



Environmental Pollution and Prevention Techniques – Sri Lanka

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Received:05 September 2022; Revised: 10 October 2022; Accepted: 30 December 2022; Available online: 10 January 2023

Abstract: Sri Lanka is a tropical island that experiences beautiful environmental conditions and consists of many natural resources. Primarily Sri Lanka includes forests and biodiversity, minerals and water resources. The main objective is to provide a concise and up-to-date insight into the state of the environment and environmental challenges. Sri Lanka has suddenly acquired industrialization as a developing country, leading to increased energy consumption. When energy consumption rises, pollution to the environment also highly increases. At present, there are many environmental issues in Sri Lanka. But the most harmful and increasing problems are water pollution, air pollution and solid waste pollution. So, this article explores the environmental problems and their impacts on the people and animals and minimization of these issues in Sri Lanka.

Index Terms: Environment, Energy, Development, Pollution, Technology

1. INTRODUCTION

The world's energy demand has increased gradually throughout the years due to economic and demographic growth [1, 2]. As a result of this phenomenon, Sri Lanka has experienced the same demand and development as other countries in the world, which likely results in a greater effort to preserve its environment. A developing country increases vast environmental pollution in many ways like energy, vehicles, industries etc. However, public, private & environmental organizations' dedication is more excellent & valuable. Here mainly focused on primary sources of environmental pollution, such as water, air & solid waste pollution in Sri Lanka. Currently, many international institutions are globally working to conserve the environment more than ever due to the threats humans have created to the natural environment. Sri Lanka is an island identified as one of the top biodiversity areas in the Asian region [3]. But insufficient environmental laws & regulation policies directly affect the environment. Therefore, it is absolute to take urgent complicated actions to protect the environmental resources for the future.

2. MAIN SOURCES OF ENVIRONMENTAL POLLUTION IN SRI LANKA.

We all know that; the environment is the fullness of man's nature and manufactured environment. This environment is also rich in resources that are beneficial to human life. Pollution is the injection of harmful

substances into those natural resources, such as water, land, or air, causing long-term or short-term damage to the atmosphere. And its environment and quantitatively and qualitatively affecting living things and their lives. This environmental pollution can happen in various methods. The primary sources of pollution are adding harmful materials such as arsenic, gaseous pollutants, toxic metals, and particulate matter (PM) into the atmosphere, electronic waste into water bodies, agricultural runoffs, sewage, industrial effluents, and also, household activities, factories.

Globally, the majority of air pollution is caused by the combustion of fossil fuels for electricity generation and transportation, which has been the primary source of greenhouse gas emissions (GHG) for decades [4, 5]. In 2015, fossil fuels accounted for around 50% of Sri Lanka's energy production [6]. Therefore, the leading causes of air pollution to affect the air quality in Sri Lanka are vehicular and fuel power plant emissions, by-products from the agricultural industry, petroleum refining and organic waste. Nearly 70% of all CO emissions and 19% of all CO₂ emissions are attributable to vehicles fueled by fossil fuels, as indicated by the global energy consumption patterns [7]. Many researchers indicate that Colombo often experiences high levels of air pollution. Vehicular emissions contribute more than 60% of the total in the western province [8]. By considering the World health organization's (WHO) guidelines, the air quality in Sri Lanka is considerably unsafe, and many datasheets indicate that [9]. There are some primary air pollutants based on atmospheric concentration like Carbon Monoxide (CO), Sulfur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Ozone (O₃), and Particulate Matter (PM 10) [10]. Some primary causes of water pollution are adding industrial waste, marine dumping, sewage and wastewater, hot water used in power plants, Oil leaks, and spills in agricultural activities.

A few critical environmental problems identified in Sri Lanka are:

- Soil erosion and land degradation.
- Waste disposal.
- Pollution in island waters.
- Depletion of coastal resources.
- Loss of biodiversity

Colombo is the commercial capital and is the most environmentally polluted area in Sri Lanka. Many projects have been launched to reduce this pollution in Colombo and other populated and industrialized cities such as Kandy, Kurunegala, Gampaha, Galle, etc. [11]. Despite the fact that renewable fuels such as hydropower, wind, solar, biomass, and biofuels account for approximately 7% of global energy demand [12], Sri Lanka relies primarily on thermal power plants to generate electricity due to insufficient energy generation from hydropower and other renewable energy power plants. Lak Vijaya power station is the largest coal-fired thermal power plant located in Norochcholai, Puttalam, on the southern end of the Kalpitiya Peninsula. But we are not focusing on environmental pollution control technologies in this power plant. CO₂ and SO₂ are the primary air-polluting emissions from this power plant, and releasing hot water, which is emitted by boilers and other solid wastes, can harm human health, acid rains, and cause global warming.

