



Impacts of water pollution in Sri Lanka

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Received:01 Nov 2021; Revised: 15 Nov 2021; Accepted: 30 Dec 2021; Available online: 10 Jan 2022

Abstract: Man-made pollution and environmental degradation pose a severe challenge to all Sri Lankans. The main water resource problems in Sri Lanka are due to various human activities such as agriculture, fossil fuel combustion, urbanization, and industrial and commercial activities. Areas in every province where waste is not managed are causing a severe environmental problem due to the unnecessary pollution of its water by various pollutants.

Index Terms: Environment, Groundwater, Health, Marine pollution, Pollutants, Water pollution.

1 INTRODUCTION

About 50% of Sri Lanka's rainwater evaporates without proper application. The remaining 20% leaks into groundwater, while only 30% is inland water [1]. Water conservation methods for a growing world are shown in Fig. 01 [2].

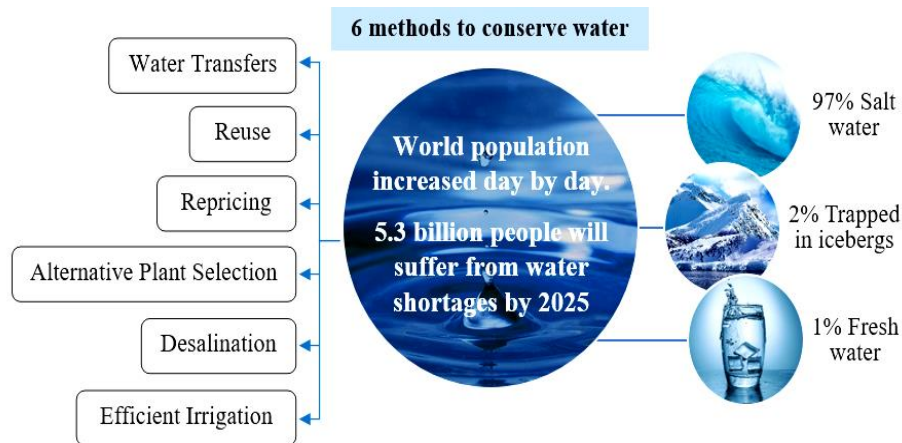


Fig. 01. World water conservation methods [1]

The water problem is internationally recognized as a crisis for human life as well as the environment [3].

The country is divided into three regions according to annual rainfall [4]:

- The wet zone - in the southwest where the annual rainfall is >2500 mm (23% of the landmass)
- The intermediate zone - annual rainfall is between 1,500 mm and 2,500 mm (12%)
- The dry zone - towards the east, northeast, and southeastern parts. The rainfall < 1,500 mm (65%)

Despite having relatively good water resources as a whole, Sri Lanka is prone to water problems

(droughts and floods). The dry zone experiences water scarcity mainly for a variety of reasons. Some of these major problems are the unpredictability of rainfall, high surface runoff and evaporation losses, poor storage conditions in solid rock areas, underground and surface reservoirs, and increased pressure from climate change and human activity. As a solution, groundwater is widely used throughout present-day Sri Lanka. This is due to the recognition that groundwater provides a relatively stable source of water and acts as a reliable complementary source to surface water. Water sources should be considered for irrigation, especially during the dry season or during prolonged dry seasons.

There are three major sources of water:

- Surface water - High levels of source pollution can occur, especially in developing countries.
- Groundwater - Not as quickly polluted as surface water.
- Seawater - The use of this resource is limited due to the high cost of treatment.

2 WATER POLLUTION

Sri Lanka is facing water pollution aggressively due to the increase in the following factors [2, 5]:

- Rapid urbanization
- Human population
- Industrial activities
- Intensive agricultural practices

2.1 Rapid urbanization

Urbanization is a process that causes urban growth due to industrialization and economic development. It leads to specialization, division of labor, and urban-specific changes in human behavior. It includes the increase in the number and size of cities and symbolizes the movement of people from rural to urban areas. Uncontrolled urbanization is causing many problems in main sectors, such as [6]:

- Environmental degradation
- Land insecurity
- Deteriorating water quality
- Air pollution
- Noise pollution
- Waste management problems

The impact of urbanization on environmental factors is mainly climate, biosphere, land, and water resources. While urbanization cannot be limited, it must be ensured that urbanization is on the right track with minimal impact on the environment.

