

ARRESTING POLLUTION OF WATER

Water can dissolve almost any substance because of the unique features of its molecule.

Water is therefore very easily polluted.

Pollution of water has been increasing due to the influence of the human during the last 125 Years. This is mainly due to increasing human population, unsanitary disposal of human wastes, burning of fossil fuel, release of harmful substances in industrial effluents, deforestation and agriculture. If unchecked, water pollution can become a major problem in the future as global warming has become at present.

To control water pollution requires public awareness of the problem, a human lifestyle that is respectful of the environment and a citizenry that is willing to actively undertake the role of custodian of the water bodies.

Many chemicals pollute waterbodies. However, it is the concentration rather than the identity of the substance that is of much importance. For example, copper and zinc are essential nutrients for plants and animals, but are harmful to many organisms at high concentrations.

In fact copper and zinc containing compounds are used to control algal and fungal growth. For that matter, nitrogen and phosphorus are necessary for the synthesis of the very basic building blocks of life, but are also two of the key items that bring about excessive algal growth in water bodies.

Pollution may be defined as the entry of substances to a medium that brings about harm to living organisms, disturbs ecological systems and damages structures or amenities. Pollution can be sudden, intense and cause immediate ill effects or be slow, hardly noticeable, and cause harm over time.

Pollution can arise from natural causes or from the activities of the human. Natural causes include effects of volcanoes, earthquakes, tsunamis and underground minerals. The eruption of Mount Karthala volcano in Comoros in the Indian Ocean in 2005 left more than 175,000 people without drinking water due to entry of ash to the waterbodies.

Earthquakes pollute water from destruction of buildings, devastating landslides and ravaging floods. Tsunamis bring enormous quantities of sea water inland suddenly, making surface water, groundwater and soils saline in its path, as happened in Sri Lanka a few years ago. More than eight million tube wells constructed in a very short time to provide drinking water to people of Bangladesh created havoc in the country as millions of people who drank water from some of the deep wells developed bladder, lung and skin cancer owing to the presence of very high levels of arsenic. This event is considered the biggest poisoning of a human population in history.

The extent of pollution caused by nature however, if brought under a single unit and added up globally over time, may show up to be extremely insignificant compared to that by the human. This paper indicates why water is easily polluted, describes some examples of pollution arising from the acts of the human, indicates their influence on living beings and the environment, and makes a few suggestions on the steps to be taken in the future with regard to arresting the increase of water pollution.

Why water is very easily polluted

A professor of chemistry once told the students that although sulphuric acid can dissolve a motor car and water cannot, water can dissolve many more substances than sulphuric acid. Some

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high-school chemistry is required to explain why water has the tag of universal solvent. The water molecule has two hydrogen atoms that are electropositive and one oxygen atom that is electronegative. The water molecule is not linear, but bent at an angle of 105 degrees.

These reasons make it behave as a dipole. As a result of its unique structure, the water molecule is attracted to other water molecules and to molecules of many other substances through what are known as hydrogen bonds. This makes water dissolve almost any substance. Consequently, water is very easily polluted.

There is a long list of items that are generally considered as water pollutants. The common pollutants are; human fecal matter, aquatic organisms, noxious gases, acidity, salinity, nitrogen, phosphorus, arsenic, cadmium, chromium, lead, mercury, nickel, uranium, chlorine, cyanides, radio nuclides, petroleum hydrocarbons, pesticides and their residues. Silt, clay, turbidity as well as high temperature of water bodies are also considered as pollutants.

Some of the diseases and problems caused by pollutants are given in the following Table:

Incidents of water pollution

Almost every activity pollutes water. Some industries that are often mentioned in water pollution include the paper, paint, textile, leather, rubber and food industries. Fertilizer, weedicides, fungicides and insecticides also pollute water. A few examples of

Table 1 : Diseases and problems caused by organisms and chemical substances in water

