Review Article

IMPACT OF IMPROPER WASTE DISPOSAL ON SURFACE AND GROUND WATER

ABSTRACT

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

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

INTRODUCTION

A pollutant is a substance or energy introduced to the environment that has an undesired effect or adversely affects the usefulness of resources [1]. A Pollutant may cause a long or short term damage by changing the growth rate of plant or animal species or by interfering with human amenities, comfort, and health or property value. Some pollutant are biodegradable which will therefore not persist in the environment on long-term.Types of pollutant areNitrogen oxide, Sulfur oxide, Particulate matter,Ground level ozone, Volatile level ozone, Mercury, Peroxyacyl nitrate [1]

Water Pollution

Water Pollution occurs when harmful substance often chemical or microorganisms contaminate a stream, river, lake, ocean, aquifer and other body of water, degrading water quality and rendering it toxic to humans or the environment [2]. There are many man made pollutant that can contaminate water sources, we recognize two categories of their sources, point and diffuse. Examples of important point sources are industrial premises, towns, agricultural installations, manure storage, and landfills. They can be more easily identified and controlled than diffuse (non-point) sources, such as leaching of nitrates and pesticides into surface and ground water as a result of rainfall, soil infiltration, and surface run off from agricultural land. Such sources because considerable variations in the contaminant load of water over time [3].

In addition to division of contaminating sources to point and non-point, we recognize two types of contamination of water:

(1) Emergency contamination (single) frequently with immediate catastrophic impact, resulting in death of fish and other water fauna and many serious damages.

(2) Long-term contamination manifested by persisting organic pollution. It has a total negative effect on water environment and structure of food supply for water fauna, resulting in absence of some fish species in the affected river zones.

Many infectious diseases of animals and humans are water-borne. The agents of these diseases are transferred by ingestion of water contaminated with human or animal feces that contain pathogenic bacteria, viruses and parasites (protozoa, eggs of parasites). They may survive in water for different periods of time depending on many factors. Monitoring of safety of water sources is based on determination of parameters that indicate pollution caused by sewage, animal excrements, storage of waste, animal manure and artificial fertilizers, and others [3,4]. An important tool that helps to eliminate pollution of water sources is the Directive 2010/75/EU on integrated prevention of pollution and control that applies to industrial and agricultural installations with large pollution potential. However, this directive generally does not apply to diffuse sources and many smaller point sources.

Organic and Inorganic Pollutants

The main source of organic pollution of rivers is the organic matter derived from diverse human activities. This involves domestic and industrial sewage, wastes from agriculture and animal production, food processing facilities and other. Many toxic organic compounds are non-biodegradable, or are degraded slowly, so they persist in the ecosystem; some are magnified in the food web; some may cause cancer in humans; others are converted into carcinogens when they react with chlorine used to disinfect water; some affect even kill fish and other aquatic organisms; some are nuisances. Freshwater eutrophication is another worldwide problem. 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.

Rivers are recipient for rain water from relevant catchment areas but also of wastewater (treated and untreated) and infiltration from landfills. Removal of some pollutants is very difficult and expensive, therefore prevention of such pollution is preferred. Partial solution of this problem is based on zones of protection of water sources [6].

The primary pollution of ground water results from substances that naturally occur in ground water and the mineral environment or by all types of point and diffuse sources of pollution. Therefore, ground water also requires protection, regular monitoring and some treatment before it is used for drinking and other domestic uses.

Microbiological Pollution of Water

Water may be polluted by various pathogens—bacteria, viruses, protozoa, and helminths. According to the WHO, 80% of all diseases in the developing countries results from contaminated water.

The major sources of infectious agents are

(1) Untreated and improperly 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.

The spectrum of pathogenic and potentially pathogenic micro-organisms spread by water is extensive. The most frequent are the causative agents of intestinal diseases (typhoid, paratyphoid, salmonellosis, tuberculosis, brucellosis, tularaemia, leptospirosis, cholera, amoebic dysentery, schisostomiasis).

A special group are diseases of viral etiology, such as infectious hepatitis, poliomyelitis, aseptic meningitis, diseases of the respiratory and gastrointestinal tracts.

Because water is not examined for the presence of viruses and because general microbiological analysis fails to detect them, they pose a considerable threat for humans and animals.

Determination of microbiological safety of drinking water has traditionally been carried out by monitoring the counts of bacteria that serve as indicators of fecal contamination. They are usually monitored at the entry to the supply system and at certain fixed and randomly located points within the distribution system. Much effort was devoted to finding an ideal indicator micro-organism but, at present, no single micro-organism used for this purpose meets satisfactorily all the desired criteria.

To ensure the safety ofmicrobiological potable water various disinfection technologies are used. When activechlorine is used for this purpose, existence of a target chlorine residual concentration after a specified contact time serves as a reliable indicator of real-time control of bacteria and viruses.

Many research studies indicated that disinfection of water with active chlorine is not the ideal way of ensuring its safety due to development of by-products, particularly when water contains traces of organic substances. Of main concern there is the potential production of trihalomethanes, particularly long exposure of humans to these substances, and formation of chloro- and bromo-benzoquinones, the by-products of the chlorination process [7].

1.6 Protection of Water

A sufficient quantity of good potable water cannot be ensured without protecting the water sources. Generally, three-fourths of the water used in agriculture, industry, and our homes comes from surface waters, and the rest from groundwater. Although ground waters are less exposed to pollution than surface waters, the consequences of their pollution are longer lasting.