Many of the major drinking water problems of the next century may be due to the continuing and sharpening of existing problems that are not currently receiving adequate political attention. In many countries, the problems are not necessarily addressed, or nothing happens even if the situation is revealed. The most pressing issues are climate change, freshwater scarcity, deforestation and freshwater pollution, and population growth [6]. That means it directly affects water pollution. As a developing country, even the interrelationships between environmental issues are now better known, and we still do not have accurate information on how problems relate, at what level they interact, and what are the most effective measures.

2.2 Population Growth

For An increase in the population of settlements and the extent of industrialization caused urbanization. The total population is increasing day by day, especially in urban areas. The main reason for the increase in population in urban areas is the migration from rural areas to cities. As a result, surface water and groundwater are becoming increasingly polluted due to industrial and domestic wastewater as well as agricultural waste [7]. In addition, water pollution in urban areas affects water quality in rural areas [8]. Some research shows that population growth causes environmental degradation [9, 10]. The main problems are large-scale farming, urbanization, and industrialization. Population growth and changes in lifestyle and technology bring worse drainage because pollution cannot coincide with the treatment of nature [9]. It conflicts between different stakeholders are increasing due to increasing corruption and depletion of resources. In addition, these issues reason for a number of direct challenges to policymakers aimed at providing better development strategies for sustainable resource management [11].

2.3 Industrial activities

Much of what we know about the marginal impact of pollution on health is derived from data reported in developed countries with relatively low levels of environmental pollution. Compared to developed countries, the health risks associated with water pollution in developing countries are much higher. Worldwide, 2.3 billion people suffer from waterborne diseases, and 2.2 billion of them live in developing countries [12,13]. Since water pollution in developed countries is minimal, these estimates may not be valid in developing countries if there is a nonlinear relationship between pollution and health.

Pollution intensity is an indicator of industrial emissions to industrial Gross Domestic Product (GDP). Each industrial gross domestic product represents the industrial economic output and eliminates the effects of population scale. According to previous environmental research [14], pollution intensity was selected as an indicator of pollution to measure the impact of pollution on health outcomes.

2.4 Agricultural practices

Agriculture can be considered as a model of an industry that has experienced the sequence of technological advances and their adaptation. Agriculture has progressed through the most recent and rapid sequencing of mechanical and chemical agricultural production systems, from the basic hunting and collecting methods and techniques of the last millennium (Fig. 2).



Fig. 02. Water polluting activities in the agricultural sector [3]

In the agricultural sector, farm water is the main cause of water pollution. Due to the rainwater being allowed to drain into nearby water sources on farms, such as sedimentary lakes and rivers, water pollution is increasing day by day in Sri Lanka. This is detrimental to plants, animals, and humans as we need clean drinking water to live and stay healthy. Excessive use of fertilizers can also lead to algae production, as rivers with high supplies of nitrates and phosphates can become polluted. Therefore, excess sediment can cover water surfaces and clog the gills of fish. As a result, oxygen levels may drop, which can lead to the

death of fish and other aquatic animals [15].

Riverine habitats are among the main economically valuable and biologically rich ecosystems in Sri Lanka. But many riverine daily activities in Sri Lanka are rapidly changing through many human activities such as [16]:

- Agrochemical misuse
- Damming
- Various waste disposal
- Industrial waste
- Deforestation
- Agricultural runoff
- Religious and social practices
- Oil spillage
- Toxic waste disposal at sea
- Sand and coral mining

3 WATER POLLUTANTS

As Industrial and agricultural activities, discharge organic matter, nitrates, and phosphates directly into water sources. It causes the growth of blue or green algae (Macrocystis) [17]. Water pollutants emit toxins that are harmful to humans as well as animals. Some of the water pollutants are:

