

VISUALIZING POLLUTION FREE RIVERS: A REVIEW OF ETHIOPIAN CITY

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ABSTRACT

Despite the fact that Addis Ababa, Ethiopia, is pursuing sustainable development (SD), the city's waterways are heavily polluted, resulting in severe ecological and socioeconomic consequences. The primary causes of the city's waterways pollution are industrialization, fast urbanization, population development, and informal settlements, which have led to the production of a large volume of industrial and residential effluents. Other anthropogenic activities, such as agricultural activities, unplanned and judicious disposal of municipal, hospital, and garage wastes, poor sanitation facilities, poor wastewater treatment, and environmental degradation both within the city and in the surrounding countryside, all contribute to the pollution of the rivers. All of these causes combined to create a vicious cycle of pollution, environmental deterioration, water-borne illnesses, and poverty in rivers. In summary, this article describes the primary causes, analyzes the key issues with river pollution, their consequences, and then proposes a potential method for reducing them. Furthermore, the paper argues that in order to reduce the sources of water pollution in the Addis Ababa City River, as well as address some of the impacts on the riverine ecosystem and people, multi-stakeholder efforts are critical, with the goal of increased biodiversity, restored riverine ecosystems, improved water quality in the Addis Ababa river basins, and a healthier environment for the city's residents. In order to develop long-term answers, there is also a need for additional discussion and study on the issues.

KEYWORDS: *Addis Ababa, City Rivers, Groundwater, Pollution, River Pollution, Sustainable Development.*

1. INTRODUCTION

Water is one of the most essential compounds that make up our biggest planet (Earth), and it is the fluid that most living creatures need to survive. It is continuously exchanged between the atmosphere and the earth's surfaces, which include the land, rivers, lakes, ponds, and seas [1]. Water covers 70.9 percent of the earth's surface, with approximately 97 percent of that found in salt water oceans, 2.4 percent in ice caps, 0.6 percent in land surface water such as rivers, lakes, and ponds, 1.6 percent in ground water, and the remaining 0.001 percent in vapor, clouds, and precipitation. Africa seems to have abundant water resources, with over 17 major rivers covering over 1,700,000 km², over 160 lakes covering catchments greater than 27 km², huge wetlands,

and restricted but widespread wetlands. In comparison to Europe and North America, Africa receives a lot of rain on a yearly basis.

Water is mostly used for agricultural and household purposes in Africa. Water use for industry, on the other hand, is very low, accounting for just 3.8 percent of total annual renewable water resources[2]. Our nation, Ethiopia, has 12 river basins with a total annual runoff volume of 122 billion m³ of water, equal to 2.6-6.5 billion m³ of groundwater potential. Addis Ababa, Ethiopia's capital city, is home to many rivers that are tributaries of the big and small Akaki Rivers. The major tributaries of the Akaki Rivers are the Kebena, Banche Yeketu, Kortame, Bulbula, Lequ Soramba, and kotebe and Fincha rivers. The major streams of the Akaki river, the large and tiny Akaki rivers, run towards the southern direction of Aba-Samuel Lakes.

The Awash basin's major water resources are the Legedadi, Gefersa, Dire, and Aba Samuel lakes, which provide residential and industrial water to Addis Ababa through artificial water reservoirs[3][4]. Despite the fact that the Aba-Samuel reservoir was built for electric production in the late 1930s, it is currently contaminated by urban and industrial effluents. With a combined capacity of 77 million cubic meters (MCM) yr⁻¹ or 210,000 m³ day⁻¹, these three reservoirs provide 80% of Addis Ababa's water supply, with the remaining 20% coming from a single well system. Rivers, lakes, and ground water in and around Addis Ababa are used for irrigation, sand mining, industrial use, electric power generation, food production, leisure, habitat for birds and aquatic animals, and drinking and sanitation. Furthermore, in the southern portions of Addis Ababa city, the same rivers and streams are used for agriculture, cattle drinking water, and other household activities.

