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Review

Various Natural and Anthropogenic Factors Responsible for Water Quality Degradation: A Review

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Abstract: Recognition of sustainability issues around water resource consumption is gaining traction under global warming and land utilization complexities. These concerns increase the challenge of gaining an appropriate comprehension of the anthropogenic activities and natural processes, as well as how they influence the quality of surface water and groundwater systems. The characteristics of water resources cause difficulties in the comprehensive assessment regarding the source types, pathways, and pollutants behaviors. As the behavior and prediction of widely known contaminants in the water resources remain challenging, some new issues have developed regarding heavy metal pollutants. The main aim of this review is to focus on certain essential pollutants' discharge from anthropogenic activities categorized based on land-use sectors such as industrial applications (solid/liquid wastes, chemical compounds, mining activities, spills, and leaks), urban development (municipal wastes, land use practices, and others), and agricultural practices (pesticides and fertilizers). Further, important pollutants released from natural processes classified based on climate change, natural disasters, geological factors, soil/matrix, and hyporheic exchange in the aquatic environment, are also discussed. Moreover, this study addresses the major inorganic substances (nitrogen, fluoride, and heavy metals concentrations). This study also emphasizes the necessity of transdisciplinary research and cross-border communication to achieve sustainable water quality using sound science, adaptable legislation, and management systems.

Keywords: water quality degradation; natural processes; contamination sources; pathways; anthropogenic activities

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1. Introduction

Water resources are essential for life as we know it, in cultivated farmland, sustainability, human consumption, economic development, and environmental systems [1]. Globally, over five billion inhabitants are dependent on groundwater and surface water systems since people use these resources in numerous ways such as potable water, housing, crop production, and manufacturing applications [2,3]. The degradation of water resources is a much-studied phenomenon and can be caused by natural processes (climate change, water-rock interactions, and geological factors) and human activity (agriculture practices and urban waste), as well as the presence of considerable chemical compounds since the industrial revolution [4]. Despite this, the management of surface water and groundwater as resources remains complicated in many circumstances and relevant information remains unknown [5]. Apart from anthropogenic activities, natural heterogeneities of rock/soil interact with water, influencing natural water cycles and affecting water quality across all domains [6]. Such modifications can have severe repercussions for the functioning of human health and the living organism [7]. In addition, the physicochemical and biological characteristics, as well as quality, quantity and availability of water resources, fluctuate because of the impact of natural and human activities [2]. The pollutant types, pathways, and sources, as well as how they influence the surface water and groundwater systems based on natural sources and anthropogenic activities, are shown in Figure 1.

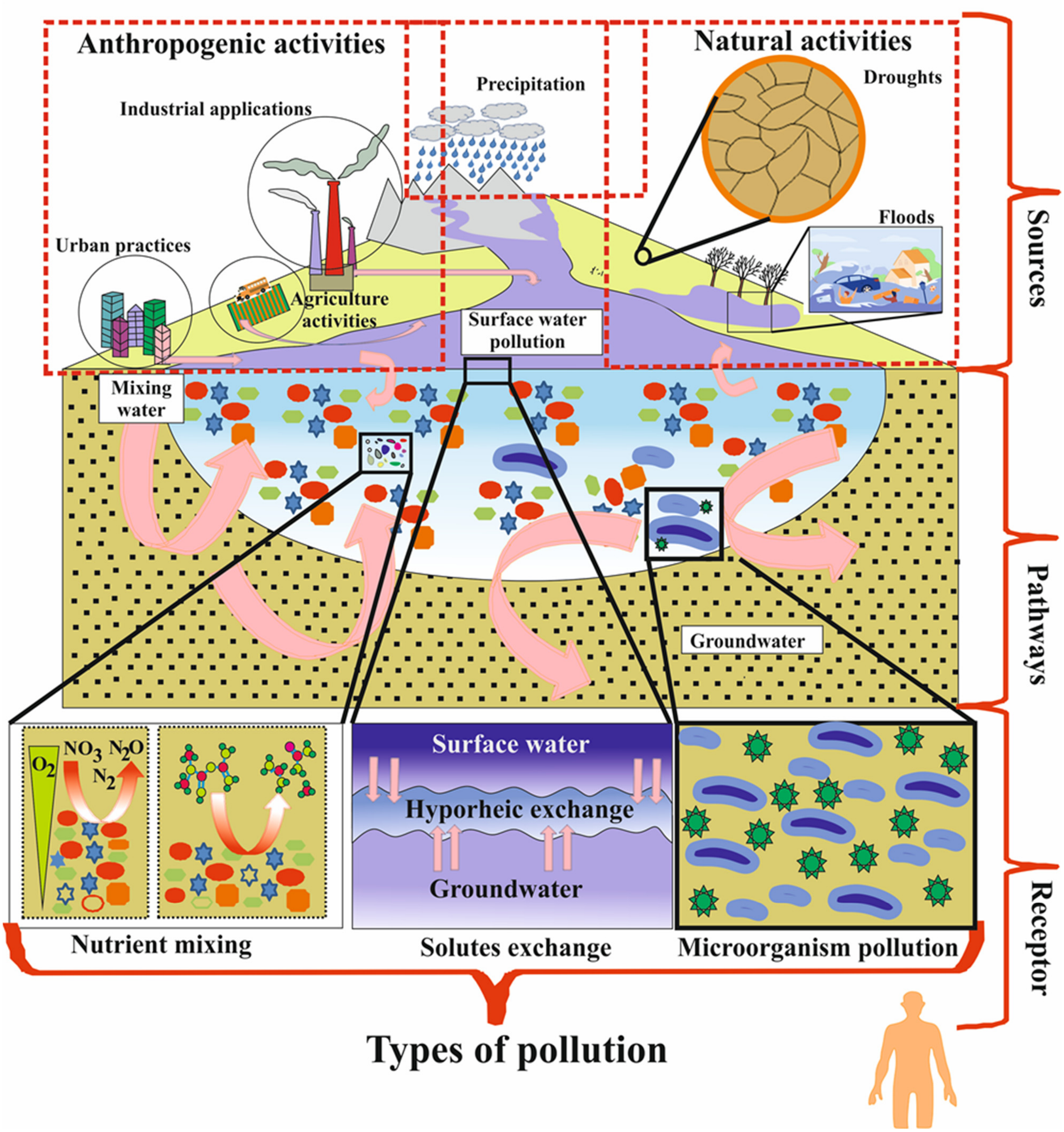

Figure 1. Schematic diagram illustrates water contamination due to natural sources (droughts and floods) and anthropogenic sources (industrial, agriculture, and urban activities), their pathways, receptors, and other types of pollution.

Surface water contaminations (specifically in rivers and streams) are mainly due to urbanization, agriculture, and manufacturing discharge [8]. In addition, environmental physical factors can also cause contamination, whereas the temperature of an aquatic environment can fluctuate with heated water discharged from power plants [9]. Moreover, hydro-heated water or water containing certain contaminants may not become an issue at any time of the year if it is immediately diluted by combining with surface water [10]. Further, pollutants released by agriculture activities include metals, pesticides, pathogens, nutrients, and salts that influence surface water [11,12]. Moreover, untreated and partially treated sewage, construction waste, and solid/liquid waste factors contain hazardous substances emitted into the river water by urban activities [13].

Some inorganic substances, such as zinc, iron, copper, nickel, etc., are necessary for the development of animals and plants, but these substances are harmful for animals or plants when the concentrations go above the acceptable limitations [14]. In addition, certain heavy metals such as lead, mercury, cadmium, and arsenic are no longer essential for the growth of plants and animals [15]. These toxic metals are mainly attributed to wastewater effluent in surface water due to conventional wastewater treatment, municipal waste based on activated sludge activities, and household waste [16]. Such pollutants are found widely at low concentrations from nanograms/liter (ng/L) to micrograms/litre (μg/L) [17]. Consequently, these toxic pollutants are released into river water either directly or indirectly, mainly by industrial waste, municipal and urban factors, as well as contaminated surface water discharge into the groundwater aquifer system by infiltration through soils and land-use practices [18].

Groundwater aquifer vulnerability and its pollution risk in the anthropogenic environment increases from the complicated interactions of the natural mechanisms of the hydrological system with the physical changes to the land surface, discharge waste from human factors, and water resource exploitation [19]. Further, physical landscape alterations cause an increase in the vulnerability of groundwater systems through topography changes, artificial water bodies, construction, river channeling, surface sealing, and changes in surface ruggedness [20]. In addition to the change in land use and land cover, the widespread utilization of synthetic and natural chemical compounds (pesticides and fertilizers) is also part of anthropogenic activity [21]. Utilization of these compounds generates agricultural productivity and can be beneficial for animal and human health, sufficient energy, functional infrastructure, and production of materials [22,23]. Nevertheless, numerous compounds used extensively today have been revealed to be persistent, mobile and soluble in aquifer systems, which is harmful to human health and environment systems [24]. Several other substances are still unknown threats, and thus far, the risk that chronic product exposure to a combination of substances has been difficult to quantify in many environmental areas.

When groundwater is polluted with toxic chemical compounds through human activities it can become unsuitable for several years [25]. The residence time of chemical pollutants can be retained in the groundwater system for weeks to months, years, and decades [26]. It depends upon the properties of the physicochemical compounds and environmental scenarios, and further lack of water supplies does not remove the effects of the groundwater pollution. Previous studies have identified the flow of groundwater through the hydrological cycle of pollutants from waste sewage or spill areas to surrounding rivers, channels, and lakes [2,27]. In the scientific community, problems in the context of groundwater pollution are widely known. Regulatory bodies have determined the high level of numerous toxic compounds in potable water systems at many places of the world. For instance, nitrate and fertilizer compounds have been recorded at high concentrations in groundwater systems [28]. Therefore, the contamination resulting directly from agriculture and industrial activities is a persistent and growing problem. According to recent estimates, 80% of the world's population in 25 countries suffer the horrible death of infectious diseases caused by groundwater contamination [29]. The current expansion of human practices is often contrasted directly with what is required to safeguard groundwater supplies for future consumption [30,31].

This review discusses several major contaminants of water resources degraded by natural and human factors, as well as several critical inorganic pollutant classifications released from anthropogenic activities. Furthermore, this study highlights several case studies in the literature investigating historical and emerging issues in polluted water resources and the diversity of issues in various areas of the globe. The impacts of these activities are described to emphasize the multiple issues arising if anthropogenic regulations are present on top of natural controls [32]. Scientific and government regulations have highlighted the critical need for better comprehension of pollutant processes in water resources and the environment [33]. The complicated interactions between types, sources, and transport pathways of water resource pollutants in various settings have been addressed in this study. Consequently, sustainable water quality should be secured rapidly, and transdisciplinary and transboundary activity is required, especially as humans go towards 2025 [23,34].

The main aim of this study was to discuss the water quality degradation due to natural and anthropogenic factors, as well as the contaminants' sources, types, and pathways. Therefore, there were three objectives: (1) to discuss anthropogenic factors such as industry (solid/liquid wastes, chemical compounds, mining activities, spills, and leaks), urban development (municipal wastes, land use practices and others), and agricultural practices (pesticides and fertilizers), (2) to address natural sources such as climate change, natural disasters, geological factors, soil/matrix, and hyporheic exchange in the aquatic environment, and(3) to focus on major pollutants based on their relevance such as inorganic substances (nitrogen, fluoride, and heavy metals concentrations). An overview of this review is shown as a flow chart in Figure 2.

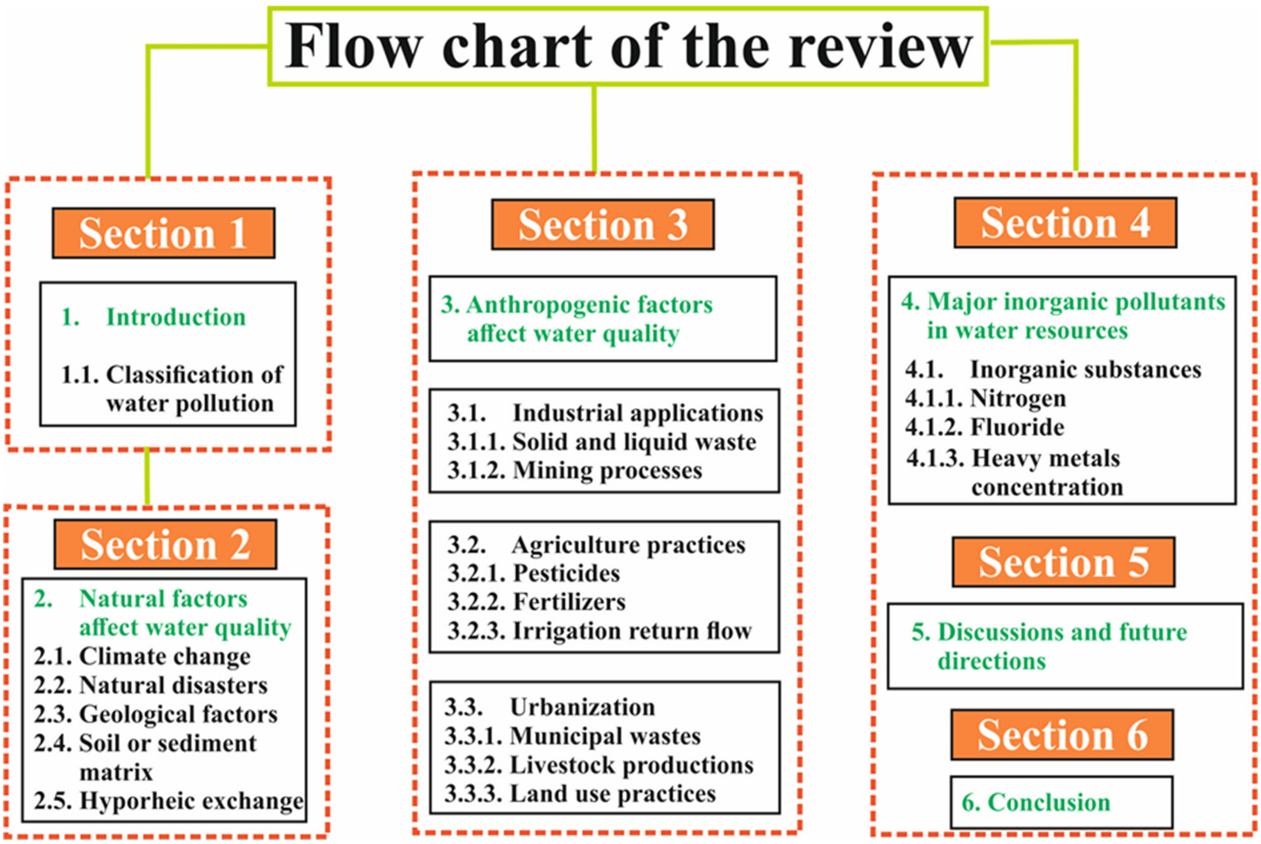

Figure 2. The flow chart of the review describes the outline of the study.

Classification of Water Pollution

Water pollution indicates the addition of compounds, elements, chemical substances, organisms, and/or pathogens into the surface water or groundwater that change the physical, chemical, and biological composition of water resources through natural and anthropogenic activities, as shown in (Figure 1). Water pollution authorities and researchers have always attempted to classify types of pollution. Sources of pollution have been divided into five major categories since the 1970s: residential, municipal, agricultural, industrial, and natural [35]. Several sources of classification for the origin of water pollution have been identified, which have also been prepared for sub-classification. For example, municipal waste is a major water pollution source category and its sub-categories such as solid waste and liquid waste can be described. Moreover, the character of the chemicals in the waste can be sub-categorized into organic waste as well as inorganic solid waste. Since the 1980s, the classification system of the Office of Technology Assessment (OTA) in the United States has been modified and expanded into six categories [36,37]. The addition of naturally occurring sources seems to have been an especially important change which is described as below:

I. Sources discharging substances because of other planned activities
II. Sources providing conduit or inducing discharge by altered flow patterns
III. Naturally occurring sources; where the discharge is created and/or exacerbated by human activity
IV. Sources designed to retain substances during transport or transmission; discharge by accident or negligence
V. Sources designed to store, treat, and/or dispose of substances; discharge through the unplanned release
VI. Sources designed to discharge substances

Finally, two major types of water pollution have been defined by the United States Environmental Protection Agency (EPA), these are point-source and non-point-source pollution [38]. According to the EPA, point-source pollution is any pollutant released from a single point entering the environment from easily identified and confined areas such as smokestacks, drainage tubes, industrial waste, municipal wastewater treatment plants, factories, and power plants. Non-point-source pollution does not come from a specific source and is a combination of pollutants that are released from a large area. It means that pollution does not come from a specific source, it comes all at once from a large distance and several locations, however, it is harder to find and more difficult to address (e.g., thunderstorm, runoff, oils, grease, animal wastes, pesticides, and fertilizer). According to the EPA (1996), six categories have been classified based on point and non-point sources such as industry and mining, forestry and agriculture, waste mismanagement, miscellaneous, urbanization, and natural sources. Moreover, the identification of contamination sources based on origin will be adhered to in this study. Generally acceptable utilization, simplicity of physical identification, and flexibility are the main reasons for its selection. In this study, the sources of contamination have been classified into two categories based on natural and anthropogenic activities, which describe their origins, pathways, and locations such as land surface and underground formations, as shown in Table 1.

Table 1. The major causes of pollution, contaminant types, and their important processes.

Main Sources	Pollution Categories	Types of Pollutant Factors	Important Processes or Pathways of Water Contamination
Natural processes	Climate change	Precipitation, humidity and evapotranspiration	Due to high gas solubility, high water viscosity, and wind dynamics, evapotranspiration (heat exchange, soil-humidity radiation), and dilution of water by heavy rainfall and acid precipitation flows into surface water directly or indirectly and affects the groundwater quality.
	Natural disasters	Droughts, floods, and landslides	Increased drought periods and higher temperatures rates are projected to affect the distribution of rainfall that produces flooding, as well as landslides which are high quantities of earth, rock, or mudthat flow quickly down mountainsides and have an enormous effect on the water resources.

