IMPACT OF IMPROPER WASTE DISPOSAL ON SURFACE AND GROUND WATER

ABSTRACT

Pollution in water occurs when harmful substance (often chemicals or biological) contaminate streams, river, lakes, oceans or other bodies of water, degrading water quality and rendering it unhealthy to humans, animal and the environment. The widespread problem of water pollution is jeopardizing our health. Water pathogens, in form of disease-causing bacteria and viruses from human and animal waste, are a major reason of illness from contaminated drinking water. Owing to the improper treatment facilities, waste is often discharged into the surface and ground water sources. Water bacteria can be limited by recycling used plastic, standard disposal of chemicals, oils or non-biodegradable items and proper collection and transportation of solid waste to a processed disposal site. In addition, waste water should be treated properly to prevent adverse health risk of the user of both surface water and ground water in the aquatic ecosystems.

KEYWORDS: Pollution, Harmful Substances, Chemicals, Pathogens, Health, Aquatic Ecosystems, Waste Disposal.

INTRODUCTION

Any material or energy source that is released into the environment and has detrimental effects or reduces the utility of natural resources is considered a pollution [1]. In addition to producing short-term or long-term harm that changes the natural growth patterns of plants and animals, pollutants can have a disastrous impact on the environment and human existence. They can also disturb vital amenities and jeopardize human comfort, health, and property values. Certain pollutants, on the other hand, are biodegradable and will naturally decompose in the environment, thus they might not be there for very long. Nitrogen oxide, sulfur oxides, particulate matter, ground level ozone, volatile organic compounds, mercury, and peroxyacyl nitrates are examples of common pollutant types [1].Any material or energy source that is released into the environment and has detrimental effects or reduces the utility of natural resources is considered a pollution [1]. In addition to producing short-term or long-term harm that changes the natural growth patterns of plants and animals, pollutants can have a disastrous impact on the environment and human existence. They can also disturb vital amenities and jeopardize human comfort, health, and property values.

Water Pollution

When dangerous materials accumulate in streams, rivers, lakes, the ocean, aquifers, and other bodies of water, they can contaminate them chemically or biologically, lowering their quality and making them hazardous to people or the environment [2]. There are numerous man-made pollutants that can contaminate water sources, including their sources can be divided into two

categories: diffuse and point. Agricultural installations, towns, landfills, industrial sites, and manure storage are a few instances of important point sources. Compared to diffuse (non-point) sources like pesticides and nitrates that seep into surface and ground water due to rainfall, soil infiltration, and surface runoff from agricultural land, they are easier to identify and manage. These sources result from significant changes in the water's pollutant load throughout time [3].
Apart from classifying contaminated sources as either point or non-point, we identify two categories of water contamination:

1. Emergency contamination (single) often has a devastating effect right away, killing fish and other aquatic life and causing several other severe damages.

2. Persistent organic pollution was a sign of long-term contamination. Some fish species are eliminated in the impacted river zones as a result of its complete detrimental impact on the water environment and the structure of the food supply for aquatic fauna.

Water-borne infectious illnesses affect both humans and animals. Ingestion of water tainted with human or animal excrement that contains harmful bacteria, viruses, and parasites (protozoa, parasite eggs) is how the agents of these diseases are spread. Depending on a variety of variables, they may live in water for varying amounts of time. Determining criteria that show pollution from sewage, animal waste, waste storage, animal manure, artificial fertilizers, and other sources is the foundation for monitoring the safety of water sources [3,4]. The Directive 2010/75/EU on integrated prevention of pollution and control, which applies to industrial and agricultural establishments with significant pollution potential, is a crucial instrument that aids in the removal of pollutants from water sources. However, dispersed sources are typically exempt from this regulation.

Organic and Inorganic Pollutants

The organic matter resulting from various human activities is the primary cause of organic pollution in rivers. This includes wastewater from homes and businesses, waste from farming and raising animals, waste from food processing plants, and other sources. Many harmful organic compounds are either non-biodegradable or only slowly degrade, meaning they remain in the environment; some are amplified in the food chain; some have the potential to cause cancer in humans; others react with chlorine used to disinfect water to form carcinogens; still others are just annoyances. Eutrophication of freshwater is another global issue.

Eutrophication (excessive growth of phytoplankton and filamentous algae resulting in increased turbidity, production of toxins, diurnal changes in dissolved oxygen) is caused by enrichment of water with nitrogen and phosphorus. Phosphorus emissions arise predominantly from domestic and industrial effluents, but the share of agriculture is not insignificant.

In addition to receiving precipitation from pertinent catchment areas, rivers also absorb treated and untreated effluent as well as infiltration from landfills. Certain contaminants are exceedingly expensive and difficult to remove; thus, it is best to prevent them. Zones of protection for water sources form the basis of one part of the answer to this issue [6]. The main sources of pollution in ground water are both naturally occurring compounds found in the mineral environment and ground water, as well as other point and diffuse sources of pollution. Thus, before ground water is used for drinking and other household purposes, it also needs to be protected, monitored frequently, and treated.

Microbiological Pollution of Water

Numerous pathogens, including bacteria, viruses, protozoa, and helminths, can contaminate water. Eighty percent of infections in developing nations are caused by unclean water, according to the World Health Organization (WHO).

The major sources of infectious agents are:
(1) Untreated and unproper treated sewage
(2) Animal waste in fields and feedlots beside waterways
(3) Meat packing and tanning plants that release untreated animal waste into water
(4) Some wildlife species, which transmit waterborne diseases.

Water can spread a wide variety of pathogenic and potentially pathogenic microorganisms. The most common ones are the pathogens responsible for intestinal disorders (amoebic dysentery, schisostomiasis, tularaemia, leptospirosis, cholera, salmonellosis, TB, brucellosis, tularaemia, paratyphoid).
Viral etiologies include infectious hepatitis, poliomyelitis, aseptic meningitis, and disorders affecting the gastrointestinal and respiratory systems. Viruses are a serious threat to both humans and animals because they were not tested for in the water and can't be found by standard microbiological investigation.

