

## Causes, negative effects, and preventive methods of water pollution in Ethiopia

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## REVIEW ARTICLE

### Abstract

Water is a finite resource necessary for life and sustainable development. Ethiopia has considerable potential for freshwater resources in East Africa. All living beings depend on water for growth and upkeep, and it is essential for supporting environmental balance and biodiversity. Ethiopia does not able to offer clean water to half of its population, and it does not make good use of its water resources. Many Ethiopians who live in urban areas struggle to have access to a consistent and adequate quantity of drinking water. Only a small number of city dwellers have access to enough of clean water. Both human activity and natural events may contaminate water. In developing nations, a major concern for public health and water security is the degradation of quality of water brought on by human activities and weak enforcement. The effectiveness of policies and institutional frameworks to address pollution, as well as their effects on the ecological status and biota of rivers, are little understood in spite of growing pollution levels in many tropical African nations. This article focuses on giving an outline of the reasons for Ethiopia's water pollution and ways to stop it.

**Keywords:** Ethiopia; prevention methods; water pollution; water quality

### Introduction

Water is the most valuable natural resource on the earth, and pollution of water sources is one of the most important environmental problems facing the globe today (United Nations Educational Scientific and Cultural Organization Wanzahun and Bezatu, 2013). Water bodies are contaminated by typical human activities, including urbanization, industrialization, and population increase. The most important issue affecting the public's health is contamination of surface and ground water (Maschal Tarekegn and Truy, 2018). Ethiopia has some of the least accessible sanitary facilities and sources of clean water in sub-Saharan Africa. In 2010, 91.5% percent of urban regions in Ethiopia had access to clean drinking water, compared to 68.5% of rural Ethiopians (within a radius of 1.5 km) (Omer, 2001). Ethiopia has been endowed with abundant natural water resources, including major rivers

and irrigation systems, that can easily meet residential needs of water. "White oil" or "blue oil" is the moniker given to the significant quantitative potential of water (Siraj and Rao, 2016). Ethiopia is known as the water tower of east Africa because of its abundant potential for both surface and ground water resources (Said, 2013). Rainfall is the primary supply of water for the nation, which leads to the existence of several trans-boundary rivers with varying water levels throughout the year. When one takes into account certain regions of the nation, notably the western, the southwestern, and the highland regions, this is factually accurate (Seleshi, 2007).

Ethiopia has not yet fully facilitated the society's access to clean water in both rural and urban regions. The nation falls short of providing access to clean water at the highest possible level, particularly in rural regions. Accessibility is often better in urban regions than in rural settings.

One of Ethiopia's efforts to achieve the Millennium Development Goal (MDG) is to increase the availability of high-quality water (Ademe and Alemayehu, 2014). According to United Nations Environment Programme (UNEP), water pollution commenced thousands of years ago with land farming and building up of towns and villages (Ara *et al.*, 2004). Pollutants enter water from a wide variety of actions and harm water sources (Maschal Tarekegn and Truy, 2018). Danquah (2010) and Tamiru *et al.* (2004) claimed that residential, agricultural, and industrial activities are uncontrolled sources of pollution in developing nations. Because of Ethiopia's growing population, unchecked urbanization and poor sanitary facilities seriously impair the quality of its surface waterways. Large- and medium-scale manufacturing industries are spread throughout the nation and water contamination because of the dumping of industrial wastes has become a worrying problem for the environment throughout Ethiopia (Mulu *et al.*, 2013). That's why many rivers and streams are extremely polluted with passage of industrial pollutants in water (Wassie, 2008). The cumulative effect of declining water quality has surely exerted pressure on the socioeconomic progress and public health of the nation (Assegide *et al.*, 2022).

Maximum degradation in the quality of water of different rivers and streams is caused by anthropogenic activities, where indiscriminate dumping of household and industrial wastes, as well as waste from other sources, such as agriculture and health facilities, is frequent (Amoatey and Baawain, 2019; Igwe *et al.*, 2017). Such activities have been justified in Ethiopia (Tadesse *et al.*, 2018), Bangladesh (Hasan *et al.*, 2019; Islam *et al.*, 2020, 2021), India (Chebet *et al.*, 2020; Kumar *et al.*, 2021; Pareek *et al.*, 2020; Rakhecha, 2020), and South Africa (Edokpayi *et al.*, 2017).