Table 1. *Cont.*

Main Sources	Pollution Categories	Types of Pollutant Factors	Important Processes or Pathways of Water Contamination
	Geological factors	Plant roots, and topography slope	Plant roots absorb contamination or hazardous chemicals via preferred flow pathways and these pollutants infiltrate through soil particles into the groundwater. Further, flat terrains have lower surface runoff to accommodate higher infiltration rates, while steep slopes have tended to raise surface runoff and reduce the residence time of groundwater.
		Mineral dissolution and radioactive decay	Mineral dissolution is a slow process that takes several days, years, or decades, depending on the mineral solubility. Radiation material is due to emissions in the atmosphere of toxic ionizing radiation (beta-alpha particles, gamma rays, or neurons) and the radioactive decay of minerals that affects the water resources.
	Soil-matrix	Grain size and pore spaces	Soil type or matrix (sand, clay, and silt) can control pollution with variable recharge or discharge rates; redox reactions are usually retarded in inorganic sediments or soils, whereas organic compounds or microorganisms bacteria tend to accelerate the rate of reactions in soil-matrix strata.
	Hyporheic exchange	Solutes exchange, pathogen exchange, and SW and GW interaction	Further, the availability of dissolved substances, solutes, organic-rich matter, and oxygen are highly reactive in the hyporheic exchange zone, and with the addition of microorganisms (viruses, bacteria, and protozoa) can lead to the death of animals under aerobic and anaerobic conditions, through both slow and quick flow routes in the groundwater. Further, the physical, chemical, and biological properties of water can change due to these elements mixing, and the intrusion of seawater makes the coastal groundwater system vulnerable to salinization.
Anthropogenic processes	Industrial waste	Solid/liquid waste and chemical compounds	Landfills (including tailings facilities) are the most frequent places of disposal of solid waste globally and landfill leachate from waste disposal, as well as the presence of organic liquid compounds in industries (proteins, lipids, and carbohydrates) and dissolved inorganic contaminants is a source of water resources pollutants. Further, chemical materials in the industrialization sectors are utilized both outdoors (susceptible to photolysis destruction which is accompanied by soil biodegradation) and indoors (distinct routes of degradation which move through a wastewater plant).
		Accidental spills and leaks	Spills and leaks in manufacturing products such as tanks and pipelines can also impact water resources, including manufacturing of environment products and chemical waste (benzene, methylbenzene, toluene, xylene) which get into surface water and contaminate groundwater

Table 1. *Cont.*

Main Sources	Pollution Categories	Types of Pollutant Factors	Important Processes or Pathways of Water Contamination
	Agriculture	Mining processes	Mining practices have effects on the groundwater and surface water by excavating solid waste due to sinkholes, erosion, coal exploration, and chemicals released from mining processes and heavy utilisation of water in mineral processing. The groundwater pumped out of the mine disperse on the Earth's surface or drain into streamswhere it penetrates the subsurface water, releasing dissolved, disintegrated, oxidized, and leached minerals, causing groundwater pollution.
		Pesticides	Pest chemicals (herbicides, insecticides, rodenticides, and fungicides) can runoff from the surface and enter groundwater systems for a considerable time with their degradation products.
		Fertilizers	When the nutrient concentration (nitrates and phosphates) supassesthe plant absorption capability, it can lead to surface runoff and percolate into the groundwater.
	Urban activities	Municipal waste	Solid garbage (wood, plastics, metals, food waste, papers, inert materials, etc.) is dumped and transported to the waste processing plant until it reaches rivers and pollutes the groundwater. Further, liquid wastewater can penetrate groundwater by way of sewage sanitary leaks connected to a storage tank or faulty structure, disturbing the water quality.
		Cemeteries	Water pollution from cemeteries was a historical issue, as 0.4–0.6 litres of leachate with a density of 1.23 g·cm^{-3} per 1 kg body weight are released during the decomposition process of the human body and can pollute aquifers.
		Transportation	Transportation produces air pollution and can directly contribute to water pollution, thus storm events; precipitation extracts air pollution from the land surface, absorbs road deposits, and flows into water bodies.
		Livestock productions	Livestock and poultry farms create animal waste which may be transferred to surrounding lakes, streams, and groundwater across the agricultural land surface, as well as animal manure, which can be used on farms to fertilize plants and add/recover nutrients to the soil.
		Land use practices	The impact of land use activities on the water system from infrastructure, which includes construction, pipelines, and highways roads.

2. Effect of Natural Factors to Water Quality

Natural processes influence the surface water and groundwater quality by various sources such as climate changes, natural disasters, geological factors, soil-matrix, and hyporheic exchange, as shown in Figure 3. The natural factors described below are considered the most widespread in terms of water quality degradation through various processes as discussed in Table 2.

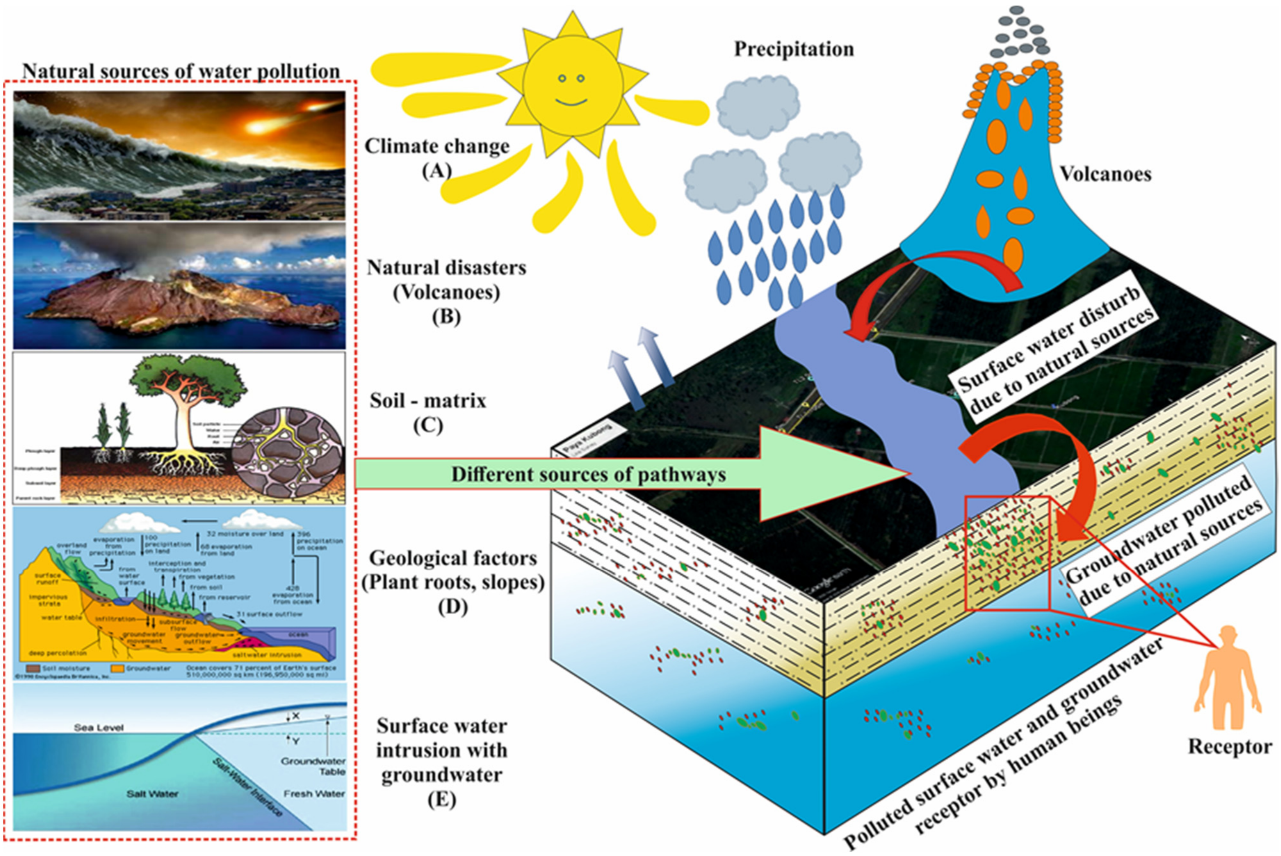

Figure 3. This diagram demonstrates the natural factors affecting the quality of surface water and groundwater, their pathways, and different types of sources: (**A**) climate change (Available online: https://flipboard.com/article/asteroid-tsunami-nasa-s-fear-of-250metre-city-killer-space-rock-striking-wate/f-fd71cce6b3%2Fco.uk accessed on 17 August 2021) (**B**) volcanoes (Available online: https://www.environmentbuddy.com/environment/volcanoes-types-importance-pros-and-cons/ accessed on 12 February 2018) (**C**) soil-matrix (Available online: http://www.fao.org/3/u8480e/U8480E0b.htm accessed on 27 June 2019) (**D**) geological factors (Available online: https://www.britannica.com/technology/water-supply-system/Surface-water-and-groundwater accessed on 17 August 2020) and (**E**) surface water and groundwater interactions (Available online: https://www.solinst.com/resources/papers/101c4salt.php accessed on 16 February 2021).

Table 2. Most crucial natural factors/processes which affect water quality.

Water Resources	Processes/Factors	Important Processes
Surface water Groundwater All water resources	Hydrological process	Evaporation, suspension, and setting Transpiration, infiltration, and leaching Dilution
All water resources Mainly river and lakes	Physical process	Adsorption and desorption, diffusion Heating and cooling, vitalization, gas exchange with the atmosphere
Groundwater All water resources	Chemical process	Ionic exchange Acid-base reactions, redox reactions, Precipitation of minerals, photo degradation, Dissolution of particles
Surface water All water resources Mainly rivers and	Biological process	Primary production Microbial die-off and growth Bioaccumulation, decomposition of organic matter, biomagnifications

2.1. Climate Change

Climate change not only influences ecological, hydrological, and biological systems; it also affects life and economy [39]. The primary and foremost occurrence and vulnerability of surface water and groundwater are natural regional climate oscillations and weather changes [40]. However, this also includes past weather patterns in the context of fossil groundwater. Consequently, precipitation, humidity, and evapotranspiration are the most significant climatic factors. Another characteristic of climatic factors is a seasonal variation in temperature [41]. It affects processing and affects coagulation and winter's softer reactions. Due to the increased solubility of gases and high viscosity of water, low temperatures cause issues with the air binding of filters, cause pressure drops by the filter beds to raise the expulsion gas and disrupt the movement [42]. The sudden river water dilution through heavy precipitation can severely affect water quality, and high rainfall can directly or indirectly charge surface water. Further, high humidity and precipitation are a primary charge for most aquifers, either through direct infiltration or indirect runoff regimes. Moreover, evapotranspiration includes other climate factors (heat exchange, radiation, and wind dynamics) that influence the quality and quantity of water resources [43]. Rainfall is irregular and evapotranspiration is typically high, leading to a reduction of recharge and a concentrated impact of solutes within the groundwater system, especially in semi-arid and arid regions [44].

2.2. Natural Disasters

The large number of wastes caused by natural disasters such as volcanic activities, earthquakes, hurricanes, tornados, flooding, and tsunami contributes considerably to the water pollution issue [45]. More than 5000 disasters concerning water-related injuries were recorded from 2001 to 2018 worldwide, representing 73.9% of natural disasters. About 1.7 trillion USD (US dollars) in economic damages and a total of 300,000 deaths and personal injuries were caused by water-related disasters through floods, storms, landslides, and droughts throughout the world [46]. Particularly in recent years, floods and droughts, which accounted for over 60% of water-related natural disasters, have had significant economic repercussions [47]. Due to around 2100 floods and 430 droughts worldwide, an estimated 365 billion USD was lost throughout the 20th century. In the 21st century, water-related catastrophes and their effect have been significantly greater. Approximately 600 billion USD has been lost globally between 2001 and 2018 because of over 2900 floods or 290 drought disasters [46]. The health of 2.8 billion humans was also affected by these catastrophes. For example, during 2001–2018, about 300,000 humans suffered severe losses from floods. Flooding and other disasters can destroy wells of drinking water and cause well pollution by human sewage, pollution of animals, human waste, chemicals, livestock waste, and other impurities [48]. Further, natural hazards contribute to huge quantities of pollutants in surface water and groundwater resources. A multitude of pollutants can disturb the water resources after devastation, including lead, total dissolved solids, chlorine, nitrates, fecal coliform, and total coliform [49].

2.3. Geological Factors

Geological factors (soil types, topography slope, plant roots, dissolution of water with minerals/soils, and radioactive decay of elements) are essential for water resource quality [50]. The regional and local geological formations, as well as tectonic deformation, indicate natural dynamics of groundwater recharge, subsurface flow, and the physical characteristics of the aquifer [51]. Soil types can fluctuate considerably between landscape forms, according to the geological formations and processes beneath the surface area, as well as recharge rates exchange. A further factor affecting how much water is transferred between the surface and groundwater resources through land cover comprises flora (both dying and living) and surface water bodies [52]. Flat terrains have lower surface runoff to accommodate higher infiltration rates, while steep slopes have tended to raise surface runoff and reduce the residence time of groundwater [51]. Further, plant root or vegetation systems can produce preferential flow routes in the unsaturation zone, whereas heavy floral cover can lead to decreased surface runoff and high rates of evapotranspiration [53]. Water is a solvent and is capable of dissolving and interacting with organic and inorganic components of soils, minerals (anions or cations), and various types of bedrock [54]. Mineral dissolution is a slow process that takes days, years, or decades and depends on the mineral solubility, and affects many of the qualitative characteristics of aquifers, for example, hardness and pH [55].

Radioactive contamination arises if radioactive materials are already present or deposited in the environment. Radioactive decay can be detrimental to ground quality. The damage caused by radiation materials is due to emissions in the atmosphere of toxic ionizing radiation (radioactive decay), such as beta or alpha particles, gamma rays, or neurons [56]. As radiation characterizes the substances, since the particles in the radioactive materials are very unstable, they can seriously harm, change, and even kill plants, animals, and humans [57,58]. In drinking water, there are two sources of nuclear pollution. The first is natural radionuclide found in soil and rock through which the water passes. Some areas are vulnerable to phosphate-rich soils and rock pollution [59]. The second radioactive source comes from human-made sources. Further, artificial radionuclides are developed due to human activities such as nuclear reactors, nuclear testing, and the development and use of radioactive sources [60]. Drinking water radionuclide consists of three radioactive radium series, plutonium, thorium, and actinium, that comprise the natural elements radium and plutonium, and the radioactive gas radon [61]. These contaminants can cause various kinds of biological damage. Radium in the bones becomes concentrated and can cause cancers, and uranium can also cause bone cancer and have toxic effects on the kidneys [62].

2.4. Soil or Sediment Matrix

All parental geological materials combined with the weathering impact of climate indicate the soil/sediment matrix characteristics which define the grain size, pore spaces, and the existence of unconfined/confining beds [63]. These physical properties of the soil/sediments matrix evaluate the pathways of water and affect the storage of groundwater aquifers, particularly the transport, magnitude, and rate of recharge [51]. Further, these factors show the mean residence time along with aquifer depth. Sediments and soil matrixes regularly interact with solutes through physical, chemical, and biological processes such as ion exchange, sorption, solute, degradation (biotic and abiotic), and rainfall [64]. In addition, redox reactions are usually retarded in inorganic sediments or soils, whereas organic compounds or microorganisms/bacteria tend to accelerate the rate of reactions in these strata [65]. To a large extent, they govern the persistence of pollution in organic matter in these strata. Oxygen deficiencies tend to occur in typically deep groundwater, while oxygen-rich groundwater often tends to be in fissured aquifers or shallow groundwater [66]. Therefore, these reactions will impact ion exchange and reduction processes whether the groundwater is shallow or deep. These variables influence how specific solutes or contaminants moving through the pores or space in the sediment matrix are degraded [40].

2.5. Hyporheic Exchange

The exchange of surface water and groundwater through streambed sediments between near-channel and in-channel water, as well as the mechanism of solute mixing between the exchange area surrounding alluvial rivers, are known as a hyporheic exchange [67–70]. Further, the availability of dissolved and suspended materials, organic-rich matter, and oxygen are highly reactive in the hyporheic exchange area [71,72]. Due to these interactions, physical, chemical, and biological processes take place. Moreover, infiltration occurs in space, either along preferential routes or across the whole wetted region, in a relatively homogenous formation [73]. Further, flow and recharge occur primarily within systems of fractures, cracks, and other isolated openings for karstic, confined, and fractured hard-rock aquifers, which permit quick and slow recharging [74]. Specific flow routes are only active during or after precipitation events or snowmelt in these environments.

One of the most complex and widely dispersed environmental issue is brackish water or seawater intrusion which pose a danger to the groundwater quality and sustainability in coastal aquifers [75]. The intrusion of seawater and up coning makes the coastal groundwater system vulnerable to salinization. The groundwater and seawater interactions can be classified into two distinct water flows: seawater flows into an aquifer (seawater intrusion) and groundwater flows into the sea or ocean water (submarine groundwater discharge) [76]. The seawater infiltration into groundwater can affect the aquifer quality and availability, and it will cause stress to the coastal aquifer. Thus, the intrusion of salty water is the transfer of saline water into freshwater aquifer systems.

3. Effects of Anthropogenic Factors to Water Quality

Anthropogenic pollutants are substances caused by human actions, mostly resulting from land-use practices. Surface water differs from groundwater because it may contain many hazardous chemicals from human practices; as a result, it is highly contaminated [2]. Anthropogenic changes have a substantial influence both in terms of modifying the magnitude of existing conditions and adding new variables on each part of the water cycle (leakages, irrigation, extraction, or wastewater) [2,31,77]. Further, the consideration of local social factors in relation to current and historical land-use practices, such as waste treatment processes and infrastructure, should not be excluded to take account of the natural setting. However, several anthropogenic activities (agricultural, industrial and urban) contaminating the surface water and groundwater systems, as well as pollutants moved various pathways has been shown in Figure 4.