However, the lack of effective environmental laws and policies has increased ecological conservation. Let's discuss these environmental issues and challenges in Sri Lanka and how to minimize this pollution.

3. WATER, AIR, AND SOLID WASTE POLLUTION

Environmental pollution in Sri Lanka also causes a variety of human activities and industrial practices. We can focus more on air, water, and solid waste pollution and discuss it. Pollution to the atmosphere due to power generation is very high. If asked, coal-fired power plants are the largest source of mercury emissions. When mercury is released into the air, it is deposited on the ground or in water. This way, it is deposited in the body of humans or animals through the food chain. On the other hand, global warming and pollution have reached catastrophic levels due to the use of fossil fuels for electrical generation and transportation [13]. Consequently, the combustion of fossil fuels resulted in the emission of numerous pollutants, including sulfur dioxide, nitrogen oxides, and particulate matter. Also, the ash leftover from burning coal is filled with contaminants, spreading throughout the environment with the wind. In addition, garbage burning, building and vehicle painting, refrigeration, and air-conditioning repairs release large amounts of particulate matter into the atmosphere, which changes the atmosphere's composition.

Along with air pollution, water is also being polluted in Sri Lanka. When sulfur and other chemicals enter the atmosphere from industrial processes, such as burning fossil fuels, they combine with water vapor floating in the air to form clouds. There, the composition of the rainwater changes and acids such as H₂SO₄ combine to form acid rain conditions.[14] Another aspect of water pollution is called "Thermal pollution". This term explains why fossil fuel plants need water to power and cool their plant. This polluted water cannot be used for the ecosystem or other activities such as agriculture. Because when water is released back into the environment, its temperature changes, and as a result, its quality deteriorates. The amount of dissolved oxygen in the heated water, added back to the environment, decreases.

In addition to these two, fertilizers, pesticides, herbicides and domestic and industrial effluents used in agriculture also contribute to water pollution from lead pollutants. For example, at the Sapugaskanda Oil Refinery, we can see the water mixing with the Kelani River. When it comes to solid waste spans a wide range. It can be classified as domestic, industrial, kitchen, hospital and surgical, agricultural, perishable, and non-perishable. Also, sometimes this waste can be classified as hazardous or non-hazardous. If we talk about the pollution caused by this solid waste, the pollution caused by not disposing of waste properly can be effectively addressed. In Sri Lanka, garbage dumps often occur, and some people dispose of waterways and the outside environment.[15] It also incinerates household waste, such as plastic and polythene. This causes pollution of water, air, and soil.

Furthermore, heavy metals are added to the environment when discarded after using industrial effluents and electronics. Also, some of these wastes, which take a long time to decompose, have become a significant problem in small island nations such as Sri Lanka, where people have limited access to habitat, forests, and farmland. We will next discuss the effects of pollution.

4. EFFECTS OF ENVIRONMENTAL POLLUTION

Sri Lanka is rapidly moving to the industrialization path as a developing country. As a result, Sri Lanka has to face the harmful effects of environmental pollution. Air pollution is a tragic problem in Sri Lanka [16].

Because of this air pollution, people have to face more health issues. Heart disease, cataract problems, wheezing, coughing, respiratory problems, and skin, nose, and throat irritation are some common health problems in Sri Lankan Society. Not only humans but also animals have to face a variety of health problems because of air pollution.

Another significant adverse effect is disruption of the photosynthesis process and reduced vegetation yield due to the accumulation of dust and other small particles on the leaves and trees.

Acid rain is another negative effect of environmental air pollution. SO₂ and NO_x are caused to form sulfuric and nitric acid rains. Acid rains can damage metal statues, bridges, and other metal buildings. It creates disadvantages to the economy of the country. Furthermore, acid rains physically harm humans, wildlife, and forests [17].