## Causes of water pollution in Ethiopia

Both point and nonpoint sources of pollution have the potential to contaminate water bodies. In contrast, non-point sources, also known as diffused sources, lack a specific location of source and include discharges from municipal sewage treatment plants, industrial plants, factories, power plants, underground coal mines, specific sources such as drain pipes, ditches, and sewer outfalls, and oil wells (Maschal Tarekegn and Truye, 2018). According to a research report compiled by Danquah (2010) and Tamiru *et al.* (2004), growth of human population has adversely affected both surface water and groundwater). Major sources of pollutants, according to this report, include industrial establishments, agricultural activities, municipal waste, fuel stations, garages, and health centers (Danquah, 2010; Gangwar *et al.*, 2012) (Figure 1). According to Addis Ababa Water and Sewage Authority (AAWSA) report, domestic animals, pit conveniences and septic tanks, inadequate solid waste management systems, government and private institutions, industries, factories, sewerage lines, wastewater treatment plant effluents, and surface runoffs are the main sources of both surface and groundwater contamination in major Ethiopian cities (Khan, 1996). Major causes of water contamination are given in Figure 1.

## Industrial growth

Water contamination is mostly caused by industry, which includes food and beverage, iron and steel, tanning, pulp and paper, and textile industries, and nuclear plants, among others. Various hazardous chemicals, organic and inorganic compounds, hazardous solvents, and volatile organic chemicals are discharged during

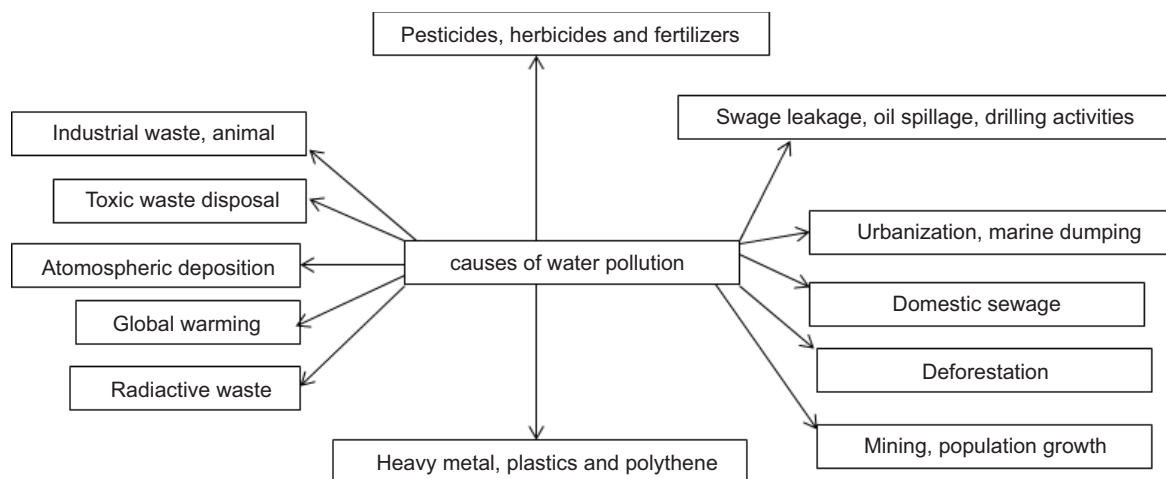


Figure 1. Major factors causing water contamination (Raouf *et al.*, 2019).

industrial manufacturing. Water contamination is caused by the discharge of these pollutants into aquatic habitats without sufficient treatment facilities (Chowdhary *et al.*, 2020). Important chemicals released in wastewater include arsenic, cadmium, and chromium, and the industrial sector is the major source of such dangerous contaminants (Chen *et al.*, 2019).

### Domestic and municipal sources

According to the Ethiopia Mini Demographic and Health Survey (EMDHS) report, in 2014, just 4.5% of the population had access to a flush toilet or an upgraded pit convenience (Central Statistical Agency [CSA], 2014; Yohannes and Elias, 2017; Table 1). Municipal trash output, including both liquid and solid waste, grows in direct proportion with growing population. Urban pollution emerges from an unbalance created between population expansion and urban infrastructure. It follows that municipal garbage from metropolitan areas must be considered as one of the causes of river water contamination.