Causative organism / substance	Disease and problems
Bacteria	Typhoid, gastroenteritis, bacterial dysentery, cholera and tuberculosis
Virus	Poliomyelitis, meningitis, infectious hepatitis, respiratory diseases, diarrhoea and enteritis
Protozoa	Amoebic dysentery, diarrhoea and amoebic meningo encephalitis
Helminths	Hook worm, round worm, tape worm and thread worm infections
Fungi/algae	Colour, turbidity, taste, odour and toxins
Aluminium	Alzheimer (memory loss)
Arsenic	Skin, bladder and lung cancer
Cadmium	Decalcification of the bones, protein and sugar in urine and kidney damage
Chromium	Kidney problem, lung cancer and skin diseases
Iron	Yellow colour, unpleasant taste and odour
Lead	Muscular paralysis, damage to nervous system, liver and kidney, lowered IQ, anaemia
Manganese	Unpleasant taste
Mercury	Affects kidney, nervous system, and causes brain damage
Zinc	Unpleasant taste
Fluoride	Mottling of teeth (dental fluorosis), cracking of teeth and osteofluorosis
Nitrate	Methemoglobinemia (blue-baby syndrome), gastric and prostate cancer
Sulphate	Diarrhoea
Hydrogen sulphide	Colour and taste problems
Pesticide	Kidney disease, reduced vision, joint pains and memory loss
Dissolved salts	Unpalatable if greater than 1200 mg/l

pollution of waterbodies are mentioned here.

Acid rain

pH is the measure of acidity or alkalinity. pH of pure water is 7.0. Pure water is neutral; meaning neither acidic nor alkaline. However, pure water hardly exists in nature, since on contact with the carbon dioxide in the atmosphere it becomes acidic. The pH of unpolluted rainwater in equilibrium with atmospheric carbon dioxide is about 5.6.

Much of the acidity in rain is caused by sulphur dioxide and nitrogen dioxide. Carbon dioxide and some other gases

formed by the oxidation of organic substances also contribute to rainwater acidity. It is correct to say that acid rain is mainly a result of burning of fuel and industrial activity.

The Taj Mahal in India, the Statue of Liberty in New York, the 2500 year-old wood carvings in Greece and the Coliseum in Rome have all suffered damage from acid rain. Rapid corrosion of bridges at many locations has been attributed to acid rain. In some industrialized parts in Poland, trains are not permitted to exceed the speed of 65 kmph because the iron railway tracks have been weakened from acid rain.

Although much of the atmospheric pollutants fall locally, some can be transported more than 1000 km before it falls as rain, sometimes in another country. In fact it has been reported a few decades ago that about 15% of the acidity in Norway is from emissions in Britain and about 20% falling in Sweden has had its origin in Eastern Europe.

Acid rain falling directly on to fresh water could lower its acidity immediately depending on the pH and the quantity of rain and the volume of the recipient waterbody. Almost all forms of life are affected by pH of water. Acid waters may contain high concentrations of cadmium, copper, zinc and other heavy metals which can cause skeletal deformities of fish. It is estimated that 200 to 400 lakes in USA may have lost their fish populations due to acidification.

Heavy metals can enter human bodies in high concentrations through drinking acidic water as their solubilities are higher in such waters. High intake of aluminium can cause bone wasting disease and Alzheimer's disease. Conventional water treatment plants are not set up for removal of heavy metals in water.

Acid rain harms forestry through slow growth, injury or even death of trees. It damages the leaves on direct impact, solubilises toxic substances to trees such as aluminium from soil and washes away plant nutrients potassium, calcium and magnesium from top soil to limit the growth of trees.

Although acid rain in Sri Lanka has been hardly reported, there is a possibility of this occurring in the future with increasing industrial activity. On the other hand Sri Lanka has to be mindful of the possibility of high quantities of acidifying atmospheric pollutants entering the Sri Lankan air space arising from the unprecedented industrial expansion in neighbouring India.

Pollution of wells

Many shallow wells are contaminated with harmful microorganisms that bring about the hospitalization and death of millions of people around the world. The National Water Supply and Drainage Board of Sri Lanka has shown that many domestic wells are contaminated with human excreta. Hospital statistics reveal that a large number of patients, particularly children from rural areas suffer from water-related diseases. Household garbage and other wastes placed indiscriminately on the surface of the land, overcrowded households with wells and latrines in close proximity, overflowing septic tanks and leaking sewers contribute to contaminated water.