The effort to protect water and watercourses against pollution has a long tradition, but only on a local scale. The growing awareness of possible problems led to a UNECE (United Nations Economic Commission for Europe, 1992) Water Convention on the protection and use of transboundary watercourses and international lakes.

This convention, together with its amendments, is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface waters and ground waters. The Water Convention requires Parties to prevent, control, and reduce transboundary impact, use transboundary waters in a reasonable and equitable way and ensure their sustainable management.

1.7 Causes of Water Pollution

Water is uniquely vulnerable to pollution. Known as a "universal solvent", water is able to dissolve more substance than any other liquid on earth. It is why water is easily polluted. Toxic substance from farms, towns and factories readily dissolve into and mix with it causing water pollution [2].

1.8 Categories of Water Pollution

1.8.1 Groundwater

When rain falls and seeps deep into the earth, filling the cracks, crevices and porous spaces of an aqulfer (basically an underground storehouse of water), it becomes groundwater one of our least visible but most important natural resources. Nearly 40 percent of Americans rely on groundwater, pumped to the earth surface, for drinking water. For some in the rural areas, it's their only freshwater source. Groundwater gets polluted when contaminates from pesticides and fertilizer to waste leached from landfills and septic system makes it unsafe for human use. Groundwater can also spread contamination far from the original polluting sources as it seep into streams, lakes, and oceans [2].

1.8.2 Surface Water

Covering about 70 percent of the earth surface is what fills our oceans, lakes, river. Nearly half of our rivers and streams and more than one-third of our lakes are polluted and unfit for swimming, fishing and drinking. Nitrate pollution, which include nitrate and phosphates is the is the leading type of contamination in these freshwater sources. While plant and animal needs these nutrient to grow, they have become a major pollutant due to farm waste and fertilizer runoff.

Industrial waste discharge contribute their fair share of toxic as well [2].

1.8.3 Ocean Water

Eighty percent of ocean pollution (also called marine pollution) originate on land whether along the coast or far inland. Contaminants such as chemicals, nutrients and heavy metals are carried from farms, factories and cities by streams and rivers into our bays and estuaries; from there they travel out to sea. Our seas sometimes spoiled by oil spills and leaks are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man-made carbon emissions [2].

1.8.4 Point Source

When contamination originated from a single source, it is called point source pollution. Example include wastewater (also called effluent) discharged legally or illegally by a manufacturer, oil refinery, or waste water treatment facility, as well as contamination from leaking septic system, chemical and oil spills, and illegal dumping. While point sources originated from a specific, it can affect miles of waterways and oceans [2].

1.8.5 Nonpoint Source

Nonpoint Source pollution is contamination derived from diffused sources. These may include agricultural or stormwater runoff or debris blown into waterways from lands. Animal waste from farms and livestock operation wash nutrients and pathogens such as bacteria and viruses into our waterways [2].

1.8.6 Sewage and Wastewater

Used water is wastewater. It comes from our sinks, showers, and toilet and from commercial, industrial, and agricultural activities metals, solvents, and toxic sludge). The term also include storm water runoff, which occurs when rainfall carries road salts, oil, grease, chemicals and debris from surfaces into our waterways [2].

1.8.6 Oil Pollution

Nearly half of the estimated 1 million tons of oil that makes its way into marine environment each year comes not from tanker spills but from land- based sources such as factories, farms and cities. At sea tanker spills account for 10 percent of the oil in waters around the world, while regular operation of the shipping industry through both legal and illegal discharge contribute about one-third. Oil is also naturally released from under the ocean floor through fractures known as seeps [2].

1.8.7 Radioactive Substance

Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It is generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that uses radioactive materials for research and medicine [2].

2.0 Impact of Improper Waste Disposal on Surface Water

Freshwater availability is one of the major problems facing the world, and approximately, one-third of drinking water requirements of the world is obtained from surface surfaces like river, dams, lakes, canals [9]. These sources of water also serve as best sink for the discharge of domestic and industrial waste [10].

Surface water has been exploited for several purposes by humans. It serves as sources of potable eater after treatment and as a source of domestic water before treatment particularly in rural areas. It has been used for irrigation purposes by farmers, and fishermen gets their occupation from harvesting fish from freshwater sources. It is used for swimming and also serves as center for tourist attraction. Surface water, therefore, should be protection from pollution.

The release of domestic and industrial wastewater led to the increase in pollution and depletion of fresh water and clean water sources.

Freshwater is a scarce and valuable resource—one that can easily be contaminated. Once contaminated to the extent it can be considered "polluted," freshwater quality is difficult and expensive to restore. Thus the study of surface water pollution has focused primarily on streams and lakes, and most of the scientific tools developed by such regulatory agencies as the U.S. Environmental Protection Agency have been applied to protecting water quality in this segment of earth's surface waters. The water stored in reservoirs and lakes, together with the water that flows perennially in streams, is subject to heavy stress, and because it is used for water supplies, agriculture, industry, and recreation, this water can easily be contaminated [11].

2.1 Surface Water Quality

Surface water is one of the most influenced ecosystem on earth, and its alteration have led to extensive ecological degradation such as a decline in water quantity and availability, intense flooding, loss of species, and changes in the distribution and structure of the aquatic biota [12], thereby making surface water not suitable in providing goods and services.