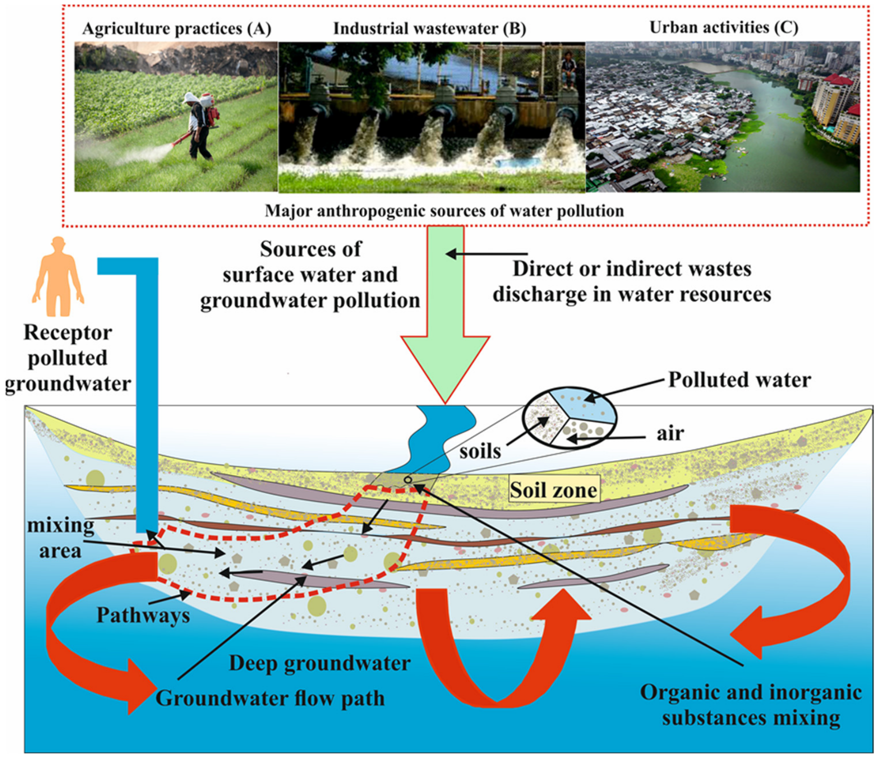

Figure 4. This diagram illustrates several anthropogenic activities contaminating the surface water and groundwater systems, as well as pollutants moved various pathways and effect on receptor. (**A**) Agriculture practices (Available online: http://www.fao.org/land-water/news-archive/news-detail/en/c/1032702/accessed on 6 September 2019) (**B**) industrial pollution: (https://www.analyticaltechnology.com/analyticaltechnology/gas-water-monitors/ accessed on 17 September 2017) and (**C**) unban activities (Available online: https://www.voanews.com/east-asia/watchdog-blames-bangladesh-agencies-many-disappearances accessed on 9 January 2021).

3.1. Industrial Applications

Water pollution is caused by industrial waste mainly released from mills, factories, and mining sectors. These sectors pose a potential hazard of polluting water resources. Those sources are placed on the Earth's surface while the industrial waste material drains into the surface water that percolates directly or indirectly into the groundwater. In recent years, various attempts have been made both in developed and developing countries to recognize these sources of water pollution. Monitoring and clean-up activities have been implemented. Despite these challenges, there is still a great deal of work required to define and store these sources and evaluate the effects of the steps taken. It is estimated that 3% of the land surface is occupied by industrial and urban uses, including mineral extraction exploration areas [78]. These two responsible factors of pollutants are the most-often addressed in water resources literature, considering the tremendous amount of liquid and solid waste discharged.

Collectively manufacturing industries contribute more waste than urban and agricultural operations, especially mining activities that produce a larger amount of waste around the world [31]. In recent decades, exponential industrial development within energy production, raw substances, and engineering applications has resulted from the discharge into the environment of an ever-expanding and diversified variety of waste products that have left their mark on water resources quality [2]. Globally, over 80% of wastewater has been reported to be discharged into the environment without treatment [79]. There are several possible primary sources of water contamination due to industrial activities including solid or liquid waste, mining practices, spills, and leaks.

3.1.1. Solid and Liquid Waste

Industrial waste is waste released through the manufacturing process that involves any useless products produced throughout industrial operations such as factories and mills [31]. Manufacturing industries develop liquid, solid, and gaseous wastes that can have adverse environmental and human impacts; acid rain is an instance of sulfur dioxides and nitrogen oxides emissions from chimneys and exhaust pipes [79,80]. Industrial waste can pollute the air, soil, or nearby water sources and eventually end up in the seas and rivers.

The presence, coverage, type, and maintenance of infrastructure, such as landfills, may have been the most critical deciding variables for the quality of water resources and the threat of solid waste pollution from solid waste materials [81]. Landfills (including tailings facilities) are the most frequent method of disposal of solid waste globally and remain typically the cheapest disposal option, especially for huge amounts of manufacturing solid waste [82]. Despite landfill leachate from waste disposal being a recognized source of groundwater pollutants, solid landfill lining is not enforced everywhere. Moreover, landfills with inadequate or non-existent lining dating from the industrial revolution are also widespread. At present, regions without access to efficient preservation or disposal systems can depend on their solid residues in shallow subsurface disposal. Further, solid waste comprises a variety of applications, such as plastic, cardboard, paper, scrap metal, packaging materials, wood, automobile parts, food waste, and all other solid garbage that cannot fulfil its intended use any longer [83].

Industrial liquid waste is considered wastewater. Such contamination is caused by the presence in industrial fluids of organic compounds (proteins, lipids, and carbohydrates) and dissolved inorganic contaminants [84]. Most manufacturing industries require massive quantities of water which can enter the interface along with dangerous chemicals. The specific infrastructure for liquid waste includes drainage systems, drains, septic reservoirs, and sewer networks [85]. The recommended solution is centralized wastewater collecting systems, associated with a properly operating treatment facility using modern treatment technology and frequent maintenance, as effluent is often better tracked for environmental protection. Comprehensive gasoline storage and pipeline networks utilized in the industrial sector are another class of infrastructure. These components are potential causes of non-aqueous liquid pollution by leakage or accidental spills [31,86].

There is a possible serious threat to the quality of groundwater from petrol stations and in numerous networks with above and subsurface routes and pipelines containing petroleum substances [87]. Accidental spills and leaks in manufacturing product tanks and pipelines can also impact the water resources. Accidents are related to the manufacturing environment products, chemicals, or hazardous waste (benzene, toluene, xylene, etc.) and their entry into freshwater [88].

A particular problem in the manufacturing process is the use of injection and disposal wells, which harm water resources. At disposal wells, industrial effluents and water for cooling and processing reach the groundwater system through the bottom of the well or through well-screens [89]. These wells, particularly industrial waste, are a source of chemicals and microorganisms that can directly contaminate aquifers. Injection wells are commonly associated with hazardous waste disposal in deep-seated rock formations that are supposed to have no interaction with freshwater resources [90]. Waste that can be deposited through injection wells include brines, radioactive products, hydrocarbons chlorinated, and liquors for bearing steel.

Improper well field design is another problem in the groundwater system; it can change the local groundwater flow as well as chemical and biological conditions. Thus, the direction of groundwater flow may be reversed or changed, and the hydrological chemistry of underground aquifer and the redox potential can also be changed [51,91]. For instance, improper screening and sitting of the well can change redox values in groundwater rich in iron and bacteria and contribute to iron, manganese, and slime precipitation into the groundwater and in well-screening and pumping [92]. Another example is improperly screened wells sitting in aquifer systems in which pesticides, fertilizers, liquid, and solid waste are present due to human-induced pollutants [93]. Moreover, the movement of pollutant infiltration by semi-confining formations may decrease groundwater quality in deeper water aquifers and enter well screens [94]. Thus, improper screening and sifting of wells will worsen the impact of human-induced and natural contaminants and can be referred to as a secondary pollution mechanism.

The use of chemical materials in pest control or the improvement of substance characteristics are common in industrial activities [95]. Pest control materials are typically known as biocides in these settings. Chemical materials in the industrialization and urbanization sectors are utilized both outdoors and indoors, but are used almost exclusively outdoors as compared to agricultural products [31]. Furthermore, outdoor materials can continue to run in sewer networks which leads to penetration into the groundwater environment, either as a point or line source [96].

3.1.2. Mining Processes

Environmental effects of mining can occur at point, large, regional, and global scales through indirect and direct mining practices. Its effects can be found due to sinkholes, erosion, biodiversity loss, exploration of radioactive substances, salt, coal, phosphate, or the chemicals emitted from mining processes [97]. Consequently, mining practices affect groundwater and surface water systems through the excavation of solid waste, heavy use of water in processing ore, seepage from tailings, waste rock impoundments, and water pollution from discharged mine effluent [98]. In addition, mining and ore processing activities mostly extract groundwater either in open-pit mines, whereas groundwater infiltrates frequently or in subsurface dewatering operations.

Observation wells or abandoned production and boreholes exploration by drilling may serve as vertical conduits for the movement of toxic pollutants [99]. Acid mine-water runoff is another cause of contamination that leads to groundwater pollution by mining waste, for example, tailings facilities [100]. This issue is most often related to coal mining. Crushed waste rock and liquid are composed of dumping tailings facilities which typically hold large amounts of by-products of host-rocks like pyrite [31]. The oxidized substance is diluted with water, and the water from the mine becomes acidic. The mine-water drainage has no usual compound but usually has relatively high sulphate, iron, and other metal concentrations; low pH; and high acidity. Water used to reduce mine dust, equipment cooling, washing, and processing, etc. can accumulate harmful compounds.

Nevertheless, previous findings demonstrate that the absorption of heavy metals from mine leachate, based on pH, soil types and leachate quantities, can be extremely effective in shallow and deep aquifers [101]. The fact that the subsurface geology has not contained calcite or carbonate or cessation of lime addition to tailings facilities decreases the ability of groundwater to tamp down the leachate from the mine. Only a minor reduction in pH has resulted in higher concentrations of soluble elements. While the leachate and groundwater pH fall to below 5, significantly higher levels of aluminums and copper can be observed in groundwater that severely affects the quality of the surface water and groundwater and its associated ecosystems [101].

3.2. Agriculture Practices

Agriculture is one of the most common activities of human beings that can affect both surface water and groundwater. The activities of this category include fish farming, crop cultivation, livestock, pesticides and fertilizers, cattle, and poultry farming. These activities take place on the Earth's surface; therefore, soil, vegetation, rainfall, surface, and irrigation water penetration can lead to pollutants entering the groundwater. Forestry can also have adverse impacts on water resources. Stockpiles of a wide range of irrigation materials and crop residues may also become possible point sources of underground water pollution. No systematic research on the contaminating impacts of crop residues has yet been performed.

3.2.1. Pesticides

Pesticides are chemicals that are used to remove undesirable organisms in community gardens, agricultural areas, and other public areas [102]. The word "pesticide" encompasses all chemicals used in killing or controlling pests. In the early 1960s, people became aware of pesticides as environmental hazards. Chemical controls have become a core of the development of farmland and are also common in rapid urbanization and industrialization. Massive surveillance estimates from 1989 reveal that pesticide usage continued to rise, with up to 3 million tonnes being consumed in 2007 [31]. In the last two decades, especially within Europe and North America, the use of pesticides has increased significantly, and global pesticide use is noticeable [103]. Pesticides remain a chronic concern for worldwide groundwater supplies notwithstanding restrictions.

In addition to plant protection against insects, pesticides include herbicides, nematicides (nematodes), insecticides (insects), rodenticides (vertebrate poisons), and fungicides (fungi). They are also crucial in food growth and protect or increase crop yields, and enable a plant to be cultivated on the same land numerous times per year [104]. The differences in pesticide degradation and sorption rates (that are the two most essential mechanisms for the control of persistence of pesticides) and their characterization of sediment and groundwater media complicate the movements of pesticide products in the subsurface. Porous groundwater aquifers generally improve the filtration of pesticides from underground, but karstic ones are more susceptible due to quick flow and low sediment reactivity to long-term pesticides contamination problems. Thus, pesticides can easily be moved over a broad geographical region to pollute surface water and groundwater [105]. Numerous pesticides are soluble in water, and are applied with water and consumed by the target. The more soluble a pesticide is the higher chance of leaching, whereas residual herbicides usually are less soluble to help bind the soil [106]. A further aspect that influences pesticide water contamination is precipitation, with high precipitation rates increasing the hazard of pesticides polluting the water. The slow movement of groundwater means it can take decades to get polluted water out of the affected wells.

Pesticides that have been used historically and that are now prohibited are nevertheless detected as enduring substances in groundwater. The reason for this is not always clear. There are currently limited operating ways or techniques for tracing the damage to the environment or for making relevant forecasts of its sustainability within water resources.

Conventional methods to identify the origins and routes of pesticide pollutants in water bodies include time series for concentration, isotopes investigation for specific compounds, and compound ratios for parent-to-metabolite.

3.2.2. Fertilizers

Improperly controlled fertilizer components may transfer through field runoff or leach into water bodies [107]. The two major fertilizer compounds that are most concerning for contamination of water resources are nitrogen (N) and phosphorus (P). Improper or excessive utilization of fertilizer can contribute to water body nitrate contamination. Nitrogen fertilizer is biologically converted to nitrate, which is highly soluble in water, either organic or inorganic [108]. Additionally, soluble nitrate is extraordinarily mobile and can be extracted from soil with percolating water, rendering it inaccessible for crop uptake and accumulation. When pollution enters drinking water sources, fertilizer nitrates can cause serious health hazards, particularly for young livestock and babies [109].

The use of nitrates can affect methemoglobinemia (blue baby syndrome) in children, by decreasing the blood's oxygen-carrying capacity. Phosphorus is another significant component of fertilizer [110]. Phosphorus can be moved easily with the soil in some circumstances. Moreover, 60 to 90% of phosphorus typically travels with the soil. Phosphorus is globally the primary cause of water quality impairments in lakes. Proper storage, handling, and usage on farms or acreages of fertilizer are crucial if water supplies are protected from chemical pollution. This is partly because fertilizer rubbings in surface water can lead to surplus algae growth and can kill fish—secure permanent storage and combining fertilizers from spills, leakage, or storm-water penetration is needed to solve this problem.

Previous studies indicated that many silage-making cases lead to the creation of polluted liquids with excessive BOD requirements and the release of phenols and sulfates [111]. The most common chemical pollutant in groundwater aquifers globally is agricultural nitrate. Agriculture is the biggest cause of pollution in streams and rivers, the second main wetland, and the third most important lake source in the United States of America [112]. Agriculture is also accountable for the huge amount of surface water pollution and groundwater pollution through nitrogen in China [78]. The intensive use of chemicals such as pesticides and chemical fertilizers has accomplished the global growth of agricultural productivity. Excess nitrogen and phosphates can leak into groundwater or be transferred into waterways by surface runoff. Phosphate is not as soluble as nitrate, and is absorbed into soil and then transferred through soil erosion to the water resource.

3.3. Urbanization

Urbanization is an all-embracing form of land-use and land cover change that is rapidly increasing globally [113]. It includes the conversion into croplands, wetlands, forests, pastures, grasslands, and other land cover forms to commercial, industrial uses, residential, and transportation practices, thus growing the areas of impervious surfaces [2]. Therefore, impervious surfaces are measurable factors that closely correlate with rises in polluted runoff sources that decrease water resource quality [114]. Construction work often includes river embankments, sluice, irrigation and drainage works, galleries for penetration, water wells, dams, and reservoirs. In this section, major pollutants released from urban activities have been discussed such as municipal practices, land development, forestation, and deforestation.

3.3.1. Municipal Wastes

Municipal (household or domestic) wastes are derived from many sources of various human activity and socio-economic areas worldwide, which may be liquid or solid and are challenging to use as raw materials [83]. Consequently, these wastewaters come from our everyday lives and include preparing food, washing, bathing, and toileting [115]. Moreover, grey water and black water are released from domestic dwellings with access to piped water, as well as business premises and establishments in residential areas such as schools and health centers.

The term sewage is used to describe all these forms of liquid waste in combination and with surface run-off. Commercial wastewaters that comprise companies, shops, stores, open markets, restaurants, and cafés are similar mainly to that of households [116]. Liquid waste such as urine, human excrement, and washing water, are released into shafts to avoid them becoming hazardous on the land's surface and, if the liquid is high, in the water table and polluted water systems near the site [46]. Particularly in densely populated urban areas, septic tanks can pollute local groundwater supplies.

Furthermore, solid waste materials are incredibly heterogeneous with variable physical properties depending on their source such as wood, plastics, metals, food waste, papers, inert materials, paint containers, yard waste, demolishing materials, construction, and textiles [2]. However, most of these sources are no longer rising in size and number of recycling purposes.

Water pollution from cemeteries has been a historical issue from several decades. Around 0.4–0.6 L of leachate with a density of 1.23 $g \cdot cm^{-3}$ per 1 kg body weight are released during the decomposition process of the human body. Leachate includes 10% organic compound, 30% salts in nitrogen ions, phosphorus, Cl, Na, and various metal compounds (Cr, Cd, Pb, Fe, Mn, Ni), and 30% water [117]. The liquid has high conductivity, pH, and BOD value distinguished by its distinctive fishy odor. Pollutants originate in the body and may include chemical compounds used in chemotherapy and embalming procedures (arsenic, formaldehyde, and methanol), make-up (cosmetics, dye, and chemical compounds), and several other compounds [31]. Moreover, these leachates include microorganisms that can contaminate the groundwater.

The average daily traffic is higher in urban areas than in rural areas, and as a result, water pollution is substantially higher in urban areas. According to the EPA [38], transport directly affects water quality in four ways:

a. The construction and maintenance of roads, including impervious surfaces, can adversely influence water quality because of higher rushes, lower groundwater recharge rates, and increased erosion.
b. Pollutants, including oil, vehicle exhaust, dirt, and de-icing chemicals, are deposited into roadways and streams' dehydration.
c. Oil spills, especially on the marine side, affect the water quality of inland waterways and coastal regions.
d. Leaking subsurface storage tanks release petroleum into groundwater.

3.3.2. Livestock Productions

Most countries have many livestock and poultry farms: the United States has an estimated 1.2 million livestock and poultry farms. In addition, this number covers all activities which increase the production of beef or dairy cattle, hogs, and swine, including both confinement and non-containment (grassing and range-fed) [118]. Furthermore, animal manure can be used on farms to fertilize plants and add/recover nutrients to the soil. Nevertheless, animal production changes, particularly the growing trend towards animal farming in major feedlots, have produced more severe issues in animal waste use and disposal. According to the assimilative land production capacity on farms, the quantity of manure nutrients has increased, especially in China, India, Australia, the USA, and South Africa, since animal farming has become denser and more spatially concentrated. Animal waste may be transferred to surrounding lakes, streams, and groundwater across the agricultural land surface. Therefore, leakage to surface water, groundwater, soil, and air of waste from animal feedlots seems to have an extensive range of environmental and human health impacts. Animal waste also contains salts and trace elements, and antibiotics, pesticides, and hormones to a limited extent. Additionally, nutrients (especially phosphorus and nitrogen), pathogens, solids, organic matter, and odor/volatile compounds are the primary pollutants concerning animal waste [119].

3.3.3. Land Use Practices

Urban areas have been estimated to cover 3% of the world's usable land since 2010. For instance, urban areas include diversified aspects of land use, large population, development of transportation systems, heavy resource usage, and heavy waste disposal, and cities can cause an even greater or equivalent risk of groundwater contamination compared to surrounding farmland regions [2]. Thus, intensity and density of their events are similar, but not higher from industries and agriculture, in relation to their spatial extent. Further, land cover modifications are typically the first step in the evolution of a region. It covers alteration of vegetation, the permeability or porosity of soil, topography, and surface water properties that all influence recharging and groundwater movements [31]. There are some examples of these impacts such as changing present topography, contributing to exotic types of vegetation (usually for cultivation), wetland drainage, soil tillage, diluting, and clearing any vegetation cover [120]. Moreover, the alteration of soil and vegetation is the driving factor underlying variation in evapotranspiration rates. The water requirements of the dominant species and alterations in the absorption or reflection of solar radiation can increase or decrease recharge. Topographic modifications are caused by various land management processes [2].

