Pond, river and thermal spring, three types of freshwater ecosystems have been investigated to compare their physicochemical properties. Comparatively thermal spring revealed higher temperature than that of pond and river. Maximum turbidity was recorded in river followed by pond and thermal spring. Higher dissolved oxygen was recorded in river than thermal spring and pond. Minimum amount of free carbon dioxide was found during summer in pond and maximum during winter in thermal springs.

A perennial reservoir in the southern Rajasthan was studied for selected limnophysical aspects to assess role of these factors on the overall productivity status. Water clarity values between 66.0 - 336 cm indicate comparatively clear water status and the reservoir can be placed under mildeutrophic category following classification. All the basis of water clarity. Interrelations of temperature and turbidity have been discussed in the paper.

This paper investigates phosphorus (P) transport and
transformation dynamics in two contrasting sub-catchments of the River Kennet, England. Samples were collected daily under baseflow and hourly under stormflow conditions using autosamplers for 2 years and analysed for a range of determinands (full P fractionation, suspended sediment (SS), cations, pH, alkalinity, temperature and oxygen). Concentrations of SRP, SUP, PP and SS were higher in the flashy River Enborne (means of 0.186, 0.071, 0.101 and 34 mg l⁻¹, respectively) than the groundwater-fed River Lambourn (0.079, 0.057, 0.028 and 9 mg l⁻¹, respectively). A seasonal trend in the daily P dataset was evident, with lower concentrations during intermediate flows and the spring (caused by a dilution effect and macrophyte uptake) than during baseflow conditions. However, in the hourly P dataset, highest concentrations were observed during storm events in the autumn and winter (reflecting higher scour with increased capacity to entrain particles). Storm events were more significant in contributing to the total P load in the River Enborne than the River Lambourn, especially during August to October, when dry antecedent conditions were observed in the catchment. Re-suspension of P-rich sediment that accumulated within the channel during summer low flows might account for these observations. It is suggested that a P–calcite co-precipitation mechanism was operating during summer in the River Lambourn, while adsorption by metal oxyhydroxide groups was an important mechanism controlling P fractionation in the River Enborne. The influence of flow conditions and channel storage/release mechanisms on P dynamics in these two lowland rivers is assessed.

Rivers whose basins are underlain by carbonate rocks exhibit high pH, lower desorption of metals and possess high buffering capacity against acidic inputs to the river. The catchment of River Nahr-Ibrahim, Lebanon, is largely underlain by limestone. Compared to neighbouring countries, Lebanon is relatively fortunate since precipitation is high. However, recently a warming in temperature and a drop in precipitation has occurred, thus causing low water levels in rivers. The objective of this
study is to investigate the variation of the total metal content (Fe, Mn, Zn, Cu, Pb and Cd) in bed sediments and water of River Nahr-Ibrahim between 1996 and 1999 (two years); and relate these variations to the effect of changes in human activities and/or due to the variations of precipitation rate, temperature and pH of water. Bed load sediments and stream water were collected simultaneously from five sampling sites. Water pH and temperature were determined in situ. Sediment samples were dried at room temperature and sieved; the sediment size < 75 microns size was retained. Water was analysed for major constituents and trace metals. Metals were extracted from sediments with aqua regia. Metal concentration in water and sediments were determined using ICP-MS technique. Data revealed a drop in metal concentrations (Zn, Cu, Pb, Cd) in sediments at quarry site after its closure. The decrease in precipitation rate, lowering the level of water and the dilution of industrial discharges and decrease in water pH led most probably to the desorption of metals from sediments into the water.

In this work, sediments of the River Tisa (Tisza) are studied to assess their environmental pollution levels for some major heavy metals, as well as to predict the investigated elements' mobility on the basis of their association type with the substrate. The Tisa River catchments area is a subbasin of the River Danube. Part of this river, 166 km long, belongs to the Serbian province of Vojvodina, before it flows into the Danube. It has been chosen for our investigation, because it has been exposed to intense pollution in the last decades. MATERIALS AND METHODS: The river sediment samples were collected at 32 locations. The proportions of sand, silt and clay fractions were determined. The sequential extraction procedure following a modified Tessier method was applied for speciation of the metal forms in the collected samples. The metal concentrations of Zn, Cd, Pb, Ni, Cu, Cr, Fe and Mn in extracts were determined by atomic absorption spectroscopy. RESULTS AND DISCUSSION: Granulometric analysis showed that some 50% of the
Tisa River sediments were silt and clay, while the rest was sand with quartz, as the main constituent. The average metal content of the surface river sediment samples for every fraction of sequential extraction was presented and discussed in relation to pH, Eh and metal fractionation. The average metal content from the Tisa River sediments, obtained as an average of the metal's concentration released in all five sequential extraction fractions was compared with: average metal contents of the Tisa River sediments in Hungary, metal content in soils formed on the Tisa River alluvium of Vojvodina, average metal content in soils of Vojvodina, and average metal content in soils of Hungary. An assessment of metal pollution levels in Tisa River sediments was made by comparing mean values for obtained results for the Tisa River sediments with the freshwater sediment's Quality Guidelines as published by US EPA, Environment Canada and soil standards for Serbia. CONCLUSION: According to US EPA and Canadian Quality Guidelines for freshwater sediments, the concentration of heavy metals in Tisa sediments were: (a) much higher than defined concentrations below which harmful effects on river biota are unlikely to be observed, (b) below defined concentrations above which harmful effects on river biota are likely to be observed. The concentration levels of Pb, Ni, Cu and Cr in Tisa River sediments are safe when compared with Serbian MAQ (Maximum Allowed Quantity) standards for soils, but they are unsafe in the case of Zn and Cd. Recommendations and Outlook. The quality of sediments in the Tisa River was on the border line between potentially polluted and polluted. This line could very easily be exceeded since the quality of sediments in the Tisa River in Hungary was already worse than in Serbia. These results indicated the need for further monitoring of heavy metals in that locality.