Water quality is describe by chemical, physical, and biological characteristics of water that determines its fitness for a variety of uses and for the protection of the health and integrity of aquatic ecosystems. Decrease in water quality may lead to increased treatment cost of potable and industrial processes water. The use of poor water quality for agricultural activities can affect crop yield and cause food insecurities.

The health of the aquatic ecosystems can be negatively affected by the presence of toxic substance. This is further exacerbated with the high population of pathogens in the water. This use of micro biologically contaminated water for domestic purposes is detrimental to human health and the society. These conditions may also affect wildlife, which uses surface water for drinking or as a habitat [12].

2.2 Impact of wastewater discharge onto Surface water.

The release of raw and ill-treated wastewater onto water causes has both short and long term effect on the environmental and human health.

2.2.1 Environmental impact

Poorly treated wastewater can have a profound influence on the receiving watershed. The toxic impact could be acute or cumulative. Acute impact from wastewater effluents are generally due to high level of ammonia and chlorine, Hugh loads of oxygen- demanding materials, or toxic concentration of heavy metals and organic contaminants [13]. Cumulative impacts are due to the gradual buildup of pollutants in receiving surface water, which we only become apparent when a certain threshold is exceeded.

All aquatic organisms have a temperature range for optimum function and survival. When there are sudden changes within those range, their reproductive cycle, growth, and life can be reduced or threatened. Owing to the organic loads of wastewater, discharged effluents from wastewater treatment facilities usually contribute to oxygen demand level of the receiving water. There is increased depletion of dissolved oxygen (DO) in the surface water that receives ill-treated wastewater.

In order to thrive, healthy ecosystems rely on a complex web of animals, plants, bacteria, and fungi—all of which interact, directly or indirectly, with each other. Harm to any of these organisms can create a chain effect, imperiling entire aquatic environments [14].

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plants and algae growth, which in turn reduced oxygen level in the water. The death of oxygen, known as eutrophication, suffocates plants and animal and can create "dead zones" where water are essentially devoid of life. In certain cases, these harmful algal blooms can also produce neurotoxins that affects wildlife, from whales to see turtles [15].

Chemicals and heavy metals from industrial and municipal wastewater contaminate waterways as well. These contaminates are toxic to aquatic life most often reducing an organisms life span and ability to reproduce and make up the food chain as predator eats prey. This is how tuna and other big fish accumulates high quantities of toxins, such as mercury.

Marine ecosystems are also threatened by marine debris, which can strangle, suffocate and starve animals. Much of this solid debris such as plastic bags and soda may, gets sweet into sewers and storm drains and eventually out to the sea.

Meanwhile, ocean acidification is making it tougher for shellfish and coral to survive. Though they absorb about quarter of the carbon pollution created each year by burning fossil, fuels, oceans and becoming more acidic. This process makes it harder for shellfish and other species to build shell and may impact the nervous system of sharks, clownfish, and other marine life [2].

2.2.2 Health impacts

Good quality potable water is essential for life. Human activities interfere in many ways with natural water cycle and affect the society-water relationship. Constant increase human population and its expectations regarding the standard of living increase demands on exploitation of existing resources including water.

Contamination of surface water with pathogenic organisms in wastewater could result in the transmission of water borne disease for people who use the water resources for domestic and other purposes downstream [16]. About 25% of all death worldwide are as a result of infectious diseases caused by pathogenic microorganisms. The major concern of wastewater discharge onto freshwater courses is the impact they have a public health. Wastewater consist of various classes of pathogens which are capable of causing diseases of various magnitude to man. Unlike some of the environmental impact that can take a long time before they manifest, pathogens causes immediate negative impact on people that use contaminated surface water for domestic, agricultural, and recreational purposes. Several episodes of disease outbreak such as diarrhea and cholera have been reported in various places with wastewater effluents as a major contributor [17].

Waterborne pathogens, in the form of disease-causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways [13].

Wide range of chemical pollutants—from heavy metals such as arsenic and mercury to pesticides and nitrate fertilizers—are getting into our water supplies. Once ingested, these toxins may cause a host of health issues, from cancer to hormone disruption to altered brain function. Children and pregnant women are particularly at risk.

Even swimming can pose a risk. Every year, 3.5 million of Americans contract health issues such as skin rashes, pinkeye, respiratory infections, and hepatitis from sewage-laden coastal waters, according to EPA estimates.

2.2.3 Health impacts of solid waste

Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth – be it land, air, and water. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal waste collection centres from where it is collected by the area municipalities to be further thrown into the landfills and dumps. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported to the final dumpsites. If at this stage the management and disposal is improperly done, it can cause serious impacts on health and problems to the surrounding environment [18].

Waste that is not properly managed, especially excreta and other liquid and solid waste from households and the community, are a serious health hazard and lead to the spread of infectious diseases. Unattended waste lying around attracts flies, rats, and other creatures that in turn spread disease. Normally it is the wet waste that decomposes and releases a bad odour. This leads to unhygienic conditions and thereby to a rise in the health problems. The plague outbreak in Surat is a good example of a city suffering due to the callous attitude of the local body in maintaining cleanliness in the city. Plastic waste is another cause for ill health. Thus excessive solid waste that is generated should be controlled through the taking of certain preventive measures.