1.1. River Pollution Sources in Addis Ababa and Surrounding Areas:

Due to improper deposition of household, municipal, medical/clinical commercial, fuel stations' garbage, industrial and agricultural wastes to open spaces of the city, pollution of rivers, streams, rivers reservoirs, and shallow ground waters water quality is alarmingly increasing from time to time, causing various diseases. Despite the fact that these wastes are essentially poisoning and ruining the aforementioned water resources, people utilize the sediments downstream of the rivers to produce a variety of crops. The following are the primary causes of river pollution and contamination in and around Addis Ababa.

1.1.1. Residential:

Domestic or domestic wastes, which are produced as a result of day-to-day activities, are the most significant cause of water pollution in Addis Ababa. Because 40 to 60 percent of Ethiopia's rural population is projected to move to urban regions, the population of Addis Ababa city is steadily growing in comparison to other Ethiopian cities, resulting in a rise of residential/domestic trash. Because the city's massive quantity of solid trash (such as organic wastes, plastics, and papers) lacks well-organized management facilities, these wastes are often deposited on open grounds, stream banks, along bridges, and near residential areas, and eventually washed into rivers. Domestic liquid waste from overflowing and seeping pit latrines, septic tanks, public and communal toilets, open ground excreta defecation, and gray water from kitchens and bathrooms flow through different drainage lines and discharge into the entire Addis Ababa River system, particularly the Akaki River.

1.1.2. Treatment Plant Sites:

In industrialized nations, sewage treatment facilities and other pollution management methods decrease or eliminate most of the worst sources of infections in inland surface waterways[5]. On the other hand, in emerging country towns like as Addis Ababa, where most of the industrial and treatment plants are built near waterways, pollution is a major issue. Rapid urbanization, poor sanitation, uncontrolled waste disposal, and unplanned sites of treatment plants for large and medium-scale industries are the main threats to the water quality of Addis Ababa's rivers. Although 40% of the city's large and medium-scale industries are located near rivers, nearly all of the city's industries do not use water treatment plants. Heavy metals and other pollution have polluted almost all of Addis Ababa's waterways [6].

1.1.3. Medical Wastes or Clinical Source:

Clinical wastes also contribute to the contamination of the waterways in and around Addis Ababa. Medical waste accounts for 10 percent to 25 percent of total trash, whereas non-clinical waste accounts for 75 percent to 90 percent of total garbage [7]. In Addis Ababa, for example, 29 separate hospitals produce 430.7 tons of infectious trash. The main wastes of these institutions include infectious wastes such as human excrement, laboratory cultures, tissues, and wound garments, as well as pathological wastes such as placenta, body parts, blood, and human fetuses. Because most hospitals lack on-site waste treatment facilities, their wastes are discharged directly or indirectly into streams that are tributaries of the Akaki Rivers, which eventually drain into Aba Samuel Lake.

2. DISCUSSION

2.1. Trends of Addis Ababa City River Pollution:

2.1.1. Big Akaki river

The Big Akaki river rises in Addis Ababa's north-eastern outskirts and feeds into the Aba Samuel dam [8]. However, it is physiologically, chemically, and physically contaminated by businesses such as Kaliti Food SC, AkremMetena Animal Feed Factory, and K.K Textile Factory. Despite the fact that this river is vital for household, industrial, commercial, and agricultural operations, the people who live downstream are in grave danger, and their livelihood is in jeopardy, due to the river's increasing water pollution. They even grow veggies in the contaminated sediments, soils, and wastewater of the large Akaki river. Furthermore, owing to water contamination in the Big Akaki river caused by harmful chemicals produced by many businesses, the river's large fishes are on the verge of extinction. As a result, several key criteria of water quality, such as heavy metals, various ions, and fecal coliform, need significant treatment techniques in order to enhance the water quality of the river and utilize it for irrigation, swimming, and aquatic ecosystems.

