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Silent Pollution



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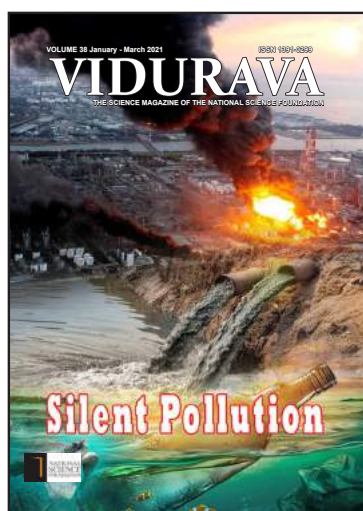
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Editorial

The Inexhaustible Spectrum of Silent Pollution

The current edition of Vidurava reviews six forms of Silent Environmental Pollution, some of which may be considered to be the consequences of advancements in scientific and technological developments. Nevertheless the range of environmental pollutants that have affected the quality of life of our people is exceedingly high.

Consider for instance, the consequences that had resulted from soil and water pollution caused through the continuous use of toxic agrochemicals, virtually from the turn of the 19th Century in Sri Lanka. The widespread occurrence of kidney disorders of people living in the North-Central Province is the main consequence of this type of pollution.

More recently, Sri Lanka had to face an unprecedented kind of pollution in the maritime provinces resulting from the discharges of spills of toxic petroleum products, as well as other waste from ship-wrecks, causing what may be considered to be 'beach-front or marine pollution'.

Nevertheless one of the commonest forms of environmental pollution that became a serious threat in the early years of the 21st Century, was air pollution caused by the increasing emissions of vehicular smoke. In fact in 2002, in response to concerns aired by all segments of our society, the then Ministry of Forestry and Environment, established under its purview the Air Quality Management Centre, in order to co-ordinate air pollution mitigation activities. Among

the early measures enacted by this Centre included the formulation of a National Policy on Air Quality Management. Additionally, regulations needed for a gas emission test and clearance for all motor vehicles before the issue of Revenue Licenses, which came into effect in November 2008, were indeed positive steps towards containing air pollution resulting from noxious emissions.

Noise and sound pollution resulting from sound frequencies that exceed human tolerance levels, have been a consistent concern of all segments of the populations. Such noise emitted by heavy machinery, industrial complexes, quarries, and the nuisance caused by horns of lorries and passenger transport vehicles, as well as intolerably loud music from transistor radios installed in busses have been the consistent grievance of the public.

Yet another time immemorial form of nauseating pollution is the wayside dumping of garbage, which apart from being an environment polluter, is also the breeding grounds of germs responsible for many infectious diseases.

Finally, it is not possible to forget the sensational disaster that resulted from the collapse of the Meethotamulla waste dump on the eve of the Sinhala and Hindu New Year of April 2017, taking in its fold the lives of several innocent people residing in that neighborhood.

M. Asoka T. De Silva

Silent Pollution : A Disguised Threat to Man and Environment

Dr P.B. Dharmasena



The advancement of science and technology brought us 'easy living' and satisfactory life by all means. With time, the man could realize that the application of such technologies has caused pollution of his environs leading to various consequences such as climate change, global warming, and health problems etc., which do not permit to enjoy the benefit of innovated technology. At present, scientific and technological strategies are explored to mitigate the impact of such consequences. Most forms of pollution are invisible to the human eye and come in a variety of different forms. In the past there were 7 major types of pollution accepted as causal factors for above consequences and recently another type was identified as electromagnetic pollution.

Water Pollution

This type of pollution refers to the contamination of bodies of water including groundwater. As all living organisms depend on water to live, the pollution of a body of water tends to affect every level of the ecosystem, including

human health. Common causes of water pollution include industrial waste, insecticides, pesticides, and fertilizers, detergents and oil spills. These pollutants either work by killing off organisms through their toxicity (industrial waste, insecticides), or reducing oxygen levels in the water (known as eutrophication) by blocking out sunlight (detergents, oil).

Air Pollution

Air is usually comprised of 78% nitrogen (N), 21% oxygen (O₂), 0.9% oxide gases and 0.1% inert

gases. When the air becomes contaminated with other elements such as poisonous gases or particles, it can cause serious problems to human health. The most common causes of air pollution include partially combusted exhaust gases, poisonous gases, which are a by-product of industry including sulphur dioxide (SO₂) and carbon monoxide (CO), and carcinogenic gases released through the burning of plastic, rubber and wood. Air pollution works either by poisoning living organisms, which breathe it in, or by disturbing the atmosphere





and mixing with air and clouds to cause acid rain. In the case of particle contamination, particles such as asbestos fibres become airborne and are inhaled, irritating the respiratory system and causing health conditions.

Soil Pollution

Soil can be mixed with chemical pollutants such as fertilizer, agrochemicals etc. and it is known as soil pollution. Common causes of soil pollution include pesticides, insecticides, agricultural chemicals, industrial waste, and radioactive waste. Plants depend on the nutrients in the soil in order to grow, but many of these poisonous chemical compounds absorb the nitrogenous compounds present in the soil, which is also required for the plants. Soil pollution is a common cause of erosion, as plants and other living organisms, which keep the soil held together, die off, the soil splits and begins to erode. The heavy metals, which are mixed with soil through chemical pollution, also have a devastating effect on the ecosystem as they alter

the metabolism of microorganisms and arthropods living in the soil. These heavy metals are more concentrated as they move up the food chain, often wiping out predator or consumer species at the apex.

Thermal Pollution

Many industries release heat energy as a by-product and once released into the environment, this thermal energy is partially responsible for global warming. Manufacturing industries release thermal energy into the air as well as into water

bodies of water. The problem arises from the excess of carbon dioxide (CO_2) in our atmosphere, as CO_2 prevents heat moving out through the atmosphere. Then the heat from the sun, combined with this trapped thermal energy raises the temperature of the atmosphere dramatically. The result is global warming, which is responsible for melting the polar ice caps, which in turn cause sea level to rise.

Radioactive Pollution

When radioactive metals disintegrate, they release alpha, beta and gamma rays, which can cause a whole host of mutative diseases in living organisms, hence this is known as radioactive pollution. As the name suggests, radioactive pollution mostly comes from the nuclear power industry, either in the form of radioactive waste being dumped or improperly disposed of and then making its way into water bodies, or from the accidental release of radioactive substances when a nuclear reactor is damaged. Once radioactive pollution is present in the environment, it can linger for decades, making large areas of land endangering the human life.





Noise Pollution

Noise pollution refers to an excess of unpleasant sounds creating from industry, infrastructure, heavy machinery, transportation, and even human activities. The noise pollution can have a detrimental effect on both mental and physical health and has been linked to high stress levels, hearing loss, hypertension, depression, sleep disturbances and an increase in incidences of coronary artery disease. Noise pollution also reduces the amount of viable habitat for wildlife as it interferes with sounds and communication, making it difficult for animals to navigate, mate and detect predators or prey.

Light Pollution

The excessive, obtrusive, and misdirected use of light in areas of human habitation as well as in industry

cause light pollution. Light pollution is defined as the alteration of natural light levels in both indoor and outdoor environments through human interference. Light pollution causes headaches, fatigue, stress and anxiety. Light pollution disrupts eco systems by confusing animal navigation, altering predator-prey relations, disrupting plant growth and pollination, and change competitor interactions.

Electromagnetic Pollution

Electromagnetic pollution, caused by increasing human activity, in



the area of utilization of electrical and electromagnetic energy, is slowly increasing without much appreciation of the consequential implications. While everyone is aware of the benefits derived from the high-tech electrical and electronic devices and systems, only few users are aware of the real or unsuspected dangers from them. At present, domestic and working place environments, sources of electromagnetic radiations are increasing rapidly. Increasing radiations from sources like power lines, microwave, telecommunication, electrical appliances, radar, transmissions of radio and television etc. are causing the problem of increasing electromagnetic pollution of environment.

Consequence of these pollution types cannot be distinguished easily as it brings an accumulated danger gradually, and the human health is affected through relatively as a slow process.



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Air and Water Pollution

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Advances in science and technology, have resulted in a rapid increase in the global population. In Sri Lanka, the population at the time of independence was around 7 million, which had increased to 20.5 million today. The number of motor vehicles has increased by more than 700% during the past 30 years. People have been moving to cities in search of employment. Increased use of agrochemicals, polythene and plastics have created a plethora of environmental problems. The result of all this

has been the pollution of air, water and soil, affecting our lives causing a wide variety of diseases, and a reduction in the quality of life.

Air Pollution: the silent killer

An average person inhales around ten thousand litres of air daily, and while we are concerned about the water we drink, have we ever thought of the purity of the air we breathe? Air pollution is now widely believed to cause not only respiratory diseases such as asthma, bronchitis and pneumonia, but is

also responsible for a plethora of other health conditions such as heart disease, obesity, low birth weight, cancer and even baldness. It is hence appropriate to see how these diseases can be minimized for a healthy living.

Recently there has been a lot of publicity in the media about the unhealthy air pollution in Colombo. US embassy's air pollution monitoring site gives hourly data on the pollution levels in Colombo. This site reports pollution levels in terms of the air quality index where



Table 1 : Health effects of air pollutants

Pollutant	Health effects
Sulphur dioxide (SO ₂)	Wheezing and exacerbation of asthma
Nitrogen dioxide (NO ₂)	Respiratory functions and symptoms of asthma
Carbon monoxide (CO)	Headaches, nausea, heart disease
Ozone (O ₃)	Exacerbate asthma, reduced lung function
Fine particles	Aggravates asthma, respiratory problems, silicosis, asbestosis, heart diseases, cancers

The following table gives the health effects of air pollutants. More recently, there has been a growing interest in very small particles of plastics, commonly called microplastics as a serious air and water pollution hazard. Worldwide, the annual total production of plastics and polythenes is around 4000 million tons, and this is a major environmental problem. When they degrade or during

the safe level is 100 and anything above 100 is considered unhealthy. Recently it reached values around 150, which is unsafe for asthmatics, children and elderly with heart problems. Children, especially babies, are affected by air pollution to a greater extent because they inhale more air relative to their body weights. At this pollution level, it is best for these sensitive groups to stay indoors.

Air pollution in Sri Lanka is mainly generated by motor vehicles during the combustion of petrol or diesel. Petrol, for example is a mixture of hydrocarbons and during combustion produces carbon dioxide, carbon monoxide and carbon in the form of soot. Minor constituents in petrol containing nitrogen and sulphur produce sulphur dioxide and nitrogen dioxide during combustion. Other sources of air pollution are thermal power plants burning diesel and coal and various industrial processes. The fine particles emitted are the most dangerous out of all pollutants. The larger particles that enter our respiratory

system gets filtered by the nose and the upper respiratory tract, but the finer particles go right inside the lung, damaging its sensitive tissues, resulting various respiratory diseases like asthma, bronchitis and pneumonia. In addition, the carbon particles have many other compounds adsorbed on them, some of which can cause cancer. Heart diseases and stroke can also be initiated by a high degree of air pollution. World Health Organization (WHO) recently classified diesel smoke as an agent definitely cause cancer.