The group at risk from the unscientific disposal of solid waste include – the population in areas where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group include population living close to a waste dump and those, whose water supply had become contaminated either due to waste dumping or leakage from landfill sites. Uncollected solid waste also increases risk of injury, and infection.

In particular, organic domestic waste poses a serious threat, since they ferment, creating conditions favourable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable.

Exposure to hazardous waste can affect human health, 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. Many studies have been carried out in various parts of the world to establish a connection between health and hazardous waste. Certain chemicals if released untreated, e.g. cyanides, mercury, and polychlorinated biphenyls are highly toxic and exposure can lead to disease or death. Some studies have detected excesses of cancer in residents exposed to hazardous waste. Many studies have been carried out in various parts of the world to establish a connection between health and hazardous waste [19]

The unhygienic use and disposal of plastics and its effects on human health has become a matter of concern. Coloured plastics are harmful as their pigment contains heavy metals that are highly toxic. Some of the harmful metals found in plastics are copper, lead, chromium, cobalt, selenium, and cadmium. In most industrialized countries, colour plastics have been legally banned. In India, the Government of Himachal Pradesh has banned the use of plastics and so has Ladakh district. Other states should emulate their example [19].

3.0 Impact of improper waste disposal on ground water

Groundwater pollution (also called groundwater contamination) occurs when pollutants are released to the ground and make their way into groundwater. This type of water pollution can also occur naturally due to the presence of a minor and unwanted constituent, contaminant, or impurity in the groundwater, in which case it is more likely referred to as contamination rather than pollution. Pollution can occur from on-site sanitation systems, landfills, effluent from wastewater treatment plants, leaking sewers, petrol filling stations or from over application of fertilizers in agriculture. Pollution (or contamination) can also occur from naturally occurring contaminants, such as arsenic or fluoride [29]. Using polluted groundwater causes hazards to public health through poisoning or the spread of disease (water-borne diseases).

The pollutant often creates a contaminant plume within an aquifer. Movement of water and dispersion within the aquifer spreads the pollutant over a wider area. Its advancing boundary, often called a plume edge, can intersect with groundwater wells and surface water, such as seeps and springs, making the water supplies unsafe for humans and wildlife. The movement of the plume, called a plume front, may be analyzed through a hydrological transport model or groundwater model. Analysis of groundwater pollution may focus on soil characteristics and site geology, hydrogeology, hydrology, and the nature of the contaminants. Different mechanisms has influence on the transport of pollutants, e.g. diffusion, adsorption, precipitation, decay, in the groundwater.

The interaction of groundwater contamination with surface waters is analyzed by use of hydrology transport models. Interactions between groundwater and surface water are complex. For example, many rivers and lakes are fed by groundwater. This means that damage to groundwater aquifers e.g. by fracking or over abstraction, could therefore affect the rivers and lakes that rely on it. Saltwater intrusion into coastal aquifers is an example of such interactions [21].

Prevention methods include: applying the applying the precautionary principle, groundwater quality monitoring, land zoning for groundwater protection, locating on-site sanitation systems correctly and applying legislation. When pollution has occurred, management approaches include point-of-use water treatment, groundwater remediation, or as a last resort, abandonment.

Groundwater forms that part of the natural water cycle present within underground strata or aquifers. Unfortunately, Groundwater is often too considered out of sight and out of mind. Groundwater is also an important source for industry and agricultural users as well as sustaining rivers experiencing low flows. A reduction in either quality of quantity of the discharging groundwater can significantly influence surface water quality and the attainment of water quality standards. If the ground water becomes polluted, it is difficult, if not impossible to rehabilitate. The slow rate of flow ofgroundwater and the low micro biological activities limits any self-purification.

The risk of groundwater pollution is increasing both from disposal of waste materials and from widespread use by industry and agriculture of potentially polluting chemicals in the environment. Pollution can occur either discrete, point source, such as from landfilling of waste. The untreated rubbish being placed in the landfill void comprises of biodegradable solids such as vegetables, paper and metal, inert solid such as glass and plastic and other unclassified materials constitute a great threat to the underground quality [22].

Many of us around the globe use groundwater supplies for drinking water and irrigation. In fact, some regions experiencing rapid population growth, often in arid or semiarid regions, depend entirely on these reserves. However, with increased use and greater population density come new threats to what was once thought to be an infinite supply of clean water. Protecting the quantity and quality of groundwater supplies comes with it many challenges.

3.1 Groundwater quality

Contamination of groundwater differs from surface water pollution in several important ways:

1. Pollutants may enter surface waters directly (e.g., industrial waste discharges), while pollutants affecting groundwater often must travel some distance through soils.

2. The behavior of pollutant in the ground is different. Since there is usually little, if any, contact between the atmosphere and groundwater, pollutants like VOCs could remain intact for long periods of time once in groundwater without being oxidized as they would on the surfac.

3.2 Types of groundwater pollutants

Contaminants found in groundwater cover a broad range of physical, inorganic chemical, organic chemical, bacteriological, and radioactive parameters. Principally, many of the same pollutants that play a role in surface water pollution may also be found in polluted groundwater, although their respective importance may differ.

3.2.1. Arsenic and fluoride

Arsenic and fluoride have been recognized by the World Health Organization (WHO) as the most serious inorganic contaminants of drinking-water on a worldwide basis.