The proportion (counts) of bacteria that act as markers of fecal contamination have long been monitored in order to assess the microbiological safety of drinking water. They are often kept an eye on at the supply system's entrance as well as at a few fixed, haphazardly placed locations inside the distribution system. A lot of work has gone into trying to identify the perfect indicator microorganism, but as of right now, none of the microorganisms that are utilized for this purpose can adequately satisfy every requirement.

Different disinfection processes are employed to guarantee the safety of microbiological potable water. The presence of a target chlorine residual concentration following a given contact period, when active chlorine is utilized for this purpose, acts as a trustworthy signal of the real-time suppression of bacteria and viruses.

Numerous studies have shown that treating water with active chlorine is not the best method for guaranteeing its safety because it might lead to the formation of byproducts, especially in cases where the water contains traces of organic materials. The major causes for worry are the generation of chloro- and bromo-benzoquinones, which are byproducts of the chlorination process, and the possible production of trihalomethanes, especially if people are exposed to these compounds for an extended period of time[7].

1.6 Protection of Water

It is impossible to guarantee an adequate supply of clean, drinkable water if the water is not shielded from its source. Typically, surface waters provide three-fourths of the water utilized for agriculture, industry, and residential consumption, with groundwater providing the remaining portion. Groundwater pollution has longer-lasting effects than surface water pollution, despite groundwater being less exposed to pollutants.

Though it has only been done locally for a long time, guiding water and watercourses against contamination has a long history. The United Nations Economic Commission for Europe (UNECE) Water Convention on the preservation and use of transboundary watercourses and international lakes was created in 1992 as a result of the increased awareness of potential issues.

The goal of this agreement and its amendments is to improve national policies for the preservation and environmentally responsible management of transboundary surface and ground waters. According to the Water Convention, Parties must guarantee the sustainable management of transboundary waters, as well as impede, control, and lessen transboundary impact.

1.7 Causes of Water Pollution

Water is particularly vulnerable to pollution. Water is referred to as a "universal solvent" because it can dissolve more substances than any other liquid on the planet. Water is contaminated quickly because of this. Water contamination is caused by harmful substances that easily dissolve into and mix with it from factories, municipalities, and farms [2].

1.8 Categories of Water Pollution

1.8.1 Groundwater

Rainwater becomes one of our most valuable yet least obvious natural resources as it percolates through the earth's pores, fissures, and cracks to fill aquifers, which are essentially subterranean water reserves. For drinking water, almost 40% of Americans rely on groundwater that is pumped to the surface of the earth. It serves as some people's sole source of freshwater in remote areas. Pollutants from fertilizers and pesticides to trash leached from landfills and septic systems contaminate groundwater, making it unsafe for human use. As groundwater seeps into streams, lakes, and oceans, it can also disperse pollution far beyond the initial sources of pollution [2].

1.8.2 Surface Water

Our oceans, lakes, and rivers are filled with a substance that makes up around 70% of the earth's surface. More than one-third of our lakes and nearly half of our rivers and streams are contaminated, making them unsafe for drinking, fishing, or swimming in. In these freshwater sources, nitrate pollution—which includes both nitrate and phosphates—is the most common kind of contamination. Although these nutrients are necessary for plants and animals to develop, farm waste and fertilizer runoff have turned them into a significant pollution. Emissions of contaminants from industrial waste discharge also played a part [2].

1.8.3 Ocean Water

Eighty percent of marine pollution, commonly referred to as ocean pollution, originates on land, either far inland or along the shore. Through streams and rivers, pollutants like pesticides, fertilizers, and heavy metals are transported from farms, factories, and towns into our bays and estuaries, where they eventually end up in the ocean. Carbon pollution from the air is continuously absorbed by our seas, which are occasionally contaminated by oil spills and leaks. Up to 25% of carbon emissions caused by humans are absorbed by the ocean [2].

1.8.4 Point Source

Point source pollution is the term used to describe contamination that originates from a single source. Examples include oil refineries, manufacturers, and waste water treatment facilities that legally or illegally release wastewater, also known as effluent; contamination from leaking septic systems; chemical and oil spills; and illicit dumping. Even when point sources originated in a particular place, miles of rivers and seas may be impacted [2].

1.8.5 Nonpoint Source

Pollutants originating from dispersed sources are referred to as nonpoint sources. These could include debris blown into waterways from lands, rainwater runoff from agriculture, or both. Farm and livestock operations' animal waste introduces nutrients and diseases, including germs and viruses, into our waterways [2].

1.8.6 Sewage and Wastewater

Wastewater is water that has been used. It originates from metals, solvents, and toxic sludge found in commercial, industrial, and agricultural operations, as well as from our toilets, sinks, and showers. The phrase also refers to storm water runoff, which happens when precipitation carries chemicals, trash, oil, and grease from surfaces into our rivers [2].

1.8.6 Oil Pollution

The estimated 1 million tons of oil that are released into the maritime environment annually come from land-based sources like farms, companies, and towns rather than from tanker disasters. Ten percent of the oil in the world's waterways comes from at-sea tanker spills, with the other thirty percent coming from the maritime industry's routine operations through both legal and illicit discharge. Seeps, or naturally occurring fractures in the ocean floor, are another way that oil is released [2].

1.8.7 Radioactive Substance

Any contamination that releases more radiation than the environment naturally produces is known as radioactive waste. It is produced by nuclear power plants, uranium mining, the building and testing of armaments, and medical facilities and academic institutions that use radioactive materials for research and teaching [2].

2.0 Impact of Improper Waste Disposal on Surface Water

One of the main issues facing the world is the supply of freshwater; roughly one-third of the world's drinking water needs comes from surface features including rivers, lakes, dams, and canals [9]. These water sources are also the ideal sinks for disposing of trash from homes and businesses [10].
Humans have used surface water for a variety of purposes. Particularly in rural locations, it serves as a supply of domestic water prior to treatment as well as a source of potable food following treatment. Farmers have utilized it for irrigation, while fishermen make their living by catching fish in freshwater bodies of water. In addition to being a bathing area, it is a tourist destination hub. Therefore, surface water ought to be shielded against pollution.Fresh water and clean water sources were being depleted and pollution increased as a result of the discharge of wastewater from homes and businesses.