Another impact of land use activities in water systems is infrastructure, which includes construction, pipelines, highways, and roads [121]. In contrast to land-based alterations, the conceptual framework of an anthropogenic water balance must be contribute to manmade source and sink components emerging from an infrastructure. Significantly transformed landscapes produced with such elements potentially transform the water balance, affecting solute mass flows and quality [12,114]. In addition to liquid chemicals, manure spread is regularly practiced in farming and works as a means of transporting a number of chemicals into the environment.

The most regular leads of anthropogenic surroundings are concrete or compacted surfaces, comprising roadways, construction sites, and park sites. Such surfaces generate elevations in storm and snowfall run-offs, and significant decreases in diffuse inflow and evapotranspiration, typical in urban and industrial areas [31]. At the same time, urban waste treatment and wastewater are an ongoing problem if we assume that more than half the global inhabitants live in urban areas. This percentage is estimated to rise to about 70% in 2050, according to the UN World Urbanization Prospects 2018 [122]. This provides an acute risk to urban residents that are adjacent to badly managed waste and that pose an increased risk to urban water sources.

4. Major Pollutants of Water Resources

An important problem for environmental researchers and decision-makers remains the improvement of understanding the extent and behavior of polluting chemicals on the surface and subsurface as well as the combined impact of a combination of substances [38,123,124]. Some countries have been performed and created a standard with limitations based on information on current regulations for water resource concentration, especially drinking water [125–127]. These are critical factors that must be recognized, regardless of the complexity of solvent movement, reaction, and surface activity, whether compound control, mitigation, or water system rehabilitation is to effectively protect or enhance water quality. In this section, the characteristics of several prominent inorganic water pollutants are discussed (nitrate, fluoride, and heavy metal concentration).

4.1. Inorganic Substances

Non-carbon-based materials are referred to as inorganic pollutants. The most significant inorganic substances are naturally found in the environment system, such as nitrogen, fluoride, and heavy metals [14]. Furthermore, arsenic, fluoride, and iron pollutants are geogenic, while nitrates and some other heavy metals are mainly caused by anthropogenic behavior such as weak wastewater systems, poor agricultural practices, and industrial discharges [128]. In groundwater, in many regions of the world, including India, high levels of metals (mainly heavy metals) and other toxicants, such as fluoride and nitrate, have been found beyond the threshold limit, rendering them unfit for drinking. The most studied heavy metals produced by different wastewater factories are arsenic, copper, chromium, mercury, nickel, and zinc [129]. The impact of inorganic contaminants and their organic forms on flora and fauna of the Earth's environment is devastating (atmosphere, lithosphere, and hydrosphere), as they cause many health-related issues (abnormal growth, high risk of breast cancer, diabetes, obesity, etc.).

This results in oxygen depletion as the phase of decomposition occurs. These components overgrow and use a lot of oxygen during their development. The dissolved oxygen may be used more than can be filled during the decomposition process, contributing to the shortage of oxygen and having severe implications for the biota stream [130]. Failure to provide oxygen may destroy aquatic species. When marine species die, the components break down and cause more oxygen depletion. A type of organic pollution can occur when aquatic environments accumulate inorganic contaminants such as nitrogen and phosphates [2]. In this section, inorganic contaminants such as nitrogen and fluoride are discussed, as well as in Table 4.

4.1.1. Nitrogen

Nitrogen is an inorganic compound which becomes harmful to human health and the environment in concentrations. Nitrate is the world's largest mobile form of nitrogen [131]. Nitrogen persistence in the subsurface is largely driven by the denitrification and nitrification of biological reactions in response function of redox environmental factors [132]. Ammonia or nitrites oxidize easily into the highly mobile nitrate in the presence of oxygen. Without oxygen, the conditions for denitrification are reduced, and nitrate converts into nitrogen gas. Nitrate remains chemically unreactive in such oxidizing conditions because of negative charging and hence it is not absorbed in the case of material such as clay in shallow groundwater zones [133].

A majority of individual actions can lead to high nitrogen levels in water resources, such as crop fertilizers and wastewater generation [134]. As a result, there has been a long history of recorded nitrate pollution in water systems, mainly through agricultural production usage; hence agriculture is considered the primary nitrate source in the environment [135] (Figure 5). Underground nitrogen pollution in several areas is a crucially relevant issue. The estimated losses from the soil-plant system through diffuse leaching are 50–70% of all the nitrogen applied for crop production [136]. Whereas the distribution of fertilizers in several nations has been moderated, the worldwide fertilizer manufacturing rate continuously grows, consuming 113 million tonnes in 2014 [103]. In addition, regulations have significantly reduced the application of agricultural nitrogen throughout many regions (especially Switzerland and the European Union) [103]. Further, the expansion of urban nitrogen pollution in agriculture is less worldwide, although urban sources are substantially larger in overall diversity. In urban areas, wastewater, atmospheric deposition, stormwater, construction places, water supply, solid waste, urban parks, and gardens are nitrogen sources [137] (Figure 5).

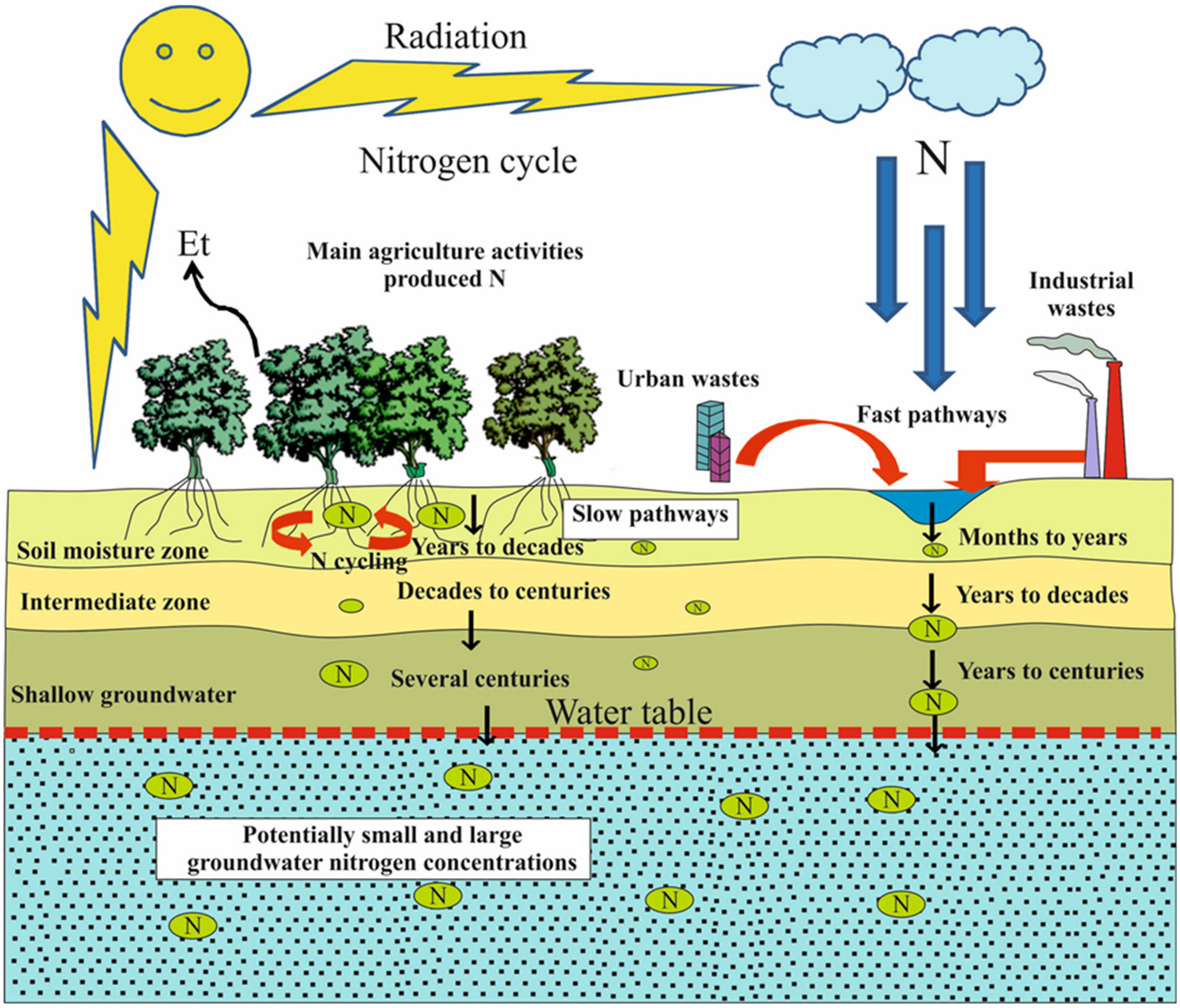

Figure 5. Demonstration of a conceptual model for nitrogen fertilizer that contaminates surface water and groundwater based on various pathways and durations of contamination.

Several sources and types of nitrogen discharged into the metropolitan region will influence the microbial communities involved in nitrogen transformation activities [138]. Wastewater nitrogen most typically appears in its ammonia type, although in the oxic conditions of certain reservoirs it can be easily changed into nitrates. Further, nitrates from wastewater are particularly common in municipalities that overlook shallow groundwater and that lack appropriate underground sewage infrastructure, but where municipal wastewater is allowed to penetrate in a somewhat diffused way [135].

Nitrate (^{15}N) and water (^{2}H, ^{3}H, and ^{18}O) isotopic tracers were applied in a study on High Plains aquifers in several parts of the United States to estimate nitrates deposited in the subsurface and their transit duration [31]. Unsaturated areas of the were compared with some of those connected with irrigated farmland areas, and chemical substances were used. McMahon et al. [139] showed how natural salt mobilization resulted in broader nitrate concentration under thick unsaturated areas below irrigated places due to evaporative concentration and irrigation return flow. This deposit approximated 60% of the nitrate detected below irrigated croplands in the groundwater basins. Although it was estimated that advective transit periods in the unsaturated zones were between 50 and 375 years (longer than any of the agricultural locations), agrochemicals have been identified in the ground water at 66% of irrigated crop sites. According to McMahon et al. [139], movement takes place across numerous flow pathways from slow routes (connected with small or no-flow finely grained sediments) to rapid routes (linked with focused recharge areas, including depressions, rivers, or playas). Therefore, the authors suggested that although the input was entirely stopped, the number of pollutants coming from irrigated locations reaching towards the shallow groundwater could increase since the mass of historically stored substances continues to move down slowly through the thick unsaturated zone under irrigated conditions. This pollutant storage in sediments is one reason for high nitrate, which has continuously increased in several groundwater systems as recorded over time.

4.1.2. Fluoride

Fluoride is another inorganic compound. Excess concentrations of fluoride in water resources is dangerous to human health and the environment [140]. Fluoride affects the water body through various sources, such as natural remedies, industrial, and agricultural practices. The parent rock itself is the primary natural source of fluoride in the soil. Weathering, mineral disintegration, and volcanic eruptions are natural phenomena that increase fluoride content in groundwater [141]. Fluorite, the only primary fluorine mineral in nature, is typically found in granite rocks as an accessory. The presence of small fluoride concentrations in groundwater causes malnutrition, particularly for children in remote and semi-urban regions [142].

As fluoride does not change the smell, color, and taste of drinking water, it typically cannot be identified unless analyzed. The precipitation that falls directly or indirectly into the surface system enriched with CO_2 throughout its downward movement in the soil, air, and biochemical interactions of the microorganisms and organic material increases the fluoride concentration in the subsurface [140]. Further, additional soil ions (a combination of $NaHCO_3$, NaCl, and Na_2SO_4) are also leached out. Additionally, the soil may have different amounts of fluoride-bearing compounds when phosphate fertilizers are applied. A simultaneous ion exchange reaction takes place in the soil clay material complex with exchangeable cations. Fluoride is likely to result in soil and fertilizer-borne fluoridated water for food and beverage processing in agricultural production (for example, tea, wheat, spinach, carrot, and cabbage) [143]. Nõmmik [144] discovered that fluoride in the soil moisture is water-soluble an comprises approximately 5–10% of the total fluoride in the soil. The pathways of inorganic fluorides in groundwater depend mainly on chemical composition, deposition rate, soil chemistry, and climate condition [140]. Extensive irrigation fertilizer application leads to the occurrence of fluoride in groundwater. In the groundwater from agricultural land and soils, higher fluoride concentration has been seen mainly by alkalinization.

Some anthropogenic activities such as coal combustion, improper disposal of waste generated from various industrial processes, including nickel, steel, copper, aluminum smelting, hydrofluoric acid, enamel, glass, brickworks, textile dyeing, plastics and glass factories, and industries that consume high sulfur non-coking coal-like thermal power contribute to the fluoride contamination in groundwater [145]. Large quantities are produced from high-tech companies producing semiconductors and integrated circuits of industrial fluoride effluents [140,146,147]. In addition, fluoride formation is affected by various other water characteristics, including pH, total solids, alkalinity and hardness, apart from the geographical and hydrological peculiarity of a specific place [148].

4.2. Sources of Heavy Metals

Heavy metals are found on the Earth's surface by natural and anthropogenic activities [149]. Heavy metals are naturally released from volcanic eruptions, metal corrosion, soil erosion, atmospheric sources, and weathering of rocks or minerals. Heavy metals are discharged primarily from industries, domestic wastes, mining, smelting or treating of ores, landfills, and livestock, and secondarily from pesticides and fertilizers. Heavy metals are a broad concept in the metals/metalloids group, and they have a more dominant atomic density of more than 4000 kg/m^3 [14]. Even with low metal ions' concentration in water supplies, nearly every heavy metal is harmful to human beings [150]. The quantity and quality of water resources are affected by the high concentration of heavy metals as well as availability for human consumption.

High quantities of these toxic substances are dangerous to humanity and may interact with several aspects of the earth because of their harmful effects and portability. In addition, these toxic metals are non-biodegradable and challenging to clean. Heavy metal contaminations in water resources and the environment must be monitored, recognized, and regulated. Toxic elements are released mainly from the exploitation of treated wastewater, industrial wastewater, sewage sludge, fertilizers, mining operation, and soil minerals; thus, the discharge of this waste into water becomes polluted [14]. Moreover, heavy metal concentrations are absorbed into the water bodies by various industries' effluents (tanneries, electrical products, electroplating, dyes, and others) and cause significant environmental problems even at low concentrations of metal ions. These substances are directly or indirectly discharged into the surface water, which increases the concentration of the ions and percolates in the groundwater, as well as polluting both [3].

4.2.1. Heavy Metals Risk in the Environment

The environment is affected by humans, animals, plants, and other living organisms. The discharge of heavy metals can cause different physical, chemical and biological mechanisms into water sources [151]. The two groups can be isolated, including the effects of heavy metal pollutants on the environment and the impact of the environment on toxic metals [14,152]. The first categorization relies on natural circumstances, whereas the population's density, diversity, community structure, and species composition might be changed. The degree and nature of modification are primarily dependent on the toxic element concentration in water and dregs. The second category emphasizes how it leads to a speciation and harmfulness adjustment of heavy metal concentration in terms of conditions in the water consumption. These circumstances include the contrast between artificial and geochemical substances, as well as the type and nature of untreated wastewater, suspended particles, and chelating agent quantities [153]. In suspended solids, colloidal particulate matter, and naturally/synthetic compounds, the aquatic environment is described in longitudinal variations and vertical variations in the living form concentrations densities, blending level, and redox condition [154].

These factors depend heavily on the metals' destiny in characteristic waters. For instance, the reduction in metallic shape and variations in methylation has an environmental influence on heavy metals. Similarly, a decrease of metals' development to the base of typical water resources comes from associative sedimentation and suspended particles [155]. Organic ligands are complex elements that decrease the process of sorption and increase the residence time in the water. Metal speciation is mainly determined by nature, and variations in speciation are responses to amendments. Heavy metal impacts are profound in aquatic plants. Although the typical responses, for example, decreased population density and diversity, occur primarily in highly defaced places, there are many more contradictory regions in either intolerantly or softly polluted locations [156]. In common environmental factors such as light and temperature, the population response to harmful toxic substances is likewise entirely affected by the natural varieties.

Biological observation initiatives are responsible for significant distinctive difficulties in the view of community criteria [157]. This implies that the assessment and control of these hazardous heavy metal releases should not be exclusively based on measurements of diversity and density. Heavy metal exposures can also cause physical alteration in the aquatic systems in which they are received. The variations in water pH, organic compound concentration, and water particle size are included here [14]. Plants in aquatic environments respond to these difficulties with a decrease in diversity, density, and species composition. Consequently, this concern can be experienced in depicting the influence from the physical effects of heavy metal contamination, which are indirectly carried out.

4.2.2. Heavy Metals Risk on the Plant

The plants are sessile forms of life that should be changed to adapt their existence and reproduction to varied compositions of the soils. Soils are often stored at high concentrations based on the plant species and the soil characteristics with an inadequate amount of essential and unessential components. Many elements are widely used to regulate their basic mortality mechanisms and the plants use general elimination routes to manage these metals. The impacts of toxic metals are exacerbated by competition because the large concentrations of one metal can unbalance other metals' removal or movement, producing the behavior of toxicity.

Plants typically produce soil minerals as inorganic ions. The enlarged root and ionic components are able to be absorbed even at low levels to make the use of minerals even more effective. Mineral components can be categorized into two classes: non-essential nutrients and essential nutrients (micro and macronutrients). The main constituents of a plant structure and its metabolisms are the necessary micronutrients (iron, copper, sodium, copper, nickel, zinc, and manganese,) and the macronutrients (nitrogen, calcium, sulfur and other ions). However, several heavy metals such as copper, nickel, iron, and nickel, are essential growth requirements for plants, but are harmful if their concentrations go beyond the limits acceptable for plants and creatures [158]. Further, for animals and plants to grow, other toxic substances such as arsenic, lead, mercury, and cadmium are not essential [159]. Even at low concentrations, various metals such as arsenic, chromium, mercury, and cadmium are hazardous for plant growth [160]. The growth in the focus on heavy metal toxicity means that the negative consequences in these initially exposed (metal take-up cells) cells are likely to be seen.