The most common type of arsenic in soil and water is inorganic arsenic. The metalloid arsenic may occur naturally in groundwater, as seen most frequently in Asia, including in China, India and Bangladesh. In the Ganges Plain of northern India and Bangladesh severe contamination of groundwater by naturally occurring arsenic affects 25% of water wells in the shallower of two regional aquifers. Groundwater in these areas is also contaminated by the use of arsenic-based pesticides [23].

3.2.2 Pathogens

The lack of proper sanitation measures, as well as unproperly placed wells, can lead to drinking water being contaminated with pathogens carried in feces and urine. Such fecal-oral transmitted diseases include typhoid, cholera and diarrhea. Of the four pathogen types that are present in feces (bacteria, viruses, protozoa, and helminths or helminth eggs), the three can be commonly found in polluted groundwater, whereas the relatively large helminth eggs are usually filtered out by the soil matrix.

Deep, confined aquifers are usually considered the safest source of drinking water with respect to pathogens. Pathogens from treated or untreated wastewater can contaminate certain, especially shallow, aquifers [24].

3.2.3 Nitrate

The most common chemical contaminant in the world's groundwater and aquifers is Nitrate. In some low-income countries, nitrate levels in groundwater are extremely high, causing significant health problems. It is also stable (it’s non degrade) under high oxygen conditions.

3.2.4 Organic compounds

Volatile organic compounds (VOCs) are a dangerous contaminant of groundwater. They are generally introduced to the environment through careless industrial practices. Many of these compounds were not known to be harmful until the late 1960s and it was some time before regular testing of groundwater identified these substances in drinking water sources [25].

Primary VOC pollutants found in groundwater include aromatic hydrocarbons such as BTEX compounds (benzene, toluene, ethylbenzene and xylenes), and chlorinated solvents including tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride (VC). BTEX are important components of gasoline. PCE and TCE are industrial solvents historically are used in dry cleaning processes and as a metal degreaser, respectively.

Other organic pollutants present in groundwater and derived from industrial operations are the polycyclic aromatic hydrocarbons (PAHs). Due to its molecular weight, Naphthalene is the most soluble and mobile PAH found in groundwater, whereas benzo(a)pyrene is the most toxic one. PAHs are produced generally as byproducts by incomplete combustion of organic matter.

Organic pollutants can also be found in groundwater as insecticides and herbicides. As many other synthetic organic compounds, most pesticides have very complex molecular structures. This complexity determines the water solubility, adsorption capacity, and mobility of pesticides in the groundwater system. Thus, some types of pesticides are more mobile than others so they can very easily reach a drinking-water source.

3.2.5 Metals

Several trace metals occur naturally in certain rock formations and can enter in the environment from natural processes such as weathering. However, industrial activities such as mining, metallurgy, solid waste disposal, paint and enamel works, etc. can lead to elevated concentrations of toxic metals including lead, cadmium and chromium. These contaminants have the potential to make their way into groundwater [19].

The migration of metals (and metalloids) in groundwater will be affected by several factors, in particular by chemical reactions which determine the partitioning of contaminants among different phases and species. Thus, the mobility of metals primarily willdepends on the pH and redox state of groundwater.

3.2.6 Pharmaceutical

Trace amounts of pharmaceuticals from treated wastewater infiltrating into the aquifer are among emerging ground-water contaminants being studied throughout the United States [26]. Popular pharmaceuticals such as antibiotics, anti-inflammatories, antidepressants, decongestants, tranquilizers, etc. are normally found in treated wastewater. This wastewater are discharged from the treatment facility, and often makes its way into the aquifer or the source of surface water used for drinking water.

Trace amounts of pharmaceuticals in both groundwater and surface water are far below what is considered dangerous or of concern in most areas, but it could be an increasing problem as population grows and more reclaimed wastewater is utilized for municipal water supplies [27].

3.2.7 Others

Other organic pollutants include a range of organohalides and other chemical compounds, petroleum hydrocarbons, various chemical compounds found in personal hygiene and cosmetic products, drug pollution involving pharmaceutical drugs and their metabolites. Inorganic pollutants might include other nutrients such as ammonia and phosphate, and radionuclides such as uranium (U) or radon (Rn) naturally present in some geological formations. Saltwater intrusion is also an example of natural contamination, but is very often intensified by human activities.

Groundwater pollution is a worldwide issue. A study of the groundwater quality of the principal aquifers of the United States conducted between 1991 and 2004, showed that 23% of domestic wells had contaminants at levels greater than human-health benchmarks [28]. Another study suggested that the major groundwater pollution problems in Africa, considering the order of importance are:

(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)

"Geogenic" refers to naturally occurring as a result from geological processes.

The natural arsenic pollution occurs because aquifer sediments contain organic matter that generates anaerobic conditions in the aquifer. These conditions result in the microbial dissolution of iron oxides in the sediment and, thus, the release of the arsenic, normally strongly bound to iron oxides, into the water. As a consequence, arsenic-rich groundwater is often iron-rich, although secondary processes often obscure the association of dissolved arsenic and dissolved iron.[citation needed]. Arsenic is found in groundwater commonly as most of the reduced species arsenite and the oxidized species arsenate, the acute toxicity of arsenite being somewhat greater than that of arsenate. Investigations by WHO indicated that 20% of 25,000 boreholes tested in Bangladesh had arsenic concentrations exceeding 50 µg/l [29].