Ozone is another pollutant formed by the reaction of nitrogen dioxide (NO₂) generated during fossil fuel combustion in the presence of sunlight. It is also produced during the operation of laser printers and photocopiers where the intense light sources break up the oxygen (O₂) molecule, and the oxygen atoms so created react with oxygen molecules to give ozone. Its concentration outdoors reaches a maximum around noon when solar intensity is at its highest.

their use fine particles of plastics are generated. They are also present in indoor air where various plastics undergo abrasion and also from various clothing made from synthetic fibers. When children play with plastic toys invariably they undergo abrasion resulting in microplastics getting into the surroundings. When polythenes and plastics undergo decay in the soil, small particles which are about one millionth of a meter in diameter get into water and air, which can penetrate deep into the lungs. They can carry bacteria and other toxic compounds into the body. Although their long-term health effects have not been fully investigated there are claims that they cause cancer, as well as heart and brain diseases.

WHO has estimated that 8 million people die of air pollution annually and out of these 4.3 million deaths are from indoor air pollution.

Cooking using firewood in congested kitchens is the main source of indoor air pollution.

Firewood smoke is rich in carbon monoxide which causes headaches, and some tear gas like compounds cause redness in eyes and produce tears. In addition, there are deadly cancer-causing compounds in kitchen smoke and mothers who have cooked in congested kitchens for a number of years are likely to develop various types of cancers in later life. Other indoor sources of pollution are the use of mosquito coils and incense sticks inside homes. These not only generate fine particles, but also toxic compounds such as benzene and polyaromatic compounds which are known cancer causing substances. Firewood can still be used if cooking is carried out in an open kitchen with adequate ventilation.

Air pollution became a much-discussed topic after the widely publicized New Delhi smog last November, where the AQI values exceeded 400. Schools were closed and children were advised to stay indoors. During the same period, Sri Lanka recorded a maximum value of 136 which is in the unhealthy category. This is not unexpected, since even in 2018 November, the AQI value in Colombo had a high value of 164, but this became a hot topic only because of the New Delhi smog. Research on air pollution monitoring in Kandy revealed that the highest air pollution levels were observed during the November to February season. Data from the Colombo monitoring station too revealed a similar trend. This is due to a phenomenon called transboundary air pollution where pollution clouds from highly polluted countries such as India and China travel thousands of kilometers and reach Sri Lanka during the north-east monsoonal period.

What should be done to ensure that we breathe clean air? Most countries discourage people from using their cars to travel to work in big cities. Instead people are encouraged to use public transport, Improving public transport is the best way to reduce vehicular pollution in major cities. Nevertheless, individually we can take precautions to alleviate the effects by wearing face masks in crowded cities. Ordinary doctor's face masks are not very efficient. A better choice is a face mask with an activated carbon filter, which can help to filter many of the undesirable compounds in air. The carbon particles in soot can adsorb the highly poisonous substances called polyaromatic hydrocarbons, which are well-known cancer-causing substances. An activated carbon filter has the ability to adsorb such toxic chemicals. Children in big cities should be advised to wear a face mask during the time they travel to their schools and even inside the classroom.

Water pollution: How clean is our water?

Water is unique to our planet covering more than two-thirds of the earth's surface. It moderates climate, provides water for agriculture and allows organisms to survive. All life forms depend on water. We drink water, cook with it, wash in it, and travel on it. It is essential for industry, agriculture, mining, energy production and waste disposal.

Water on earth is present mainly in the oceans with over 97 percent, while fresh water in rivers and lakes constitutes only about 1 percent of the total. There is water in the atmosphere, in polar ice caps,

and also as underground water. Even in areas with plenty of fresh water, increased population and industry have been responsible for deterioration of the quality of water due to pollution. Scientists believe that by the year 2025, one-third of the world's population will face severe shortages of water for drinking purposes and for irrigation.

Water is an essential component of our body, and about 65 percent of our body weight comprises of water. The average recommended daily intake of water is 1.3 to 1.7 litres for children, 3.7 litres for men and 2.7 litres for women. Even animals and plants have a high percentage of water in their compositions, with fish constituting about 80 percent and plants constituting between 80 to 90 percent.

Water Pollution may be defined as any chemical or physical change in water that may be detrimental to living things. There are two main reasons why water pollution has become a serious problem.

These are, increase in human population, and urbanisation. The slums of Colombo have poor sanitation facilities and hence faecal pollution of water is a common problem in large cities. Since World War II, a large number of synthetic chemicals have been manufactured for various purposes, and many of these contaminate water supplies. Chemical processing of ores such as gold results in dumping large quantities of toxic chemicals like mercury and cyanide which are highly toxic.

Water pollution may cause a variety of diseases, and poses serious

Table 2 : Some pollutant types and sources polluting Kelani River

Type of pollutant	Source
Textile and Batik dye waste Chromium (Cr) Lead (Pb) Mercury (Hg) and cadmium (Cd) Domestic sewage Nitrate, phosphate Pesticides Rubber processing waste Bacteria and viruses Suspended solids	Textile factories Leather tannery Reclaiming old car batteries Old batteries in waste dumps Pradeshiya sabha, households Household waste, sewage Agriculture Rubber factories Human sewage Agriculture, improper land use

problems for human health. This is mainly because we may get exposed to polluted water in various ways, including,

- ◆ Drinking polluted water
- ◆ Bathing and swimming in polluted water
- ◆ Consuming meat from animals fed with polluted water and vegetables grown with polluted water.
- ◆ Washing vegetables in polluted water streams

Types of water pollutants

Water pollution can be broadly classified as chemical or biological types. Types of chemicals causing water pollution are:

- ◆ Crude oil and various petroleum products. These include waste engine oil from service stations and garages. These compounds are lighter than water and float on water, thereby preventing oxygen from reaching living organisms in a water body. Some of these may get dissolved in water and even in small amounts can be harmful.

- ◆ Fertiliser runoffs: These include high concentrations of nitrates and phosphates.

- ◆ Trihalomethanes – These are usually byproducts of water chlorination, and may pollute groundwater and surface water via leaking sewerage lines and discharges.

Examples of such compounds are: chloroform, bromoform, dichlorobromomethane;

- ◆ Metals and their compounds – Of these higher health risk are the organo-metal compounds which may form when metals water react with organic compounds in water. Common examples include mercury, arsenic and chromium.

Thus, if water is polluted with both metals and organic compounds the health risk is higher, and can also affect aquatic life.

- ◆ Pesticides– In Sri Lanka people use pesticides far in excess of the required amounts and these contaminate the streams and rivers.

- ◆ Polychlorobiphenyls (PCB)- Transformer oils contain these deadly compounds, which during

their discharge can end up in waterways.

- ◆ Industrial waste: Waste from factories such as rubber, textile, leather tanning, battery recycling, and paper manufacture. discharge into water Biological agents. Which pollute our waterways include mainly bacteria and viruses.

The effects of water pollution may appear immediately after exposure to water with a high degree of pollutant. Other chemicals in water such as very small concentrations of pesticides may cause diseases after exposure to several years.

For example, Mahaweli River is contaminated with pesticides used in the vegetable crops grown in Nuwara Eliya, with some of the pesticides used and this may cause long term effects on people who consume such contaminated water downstream. Some of the green leaves grown around the marshes have been shown to be contaminated with chromium coming from the chromate used for leather tanning. In Sri Lanka,

Table 3 : Some major industries polluting our waterways

Industry	Waste product
Paper and pulp industry	Black liquor
Rubber processing industries	Acetic/formic acids, amino acids
Textile factories	Textile and batik dyes
Leather tanning	Animal tissues, chromate
Fruit processing industries	Carbohydrates, fats and oils
Breweries	Carbohydrates
Milk products	Carbohydrates, proteins

water borne diseases account for the highest percentage of hospital admissions. Diseases caused by this kind of pollution include cholera, typhoid, hepatitis and dysentery. Sri Lanka does not have major chemical industries with the potential to pollute our waterways, but there are still very serious pollution problems due to discharges from domestic waste, agriculture and industry. The Kelani river is the most polluted river in Sri Lanka where untreated sewage and effluents from several industries are discharged into the river, often without any pre-treatment. Some of these sources are given in Table 2.

Let us discuss some of the common water pollutants and identify their origins and health effects. There are many sources of pollution that release nitrates. Human sewage is perhaps the most important source of nitrate pollution. For example, if a well is situated close to a toilet pit, well water gets contaminated with relatively large concentrations of nitrate. It also comes from fertiliser run-offs which causes eutrophication of lakes and algal blooms. Nitrate is also produced due to the bacterial oxidation of ammonia and ammonium salts coming from fertilizers. Nitrate in drinking water is harmful to human health. In the human body,

nitrate gets reduced to nitrite which further reacts with secondary amines to give cancer causing nitrosoamines.

Phosphates leach out to water from the phosphate fertilizers used in agriculture, and also from detergents which are now commonly used for cleaning dishes, clothes etc. instead of traditional soap. Along with organic matter and nitrates, they cause algal blooms which in turn results in fish kills in lakes.

In Sri Lanka, municipal solid waste is usually dumped in low-lying marshes. The liquid that flows from these waste dumping sites is

Table 4 : Relationship between water quality and the amount of dissolved oxygen

Water quality	Dissolved oxygen (mg/L)
Excellent	8.0-9.0
Slightly polluted	6.7-8.0
Generally polluted .	4.5-6.0
Highly polluted	<4.

called leachate. This leachate has very high dissolved organic matter and disease-causing bacteria that pollutes our waterways. Heavy metals such as Ni, Cd and Hg from used batteries are also present in the leachate and these are highly toxic.

Water purification

Living matter that is added to our waterways get oxidised by bacteria which also include all organic matter arising from plants and animal tissues. However, the expanding human population, industrial pollution and increased use of agrochemicals makes natural purification processes insufficient for the direct consumption of water from a river or a stream. Hence water has to be purified before consumption.

Water purification at government sponsored water schemes involves aeration, to remove undesirable gases such as hydrogen sulphide, filtration to remove fine particles of clay and soil, and chlorination to kill bacteria.

Many countries have now abandoned the use of chlorine since it reacts with dissolved organic compounds in water to give a class of highly carcinogenic compounds called chloroaromatics. Instead of chlorine, ozone or irradiation with ultra-violet rays are used in most developed countries for water purification.

