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Proposed Solutions to Improve Deterioration of Drinking Water Quality

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Abstract
Water is vital for survival, yet polluted water can have negative effects on human health. Many people in underdeveloped nations are still afflicted by the spread of waterborne illnesses, which are made worse by inadequate sanitation and a lack of access to clean water, particularly for drinking. Our goal in compiling this fundamental information from academic sources on water quality treatment and water-borne disease prevention is to help in the creation of a workable plan to deal with the possibility of poor water quality in certain parts of Kirkuk. Improving water quality and creating a healthy environment requires a multi-pronged approach that includes reforming public health institutions, reestablishing monitoring and evaluation systems within competent services, implementing sustainable development techniques, and raising public health awareness and education through media campaigns.

Keywords: water quality, water-borne disease, healthy environment, public health

Introduction

Water exists in liquid, solid, and gaseous states and is the most prevalent compound on Earth. It is also necessary for life. In general, freshwater is seen as an important input for human production and an efficient means of promoting economic development. It is necessary in many aspects of human life [1-3]. Some drinking water supplies have become contaminated in several nations, including Iraq, and surface water quality degradation has become a major issue in many urban areas [4,5]. Water pollution, originating from diverse sources, poses a significant threat not only to the environment but also to human health and the economy [6].In addition to common, interactive natural processes like hydrological conditions, terrain, rocks, climate, rainfall inputs, watershed area, tectonic factors, synthetic factors, erosion, and rock geology, along with environmental impacts, all have an impact on changes in the physical and chemical properties of water quality. Freshwater can be found in numerous places, including natural springs, rivers, lakes, and groundwater reservoirs. Groundwater sources provide the majority of the water used for drinking [7,8].Due to the poor state of the water supply infrastructure, there are several issues with the availability of drinking water in our cities, many of which include issues with the distribution network. Water quality is traditionally determined by comparing values

to regional norms, which includes Iraq. On the other hand, this method offers no data regarding temporal and spatial patterns in overall quality [8]. As a result, contemporary methods have been created, such as the Water Quality Index (WQI). Many water quality indicators have been developed globally, based on comparing water quality standards and assigning a single water quality value to a specific source [9]. It condenses a significant amount of water quality data into a single number and a straightforward term (such as excellent, good, or weak) to inform water distributors, planners, managers, and related parties about the general state of the water [10].Also, it can be a crucial component in evaluating and managing the water source and provide insight into how water quality is likely to change over time [12,11].In an earlier study, samples from 60 wells in the Kirkuk area were used to evaluate the quality of the groundwater for drinking water in Kirkuk using the WQI tool. The study was based on Iraqi and World Health Organization guidelines. The findings for the wells analyzed in 2017 and 2018 indicated that the drinking water quality was marginally acceptable. However, WQI indicated that the wells examined in 2019 had poor (bad) drinking water quality. Additionally, this investigation demonstrated that groundwater is unfit for human consumption, particularly when compared to earlier research [13].As a result, additional research is necessary to pinpoint the precise reasons and sources of contamination that contribute to the declining quality of the water over time.This study's primary goal is to examine key ideas for improving the low quality of drinking water in Kirkuk's various regions so that it meets international and national drinking water standards as determined by the WQI water quality index and lessens the prevalence of water-borne illnesses.

Water's critical importance

Water is a vital nutrient for human health and wellness. Humans consume water through eating, drinking (water and other beverages), and metabolism. Water is regarded as a universal solvent because it has the highest melting point of any liquid. It can contain both dangerous and useful compounds due to its dissolved nature. It is recognized that twenty-one components of water are necessary for human health. Chlorine, phosphorus, molybdenum, fluorine, ions (buron, chromium, nickel, silicone, and vanadium), metabolism-based non-metallic corrosive chemicals (selenium), and cationic groups (calcium, magnesium, sodium, potassium, iron, copper, zinc, and manganese) are examples of these anionic groups. Bone and membrane construction, water and electrolytic balance, metabolic catalysis, oxygen binding, and hormone function all depend on fourteen elements [14]. Exhaustion of these components has negative health implications, such as elevated morbidity and death. The drinking water supply typically contains many of these basic metals, both naturally occurring and artificially added, notwithstanding the extreme variability in the water supply. The properties and interactions of the metals, the physiological state of the intestines, the amount consumed, and other dietary factors—such as the metals being treated—all affect how well the intestines absorb metals from drinking water. In addition to non-

nutritional elements, hazardous elements include lead, cadmium, mercury, arsenic, aluminum, lithium, and tin. Increased exposure to humidity, drought, high temperatures, or physical activity can all lead to an increase in daily water requirements. Water containing food ingredients has a major impact on human health in a number of ways [15]. Copper and selenium are crucial for antioxidant function; calcium and magnesium are needed for bone, heart, and vascular health; fluoride prevents tooth decay; and sodium is required to maintain the electrolyte balance. In addition to being essential for utilizing iron, copper also supports cardiovascular function. Potassium is required to regulate energy levels, heart rate, muscular contraction, and neuropulse. A prolonged deficit in calcium through diet can cause osteoporosis in the abdomen, fracturing, finger pricks, muscle spasms, inactivity, anorexia, heart problems, and osteoporosis. Anorexia, nausea, vomiting, exhaustion, body odour, itching, muscle cramps, epilepsy, personality changes, heart disease, coronary artery cramps, hypocalcemia are some of the symptoms of magnesium insufficiency. Decreases the amount of fluoride used in tooth decay prevention efforts significantly, aids in the retention of calcium, and strengthens teeth and bones [16, 17]. One of the most significant global public health concerns is still water. Diseases caused by water were responsible for about 4 million deaths globally in 2001. Approximately 11% of people worldwide do not have access to inexpensive or clean drinking water. Because of its capacity to melt and disperse materials widely, water can have a negative impact on people's health. Pollutants from the environment, including depleted uranium, petroleum products, oil, lead, cobalt, cadmium, mercury, and arsenic, can find their way into water supplies. According to WHO estimates, water-related diseases like cholera, hepatitis, dengue fever, malaria, and other parasitic illnesses are responsible for millions of deaths annually [18-20].