### Agricultural value added

Agriculture and water pollution are interconnected. Agricultural land drains its run-off, which includes manure, fertilizers, pesticides, trash from farms, slaughter houses, and poultry farms, salt, and silt. Water contamination is mostly brought on by pesticides, nitrogen fertilizers, and organic farm wastes. The water is contaminated by pathogens, nitrates, phosphates, pesticides, soil sediments, and salts because of agricultural operations (Parris, 2011; Figure 2). In addition, agriculture has seriously harmed all freshwater systems in their original conditions (Moss, 2008).

### Negative effects of water pollution

The health and existence of all living organisms is negatively affected by water pollution. Water pollution has a negative impact on crops and soil fertility, and is bad for agriculture (Khatun, 2017). As its effects last for a

longer period, water contamination affects the future as well as the present generations. If a body of water is contaminated, all living things are forced to consume it without having an alternative. It causes malignancies, birth defects, and other disorders, and it affects the skin, lungs, brain, liver, and kidneys (Khatun, 2017). Hence, both natural and human-caused factors contaminate water. Urbanization, population explosion, industrialization, climatic changes, and other factors (Halder and Islam, 2015), as well as religious and non-religious activities (Dwivedi *et al.*, 2018), have a direct impact on water quality.

### Impact of water pollution on human health

Even though we as humans are aware that freshwater rivers used to offer safe drinking water and freshwater rivers serve as a sanitation system, we still pollute them. Human health is seriously impacted by unsafe water. According to the UNESCO (2021) World Water Development Report, almost 300,000 children aged <5 years, or 5.3% of all deaths in this age group, die each year because of diarrhea caused by contaminated drinking water, improper sanitation, and poor hand hygiene.

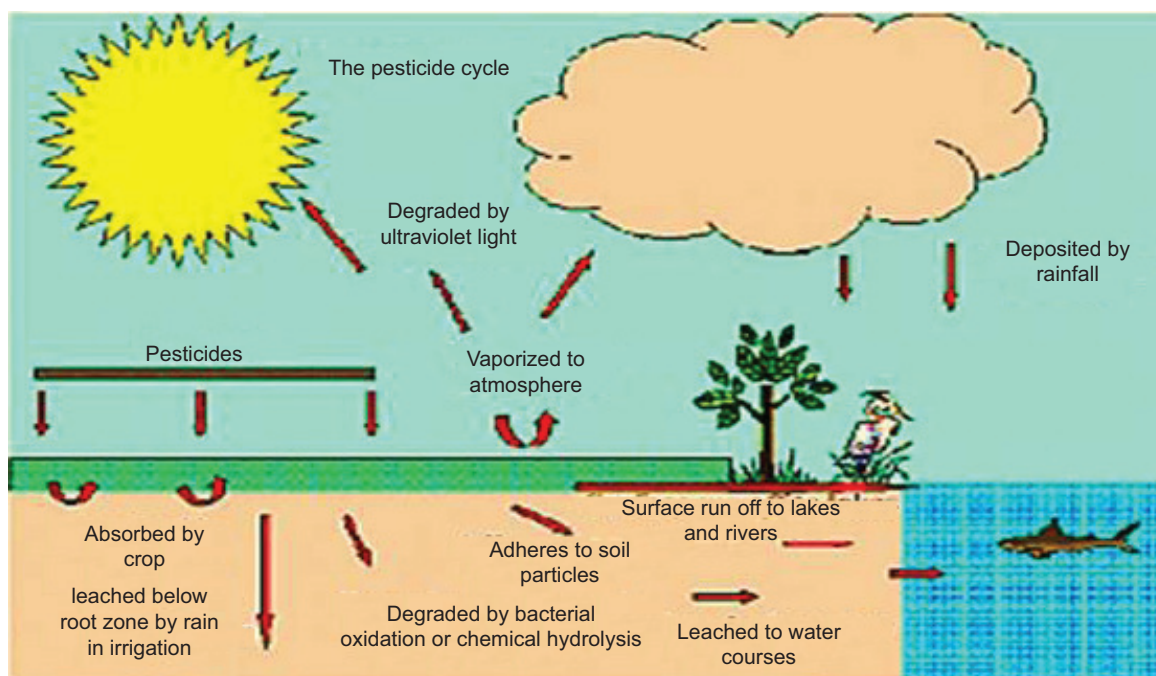
According to the data from Palestine, individuals consuming desalinated and home-filtered drinking water are less likely to contact ailments such as diarrhea than those consuming municipal water directly (Yassin *et al.*, 2006). The prevalence of illnesses, including cholera, trachoma, schistosomiasis, and helminthiasis, is high in areas having no access to water and sanitary facilities. Research data from underdeveloped nations have clearly demonstrated a link between cholera and contaminated water, and established that home water treatment and storage can lower acquiring of cholera (Gundry *et al.*, 2004).