While it is certainly devoid of bacteria and other pathogens, there are many other harmful chemicals dissolved in municipal drinking water supplies which are not removed during purification.

These include pesticides, nitrate, heavy metals and even extremely toxic compounds such as dioxin. These are not even monitored in Sri Lanka's drinking water supplies, and some of these are accumulative poisons which may cause kidney ailments and cancer at later stages. Organic matter and water quality The accumulation of oxygen demanding wastes adversely affect aquatic life. Table 3 gives some examples of water pollution arising from organic wastes of industries. Human excreta and organic garbage fall into this category. To break down the organic waste from animal farms, breweries and food processing industries, aerobic bacteria are required.

Some major industries polluting our waterways Since oxygen is utilised for this process, oxygen gets depleted in the river which in turn makes the river unhealthy for both fish and plant life. The concentration of dissolved oxygen in a water body gives the extent to which the water body is polluted (Table 4).

Marine pollution

Oceans receive a heavy dose of what we throw away from land. Pollutants such as chemicals, nutrients, and heavy metals are carried from factories, agriculture and cities by streams and rivers into the sea. At the same time a large amount of polythenes and plastics too end up in the ocean, and in fact microplastics have been detected in fish. An estimated one million tons of oil make their way into the oceans from land-based sources.

Conclusion

The Earth summit conference held

in June 1992 in Rio de Janeiro and attended by a large number of World leaders, was the first major attempt at creating awareness on global issues related to human survival. In their proclamation, the importance of education has been aptly described.

“Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. Both formal and non-formal education are indispensable to changing people's attitudes, so that they have the capacity to assess and address their sustainable development concerns. It is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective participation in decision making. To be effective, environment and development education and human (which may include spiritual) development, should be integrated in all disciplines, and should employ formal and non-formal methods and effective means of communication.” Agenda 21, chapter 36.3 (UNCED Rio de Janeiro, 3-14 June 1992)



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Radioactive Pollution

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Introduction

We live in a radioactive world and human beings have been exposed to radiation from natural sources from the time of their appearance on this planet. These sources of radiation include natural radioactive materials in our surroundings, natural radioactive materials in our bodies and the cosmic radiation that enter our earth's atmosphere from outer space. Since the discovery of radioactivity by a French scientist by the name of Henri Becquerel in 1896, and the development of the uses of nuclear technology that followed, human beings have been also exposed to radiation from manmade sources. On a global scale, exposure to natural sources of radiation is greater than the exposure to manmade sources of radiation.

This article describes what radioactive materials are, the health effects of exposure to radiation, measures taken to control such exposure, and the sources of radioactive pollutants.

Radioactive materials and radiation
As we know, everything on this

earth is made of atoms. A material that has only one type of atom is called an element. For example, carbon, oxygen and hydrogen are elements. An atom consists of a nucleus surrounded by moving electrons, as shown in Fig.1. The nucleus contains two types of particles known as protons and neutrons. The element to which an atom belongs depends on the number of protons. For

example, all carbon atoms have 6 protons, oxygen atoms 8 protons and hydrogen atoms 1 proton. The atoms of a given element can have different numbers of neutrons. For example, carbon atoms can have 6, 7 or 8 neutrons in the nucleus, in addition to 6 protons. Atoms of the same element with different numbers of neutrons are known as isotopes.

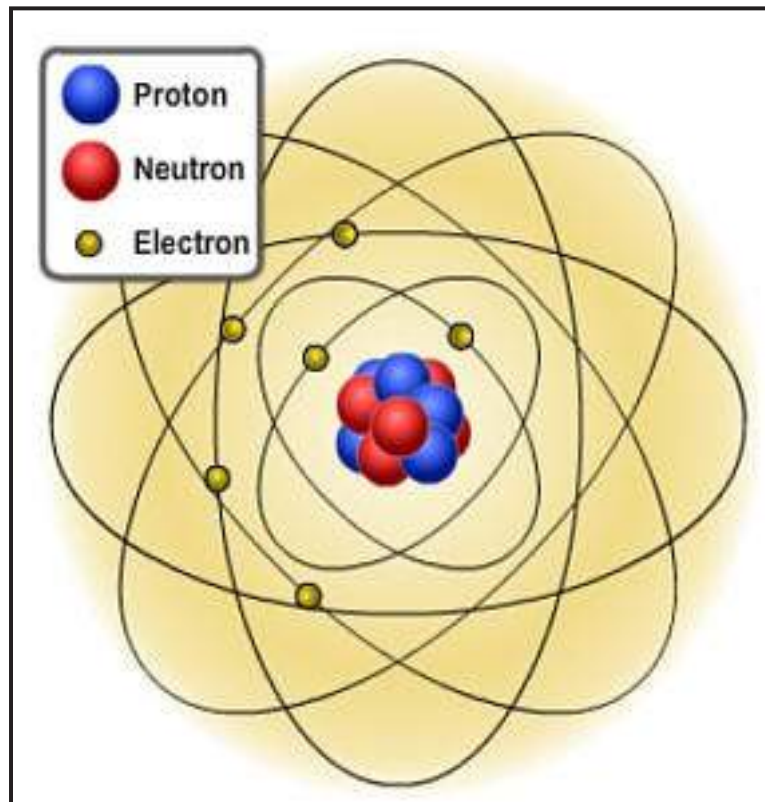


Figure 01 : Structure of an atom

Some of these isotopes are stable, but some are not. Isotopes with too many neutrons or too few neutrons compared to the number of protons are unstable. For example, carbon atoms with 6 or 7 neutrons (Carbon -12 and Carbon 13) are stable but carbon atoms with 8 neutrons (Carbon-14) are not. Unstable atoms try to become stable by emitting particles, usually accompanied by emission of energy in the form of waves. (Electromagnetic waves). The particles emitted are of two different types called alpha and beta and the waves are known as gamma radiation. The isotopes that behave in this manner are called radioactive isotopes or radioisotopes and the particles and electromagnetic waves emitted are collectively called radiation or more correctly, ionizing radiation. This is to distinguish it from other types of radiation such as radio waves and microwaves that do not have enough energy to produce ionizations (i.e. removal of electrons from the influence of the nucleus of an atom).

The presence of radioactive materials can be easily detected by using devices that detect the radiation emitted (i.e. alpha and beta particles and gamma radiation). It is possible to identify the presence of radioactive materials in extremely small concentrations, which could be as low as 1 part in 10^9 .

Exposure to radiation and its effects

The health effects due to exposure to ionizing radiation depend on the amount of energy absorbed by the cells in our bodies from radiation. The amount of energy absorbed by a unit mass of body tissue is

called the radiation dose. Radiation dose is measured using a unit called Grays (Gy). The dose with a correction factor to account for different types of radiation is called the dose equivalent and is measured using a unit called the Sievert (Sv). Persons exposed to extremely high doses in the range of 3-5 Gy could experience severe health effects and could die within a few days. Many of the Japanese atomic bomb victims received such high radiation doses. These effects are known as acute effects of radiation and are deterministic, i.e. the effects are seen in all those who are exposed.

There would not be immediate health effects in those who are exposed to lower doses of radiation, but could experience cancer and leukemia several years after the exposure. These are called chronic effects. Chronic effects unlike acute effects are stochastic, i.e. all those who are exposed will not be affected, but an average increase in the above mentioned diseases could be seen in a large population. An international organization known as the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR) had been engaged in studying the effects of ionizing radiation on human beings since its inception in 1955. Based on the studies conducted on the Japanese bomb victims who were exposed to lower levels of radiation and survived, cancer patients who had received radiotherapy and other sources, UNSCEAR had estimated that the additional chance of dying of cancer due to radiation exposure above 100 mSv to be about 0.3 to 0.5 in a hundred per 100 mSv. In other words the chances of getting cancer as a result of being exposed to a dose equivalence of 1 mSv are

about 1 in 20,000 to 1 in 33,000. Exposure of pregnant mothers to radiation could have an effect on the embryo. UNSCEAR had estimated that no more than two out of every 1 000 live-born children who have been exposed to a dose equivalent of a hundredth of a Sievert in the womb might be affected—compared with the 6 per cent who develop the same effects naturally.

Sources of Radiation

As mentioned earlier, all human beings are continuously exposed to radiation from natural sources. The dose equivalent rate from natural sources varies depending on the location on the earth, and has a range of 1.0 mSv per year to 12.4 mSv per year. (1Sv=1000 mSv). The global average is 2.4 mSv per year.

We are also exposed to radiation from a number of manmade sources. The highest doses received from manmade sources are due to use of radiation for medical diagnostics and therapy. A typical X-ray examination will expose a person to about 0.1 mSv. The CT scan of the abdomen will give a dose equivalent of about 10 mSv. Nuclear power plants expose the population living in their vicinity to a very small dose during normal operation. United Nations Environmental Programme had estimated the average dose equivalent received by a person living in the vicinity of a nuclear power plant to be about 0.0001 mSv per year. (Exposure during accidents are described under sources of radioactive pollutants) A summary of the dose equivalents from natural and manmade sources is given in Table 1.

Measures taken to regulate exposure to radiation

Since the discovery of the harmful nature of ionizing radiation, action had been taken to regulate human exposure to radiation. This is done through a regime of standards, laws, rules, regulations and codes of practices. The current international standard used is known as “International Basic Safety for Protection against Ionizing Radiation and for the Safety of Radiation Sources”. This is a standard jointly adopted by the International Atomic Energy Agency (IAEA), World Health Organization (WHO), International Labor Organization (ILO), and Food and Agriculture Organization (FAO) of the United Nations and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA).

Within the framework of this standard, all countries that use nuclear technology for power generation and for a number of other purposes mainly in the medical, industrial and agricultural

sectors, have promulgated their own laws and regulations and have established regulatory bodies to implement them. In Sri Lanka, the national body responsible for regulating the uses of radiation and radioisotopes is the Atomic Energy Regulatory Council, which functions under the Ministry of Power and Energy.

According to national regulations it is mandatory for all users of radiation and radioisotopes to obtain a license from the Regulatory Council. All activities connected with the use of radiation and radioisotopes should be carried out according to the conditions stipulated in the licenses. Inspectors of the regulatory authority periodically inspect the facilities to ensure safety. No activity that will expose the general public to a dose equivalence of more than 1 mSv per year is allowed.

The regulations also specify the maximum permissible levels of radioactive contaminants allowed in water, food and air in order to limit the radiation dose equivalence levels to the public to

1 mSv per year. The regulations also stipulate the measures to be taken in handling and storing radioactive materials and managing radioactive waste. It is beyond the scope of this article to provide a comprehensive description of all regulatory measures. More details can be obtained from the web-site of the Atomic Energy Regulatory Council; www.aerc.gov.lk.