Nitrates have been identified as the leading cause of ground water pollution in forty nine out of the fifty States in USA. In some countries more than 10% of the population is exposed to nitrate levels in drinking water that are higher than the WHO guideline limit of 50 parts per million (ppm). Nitrate pollution arises mostly from addition of nitrogen containing fertilizers.

High nitrate levels in drinking water have been associated with a disease known as methemoglobinemia, or blue baby syndrome. Nitrate itself is not considered toxic but nitrate is reduced to the nitrite by bacteria in the intestinal tract which is then absorbed into the blood stream. Infants are unable to detoxify the nitrite which combines with hemoglobin and reduces the absorption of oxygen by blood. Infants drinking water containing high nitrate levels could become seriously ill and may die if not given medical treatment. In fact the Department of Environmental Quality in Idaho, USA has recently advised against giving water containing more than the WHO guideline limit to children younger than six months. They further advice pregnant women and nursing mothers to avoid drinking such water.

The nitrate levels in the water from many of the farm wells of Jaffna and Kalpitiya given above are higher than the Sri Lanka Standards Institute and WHO limits for drinking water. Studies conducted by the University of Jaffna in 2006 on the nitrate content in the water from 70 wells in Jaffna, have shown that high nitrate values exceeding the 50 ppm limit were present in many community wells, and in domestic wells where the water is used for drinking.

Pollution of lakes and reservoirs

The Beira Lake in Sri Lanka is a good example of a water body which got converted slowly from a sparkling lake to a foul smelling eyesore with the advent of time by the activities of man. The lake was constructed by the Portuguese for military purposes over 500 years ago while the Dutch developed it to be the central point in the famous canal transport network connecting the Beira to Negombo and Panadura. The lake was such a beautiful spot that its banks were subsequently chosen to hold parties for the British elite. It is on record that a lavish celebration of the defeat of Napoleon was held at the Beira lake by the British government in 1815.

With respect to life on the lake, there is evidence that a well-known Botanist named Trimen made a systematic study of the aquatic plants in the Lake in 1879 and prepared a very long list of them that provided testimony to the health of the water body at that time. But twenty years later the lake got polluted as people began to settle down illegally on its banks. Human excreta found its way to the water, industries discharged their effluent and oil from garages and service stations went direct to the lake. The organic matter input to the lake increased rapidly over the years, their breakdown significantly increased the concentration of plant nutrients in the water and caused massive growth of algae, some of which had the property

of producing extremely poisonous toxins. Furthermore, the decomposition of the algal biomass reduced the oxygen concentration in the water, leading to the formation of bad smelling hydrogen sulphide gas and other harmful products. A combination of these factors led to frequent fish kills in the Beira Lake. A beautiful lake was destroyed by man.

The word eutrophication is derived from the Greek words *eu* and *trophe* meaning well nourished. Eutrophication may be defined as the enrichment of water by plant nutrients. Plants require seventeen elements, referred to as essential plant nutrients, for their growth and each has a unique role to play. While all the seventeen elements are equally important for plant growth, nitrogen and phosphorus stand out as the two nutrients that are commonly limiting productivity of plants in aquatic media. It is for this reason that aquatic plants often increase their growth significantly when the concentrations of these two nutrients in water are high.

Nutrients enter a waterbody in a number of ways. They include weathering of soil minerals, silt and clay from exposed land surfaces, soil disturbing agricultural activities, chemical fertilizers and organic manures. Plant nutrients found in cattle and buffalo dung near the water bodies find their way to the water by direct impact of rain and also by the rising water levels during the rainy season. Another way for nutrients to enter a reservoir is through the death and decay of fauna and flora found therein. Nutrients entering water bodies also come from domestic solid waste, sewage, sludge from sewage treatment plants and urban wastes.