Toxic elements interact with enzyme activities and ion homeostasis, which are evident in physiological practices consisting of single organs (such as the addition of the roots) through the use of more broad practices such as photosynthesis, crucial digestion, germination, multiplication, and plant water balance [157]. In fact, the undiscovered adverse effects of the hazardous toxic metals include low biomass generation, incorporate chlorosis, shriveling, senescence, hindered development, leaf rolling and putrefaction, limited seed quantity, and long-term demise. The large dispersion of heavy metals in the environment, and the (acute and chronic) consequences of heavy metal contamination in the agricultural soil on the growth of the plant, are serious environmental issues [161]. High amounts of copper intake in plants cause reactive oxygen species to develop and oxidative stress to be produced. Because of the phytotoxicity of both copper and zinc, plant growth and its metabolic activities, as well as oxidative risk have been seen in many species. In many plant species, increased levels of lead in the soil cause instigate irregular morphology. Elevated nickel concentrations in plant tissues lead to dispersion of cell membrane capacities and demonstrate a disability in the nutrient balance.

Exposure to plants by chromium in large amounts affects the photosynthesis process in terms of photophosphorylation and electron transport, enzyme activity, and carbon dioxide fixation [162]. Symptoms of arsenic phytotoxicity include shrinking and leaf putrefaction which can be tracked by root stain and the impediment of the growth of the shoot. Research has shown that arsenic behavior is observable in flagging routes, especially those related to membrane damage, reactive oxygen species generation, and electrolyte spillage. Due to large exposures to mercury, physiological problems and visual damage were found in the plants.

4.2.3. Heavy Metals Risk on the People Health

Heavy metals concentrations in soil are often higher than acceptable standard values, which can lead to serious health problems. Some essential metals are crucial for maintenance of skeletal structures such as the colloidal system, acid–base equilibrium regulation, structural proteins, key enzymes, and hormones [151]. For instance, iron is essential for hemoglobin and zinc for many enzymes. Further, non-essential metals do not have a major role in the human body but may affect the human nervous system. Heavy metal toxicity may damage cell components, cellular organelles, mental and central nerve activities, cell membrane, nuclei, and blood compositions; and destroy lungs and kidneys. Extended exposure periods of toxic metals can lead to multiple sclerosis, Alzheimer's disease, muscle degeneration, and various types of cancer. Moreover, metal ions interact with nuclear proteins and DNA, resulting in damage to DNA and thus causing cell cycle modulation, carcinogenesis, or apoptosis. A pathway illustrating the impacts of heavy metal contamination is shown in Figure 6.

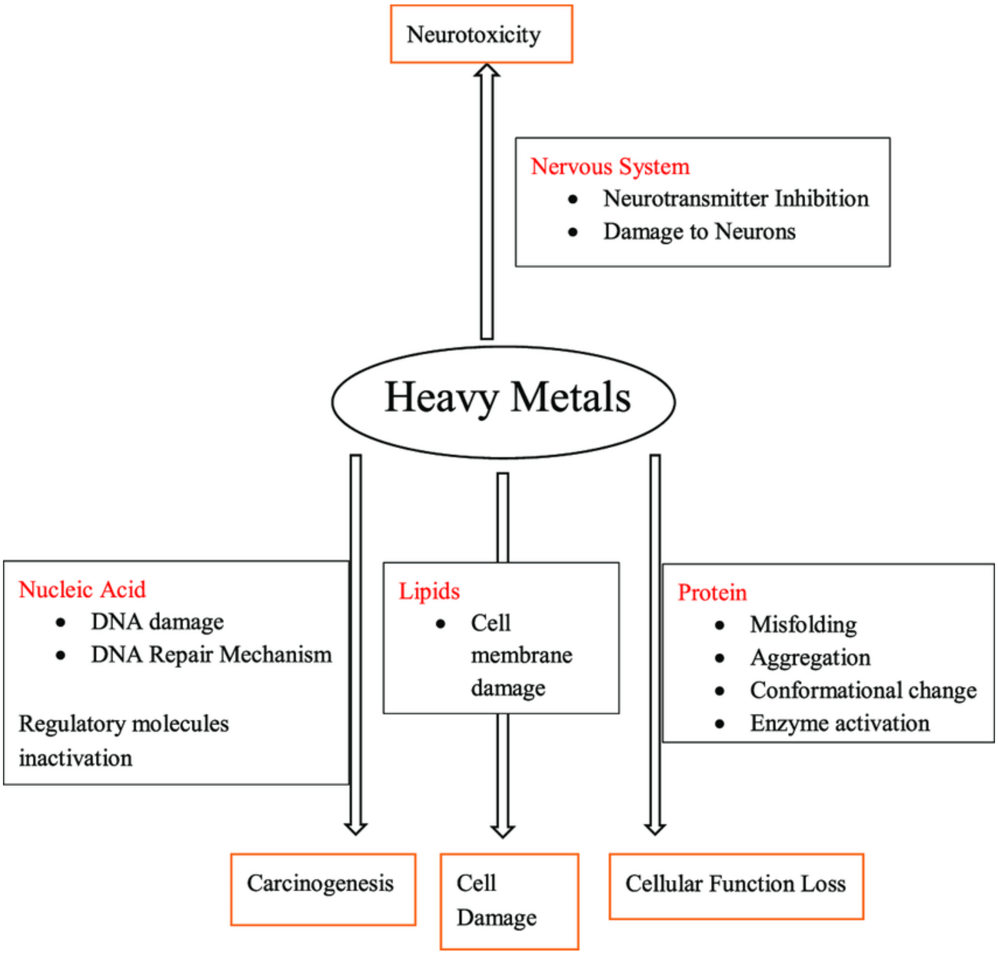

Figure 6. This is showing the source pathways and human exposure of heavy metals [14].

Toxicity of heavy metals in humans has largely been reported via three remarkable pathways: dermal exposure, oral intake, and inhalation. The main path of human heavy metals exposure in inhabitants is dependent on heavy metal characteristics. Because heavy metals are water-soluble in nature, oral intake is the most effective pathway for copper to enter the people body. Mercury can bioaccumulate in living organism species, which is a key route for mercury intake in marine living organisms.

Exposure to heavy metals via the skin is only concerning for certain. A number of metals can enter the internal human system in combination with other substances. Heavy metals have become common sensitizers in human contacts, particularly nickel, which has a growing rate of hypersensitivity in children, especially in industrialized nations or developed countries [163,164]. Some heavy metals are well known environmental pollutants found in water bodies throughout the world in high concentrations, including iron, copper, nickel, cadmium, zinc, aluminum, chromium, arsenic, cobalt, manganese, mercury, and lead, as shown in Table 3.

Table 3. Water pollution due to heavy metals in numerous countries across the world.

Heavy Metals	Source	Pollution Type	Regions/Countries	GW Maximum Concentration	References
Aluminium (Al)	Natural source	Hydrological alkaline massif	Imandra, Kola Peninsula	1.81 mg/L	[169]
	Aluminium industry	Waste material	Canada	12.5 mg/L	[170]
	Ni-SO_4 mining	Waste material	Western, Australia	11 mg/L	[171]
	Natural source	Peaty acid sulphate soil	Kalimantan, Indonesia	180 mg/L	[172]
Arsenic (As)	Mining Activity	Deepwater	Thammarat, Thailand	503 µg/L	[173]
	Industrial	Wastewater	Ondo, Nigeria	1.23 mg/L	[174]
	Natural source	Arsenic bearing mineral	NE Ohio, USA	200 µg/L	[175]
	Pesticide Production Plant	Infiltration	Kolkata, India	23,050 µg/L	[176]
Cadmium (Cd)	Fe-Ni-Co Mining	Waste material	Albania, several sites	185 µg/L	[177]
	Textile Industry	Wastewater	Haridwar, India	40 µg/L	[178]
	Household waste	Wastewater	Ikare, Nigeria	580 µg/L	[179]
	Fertilizer production	Atmospheric deposition	Rio, Brazil	3 µg/L	[180]
Cobalt (Co)	Natural source	weathering	Imo, Nigeria	2 mg/L	[181]
	Bonab Industrial Estate waste material	Waste material	Zanjan, Iran	308 µg/L	[182]
	Industrial effluents	Waste material	Tamil Nadu, India	0.5 mg/L	[183]
	Household waste	Wastewater	Zahedan City, Iran	0.204 mg/L	[184]
Chromium (Cr)	Brownfield	Wastewater	Xiangjiang River, China	94.4 mg/L	[185]
	Industrial	Wastewater	Spain	25 mg/L	[186]
	Natural source	Biological activity	North-western Nigeria	2.2 mg/L	[187]
	Urban land use/agriculture	wastewater/infiltration	California	10 µg/L	[188]
Copper (Cu)	Qilan Mountain Mining	Waste material	Qinghai-Tibet Plateau, China	11.3 mg/L	[189]
	Natural	Dissolution of Cu-weathering	Kampinos, Poland	0.59 mg/L	[190]
	Urbanization/ industrialization	Wastewater	Bahia, Brazil	1.596 mg/L	[191]
	Roadways	Waste material infiltrates	Corlu, Turkey	554.45 µg/L	[192]
Iron (Fe)	Yimin open pit mine	Waste material	Inner Mongolia, China		[193]
	El-Hadjar Industrial	Wastewater	Annaba, (Algeria)	32 mg/L	[194]
	Natural source	Dissolution of Fe-minerals	Shuangliao, China	46.3 mg/L	[92]
	Household waste	Wastewater	Tangail, Bangladesh	25 mg/L	[195]
Manganese (Mn)	P fertilizer application	Infiltration	Cauvery River basin, India	7 mg/L	[196]
	Hattar industrial estate	Wastewater	Haripur, Pakistan	2 mg/L	[197]
	Textile Industry	Atmospheric deposition	Unnao, India	2.72 mg/L	[198]
	Natural source	Dissolution of pyrite	Coode Island, Australia	0.9 mg/L	[129]

Table 3. *Cont.*

Heavy Metals	Source	Pollution Type	Regions/Countries	GW Maximum Concentration	References
Mercury (Hg)	Household waste	Wastewater	Sekondi-Takoradi Metropolis, Ghana	90 µg/L	[199]
	Chloro-alkali Industry	Wastewater	Kerala, India	9.9 mg/L	[200]
	Natural source	Marine sediment intrusion	Zhoushan Island, China	1 µg/L	[92]
	Municipal Waste	Wastewater	Swabi, Pakistan	2 µg/L	[201]
Nickel (Ni)	Electronically waste recycling	Wastewater	Krishna Vihar, India	2.9 mg/L	[202]
	Taichung industrial	Wastewater	Taiwan	1.022 mg/L	[203]
	Sewerage	Leakage	Rastatt, Germany	0.02 mg/L	[204]
	Mining Activity	Wastewater	KwaZulu-Natal Province, South Africa	2 mg/L	[205]
Lead (Pb)	Landfill	Leachate	Taiwan Alexandria, Egypt	51 µg/L	[206]
	Electro planting	Wastewater	Zagreb, Croatia	8.6 mg/L	[207]
	Au-Ag-Pb-Zn mining	Wastewater	Chloride, Arizona USA	19 µg/L	[208]
	Natural source	Oxidation reactions, leaching	South Africa	1 mg/L	[30]
Zinc (Zn)	Pb-Zn mining	Wastewater	Coeur d'Alene basin, Idaho, USA	389 µg/L	[209]
	Engineering plant	Waste material	China	505 mg/L	[210]
	Road Traffic	Infiltration	Celle, Germany	2.34 mg/L	[211]
	Natural source	Atmospheric deposition	Strijer, Netherlands	More than 15 mg/L	[212]

Table 4. Water pollution due to fluorides and nitrates in numerous countries across the world.

Heavy Metals	Source	Pollution Type	Regions/Countries	GW Maximum Concentration	References
Fluoride	Indusrial	Wastewater	Roopnagar, Delhi, India	7.4 mg/L	[165]
	Agriculture fertilizers	Infiltration	Pampa, Argentina	21.1 mg/L	[166]
	Municipal	Waste material	Taiwan	1.81 mg/L	[167]
	Power plant	Thermal Water	China	50 mg/L	[143]
Nitrate	Agriculture fertilizers	Infiltration	Jharkhand, India	319.1 mg/L	[168]
	Livestock farms and landfill	Wastematerial	Beijing, China	1736 mg/L	[131]
	Industrial hazardous	Wastematerial	Liaohe River, China	175 mg/L	[133]
	Anthropogenic activities	Chemical fertilizer	Sicily, Italy	225 mg/L	[135]

5. Discussion and Future Directions

A complete understanding and assessment of the environmental behavior and types of pollutants that cause significant damage are required to address the management of water bodies and their quality issues [213]. A crucial component of this assessment is the demand for enhanced awareness of the sources and nature of chemical contaminants in and around effective water systems, which contribute to providing humans with drinking water and residence to aquatic organisms [214]. Water sources are often polluted or contaminated by a specific availability of natural factors and anthropogenic activities. Natural factors influence water quality through geological processes, natural disasters, climate change, and hyporheic exchange. These factors can pollute surface water and groundwater gradually and rapidly. Such factors also take place over several years to thousands of years to contribute to the pollution in water resources. Further, changes in seasonal rainfall, variations in rainfall rates, increasing temperature, and the direct effects of increased atmospheric carbon dioxide are the main repercussions of climate change [116]. Surface water and groundwater interact at the hyporheic zone and their solutes mix, as well as during hyporheic exchange near channels, which mixes with shallow aquifers rapidly at shallow depth.

Human (anthropogenic) activities have increased because of demographic changes, consumer behavior, rapid industrialization, and urbanization, as well as the fast-growing population [3]. Decision-makers in developing countries are confronted with major new issues regarding solid/liquid waste management. Over the last several years, many communities have increased their efforts to develop long-term sustainable solutions to the solid/liquid waste management challenge [215]. Liquid waste factors have been increased such as industrial waste (chemical compounds and wastewater) and municipal waste (sanitary sewers). Integrated solid waste has increased such as in the maintenance of sanitary landfills, construction, manufacturing applications, and municipal waste effluents [83]. Wastewater and other toxic compounds (heavy metals) from urban practices and industries have been discharged into surface water, which then infiltrates into groundwater through soil/rock formations. Therefore, many reasons are still unidentified, although there is very little knowledge regarding contaminant types and pathways, particularly in developed countries. Many other types of urban and industrial compounds with pollution risks have not been extensively discussed in this study. Although there are still limited publications on this topic regarding human activities, the risk is becoming more widely recognized in the hydrological and environmental sciences.

The use of fertilizers and pesticides in agriculture, industrial applications, and some urban practices increases the toxicity in water resources [216]. These changes in soil mineralization, agriculture, leaching, recharging, and groundwater pathways are controlled at the receptor by a number of competing consequences. Specific processes have been widely investigated, but the overall influence remains challenging to estimate. In agriculture practices, substances such as nitrate and fluoride are simultaneously released into the water bodies by numerous causes which are mostly unknown [131,140,143]. There is a lack of proper knowledge about contaminant hydro-geochemistry, especially in areas with high levels of both. Future studies should aim to understand the potential relationships of co-occurring pollutants and other characteristics with co-contaminants. The degree to which their co-occurrence has an impact on the local environment, geological processes, geochemistry, and hydrological processes of the water sources is still unknown [214]. It is necessary to determine how these anions work in the vicinity of others, and the antagonistic/synergistic relationship that may change under different circumstances. In addition, it creates a much wider path that allows for additional investigation into the nature and behavior of co-occurrence.

Due to significant advancements in technology, there have been significant advances over the past several decades towards enhancing water resources characterization. Numerical modelling of transportation and flow of water, isotope monitoring, water quality method, and improved analytical strength for synthetic substances have been used to understand the issues of water resources [31]. For example, geophysical surveying has been used to investigate groundwater pollution at the local scale, and remote sensing techniques developed at local to regional scale for surface and groundwater systems. Nevertheless, these methods persist with significant uncertainties. The extensive assessment of connections of surface water and groundwater systems in response to changes in land use and the consequent risk of contamination remains a challenge because of heterogeneity in the spatial and temporal scale of the activities [139]. At present, there is no single criterion for any water resources that can characterize water quality. Uncertainty is also the consequence of insufficient assessment of how anthropogenic practices may affect water resources, extending with additional activities. For instance, in temperature changes or illness outbreaks, groundwater vulnerability and susceptibility to medication is little-known. The problem of antibiotic resistance and the proliferation of substances in the water body should concern us, with an increasing number of publications finding pharmaceuticals in water systems [97]. Additional research on the determinants of these compounds in their quantities and cocktails in the aqueous environment is required.

Future research is needed to better understand the impact of products utilized in new technologies. As a result, there is a worldwide necessity for a comprehensive preventive warning system that can predict problems associated with inorganic substances (nitrogen, fluoride, and heavy metals) [216,217]. It is vital to remove harmful heavy from water resources or wastewater since they are significant health hazards to people and other living things. In order to reduce pollution in nature, treatment techniques are necessary in order to eliminate dangerous metal ions from multiple water systems. Heavy metals monitoring technologies, such as wireless technology, treatment methods, automated detectors, and new tracers, have all contributed to the enormous increase in data accessibility, implying that elevated, increased data collection and data management should develop the capacity to track and share knowledge in environmental science and related fields [217]. The relationship between water resources and their dependent industries and urban practices, as well as water governance, should be recognized and expressed, both in legislation and in practice, in order to address these and other shortcomings [2]. It is crucial to highlight that some countries are decreasing their tracking expenditures. Monitoring pollutants in the affected system will become critical in a world where water use is expected to rise, water scarcity to increase, and dependency on water reuse to become common practice [213]. In the context of resource restrictions, it is essential to the research community to properly emphasize the importance of monitoring networks and the maintenance and improvement of long-term data sets, while recognizing the need for installation and maintenance of monitoring equipment [217]. Adaptive management techniques and transdisciplinary studies give a mechanism to tackle sustainable natural resource management under uncertain conditions, as situations change faster than researchers or legislators can anticipate.

6. Conclusions

This study focused on some of the major serious water resources pollution issues resulting from both natural and anthropogenic activities. Anthropogenic activities such as industrial applications and agricultural practices as well as toxic contaminants, have been addressed in this study. Geological processes, natural disasters, climate change, and surface water and groundwater interactions are the main natural causes of contamination. There are case studies available that cover various issues such as surface water and groundwater quality and contaminating sources. However, there are few case studies that examine specific topics such as water resources pollution types, sources, and pathways. The multitude of cases demonstrates the wide range of subjective challenges to water systems as a result of long-term supplies for human utilization and environmental protection. Challenges include food production, urban development, increased drug production and usage, and inadequate sewage facilities, as well as declining scientific evidence on water quality. In such cases, a lack of importance placed on water resources as renewable hampers the complicated problem of maintaining water quality. Transdisciplinary study and practice can serve to gain better knowledge to understand the pollution processes, types, pathways, and their consequences on water resources. This makes for a lot of possibilities for interdisciplinary research areas (environmental sciences and related fields) and transboundary communication.