Radioactive Pollutants

Radioactive materials released to the environment above limits allowed by radiation protection regulations can be considered as radioactive pollutants. The main sources of radioactive pollutants include, the tests that had been carried out on nuclear weapons in the past, accidents at nuclear power plants, accidents at other nuclear facilities, improper management of radioactive waste and mining and mineral processing operations.

Over 500 of nuclear weapons had been tested up to 1980 with a total explosive power of 430 MT of TNT equivalent. These tests released radioactive materials produced in the nuclear explosions to the atmosphere. Testing of nuclear weapons is now prohibited

Table 1 : Average Public Exposure by Radiation Source

Natural Sources		Manmade Sources	
Source	Annual Dose Equivalent (mSV)	Source	Annual Dose Equivalent (mSV)
Food	0.29	Nuclear power plants	0.0002
Cosmic radiation	0.39	Chernobyl accident	0.002
Soil	0.48	Fallout from weapons testing	0.005
Radon	1.3	Nuclear medicine	0.03
		Radiology	0.62
Total	2.4	Total	0.65

under an international treaty known as the Comprehensive Test Ban Treaty (CTBT). The radioactive fallout from these tests produced an average dose equivalent of about 0.11 mSv per year in 1963 around the peak of nuclear weapons testing. The current dose equivalent is about 0.005 mSv per year.

There had been 35 severe radiation accidents in nuclear facilities since 1945, which resulted in deaths or serious injuries to the employees of these facilities. They also released radioactive material to the environment, exposing populations living close by to detectable levels of radiation.

There had been three major accidents in nuclear power plants. The first accident occurred at the Three Mile Island nuclear power plant in the USA, on 28th March 1979. A series of events, compounded by faulty response of the plant operators caused a partial meltdown of the reactor core, which contains reactor fuel and the radioactive material produced during the operation of the plant. The accident released a large amount of radioactive material to the containment building of the plant (the concrete structure that surrounds the reactor), but the release of radioactive material to the environment was very low. The most severe accident at a nuclear power plant occurred in the Chernobyl nuclear power plant in Ukraine on the 26th of April 1986. An attempt by the operators to conduct an experiment on the reactor after disabling a number of safety systems grossly overheated the reactor core. This particular type

of reactors (unlike most reactors in operation at present) had a core made of graphite and uranium fuel. The high temperatures made the graphite core catch fire and produce combustible gases in chemical reactions with cooling water, resulting in a chemical explosion. The radioactive material released from the accident spread over a number of European countries. About 30 fire fighters who responded to the emergency were exposed to very high levels of radiation (acute exposure) and died within a few days. The radioactive contamination of milk (by radioactive iodine) produced thyroid cancer among 6000 children, with 15 fatalities. International experts had concluded that the accident had caused 4000 additional cancers among those who were exposed to higher levels of radiation, i.e. emergency workers, evacuees and residents of the most contaminated areas. An earthquake of magnitude 9.0 on the 11th of March 2011, followed by a tsunami disabled the cooling systems of the Daiichi-Fukushima nuclear power plant in Japan and caused a partial meltdown of the reactor cores of 4 units of the plant in operation at the time of the accident. About 85,000 residents living within 20 km from the power plant were evacuated to reduce their exposure to radiation. A study conducted by UNSCEAR had estimated the dose equivalent to persons in the evacuated areas of Fukushima prefecture during the first year after the accident to be between 1 mSv and 10 mSv. Improper disposal of low and intermediate level radioactive waste in the sea in the past had also produced radioactive pollution. This practice is no

longer permitted. Low level and intermediate level wastes are currently disposed of in specially designed facilities, and high level waste that are produced in nuclear power plants are presently stored in storage ponds inside the reactor buildings of the power plants. They should be eventually disposed of in a manner that will not expose the public to radiation.

Mining and processing of materials that contain naturally occurring radioactive material (NORM) such as uranium and thorium also cause radioactive pollution. Examples are mining and smelting of metals, production of phosphates, coal mining, rare earth and titanium oxide industries.



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Electromagnetic Pollution due to Industrial Activities

Ms Anuradha Nanayakkara



Electromagnetic waves

Electromagnetic waves are energy waves imperceptible to the human eye. They can travel through empty space, through the air and different substances. They are described with three physical properties, namely frequency, wavelength and photon energy. When we align the electromagnetic waves with respect to their range of frequencies, we get what is called electromagnetic spectrum (Figure 1). As can be noted from Figure 1, the spectrum is in respect of the wavelengths and photon energies. This spectrum is divided into separate bands, and the electromagnetic waves within each frequency band are given different names; radio waves, microwaves, infrared, visible light, UltraViolet (UV), X-rays, and Gamma rays. This is when we start at the low frequency (long wavelength) end of the spectrum and going towards the high-frequency (short wavelength) end. The electromagnetic waves in each of these bands have different characteristics, in terms of how they are produced, how they interact with matter and for what

they can be used for. The electromagnetic radiation is twofold, ionizing radiation and non-ionizing radiation. Ionizing radiation is by high energy electromagnetic waves such as Gamma rays, X-rays and higher frequency UV. They are sitting towards the higher frequency edge of the spectrum. These waves detach electrons and ionize atoms or molecules. Ionizing radiation is used in different fields such as medicine, nuclear power, research, and industrial manufacturing.

Lower energy UV, visible light, laser light, infrared, microwaves, and radio waves are lower energy waveforms. Thus, they contribute to non-ionizing radiation. They have enough energy, just to excite electrons to higher energy states and will not ionize atoms or molecules. These are also being used in different industries, medicine, consumer devices, household devices, etc.

Electromagnetic pollution

Electromagnetic pollution is a newer version of pollution, caused by electric, magnetic, and

electromagnetic fields generated naturally or technically. We observed a rapid development in advanced electrical, electronic, and electromagnetic systems in the recent past, which in terms increase the utilization as well as release of electromagnetic radiation to the environment. Number of investigations carried out in this realm is not that much; yet has proved that electric field strength caused by the electromagnetic radiation, in normal human inhabited areas have been increasing by at least one order in every decade. Electromagnetic pollution caused by non-ionizing radiation is also termed as Radiation Hazard (RADHAZ). When modern domestic and industrial activities are concerned, there is an augmented and widespread use of electronic devices. These devices make use of various parts of the electromagnetic spectrum. They either transmit or receive and process electromagnetic waves. There are innumerable applications residing in quite different domains including, but not limited to satellite communication, terrestrial communication, radio

and television broadcasting, radar, industrial processing, power transmission, and remote controlling. Healthcare and consumer devices can be identified as the recently emerging industrial verticals that are heavily dependent on the electromagnetic radiation related activities.

In some scenarios as in communication, the electromagnetic signal primarily dependent on the distance between the transmitter and receiver units. These units are known as the functional sources of electromagnetic radiation. Also, when used in communications, broadcasting and radar devices, electromagnetic radiation propagates over large areas. Need of speed network covering the full population, brings up telecommunication towers everywhere, and opens the public to the continuous (24x7) exposure of electromagnetic radiation. There are many devices, which emit electromagnetic radiations as incidental sources. Almost all consume electronic products namely washing machines, mixer grinders, microwave ovens, televisions, mobile phones, digital computers, network equipment, etc. fall in this category. Welders, motor-operated machinery, electro-erosion machinery housed in industrial plants are incidental sources and heavily contribute for electromagnetic pollution.

In the medical field electro-medical devices in which electronics are used either for diagnostic or for therapeutic purposes, are coming up. Electronic display devices have opened new era for patient diagnostic and monitoring systems. All these instruments use electromagnetic waves and counts on to the growth of electrical field

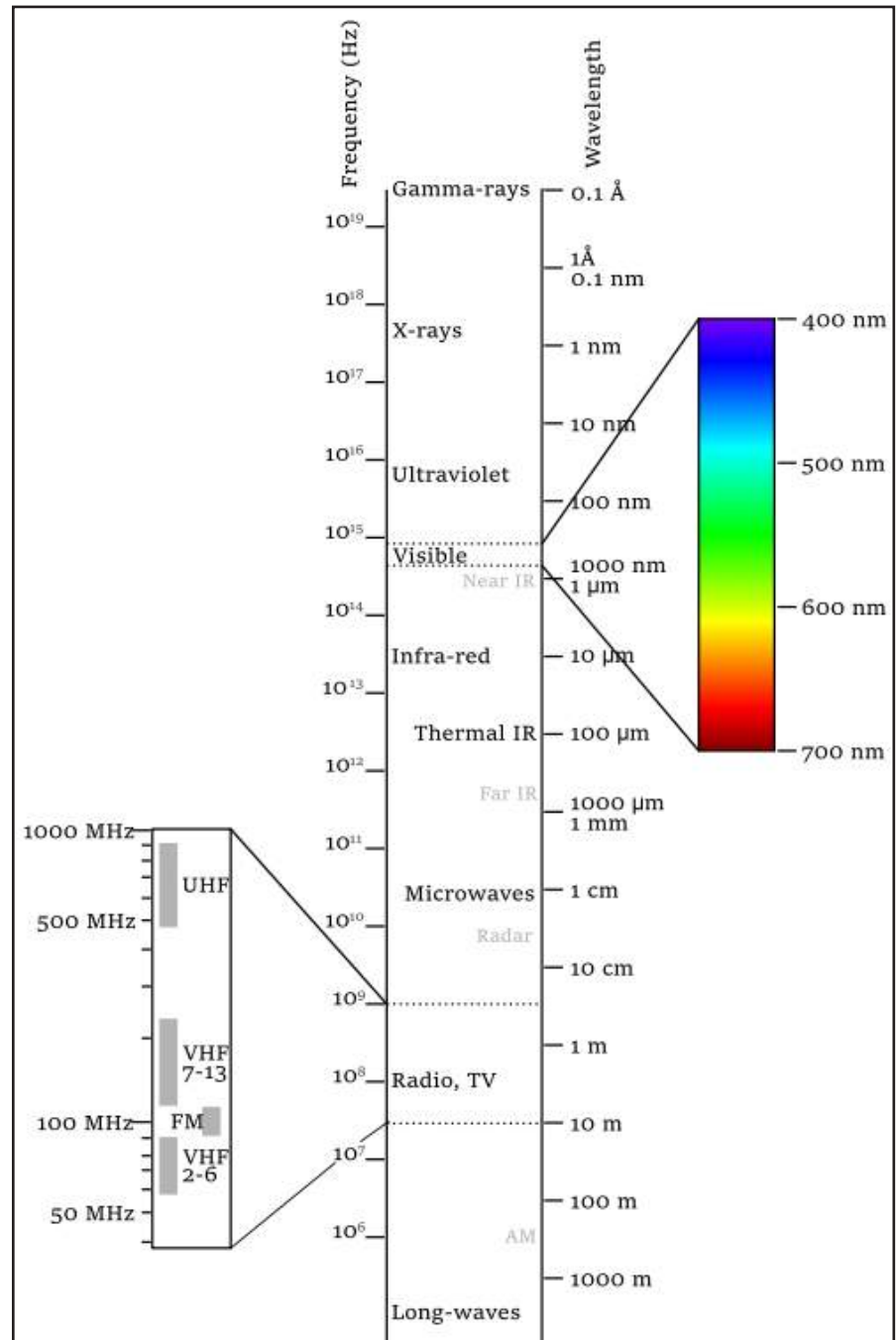


Figure1 : Electromagnetic Spectrum

strength in hospital areas. Urban areas as well as industrial zones have a dense network of utility powerlines which originates ubiquitous power frequency electromagnetic fields. Also, a low frequency electromagnetic field forms with the domestic electricity exposure. When it comes to industrial, medical and consumer

use cases radiation spreads over small areas.