A vital but finite resource, freshwater is easily contaminated. The quality of freshwater can be expensive and difficult to recover after it has been corrupted to the point that it is deemed "polluted." Because of this, research on surface water pollution has mostly concentrated on streams and lakes, and the majority of the scientific instruments created by regulatory bodies like the US Environmental Protection Agency have been employed to safeguard the quality of the water in this area of the planet's surface waters. In addition to being subjected to extreme stress, water in lakes and reservoirs as well as water that flows continuously via streams is also easily contaminated due to its usage in agriculture, industry, recreation, and water storage [11].

2.1 Surface Water Quality

One of the most impacted ecosystems on the planet is surface water, and changes to it have resulted in widespread ecological degradation, including a reduction in the amount and availability of water, severe flooding, the extinction of species, and modifications to the distribution and composition of the aquatic biota [12]. As a result, surface water is no longer a suitable resource for providing goods and services.

The chemical, physical, and biological properties of water are what define its quality and decide how suitable it is for different applications as well as for maintaining the integrity and health of aquatic ecosystems. A drop in water quality could result in higher treatment costs for industrial and potable water activities. Inadequate water quality for agricultural purposes can have an impact on crop productivity and lead to food insecurity.

Toxic substances can have a detrimental effect on the health of aquatic environments. The large pathogen population in the water makes this situation even worse. Utilizing microbiologically tainted water for household uses is harmful to both society and human health. Wildlife, which depends on surface water for habitat or drinking, may also be impacted by these circumstances [12].

2.2 Impact of wastewater discharge onto Surface water.

The ecosystem and public health are impacted in the short- and long-term when untreated and raw effluent is dumped into bodies of water.

2.2.1 Environmental impact

Wastewater that has not been adequately treated may have a significant influence on the receiving watershed. There could be a single negative impact or recurring ones. Acute impacts from wastewater effluents are usually caused by high quantities of chemicals that require oxygen, high concentrations of ammonia and chlorine, or dangerous concentrations of organic contaminants and heavy metals [13]. Cumulative consequences result from the gradual build-up of pollutants in receiving surface water, which become apparent only after a threshold is reached.

There is a temperature range within which all aquatic species may survive and function optimally. Their life expectancy, growth, and reproductive cycle may be hampered or endangered by abrupt changes within that range. Discharged effluents from wastewater treatment facilities typically raise the receiving water's oxygen demand due to the organic loads in the wastewater. When untreated wastewater is introduced into surface water, there is a greater loss of dissolved oxygen (DO). Healthy ecosystems depend on a complex network of fungi, bacteria, plants, and animals that interact with one another either directly or indirectly in order to survive. Damage to any one of these species can start a domino effect that puts entire aquatic ecosystems in jeopardy [14].

When freshly added nutrients proliferate and encourage the growth of plants and algae, water pollution in lakes and marine environments can result in an algal bloom. This lowers the oxygen content of the water. Eutrophication, or the death of oxygen, suffocates animals and plants and can result in "dead zones"—areas where there is practically no life in the water. Under certain circumstances, these dangerous algal blooms can also create neurotoxins that have an impact on species, including turtles and whales [15].

Waterways are also contaminated by heavy metals and chemicals from urban and industrial wastewater. The majority of the time, these contaminants are hazardous to aquatic life, shortening their lifespans, preventing them from reproducing, and causing them to move up the food chain as predators devour prey. This is the process by which large fish, like tuna, collect large amounts of pollutants, such mercury.

Marine debris, which can smother, starve, and strangle animals, is another danger to marine ecosystems. A large portion of this solid waste, including plastic bags and soda cans, ends up in storm drains and sewers before entering the ocean. In the meantime, coral and shellfish are having a harder time surviving due to ocean acidification. Despite this, they absorb over 25% of the carbon pollution produced year by burning fossil fuels, acidifying the ocean, and burning fossil fuels. This process affects the neural systems of sharks, clownfish, and other marine animals and makes it more difficult for shellfish and other species to form shells [2].

2.2.2 Health impacts

Potable water of high quality is necessary for survival. Numerous human actions disrupt the natural water cycle and have an impact on the link between society and water. The demand for the exploitation of the world's resources, particularly water, is rising due to the population's constant growth and rising aspirations for a high quality of living.

People who use the water resources for residential and other uses downstream may get a water-borne illness as a result of surface water contamination with pathogenic organisms from wastewater [16]. Approximately 25% of all deaths globally are attributable to infectious diseases brought on by harmful microbes. The public health effects of wastewater discharge onto freshwater streams are the main cause for worry. Wastewater is home to a variety of pathogen classes that can infect humans and cause illnesses of varying severity. When individuals use contaminated surface water for home, agricultural, or recreational uses, pathogens have an instantaneous detrimental influence on them, unlike some environmental effects that may take a long time to show symptoms. Multiple outbreaks of diseases, like diarrhea.

One of the main causes of illness from contaminated drinking water is waterborne pathogens, which are disease-causing bacteria and viruses from human and animal waste. Contaminated water can spread cholera, giardiasis, and typhoid fever. Harmful microorganisms are released into waterways even in wealthy nations due to agriculture and urban runoff, as well as unintentional or illegal releases from sewage treatment facilities [13].

Our water supplies are being contaminated by a wide range of chemical pollutants, including pesticides, nitrate fertilizers, and heavy metals like arsenic and mercury. When consumed, these poisons can result in a variety of health problems, including as cancer, hormone imbalances, and changes in brain function. Pregnant women and children are especially vulnerable. Swimming itself can be dangerous. The EPA estimates that 3.5 million Americans get health problems from sewage-filled coastal waters each year, including hepatitis, pinkeye, lung infections, and skin rashes.