3.3.2 On-site sanitation systems

Groundwater pollution with pathogens and nitrate can also occurs from the liquids infiltrating into the ground from on-site sanitation systems such as pit latrines and septic tanks, depending on the population density and theconditions hydrogeological.

Factors controlling the fate and transport of pathogens are quite complex and the interaction among them is not well understood [29]. If the local hydrogeological conditions (which can vary within a space of a few square kilometers) are ignored, simple on-site sanitation infrastructures such as pit latrines can cause significant public health risks via contaminated groundwater.

3.3.3 Sewage and sewage sludge

Groundwater pollution can be caused by untreated waste discharge leading to diseases like skin lesions, bloody diarrhea and dermatitis. These are mostly common in locations having limited wastewater treatment infrastructure, or where there are systematic failures of the on-site sewage disposal system. Along with pathogens and nutrients, untreated sewage can also have an important load of heavy metals that may seep into the groundwater system.

The treated effluent from sewage treatment plants may also reach the aquifer if the effluent is infiltrated or discharged to local surface water bodies. Therefore, those substances that are not removed in conventional sewage treatment plants may reach the groundwater as well [30]. For example, detected concentrations of pharmaceutical residues in groundwater were in the order of 50 mg/L in several locations at Germany. This is because in conventional sewage treatment plants, micro-pollutants such as hormones, pharmaceutical residues and other micro-pollutants contained in urine and feces are only partially removed and the remainder is discharged into surface water, from where it may also reach the groundwater.

3.3.4 Fertilizers and pesticides

Nitrate can also enter the groundwater via excessive use of fertilizers, including manure spreading. This is because only a fraction of the nitrogen-based fertilizers is converted to produce and other plant matter. The remainder in the soil accumulates or lost as run-off . High application rates of nitrogen-containing fertilizers combined with the high water-solubility of nitrate leads to increased runoff into surface water as well as leaching into groundwater, thereby causing groundwater pollution [31]. The excessive use of nitrogen-containing fertilizers (be they synthetic or natural) is particularly damaging, as much of the nitrogen that is not taken up by plants is transformed into nitrate which is easily leached [32].

Poor management practices in manure spreading can introduce both pathogens and nutrients (nitrate) in the groundwater system.

The nutrients, especially nitrates, in fertilizers can cause problems for natural habitats and for human health if they are washed off soil into watercourses or leached through soil into groundwater. The heavy use of nitrogenous fertilizers in cropping systems is the largest contributor to anthropogenic nitrogen in groundwater worldwide [33].

3.3.5 Commercial and individual leaks.

A wide variety of both inorganic and organic pollutants have been found in aquifers underlying commercial and industrial activities.

Ore mining and metal processing facilities are the primary responsible of the presence of metals in groundwater of anthropogenic origin, including arsenic. The low pH associated with acid mine drainage (AMD) contributes to the solubility of potential toxic metals that could eventually enter the groundwater system.

4.0 Proper waste disposal systems

Waste management (or waste disposal) includes the processes and required actions to manage waste from its inception to its final disposal This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms.

Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological, household, municipal, organic, biomedical, radioactive wastes. In some cases, waste can pose a threat to human health [34]. Health issues are associated throughout the entire process of waste management. Health issues can also arise indirectly or directly. Directly, through the handling of solid waste, and indirectly through the consumption of water, soil and food. Waste is produced by [35] human activity, for example, the extraction and processing of raw materials . Waste management is intended to reduce adverse effects of waste on human health, the environment, planetary resources and aesthetics.

Waste management practices are not uniform among countries (developed and developing nations); regions (urban and rural areas), and residential and industrial sectors may all take different approaches.

In general, waste should undergo material recycling or thermal treatment. If this is not possible for technical reasons, or it is not economically viable, the waste is deposited in a landfill following suitable treatment.

4.1 Recycling

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. This process involves breaking down and reusing materials that would otherwise be gotten rid of as trash. There are numerous benefits of recycling, and with so many new technologies making even more materials recyclable, it is possible to clean up the Earth [36]. Recycling not only benefits the environment but also positively affects the economy. The materials from which the items are made can be made into new products. Materials for recycling may be collected separately from general waste using dedicated bins and collection vehicles, a procedure called kerbside collection. In some communities, the owner of the waste is required to separate the materials into different bins (e.g. for paper, plastics, metals) prior to its collection. In other communities, all recyclable materials are placed in a single bin for collection, and are sortedand handled later at a central facility. The latter method is known as "single-stream recycling".

Recycling refers to both the direct reuse of used products (e.g. used clothing and functioning parts removed from used vehicles) and material recycling, that is the recovery of raw materials from waste (e.g. production of new glass from fragments, the melting of scrap iron and the production of recycled building materials from construction waste). Downcycling refers to the transformation of waste to materials of lower quality than the initially used material [37].

4.2. Incineration

Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of both municipal solid waste and solid residue from waste water treatment. This process reduced volumes of solid waste by 80 to 95 percent Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam, and ash [29].

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants including substantial quantities of carbon dioxide [38].