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References

1. Akhtar, N.; Ishak, M.; Ahmad, M.; Umar, K.; Yusuff, M.M.; Anees, M.; Qadir, A.; Almanasir, Y.A. Modification of the Water Quality Index (WQI) Processfor Simple Calculation Using the Multi-Criteria Decision-Making(MCDM) Method: A Review. *Water* **2021**, *13*, 905. [CrossRef]
2. Khatri, N.; Tyagi, S. Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Front. Life Sci.* **2014**, *8*, 23–39. [CrossRef]
3. Akhtar, N.; Syakir, M.I.; Rai, S.P.; Saini, R.; Pant, N.; Anees, M.T.; Qadir, A.; Khan, U. Multivariate Investigation of Heavy Metals in the Groundwater for Irrigation and Drinking in Garautha Tehsil, Jhansi District, India. *Anal. Lett.* **2019**, *53*, 774–794. [CrossRef]
4. Nagaraju, A.; Thejaswi, A.; Sreedhar, Y. Assessment of Groundwater Quality of Udayagiri area, Nellore District, Andhra Pradesh, South India Using Multivariate Statistical Techniques. *Earth Sci. Res. J.* **2016**, *20*, 1. [CrossRef]
5. Macdonald, A.M.; Davies, J.; Dochartaigh, B.E.O. Simple methods for assessing groundwater resources in low permeability areas of Africa. British Geological Survey Commissioned Report, CR/01/168N. South Africa. *Br. Geol. Surv.* **2002**, *71*. [CrossRef]
6. Trabelsi, R.; Zouari, K. Coupled geochemical modeling and multivariate statistical analysis approach for the assessment of groundwater quality in irrigated areas: A study from North Eastern of Tunisia. *Groundw. Sustain. Dev.* **2019**, *8*, 413–427. [CrossRef]
7. Akhtar, N.; Rai, S.P. Heavy Metals Concentrations in Drinking Water and Their Effect on Public Health around Moth Block of Jhansi District, Uttar Pradesh, India. *Indian J. Environ. Prot.* **2019**, *39*, 945–953.
8. Sasakova, N.; Gregova, G.; Takacova, D.; Mojzisova, J.; Papajová, I.; Venglovsky, J.; Szaboova, T.; Kovacova, S. Pollution of Surface and Ground Water by Sources Related to Agricultural Activities. *Front. Sustain. Food Syst.* **2018**, *2*. [CrossRef]
9. Manjunatha, S.; Bobade, K.; Kudale, M. Pre-cooling Technique for a Thermal Discharge from the Coastal Thermal Power Plant. *Procedia Eng.* **2015**, *116*, 358–365. [CrossRef]
10. Issakhov, A. Numerical Study of the Discharged Heat Water Effect on the Aquatic Environment from Thermal Power Plant by using Two Water Discharged Pipes. *Int. J. Nonlinear Sci. Numer. Simul.* **2017**, *18*, 469–483. [CrossRef]
11. USEPA. *Protecting Water Quality from Agricultural Runoff*; United State Enviromental Protection Agency (USEPA): Washington, DC, USA, 2005.
12. Parris, K. Impact of Agriculture on Water Pollution in OECD Countries: Recent Trends and Future Prospects. *Int. J. Water Resour. Dev.* **2011**, *27*, 33–52. [CrossRef]
13. Varol, M.; Şen, B. Assessment of nutrient and heavy metal contamination in surface water and sediments of the upper Tigris River, Turkey. *CATENA* **2012**, *92*, 1–10. [CrossRef]
14. Vardhan, K.H.; Kumar, P.S.; Panda, R.C. A review on heavy metal pollution, toxicity and remedial measures: Current trends and future perspectives. *J. Mol. Liq.* **2019**, *290*, 111197. [CrossRef]
15. Bhardwaj, R.; Gupta, A.; Garg, J. Evaluation of heavy metal contamination using environmetrics and indexing approach for River Yamuna, Delhi stretch, India. *Water Sci.* **2017**, *31*, 52–66. [CrossRef]
16. Coelho, L.M.; Rezende, H.C.; Coelho, L.M.; Sousa, P.A.R.; Melo, D.F.O.; Coelho, N.M.M. Bioremediation of Polluted Waters Using Microorganisms. In *Advances in Bioremediation of Wastewater and Polluted Soil*; Shiomi, N., Ed.; IntechOpen: London, UK, 2015; pp. 1–22.
17. Galindo-Miranda, J.M.; Guízar-González, C.; Becerril-Bravo, E.J.; Moeller-Chávez, G.; León-Becerril, E.; Vallejo-Rodríguez, R. Occurrence of emerging contaminants in environmental surface waters and their analytical methodology. *Water Supply* **2019**, *19*, 1871–1884. [CrossRef]
18. Shahabudin, M.M.; Musa, S. Occurrence of Surface Water Contaminations: An Overview. *IOP Conf. Ser. Earth Environ. Sci.* **2018**, *140*, 012058. [CrossRef]
19. Li, H.; Yu, X.; Zhang, W.; Huan, Y. Risk Assessment of Groundwater Organic Pollution Using Hazard, Intrinsic Vulnerability, and Groundwater Value, Suzhou City in China. *Expo. Health* **2017**, *10*, 99–115. [CrossRef]
20. Lyon, S.W.; Grabs, T.; Laudon, H.; Bishop, K.H.; Seibert, J. Variability of groundwater levels and total organic carbon in the riparian zone of a boreal catchment. *J. Geophys. Res. Space Phys.* **2011**, *116*. [CrossRef]
21. Bellin, A.; Fiori, A.; Dagan, G. Equivalent and effective conductivities of heterogeneous aquifers for steady source flow, with illustration for hydraulic tomography. *Adv. Water Resour.* **2020**, *142*, 103632. [CrossRef]
22. Cabral, J.P.S. Water Microbiology. Bacterial Pathogens and Water. *Int. J. Environ. Res. Public Health* **2010**, *7*, 3657–3703. [CrossRef]
23. OECD. Pharmaceutical Residues in Freshwater: Hazards and Policy Responses. In *OECD Studies on Water*; Organisation for Economic Cooperation and Development: Paris, France, 2019.
24. Shwetank; Suhas; Chaudhary, J.K. A Comparative Study of Fuzzy Logic and WQI for Groundwater Quality Assessment. *Procedia Comput. Sci.* **2020**, *171*, 1194–1203. [CrossRef]

25. Akhila, J.S.; Shyamjith, D.; Alwar, C.M. Acute Toxicity Studies and Determination of Median Lethal Dose. *Curr. Sci.* **2007**, *93*, 917–920.
26. Singh, T.; Wu, L.; Gomez-Velez, J.D.; Lewandowski, J.; Hannah, D.M.; Krause, S. Dynamic Hyporheic Zones: Exploring the Role of Peak Flow Events on Bedform-Induced Hyporheic Exchange. *Water Resour. Res.* **2019**, *55*, 218–235. [CrossRef]
27. Varol, M. Use of water quality index and multivariate statistical methods for the evaluation of water quality of a stream affected by multiple stressors: A case study. *Environ. Pollut.* **2020**, *266*, 115417. [CrossRef] [PubMed]
28. Kumar, M.; Das, A.; Das, N.; Goswami, R.; Singh, U.K. Co-occurrence perspective of arsenic and fluoride in the groundwater of Diphu, Assam, Northeastern India. *Chemosphere* **2016**, *150*, 227–238. [CrossRef] [PubMed]
29. Ntanganedzeni, B.; Elumalai, V.; Rajmohan, N. Coastal Aquifer Contamination and Geochemical Processes Evaluation in Tugela Catchment, South Africa—Geochemical and Statistical Approaches. *Water* **2018**, *10*, 687. [CrossRef]
30. Verlicchi, P.; Grillini, V. Surface Water and Groundwater Quality in South Africa and Mozambique—Analysis of the Most Critical Pollutants for Drinking Purposes and Challenges in Water Treatment Selection. *Water* **2020**, *12*, 305. [CrossRef]
31. Burri, N.M.; Weatherl, R.; Moeck, C.; Schirmer, M. A review of threats to groundwater quality in the anthropocene. *Sci. Total. Environ.* **2019**, *684*, 136–154. [CrossRef]
32. Ben Alaya, M.; Saidi, S.; Zemni, T.; Zargouni, F. Suitability assessment of deep groundwater for drinking and irrigation use in the Djeffara aquifers (Northern Gabes, south-eastern Tunisia). *Environ. Earth Sci.* **2013**, *71*, 3387–3421. [CrossRef]
33. Bhaskar, A.S.; Beesley, L.; Burns, M.J.; Fletcher, T.D.; Hamel, P.; Oldham, C.E.; Roy, A.H. Will it rise or will it fall? Managing the complex effects of urbanization on base flow. *Freshw. Sci.* **2016**, *35*, 293–310. [CrossRef]
34. McInnes, R.J. Sustainable Development Goals. In *The Wetland Book*; Springer: Berlin/Heidelberg, Germany, 2018; pp. 631–636. [CrossRef]
35. USEPA. *The Report to Congress: Waste Disposal Practices and Their Effects on Water*; United State Enviromental Protection Agency: Washington, DC, USA, 1977.
36. OTA. *Protecting the Nation's Groundwater from Contamination*; U.S. Congress Office of Technology Assessment: Washington, DC, USA, 1984; Volume I–II, OTA-0-233.
37. USEPA. *Wellhead Protection Programs: Tools for Local Governments*; United State Enviromental Protection Agency: Washington, DC, USA, 1989; 440/6-89-002.
38. EPA. *Point and Non-Point Sources of Water Pollution*; United States Environmental Protection Agency: Washington, DC, USA, 1996.
39. Nan, Y.; Bao-Hui, M.; Chun-Kun, L. Impact Analysis of Climate Change on Water Resources. *Procedia Eng.* **2011**, *24*, 643–648. [CrossRef]
40. Kammoun, S.; Trabelsi, R.; Re, V.; Zouari, K. Coastal Aquifer Salinization in Semi-Arid Regions: The Case of Grombalia (Tunisia). *Water* **2021**, *13*, 129. [CrossRef]
41. Anders, I.; Stagl, J.; Auer, I.; Pavlik, D. Climate Change in Central and Eastern Europe. In *Managing Protected Areas in Central and Eastern Europe under Climate Change*; Rannow, S., Neubert, M., Eds.; Springer: New York, NY, USA, 2014; Chapter 23; pp. 17–30. [CrossRef]
42. Ching, Y.C.; Lee, Y.H.; Toriman, M.E.; Abdullah, M.; Bin Yatim, B. Effect of the big flood events on the water quality of the Muar River, Malaysia. *Sustain. Water Resour. Manag.* **2015**, *1*, 97–110. [CrossRef]
43. Scardina, P. Effects of Dissolved Gas Supersaturation and Bubble Formation on Water Treatment Plant Performance. Master's Thesis, Faculty of the Virginia Polytechnic Institute and State University, Blacksburg, VN, USA, 2004.
44. Payus, C.; Huey, L.A.; Adnan, F.; Rimba, A.B.; Mohan, G.; Chapagain, S.K.; Roder, G.; Gasparatos, A.; Fukushi, K. Impact of Extreme Drought Climate on Water Security in North Borneo: Case Study of Sabah. *Water* **2020**, *12*, 1135. [CrossRef]
45. PAHO. *Natural Disaster Mitigation in Drinking Water and Sewerage Systems*; World Health Organization: Washington, DC, USA, 1998.
46. Lee, J.; Perera, D.; Glickman, T.; Taing, L. Water-related disasters and their health impacts: A global review. *Prog. Disaster Sci.* **2020**, *8*, 100123. [CrossRef]
47. Knap, A.H.; Rusyn, I. Environmental exposures due to natural disasters. *Rev. Environ. Health* **2016**, *31*, 89–92. [CrossRef]
48. Sholihah, Q.; Kuncoro, W.; Wahyuni, S.; Suwandi, S.P.; Feditasari, E.D. The analysis of the causes of flood disasters and their impacts in the perspective of environmental law. *IOP Conf. Ser. Earth Environ. Sci.* **2020**, *437*, 012056. [CrossRef]
49. Euripidou, E.; Murray, V. Public health impacts of floods and chemical contamination. *J. Public Health* **2004**, *26*, 376–383. [CrossRef]
50. Schoonover, J.E.; Crim, J.F. An Introduction to Soil Concepts and the Role of Soils in Watershed Management. *J. Contemp. Water Res. Educ.* **2015**, *154*, 21–47. [CrossRef]
51. Winter, T.C.; Harvey, J.W.; Franke, O.L.; Alley, W.M. *Ground Water Surface Water and A Single Resource*; U.S. Geological Survey Circular 1139: Denver, CO, USA, 1998.
52. Liu, J.; Zhang, C.; Kou, L.; Zhou, Q. Effects of Climate and Land Use Changes on Water Resources in the Taoer River. *Adv. Meteorol.* **2017**, *2017*, 1–13. [CrossRef]
53. Riedel, T.; Weber, T.K.D. Review: The influence of global change on Europe's water cycle and groundwater recharge. *Hydrogeol. J.* **2020**, *28*, 1939–1959. [CrossRef]
54. Zaharescu, D.G.; Burghelea, C.I.; Dontsova, K.; Presler, J.K.; Hunt, E.A.; Domanik, K.J.; Amistadi, M.K.; Sandhaus, S.; Munoz, E.N.; Gaddis, E.E.; et al. Ecosystem-bedrock interaction changes nutrient compartmentalization during early oxidative weathering. *Sci. Rep.* **2019**, *9*, 1–16. [CrossRef] [PubMed]

55. Sharma, S.; Bhattacharya, A. Drinking water contamination and treatment techniques. *Appl. Water Sci.* **2016**, *7*, 1043–1067. [CrossRef]
56. Wirt, L. *Radioactivity in the Environment A Case Study of the Puerco and Little Colorado River Basins, Arizona and New Mexico*; U.S. Geological Survey, Water Resources Division: Tucson, AZ, USA, 1994.
57. Rejah, B.K.; Alameer, N.K.A.; Kadim, W.H.; Murad, S.T.M. Estimate Level of Radon Concentration for Drinking Water in Some Regions of Baghdad City. *Arab. J. Sci. Eng.* **2018**, *43*, 3831–3835. [CrossRef]
58. Aarkrog, A. Disposal of radioactive wastes into marine and fresh waters: IAEA bibliographical series No. 5 (Vienna, 1962. 368p. $3.00). *Nucl. Phys.* **1962**, *37*, 693. [CrossRef]
59. Alam, I.; Rehman, J.U.; Ahmad, N.; Nazir, A.; Hameed, A.; Hussain, A. An overview on the concentration of radioactive elements and physiochemical analysis of soil and water in Iraq. *Rev. Environ. Health* **2020**, *35*, 147–155. [CrossRef]
60. Al-Alawy, I.T.; Mohammed, R.S.; Fadhil, H.R.; Hasan, A.A. Determination of Radioactivity Levels, Hazard, Cancer Risk and Radon Concentrations of Water and Sediment Samples in Al-Husseiniya River (Karbala, Iraq). *J. Phys. Conf. Ser.* **2018**, *1032*, 012012. [CrossRef]
61. Ahmad, N.; Jaafar, M.S.; Bakhash, M.; Rahim, M. An overview on measurements of natural radioactivity in Malaysia. *J. Radiat. Res. Appl. Sci.* **2015**, *8*, 136–141. [CrossRef]
62. Hussein, Z.A. Assessment of Natural Radioactivity Levels and Radiation Hazards for Soil Samples Used in Erbil Governorate, Iraqi Kurdistan. *Aro-Sci. J. Koya Univ.* **2019**, *7*, 34–39. [CrossRef]
63. Fookes, P.G. Geology for Engineers: The Geological Model, Prediction and Performance. *Q. J. Eng. Geol. Hydrogeol.* **1997**, *30*, 293–424. [CrossRef]
64. Wuana, R.A.; Okieimen, F.E. Heavy Metals in Contaminated Soils: A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation. *ISRN Ecol.* **2011**, *2011*, 1–20. [CrossRef]
65. Cumberland, S.A.; Douglas, G.; Grice, K.; Moreau, J.W. Uranium mobility in organic matter-rich sediments: A review of geological and geochemical processes. *Earth-Sci. Rev.* **2016**, *159*, 160–185. [CrossRef]
66. Wali, S.U.; Umar, S.W.; Abubakar, S.D.; Ifabiyi, I.P.; Dankani, I.M.; Shera, I.M.; Yauri, S.G. Hydrochemical characterization of shallow and deep groundwater in Basement Complex areas of southern Kebbi State, Sokoto Basin, Nigeria. *Appl. Water Sci.* **2019**, *9*, 169. [CrossRef]
67. Brunner, P.; Cook, P.; Simmons, C.T. Disconnected Surface Water and Groundwater: From Theory to Practice. *Groundwater* **2010**, *49*, 460–467. [CrossRef]
68. Turnadge, C.; Smerdon, B.D. A review of methods for modelling environmental tracers in groundwater: Advantages of tracer concentration simulation. *J. Hydrol.* **2014**, *519*, 3674–3689. [CrossRef]
69. Winter, T.C. Recent advances in understanding the interaction of groundwater and surface water. *Rev. Geophys.* **1995**, *33*, 985–994. [CrossRef]
70. Sophocleous, M. Interactions between groundwater and surface water: The state of the science. *Hydrogeol. J.* **2002**, *10*, 52–67. [CrossRef]
71. Williams, D.D. Nutrient and flow vector dynamics at the hyporheic/groundwater interface and their effects on the interstitial fauna. *Hydrobiologia* **1993**, *251*, 185–198. [CrossRef]
72. Cardenas, M.B. Hyporheic zone hydrologic science: A historical account of its emergence and a prospectus. *Water Resour. Res.* **2015**, *51*, 3601–3616. [CrossRef]
73. Brunner, P.; Therrien, R.; Renard, P.; Simmons, C.T.; Franssen, H.-J.H. Advances in understanding river-groundwater interactions. *Rev. Geophys.* **2017**, *55*, 818–854. [CrossRef]
74. Schmadel, N.M.; Ward, A.S.; Lowry, C.S.; Malzone, J.M. Hyporheic exchange controlled by dynamic hydrologic boundary conditions. *Geophys. Res. Lett.* **2016**, *43*, 4408–4417. [CrossRef]
75. Alfarrah, N.; Walraevens, K. Groundwater Overexploitation and Seawater Intrusion in Coastal Areas of Arid and Semi-Arid Regions. *Water* **2018**, *10*, 143. [CrossRef]
76. Kumar, P.J.S. Deciphering the groundwater–saline water interaction in a complex coastal aquifer in South India using statistical and hydrochemical mixing models. *Model. Earth Syst. Environ.* **2016**, *2*, 1–11. [CrossRef]
77. Doble, R.C.; Crosbie, R. Review: Current and emerging methods for catchment-scale modelling of recharge and evapotranspiration from shallow groundwater. *Hydrogeol. J.* **2016**, *25*, 3–23. [CrossRef]
78. Sagasta, J.M.; Zadeh, S.M.; Turral, H. *Water Pollution from Agriculture: A Global Review*; Food and Agriculture Organization of the United Nations (FAO) and the International Water Management Institute (IWMI): Colombo, Sri Lanka, 2017. Available online: http://www.fao.org/documents/card/en/c/a9598c47-0ca1-4c77-8d9d-1c2708050ba0/ (accessed on 19 July 2021).
79. Masi, F.; Rizzo, A.; Regelsberger, M. The role of constructed wetlands in a new circular economy, resource oriented, and ecosystem services paradigm. *J. Environ. Manag.* **2017**, *216*, 275–284. [CrossRef]
80. USEPA. *Defining Hazardous Waste: Listed, Characteristic and Mixed Radiological Wastes*; United State Environmental Protection Agency: Washington, DC, USA, 2020.
81. Han, D.; Tong, X.; Currell, M.J.; Cao, G.; Jin, M.; Tong, C. Evaluation of the impact of an uncontrolled landfill on surrounding groundwater quality, Zhoukou, China. *J. Geochem. Explor.* **2014**, *136*, 24–39. [CrossRef]
82. Ferronato, N.; Torretta, V. Waste Mismanagement in Developing Countries: A Review of Global Issues. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1060. [CrossRef]