Electromagnetic pollution is somewhat obscure in nature and cannot be treated as other types of pollution as we are already familiar with. Consequential implications are not readily visible. The harm caused by this pollution is still open



Further, some studies have shown that plants can retain electromagnetic radiation adequately. So such evidence may encourage raising plants and flowers around electromagnetically polluted areas.

Conclusion

Electromagnetic radiations are utilized as technological enhancements, and for benefit to mankind in almost all aspects. It has become an inevitable component in today's world. In depth research and investigations are required to realize the real impact of electromagnetic pollution, and to identify potential solutions. All of us need to understand the pitfalls, and work collaboratively to minimize the undesirable aftermaths.



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to question for study and analyses. Some studies conclude that definitive evidence of its negative influence on human health is not enough, while others have identified a correlation in between. This has paved the way for further studies of possible hazards to human health from exposure to ionizing as well as non-ionizing radio frequency with the emerge of electromagnetic pollution. As some studies reveal, the effects depend on the type and strength of electromagnetic field as well as the duration of exposure. A couple of studies reveal that low-frequency range of electromagnetic fields cause infantile leukemia, and is carcinogenic. If proper measures are not taken, high frequency electromagnetic fields or ionizing radiation can cause damage to living tissue, with radiation burns and cancers.

Remedies

With the aim of combating the threat of electromagnetic pollution, different governments, organizations, and authorities have formulated various EMC

(Electro Magnetic Compatibility) standards and safety standards for specific environments/ platforms like industrial, residential, automobile or aircraft. CISPR (International Special Committee for Radio Protection) standards, IEC standards on electromagnetic compatibility IEC6100 family, European standards concerning unwanted electrical emissions, ISO standards, Society of Automotive Engineers standards for EMC are few to mention. IEEE (Institute for Electrical and Electronic Engineers) established the Committee on Man and Radiation (COMAR) in 1972. The purpose of this committee is to evaluate information published on the effects of non-ionizing radiation on biological systems. Environmental Health Division of World Health Organization develops health criteria for non-ionizing electromagnetic radiation. Both the International Non-Ionising Radiation Committee (INIRC) of the International Radio Protection Agency (IRPA), and Environmental Health Division of World Health Organization are collaborating on this issue.

Light Pollution; is the Night Really Dark?

Mrs Madhavi Perera



Have you ever had trouble in sleeping because of the light of a street lamp or lights from a neighboring house entering your room? This is called light trespassing, which is a classic example of light pollution. Light pollution is a silent type of pollution that have been increasing gradually with the advancement of artificial lighting and the urbanization.

In the past when the electricity was something only privileged people had, majority of the houses had one or two kerosene lamps and there were very minimum light in outdoor at night. But with more and more areas being electrified and our houses, offices and

roads been developed, today almost all the buildings and roads will be lit with lights at night and this phenomena is called ALAN (Artificial Light at Night). While all this can be seen as an advancement of the quality of life of humans, artificial light at night has introduced a silent mode of pollution, light pollution. Light pollution can be recognized as the

excessive light that is directed to unintended directions including towards the sky.

Over many years humans, animals and plants are used to having bright lighting conditions at the daytime and low light in night. In fact most of the animals and plants have “circadian cycle” which is a 24 hour cycle that regulates

their internal body functions. It is proved by scientists that lighting conditions in the environment can affect the circadian cycle. Therefore if these living beings are exposed to unusually high lighting conditions at night, it can affect their circadian cycle which regulates the internal body functions. The excessivelight



Figure 01 : Light Trespassing



Figure 02 : Sky Glow

emitted by windows of buildings, street lighting, name boards and any other similar light sources in the night can create these harmful effects for humans, animals and plants who are living in that environment. This can happen as light trespassing to areas that is not intended to get lit, or by glare created by bright light sources such as a signboard, LED screen or street light. The figure 1 indicates light pollution created by light trespassing by windows of one house entering to the neighboring house through windows.

In recent years there have been arguments that LED lighting is also responsible for pollution. The main reason for this argument is, in most of the LED lights the major component of its spectrum is blue light. Whereas before the introduction of LEDs, most of the street lights and other outdoor lights used sodium vapour lamps that had majority of the spectrum in red and orange (yellowish light). It has been observed from the researches that the bluish light is more disrupting to the circadian

rhythm when compared with yellowish light. This is the reason for the idea that LED lighting can affect the human health. Although they are not widely used, LED lights are also available with lesser blue spectrum so that the light will be more yellowish and will have less impact on the circadian rhythm.

Lighting pollution creates skyglow which disturbs activities such as sky watching and other astronomical research activities. The light that is emitted from buildings and other outdoor lighting that is directed upwards will enter the sky and create this sky glow. The above figure 2 shows an example for the sky glow created by the lighting pollution. Apart from disruption for astronomical activities, sky glow also affects animals since it will be a disruption to their normal living conditions.

At present many high rise buildings and monuments are also lighted up for aesthetic purposes and also to draw the attention of the people to these locations. If very strong lighting is used for this purpose and the lighting that is directed to the

sky is not controlled these systems will also create skyglow and be disruptive to animals and humans. These problems have risen because of installing lighting systems without proper planning and design, which has created situations where the light will be directed to unintended areas. The solution for lighting pollution is not entirely stopping using artificial lighting at night. When lighting is installed in a

certain location the effect created by light pollution must be evaluated and necessary remedial actions should be taken.

For outdoor lighting such as street lighting, the light fittings which minimize the light directed upwards should be used. These light fittings are called full cutoff and cutoff luminaires. In order to control lighting pollution all the outdoor lighting should be at least semi cutoff type. The below figure 3 shows the different types of light fittings and the suitability of them in terms of light pollution control.

Also when selecting LED lighting for outdoor areas special care should be taken to select the lights with colour temperature. Since higher colour temperature (bluish light) is believed to be affecting circadian rhythm of people and other living beings, the LED lighting of lower colour temperature (yellowish) should be selected. This will minimize the disruption created by bluish light to the body rhythms of humans and other animals and plants.



Figure 03 : Cutoff Classification of Light Fittings

In several countries rules and regulations has been established by the government to make sure that any lighting system installed will have minimum lighting pollution. In Sri Lanka, upto now there are no such regulation. However, the GreenSL rating system for built environment published by the Green Building Council Sri Lanka specifies that the green buildings should take necessary precautions to minimize the lighting pollution. The relevant regulatory institutes in our country should seriously consider about introducing rules to control lighting pollution in Sri Lanka since we can observe lighting pollution in many situations.

As general public we can also contribute to reduce the lighting pollution. Even the lighting at our homes can create light pollution. We can switch off the unnecessary lights, specially the ones installed in outdoors . We can also rethink whether we have installed the lights with correct brightness, because excessively bright lights also creates lighting pollution. To reduce the lighting trespassing

created by the indoor lighting we can use shades or curtains to cover the windows during the night time. If the street lights in your lane is creating lighting pollution you can request the local authority who maintain the street lighting to do the necessary modifications to reduce light pollution. By doing so, you contribute to a better, healthy and comfortable nighttime environment not only for yourself but also for the animals and plants in your neighborhood.

Lighting pollution is truly a form of silent pollution where all of us are unknowingly subjected to harmful effects of lighting pollution and we are not preventing the pollution due to our ignorance. Hence education regarding lighting pollution is very important since we all have our part to play to reduce the disruptions created by lights we use, to our neighbors, animals and plants. Doing the minor modifications to existing lighting systems and being careful about lighting pollution when designing new lighting systems can reduce the lighting pollution

happening today. If each one of us work towards reducing the lighting pollution in these methods we can make the nighttime life of humans, animals and plants comfortable and undisruptive without compromising the luxuries we enjoy with artificial light at night.



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Microplastic Pollution - Nature fed the thrown away plastics to humans which disposed to the environment by us

Dr Sajith Edirisinghe



From our childhood, we have heard and learned about how plastic pollutes the environment. We must have written essays about plastic pollution for various competitions and sometimes we might have won from those. All that we have talked about are plastic waste which we can see from our naked eye. Its accounts only for 15%. Therefore where and what is the rest of the 85%? It's call microplastics and nano plastics. According to the estimated amounts by the year 2017,

approximately 6300 million tons of plastic waste had been generated throughout the world. From this huge amount, nearly 20% was recycled or incinerated. In contrast, the remaining 80% was either used in landfills or released without control of natural environments. Microplastics(MPs) and Nanoplastics (NPs) refer to the fraction of plastic that is released into the environment, either properly or otherwise, through various environmental or human processes. These MPs particles range from 1 micrometer (10^{-6m})

to 5 millimeters and those that are smaller than that ($< 1 \mu m$ scale) are called Nanoplastics.

How do these micro and nano plastics join the environment? There are many ways that micro and nano plastics enter the environment. For studying purposes, we can divide it into primary and secondary microplastics.

Primary Microplastics

Primary MPs are plastics that are manufactured in sizes less than 5mm and released to the market. For example, plastic nurdles washed to the Sri Lankan beach by recent marine disaster - MV X-Press Pearl, small plastic beads used in textiles, tiny plastic beads found in face washes/toothpaste/shower gels, belong to this category. Do you know that per one wash of face scrub it is estimated that 94,000-100,000 microplastics are released to the environment?

Secondary Microplastics

Secondary MPs include plastics that are released to the environment after being used once (plastic drink



Figure 01 : Plastic nurdles washed to the Sri Lankan beach by recent marine disaster - MV X-Press Pearl



Figure 02 : Microplastics in the face wash /scrubs

bottles, straws) or several times (plastic pans). These plastics get continuously broken down into very small pieces by sunlight, rain, crushed by vehicle tires, burning, etc...

Furthermore, nylon clothing also releases these secondary micro-plastics as fibers into the environment. According to scientific studies most fibers are coming from acrylic-based clothing.