Industrial effluents are also a major source of supply of nutrients to a water body. An important supplier of phosphorus to waterbodies has been detergents. The presence of phosphates

in detergents which was as high as 15% in the 1960s created a great public uproar in North America as it was attributed to the eutrophication of Lake Erie, the formation of algal blooms and the death of fish. At that time as much as 20,000 pounds of phosphorus per day was getting into Lake Erie from the use of detergents. Many citizen action groups were formed during this period to protest on the use of high phosphorus containing detergents. Among them the "The Student Council on Pollution and Environment" and the "Housewives to End Pollution" played a leading role. Consequently many countries placed limits on the phosphorus content of detergents. The Canada Water Act of 1970 placed a 2.2% limit on phosphorus in detergents while in the US many states banned phosphorus from detergents altogether. Most detergents in the developed countries are now phosphorus free.

When a mass of aquatic plants is sufficiently dense as to be clearly visible, it is referred to as a bloom. Most of the blooms are algal, hence the commonly heard term the algal bloom. Many small water bodies in the dry zone of Sri Lanka get covered by algae especially in the dry season. Animal dung may be primarily responsible for this situation.

Blooms are a hindrance to recreational activities such as swimming, sailing and angling. The water with an algal presence requires special treatment if it is to be used for drinking owing to the disagreeable colour, unpleasant odour and unacceptable taste. Two major problems with algal blooms are the likely drop in the level of oxygen in water and the possible production of algal toxins during their degradation.

While the desired oxygen level in water for fish is about 5 ppm, the oxygen concentration can drop below 3 ppm when an algal bloom is being decomposed. In this situation fish are

adversely affected as they have to breathe more rapidly, the movement of oxygen through the gills is restricted and their muscular performance significantly diminished.

While there are many types of blue-green algae only a few produce toxins. Some of these toxins are harmful to humans and other animals. Symptoms seen in humans after contamination include skin irritation, dermatitis, gastroenteritis, diarrhea and vomiting. Microcystin LR, an algal toxin has a toxicity 1000 times that of cyanide. These toxins are colourless and could remain active for several weeks after the algae have completely decomposed. They cannot be destroyed by boiling the water.

The first recorded toxic algal bloom occurred in 1878 in South Australia where cattle, sheep and pigs died few hours after consuming the scum. In Canada ten children fell sick in late 1950s after swimming in a lake covered with algae. There have been many similar instances of human illness after recreational use of water contaminated with poisonous algae.

In Sri Lanka algal blooms have been reported in reservoirs at Kotmale, Mausakelie, Castlereigh, Rajangana, Kandalama, Nachchaduwa, Nuwerawewa, Tissawewa, Giritale, and at Parakrama Samudraya. In 1991 the entire Kotmale reservoir had a dense thick bloom of a toxin containing alga. Fish kills have been reported from many water bodies in Sri Lanka over the years. They include Parakrama Samudraya, Pimburettawa reservoir, Tissawewa and the Beira Lake. In March 2007 about three tonnes of fish died in Rekawa lagoon. It is reported that the main cause was the dumping of large amounts of solid wastes by a Government organization near the lagoon that led to enrichment of the nutrient concentration in the water, excessive algal growth and the reduction of the dissolved oxygen during algal decomposition.

Pollution of streams and rivers

Gem mining, quarrying, building construction, laying pipe lines underground and road construction and maintenance are activities which add soil particles to streams and rivers.

Coal mining pollutes water as the exposed pyrite mineral is oxidized to sulphuric acid. It has been established that about 16,000 km of streams were polluted in USA in this manner.

Several rivers in the world have been polluted. They include the Ganges in India, Rhine, Thames and Tyne in Europe, Rhone, Arno and Po from the Mediterranean and Darling from Australia. The largest algal bloom occurred in the Darling River in 1991 when 1000 km of the river was affected which led to New South Wales declaring a State of Emergency for a period of 21 days.

It is a fairly common sight in Sri Lanka for rivers to be muddied after a fairly high intensity rainfall. This is a direct result of transport of soil particles largely from exposed sloping land by moving water. A sizeable extent of sloping land without adequate soil conservation measures is planted with annual crops that do not cover the land during most times of the year, thereby subjecting it to erosion. Furthermore, in many commonly cultivated crops like potato, carrot, beetroot and radish the marketable portions are underground and at harvest the plant is uprooted disturbing the soil, bringing it up and spreading it on the surface, in sharp contrast to plucking few young leaves of a tea bush which does not disturb the soil in any way.