The Fractionation of Fe, Zn, Cu, Pb, Mn and Cd in the sediments of the Achankovil River, Western Ghats, India using a sequential extraction method was carried out to understand the metal availability in the basin for biotic and abiotic activities. Spatial distribution of heavy
metals has been studied. Sediment grain size has significant control over the heavy metal distribution. The fluctuations in their concentration partly depend upon the lithology of the river basin and partly the anthropogenic activities. The sediments are dominated by sand and are moderately to strongly positively skewed and are very leptokurtotic in nature. The quartzite and feldspars are abundant minerals along with significant amount of mica with low clay content. The core sediments show increasing trend of heavy metal concentration with depth due to the recent addition of anthropogenic sources and post-diagenic activities. Significant amount of Cd (18%) was found in carbonate fraction, which may pose environmental problems due to its toxic nature. Small concentrations of metals, except Cd and Cu, are in exchangeable fraction, which indicate low bio-availability. Enrichment Factor (EF) for individual metals shows the contribution from terregious and in part from anthropogenic sources. Selective Sequential Extraction (SSE) study shows the variation in specific metal distribution pattern, their distribution in different phases and their bio-availability. Maximum amount of the metals were bound to the non-residual fractions (mainly Fe-oxides). Overall, bio-availability of these micronutrients from sediments seems to be very less. Non-residual phase is the most important phase for majority of heavy metals studied. Among the non-residual fraction, maximum amount of the heavy metals bound to Fe-oxides. The study high lights the need for in-depth study of heavy metals distribution and fractionation in the smaller river basins to get precise information on the behavior and transport of heavy metals in the fluvial environment and their contribution to the world ocean.

The Ganga River is the largest river in India which, originates in the Himalayas and along with the Brahmaputra River, another Himalayan river, transports enormous amounts of sediments from the Indian sub-continent to the Bay of Bengal. Because of the important role of river sediments in the biogeochemical cycling of elements, the Ganga river
sediments, collected from its origin to the down stretches, were studied in the present context, to assess the heavy metals associated with different chemical fractions of sediments. The fractionation of metals were studied in the sediments using SM&T protocol for the extraction of heavy metals and geo-accumulation index (GAI) (Muller, Schwermetalle in den sedimenten des rheins - Veranderungen seit. Umschau, 79, 778-783, 1979) and Metal Enrichment Factor (MEF) in different fractions were calculated. As with many river systems, residual fractions constitute more than 60% of total metals, except Zn, Cu and Cr. However, the reducible and organic and sulfide components also act as major sinks for metals in the down stretches of the river, which is supported by the high GAI and MEF values. The GAI values range between 4 and 5 and MEF exceed more than 20 for almost all the locations in the downstream locations indicating to the addition of metals through urban and industrial effluents, as compared to the low metals concentrations with less GAI and MEF in the pristine river sediments from the rivers in Himalayas.

Natural surface coating samples (NSCSs) from the surface of shingles and surficial sediments (SSs) in the Songhua River, China were employed to investigate the relationship between NSCSs and SSs in fractions of heavy metals (Fe, Mn, Zn, Cu, Pb, and Cd) using the modified sequential extraction procedure (MSEP). The results show that the differences between NSCSs and SSs in Fe fractions were insignificant and Fe was dominantly present as residual phase (76.22% for NSCSs and 80.88% for SSs) and Fe-oxides phase (20.33% for NSCSs and 16.15% for SSs). Significant variation of Mn distribution patterns between NSCSs and SSs was observed with Mn in NSCSs mainly present in Mn-oxides phase (48.27%) and that in SSs present as residual phase (45.44%). Zn, Cu, Pb and Cd were found dominantly in residual fractions (>48%), and next in solid oxides/hydroxides for Zn, Pb and Cd and in easily oxidizable solids/compounds form for Cu, respectively. The heavy metal distribution patterns implied that Fe/Mn oxides both in NSCSs and SSs
were more important sinks for binding and adsorption of Zn, Pb and Cd than organic matter (OM), and inversely, higher affinity of Cu to OM than Fe/Mn oxides in NSCSs and SSs was obtained. Meanwhile, it was found that the distributions of heavy metals in NSCSs and SSs were similar to each other and the pseudo-total concentrations of Zn, Cu, Pb and Cd in NSCSs were greater than those in SSs, highlighting the more importance for NSCSs than SSs in controlling behaviours of heavy metals in aquatic environments.