2.1.2. Kebena river

The Kebena River is a major tributary of the Awash River basin, and it flows through Addis Ababa's northern outskirts [9]. Despite the fact that the community's livelihood is dependent on the Kebena River as a source of water for a variety of purposes, including drinking water, bathing, washing house items, sanitation, irrigation, and livestock production, the river is constantly contaminated by solid and liquid wastes from various sources. Water quality parameters such as COD, Chlorine (Cl), Manganese (Mn), pH, Silicon Dioxide (SiO₂), Sodium

(Na), potassium (K), and bicarbonate (HCO_3) were lower in the upper stream parts of the Kebena River, whereas downstream water quality parameters such as Sulphate (SO_4 -), Nitrate (NO_3), and Arsenic were higher (As). The physical and chemical values of water quality parameters in the Kebena river are almost the smallest of all the water quality parameters in the Akaki rivers, large and small. In addition, as compared to the smaller and larger Akakai rivers, the Kebena river contains greater organic pollution from commercial, agricultural, and institutional wastes, as well as household pollutant sources.

2.1.3. KolfeKeranio river:

The KolfeKeranio river is situated in Addis Ababa's western outskirts, and it is surrounded by more than 50 businesses that discharge solid and liquid pollutants into the river [10]. Gullele Soap Factory and Addis Ababa Tannery, for example, have been recognized as having industrial waste disposal issues, and their wastes are discharged directly or indirectly into this river. The worrisome increases in heavy metals, coliform, and pathogen concentrations in and around the KolfeKeranio river had an impact on irrigation water quality and agricultural operations both upstream and downstream.

2.2. Impacts of River Pollution:

Addis Ababa's metropolitan metropolis contains more than 65 percent of the country's industry. The bulk of Addis Ababa's industries, on the other hand, have substantial negative and positive effects on the environment, human and animal health, and economic factors. In most city roadside drains, improper dampening of residential wastes and sewage stench are frequent apparent issues. Due to these major environmental health issues, the majority of the rivers and reservoirs along the city's main industrial zones are excessively polluted, resulting in the spread of water-borne diseases, a reduction in quality of life, and an underestimation of the city's attractiveness to foreign investors and the tourism industry's competitiveness.

2.2.1. Biological Pollutants and their Effects on Human Health:

Biological pollutants such as bacteria may cause illnesses such as hepatitis A or E, dysentery, typhoid fever, cholera, and diarrhea in individuals who live near rivers. These diseases can occur when people utilize polluted river water for household purposes or other associated facilities. In Addis Ababa, for example, diarrhea and viral hepatitis, both of which are linked to fecal contamination, have been the most common infectious illnesses. It's also worth noting that diarrhea alone accounts for 212,809 outpatient cases throughout the nation, with typhoid fever accounting for 14,913 cases in Addis Ababa.

2.2.2. Heavy Metals in Vegetables:

Some crops, such as potatoes, contain hazardous metals like as zinc, nickel, mercury, copper, cadmium, and chromium, as do red beet and chromium-containing onions that were grown on 390 hectares along the Akaki River. People living along the Akaki River and in Addis Ababa consumed carrots, which are rich in arsenic and cadmium, lettuce, which is high in chromium, Swiss chard vegetables, which are high in iron, and zinc cabbage, which is high in lead. As indicated in Table 3, these veggies posed a health danger to humans. According to Mulu and Ayenew, the majority of people living near the AkakiKality industrial zone were afflicted with

cough, diarrhea, typhoid, and typhus as a result of severe pollution of the adjacent Akaki River and the consumption of contaminated vegetables containing high levels of heavy metals.