- Pathogenic microorganisms
- Excessive amounts of nutrients (Nitrogen, Phosphorus, Potassium)
- Heavy metals such as: Cadmium, Chromium, Mercury, Nickel, Lead
- Organic pollutants (Polychlorinated biphenyls, Polyaromatic hydrocarbons)
- Biodegradable organics
- Micro-pollutants (Medicines, cosmetics, cleaning agents, dyes)

Concentrations of lead (Pb), mercury (Hg), arsenic (As), chemical oxygen demand (COD), ammonia nitrogen (NH₃-N), and volatile phenol were also used to measure water pollution [18]. These indicators can be used to map industrial water pollution in the city. Also, this type of contaminant conforms to official statistical indicators.

3.1 Pollutants related to the groundwater

Groundwater contains only 20% of the water and is already more than half heavily polluted. Groundwater management in Sri Lanka is in its infancy as there is no single or formally recognized water policy or water law. This problem is of particular importance to Sri Lanka as the vast majority of the country's population depends on untreated groundwater for their domestic water supply.

Some of the major issues related to groundwater pollution are:

- Fluoride geochemistry of groundwater and dental health [19] - Fluoride in surface and groundwater is can observe in the following locations. Those are:
 - a. Fluorine-rich rock leakage.
 - b. Dissolution of fluoride from volcanic gases. It is caused by the penetration of groundwater through large deep faults and joints and the discharge as fresh and mineral springs.
 - c. Rainwater receives small amounts of fluoride from the ocean and continental dust.

- d. Industrial emissions (freons, organo-fluorine, and dust in cryolite factories).
 - e. Industrial effluents.
 - f. From farms where phosphatic fertilizers are widely used.
- Hydrogeological conditions and endemic problems [4] - Along with overall rainfall regimes and topography, landscaping, hydrological composition, land use, and groundwater use are largely affected. Six major aquifers have been identified in Sri Lanka.
 - a. Shallow unconfined karstic aquifers - Occur in the channels and cavities (karsts) of the Miocene limestone formation, which underlies the Jaffna Peninsula in the north.
 - b. Deep confined sandstone and Miocene limestone aquifers - Occur within sedimentary limestone and sandstone formations of the north-western and northern coastal plains.
 - c. Shallow Quaternary unconfined coastal sand aquifers - Consist of different types, i.e. raised beaches, coastal spits, and bars. Occurs on the east and northwest coasts.
 - d. Alluvial aquifers of variable depth - Occur in coastal and inland flood plains, inland river valleys, and old buried riverbeds.
 - e. Shallow regolith aquifers of the hard rock region - Groundwater in these formations is found as separate pockets formed in the shallow weathered mantel rock (regolith) or deeper fracture zones of the non-weathered material. Occurs in the large central part of the island.
 - f. Confined or semi-confined lateritic aquifers - Occurs in the southwestern low-lying parts of the country.
 - Water hardness and cardiovascular disease- Although something in drinking water has little effect, many people are prone to cardiovascular disease, and changing the composition of drinking water can extend several lives. In addition, preventive health measures that are implemented at the community level should be emulated like water purifications. Also, cleansing methods have proven to be more effective and less expensive than procedures that should be applied individually.

4 WATER QUALITY LEVEL

Due to the poor average water resource management in Sri Lanka, there are regulations to control water-related problems. But there is a lack of implementation of these regulations. Water quality level according to the dissolved oxygen content is shown in Table 01 [17].

Table 01. Water quality according to the dissolved oxygen content [17]

Water quality	Dissolved oxygen content (mg/l)
Excellent	8.0 – 9.0
Slightly	6.7 – 8.0
Moderately Polluted	4.5 – 6.0
Highly polluted	< 4.5

5 EFFECTS OF WATER POLLUTION

Contamination of drinking water by untreated effluents in developing countries causes about 14,000

deaths a day [18]. The result of depletion and degradation of water resources is an increase in health hazards.

- Depletion of water resources is a significant problem, mainly affecting the dry zone of the country. Water resources are rapidly depleting in the wet zone due to increased demand for agriculture, industrialization, and rapid urbanization.
- Degradation in the quality of surface and groundwater resources is one of the country's major environmental problems today. Fig. 03 shows a polluted well in Jaffna [6].