83. Abdel-Shafy, H.; Mansour, M.S. Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egypt. J. Pet.* **2018**, *27*, 1275–1290. [CrossRef]
84. Elnasri, R.A.A. Assessment of Lndustrial Liquid Waste Management in Omdurman Lndustrial AreaBy, University of Khartoum, Sudan. April 2003. Available online: https://www.osti.gov/etdeweb/biblio/20943506 (accessed on 19 July 2021).
85. Marszelewski, W.; Piasecki, A. Changes in Water and Sewage Management after Communism: Example of the Oder River Basin (Central Europe). *Sci. Rep.* **2020**, *10*, 1–14. [CrossRef] [PubMed]
86. Jackson, R.; Gorody, A.; Mayer, B.; Roy, J.; Ryan, M.C.; Van Stempvoort, D. Groundwater Protection and Unconventional Gas Extraction: The Critical Need for Field-Based Hydrogeological Research. *Groundwater* **2013**, *51*, 488–510. [CrossRef] [PubMed]
87. Corapcioglu, M.Y.; Baehr, A.L. A compositional multiphase model for groundwater contamination by petroleum products: 1. Theoretical considerations. *Water Resour. Res.* **1987**, *23*, 191–200. [CrossRef]
88. Holt, M. Sources of chemical contaminants and routes into the freshwater environment. *Food Chem. Toxicol.* **2000**, *38*, S21–S27. [CrossRef]
89. Pichtel, J. Oil and Gas. *Production Wastewater. Soil Contam. Pollut. Prev.* **2020**. [CrossRef]
90. Van Der Gun, J.; Aureli, A.; Merla, A. Enhancing Groundwater Governance by Making the Linkage with Multiple Uses of the Subsurface Space and Other Subsurface Resources. *Water* **2016**, *8*, 222. [CrossRef]
91. Michael, H.A.; Voss, C.I. Estimation of regional-scale groundwater flow properties in the Bengal Basin of India and Bangladesh. *Hydrogeol. J.* **2009**, *17*, 1329–1346. [CrossRef]
92. Zhang, Z.; Xiao, C.; Adeyeye, O.; Yang, W.; Liang, X. Source and Mobilization Mechanism of Iron, Manganese and Arsenic in Groundwater of Shuangliao City, Northeast China. *Water* **2020**, *12*, 534. [CrossRef]
93. Ayilara, M.S.; Olanrewaju, O.S.; Babalola, O.O.; Odeyemi, O. Waste Management through Composting: Challenges and Potentials. *Sustainability* **2020**, *12*, 4456. [CrossRef]
94. Sheng, Z. An aquifer storage and recovery system with reclaimed wastewater to preserve native groundwater resources in El Paso, Texas. *J. Environ. Manag.* **2005**, *75*, 367–377. [CrossRef] [PubMed]
95. Usta, C. Microorganisms in Biological Pest Control a Review (Bacterial Toxin Application and Effect of Environmental Factors). In *Current Progress in Biological Research*; Silva, M., Ed.; IntechOpen: London, UK, 2013; Chapter 13; pp. 287–317. [CrossRef]
96. Hensen, B.; Lange, J.; Jackisch, N.; Zieger, F.; Olsson, O.; Kümmerer, K. Entry of biocides and their transformation products into groundwater via urban stormwater infiltration systems. *Water Res.* **2018**, *144*, 413–423. [CrossRef] [PubMed]
97. Agboola, O.; Babatunde, D.E.; Fayomi, O.S.I.; Sadiku, E.R.; Popoola, P.; Moropeng, L.; Yahaya, A.; Mamudu, O.A. A review on the impact of mining operation: Monitoring, assessment and management. *Results Eng.* **2020**, *8*, 100181. [CrossRef]
98. Jain, M.K.; Das, A. Impact of Mine Waste Leachates on Aquatic Environment: A Review. *Curr. Pollut. Rep.* **2017**, *3*, 31–37. [CrossRef]
99. Rybicki, C.; Solecki, T.; Winid, B. Threats to the environment in the areas of abandoned extraction of hydrocarbon deposits. *Drill. Oil Gas* **2015**, *32*, 103. [CrossRef]
100. Anawar, H.M. Sustainable rehabilitation of mining waste and acid mine drainage using geochemistry, mine type, mineralogy, texture, ore extraction and climate knowledge. *J. Environ. Manag.* **2015**, *158*, 111–121. [CrossRef]
101. Schwartz, M.O.; Kgomanyane, J. Modelling natural attenuation of heavy-metal groundwater contamination in the Selebi-Phikwe mining area, Botswana. *Environ. Earth Sci.* **2007**, *54*, 819–830. [CrossRef]
102. Hassaan, M.A.; El Nemr, A. Pesticides pollution: Classifications, human health impact, extraction and treatment techniques. *Egypt. J. Aquat. Res.* **2020**, *46*, 207–220. [CrossRef]
103. European Commission. *Groundwater Protection in Europe: The New Groundwater Directive Consolidating the EU Regulatory Framework*; Publications Office of the European Union: Luxembourg, 2008. [CrossRef]
104. Kim, K.-H.; Kabir, E.; Jahan, S.A. Exposure to pesticides and the associated human health effects. *Sci. Total. Environ.* **2017**, *575*, 525–535. [CrossRef] [PubMed]
105. Agrawal, A.; Pandey, R.S.; Sharma, B. Water Pollution with Special Reference to Pesticide Contamination in India. *J. Water Resour. Prot.* **2010**, *2*, 432–448. [CrossRef]
106. Šperl, J.; Trčková, J. Permeability and Porosity of Rocks and Their Relationship Based on Laboratory Testing. *Acta Geodyn. Geomater.* **2008**, *5*, 41–47.
107. Smith, L.; Siciliano, G. A comprehensive review of constraints to improved management of fertilizers in China and mitigation of diffuse water pollution from agriculture. *Agric. Ecosyst. Environ.* **2015**, *209*, 15–25. [CrossRef]
108. Hallberg, G.R. The impacts of agricultural chemicals on ground water quality. *GeoJournal* **1987**, *15*, 283–295. [CrossRef]
109. Briški, M.; Stroj, A.; Kosović, I.; Borović, S. Characterization of Aquifers in Metamorphic Rocks by Combined Use of Electrical Resistivity Tomography and Monitoring of Spring Hydrodynamics. *Geosciences* **2020**, *10*, 137. [CrossRef]
110. Akhter, G.; Hasan, M. Determination of aquifer parameters using geoelectrical sounding and pumping test data in Khanewal District, Pakistan. *Open Geosci.* **2016**, *8*, 630–638. [CrossRef]
111. López-Pacheco, I.Y.; Silva-Núñez, A.; Salinas-Salazar, C.; Arévalo-Gallegos, A.; Lizarazo-Holguin, L.A.; Barceló, D.; Iqbal, H.M.; Parra-Saldívar, R. Anthropogenic contaminants of high concern: Existence in water resources and their adverse effects. *Sci. Total. Environ.* **2019**, *690*, 1068–1088. [CrossRef]
112. USEPA. *2018 Edition of the Drinking Water Standards and Health Advisories Tables*; United State Enviromental Protection Agency: Washington, DC, USA, 2018.

113. Müller, A.; Österlund, H.; Marsalek, J.; Viklander, M. The pollution conveyed by urban runoff: A review of sources. *Sci. Total. Environ.* **2019**, *709*, 136125. [CrossRef] [PubMed]
114. McGrane, S.J. Impacts of urbanisation on hydrological and water quality dynamics, and urban water management: A review. *Hydrol. Sci. J.* **2016**, *61*, 2295–2311. [CrossRef]
115. Milla, O.V.; Company, N.W.; Salvador, E.; Huang, W. Relationship between Solid Waste Pollution and Polluted Drinking Water in El Relationship between Solid Waste Pollution and Polluted Drinking Water in El Salvador. *Int. Coop. Dev. Fund.* **2012**, *7*, 37–60.
116. Stuart, M.; Gooddy, D.; Bloomfield, J.; Williams, A. A review of the impact of climate change on future nitrate concentrations in groundwater of the UK. *Sci. Total. Environ.* **2011**, *409*, 2859–2873. [CrossRef]
117. Żychowski, J.; Bryndal, T. Impact of cemeteries on groundwater contamination by bacteria and viruses a review. *J. Water Health* **2014**, *13*, 285–301. [CrossRef] [PubMed]
118. Akinbile, C.; Erazua, A.; Babalola, T.; Ajibade, F. Environmental implications of animal wastes pollution on agricultural soil and water quality. *Soil Water Res.* **2016**, *11*, 172–180. [CrossRef]
119. Polat, H.E.; Olgun, M. Water Pollution from Livestock Wastes and Required Strategies in Efforts to Adapt to European Union. *Int. Water Assoc.* **2018**, *18*, 1–9.
120. Camara, M.; Jamil, N.R.; Bin Abdullah, A.F. Impact of land uses on water quality in Malaysia: A review. *Ecol. Process.* **2019**, *8*, 10. [CrossRef]
121. EPA. *Monitoring Site Information*; United States Environmental Protection Agency: Washington DC, USA, 2011.
122. World Bank. *Investing in Opportunity, Ending Poverty*; World International Bank for Reconstruction and Development (IBRD): Washington, DC, USA, 2020; p. 319. Available online: https://www.worldbank.org/en/about/annual-report (accessed on 19 July 2021).
123. Wu, Z.; Wang, X.; Chen, Y.; Cai, Y.; Deng, J. Assessing river water quality using water quality index in Lake Taihu Basin, China. *Sci. Total. Environ.* **2018**, *612*, 914–922. [CrossRef] [PubMed]
124. Singhal, B.B.S.; Gupta, R.P.; Singhal, B.B.S.; Gupta, R.P. Introduction and basic concepts. In *Applied Hydrogeology of Fracture Rocks*; Springer: London, UK; New York, NY, USA, 2010; Chapter 1. [CrossRef]
125. UNESCO. *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water*; United State Enviromental Protection Agency: Paris, France, 2018.
126. WHO. *Guidelines for Drinking Water Quality*; World Health Organization: Geneva, Switzerland, 2017.
127. BIS. *Indian Standards Drinking Water Specifications IS 10500:2012*; Bahadur Shah Zafar Marg: New Delhi, India, 2012.
128. Abiye, T.A.; Bhattacharya, P. Arsenic concentration in groundwater: Archetypal study from South Africa. *Groundw. Sustain. Dev.* **2019**, *9*. [CrossRef]
129. Hepburn, E.; Northway, A.; Bekele, D.; Liu, G.-J.; Currell, M. A method for separation of heavy metal sources in urban groundwater using multiple lines of evidence. *Environ. Pollut.* **2018**, *241*, 787–799. [CrossRef] [PubMed]
130. Qu, L.; Huang, H.; Xia, F.; Liu, Y.; Dahlgren, R.; Zhang, M.; Mei, K. Risk analysis of heavy metal concentration in surface waters across the rural-urban interface of the Wen-Rui Tang River, China. *Environ. Pollut.* **2018**, *237*, 639–649. [CrossRef]
131. Huan, H.; Hu, L.; Yang, Y.; Jia, Y.; Lian, X.; Ma, X.; Jiang, Y.; Xi, B. Groundwater nitrate pollution risk assessment of the groundwater source field based on the integrated numerical simulations in the unsaturated zone and saturated aquifer. *Environ. Int.* **2020**, *137*, 105532. [CrossRef] [PubMed]
132. Schwarzenbach, R.P.; Egli, T.; Hofstetter, T.; Von Gunten, U.; Wehrli, B. Global Water Pollution and Human Health. *Annu. Rev. Environ. Resour.* **2010**, *35*, 109–136. [CrossRef]
133. Teng, Y.; Zuo, R.; Xiong, Y.; Wu, J.; Zhai, Y.; Su, J. Risk assessment framework for nitrate contamination in groundwater for regional management. *Sci. Total Environ.* **2019**, *697*, 134102. [CrossRef]
134. Suvarna, B.; Sunitha, V.; Reddy, Y.S.; Reddy, N.R. Data health risk assessment of nitrate contamination in groundwater of rural region in the Yerraguntla Mandal, South India. *Data Brief.* **2020**, *30*, 105374. [CrossRef] [PubMed]
135. Pisciotta, A.; Cusimano, G.; Favara, R. Groundwater nitrate risk assessment using intrinsic vulnerability methods: A comparative study of environmental impact by intensive farming in the Mediterranean region of Sicily, Italy. *J. Geochem. Explor.* **2015**, *156*, 89–100. [CrossRef]
136. Green, C.T.; Fisher, L.H.; Bekins, B.A. Nitrogen Fluxes through Unsaturated Zones in Five Agricultural Settings across the United States. *J. Environ. Qual.* **2008**, *37*, 1073–1085. [CrossRef] [PubMed]
137. Galán, M.J.G.; Garrido, T.; Fraile, J.; Ginebreda, A.; Díaz-Cruz, M.S.; Barceló, D. Simultaneous occurrence of nitrates and sulfonamide antibiotics in two ground water bodies of Catalonia (Spain). *J. Hydrol.* **2009**, *383*, 93–101. [CrossRef]
138. McMahon, P.B.; Dennehy, K.F.; Bruce, B.W.; Bohlke, J.K.; Michel, R.L.; Gurdak, J.J.; Hurlbut, D.B. Storage and transit time of chemicals in thick unsaturated zones under rangeland and irrigated cropland, High Plains, United States. *Water Resour. Res.* **2006**, *42*. [CrossRef]
139. Ayoob, S.; Gupta, A.K. Fluoride in Drinking Water: A Review on the Status and Stress Effects. *Crit. Rev. Environ. Sci. Technol.* **2006**, *36*, 433–487. [CrossRef]
140. Rafique, T.; Naseem, S.; Usmani, T.H.; Bashir, E.; Khan, F.A.; Bhanger, M.I. Geochemical factors controlling the occurrence of high fluoride groundwater in the Nagar Parkar area, Sindh, Pakistan. *J. Hazard. Mater.* **2009**, *171*, 424–430. [CrossRef]
141. Mohanta, V.L.; Singh, S.; Mishra, B.K. Human health risk assessment of fluoride-rich groundwater using fuzzy-analytical process over the conventional technique. *Groundw. Sustain. Dev.* **2019**, *10*, 100291. [CrossRef]