How do these microplastics and nano plastics enter the human body and how it affects human health? These microplastics enter humans in many pathways. Main pathways are described below.

Via the food we eat

One pathway is via the marine environment. The microplastic that joins the environment gets washed away by rivers and streams and eventually ends up in the ocean. When it enters the marine environment these MPs/NPs are ingested by the animals. The microscopic animals see these small MPs/NPs as their food. These tiny zooplankton are the basic steps of a food chain. When these zooplankton are eaten by bigger



Figure 03 : Microplastics in toothpaste

fish and as it ascends in the food chain these MPs/NPs will gradually undergo bioaccumulation. As humans being the end stage of the food chain, tend to consume these fish/ mussels belong to various stages of the food chains. Therefore humans are at risk of end-stage bioaccumulation.

The diagram shown below shows a simple food chain. Number 01 in fig.06 represents the basic step in the food chain(zooplankton). The zooplankton are eaten by the bigger fish represent by the number 02 and hose fish are eaten by even bigger fish represented by the number 03 (Fig.06). Finally,



Figure 04 : Methods of production of secondary microplastics

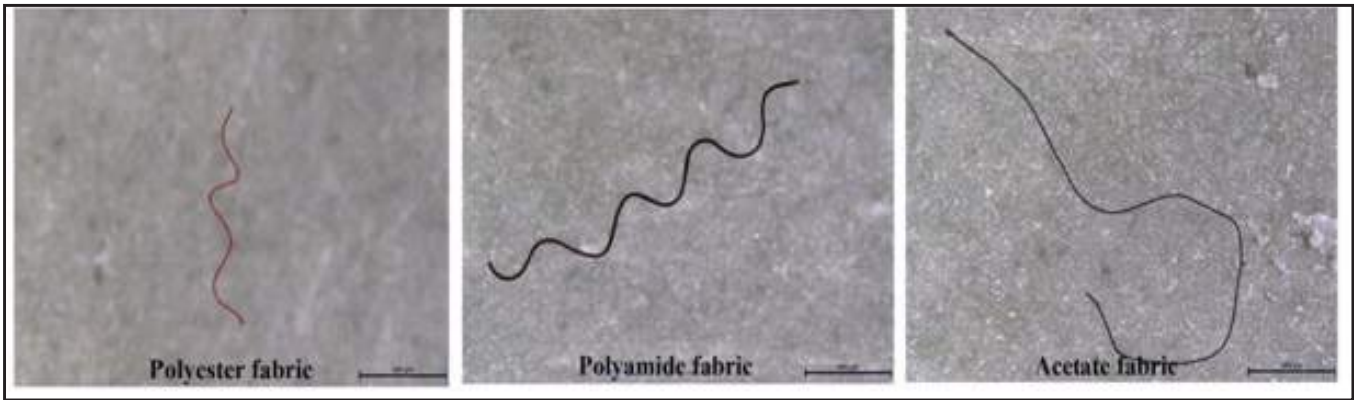


Figure 05 : secondary microplastics fibers released to the environment by washing nylon or acrylic cloths

below web link.

humans take the marine products that belong to different stages of the food chain. Since these microplastics are bioaccumulated in the food chain, as the final recipient humans ingest quite a number of these microplastics.

Not only seafood, but microplastics can also enter the human body via other meat products as well.

Via water we drink

According to available literature in addition to the microplastic contaminated food that we eat, MPs/NPs have been shown that it can be found in table salt, drinking water bottles, tap water, and bottled water. Research done in the USA using branded bottled water has shown 93% of

the total 259 water bottles are contaminated with MPs. According to the calculations, an average of 325MPP/L(microplastic particles per liter) MP particles were found. Furthermore, the concentration of MPs size more than 100 μm were 10.4MPP/L and MPs size between 6.5-100μm were 315MPP/L. It was interesting to know that water stored in glass bottles had fewer MPs than plastic bottles. The World Health Organization(WHO) in 2019 has issued a report about “Microplastics in Drinking water” (ISBN: 978-92-4-151619-8). The report can be downloaded by the

Whatever the way these plastic particles enter the human gastrointestinal tract can pass through the intestinal epithelium and enter the blood circulation via inhalation

These MPs/NPs are also present in the air, so they enter our bodies through inhalations. Artificial

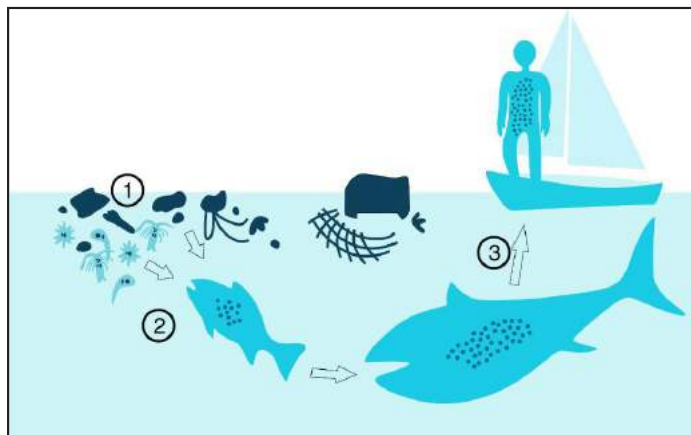


Figure 06 : Microplastics in the simple food chain

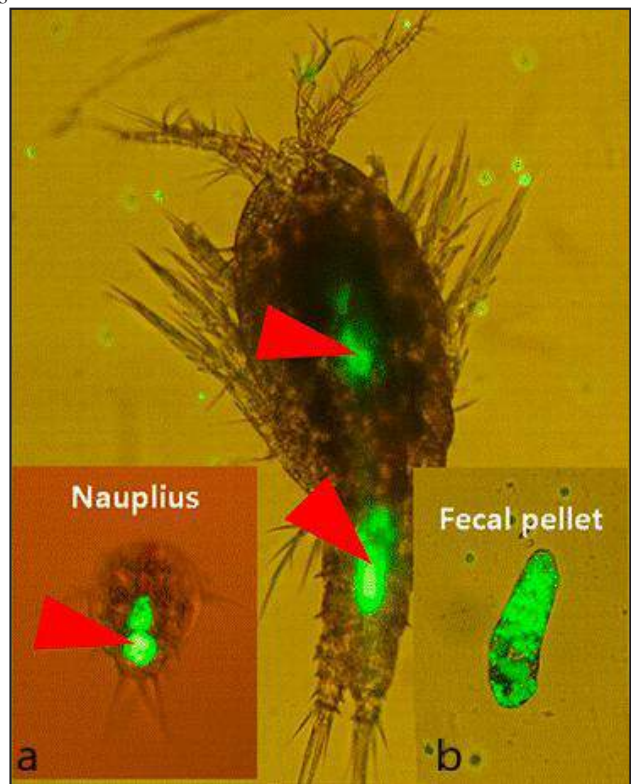


Figure 07 : microscopic marine animals ingested microplastics. (a) microplastics in the intestine of the animal, (b) microplastic particle – Luminas green

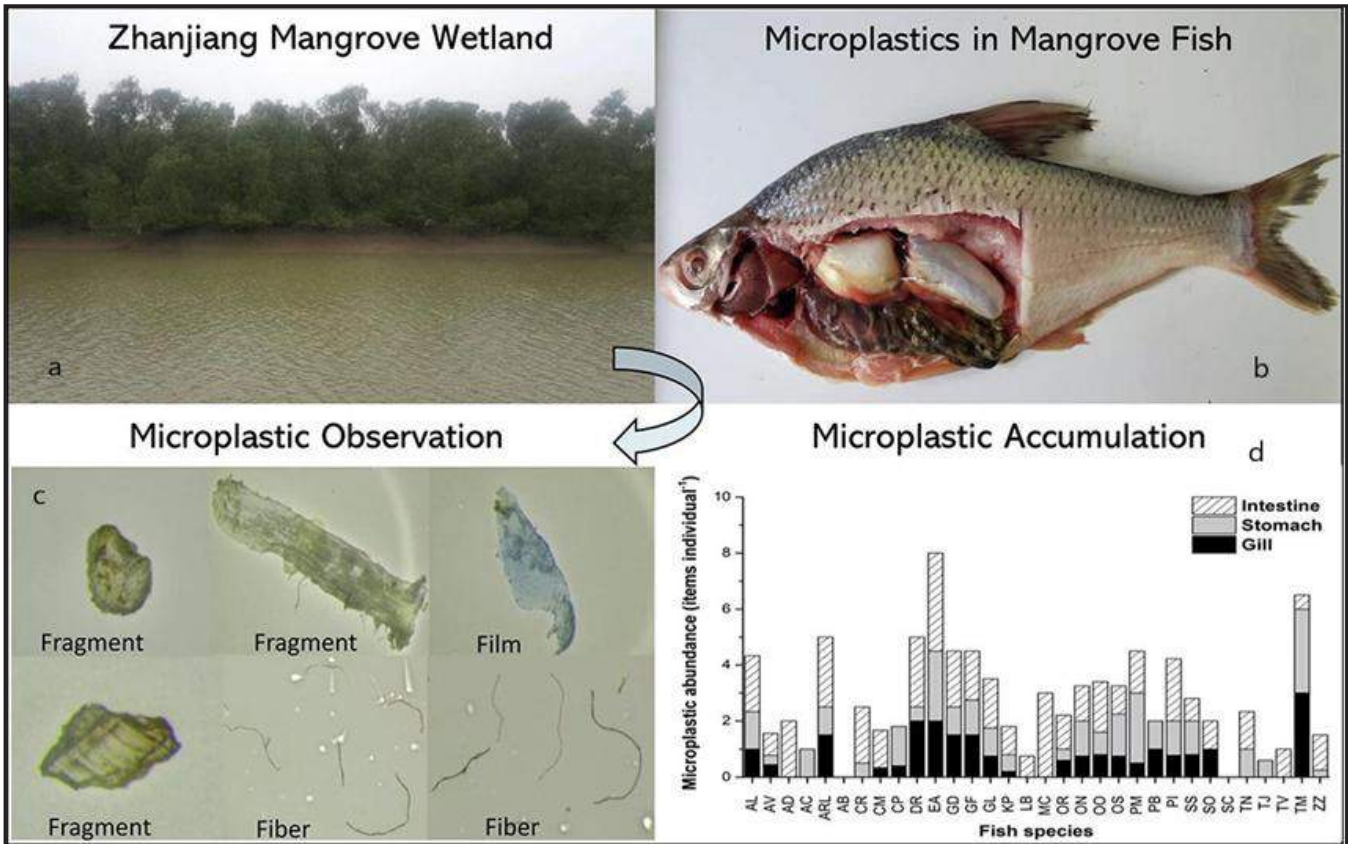


Figure 08 : Microplastic in (a) Zhanjiang mangrove wetland (b) fish (c) different plastic particles (d) type of fish and microplastic content in different body parts

cloths, tire dust, burning of plastics, packing material, constructing site waste, 3D printing, etc could release MPs/NPs to the environment.