Fig. 03. Polluted well in Jaffna [6]

- Many species of fish, especially those eaten by humans, die from polluted water. In this case, even living fish have side effects.
- Water pollution is detrimental to human health as well as to animals and plants.
- Carriers of diseases such as bacteria and viruses are carried to the groundwater and surface.
- Drinking water is affected by contaminated water and can cause health hazards.
- Algae and excessive weed growth (plant nutrients, including nitrogen, phosphorus, and other substances, are created by the waste and support the growth of aquatic plant organisms).
- Contaminated water gives the water its aroma, taste, and sometimes color.
- The ecological balance of a body of water changes.
- Sulfur dioxide and nitrogen oxides cause acid rain, which lowers soil pH and carbon dioxide emissions. It causes ocean acidity. As CO_2 dissolves, there is a continuous decrease in the pH of the Earth's oceans [18].

5.1 Problems caused by water pollution[1]

According to research diseases caused by polluted water are variously understood by people according to community type, level of education, gender, and socio-economic status. Despite the relatively well water resources as a whole, water problems such as drought occur in Sri Lanka. Water resources are declining due to the unpredictability of rainfall, high surface runoff, and evaporation losses in groundwater and surface reservoirs, climate change, and increased pressure from human activities. All irresponsible activities cause water to become polluted. Then polluted water causes a lot of problems for every living thing as follows [1].

- Waterborne and vector-borne diseases are prevalent among urban low-income communities with poor sanitation and drainage.
- Damaging to the water cycle.
- There are also changes in water flow rates and water yields related to changes in land use.
- Water absorption is significantly reduced due to the loss of forest cover and surface soil.
- Drinking water contamination.

6 WATER POLLUTION CONTROLLING MECHANISM IN SRI LANKA

Water pollution problems arise primarily due to depletion of water resources and deterioration of its supply and quality. The Government of Sri Lanka has taken several initiatives to address water-related issues. But the Colombo is the only city in Sri Lanka that currently has a functioning sewerage system. Imitated initiatives are [1]:

- Sri Lanka is governed by about 50 water laws and about 20 government agencies that regulate water resources.
- The Water Resources Council (1995), Water Resources Secretariat (1996), and Water Resource Authority (2000) were established.
- Follow the CEA Pollution Control Guidelines.
- Environmental Protection License (EPL) for Pollution Industries.
- A management strategy and proper monitoring are essential for groundwater extraction.
- Even marine pollution is crucial as it affects its prosperous fisheries and tourism industry and must be controlled.
- The Coastal Resource Management Plan had an update in 1997.
- A new Fisheries Act was introduced in 1996 to address environmental issues related to coastal and marine resources.

7 CONTROLLING OF WATER POLLUTION

Controlling water pollution in Sri Lanka requires environmental action plans to create a better living environment. Water pollution controlling activities are:

- Development of a well-managed waste management system.
- Conducting awareness programs for the residents of the area on waste disposal.
- Urgent action must take to protect environmental resources for the future.
- Deforestation must avoid.
- Industries should emulate water purification methods or wastewater treatment plants.
- Environmental laws and fines should be stricter.
- Pesticides in drinking water should be monitored as they make long-term health effects.
- Should supply polluted water discharge permits based on environmental quality standards with fees and fines.
- The concept of circular systems should emulate through wastewater recycling and reuse.
- Polluters must submit an emission report after each fixed period.
- Continuous audits should conduct.

8 CONCLUSION

This paper covered the polluted water-related issues in Sri Lanka and their controlling suggestions. One of the reasons Sri Lanka does not use water optimally is that it is still not considered an economic good. Improper soil management and prudent use of chemicals have contributed to some serious global environmental problems. In a developing country like Sri Lanka, groundwater cannot withstand expensive purification processes, and therefore "prevention" of pollution is the most cost-effective method of control. Despite the initiatives taken by the government, many existing industries have not yet invested in clean technology and waste treatment.

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