Acid rains lead the way to acidifying rivers, lakes, and other water reservoirs. It is caused to kill aquatic life and decreases the fish population as well. The minerals and other nutrients dissolved in soil are destroyed after acid rain. Because of that, the ground becomes barren. Table 1 shows that some pH values of acid rains in several districts in Sri Lanka.

Table 1. Acid rains in Sri Lanka [18]

District	pH
Colombo	5.89
Galle	6.45
Matara	6.00
Hambantota	5.89
Peradeniya	6.26
Anuradhapura	6.00

The water reservoirs are affected by contaminated water and can cause hazards to plants, fish, and even humans [19]. The accumulation of heavy metals like arsenic, cadmium, and mercury in water reservoirs is directly caused damage to the quality of the drinking water. Its cases disrupt the food chains and damage the health of humans and animals. Table 2 Shows some heavy metals and diseases that occur due to those metals.

Table 2. Diseases related to heavy metal

Heavy metal	Disease
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Mercury	<ul style="list-style-type: none"> • Numbness of limbs, lips, and tongue • Blurring of vision • Metal derangement
Cadmium	<ul style="list-style-type: none"> • Cancer of the lungs • Cancer of the liver • Itai Itai disease
Lead	<ul style="list-style-type: none"> • Anemia • Headache • Loss of muscle power

Sedimentation of toxic substances in the water reservoirs kills aquatic species. And also, the accumulation of poisonous substances in drinking water is caused to make human health issues. Express pearl ship accident is one of the best examples of that. According to the literature, 251 turtles and 28 dolphins died, and many other whales and fishes were affected by environmental pollution [20].

Government municipal councils collect solid waste and dump that solid waste into garbage dump yards. Garbage dump yards are directly affected by environmental pollution, and the following negative impacts can be seen around garbage dump yards.

- The stench emanating from the garbage dump yards spreads over a large area, causing people to have difficulty breathing.
- Explosions in Garbage dump yards are caused to damage the properties of human and animal life.
- Waste overflow is caused to surface water pollution.
- So many diseases are spread around the garbage dump yards. Hence it is negatively affected human health.

5. HOW TO MINIMIZE THE ENVIRONMENTAL POLLUTION

"This entire planet is our home. We are the only species that systematically destroy our own habitat." [21] Environmental pollution prevention has received global attention due to the adverse effects of pollution on an individual's health and the environment. Pollution occurs in different ways. That is air pollution, water pollution, soil pollution, etc. Since we are all citizens of this same motherland, everyone is a partner. Everyone can contribute to the advancement of pollution reduction measures. Also, many countries have already solved some problems by adopting anti-corruption measures. Preventing the onset of pollution in any area, be it water, air, or land, could be a start and the simplest preventive solution to the problem. The diligent pursuit of sound policies or habits by the populace, the introduction of pertinent legislation by the government, and their correct implementation can all help to some extent, reduce environmental pollution. Accordingly, how to minimize environmental pollution is as follows.

5.1 HOW TO MINIMIZE WATER POLLUTION

Focusing on water pollution there are many different activities we can do to control this water pollution. To prevent water pollution, the sources of water pollution must be maintained. One solution is to purify the effluent from polluted water sources and release it into the environment. It can also reduce the risk level of wastewater and release it into the atmosphere. Examples include the removal of heavy metal contaminants from wastewater discharged by metal factories and their release into the environment.

Further, the pH of polluted water emitted by factories in the field of chemicals can be tested and released into the environment. You know, it's a fact that textile factories also cause water pollution. That is, it is advisable to set up centralized treatment plants to remove contaminants from the water and add them to the environment and water sources. How much water do we pollute on a large scale and daily? Water can be purified as much as possible after using it for everyday use, such as laundry, bathing, and other cleanings; it can directly contribute to preventing water contamination. Water used for cleaning, such as laundry, can also be used for toilets. The water used for tasks such as car washing can be used to water garden plants. Such water-saving methods can also directly or indirectly help us prevent water pollution. The most effective way to control water pollution is to impose laws, regulations, and fines. The maximum number of pollutants in the waste should be legalized even when discharged from a factory, institution, or household. Here, people have to contribute to preventing water pollution. They are concerned with reducing pollution and disposing of water. As in many other parts of the world, Sri Lanka has legislation regulating the maximum number of pollutants that must be present in water disposal. This varies depending on the industry and the source of water discharged. Pollution of water sources can be prevented by enforcing these laws as much as possible and conducting awareness programs.