Scientists have found out the commonest size of the atmospheric MP is 5 µm and the microfibers with 3 µm diameter. The apparel industry use microfibers of 1-5 µm are one of the reasons to increase the atmospheric microfibers.

(approximate equivalent to a credit/debit card which is 5g in weight) weekly from a variety of commonly eaten foods, beverages, and air. This has been confirmed by examination of stool samples obtained from 7 countries including the USA, United Kingdom, and Japan.

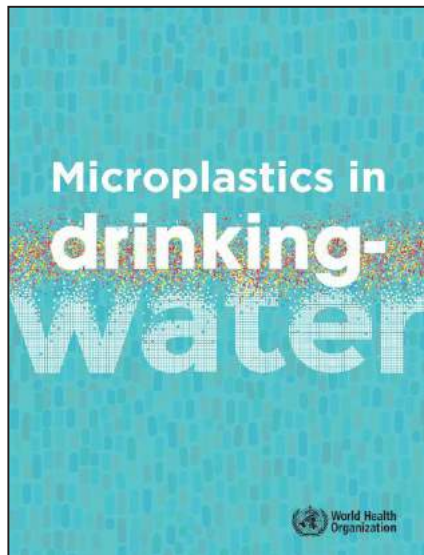


Figure 09 : WHO report on Microplastics in drinking water

These MPs/NPs and Microfibers inter into the human body via the lungs. Inhaled particles and fibers cross the respiratory epithelium and enter the pulmonary circulation. After that, the particles are carried away via blood to different organs/locations in the body.

The consequences of ingested plastic particles can be divided into two main categories. One is due to the physical properties of the particle and the other one is due to the chemicals in the particle.

Therefore scientists at the University of Newcastle estimate that an average adult could consume about 5 g of plastic (74,000-121,000 particles)

During the plastic manufacturing process, various chemicals are added to obtain different colours, properties, thermal resistance, bending properties and to prevent

oxidation, etc. These chemicals include heavy metals and chemicals already proven to cause cancers. The ultimate plastic product we see or use is a cocktail of various chemicals.

These MPs/NPs are fond of adsorbing and absorbing various heavy metals and carcinogenic chemicals when in the environment.

As shown above, in figure 06, there are known bioaccumulation when climbing the food chain ladders. Therefore these chemicals are entered into the human body in higher concentrations. After entering into the blood circulation these particles will be deposited in various organs and start releasing the absorbed chemicals in simple diffusions. This chemical could lead to genetic changes in the surrounding cells and ultimately cause cancers. This chemical not only can cause cancers but also can mimic certain endocrine hormones and affect the endocrine system of the human body. This could lead to various non-communicable diseases and reproductive system health problems.

One such harmful chemical is

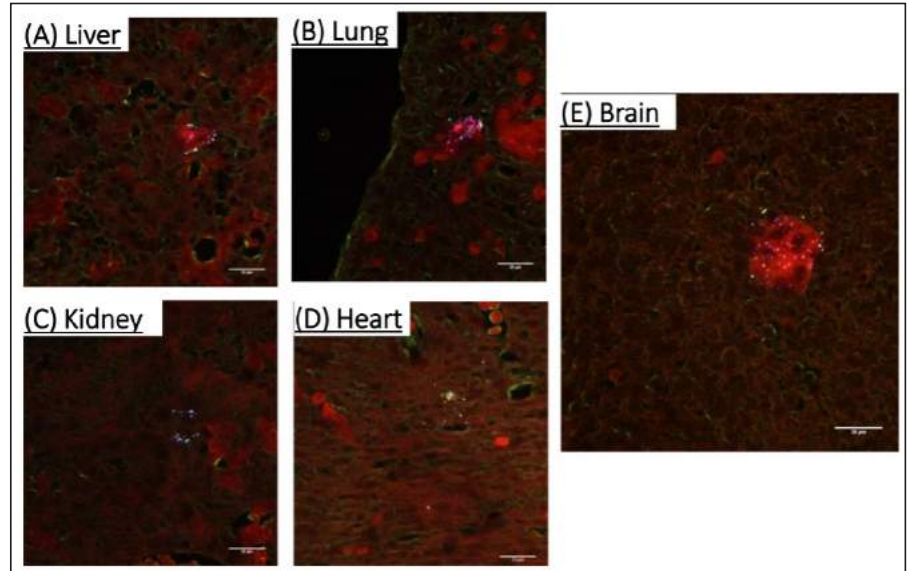


Figure 11 : Laboratory test results of fetal rat specimen where microplastics were inhaled by the mother rat. (MPs particles are shown as white dots)

Bisphenol A (BPA). These BPH can mimic estrogen hormone and react on estrogen receptors α and β . These stimulations can cause program cell deaths, cell mortality changes. Therefore these BPA can affect the development of the ovaries, breast, and prostate gland and their function.

Finally, the scientist has shown that these NPs can cross the placenta and enter to the unborn fetus. This means the future generations are born with various plastics inside

their bodies and could have inborn chemical toxins which could lead to various diseases.

Think now. How much damage have we done to ourselves? Think twice. Save the planet from plastic for future generations.



Figure 10 : Average of 5 g of plastics are consumed per week



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A Silent Pollution Caused By “Spitting in Common Places”

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There is a thick liquid which is scientifically called ‘saliva’ (some other names are spittle, sputum) in the human mouth for the use of several essential purposes. Saliva automatically activates in various conditions with different reactions. The desire to digest a delicious meal is shown by salivating, while similar reactions occur in unpleasant situation where a bad smell is emitted. However, in an undesirable moment we tend to spit instead of showing a relish. This means that saliva which beneficially participates in the digestive system, becomes an adversity and a silent pollutant when one spits in public places. This issue of showing the benefits of saliva for human beings, and the adversities caused when spitting in public places are briefly discussed in the article.

Our living environment

Our surroundings are full of the green gardens

with unbelievable biodiversity, as well as water sources and streams with pure natural water. This attractive and greenish environment is continuously altered by nature and by man. Out of these natural changes, negative results can be controlled and minimized only up to a certain level. However,

it is imperative that man-made hazardous activities should be definitely reduced to preserve the environment. For example, when a volcanic eruption occurs, the resulting volcanic ash spreads all over the neighborhood thereby causing an unsuitable living environment. Nevertheless the

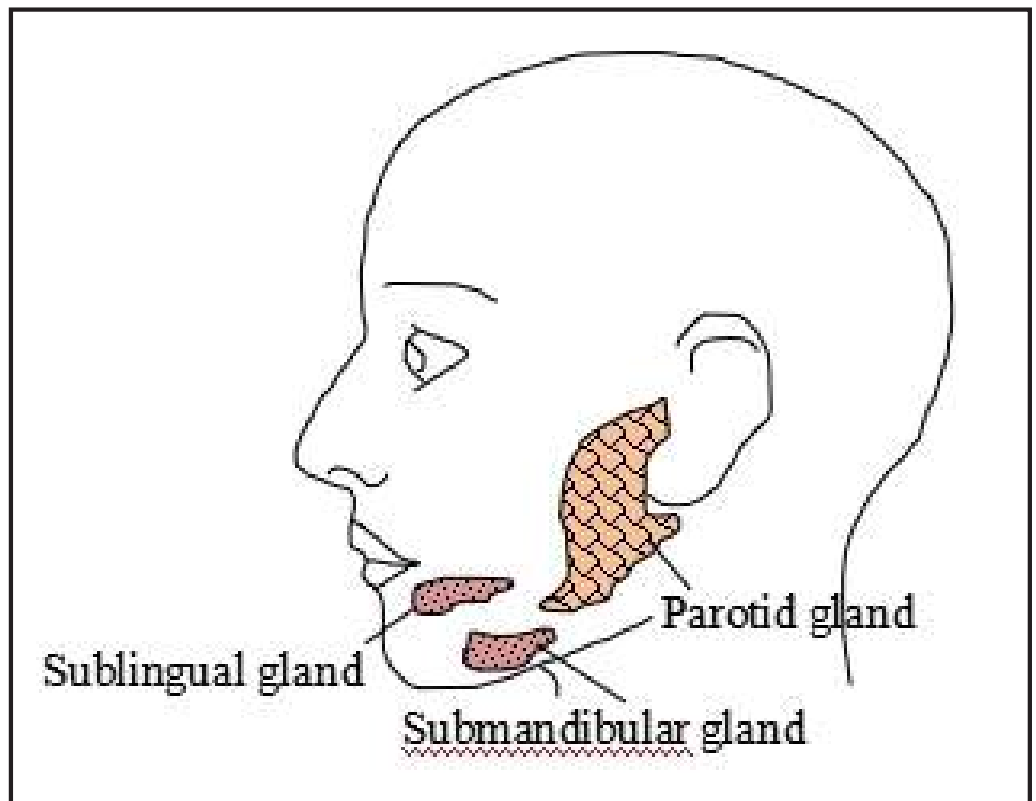


Figure 01 : Salivary glands

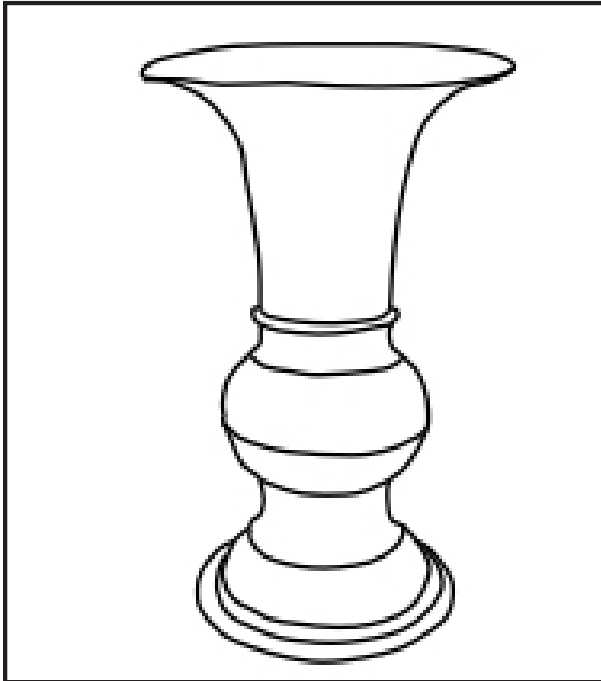


Figure 02 : The spittoon

gases that are emitted from the core of the earth during mineral mining tend to fertilize the surface of the Earth. It is also popularly known that the smoke emitted from vehicles has a serious adverse effect on the composition of the atmosphere. This is yet another case of environmental pollution with serious consequences of breathing unclean air that causes various types of diseases. Therefore ensuring the decrease of these directly recognizable and unrecognizable destructive environmental pollutants is a duty and a responsibility of man. This type of refinements cannot be achieved in the short run, nevertheless it must be brought

about gradually by motivating people to follow the correct ways in dealing with their surroundings. Most countries in the world have reached the required level by doing consciously what is required.