Combustible waste from households and waste wood that is not suitable for recycling undergo thermal treatment in waste incineration plants or waste wood furnaces. The heat released in the process is used to generate electricity and heat buildings. Waste with a high calorific value and low level of pollutant contamination can be used in industrial plants, e.g. cement plants, as an alternative to fossil fuels. Waste that is contaminated with organic pollutants undergoes separate thermal treatment (e.g. in hazardous waste incineration plants). Incinerators must have a flue gas treatment system. The requirements for flue gas treatment and the incineration system are based on the nature of the waste.

Incineration is common in countries such as Japan where land is more scarce, as the facilities generally do not require as much area as landfills. Waste-to-energy (WtE) or energy-from-waste (EfW) are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam or electricity. Combustion in an incinerator is not always perfect and there have been concerns about pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organic compounds such as dioxins, furans, and PAHs, which can be created and which may have serious environmental consequences and some heavy metals such as mercury and lead which can be volatilised in the combustion process.

Specialised waste disposal companies treat the waste in accordance with the requirements of the incineration plant. This guarantees that the fuel will be of a high quality and reduces the accident risk. The companies ensure, for example, that no undesirable reactions occur when liquids are being mixed.

4.3 Chemical-physical and biological treatment

The objective of both chemical-physical and biological treatment is to enable the removal of pollutants from waste or its safe landfilling. Wastewater and polluted excavated material are typical of the types of waste that are managed in this way. Following chemical-physical treatment, the pollutants can be disposed of as concentrated form in facilities suitable for this purpose.

4.4 Landfills

A landfill site, also known as a tip, dump, rubbish dump, garbage dump, or dumping ground, is a site for the disposal of waste materials. Landfill is the oldest and most common form of waste disposal, although the systematic burial of the waste with daily, intermediate and final covers only began in the 1940s. In the past, refuse was simply left in piles or thrown into pits; in archeology this is known as a midden.

Some landfill sites are used for waste management purposes, such as temporary storage, consolidation and transfer, or for various stages of processing waste material, such as sorting, treatment, or recycling. Unless they are stabilized, landfills may undergo severe shaking or soil liquefaction of the ground during an earthquake. Once full the area over a landfill site may be reclaimed for other uses.

Residues from waste incineration or waste that is not suitable for material recycling or thermal treatment are deposited in landfills that are compliant with the legal requirements. If the waste do not fulfil the requirements for landfilling, it must be pre-treated .

4.5 Collection and logistics

The waste management sector involves many different specialised actors. Their tasks include the collection of waste at source (industry, commerce and households) in suitable transport containers, its intermediate storage and handover to waste disposal operations. The treatment of waste is often based on a cascade of specialised plants. In all cases, smooth logistics are a precondition for the efficient management of waste. In the case of hazardous waste, in accordance with the Ordinance on Movements of Waste, the handover must be documented.

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private companies for industrial and commercial waste. Some areas, especially those in less developed countries, does not have formal waste-collection systems.

4.6. Waste handling practices

Curbside collection is the most common method of disposal in most European countries, Canada, New Zealand, United States, and many other parts of the developed world in which waste is collected at regular intervals by specialised trucks. This is often associated with curb-side waste segregation. In rural areas, waste may need to be taken to a transfer station. Waste collected is then transported to an appropriate disposal facility. In some areas, vacuum collection is used in which waste is transported from the home or commercial premises by vacuum along small bore tubes. Systems are in use in Europe and North America [39].

4.7 Waste segregation

This is the separation of wet waste and dry waste. The purpose is to recycle dry waste easily and to use wet waste as compost. When segregating waste, the amount of waste that gets landfilled reduces considerably, resulting in lower levels of air and water pollution. Importantly, waste segregation should be based on the type of waste and the most appropriate treatment and disposal. This also makes it easier to apply different processes to the waste, like composting, recycling and incineration. It is important to practice waste management and segregation as a community. One way to practice waste management is to ensure there is awareness. The process of waste segregation should be explained to the community [40].

Segregated waste is also often cheaper to dispose of because it does not require as much manual sorting as mixed waste. There are a number of important reasons why waste segregation is important such as legal obligations, cost savings and protection of human health and the environment. Institutions should make it as easy as possible for their staff to correctly segregate their waste. This can include labelling, making sure there are enough accessible bins and clearly indicating why segregation is so important. Labeling is especially important when dealing with nuclear waste due to how much harm to human health the excess products of the nuclear cycle can cause [41].

4.8.Biological reprocessing

Recoverable materials that are organic in nature, such as plant material, food scraps, and paper products, can be recovered through composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity and heat (CHP/cogeneration) maximising efficiencies. There are different types of composting and digestion methods and technologies. They vary in complexity from simple home compost heaps to large scale industrial digestion of mixed domestic waste. The different methods of biological decomposition are classified as aerobic or anaerobic methods. Some methods use the hybrids of these two methods. The anaerobic digestion of the organic fraction of solid waste is more environmentally effective than landfill, or incineration [42]. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter.

A recycling and waste-to-energy plant for waste that is not exported

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Waste management practices are not uniform among countries (developed and developing nations); regions (urban and rural areas), and residential and industrial sectors can take different approaches.

Proper management of waste is important for building sustainable and loveable cities, but it remains a challenge for many developing countries and cities. A report found that effective waste management is relatively expensive, usually comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported [43]. A large portion of waste management practices deal with municipal solid waste (MSW) which is the bulk of the waste that is created by household, industrial, and commercial activity [44]. Measures of waste management include measures for integrated techno-economic mechanisms (Gollakota) of a circular economy, effective disposal facilities, export and import control (Elegba) and optimal sustainable design of products that are produced.