This waste is treated and disposed of in several ways to prevent contamination of water sources [22]. The first step is to remove the large solid waste; in the second stage, remove the medium to large trash; in the third stage, remove the small debris and micro-waste and purify the water. For this purpose, unique refining processes are used in each step. Water pollution can also be controlled by producing biodegradable plastics and reusing plastics without disposal. In addition, wastewater in the agricultural sector should be closely monitored to prevent water pollution. Although sewage discharge into the environment is already prohibited in Sri Lanka, this does not seem to be the case for the agricultural sector. Censuses have shown that agricultural fields contribute significantly to water pollution. For agriculture, using natural fertilizers instead of synthetic fertilizers, non-cultivation of deforestation, and avoidance of cultivation along river banks can contribute to the prevention of water pollution. We also found answers to water pollution through processes. Such as setting up drainage systems so that the water leaving the industrial estates does not mix with clean water, setting up centralized treatment plants, purifying and disposing of water, and treating the effluent from vehicle service centers by bypassing the contaminated water through sand filters.

5.2 HOW TO MINIMIZE AIR POLLUTION

There are several ways we can contribute to reducing this air pollution. Basically, the sources of air pollution must be controlled. Fossil fuels can be identified as a major contributor to air pollution. Most of the country's electricity needs are met by fossil fuels. The burning of fossil fuels such as coal, petroleum,

and natural gas releases pollutants such as CO₂, SO₂, NO_x, CH₄ and particulate matter. This causes air pollution. Controlling these conditions can provide answers to air pollution [23]. Air pollution can be controlled by releasing polluted air from internal combustion engines into the environment through an air filter. Factories also emit a variety of pollutants into the atmosphere, causing air pollution. That is, it is possible to control air pollution to some extent by generating electricity using the least refined coal. Air pollution can also be controlled by using modern refrigerators that are CFC-free, which is a polluting gas. Strict laws, regulations, and awareness programs should be formulated against the addition of air pollutants to the environment. It can also prevent air pollution [24]. Air pollution can also be prevented by using public transportation instead of private transportation for transportation. Also, be accustomed to using non-fuel-consuming modes of transport, such as bicycles. Focusing on high-efficiency engines when using combustion chambers, such as internal combustion engines, can also indirectly address air pollution. Air pollution can also be reduced by setting up animal husbandry centers, afforestation, and minimizing wildfire.

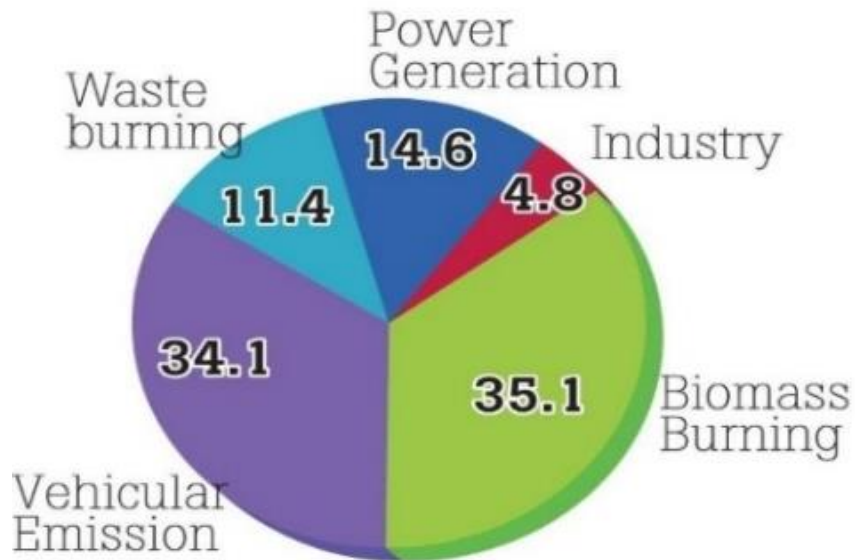


Fig 1. Sources of air pollution in Sri Lanka [25]

The following pie chart Fig.1. Shows the sources of air pollution in Sri Lanka. By controlling these, air pollution can be minimized.