Seasonal variation of the concentrations of trace metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were measured by ICP-AES in the water and sediment from the Saricay Stream, Geyik Dam and Ortakoy Well in the same basin. Comparisons between trace metal concentrations in water and sediment in three sources (Stream, Dam and Well) were made. The concentrations of a large number of trace metals in the water and sediment were generally higher in the Stream than in the Well and Dam, particularly in summer. Trace metal concentration ranges in sediments of the Saricay Stream and its sources showed very wide ranges (as mass ratio): Co: 5-476 microg g(-1), Cr: 15-1308 microg g(-1), Cu: 7-128 microg g(-1), Fe: 1120-13210 microg g(-1), Mn: 150-2613 microg g(-1), Ni: 102-390 microg g(-1), Pb: 0.7-31.3 microg g(-1) and Zn: 18-304 microg g(-1), whereas Cd was not detected. Trace metal concentration ranges found in waters were: Co: 9.5-20.7 microg L(-1), Cr: 20.3-284 microg L(-1), Cu: 170-840 microg L(-1), Fe: 176-1830 microg L(-1), Mn: 29.3-387 microg L(-1), and Ni: 4.3-21.9 microg L(-1). Among the trace metals studied, Cd and Zn in two seasons and Pb in winter were usually not detected or in the recommended levels. In addition, Cd was not detected in the sediment during the winter season. The analysis of variance (one-way ANOVA) and correlation matrix was employed for the sediment and water samples of the two field surveys (summer and winter) comparison. The three sources showed differences in metal contents. The metal levels in sediments displayed marked seasonal and regional
variations, which were attributed to anthropogenic influences and natural processes. In the Saricay Stream, high values of metals during the dry season showed an anthropological effect from small industry firms, e.g.: an olive mill and a dairy farm or water dilution during summer seasons. Finally, the pollution in this basin probably originated from small industrial, low quality coal-burned thermal power plants, and particularly agricultural and domestic waste discharges.

Overlying bottom water samples were collected in the Vistula River plume, southern Baltic Sea, (Poland) and analysed for dissolved and labile particulate (1 M HCl extractable) Cu, Pb, Zn, Mn, Fe and Ni, hydrological parameters being measured simultaneously. Particulate organic matter (POM), chlorophyll a and dissolved oxygen are key factors governing the chemical behaviour of the measured metal fractions. For the dissolved Cu, Pb, Zn, Fe and Ni two maxima, in the shallow and in the deeper part of the river plume, were found. In the shallow zone desorption from seaward fluxing metal-rich riverine particles account for markedly increased metal concentrations, as confirmed also by high particulate metal contents. For Pb, atmospheric inputs were also considered to have contributed to the elevated concentrations of dissolved Pb adjacent to the river mouth. In the deep zone desorption from detrital and/or resuspended particles by aerobic decomposition of organic material may be the main mechanism responsible for enrichment of particle-reactive metals (Cu, Pb, Zn) in the overlying bottom waters. The increased concentrations of dissolved Fe may have been due to reductive dissolution of Fe oxyhydroxides within the deep sediments by which dissolved Ni was released to the water. The distribution of Mn was related to dissolved oxygen concentrations, indicating that Mn is released to the water column under oxygen reduced conditions. However, Mn transfer to the dissolved phase from anoxic sediments in deeper part of the Vistula plume was hardly evidenced suggesting that benthic flux of Mn occurs under more severe reductive
regime than is consistent with mobilization of Fe. Behaviour of Mn in a shallower part has been presumably affected by release from porewaters and by oxidization into less soluble species resulting in seasonal removal of this metal (e.g. in April) from the dissolved phase. The particulate fractions represented from about 6% (Ni) and 33% (Mn, Zn, Cu) to 80% (Fe) and 89% (Pb) of the total (labile particulate plus dissolved) concentrations. The affinity of the metals for particulate matter decreased in the following order: Pb > Fe > Zn > or = > Cu > Mn > Ni. Significant relationships between particulate Pb-Zn-Cu reflected the affinity of these metals for organic matter, and the significant relationship between Ni-Fe reflected the adsorption of Ni onto Fe-Mn oxyhydroxides. A comparison of metal concentrations with data from other similar areas revealed that the river plume is somewhat contaminated with Cu, Pb and Zn which is in agreement with previous findings on anthropogenic origin of these metals in the Polish zone of southern Baltic Sea.