### Death of aquatic life

Water contamination, such as eutrophication, toxics (pesticides), heavy metals, acidification, and siltation, is dangerous for the health of rivers, lakes, estuaries, coastal systems as well as marine resources worldwide

**Table 1. Major industrial pollutants discharged into rivers and streams (Environmental Protection Authority (EPA), 2005; Yohannes and Elias, 2017).**

No.	Type of Industry	Pollutants
1.	Food and beverages	NaOH, detergents, fuel combustion
2.	Textile, leather, and leather products	Water pollutants, e.g., chromium, sulphides, ammonium salts, chlorides, etc.
3.	Steel and wood products	Paint, iron rusts, varnish, etc.
4.	Paper and paper products	Printing chemicals, lead
5.	Non-metals	Air pollutants: dust and particulates, fuel combustion, etc.



**Figure 2.** Illustration showing the different stages of pesticide cycle. *Source websites:* The University of Reading, pesticides (Agrawal *et al.*, 2010).

(Mekuriaw and Gokcekus, 2019). Water pollution also affects plants and animals relying on it for survival. Water pollution kills small creatures such as plankton, mollusks, and fish, among others, by reducing the amount of dissolved oxygen (DO) in water. Heavy metals, polychlorinated biphenyls (PCBs), and other biocides directly kill delicate aquatic species. Hot industrial waste fluid entering into water bodies decreases DO concentration (Abiye, 2021).

### Economic impacts

Huge budgets in developing nations are allocated to deal with water contamination, resulting in a real and prospective loss of development opportunities (Mekuriaw and Gokcekus, 2019). Poverty is both a cause and an effect of the availability of polluted water. When dirty water is used to irrigate crops, agricultural output suffers, resulting in lower yield and quality threats to food resources. Additionally, the destruction of commercial fisheries has an impact on riparian towns and self-sufficient fishing communities (Mekuriaw and Gokcekus, 2019).

### Food chain disruption

Balance is disrupted by causing the poisons to enter food chains. Under certain circumstances, pollution completely destroys a food chain. Death of a predator has an adverse effect on other species by either causing mortality or unreasonable development (Garg, 2012).

## Materials and Methods

### The process of data extraction

According to the available literature, extensive research has been conducted on the origins, effects, and preventative strategies of water contamination. These issues are significant in the fields of economics and health. A total of 114 linked publications, including research articles, reviews, and conference papers, were looked up as on December 30, 2022. Of these examined papers, 12 were removed and 102 were considered based on topic relevance. The present review paper aimed to provide an overview of Ethiopia's water pollution sources, detrimental impacts, and modes of prevention. Information about research authors, publication date, country of origin, research technique, and major findings from all relevant publications was considered for the present study. In order to make sure that all the data had been filtered and evaluated, the results were first retrieved by one researcher, and cross checked by another researcher. In case of a disagreement between both researchers, it was discussed to reach a final decision.

### Quality assessment of the literature

Every article was assessed for quality using the Joanna Briggs Institute (JBI) model's critical appraisal checklist. After thorough peer review, the JBI scientific committee created the core evaluation instrument for JBI, which is

intended for system reviews. The final summary contains all elements of the study that adhere to the eight criteria listed here: (1) a defined aim; (2) thorough information about the sample variables; (3) data base; (4) the validity of data sorting; (5) ethical standards; (6) and 7) effective outcomes; and (8) use suitable quantitative techniques and properly communicate the outcomes. Different studies have been carried out in Ethiopia on water pollution (Table 2).