2.2.3 Health impacts of solid waste

There are drawbacks to modernization and advancement, but one major issue is the pollution that it is bringing about on land, in the air, and in the sea. The amount of waste produced everyday by each home has increased due to the growth in the global population and the increased need for food and other necessities. In the end, this material is dumped into municipal waste collection centers, where local municipalities gather it and dispose of it in landfills and dumps. However, not all of this trash is collected and sent to the designated dumpsites, either because of a lack of resources or ineffective infrastructure. If incorrect management and disposal are carried out at this point, it may have detrimental effects on one's health as well as environmental issues [18].

Waste management that is not up to pace can seriously jeopardize public health by spreading infectious diseases, especially when it comes to excreta and other liquid and solid waste from homes and communities. Unattended trash outside attracts flies, rodents, and other pests that aid in the spread of illness. Usually, as moist waste decomposes, an unpleasant smell is emitted. This leads to unhygienic conditions, which subsequently contribute to a rise in health problems. The plague epidemic in Surat is a great example of a city suffering because of the local population's heartless disdain for maintaining the city's cleanliness. Plastic waste is another factor in poor health. As a result, it's critical to control the volume of excessive solid waste produced by implementing certain preventive actions.

The people who work with trash, those who produce dangerous and infectious materials, and those living in locations without appropriate waste disposal methods are among the groups most at risk from the careless disposal of solid waste. Preschoolers are particularly vulnerable. The people who live next to a trash dump and those whose water supply has been tainted by waste dumping or landfill site leaks are two more high-risk groups. The risk of infection and harm is also increased by uncollected solid trash.Particularly dangerous are home waste materials that are organic because they can ferment and provide an environment that is conducive to the growth and survival of microorganisms. trash workers and rag pickers are particularly prone to the many infectious and chronic diseases that can arise from direct handling of solid trash.

Many studies have been conducted in different parts of the world to establish a connection between health and hazardous waste. Exposure to hazardous waste can affect human health, with children being more vulnerable to these pollutants. In fact, direct exposure can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning. Untreated discharge of some chemicals, such as polychlorinated biphenyls, mercury, and cyanides, can result in illness or even death. Residents exposed to hazardous waste have shown excesses of cancer, according to several research. Numerous investigations have been conducted globally to establish a link between hazardous waste and health [19]. Concerns have arisen around the improper usage and disposal of plastics and their impact on human health.

Because the pigment in colored plastics contains extremely poisonous heavy metals, it is dangerous. Lead, copper, chromium, cobalt, selenium, and cadmium are a few of the dangerous metals that can be found in plastics. It is now illegal to use colored plastics in the majority of developed nations. The Himachal Pradesh government and the Ladakh district of India have both outlawed the usage of plastics. Other states ought to follow their lead [19].

3.0 Impact of improper waste disposal on ground water

When pollutants are discharged into the earth and find their way into groundwater, it is known as groundwater pollution (or groundwater contamination). This kind of water pollution can also happen organically as a result of a little amount of an undesired component, contaminant, or impurity existing in the groundwater; in this instance, contamination is more likely to be used than pollution. On-site sanitation systems, landfills, wastewater treatment plant effluent, leaking sewers, gas stations, and excessive fertilizer application in agriculture are some of the sources of pollution. Naturally occurring pollutants like fluoride and arsenic can also cause contamination or pollution [29]. Utilizing contaminated groundwater puts the general people at risk for illness or poisoning (water-borne illnesses).

Within an aquifer, the pollution frequently causes a contaminated plume. The pollution is dispersed across a larger area by water movement and aquifer dispersion. Its expanding edge, also known as a plume edge, may cross over into surface water sources like seeps and springs and groundwater wells, endangering both human and wildlife health. An analysis of theplume's flow, known as a plume front, can be done using a groundwater or hydrological transport model. Groundwater pollution analysis may concentrate on site geology, hydrogeology, hydrology, and soil properties as well as the types of contaminants present. Pollutant movement in groundwater is influenced by a variety of processes, including adsorption, diffusion, precipitation, and degradation.

Hydrology transport models are used to examine how surface waters and groundwater contaminants interact. Complex interactions exist between surface water and groundwater. For instance, groundwater supplies a large number of rivers and lakes. Therefore, harm to groundwater aquifers, such as that caused by fracking or excessive abstraction, may have an impact on the rivers and lakes that depend on them. One example of these interactions is the intrusion of saltwater into coastal aquifers [21].

Applying the precautionary principle, monitoring groundwater quality, protecting groundwater through land zoning, appropriately placing on-site sanitation systems, and enforcing the law are some prevention strategies. Management strategies for pollution include groundwater remediation, point-of-use water treatment, and, as a last resort, abandonment.

The portion of the natural water cycle found in subterranean layers or aquifers is made up of groundwater. Regrettably, groundwater is much too frequently dismissed as invisible. In addition to being vital for agriculture and industry, groundwater keeps rivers in good condition even during periods of low water. Surface water quality and meeting water quality criteria can be strongly impacted by a decrease in the amount or quality of groundwater that is discharging. Rehabilitating contaminated ground water is challenging, if not impossible. Any self-purification is limited by the poor microbiological activity and the sluggish groundwater flow rate. Groundwater pollution is becoming more likely due to improper waste disposal practices as well as the extensive use of potentially harmful chemicals in agriculture and industry. Pollution can come from isolated, point sources, like rubbish dumped in landfills. The untreated trash being dumped in the landfill void include inert solids like glass and plastic, biodegradable solids like vegetables, paper, and metal, and other unclassified items that pose a serious risk to the subsurface quality [22].

Groundwater supplies are used by a large number of people worldwide for irrigation and drinking water. In reality, these reserves are the only source of income for some areas that are seeing fast population expansion, frequently in arid or semiarid regions. However, new dangers to what was once believed to be an endless supply of pure water also arise with rising use and population density. There are numerous obstacles in the way of maintaining the amount and quality of groundwater resources.

3.1 Groundwater quality

There are numerous significant distinctions between surface water and groundwater contamination:

1. While pollutants influencing groundwater frequently need to travel some distance via soils, pollutants impacting surface waterways might enter them directly (e.g., industrial waste discharges).
2. Pollutants behave differently in the earth. Pollutants like volatile organic compounds (VOCs) may stay undisturbed in groundwater for extended periods of time without oxidizing, unlike on the surface, since there is typically little to no contact between the atmosphere and groundwater.