What is 'Saliva'?

The 'Parotid', Submandibular or Submaxillary and Sublingual (Figure 1) organs in the mouth of human beings which produce the saliva, are called 'salivary glands'. The proper flow of saliva means that the body condition is healthy. The composition of saliva which comprise largely of water, has also several enzymes used in digestion of a meal. No sooner food is taken into the mouth, the digestive process commences by salivating. In this stage, the enzymes activate on the food by masticating these

into smaller components and mixing with saliva. As a result, the carbohydrates are converted to the simple sugar 'maltose' by enzyme 'amylase'. Apart from that, saliva includes enzymes to energize the teeth for chewing, and protecting the enamel. In addition, it can fight against the viruses, bacteria and fungi that enter the mouth. As we know, the moisture of the mouth is retained by this liquid. Thus it has to be noted that 'saliva' carries out a significant role in our life process.

Diseases caused by saliva

The usual moisturizing of the components of digestive system such as the larynx, etc., due to the relishing of automatically produced saliva is good for health. Lots of diseases have been identified which are directly or indirectly spread by spitting, and the present Corona virus (COVID 19) pandemic can be placed on the top of this list. According to the World Health Organization (2021). Coronavirus. (https://www.who.int/health-topics/coronavirus#tab=tab_1), this disease can be primarily passed from an



Figure 03 : Spitting on the sidewalk



Figure 04 : Symbol of ‘No spitting’

infected person to others by the droplets of saliva through coughs, or discharges from the nose as a result of sneezes. However, it may spread in several other ways by saliva, as for example through droplets that are released when talking, sneezing freely through the mouth, coughing without covering the mouth etc. On rare occasions, the use of equipment close to the mouth, like microphones, can be a path of carrying the virus. People should take note and prevent these types of situations in the society. Apart from this pandemic, some other diseases such as influenza, hepatitis, tuberculosis also can spread through saliva.

Inheriting the great traditions and lifestyle practices of our forefathers As citizens of an Asian country, we are being

constantly reminded by our parents and elders of following the great traditions of our forefathers. From childhood they try to orient children to follow the good traditions and habits that have been a characteristic of our great forefathers. Children are often advised to avoid speaking when they are either in

the process of partaking food or when in the process of masticating food, that may cause spitting out of saliva, to the discomfort of others. Often infants and young children tend to spit out without realizing that this is a bad habit or practice. Chewing betel leaves is a traditional habit. Nevertheless, it was always the practice for elders to ensure the use of a spittoon for spitting or throwing out the chewed or masticated matter (see

Figure 2). Since conservation of the environment was a great tradition of ancient people, they always advised the younger generation to avoid polluting streams and rivers by spitting into the flowing waters of such streams and rivers. The poem ‘Sirith Maldama’ [පාසලෙහි තැන තැන.. කෙල නො ගසන් නොහොබි දැන.. සෙම් සොටු සුරමින.. මිදුලෙහිද නො දමන් කිසි තැන.. (සිරිත් මල්දමල ඇම්. ඇල්. සිල්වා ගුරුමුහන්දිරම්)] which provides guidance on how to be a good child, describes the proper manner in which spitting should be done (translation), “Everywhere in the school Not to spit knowing that is an unpleasant habit Removals of phlegm and snot Not to put everywhere in the courtyard” (M.L.Silva Gurumuhandiram) In any case, it was not the practice of our forefathers to spit on the roads. especially because shoes were not worn by them, and



Figure 05 : Street art on a school wall

consequently they always ensured that beetle chew would not cause distress to others.

How the saliva coming to the environment.

The process of relishing is an automatic process that occurs in salivating, but spitting without regard to others is a habitual practice among some people. They are not concerned about the displeasure that may be felt by other road users. In most cases, this is done by those chewing betel, and especially by those who addicted to this practice. They do not attempt to find alternative sites to spit out the betel residue which are not likely to be a distaste to other people. In urban areas defacing of streets, sidewalks, cement walls, pavements, bus stands, and platforms in railway station have caused massive environmental problems. An example of spitting on the sidewalk is shown on Figure 3. It is also the pedestrians and roadside sellers who face this inconvenience, usually with unpleasant smells and saliva, which spread on the floor. To make matters worse, passengers in public transport systems, especially passengers in buses tend to spit out of the windows without any regard to the nuisance caused to pedestrians. In such instances very often pedestrians are inconvenienced because their dresses or clothing are dirtied. Although some may tend to ignore such behavior, it has to be noted that this practice is one of the ways in which the Corona 19 virus spreads in the public domain.

Strategies to control and an example of self control

Controlling of spitting in urban areas is not an easy task, because there are no specific areas where spitting can be permitted. However, to minimize the disposal of saliva in the office premises, some devices have been introduced by the government and other institutions. For example, placement of 'No spitting' sign boards near densely populated areas and hospitals, use of 'No spitting' symbols (Figure 4) to imply prohibition to spit out. However, this is rare in Sri Lanka. In early times, sand filled baskets were used for spitting in hospital areas etc. which are presently not in use.

This situation has been recently corrected by the society with or without their knowledge. The walls along roads, school buildings as well as near the base of towers have been decorated with paintings by street artists. Figure 5 shows a school wall which has been beautified with an advisory street art. Many have supported and offered to assist in this task. What has been identified is that, spitting near these paintings has automatically stopped. As a result, pleasant pavements have been opened for pedestrians. This is a silent attempt at preventing spitting in common places, which can be explained as a way of helping people to realize their errors by themselves.

Environmental and mental influences

The environment primarily consists of atmosphere, water and earth (soil), in the absence of which

there will be no life. Any pollution of these will be regarded as areas unsuitable for living. We are very much concerned about any contamination of these, especially through careless spitting. Under the present COVID 19 pandemic situation spitting in such social areas has to be prevented. The droplets of saliva can directly spread the disease to people in the close neighborhood, while wind will work as a carrier of the infection to even remote areas.

Regardless of seasons, and whether rainy or not, saliva will continue to survive in the soil. During the rainy season, saliva will be transported through rivers and streams via drains, and get deposited in fruit and vegetable gardens. Under arid conditions, saliva can be transferred to other places through slippers, and will infect without recognizing the source. Likewise, such improper spitting can create temporary mental problems such as confusion, backwardness, anger, stress, etc. due to its unpleasantness. In this manner, environmental, mental and social pollution can occur through such 'spitting in common places.



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QUESTIONS And Answers

What have you learnt from the Vidurava 2021 Jan - Mar Q₁ Issue? Scan your own memory!

1] Silent Pollution : A Disguised Threat to Man and Environment

True or False?

1. An average person inhales around ten thousand litres of air daily.
2. Worldwide, the annual total production of plastics and polythene is around 4000 million tons, and this is a minor environmental problem.
3. Cooking using firewood in congested kitchens is not a source of indoor air pollution.
4. Water is unique to our planet covering more than two-thirds of the earth's surface.
5. In Sri Lanka, municipal solid waste is usually dumped in low-lying marshes.

2] Air and Water Pollution

True or False?

1. Air pollution in Sri Lanka is mainly generated by motor vehicles during the combustion of petrol or diesel.
2. More recently, there has been a growing interest in very small particles of plastics, commonly called microplastics as a serious air and water pollution hazard.

3. The slums of Colombo have good sanitation facilities, and hence faecal pollution of water is a not common problem in large cities.

4. The effects of water pollution may not appear immediately after exposure to water with a high degree of pollution.

5. Living matter that is added to our waterways get oxidised by bacteria which also include all organic matter arising from plants and animal tissues.

3] Radioactive Pollution

True or False?

1. Unstable atoms try to become stable by emitting particles, usually accompanied by emission of energy in the form of waves.
2. The health effects due to exposure to ionizing radiation does not depend on the amount of energy absorbed by the cells in our bodies from radiation.
3. Nuclear power plants expose the population living in their vicinity to large doses during normal operation.
4. Since the discovery of the harmful nature of ionizing radiation, action had been taken to regulate human exposure to radiation.
5. The most severe accident at a nuclear power plant occurred in the Chernobyl nuclear power plant in Ukraine on the 26th of April 1986.

4] Electromagnetic Pollution due to Industrial Activities

True or False?

1. Electromagnetic waves are described with three physical properties, namely frequency, wavelength and photon energy.
2. Lower energy UV, visible light, laser light, infrared, microwaves, and radio waves are higher energy waveforms.

3. When modern domestic and industrial activities are concerned, there is an augmented and widespread use of electronic devices.

4. Urban areas as well as industrial zones have a dense network of utility power lines which originates ubiquitous power frequency electromagnetic fields.

5. Electromagnetic pollution is somewhat obscure in nature and can be treated as other types of pollution as we are already familiar with.

5 Visual Pollution

True or False?

1. The increase in high-rise buildings brings positive changes to the visual and physical characteristics of a city.

2. Visual pollution is more prevalent in developing countries than in developed countries.

3. Open dumping of garbage must be banned in developing countries, and effective environmental legislation such as the Principle of “Polluter Pay Principle” could be implemented.

4. Hanging wires, unsystematic display of billboards and unplanned buildings, as well as display of banners for campaigning, are uncommon practices in major cities of developing countries including Sri Lanka.

5. When the sun comes up, a disoriented, land-locked turtle is dehydrated, overheated, and are at an increased risk of mortality from fatigue, predation, and collision with vehicles.

7] A Silent Pollution Caused By “Spitting in Common Places”

True or False?

1. It is imperative that man-made hazardous activities should be definitely reduced to preserve the environment.

2. Ensuring the increase of directly recognizable and unrecognizable destructive environmental pollutants is a duty and a responsibility of man.

3. The ‘Parotid’, Submandibular or Submaxillary and Sublingual organs in the mouth of human beings which produce the saliva, are called ‘salivary glands’

4. Often infants and young children tend to spit out without realizing that this is a bad habit or practice.

5. Spitting without regard to others is not a habitual practice among some people.

Answers

- 01) 1. True, 2. False, 3. False, 4. True, 5. True
- 02) 1. True, 2. True, 3. False, 4. False, 5. True
- 03) 1. True, 2. False, 3. False, 4. True, 5. True
- 04) 1. True, 2. False, 3. True, 4. True, 5. False
- 05) 1. False, 2. True, 3. True, 4. False, 5. True
- 06) 1. True, 2. False, 3. True, 4. True, 5. False



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