5.3 HOW TO MINIMIZE SOLID WASTE

There are several ways in which this can be seen when focusing on pollution caused by solid waste. Pollution can be seen in various sectors, such as industrial solid waste, agricultural solid waste, and urban solid waste. Here it can be taken as a “solid waste”, a collection of decomposing waste, glass, chemicals, metal, plastic, etc. This has already become a burning issue in Sri Lanka as well. That is because we do not have the proper methods and techniques for managing this solid waste. Here are some steps you can take to begin the process of preparing for mediation. That is, after the solid waste is taken and separated into decomposable and non-decomposable waste, this decomposing waste can be used for compost production. These contain a high concentration of nutrients, which provides economic benefits while also reducing

pollution caused by unnecessarily solid waste on the land. It also collects these decomposing wastes and uses them to produce biogas, preventing the accumulation of solid wastes on the ground. Pollution is also controlled by recycling waste such as discarded plastics. The economic benefits of these actions are numerous. Discarded electrical and electronic waste can be used to obtain precious metals such as gold and copper. They can be used for that. Solid wastes such as *dahaiya* emitted by paddy mills, can be used to fertilize crops in agriculture. Also, methods such as reducing the amount of waste emitted, recycling, and minimizing damage to the environment can be used to control pollution caused by non-degradable waste. [26] Here, except in the case of essential goods, methods such as reducing the size of the package as much as possible and releasing it to the market can be used. Here, the addition of waste is somewhat limited. Instead of simply dumping leftovers in the home as well as in the kitchen, use them to produce energy such as biogas. Making new products that reduce pollution. That is, manufacturing products with minimal raw material quantities, issuing production units only in the quantities required, improving the durability of the goods, and developing technology for reusability; this also prevents solid waste from accumulating. Furthermore, If the above measures are not followed to prevent the pollution caused by industrial toxins, this waste can be incinerated under controlled conditions to prevent environmental pollution caused by the accumulation of unusable solid waste on the ground. Such methods can control the pollution caused by solid waste.

6. PROPOSALS TO MINIMIZE ENVIRONMENTAL POLLUTION

6.1 SOLID WASTE RECYCLING

Recycling is a proper management method of solid waste in Sri Lanka. However, at present, the recycling process is not managed correctly due to the high volume of solid waste discharged into the environment and the inadequacy of the equipment used to recycle it. Sri Lanka already segregates recyclable materials for waste disposal and directs them to recycle. Different types of solid waste consist of various elements, which require new equipment and new technologies for recycling. This is costly and requires new technological strategies, so public awareness and awareness programs must be designed and implemented.

6.2 REUSE CONCEPT FOR SOLID WASTE

This involves recycling the solid waste described in concepts such as 3R, 5R, and 7R (Rethink, Refuse, Reduce, Reuse, Repair, Regift, Recycle) introduced for solid waste management. Solid waste is a valuable resource that exists in the wrong location. All we have to do is process that solid waste and give it a real value or further enhance that value. In Sri Lanka, as in many other parts of the world, as this reuse process has grown into a business system today. [27]

- Ex: Cruelty-free deodorants made from ocean plastic
- Plastic toys made from waste plastic
- Extraction of metals such as gold by e-waste
- Decoration items
- Bricks made of waste plastic
- Plastic threads

By providing the technical know-how and machinery required to make such products to the public, solid waste management and the economic status of individuals can be enhanced.

6.3 PUBLIC AWARENESS

The process of educating the public individually or in groups to prevent and minimize air, water and soil pollution is called public awareness. Most people in the country unknowingly dump harmful substances into the environment, and the main objective of this awareness process is to prevent or control the problem to some extent.