3.2 Pollutant types in groundwater

Groundwater is contaminated by a wide variety of physical, inorganic, organic, bacteriological, and radioactive factors. Primarily, numerous contaminants that contribute to the contamination of surface waters can also be detected in contaminated groundwater, albeit with varying degrees of significance.

3.2.1. Arsenic and fluoride

The World Health Organization (WHO) has determined that fluoride and arsenic are the two most dangerous inorganic contaminants in drinking water globally.

Inorganic arsenic is the most prevalent form of arsenic found in water and soil. Groundwater may naturally include the metalloid arsenic, as is most commonly observed in Asia, notably in Bangladesh, China, and India. In the shallower of two regional aquifers in the Ganges Plain in northern India and Bangladesh, 25% of water wells are severely contaminated by naturally occurring arsenic. The usage of insecticides containing arsenic has also affected the groundwater in some places [23].

3.2.2 Pathogens

Drinking water contamination from pathogens transported in pee and feces can result from improper well placement and lack of sanitation precautions. Typhoid, cholera, and diarrhea are examples of such fecal-oral transmissible diseases. Out of the four types of pathogens found in feces, which include viruses, bacteria, protozoa, and helminths or helminth eggs, the soil matrix typically filters out the relatively large helminth eggs, but the other three are frequently detected in contaminated groundwater.In terms of pathogens, deep, constrained aquifers are typically thought to be the safest sources of drinking water. Certain aquifers, particularly shallow ones, might get contaminated by pathogens from treated or untreated wastewater [24].

3.2.3 Nitrate

Nitrate is the most prevalent chemical contamination found in aquifers and groundwater worldwide. Extremely high groundwater nitrate levels in several low-income nations pose serious health risks. In high oxygen environments, it remains stable and does not decompose.

3.2.4 Organic compounds

Groundwater contamination by volatile organic compounds (VOCs) is a serious concern. They are typically released into the environment as a result of negligent industrial processes. Before these contaminants were found in drinking water sources through routine groundwater testing, many of these compounds were not known to be toxic until the late 1960s [25].

Groundwater is known to include primary volatile organic compounds (VOCs), which include aromatic hydrocarbons like BTEX chemicals (benzene, toluene, ethylbenzene, and xylenes) and chlorinated solvents like vinyl chloride (VC), trichloroethylene (TCE), and tetrachloroethylene (PCE). BTEX are significant petroleum constituents. Industrial solvents PCE and TCE have historically been employed as metal degreasers and in dry cleaning procedures, respectively.

Additionally, polycyclic aromatic hydrocarbons (PAHs), which are produced by industrial processes, are organic contaminants found in groundwater. While benzo(a)pyrene is the most hazardous PAH detected in groundwater, naphthalene is the most soluble and mobile due to its molecular weight. Generally speaking, incomplete combustion of organic matter produces PAHs as byproducts.

Groundwater may also contain organic contaminants in the form of herbicides and pesticides. The majority of pesticides have extremely complicated chemical structures, just like many other synthetic organic substances. Pesticide mobility, adsorption capacity, and water solubility in the groundwater system are all influenced by this complexity. As a result, certain pesticides are more mobile than others and can quickly get to a supply of drinking water.

3.2.5 Metals

Numerous trace metals can find their way into the environment through natural processes like weathering and can be found naturally in specific rock formations. However, industrial processes including metallurgy, paint and enamel manufacturing, mining, and solid waste disposal can result in higher than usual quantities of hazardous metals like chromium, lead, and cadmium. There is a chance that these pollutants will find their way into groundwater [19].

Many factors, most notably chemical interactions that dictate the partitioning of pollutants across various phases and species, will influence the migration of metals (and metalloids) in groundwater. Therefore, the pH and redox state of groundwater will be the main determinants of metal mobility.

3.2.6 Pharmaceutical

Among the developing ground-water pollutants being researched across the US are trace levels of pharmaceuticals from treated wastewater seeping into the aquifer [26]. Treated wastewater typically contains common medications such decongestants, tranquilizers, antidepressants, antibiotics, and anti-inflammatories. After leaving the treatment plant, this wastewater frequently finds its way into the aquifer or the source of surface water that is utilized to generate drinking water.In most places, trace levels of pharmaceuticals in surface and groundwater are well below those deemed harmful or concerning, but as the population increases and more reclaimed wastewater is used for municipal water sources, this could become a bigger issue [27].

3.2.7 Others

Petroleum hydrocarbons, other chemical compounds present in personal hygiene and cosmetic goods, a variety of organohalides and other chemical compounds, and drug pollution including pharmaceutical medications and their metabolites are examples of additional organic pollutants. Other nutrients like phosphate and ammonia, as well as radionuclides like uranium (U) or radon (Rn) that are naturally occurring in some geological formations, can also be considered inorganic pollutants. Another example of natural pollution is saltwater intrusion, which is frequently made worse by human activity.

Groundwater contamination is a global problem. According to a study done between 1991 and 2004 on the groundwater quality of the main aquifers in the US, 23% of household wells had pollutants in them at levels higher than those considered harmful to human health [28]. According to a different study, the following are the main groundwater pollution issues in Africa, ranked by significance:

(1) Nitrate pollution
(2) Pathogenic agents
(3) Organic pollution
(4) Salinization
(5) Acid mine drainage.

3.3 Causes of groundwater pollution

3.3.1 Naturally-occurring (geogenic)

The term "geogenic" describes things that arise naturally as a result of geological processes.
Because organic matter in aquifer sediments creates anaerobic conditions in the aquifer, natural arsenic poisoning happens. Due to these circumstances, iron oxides in the sediment undergo microbial disintegration, which releases arsenic into the water, which is typically tightly bonded to iron oxides. Because of this, groundwater that is high in arsenic is frequently rich in iron, however later processes frequently mask the relationship between dissolved arsenic and dissolved iron [47]. The majority of reduced species arsenite and oxidized species arsenate, with arsenite having a slightly higher acute toxicity than arsenate, are widely found in groundwater. Twenty percent of the 25,000 boreholes studied in Bangladesh had arsenic values higher than 50 μg/l, according to WHO investigations [29].