Particulate matter impedes the passage of light through water by scattering and absorbing the rays. This interference of light is referred to as turbidity which is a measure of cloudiness. High turbidity can hinder the effectiveness of disinfectants in public water systems. Turbidity of

water reduces photosynthetic activity of phytoplankton through reducing entry of sunlight. Turbid waters may allow the growth of disease causing organisms such as bacteria, viruses and parasites.

Clay particles in water can harm gills of fish. Furthermore, their spawning is adversely affected. Increase in sediment load reduces the water depth in many water bodies and at times adversely affects navigation.

Pollution of the ocean

There is a serious misconception in the minds of some that the sea has an unlimited capacity to absorb anthropogenic wastes and biodegrade them quickly. Many rivers carry industrial pollutants to the sea. In some countries untreated sewage is pumped into the sea even at present. Massive algal blooms are a common site on the coastline of some European countries caused by the discharge of several hundred thousand tonnes of nitrogen by their rivers to the Baltic and North Sea.

The occasional red tides consisting of algae in the western coast of Sri Lanka with foul odour is ample testimony to the fact that the sea in some areas has reached its limit of waste assimilation, and a warning that pollution of the sea is taking place in and around Colombo.

The sea is also polluted by the acidifying effect of the increasing carbon dioxide content of the atmosphere since about one third of it is absorbed by the sea, alarms were raised by scientists of the Plymouth Marine Laboratory in England in 2005 that coral reefs could be dead within a few generations and that some of the fish that contribute significantly to human nutrition and the economy of many countries would disappear from the oceans owing to high acidity of the sea water in the next 35 to 70 years.

The current annual world oil production is about three billion tonnes. It is inevitable that some portion of oil used in almost any industry will get into water bodies. While the amounts entering fresh water bodies have not been fully assessed, the oil input into the marine environment is estimated at about 2.2 million tonnes a year. Much of this pollution comes from terrestrial discharge and in transport such as discharge of oil during tank cleaning and fuel oil sludge and other forms of waste oil.

There is hardly any evidence of a build up of oil residues in the seas as the marine environment is presently able to breakdown the anthropogenic introduction of oil. However, accidental oil spills amounting to about 400,000 tonnes a year can be extremely harmful in a localized environment because of its concentrated effect on a relatively small area.

The ship Exxon Valdez sank in Alaska in 1989 spilling 48 million litres (40,000 tonnes) of crude oil killing tens of thousands of sea birds, destroying the fisheries and harming many other living organisms. This is considered as the worst reported incident of marine pollution.

Oil spills can cause economic damage to the fishing industry. It can also hinder bathing, diving, boating and angling and other recreational activities and adversely affect tourism. Some power stations located close to the sea using sea water for cooling purposes can be forced to shut down if the water is highly polluted with oil. Likewise, desalination industry will be badly affected. Oil spills at harbours caused by accidents in loading and discharging can restrict the movement of ships.

Pollution of lagoons from fresh water

Lagoons are shallow brackish water bodies with connections to the sea by

which sea water flows into the lagoon and vice versa. The basically brackish aquatic ecosystem has fish, shrimp, small plants and other forms of life adapted to the high salt content of the water.

The Bundala National Park which has several lagoons has international recognition as a bird sanctuary hosting more than fifty species of birds, mostly migrants who leave their mother countries during the winter season. They enjoy the food in the lagoons including salt water shrimp. However, two of the lagoons at Bundala namely, Malala and Embilikala, have lost their brackishness due to the entry of discharged irrigation water from the Lunugamwehera and Kirindi Oya irrigation settlement projects. In fact the salt content of the water has fallen to less than 10% of the value prior to the said irrigation projects. Consequently, the salt water shrimp has begun to decrease at Malala and Embilikala lagoons and may disappear in time to come. From the definition of pollution given at the beginning of this paper, fresh water is clearly the pollutant here.

Reduction of the salt level of the lagoons may drastically reduce the number of migrant birds visiting Bundala in the future.