In the first systematic review of the scientific evidence around global waste, its management and its impact on human health and life, authors concluded that about a fourth of all the municipal solid terrestrial waste is not collected and an additional fourth is mismanaged after collection, often being burned in open and uncontrolled fires – or close to one billion tons per year when combined. They also found that broad priority areas each lack a "high-quality research base", partly due to the absence of "substantial research funding", which motivates scientists often require. Electronic waste (ewaste) includes discarded computer monitors, motherboards, mobile phones and chargers, compact discs (CDs), headphones, television sets, air conditioners and refrigerators. According to the Global E-waste Monitor 2017, India generates ~ 2 million tonnes (Mte) of e-waste annually and ranks fifth among the e-waste producing countries, after the US, P.R. China, Japan and Germany.

4.9 Liquid waste-management

Liquid waste is an important category of waste management because it is so difficult to deal with. Unlike solid wastes, liquid wastes cannot be easily picked up and removed from an environment. Liquid wastes spread out, and easily pollute other sources of liquid if brought into contact. This type of waste also soaks into objects like soil and groundwater. This in turn carries over to pollute the plants, the animals in the ecosystem, as well as the humans within the area of the pollution [45].

4.10 Industrial wastewater

Wastewater from an industrial process can be converted at a treatment plant to solids and treated water for reuse.

Industrial wastewater treatment describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Some industrial facilities generate wastewater that can be treated in sewage treatment plants. Most industrial processes, such as petroleum refineries, chemical and petrochemical plants have their own specialized facilities to treat their wastewaters so that the pollutant concentrate in the treated wastewater comply with the regulations regarding disposal of wastewaters into sewers or into rivers, lakes or oceans. This applies to industries that generate wastewater with high concentrations of organic matter (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or nutrients such as ammonia. Some industries install a pre-treatment system to remove some pollutants (e.g., toxic compounds), and then discharge partially treated wastewater to the municipal sewer system.

Most industries produce some wastewater. Recent trends have been to minimize such production or to recycle treated wastewater within the production process. Some industries have been successful at redesigning their manufacturing processes to reduce or eliminate pollutants, through a process called pollution prevention. Sources of industrial wastewater include battery manufacturing, electric power plants, food industry, iron and steel industry, mines and quarries, nuclear industry, oil and gas extraction, organic chemicals manufacturing, petroleum refining and petrochemicals, pulp and paper industry, smelters, textile mills, industrial oil contamination, water treatment, wood preserving. Treatment processes include brine treatment, solids removal (e.g. chemical precipitation, filtration), oils and grease removal, removal of biodegradable organics, removal of other organics, removal of acids and alkalis, removal of toxic materials.

4.11 Sewage sludge

Sludge treatment in anaerobic digesters at a sewage treatment plant in Cottbus, Germany

Sewage sludge treatment describes the processes used to manage and dispose of sewage sludge produced during sewage treatment. Sludge treatment is focused on reducing sludge weight and volume to reduce transportation and disposal costs, and on reducing potential health risks of disposal options. Water removal is the primary means of weight and volume reduction, while pathogen destruction is frequently accomplished through heating during thermophilic digestion, composting, or incineration. The choice of a sludge treatment method depends on the volume of sludge generated, and comparison of treatment costs required for available disposal options. Air-drying and composting may be attractive to rural communities, while limited land availability may make aerobic digestion and mechanical dewatering preferable for cities, and economies of scale may encourage energy recovery alternatives in metropolitan areas [45].

Sludge is mostly water with some amounts of solid material removed from liquid sewage. Primary sludge includes settleable solids removed during primary treatment in primary clarifiers. Secondary sludge is sludge separated in secondary clarifiers that are used in secondary treatment bioreactors or processes using inorganic oxidizing agents. In intensive sewage treatment processes, the sludge produced needs to be removed from the liquid line on a continuous basis because the volumes of the tanks of the liquid line have insufficient volume to store sludge. This is done in order to keep the treatment processes compact and in balance (production of sludge approximately equal to the removal of sludge). The sludge removed from the liquid line goes to the sludge treatment line. Aerobic processes (such as the activated sludge process) tend to produce more sludge compared with anaerobic processes. On the other hand, in extensive (natural) treatment processes, such as ponds and constructed wetlands, the produced sludge remains accumulated in the treatment units (liquid line) and is only removed after many years of operation .

Sludge treatment options depend on the amount of solids generated and other site-specific conditions. Composting is most often applied to small-scale plants with aerobic digestion for mid-sized operations, and anaerobic digestion for the larger-scale operations. The sludge is sometimes passed through a so-called pre-thickener which de-waters the sludge. Types of pre-thickeners include centrifugal sludge thickeners, rotary drum sludge thickeners and belt filter presses. Dewatered sludge could be incinerated or transported offsite for disposal in a landfill or use as an agricultural soil amendment.

5.0 Conclusion

Exposure to hazardous waste in dumpsites can affect human health, children being the most vulnerable to these pollutants. Direct exposure can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning.

The lack of Public waste bins and proper waste collection processes have significantly affected the unauthorized waste disposal practices. It is clear that improper waste management practices have a significant impact on the natural environment and sustainable development in the study area.

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