The metal pollution in water and sediment of the River Hindon in western Uttar Pradesh (India) was assessed for Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn. The metal concentrations in water showed wide temporal variation compared with bed sediment because of variability in water discharge and variations in suspended solid loadings. Metal concentrations in bed sediments provided a better evaluation of the degree and the extent of contamination in the aquatic environment, Santagarh and Atali being the most polluted sites of the river. The ratio of heavy metals to conservative elements (Fe, Al, etc.) may reveal the geochemical imbalances due to the elevated metal concentrations normally attributed to anthropogenic sources. Metal/Al ratios for the bed sediments of the river Hindon were used to determine the relative mobility and general trend of relative mobility occurred Fe > Mn > Zn > Cr > Ni > Pb > Cu > Cd.
Jyotsna Chaturvedi¹ and Narendra Kumar Pandey² (2006) Physico-chemical analysis of river Ganga at Vindhyachal Ghat The result indicates that the river Ganga at Vindhyachal ghat is in a serious grip of water pollution during Navratri Pooja due to huge gathering of population. The few toxic metals namely Fe, Cu, Ni, Cr, Zn & Cd were collected and studied at sites

Kinjo Kazutoshi (Kagoshima Univ., Kagoshima, Jpn) Tokashiki Yoshihiro, Sato Kazuhiro, Kitou Makoto, Shimo Moritaka (Univ. Ryukyus, Okinawa, Jpn) (2005) Physico-chemical and mineralogical characteristics of surface water in a mangrove forest were investigated. Fukido River basin, Ishigaki Island was selected as the study site. Six locations along the river in the forest were selected, mineral composition was similar at all the points. Both the pH and EC values of the surface sediments tended to decrease toward the upper reaches of the river and to be higher on the bank.

Barber, L.B., Murphy, S.F., Verplanck, P.L., Sandstrom, M.W., Taylor, H.E., and Furlong, E.T (2006) undergo investigation of geochemical transformations. The 1160 km² Boulder Creek Watershed in the Colorado Front Range encompasses a gradient of geology, ecotypes, climate, and urbanization. Water samples were collected along a 70-km transect during spring-runoff and base-flow conditions, and analyzed for major elements, trace elements, bulk organics, organic wastewater contaminants (OWCs), and pesticides

selected, which vary markedly with respect to climate, geology, physiography, and ecology, are: Allequash Creek, Wisconsin. It was concluded that $SO_4$ is most variable and $NH_4$ and $NO_3$ generally retained except for $NO_3$ at Andrews.

Ayoko, Godwin A. and Singh, Kirpal and Balerea, Steven and Kokot, Serge (2007) studied physico-chemical properties of surface water and groundwater samples from some developing countries and have enabled relationships between the physico-chemical properties and water quality. Thus, the ranking of the quality of the water bodies was found to be strongly dependent on the total dissolved solid, phosphate, sulfate, ammonia-nitrogen, calcium, iron, chloride, magnesium, zinc, nitrate and fluoride contents of the waters.

Akpofure Rim-Rukeh, Grace O. Ikhifa and Peter A. Okokoyo (Feb 2007) Physico-chemical characteristics of some river and hand-dug well waters used for drinking and domestic purposes in the oil rich Niger Delta area of Nigeria were assessed using standard methods. The concentrations of the parameters in the river water samples were also studied. The concentrations of BOD, turbidity, $NO_3^-$ and Fe in the water samples were above WHO and FMENV permissible limits for safe drinking water.

Ayoko, Godwin A. and Singh, Kirpal and Balerea, Steven and Kokot, Serge (2007) studied Physico-chemical properties of surface water and groundwater samples from some developing countries have been subjected to multivariate analyses by the non-parametric multi-criteria decision-making methods the ranking of the quality of the water bodies was found to be strongly dependent on the total dissolved solid, phosphate, sulfate, ammonia-nitrogen, calcium, iron, chloride, magnesium, zinc, nitrate and fluoride contents of the waters.
C. K. Jain (2001) underwent a hydro-chemical study has been carried out on a 37-km stretch of the River Ganga from Deoprayag to Rishikesh (India). The maximum suspended sediment concentrations. A large amount of sediment and nutrient load is transported from the watershed during the rainy season. Concentrations of NO$_3$–N and NH$_3$–N at Deoprayag varied from 0.30 to 0.50 and 0.02 to 0.12 mg/L, respectively, depending on season.

Paresh Lacoul, Bill Freedman (2005) studied physical and chemical factors were studied in 34 lentic waterbodies distributed along a steep altitudinal gradient ranging from tropical (77 m) to high alpine (up to 4,980 m) environments in Nepal. Bicarbonate and calcium were dominant among anions and cations, respectively, reflecting a strong influence of carbonate weathering and watershed area, rather than altitudinal climate. Total suspended solids were relatively high in the study lakes, as is also typical of rivers in the Ganges watershed.

M. E. H. Ala Eldin, M. Sami Ahmed, V. V. S. Gurunadha Rao, (1999) Groundwater-flow modelling was carried out to assess the degree of Ganga river and aquifer interaction. Abstraction from all existing deep and shallow tube wells has been assigned as output at various cells. A steady state flow simulation was carried out and calibrated against the June 1986 water level; subsequent transient conditions were calibrated up to May 1995. The computed groundwater balance was comparable to that estimated from field investigations. The aquifer modelling study has attempted to integrate all available information and provided a tool that could be used for predictive simulation.