Remediation of polluted waters

The two basic steps to be taken in remediation are; reduction in the inflow of pollutants into the waterbody and a reduction in their concentration in the water. This is followed by selection of methods that are likely to succeed and cost effective. Remedial procedures often require much scientific input, long periods of time and enormous financial resources.

Many examples of restoration of large lakes and reservoirs have ended up in failure. China has spent more than 564 million US dollars over a 14 year period

to improve the water quality of Dianchi Lake in the Yunnan Province without much success in spite of decreases of external nutrient loading, owing to nutrient releases from lake sediments especially under low oxygen conditions.

There are examples of successful restoration as well. Lake Mjosa, the largest lake in Norway, was eutrophic from the 1970s giving an unbearable odour in the vicinity and an unpleasant taste in the drinking water due to a heavy algal presence. This led to the initiation of several programmes directed towards the remediation of the lake. A survey carried out on the source of pollution revealed that phosphorus was the main pollutant. A new sewage plant was accordingly introduced in 1980 that could remove phosphorus with 90% efficiency and its concentration which ranged from 0.015 to 0.018 mg/l decreased to 0.011 mg/l. The algal concentration was reduced as a result.

The phosphorus concentration in waters of Lake Zurich in Switzerland was less than 0.03 mg/l prior to 1950, increased to 0.09 mg/l in 1965 as a result of sewage discharge from the highly populated cities. This was decreased by more than 85% by addition of ferric or aluminium sulphate in the waste water treatment process. This in fact was the first lake in the world where phosphorus was reduced successfully by chemical precipitation.

A few years ago, the water in the Kandy Lake was highly polluted. The water was turbid, algae was present on the surface, a foul smell emanated from the lake, fish was scarce, birds were hardly present and human fecal matter was detected in the water. This state of affairs was caused mainly from the harmful materials brought in from the effluent of many of the industries operating nearby, and from the storm water coming into contact with animal

fecal matter and other harmful waste materials spread on the surface of the land.

Restoration activities of the lake were begun seriously about six years ago under the leadership of the Irrigation Department. The remediation activities included installation of corrective measures by the industrialists and hoteliers to reduce the levels of pollutants in their effluent and the dredging of the lake at a cost of Rs. 38 million. As of May 2009, the water is clear, algae is absent, fish is present and the birds are back.

Concluding remarks

Rainwater, wells, lakes, reservoirs, streams, rivers and the ocean have been polluted by the activities of the human through human wastes, city garbage, sewage, industrial wastes, carbon dioxide emissions, deforestation, and agriculture. As a result of pollution millions are dying annually from water-related diseases, lakes are becoming fishless, waterbodies are getting eutrophied, and the acidity of the ocean is on the increase.

It can be said that almost all the major events that very significantly altered the environmental status of the earth took place in the last 125 years although the human has been in existence for about a million years. The printing, textile, leather and many other polluting industries began in the early 1900s. The world's first mass produced car, the Ford Model T, was developed by Henry Ford in 1908. The large scale chemical fertilizer industry commenced in the 1920s. DDT was used as a pesticide in 1945. Forest cover decreased by 75% after the 1900s. Human population increased by about the same amount during this period.

From chemical analysis of trapped air present in ice cores brought from the lower depths of the earth, scientists

have found what the carbon dioxide concentration in the atmosphere was as far as 600,000 years ago. Its concentration has risen from about 280 ppm during the pre industrial period to 387 ppm at present and is expected to reach 500 ppm within the next 50 years, if emissions continue to increase at the current rates. Although long term data on the content of other pollutants in air and water are not readily available, it could be assumed that many of them too must have progressively increased, for pollution is a result of human activity on several fronts, and the emissions of carbon dioxide only one of them.

If the recent past brought about a number of environmentally adverse changes at such alarming speeds, what of the future? The current world population of 6.7 billion is expected to rise to between 8 and 11 billion in 2050. Growing crops and raising livestock to meet human food requirements will incur a heavy environmental cost. Disposing of the trillions of tonnes of human wastes that will be generated will be a nightmare, given the struggle at the moment with the current levels of production of wastes. The number of motor cars that count 600 million at present will reach one billion in twenty years. Net forest losses exceed 10 million hectares a year, mostly in the environmentally fragile regions of Asia, Africa and South America. A range of chemicals, many whose effects on living organisms and the environment would not be fully known, will be developed and used to meet the ever increasing needs and wants of the human.