2.2.3. Social Impacts:

Inadequate collection and transportation of home wastes (liquid waste, wood, scrap metals, and wasted food) and industrial wastes, as Mohammed and Elias argued, are major issues affecting society's well-being and health. People who live near rivers are impacted by a variety of health issues as a result of drinking contaminated river water. Organic, inorganic, and other heavy metals in river water collect and bio-magnify in water species such as fish, soil, sediment, and vegetables, posing serious health risks to living creatures. Furthermore, since the majority of people living near rivers rely on the rivers for their water supply, they consume vegetables produced on severely contaminated soils.

2.3. Institutional Contributions to River Pollution Mitigation:

2.3.1. Addis Ababa Environmental Protection Authority (AAEPA):

Environmental Protection Authority is a statutory regulating authority on all waste management systems in Addis Ababa municipal government, and it developed and structured a great set of policies, rules, and standards to help prevent pollution in Addis Ababa rivers and riverside areas. This organization has a research section that focuses on pollution in the environment. As a result, many researchers are working on studies that look at the pollution levels in rivers like the Akakai River, as well as the quantity of effluents that are discharged directly into the rivers. Additionally, the Addis Ababa Environmental Protection Authority (AAEPA) has a powerful division known as Environmental Pollution Inspection (old name) or Environmental Law and Monitoring (new name), which monitors and controls the pollutant status of industries and their products using a set of policies, rules, and standards.

2.3.2. Addis Ababa water and sewerage authority (AAWSA):

The Addis Ababa Water and Sewerage Authority (AAWSA) is one of the organizations in charge of controlling and managing liquid and solid waste from homes and various businesses inside Addis Ababa's municipal limits and suburbs. The primary responsibilities of this company are to offer liquid waste collection services in collaboration with private operators that provide septic tank emptying services. As a result, AAWSA is in charge of the city's liquid waste, and according to AAWSA's report, the organization processes less than 10% of the city's liquid waste, with the remaining pit latrines discharging their effluent into the city's storm water drainage system. The management of wastewater treatment residuals and other byproducts of industrial operations is handled via a centralized waste water treatment system, whereas pit latrines utilize a mix of centralized and decentralized waste treatments.

2.3.3. Institutional coordination:

Coordination is the process of coordinating connections and is essential for decreasing both point and non-point sources of pollution. The city's coordination and cooperation improves efficiency, makes it easier to share risks and rewards, and provides a favorable environment for assessing the health of city rivers. Coordination and collaboration on river pollution efforts with all relevant authorities at all levels would assist to create synergy and ensure efficient delivery.

Coordination with and among stakeholders allows for the expression of national priorities, as well as the avoidance of duplication of effort and needless overburdening of operations.

3. CONCLUSION

The rivers in most parts of Ethiopia, including Addis Ababa, are now severely polluted, owing to an insufficient industrial waste management system, increases in urban human population, urbanization, and a lack of sanitary infrastructure services. The water quality of Addis Ababa city waterways has been deteriorating rapidly over time, with the major sources of pollution being trash from residents along the river and away from the river, industry, hospitals (point and nonpoint sources), and macro and micro sectors of the city. The big and little Akaki waterways, among the many municipal rivers, are heavily contaminated by heavy metal buildup from nearby businesses. Residents living upstream and downstream of these rivers, on the other hand, use the rivers for irrigating their vegetable fields, drainage, animal breeding, and other domestic uses. Despite the fact that plants have the ability to collect high levels of heavy metals, the vegetables produced by these farms have the potential to damage human and animal health via the food chain and food web. Furthermore, a large number of city inhabitants are experiencing health problems as a result of drinking and eating polluted water and vegetables, which increases medical costs.

All of the above facts indicate that the city's water quality problem is having serious consequences for the city's environmental, social, and economic aspects, and that the problem is rapidly worsening due to infrequent inspections by mandated regulatory institutions, lax enforcement of environmental policies, a lack of institutional capacity, and poor cooperation among environmental agencies. As a result, all stakeholders, including the city administration and the local community, are strongly encouraged to engage in the development of policies, standards, guidelines, and other activities that aid in the mitigation of pollution in the city rivers.

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