3.3.2 Systems for on-site sanitation

Depending on the population density and hydrogeological circumstances, liquids from on-site sanitation systems like pit latrines and septic tanks that seep into the ground can also cause groundwater pollution with pathogens and nitrate. Pathogen fate and transit are governed by a number of intricate factors, the interactions between which are not well understood [29]. Unheeded to local hydrogeological circumstances, which can change over a few square kilometers, basic on-site sanitation infrastructures like pit latrines can pose serious health threats to the public by contaminating groundwater.

3.3.3 Sewage and sewage sludge

Untreated waste output can lead to dermatitis, bloody diarrhea, and skin sores, among other ailments that can contaminate groundwater. These are most prevalent in areas with inadequate infrastructure for treating wastewater or when the on-site sewage disposal equipment frequently malfunctions. Untreated sewage can include a significant amount of heavy metals, which can seep into the groundwater system together with infections and nutrients.

If treated sewage treatment plant effluent seeps into or is released into nearby surface water bodies, it could potentially make its way into the aquifer. As a result, compounds that are not eliminated by traditional sewage treatment facilities may also find their way into groundwater [30]. For instance, in some places in Germany, pharmaceutical residue amounts in groundwater were found to be in the range of 50 mg/L.

This is owing to the fact that only a portion of the micro-pollutants found in urine and feces—such as hormones, medication residues, and other micro-pollutants—are removed by conventional sewage treatment plants before being released into surface water, where they may eventually find their way into groundwater.

3.3.4 Fertilizers and pesticides

Spreading manure is one way that excessive fertilizer use might lead to nitrate entering the groundwater. This is due to the fact that produce and other plant materials only makes up a small portion of the fertilizers based on nitrogen. The rest either builds up in the soil or is lost as runoff. Because nitrate is highly soluble in water and may be applied at large rates, nitrate-containing fertilizers increase discharge into surface water and leach into groundwater, which can pollute groundwater [31]. Overuse of fertilizers containing nitrogen, whether synthetic or natural, is especially harmful because a large portion of the nitrogen that plants are unable to absorb is converted to easily leached nitrate [32].

When manure is applied improperly, pathogens and nutrients (nitrate) might enter the groundwater system.
If fertilizer nutrients—particularly nitrates—wash into watercourses or seep through the soil into groundwater, they may pose a threat to human health and natural ecosystems. The primary cause of anthropogenic nitrogen in groundwater globally is the extensive application of nitrogenous fertilizers in agricultural systems [33].

3.3.5 Commercial and individual leaks.

Aquifers supporting commercial and industrial operations have been discovered to contain a wide range of both organic and inorganic contaminants. The main cause of the metals, including arsenic, found in anthropogenic groundwater is ore mining and metal processing facilities. The solubility of potentially hazardous metals that may eventually find their way into the groundwater system is facilitated by the low pH linked to acid mine drainage (AMD).

4.0 Proper waste disposal systems

The procedures and necessary steps to handle trash from its creation to its ultimate disposal are referred to as waste management (or waste disposal). This covers waste collection, transportation, treatment, and disposal in addition to waste management process monitoring and control, as well as waste-related laws, technology, and economic mechanisms.There are various ways to manage and dispose of different types of waste, which might be solid, liquid, or gaseous. All forms of waste, including organic, radioactive, biological, household, municipal, and industrial wastes, are dealt with via waste management. Waste may occasionally be harmful to people's health [34]. Health problems arise at every stage of the waste management process. Aside from directly, health complications might also occur indirectly. Indirectly, through the use of food, water, and soil; directly, through the management of solid waste. Human activity, such as the extraction and processing of raw resources, produces waste [35].
The goal of waste management is to lessen the negative consequences that waste has on the environment, human health, planetary resources, and aesthetics.

Countries (developed and developing), regions (urban and rural), and the residential and industrial sectors may all have diverse methods to waste management. Waste should generally be thermally treated or its materials recycled. If this isn't feasible due to technical or financial constraints, the trash is dumped in a landfill after being appropriately treated.

4.1 Recycling

Recycling is the process of gathering and reusing waste materials, such as empty beverage containers. Recycling is a resource recovery technique. In this procedure, things that would normally be disposed of as trash are broken down and reused. Recycling has several advantages, and it can help clean up the planet because of the countless new technologies that are making even more materials recyclable [36]. Recycling has a good economic impact in addition to environmental benefits. It is possible to create new products from the ingredients used to make the existing ones. Kerbside collection is the process of collecting recyclables independently from regular garbage using special containers and pickup trucks. In many localities, it is mandatory for the garbage owner to separate the materials.

Recycling includes the recovery of raw materials from waste (e.g., the production of new glass from fragments, the melting of scrap iron, and the production of recycled building materials from construction waste) as well as the direct reuse of used products (e.g., used clothing and functioning parts removed from used vehicles). The process of converting garbage into products that are of poorer grade than the original material is known as downcycling [37].

4.2. Incineration

One form of disposal for solid organic waste is incineration, which involves burning the trash to produce residue and gaseous products. Both municipal solid waste and solid residue from waste water treatment can be disposed of with this technique. By using this method, solid waste volumes were decreased by 80–95%. "Thermal treatment" refers to incineration and other high temperature waste treatment methods. Waste materials are converted by incinerators into ash, gas, steam, and heat [29].Both small-scale incinerators and large-scale incinerators are used in the industry. Waste that is solid, liquid, or gaseous is disposed of using it. It is acknowledged as a workable way to get rid of some hazardous waste (such biological medical waste). Because it releases a significant amount of carbon dioxide and other gaseous pollutants, incinerating garbage is a contentious method of disposing of it [38].

Waste incineration plants or waste wood furnaces are used for thermal treatment of combustible household garbage and waste wood that is not suitable for recycling. Buildings are heated and electricity is produced by the process's emitted heat. Waste that has a high calorific value and little pollution can be utilized in place of fossil fuels in industrial facilities like cement factories.