## Results and Discussion

Two different types of economic losses are associated with water contamination. First, pollution decreases the overall quantity of acceptable water available for home use as well as for agricultural and industrial purposes. As a result, holding back water has financial expenses. Second, there are expenses associated with using contaminated water for both production and consumption. The reduction in product quality and quantity is referred to as the cost of utilizing polluted water for manufacturing (World Bank, 2007). Integrating environmental protection with development activities is one of the most important environmental law concerns. We must grow economically. Additionally, we must safeguard the environment. Environmental law addresses the difficulty of having both at once.

### Water pollution and diarrhea

Ethiopia has the second-highest rate of fatalities because of diarrhea in Africa. Diarrhea is the second most common cause of mortality and accounts for more than one in 10 infant deaths in Ethiopia (Dagneu *et al.*, 2019; World Health Organization [WHO], 2014). In Ethiopia, 12% of children had diarrhea (Ethiopia Demographic and Health Survey [EDHS], 2016; Tafere *et al.*, 2020). According to past studies, childhood diarrhea had been one of Ethiopia's fundamental health issues (Dagneu *et al.*, 2019; Fenta *et al.*, 2020; Melese *et al.*, 2019; Shine *et al.*, 2020; Tafere *et al.*, 2020). The most typical illness caused by water pollution is diarrhea, which is a frequent indication of gastrointestinal tract (GIT) ailments. In low-income nations, diarrhea has been a major ailment and cause of mortality in children. In underdeveloped nations, diarrhea is responsible for 21% of annual deaths in children aged <5 years (Waddington *et al.*, 2009).

Water contamination is a direct cause of many infectious diseases linked to diarrhea (Ahmed and Ismail, 2018). Several studies have been accomplished to look at the factors that contribute to childhood diarrhea in different nations, mostly poor nations such as Ethiopia (Alebel *et al.*, 2018; Al-Hindi, 2017; Asfaha *et al.*, 2018;

Aziz *et al.*, 2018; Fontoura *et al.*, 2018; Getachew *et al.*, 2018). However, a lot of research has been conducted in Ethiopia on institutional levels as well as in narrow geographic regions, comprising a small number of populations, often rural ones, on childhood diarrhea (Asfaha *et al.*, 2018; Getachew *et al.*, 2018; Girma *et al.*, 2018; Melese *et al.*, 2019; Mengistie *et al.*, 2013; Teklemariam *et al.*, 2000).

### Water pollution and skin diseases

In studies conducted as early as in the 1950s, it was observed that swimming dramatically increased incidence of illnesses, compared to non-swimmers, defying the notion that swimming is excellent for health. According to a report, about 100% more incidences of ailments were reported in children aged <10 years than in children aged >10 years. A portion of these patients comprised having skin ailments (Stevenson, 1953). A number of harmful bacteria present in water cause skin disorders in swimmers (Yau *et al.*, 2009). Levels of bacteria present in seawater are strongly associated with skin disorders. Individuals, both swimmers and non-swimmers, exposed to water bodies having higher levels of bacteria had relatively higher chances of suffering from skin diseases.

### Water pollution and child health

A major cause of malnutrition in children aged <5 years is diarrhea, which is also the second most prevalent cause of childhood fatalities. According to WHO (2007) estimates, more than 525,000 childhood deaths aged <5 years, or roughly 1,439 deaths every day, are reported annually. Five countries, including Ethiopia, had 50% of these deaths. Each year, more than 1.7 billion pediatric cases of diarrhea are reported globally (Fenta and Nigussie, 2021). For instance, South Asia and sub-Saharan Africa account for almost 80% of morbidity and mortality because of diarrhea. Malnutrition is a major cause of deadly diarrheal bouts and a contributing factor in one-third of avoidable childhood deaths (United Nations International Children's Emergency Fund [UNICEF], 2018; WHO, 2007).