Kunwar P. Singh, Vinod K. Singh and Amrita Malik (2005) A hydrochemical study on a 630 km stretch of river Gomti, a tributary of the river Ganges examined the distribution of heavy metals in sediments and the partitioning of their chemical species between five geochemical phases. Various physicochemical parameters such as pH, total solids, total
dissolved solids, total suspended solids, COD, BOD, DO, conductivity, chloride, sulphate, phosphate, fluoride, total alkalinity, total hardness, etc. were also reported. According to the Risk Assessment Code (RAC), the sediments having 11–30% carbonate and exchangeable fractions are at medium risk. The concentrations of cadmium and lead at mid Lucknow, Pipraghat, Sultanpur U/S and Sulthanpur D/S are between 31 and 50%. They thus pose a high risk to the environment.

S.K.Das¹ and D.Chakrabartiy² Study on the Diurnal Variation of Physico-chemical Properties and Primary Productivity of Phytoplankton in Tropical River of eastern India. Well mark dial variations have been recorded in respect of some of the factors analyzed. The gross primary productivity (GPP) and net primary productivity (NPP) depicted a declining trend from morning to evening hours. The percentage respiration rate (r) to GPP was less than 50%, which suggested non-polluted status of the river as in polluted aquatic sites the GPP generally reflects more than 50% value. The river is almost free from pollution and anthropogenic hazards.

Wetzel & Likens (2004) studied Physico-chemical condition of aquatic systems may change markedly in tropical region during 24h period. Small streams in tropical India are usually physico-chemically dynamic and biologically rich. So these streams provide excellent opportunities for diurnal rhythm studies.

Work were made by Mortan and Bayly (1977), Saha and Pandit (1986), Saksena and Adoni (1973), Vijayaraghavan (1971) in Tropical River of eastern India. The dissolved oxygen content varied from 6.36 to 6.93 mg. L⁻¹ in the study period. The D.O values content showed marked rise from the morning, reaching peak value in the afternoon (2 p.m.). Comparatively higher oxygen values were obtained during the day than night hours.
Ramarao et. al. 1979; Schmidt 1994 Study on the Diurnal Variation of Physico-chemical Properties. The ratio of NPP to GPP never exceeded 0.67, while the ratio of NPP to respiration rate was 1.67. The ratio of NPP to GPP ranged from 0.63–0.67 recording a lowest value during 10 a.m.–2 p.m. incubation period. The average ratio of NPP to respiration was 1.58. The percentage of respiration rate to GPP ranged from 37.90–42.75. In polluted waters the percentage value of respiration rate is more than 50%.


M. Pandey, V.K. Dixit, G.P. Katiyar, G. Nath, S.M. Sundram, N. Chandra, A.K. Shomvansi, S. Kar, V.K. Upadhay (2005) Ganga water quality data. 11 parameters were procured from CWC (Central Water Commission) office at Varanasi. The concentration levels of the water quality parameters were determined by CWC. The levels are above standard and hence Ganga water quality is still degraded. Due to low and medium run offs in rivers Ganga and Yamuna and very dense concentration of large scale urban and industrial centres at Kanpur and Delhi, respectively, In study, the Seasonal Mean Concentrations of DO & BOD and Total & Faecal coliforms are found to be much higher than the respective tolerance limits as given by the WHO and ISI standards.

S. Kumar *, Dr. L. C. Saha (1990) studied bottom sediments of a river and of two sites of well showed significant changes in relation to different water factors. Comparatively, organic carbon, organic matter and free CaCO$_3$ concentration were higher in the Sutapatti well than at other sites which may affect the quality of potable water considerably.
The paper of G. P. Mishra and A. K. Yadav (1978) deals with a comparative study of the physico-chemical characteristics of river and lake waters in Central India. The surface water has been analysed for pH, turbidity, conductivity, alkalinity, dissolved oxygen and chlorides. The results of analyses of river water have been compared with those from lake water. The study reveals that the lake water is highly turbid, rich in organic matter, contains more of chlorides and has a higher pH value as compared to river water.

Cheung KC, Poon BH, Lan CY, Wong MH. The effects of anthropogenic activities, industrialization and urbanization on the accumulation of heavy metals and nutrients in sediments and water of rivers in the Pearl River Delta region were examined. High carbon (C), N, P and sulphur (S) levels at Yuen Long Creek were related to the discharge of industrial effluents along the river. The concentrations of nitrate-nitrogen NO3--N in surface water were under the maximum contaminant level in public drinking water supplies (10 mg/l).