Organic polluted waste is subjected to a different kind of thermal treatment (such as in facilities that incinerate hazardous garbage). A method for treating flue gas is required for incinerators. The type of garbage determines the specifications for the incinerator system and flue gas treatment.

Since incinerators typically don't need as much space as landfills, they are popular in nations with limited land, like Japan. Facilities that burn waste in a boiler or furnace to produce heat, steam, or electricity are referred to as waste-to-energy (WtE) or energy-from-waste (EfW) facilities. There have been worries over contaminants in the gaseous emissions from incinerator stacks due to imperfect combustion in incinerators. Some extremely persistent organic compounds, like dioxins, furans, and PAHs, which can be produced and may have detrimental effects on the environment, as well as some heavy metals, like mercury and lead, which can volatilize after combustion, have drawn special attention.

Trained trash disposal firms handle the waste according to the incinerator plant's specifications. This lowers the chance of an accident and ensures that the gasoline will be of the highest quality. When mixing liquids, for instance, the companies make sure that no unwanted reactions take place.

4.3 Chemical-physical and biological treatment

The aim of chemical-physical and biological treatment is to facilitate the safe disposal of trash or the removal of pollutants from it. The waste kinds that are often managed in this manner include wastewater and contaminated excavated debris. Pollutants can be disposed of in concentrated form in facilities that are appropriate for this purpose after undergoing chemical and physical treatment.

4.4 Landfills

Waste products are disposed of in a landfill site, sometimes referred to as a tip, dump, rubbish dump, garbage dump, or dumping ground. Although the systematic burying of garbage with daily, intermediate, and ultimate covers only started in the 1940s, landfills are the oldest and most popular place to dispose of waste. Historically, trash was merely piled up or dumped into pits; this is referred to as a midden in archaeology.

Certain landfills are utilized for waste management activities, including short-term storage, consolidation, and transportation, as well as several phases of waste material processing, including recycling, sorting, and treatment. Landfills may experience intense shaking or ground liquefaction during an earthquake if they are not stabilized. After a landfill is filled, the land above it may be recovered for different use.Landfills that adhere to legal regulations receive the disposal of waste from incinerated waste as well as waste that is unsuitable for thermal treatment or material recycling. Waste needs to be pre-treated if it doesn't meet landfill regulations.

4.5 Collection and logistics

Numerous specialized actors are involved in the waste management industry. Among their responsibilities include gathering waste from homes, businesses, and industries at the source, storing it in transit containers, and transferring it to waste disposal facilities. Waste treatment frequently relies on a series of specialized plants working together. In any situation, effective waste management requires seamless logistics. According to the Ordinance on Movements of Waste, the handover of hazardous waste must to be documented.

The ways in which waste is collected range greatly between nations and areas. Local government agencies or private businesses handle the collection of household waste, whereas commercial and industrial waste is handled by private corporations. Certain regions, particularly those in less developed nations, lack official garbage collection systems.

4.6. Waste handling practices

In many industrialized nations, including the United States, Canada, New Zealand, and much of Europe, curbside collection—where waste is picked up on a regular basis by specialized trucks—is the most popular method of disposal. This is frequently connected to waste segregation at the curb. It can be necessary to transport waste to a transfer station in remote locations. After collection, waste is delivered to the proper disposal location. Vacuum collection is a practice in certain places where garbage is drawn from residential or commercial spaces and moved via small bore tubes under vacuum. Both North America and Europe employ these systems [39].

4.7 Waste segregation

This is how dry waste and moist waste are separated. The idea is to turn wet trash into compost and recycle dry garbage with ease. Waste that is separated out is significantly less likely to be landfilled, which lowers pollution levels in the air and water. Waste segregation should, crucially, be determined by the kind of waste and the best course of action for treatment and disposal. Additionally, this facilitates the application of various waste management methods, such as burning, recycling, and composting. Waste management and segregation are crucial community practices. Making sure people are aware is one method to implement waste management. The community should be made aware of the trash segregation procedure [40].

Because segregated waste requires less physical sorting than mixed waste, it is frequently less expensive to dispose of. Waste segregation is crucial for several reasons, including compliance with regulations, financial savings, and safeguarding the environment and public health. It should be as simple as possible for institutions' employees to properly separate their waste. This can involve labeling, ensuring that there are sufficient accessible containers, and outlining the critical importance of segregation.Given the potential harm that excess products of the nuclear cycle can do to human health, labeling is particularly crucial when handling nuclear waste [41].

4.8.Biological reprocessing

Organic resources that can be recovered include plant debris, food wastes, and paper products. These materials break down through the processes of composting and digesting. After that, the organic material is recycled and used in landscaping or agriculture as mulch or compost. Furthermore, waste gas from the process, like methane, can be recovered and used to maximize efficiency by producing heat and electricity (CHP/cogeneration). Different technologies and procedures exist for digesting and composting. The degree of complexity varies, ranging from basic residential compost piles to extensive industrial digestion of diverse household garbage. The various biological breakdown processes are divided into aerobic and anaerobic categories. Some techniques employ these two methodologies' hybrids. Anaerobic breakdown of the organic matter.

A trash-to-energy and recycling facility for non-exported waste

There are various ways to manage and dispose of different types of waste, which might be solid, liquid, or gaseous. All forms of waste, including organic, radioactive, biological, household, municipal, and industrial wastes, are dealt with via waste management. Waste may occasionally be harmful to people's health [34]. Health problems arise at every stage of the waste management every stage of the waste management process. Aside from directly, health complications might also occur indirectly. Indirectly, through the use of food, water, and soil; directly, through the management of solid waste. Human activity, such as the extraction and processing of raw materials, produces waste [35, 43]. The goal of waste management is to lessen the negative consequences that waste has on the environment, human health, planetary resources, and aesthetics.

Different approaches to waste management can be taken by the residential and industrial sectors, regions (urban and rural), and countries (developed and developing).