They were conducting various workshops and awareness programs in schools, rural or urban areas to create awareness among the public through multiple programs using electronic and print media to introduce pollution prevention methods as well as systematic management waste disposal methods through social media. Awareness programs can be expanded, and so on. Thus, the most effective methodology is to raise awareness of the abovementioned methods of air pollution, water pollution and soil pollution through practical activities so that people can understand them individually or as a group. In implementing these awareness programs, more attention should be paid to the people in urban and rural areas and those involved in the industrial and infrastructure sectors. Awareness-raising of industrialists, especially those involved in industrial processes, should be on the optimum quality and quantity of each chemical substance to be contained in industrial waste disposal, awareness of the rules and regulations on industrial waste disposal and by-law violations and an understanding of legal penalties should be provided primarily. Public awareness through these public awareness programs is a great help in reducing pollution to some extent.

6.4 MAINTAINS THE RULES AND REGULATIONS

Due to industrialization, various types of solid waste are added to the environment, polluting the entire environment, including air, water, and soil, from multiple angles. Different laws and measures have been in place in Sri Lanka since ancient times to remove this waste from the environment and minimize the damage caused by it.

Ex:

1990 - Regulation gazette in relation to EPL and wastewater discharge standards. Gazette Extraordinary No. 595/16 dated 1990 February 02. [28]

2008 - Regulation gazette in relation to scheduled waste management and revised wastewater discharge standards. Gazette Extraordinary No. 1534/18 dated 2008 February 01. [28]

1980 - The national environmental act no 47 of 1980 Order under Section 23W - Prohibition of Ozone-depleting substances [28]

2008 - Regulation gazette in relation to vehicle exhaust emission standards. Gazette Extraordinary No. 1557/14 dated 2008 July 09. [28]

2019 - Regulation gazette in relation to Stationary Source Emission Control standards. Gazette Extraordinary No. 2126/36 dated 2019 June 05. [28]

But today, due to rapid urbanization and industrialization, the amount of waste added to the environment has increased. Due to the ignorance and carelessness of the people, the direct disposal of pollutants into the environment has become a significant problem. Therefore, action should be taken to make the public aware of the existing rules and regulations, to modernize the current management or to formulate new laws to release waste into the environment and to manage it properly.

6.5 AIR POLLUTION CONTROL

Increasing the greenhouse effect Global warming is a topic that is being talked about by many people today. Atmospheric pollution is a significant factor in both of these factors. In addition, factors such as acid rain and photochemical fumes are also involved in air pollution. The following measures can be taken to reduce air pollution. Exhaust fumes from vehicles emit most of the harmful gases into the atmosphere. Of these, nitrous oxide (NO_x) and carbon monoxide (CO) are the most important. Excessive vehicle use emits large amounts of atmospheric pollutants. Many vehicles currently on the market have NO_x sensors and catalytic sensors installed to detect harmful gases, and various systems have been incorporated into automobiles to reduce those emissions. As petroleum fuels emit these harmful gases, alternative energy sources such as solar cells and hydropower can be used to charge car batteries. Using public transportation instead of commonly used private vehicles can also reduce the amount of smoke emitted by cars from the atmosphere.

6.6 WASTEWATER TREATMENT

Wastewater treatment removes non-toxic or non-toxic substances that have been added to the water in an environmentally friendly manner and makes the water ecologically friendly. [29] This is done in four main stages: primary, secondary, tertiary, and anaerobic digestion. We can use water treatment methods such as the trickling filter, activated sludge, and rotating drum. Still, the activated sludge method is the most commonly used for our water treatment. Microbial support is sought in this process but it is time-consuming and inefficient. Instead, new methods must be developed using the appropriate machinery, equipment and technology. In addition to the chlorination, ozonation and ultraviolet exposure methods used to treat our water, new technological disinfection methods must be used to re-use the contaminated water.

7. CONCLUSION

Environmental pollution is the main point in Sri Lanka with the increase in population and industrialization. A huge percentage of water resources are polluted by sewages which directly impact humans and animals. Environmental pollution has been a significant issue in Sri Lanka with the increase in population and industrialization. Most water resources are polluted by sewage released by industries, pesticide sprays, hospitals, and electrical, and many wastages directly impact humans and animals. Air

pollution is also a significant health problem in Sri Lanka, especially in industrialized areas & many no. of vehicles travelling to cities like Colombo. They release Ozone gases, and fine particles are the most hazardous air pollutants. Therefore, it is an excellent requirement to take the best solutions to control these pollutions in Sri Lanka to build a better living environment for humans, animals and future generations.

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