The future cannot be considered to be one of optimism given the rather lackadaisical nature of the human response in the past to some of the danger signals of environmental degradation. Although Professor Richard Revelle and Dr. Charles Keeling started measuring the carbon

dioxide concentrations in the atmosphere on a daily basis in Hawaii way back in 1957, the world hardly took notice of their pioneering work and the repeated warnings until the topic was raised at the United Nations meeting on Environment and Development held in Rio de Janeiro in 1992. Even today, while much attention is given to carbon dioxide increase and climate change, the world has still not begun to realize that this gas is not the only damaging pollutant, and that climate change is but only one item in the catalogue of environmental change.

Water pollution is basically due to two factors, the chemistry of the water molecule and the activities of the human. The former cannot be changed. Humankind will have to refrain from indulging in environmentally damaging activities that were undertaken in the past with abandon. This will not be easy but will require moral courage and utmost commitment. This is the responsibility of this generation to itself and to future generations. Some of the matters to be given consideration for Sri Lanka in this regard are given here.

1. Create public awareness on water pollution

Public awareness programmes should be carried out regularly by issue of brochures, publication of newspaper articles, conduct of radio and television programmes and by other means to educate the public on the importance of water to humans, animals, plants and the environment, the reasons for water pollution, the damage it does and the methods and approaches to arrest it.

2. Improve public health and sanitation

Public health programmes should be strengthened particularly in rural areas where public water supply schemes are scarce. Special emphasis should be

given to improving personal and food hygiene. Drinking water sources should be regularly checked for presence of disease causing organisms by the public health officers.

3. Monitor water quality of water bodies

Many rivers and reservoirs are used as sources of public water supply at present, and more are likely to be used in the future for this purpose. Presence of a highly poisonous alga in a reservoir that is connected to other reservoirs can create havoc in the country. A countrywide continuous monitoring programme of rainwater, wells, rivers, streams, lakes, reservoirs and other water bodies should be initiated. Such a programme is absent at present.

4. Encourage citizens to act as custodians in protecting water bodies

Sri Lanka cannot depend on its laws and law enforcement agencies alone to protect its water bodies. This is borne out by the water pollution that goes unabated notwithstanding the numerous Acts of Parliament, Gazette Notifications and Regulations that have been in force for more than forty years. The government should assist and encourage local bodies, community groups, schoolchildren and individual citizens to protect the water bodies in their habitats.

5. Promote demographic policies that can sustain the environment

It is universally accepted that more people will bring about more pollution. In any given area the environmental status will depend mainly on the nature of the land, the quality and quantity of water available, the number of inhabitants and the activities they are engaged in.

A given locality may have reached the population limit that has exceeded its environmental carrying capacity. Yet the subject is hardly discussed owing to its sensitivity. The time has come however, to discuss the matter in earnest with all religious, ethnic, cultural and other social groups. In fact the Principle 8 adopted at the Rio Conference on Environment and Development held in 1992 states that appropriate demographic policies should be promoted to achieve sustainable development. The emphasis should be on controlling the populations in polluting areas rather than targeting changes on a national basis.

6. Follow a new path

Almost all water bodies on earth were very much less polluted a hundred years ago as compared to the present. This was mostly because the population was less, living standards were modest and processes of self purification of water were in place. Sunlight, microorganisms, forest cover, filtration through soil and other natural mechanisms purified the water. The situation is very different now. Population is much higher and increasing, forests are felled more than established, soil erosion has increased, more fuels are burnt increasing the carbon dioxide content in the atmosphere, new substances are synthesized that are not easily degraded and have the ability to cause harm to living organisms. Much of the pollution arises from activities aimed at raising the standards of living of the humans.

An attitudinal change for the world, countries, governments and individuals to be much more environmental conscious in all their activities is urgently needed.