Building sustainable and lovable communities requires effective trash management, although many developing nations and cities still struggle with this. According to a survey, efficient waste management often costs between 20% and 50% of municipal budgets. To run this vital city service, integrated systems that are effective, long-lasting, and socially beneficial are needed [43]. The majority of garbage produced by residential, commercial, and industrial activities is municipal solid waste (MSW), which is the subject of many waste management procedures [44].Integrated techno-economic mechanisms (Gollakota) of a circular economy, efficient disposal facilities, export and import control (Elegba), and the most sustainable product design are all examples of waste management strategies.

The authors of the first systematic review of the scientific literature on waste management, the environment, and human health and life came to the conclusion that nearly one-fourth of all municipal solid terrestrial waste is either not collected at all or is mismanaged after it is, frequently being burned in uncontrolled, open fires. Taken together, these figures approach one billion tons annually. Additionally, they discovered that, in part because of a lack of "substantial research funding," which is a necessary motivator for scientists, each of the major priority areas lacks a "high-quality research base." Computer monitors, motherboards, cell phones and chargers, compact discs (CDs), headphones, television sets, air conditioners, and refrigerators are examples of electronic garbage, or ewaste. India produces about 2 million tonnes of e-waste annually, according to the Global E-waste Monitor 2017.

4.9 Liquid waste-management

Since liquid waste is so challenging to handle, it is a crucial area in waste management. Liquid wastes are more difficult to remove from an environment than solid wastes. When liquid wastes come into touch with other liquid sources, they quickly spread and contaminate them. Additionally, this kind of garbage seeps into groundwater and soil. This consequently leads to pollution of the surrounding human population as well as the plants and animals in the ecosystem [45].

4.10 Industrial wastewater

A treatment plant can turn wastewater from an industrial operation into treated water and solids that can be used again.The term "industrial wastewater treatment" refers to the procedures utilized to clean up wastewater that is an unwanted byproduct of industry. Following treatment, the cleaned industrial wastewater (also known as effluent) can be disposed of naturally in surface waters or sanitary sewers, or it can be recycled. Sewage treatment plants can handle the wastewater produced by certain industrial facilities. The majority of industrial processes, including petrochemical, chemical, and petroleum refineries, have dedicated facilities to treat their wastewaters in order to ensure that the concentration of pollutants in the treated wastewater complies with the laws governing the disposal of wastewaters into rivers, lakes, or the ocean. This is relevant to sectors that produce wastewater that contains high levels of hazardous contaminants (including heavy metals, volatile oganic compounds, and oil and grease), organic matter, and hazardous substances (such volatile organic compounds, heavy metals) or fertilizers (like ammonia). After installing a pre-treatment system to filter out some contaminants (such hazardous chemicals), some industries release wastewater that has only partially been treated into the public sewer system.

Wastewater is produced by most industries. Reducing this kind of manufacturing or recycling treated wastewater in the production process are recent trends. Pollution prevention is the technique by which certain industries have successfully redesigned their manufacturing processes to minimize or completely eliminate pollutants. Battery manufacturing, electric power plants, the food industry, the iron and steel industry, mines and quarries, the nuclear industry, oil and gas extraction, the production of organic chemicals, the refinement and petrochemicals of petroleum, the pulp and paper industry, smelters, textile mills, industrial oil contamination, water treatment, and wood preservation are some of the sources of industrial wastewater. Brine treatment, solids removal (such as chemical precipitation and filtration), oils and grease removal, biodegradable organics removal, other organics removal, acids and alkalis removal, and toxic material removal are some of the treatment procedures.

4.11 Sewage sludge

Anaerobic digesters used for sludge treatment at a Cottbus, Germany, sewage treatment facility
The management and disposal of sewage sludge generated during sewage treatment are referred to as sewage sludge treatment procedures. The goals of sludge treatment are to minimize the weight and volume of the sludge in order to lower transportation and disposal expenses, as well as any possible health hazards associated with disposal methods. The main method of reducing weight and volume are to remove water, and the process of heating, such as in thermophilic digestion, composting, or burning, is often used to destroy pathogens.

The amount of sludge produced and a comparison of the treatment expenses needed for the various disposal choices are the deciding factors when selecting a sludge treatment procedure. Rural communities might find air-drying and composting appealing, whereas cities might find aerobic digestion and mechanical dewatering more advantageous due to land constraints, and metropolitan locations might benefit from energy recovery alternatives due to economies of scale [45].

Sludge is primarily made up of water with some solid material extracted from liquid sewage. Settling solids extracted from primary clarifiers during first treatment are included in primary sludge. Sludge separated in secondary clarifiers and utilized in secondary treatment bioreactors or procedures involving inorganic oxidizing agents is referred to as secondary sludge. Because the tanks in the liquid line are not large enough to hold sludge, the sludge generated in intensive sewage treatment procedures must be continuously evacuated from the line.

This is done to maintain the compactness and balance of the treatment operations (about equal amounts of sludge produced and removed). The sludge treatment line receives the sludge that was taken out of the liquid line. Compared to anaerobic processes, aerobic procedures—like the activated sludge process—usually yield more sludge. Conversely, in large-scale (natural) treatment systems, like artificial wetlands and ponds, the generated sludge accumulates in the treatment units (liquid line) and is only removed after many years of use.

Options for treating sludge are contingent upon the quantity of solids produced and additional site-specific factors. Most typically, composting is used in small-scale factories that have anaerobic digestion for larger-scale operations and aerobic digestion for mid-sized activities. Sometimes the sludge is de-watered by passing it through a device known as a pre-thickener. Pre-thickeners come in three different varieties: belt filter presses, rotary drum sludge thickeners, and centrifugal sludge thickeners. Sludge that has been dewatered can be burned, moved off site to a landfill, or added to soil in agriculture.

5.0 Conclusion

Children are particularly susceptible to the health effects of hazardous material exposure at landfills. Chemical poisoning results from the release of chemical waste into the environment, whereas direct exposure can cause diseases through chemical exposure. Unauthorized garbage disposal techniques have been greatly impacted by the absence of public trash cans and appropriate waste collection procedures. It is evident that the study area's sustainable growth and the environment are significantly impacted by inappropriate waste management techniques.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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