Inferior height in adults is linked to childhood exposure to pollution during key developmental years (Zaveri *et al.*, 2020). Malnutrition and illnesses directly linked to sanitation and contaminated water contribute to additional fatalities, with measles and pneumonia being other reasons. More than one-third of children worldwide continue to experience stunting and malnutrition because of poor access to clean water and proper sanitation (Bartlett, 2003). According to a research conducted in rural India, children in families having access tap water had much

Table 2. Some studies on water pollution in Ethiopia.

Rank	Authors	Journals	Country	Methods	Objectives	Key findings
<b>Causes and Effects of Water Pollution</b>						
1	Hadis <i>et al.</i> (2019)	Social Sciences	Ethiopia	A sample survey	Exploring the causes and effects of river pollution	Protecting rivers from pollution and maintaining environmental sustainability
2	Mitiku (2020)	International Journal of Pharmaceutical Sciences Review and Research	Ethiopia	Review	A systematic review on the causes, effects, and treatment methods of water pollution	The physicochemical properties help in the identification of sources of pollution, for conducting further investigation
3	Belete (2020)	A case study paper	Ethiopia	A sample survey and document analysis	To asses and identify the main cause of water pollution and its impact	Polluted water has a great impact on health conditions, and in turn it affects the fundamental human rights
4	Amare (2020)	Thesis	Ethiopia	Meta-analysis	To investigate the causes and effects of water pollution on human health	Polluted water is harmful, and it was recommended to enhance public awareness, preventive enforcement, and legislative measures
5	Agumassie (2019)	African Journal of Environmental Science and Technology	Ethiopia	Review	A systematic review for providing useful information for the proper management of water bodies and fishes	Addressed the problems in order to sustain the fish and water resources for the present and the next generation
6	Shako and Ping (2021)	International Journal of Scientific and Research Publications (IJSRP)	Ethiopia	Review	A systematic review on Ethiopia's water resources management and to inform challenges and opportunities	Identify the quantitative potential of water resources and elements that need to be explored to meet growing water demand
7	Asnake <i>et al.</i> (2021)	Environmental Systems Research	Ethiopia	Meta-analysis	Examining the impact of watershed land use on the quality of river water across spatial and seasonal continuum	Urban and forest-dominated sub-watersheds contribute significantly a high amount of pollutant load to the river
8	Ademe and Alemayehu (2014)	Intellectual Properties Rights (Open Access)	Ethiopia	A sample survey	Identifying the main determinants of organic water pollution	Assess sources and determinants of organic water pollutant (BOD) emissions
9	Mohammed and Handiso (2018)	International Journal of Environmental Sciences	Ethiopia	A sample survey and document analysis	Examining the main causes of water pollution and its effect on societal health in the area of river basin	Sewage from domestic households, underground storage and tube leakages, and waste water are considered as the major causes of water pollution around a river
10	Gashaye (2020)	Cogent Food & Agriculture	Ethiopia	Review	Reviewing the benefits and potential health risks in wastewater-irrigated vegetables	Management of water resources and proper utilization of vegetables grown in wastewater irrigation has become an option for farmers in developing countries to ensure food
11	Maschal Tarekegn and Truye (2018)	Journal of Environmental Risk Assessment and Remediation	Ethiopia	Meta-analysis	Assessing the pollution profile, causes, and its effect on aquatic environment	Main causes of contamination of a river were the introduction of uncontrolled solid waste and untreated sewerage effluent into the river

(continues)

Table 2. Continued.