Gaur VK, Gupta SK, Pandy SD, Gopal K, Mishra V (2005) study the impacts of domestic/industrial wastes on the water and sediment chemistry of river Gomti with special reference to heavy metals have been investigated in different seasons (summer, winter and rainy). For this, seven sampling sites: Gaughat, Mohan Meakin, Martyr's Memorial, Hanuman Setu, Nishatganj bridge, Pipraghat and Malhaur, in the river Gomti in Lucknow region were identified and samples of water and sediments were collected in all the three seasons. In the collected water and sediment samples, six metals (Cd, Cr, Cu, Ni, Pb, and Zn) were analyzed on ICP-AES (Inductively coupled plasma emission spectroscopy) Labtam Plasmalab 8440. High concentrations of all the metals were noticed in water and sediment in rainy season compared to summer and winter. Because in rainy season runoff from open contaminated sites, agricultural field and industries, directly comes into
the river without any treatment. In both the cases, the concentration of zinc was maximum (0.091 microg/ml in water and 182.13 microg/g in sediment) and the concentration of cadmium (0.001 microg/ml in water and 17.26 microg/g in sediment) was minimum. Higher concentration of metal in water and sediment during rainy season could be due to the industrial/agricultural/domestic runoff coming into the river.

Khwaja A.R.; Singh R.; Tandon S.N. (2001) study Ganga Water and Sediments Vis-à-Vis Tannery Pollution at Kanpur. The results reveal that most parameters increase as the river traverses between these two points. The increase in values of parameters such as BOD, COD, Cl^-, and total solids could be due to the domestic wastes just as much as to the tannery wastes. Phenols and sulfides, can also come from other sources, but their probability of coming from tanneries is higher.

Jain C K, Singhal DC, Sharma MK (2005) studied the metal pollution in water and sediment of the River Hindon in western Uttar Pradesh (India) was assessed for Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn. The ratio of heavy metals to conservative elements (Fe, Al, etc.) may reveal the geochemical imbalances due to the elevated metal concentrations normally attributed to anthropogenic sources. Metal/Al ratios for the bed sediments of the river Hindon were used to determine the relative mobility and general trend of relative mobility occurred Fe > Mn > Zn > Cr > Ni > Pb > Cu > Cd.

Neal C, Jarvie HP, Neal H, Hill M, Wicham H,(2006) The spatial and temporal patterns of in-stream nitrate concentrations for the upper Thames and selected tributaries are described in relation to point and diffuse sources for these rural catchments. There is a decrease in the average nitrate concentration downstream for the Kennet where average concentrations decrease from around 35 to 25 mg. On a flow weighted basis, the average diffuse component of nitrate is around 95% for the Thames Basin rivers.
Polluted water of Ulhas river inhibited green pigments of chlorophyll-a, chlorophyll-b and total chlorophyll, vitamins like C, B₁, B₂, and organic contents of total carbohydrates, proteins and liquids observed in the plant species. Due to inhibition in the contents of chlorophylls, vitamins and organic contents, adverse effects have been created in biosynthetic processes leading to growth performance of the bank vegetation of Ulhas river.

Appa Rao BV, Gopal V, Karthikeyan G, Pius Anitha, Meenakshi S (1991) Made an attempt has been made to assess the extent of pollution of ground water sources in and around the tannery units located in the southern side of Dindigul town. It has been found that the amounts of total solids, hardness and chlorides in the ground water sources are several times higher than the tolerance limits for drinking and industrial purposes; fluorides, oxygen, BOD, and pH are within the limits. Remedial measures have been suggested in order to control further ground water pollution and save the people as well as industries of Dindigul town from a big water crisis in the near future.

Chauhan Anil (1991) studied effect of distillery effluent on the characteristics of river Wainganga, before and after closure of the factory was studied. Addition of the effluent to the river caused toxic conditions by increasing BOD, COD, and TSS along with decrease in DO.

Gadh Ranu, Singh OV, Tandon SN, Mathur RP (1991) A study of the water quality parameters, total metal and metal speciation of the Yamuna river waters from Dakpathar to Agra has been undertaken. An attempt has been made to expound their temporal and spatial variations. The studies indicate that pollutional load increases along its route downstream the river. A larger percentage of cadmium, copper and zinc are in the bound form (particulate and dissolved) while lead is more bioavailable.
Gajghate DG, Reddy PJ (1990) in recent study of Musi river water shed in Hyderabad indicates that the nitrate level in water decreased from the year 1988 but potential of water level increased during the same period. Alarming nitrate levels have been observed which exceed excessive limit of drinking water standard and there is an imperative need for proper control of indiscriminate industrial discharge and sewerage system to safeguard sources.

Garg Dinesh K, Goyal RN, Agarwal VP (1991), Analyse six tube well water which are the source of drinking water in Roorkee city of Hardwar district was carried out along with physicochemical and biotic analysis. Presence of bacterial community in relation to biotic factors is saught.