142. Haldar, D.; Duarah, P.; Purkait, M.K. MOFs for the treatment of arsenic, fluoride and iron contaminated drinking water: A review. *Chemosphere* **2020**, *251*, 126388. [CrossRef]
143. Nõmmik, H. *Fluorine in Swedish Agricultural Products, Soil and Drinking Water*; Swedish National Institute of Public Health: Stockholm, Sweden, 1953.
144. Latimer, G. *The Health and Environmental Impacts of Hazardous Wastes*; The Department of the Environment, and Ascend Waste and Environment Pty Ltd.: Melbourne, Australia, 2015. Available online: https://www.environment.gov.au/protection/publications/hazardous-waste-impacts (accessed on 19 July 2021).
145. Saipudin, N.A.; Omar, F.M. International Conference on Environmental Research and Technology (ICERT 2017). In *International Conference on Environmental Research and Technology (ICERT 2017)*; Universiti Sains Malaysia: Penang, Malaysia, 2001; pp. 61–66.
146. Kabir, M.M.; Fakhruddin, A.N.M.; Chowdhury, M.A.Z.; Fardous, Z.; Islam, R. Characterization of Tannery Effluents of Hazaribagh Area, Dhaka, Bangladesh. *Pollution* **2017**, *3*, 395–406. [CrossRef]
147. Valdez-Alegría, C.J.; Fuentes-Rivas, R.M.; Garcia-Rivas, J.-L.; De Oca, R.M.G.F.-M.; García-Gaitán, B. Presence and Distribution of Fluoride Ions in Groundwater for Human in a Semiconfined Volcanic Aquifer. *Resources* **2019**, *8*, 116. [CrossRef]
148. Sankhla, M.S. Contaminant of Heavy Metals in Groundwater & its Toxic Effects on Human Health & Environment. *Int. J. Environ. Sci. Nat. Resour.* **2019**, *18*, 1–5. [CrossRef]
149. Tchounwou, P.B.; Yedjou, C.G.; Patlolla, A.K.; Sutton, D.J. Heavy Metal Toxicity and the Environment. In *Molecular, Clinical and Environmental Toxicology*; Springer: Chem, Switzerland, 2012; Chapter 4; pp. 133–164.
150. Briffa, J.; Sinagra, E.; Blundell, R. Heavy metal pollution in the environment and their toxicological effects on humans. *Heliyon* **2020**, *6*. [CrossRef] [PubMed]
151. Mandich, M. Ranked effects of heavy metals on marine bivalves in laboratory mesocosms: A meta-analysis. *Mar. Pollut. Bull.* **2018**, *131*, 773–781. [CrossRef] [PubMed]
152. Kapahi, M.; Sachdeva, S. Bioremediation Options for Heavy Metal Pollution. *J. Health Pollut.* **2019**, *9*, 191203. [CrossRef] [PubMed]
153. Gurung, S.B.; Geronimo, F.K.; Hong, J.; Kim, L.-H. Application of indices to evaluate LID facilities for sediment and heavy metal removal. *Chemosphere* **2018**, *206*, 693–700. [CrossRef]
154. Yunus, K.; Zuraidah, M.; John, A. A review on the accumulation of heavy metals in coastal sediment of Peninsular Malaysia. *Ecofeminism Clim. Chang.* **2020**, *1*, 21–35. [CrossRef]
155. Saha, P.; Paul, B. Assessment of Heavy Metal Pollution in Water Resources and Their Impacts: A Review. *J. Basic Appl. Eng. Res.* **2016**, *3*, 671–675.
156. Ali, H.; Khan, E.; Ilahi, I. Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity, and Bioaccumulation. *J. Chem.* **2019**, *2019*, 1–14. [CrossRef]
157. Chibuike, G.U.; Obiora, S.C.; Chibuike, G.U.; Obiora, S.C. Heavy Metal Polluted Soils: Effect on Plants and Bioremediation Methods. *Appl. Environ. Soil Sci.* **2014**, *2014*, 1–12. [CrossRef]
158. Tangahu, B.; Abdullah, S.R.S.; Basri, H.; Idris, M.; Anuar, N.; Mukhlisin, M. A Review on Heavy Metals (As, Pb, and Hg) Uptake by Plants through Phytoremediation. *Int. J. Chem. Eng.* **2011**, *2011*, 1–31. [CrossRef]
159. Razak, N.H.A.; Praveena, S.M.; Aris, A.Z.; Hashim, Z. Drinking water studies: A review on heavy metal, application of biomarker and health risk assessment (a special focus in Malaysia). *J. Epidemiol. Glob. Health* **2015**, *5*, 297–310. [CrossRef]
160. Alidadi, H.; Belin, S.; Sany, T.; Zarif, B.; Oftadeh, G.; Mohamad, T. Health Risk Assessments of Arsenicand Toxic Heavy Metal Exposure in Drinking Waterin Northeast Iran. *Environ. Health Prev. Med.* **2019**, *24*, 1–17. [CrossRef] [PubMed]
161. Huang, L.; Rad, S.; Xu, L.; Gui, L.; Song, X.; Li, Y.; Wu, Z.; Chen, Z. Heavy Metals Distribution, Sources, and Ecological Risk Assessment in Huixian Wetland, South China. *Water* **2020**, *12*, 431. [CrossRef]
162. Tchounwou, P.B.; Yedjou, C.G.; Patlolla, A.K.; Sutton, D.J. Molecular, Clinicaland Environmental Toxicology. *NIH Public Access* **2012**, *101*, 1–30. [CrossRef]
163. Kinuthia, G.K.; Ngure, V.; Beti, D.; Lugalia, R.; Wangila, A.; Kamau, L. Levels of heavy metals in wastewater and soil samples from open drainage channels in Nairobi, Kenya: Community health implication. *Sci. Rep.* **2020**, *10*, 1–13. [CrossRef]
164. Shekhar, S.; Sarkar, A. Hydrogeological characterization and assessment of groundwater quality in shallow aquifers in vicinity of Najafgarh drain of NCT Delhi. *J. Earth Syst. Sci.* **2013**, *122*, 43–54. [CrossRef]
165. Smedley, P.; Nicolli, H.; Macdonald, D.; Barros, A.; Tullio, J. Hydrogeochemistry of arsenic and other inorganic constituents in groundwaters from La Pampa, Argentina. *Appl. Geochem.* **2002**, *17*, 259–284. [CrossRef]
166. Ali, S.; Thakur, S.K.; Sarkar, A.; Shekhar, S. Worldwide contamination of water by fluoride. *Environ. Chem. Lett.* **2016**, *14*, 291–315. [CrossRef]
167. Thapa, R.; Gupta, S.; Kaur, H.; Baski, R. Assessment of groundwater quality scenario in respect of fluoride and nitrate contamination in and around Gharbar village, Jharkhand, India. *HydroResearch* **2019**, *2*, 60–68. [CrossRef]
168. Popugaeva, D.; Kreyman, K.; Ray, A.K. Study of aluminium in groundwater using chemometric methods. *Environ. Technol.* **2018**, *41*, 1691–1699. [CrossRef]
169. Blais, J.-F.; Mercier, G. Transformation of red mud from aluminium industry into a coagulant for wastewater treatment. *Hydrometallurgy* **2008**, *92*, 16–25. [CrossRef]
170. Lei, L.-Q.; Song, C.-A.; Xie, X.-L.; Li, Y.-H.; Wang, F. Acid mine drainage and heavy metal contamination in groundwater of metal sulfide mine at arid territory (BS mine, Western Australia). *Trans. Nonferrous Met. Soc. China* **2010**, *20*, 1488–1493. [CrossRef]

171. Fahmi, A.; Radjagukguk, B.; Purwanto, B.H.; Hanudin, E. The Influnece of Peat Layer on Hidrogen and Aluminium Concentration Originating from the Substratum Sulphidic Materials. *J. Tanah Trop. (J. Trop. Soils)* **2012**, *17*, 197–202. [CrossRef]
172. Williams, M.; Fordyce, F.; Paijitprapapon, A.; Charoenchaisri, P. Arsenic Contamination in Surface Drainage and Groundwater in Part of the Southeast Asian Tin Belt, Nakhon Si Thammarat Province, Southern Thailand. *Environ. Geol.* **1996**, *27*, 16–33. [CrossRef]
173. Oluwatosin, Q.I.; Anthony, I.A. Determination of Heavy Metal Contents in Some Industrial Effluents from Ondo State, Nigeria. *J. Environ. Chem. Ecotoxicol.* **2013**, *5*, 216–219. [CrossRef]
174. Matisoff, G.; Khourey, C.J.; Hall, J.F.; Varnes, A.W.; Strain, W.H. The Nature and Source of Arsenic in Northeastern Ohio Ground Water[a]. *Groundwater* **1982**, *20*, 446–456. [CrossRef]
175. Chatterjee, A.; Das, D.; Chakraborti, D. A study of ground water contamination by arsenic in the residential area of behala, calcutta due to industrial pollution. *Environ. Pollut.* **1993**, *80*, 57–65. [CrossRef]
176. Shallari, S.; Schwartz, C.; Hasko, A.; Morel, J. Heavy metals in soils and plants of serpentine and industrial sites of Albania. *Sci. Total. Environ.* **1998**, *209*, 133–142. [CrossRef]
177. Deepali, K.K.; Gangwar, K. Metals Concentration in Textile and Tannery Effluents, Associated Soils and Ground Water. *N. Y. Sci. J.* **2010**, *3*, 82–89.
178. Ololade, I.A.; Adewunmi, A.; Ologundudu, A.; Adeleye, A. Effects of Household Wastes on Surface and Underground Waters. *Int. J. Phys. Sci.* **2009**, *4*, 22–29.
179. Mirlean, N.; Roisenberg, A. The effect of emissions of fertilizer production on the environment contamination by cadmium and arsenic in southern Brazil. *Environ. Pollut.* **2006**, *143*, 335–340. [CrossRef]
180. Duru, M.K.C.; Nwanekwu, K.E.; Adindu, E.A.; Odika, P.C. Heavy Metal and Bioload Levels of Otamiri River, Owerri, Imo State, Nigeria. *Arch. Appl. Sci. Res.* **2012**, *4*, 1002–1006.
181. Zamani, A.A.; Yaftian, M.R.; Parizanganeh, A. Multivariate statistical assessment of heavy metal pollution sources of groundwater around a lead and zinc plant. *Iran. J. Environ. Health Sci. Eng.* **2012**, *9*, 1–10. [CrossRef] [PubMed]
182. Sridhar, S.G.D.; Sakthivel, A.M.; Sangunathan, U.; Balasubramanian, M.; Jenefer, S.; Rafik, M.M.; Kanagaraj, G. Heavy metal concentration in groundwater from Besant Nagar to Sathankuppam, South Chennai, Tamil Nadu, India. *Appl. Water Sci.* **2017**, *7*, 4651–4662. [CrossRef]
183. Atashi, H.; Shahemabadi, M.S.; Mansoorkiai, R.; Spaili, F.A. Cobalt in Zahedan Drinking Water. *J. Appl. Sci. Res.* **2009**, *5*, 2203–2207.
184. Li, F.; Qiu, Z.; Zhang, J.; Liu, W.; Liu, C.; Zeng, G. Investigation, Pollution Mapping and Simulative Leakage Health Risk Assessment for Heavy Metals and Metalloids in Groundwater from a Typical Brownfield, Middle China. *Int. J. Environ. Res. Public Health* **2017**, *14*, 768. [CrossRef] [PubMed]
185. Inácio, M.; Neves, M.O.; Pereira, V.; da Silva, E.F. Levels of selected potential harmful elements (PHEs) in soils and vegetables used in diet of the population living in the surroundings of the Estarreja Chemical Complex (Portugal). *Appl. Geochem.* **2014**, *44*, 38–44. [CrossRef]
186. Dabai, M.U.; Bagudo, B.U.; Jodi, L.M.; Ocheni, L. Evaluation of Some Trace Metal Levels in the Water, Fish and Aquatic Plant in River Sokoto, North-Western Nigeria. *Asian J. Appl. Sci.* **2013**, *1*. Available online: https://ajouronline.com/index.php/AJAS/article/view/601 (accessed on 19 July 2021).
187. Izbicki, J.A.; Wright, M.; Seymour, W.A.; McCleskey, R.B.; Fram, M.S.; Belitz, K.; Esser, B.K.; Izbicki, J.A.; Wright, M.; Seymour, W.A.; et al. Cr(VI) occurrence and geochemistry in water from public-supply wells in California. *Appl. Geochem.* **2015**, *63*, 203–217. [CrossRef]
188. Wei, W.; Ma, R.; Sun, Z.; Zhou, A.; Bu, J.; Long, X.; Liu, Y. Effects of Mining Activities on the Release of Heavy Metals (HMs) in a Typical Mountain Headwater Region, the Qinghai-Tibet Plateau in China. *Int. J. Environ. Res. Public Health* **2018**, *15*, 1987. [CrossRef]
189. Małecki, J.J.; Kadzikiewicz-Schoeneich, M.; Eckstein, Y.; Szostakiewicz-Hołownia, M.; Gruszczyński, T. Mobility of copper and zinc in near-surface groundwater as a function of the hypergenic zone lithology at the Kampinos National Park (Central Poland). *Environ. Earth Sci.* **2017**, *76*, 276. [CrossRef]
190. Souza, A.M.; Salviano, A.M.; Melo, J.F.B.; Felix, W.P.; Belém, C.S.; Ramos, P.N. Seasonal study of concentration of heavy metals in waters from lower São Francisco River basin, Brazil. *Braz. J. Biol.* **2016**, *76*, 967–974. [CrossRef]
191. Ongen, A.; Dokmeci, H.; Celik, S.O.; Sabudak, T.; Kaykioglu, G.; Dokmeci, I. Copper and Cadmium Contents in Ground and Surface Water in Corlu. *Turk. J. Environ. Prot. Ecol.* **2008**, *9*, 753–762.
192. Li, T.; Li, L.; Song, H.; Meng, L.; Zhang, S.; Huang, G. Evaluation of groundwater pollution in a mining area using analytical solution: A case study of the Yimin open-pit mine in China. *SpringerPlus* **2016**, *5*, 1–13. [CrossRef] [PubMed]
193. Bougherira, N.; Hani, A.; Djabri, L.; Toumi, F.; Chaffai, H.; Haied, N.; Nechem, D.; Sedrati, N. Impact of the Urban and Industrial Waste Water on Surface and Groundwater, in the Region of Annaba, (Algeria). *Energy Procedia* **2014**, *50*, 692–701. [CrossRef]
194. Hossain, D.; Islam, M.; Sultana, N.; Tusher, T. Assessment of Iron Contamination in Groundwater at Tangail Municipality, Bangladesh. *J. Environ. Sci. Nat. Resour.* **2015**, *6*, 117–121. [CrossRef]
195. Vetrimurugan, E.; Brindha, K.; Elango, L.; Ndwandwe, O.M. Human exposure risk to heavy metals through groundwater used for drinking in an intensively irrigated river delta. *Appl. Water Sci.* **2016**, *7*, 3267–3280. [CrossRef]

196. Afzal, M.S. Characterization of industrial effluents and groundwater of Hattar industrial estate, Haripur. *Adv. Agric. Environ. Sci. Open Access* **2018**, *1*, 70–77. [CrossRef]
197. Dwivedi, A.K.; Vankar, P.S. Source identification study of heavy metal contamination in the industrial hub of Unnao, India. *Environ. Monit. Assess.* **2014**, *186*, 3531–3539. [CrossRef]
198. Affum, A.O.; Osae, S.D.; Nyarko, B.J.B.; Afful, S.; Fianko, J.R.; Akiti, T.T.; Adomako, D.; Acquaah, S.O.; Dorleku, M.; Antoh, E.; et al. Total coliforms, arsenic and cadmium exposure through drinking water in the Western Region of Ghana: Application of multivariate statistical technique to groundwater quality. *Environ. Monit. Assess.* **2015**, *187*, 1–23. [CrossRef]
199. Anirudhan, T.; Sreekumari, S. Adsorptive removal of heavy metal ions from industrial effluents using activated carbon derived from waste coconut buttons. *J. Environ. Sci.* **2011**, *23*, 1989–1998. [CrossRef]
200. Khattak, S.A.; Rashid, A.; Tariq, M.; Ali, L.; Gao, X.; Ayub, M.; Javed, A. Potential risk and source distribution of groundwater contamination by mercury in district Swabi, Pakistan: Application of multivariate study. *Environ. Dev. Sustain.* **2020**, *23*, 2279–2297. [CrossRef]
201. Panwar, R.M.; Ahmed, S. Assessment of Contamination of Soil and Groundwater Due to e-Waste Handling. *Curr. Sci.* **2018**, *114*. [CrossRef]
202. Hsu, L.-C.; Chuang, Y.-H.; Chen, H.-W.; Chan, Y.-T.; Teah, H.Y.; Chen, T.-Y.; Chang, C.-F.; Liu, Y.-T.; Tzou, Y.-M. Accumulation of heavy metals and trace elements in fluvial sediments received effluents from traditional and semiconductor industries. *Sci. Rep.* **2016**, *6*, 34250. [CrossRef] [PubMed]
203. Eiswirth, M.; Hotzl, H. The Impact of Leaking Sewers on Urban Groundwater. In *Urban Groundwater Management and Sustainability*; Springer: Cham, Switzerland, 2006; pp. 399–404.
204. Elumalai, V.; Brindha, K.; Lakshmanan, E. Human Exposure Risk Assessment Due to Heavy Metals in Groundwater by Pollution Index and Multivariate Statistical Methods: A Case Study from South Africa. *Water* **2017**, *9*, 234. [CrossRef]
205. Chen, C.-M.; Liu, M.-C. Ecological risk assessment on a cadmium contaminated soil landfill—a preliminary evaluation based on toxicity tests on local species and site-specific information. *Sci. Total. Environ.* **2006**, *359*, 120–129. [CrossRef] [PubMed]
206. Oreščanin, V.; Mikelic, L.; Lulic, S.; Nad, K.; Mikulić, N.; Rubčić, M.; Pavlović, G. Purification of Electroplating Wastewaters Utilizing Waste By-Product Ferrous Sulfate and Wood Fly Ash. *J. Environ. Sci. Health Part. A* **2004**, *39*, 2437–2446. [CrossRef] [PubMed]
207. Rösner, U. Effects of historical mining activities on surface water and groundwater an example from northwest Arizona. *Environ. Earth Sci.* **1998**, *33*, 224–230. [CrossRef]
208. Paulson, A.J. The transport and fate of Fe, Mn, Cu, Zn, Cd, Pb and SO4 in a groundwater plume and in downstream surface waters in the Coeur d'Alene Mining District, Idaho, U.S.A. *Appl. Geochem.* **1997**, *12*, 447–464. [CrossRef]
209. Frank, V.; Harangozó, M. Heavy metals in industrial wastewater determined by radionuclide X-ray fluorescence analysis and their effects onAllium cepa root tip cells. *J. Radioanal. Nucl. Chem.* **1994**, *187*, 137–141. [CrossRef]
210. Kocher, B.; Wessolek, G. Verlagerung Straßenverkehrsbedingter Stoffe Mit Dem Sickerwasser. 99 S. *Straßenbau Straßenverkehrstechnik* **2003**, *864*, 1–15.
211. Pedroli, G.M.; Maasdam, W.A.; Verstraten, J.M. Zinc in poor sandy soils and associated groundwater. A case study. *Sci. Total. Environ.* **1990**, *91*, 59–77. [CrossRef]
212. Ritter, K.S.L. Sources, Pathways, and relative risks of contaminants in surface water and groundwater: A perspective prepared for the walkerton inquiry. *J. Toxicol. Environ. Health Part. A* **2002**, *65*, 1–142. [CrossRef]
213. Kumar, M.; Goswami, R.; Patel, A.K.; Srivastava, M.; Das, N. Scenario, perspectives and mechanism of arsenic and fluoride Co-occurrence in the groundwater: A review. *Chemosphere* **2020**, *249*, 126126. [CrossRef] [PubMed]
214. K'Oreje, K.; Vergeynst, L.; Ombaka, D.; De Wispelaere, P.; Okoth, M.; Van Langenhove, H.; Demeestere, K. Occurrence patterns of pharmaceutical residues in wastewater, surface water and groundwater of Nairobi and Kisumu city, Kenya. *Chemosphere* **2016**, *149*, 238–244. [CrossRef]
215. Meffe, R.; de Bustamante, I. Emerging organic contaminants in surface water and groundwater: A first overview of the situation in Italy. *Sci. Total. Environ.* **2014**, *481*, 280–295. [CrossRef]
216. Rehman, M.S.U.; Rashid, N.; Ashfaq, M.; Saif, A.; Ahmad, N.; Han, J.-I. Global risk of pharmaceutical contamination from highly populated developing countries. *Chemosphere* **2015**, *138*, 1045–1055. [CrossRef] [PubMed]
217. Tang, Y.; Yin, M.; Yang, W.; Li, H.; Zhong, Y.; Mo, L.; Liang, Y.; Ma, X.; Sun, X. Emerging pollutants in water environment: Occurrence, monitoring, fate, and risk assessment. *Water Environ. Res.* **2019**, *91*, 984–991. [CrossRef] [PubMed]