Rank	Authors	Journals	Country	Methods	Objectives	Key findings
12	Eriksson and Sigvan (2019)	Uppsala University	Ethiopia	A sample survey and document analysis	Investigating causes and impact of surface water pollution	A high surface water contamination mostly from domestic, municipality, and industrial wastewater and solid waste
<b>Status of Water Quality in Ethiopia</b>						
1	Yimer and Jin (2020)	American Journal of Water Resources	Ethiopia	Meta-analysis	Assessing the impact of poor mixing L/B ratio on socioeconomic and environmental disaster on downstream water users	Untreated discharge from industries, domestic wastes, flower farms, and irrigation runoff is the major source of water pollution
2	Mekonnen <i>et al.</i> (2020)	Ethiopian Journal of Public Health and Nutrition	Ethiopia	A sample survey	Reviewing major sources of water pollution and implication of pollutants	Sludge and wastewater have made a significant contribution to the worsening of the quality of river water
3	Yohannes and Elias (2017)	Environment Pollution and Climate Change	Ethiopia	A sample survey	Identifying the main source, impact, and trend of river and water reservoir pollution	There is a high amount of waste disposal in rivers and riverbanks from municipal sources, liquid wastes from toilets, open urination, and defecation
4	Melese (2022)	Preprint platform	Ethiopia	Meta-analysis	Evaluating the suitability of groundwater in major groundwater sources	Determining the physical, chemical, and heavy metal parameters of water samples
5	Prabu <i>et al.</i> (2011)	Journal of Agricultural Science and Technology	Ethiopia	Meta-analysis	Determining physicochemical parameters, nutrient status, and heavy metal ions present in rivers	Analysis selected heavy metals and various water quality profiles
L/B ratio: ratio of the length of a grain to its breadth.						

reduced prevalence and duration of illnesses than those having no access to tap water (Jalan and Ravallion, 2003).

### Prevention of water pollution

We all, in one way or the other, are subjected to water contamination. Being a serious issue, water contamination could be controlled by proper intentions, planning, and information (Khatun, 2017).

### Agricultural practices

The detrimental impact of agriculture on water can be avoided, regulated, or decreased at source from an ecological and economic point of view. This could be achieved by finding an appropriate balance between yield and water protection. It is necessary to take two different types of technical measures to better regulate non-point dispelling conditions. These include collection of water into streamflow and improving soil characteristics to minimize soil weakness to prevent erosion and surface runoff in agricultural regions. Reduced seepage-based

inputs into water are achieved by different anti-erosion measures that maintain a permanent plant cover and conserve or enhance soil structure.

Environmental factors are being considered for including these standards. To meet the demands of water protection, a number of extensification measures are considered, including; switching from very intensive land utilization to less intensive grassland farming, especially with a view of preventing erosion and reducing seepage-based material outputs; reducing fertilizer and pesticide application; restoring former wetlands and flood plains; and simply leaving arable lands fallow and reforestation (Owa, 2014; United Nations Economic Commission for Europe (UNECE), 1992).

### Fertilization

Fertilization, according to water protection standards, refers to limiting the application of fertilizers to the point where developing plants can utilize nutrients from the soil as well as from mineral and organic fertilizers as thoroughly as feasible. For instance, according to the

German Fertilizer Act 1989, it is a good agricultural practice to adjust fertilization of the plants and soil according to type, amount, and application time, taking into account the available nutrients and organic substances in the soil as well as the location and cultivation conditions. Plants' need for nutrients must be determined in accordance with expected yields, local cultivation conditions, and product quality requirements (Owa, 2014; UNECE, 1992).

### Use of pesticides

Strategies to reduce pesticides and environmental impact can take a variety of forms, from preventing pollution at the source to treating its symptoms, such as unfavorable environmental consequences (Owa, 2014; UNECE, 1992).

### Conclusions

In developing countries, the status of water quality varies greatly, reflecting various degrees of development and demands on water quality programs. Water contamination, a major problem, occurs through a variety of modes. However, a number of means are available today to act constructively to address the issue of water contamination. Considering the protection of the environment, we should never assume that our individual acts are insignificant. The environment, the society, and the economy are all seriously struck by declining water quality. Because there are significant urban agricultural operations to primarily cultivate vegetables nearby, heavy metal deposition in the Akaki River warrants urgent attention. Vegetables are able to collect high concentrations of heavy metals, which then enter human bodies through food chains and impact community health. Hence, most of the investigations have concluded that direct river water should never be utilized for irrigation, human consumption, and cattle consumption as well as washing purposes.

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### Data Availability

All data generated or analyzed during this study are included in this published paper and its supplementary information file.

### Ethical Approval

This study did not involve any human or animal participation; hence, no ethical approval was required.

### Informed Consent

Informed consent was obtained from one participant included in this study.

### Conflicts of Interest

The author declared to have no conflict of interest to disclose for this review paper.

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