Israili Abdul Wahid, Nabi Ald, Qadeer Hasan, Naqvi S(1990)shows results of trace metals namely, Fe, Cu, Zn, Ni, Co, Pb and Cd in soil sediments and associated water bodies of the districts of Western Uttar Pradesh reveal that the levels of Cu, Zn, Co, Pb, and Cd are well within the permissible limits as recommended by various organisations, whereas concentrations of Cr, Fe, Mn and Ni exceed much above the recommended values in both water as well as soil sediments of districts Meerut, Ghaziabad, and Saharanpur. Respiratory illness, neurological disorders are common symptoms associated with higher Mn uptake in the districts of Saharanpur and Muzaffarnagar. Development of dermatitis in some workers engaged in electroplating polishing, paint and pigment industries in Saharanpur may be caused by Ni poisoning. Lead in human body may affect skin, gastrointestinal tract, lungs and central nervous system and several cases of these damages are noticed to be reported daily in various hospitals of Meerut district. The symptoms of Cd poisoning such as vomitinga abdominal cramps, headaches and shortness of breath are common among the human beings of districts Meerut and Ghaziabad.
Kumar Sheo, Saha LC(1989) studied population of Bhagalpur town is mainly fed by surface water and underground water which are contaminated through seepage from deep sewerage, septic tanks, drains and domestic outlets. Comparatively, hand pump of underground water source, showed higher concentrations of total solids, free CO₂, HCO₃ alkalinity, total and calcium hardness, chloride, NO₃N, Ca⁺⁺ and Mg⁺⁺ whereas total bacterial density was maximum in well water.

Mittal Sharad, Sengar RMS(1990) studied physicochemical characteristics of water of Karwan river, Agra, U.P, India, were studied at various sampling stations in the stretch of 15 Km towards upstream from its merger into Yamuna to assess the magnitude of pollution. The parameters showed that the river was highly polluted at station III in all the seasons due to the discharge of domestic and industrial effluents into it.

Naik UG, Neelakantan B(1991)studied that hydrographic factors of Kali estuary varied spatially and temporally but the impact of the latter on the biotic community was conspicuous. Change in the weather condition was noticed according to the seasons at this latitude with heavy rainfall, high percentage of relative humidity during the southwest monsoon season. Surface water temperature and salinity registered low and maximum during these seasons.

Ramaswami V, Rajaguru P (1991) collect water samples from dug and tube wells near the Noiyyal river in Tiruppur Municipal area which were analysed for the assessment of chemical quality with reference to Indian Standards for drinking water. It was observed that values of several parameters exceeded the permissible limits pointing out to the necessity of proper treatment, disposal and management of wastes discharged into the river and on open land.
A. K. Sinha, D. P. Pande, R. K. Srivastava, P. Srivastava, K. N. Srivastava, A. Kumar and A. Tripathi (1990) in his paper reports on the impact of mass bathing on Ganga River water quality on the occasion of the Maha-Shivaratri festival at Haudeshwarnath Ghat situated on the left bank of the River Ganga in the district of Pratapgarh, India. Water samples collected from three sampling points before and after mass bathing were analysed for a total of 17 physico-chemical and seven biological parameters. It was concluded from the results that mass bathing causes a significant change in water quality of the river, which may represent a health hazard to users of the river water.

Colin David Brown, Nigel Turner, John Hollis, Pat Bellamy, Jeremy Biggs, Penny Williams, Dave Arnold, Tim Pepper and Steve Maund (2006) studied Morphological and physico-chemical properties of British aquatic habitats potentially exposed to pesticides. The data describe major differences in the abundance, dimensions and chemistry of waterbodies in the different landscapes. There is almost an order of magnitude difference in the total input of pesticide per unit area between the different landscapes.

M. Felipe-Sotelo, J.M. Andrade, A. Carlosena and R. Taule (2006) Temporal characterisation of river waters in urban and semi-urban areas using physico-chemical parameters and chemometric methods. Three sampling campaigns were carried out in rivers located at two hydrographic basins affected by urban and semi-urban areas around the Metropolitan area of A Coruña. to study local and temporal variations of 21 physicochemical parameters (pH, conductivity, Cl, SO$_4^{2-}$, SiO$_2$, Ca$^{2+}$, Mg$^{2+}$, Na$^+$, K$^+$, hardness, NO$_3^-$, NO$_2^-$, NH$_4^+$, COD, PO$_4^{3-}$, Zn$^{2+}$, Cu$^{2+}$, Mn$^{2+}$, Pb$^{2+}$, alkalinity and acidity. The temporal evolution of the water quality was mostly related to seasonal increments of the physicochemical parameters defining the decomposition of the organic matter.
Surface water bodies are progressively subjected to stress as a result of anthropogenic activities. This study assessed and examined the impact of human Multivariate statistical techniques were applied to identify characteristics of the water quality in the studied rivers. The results showed that rivers strongly influenced by household wastewater have the highest concentrations of nutrients. Two rivers influenced by sewage from industry and ships were distinguished from other rivers with high values of petroleum activities on spatial variation in the water quality of 19 rivers in the Taihu watershed.

Emmanuelle Petelet-Giraud and Philippe Negrel, (2007), This study, based on a chemical and isotopic approach (major, trace elements and strontium isotopes), focuses on the geochemical hydrograph separation during flood events in a Mediterranean watershed (Hérault, Southern France). Major element contents present a typical decreasing logarithmic curve when plotted against river discharge. The concentrations measured during floods are, however, always higher than the theoretical dilution curve.

Vinod K. Singh, Kunwar P. Singh and Dinesh Mohan, (2005) The concentrations of cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc in water and bed sediments of river Gomti have been studied in a fairly long stretch of 500 km from Neemsar to Jaunpur. Based on the geoaccumulation indices, the Gomti river sediments from Neemsar to Jaunpur are considered to be unpolluted with respect to Cr, Cu, Fe, Mn, and Zn. It is unpolluted to moderately polluted with Pb. In case of Cd it varies from moderately polluted to highly polluted. As far as Ni is concerned the sediment is very highly polluted at Barabanki and Jaunpur D/s. No correlation was found between enrichment factor and geoaccumulation index.
Ravinder Kaur¹ and Rupa Rani¹ (2006), Spatial Characterization and Prioritization of Heavy Metal Contaminated Water Resources in Peri-Urban Areas of National Capital Territory (NCT), Delhi. The present study was thus basically aimed at assessing the spatial distribution/extent and type of heavy metal pollution in the study area. The study showed that concentration of all micronutrients (viz. Zn: 0.05–0.18 ppm; Cu: in traces; Fe: 0–0.5 ppm; and Mn: 0–1.2 ppm) and most heavy metals (viz. Ni: 0–0.7 ppm; Pb: 0–0.15 ppm and Cd: in traces) in the surface/sub-surface irrigation waters were well within permissible limits. However Cr concentrations in irrigation waters of Alipur and Shahdara blocks were far above their maximum permissible limit of 1 ppm

F. R. Espinoza-Quiñones, S. M. Palacio, R. M. Galante, F. L. Rossi, D. C. Zenatti, I. R. A. Pereira, R. A. Welter, N. Rossi, C. L. Obregón, J. M. T. de Abreu, (2005) Trace element concentrations in water from São Francisco River using Particle Induced X-ray Emission (PIXE) and Synchrotron Total Reflection X-ray Fluorescence (STXRF) techniques are measured. Water samples were collected monthly at five locations along the course of the river. Up to 15 elements were quantified. The highest total content of Cr, As, Cu and Zn detected in river water are above the limits recommended by the environmental legislation.

Conselho Nacional do Meio Ambiente (CONAMA) (1986) showed that the concentrations of total copper in river water at all sites are much higher than the 20 ppb recommended by the Brazilian environmental legislation[11] for river water class II. Except for Cu, all other elements show average concentrations below the allowed limits. However, at some sites, the upper limits of Cr, Zn, and As are above the allowed limit.
Kunwar P. Singh, Dinesh Mohan, Vinod K. Singh and Amrita Malik present a hydrochemical study on a 630 km stretch of river Gomti river. They pose a high risk to the environment. Since the concentrations of cadmium and lead at Neemsar (Cd 56.79%; Pb 51%) are higher than 50%, the RAC (Risk Assessment Code) is very high. In most cases, the average metal concentrations were lower than the standard shale values. Various physicochemical parameters such as pH, total solids, total dissolved solids, total suspended solids, COD, BOD, DO, conductivity, chloride, sulphate, phosphate, fluoride, total alkalinity, total hardness, etc. were also reported.

D. P. Modak, K. P. Singh, H. Chandra and P. K. Ray (1992), studied mobile and bound trace metals associated with sediment components (viz. exchangeable, carbonate, organic, Fe/Mn oxide and residual fractions) were determined at five locations on the River Ganges in the lower reaches. In the exchangeable phase, 5–22% of Pb, 5–14.4% of Cr, 3–16.4% of Cd, 3–16% of Zn and 1–13.5% of Cu were found, and in the carbonate phase 73–87% of Zn, 38–41% of Cd, 13–27% of Ni and 3–10.1% of Pb were found. The Fe/Mn oxide phase retained about 79–83% of Mn, 30–40% of Cr and Fe, 22–25% of Cu, 14–16% of Ni and 9–11% of Pb. In the organic phase about 36–47% of Cd, 22–28% of Cu and 10–15% of Pb were found.

M. K. Gupta, Vibha Singh, Poonam Rajwanshi, Meetu Agarwal, Kavita Rai, Shalini Srivastava, Rohit Shrivastav and Sahab Dass (1999) Fluoride concentration and other parameters in groundwater from 261 villages in Tehsil Kheragarh of District Agra were assessed and attempts were made to observe the relationship between fluoride and other water quality parameters. Of 658 groundwater samples (collected from separate sources) analysed for fluoride, 27% were in the range of 0–1.0 mg/L, 25% in 1.0–1.5 mg/L, 32% in 1.5–3.0 mg/L and
16% above 3.0 mg/L. The highest fluoride concentration recorded was 12.80 mg/L. Significant correlation of fluoride with pH, alkalinity, Na, SiO₂ and PO₄ were observed.