Water quality standards

Water quality refers to the suitability of water for different uses according to its physical, chemical, biological, and sensory characteristics. It is important to measure water quality because it directly affects human consumption, health, industrial and domestic use, and the natural environment. Water quality is measured using laboratory techniques or home testing tools. Laboratory tests measure several criteria and provide the most accurate results, but they take longer. Home test sets, including test tapes, provide quick but less accurate results [21]. Water suppliers, including municipalities and bottled water companies, often make their water quality reports publicly available on their websites. Laboratory water quality standards must meet those set by local governments, which are often influenced by international standards developed by industry or water quality organizations such as WHO. Water quality is a measure of the suitability of water for a particular use based on the selected physical, chemical, and biological properties of the United States Geological Survey. It is therefore a measure of water conditions in relation to human needs, purposes, or even the requirements of different species of wild or aquatic animals [22].

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Categories of requirements for water quality measurements

1. The senses of taste, smell, touch, and sight will be used to determine the physical measurements of water quality. Temperature, colour, bait, odour, nudity, and the amount of dissolved materials are some examples of these physical requirements.
2. The features that represent the environment that water comes into contact with are measured by the chemical variables of water quality. These chemical parameters include pH, solid, dissolved oxygen, acidity, residual chlorine, sulphate, nitrogen, fluoride, iron, manganese, copper, zinc, and hazardous organic and inorganic materials. They can also measure the levels of chlorine and residual chlorine.
3. Measurements of the quantity of bacteria, algae, viruses, and other water-based firsts are known as biological water quality parameters [23,24].

Factors affecting water quality

• Pollution of the atmosphere

Environmental air pollution with gases such as carbon dioxide, sulphur dioxide, and nitrogen oxides is mixed with water molecules in the air to produce contaminated rainfall, sometimes referred to as acid rain. The acid rain then contaminated the water systems.

• Surface flow

Surface flow refers to the flow of excess water across the earth's surface and into watercourses. With the flow of water, agricultural and industrial pollutants such as garbage, oil, chemicals, fertilizers, and other toxic substances that pollute water can be picked up.

• Stripping and deposition

Soil erosion increases the amount of sediment entering the water. This can contribute to the degradation of water quality because toxic or naturally occurring chemicals and unhealthy elements can be attached to or absorbed in sediment molecules and then transported to water bodies [25,26].

Adverse Environmental Implications of Water Pollution

Water pollution has a negative impact on the ecosystem as well as the plants and animals that depend on it. Pollution can harm, kill, or disrupt biological processes in many different ways, including oil spills, radioactive discharges, trash, chemical releases, and many others. Vomiting is one of the main issues, and it happens when the environment gets high in nutrients like phosphates and nitrates. Congested nutrients can be found in significant amounts in fertilizers that are the result of agricultural pollution. Overabundance of nutrients encourages the growth of dangerous algae, which drastically reduces oxygen levels, creates dead, deoxydent zones, and kills fish. According to the National Oceanic and Atmospheric Administration (NOAA), mild to moderate condensation has an impact on up to 65% of American estuaries and coastal waters [27,28].

Water Quality for Human Consumption

The quality of water for human consumption covers safe drinking water and cooking, which is vital for the preservation of human health and is part of public health policy. Access to high-quality water for human consumption, known as drinking water, is a fundamental human right and a necessity for a healthy life and the development of individuals and communities [29]. United Nations Resolution No. 64/292 of July 2010 codified this right in international law. All over the world, not all people get high-quality water. According to WHO statistics, some 785 million people lack access to basic drinking water services, and more than 2 billion consume contaminated drinking water with poop [30].

Water Quality and Diseases Outbreaks in Iraq

Since earlier years, Iraq's water quality has remained poor, and several sources have been found to contain dangerous substances such carbonate, sulphur, chloride, and nitrate. A significant amount of drinking water has elevated concentrations of salt, suspended particles, and hazardous metals [31]. A large number of groundwater supplies for drinking water are either excessively or less salinized. The World Health Organization's (WHO) recommended limit for human consumption is 500 parts per million, however Basra has salinity levels above 7,000 parts per million. Sewage, pollution, and dangerous microorganisms can be found in the river waters that encircle Basra. Although industrial operations along the banks of the Tigris River contaminate the river, an estimated 60% of Iraq's industrial facilities lack operational sewage water treatment systems. Chlorophenol levels in drinking water reservoirs and rivers were examined in a prior study, and the findings showed that water treatment facilities had not properly sterilized or purified their water. In the Shatt al-Arab area, incinerators and oil leftovers were detected in the water column as well. It was observed that the oil residues came from several sources of crude oil. Petroleum product spills and releases occur often, and these occurrences have the potential to produce elevated levels of total petroleum hydrocarbons. Refined and non-repeat petroleum products contain a variety of hazardous compounds. Acoustic hydrocarbons can be dissolved or suspended in a mixture of molecules, such as nitrogen, sulphur, methane, heptane, or other molecules. Hydrocarbons can be harmful in high amounts. Toluene, benzopyrene, and petrol are examples of aromatic hydrocarbons; petrol is known to cause cancer. According to UNICEF data from 2011, 17% of Iraqis lacked access to proper sanitation, 20% of the country's overall population did not have access to safe drinking water, and 40% of residents lived in rural areas. According to the UNICEF report, most people living in rural areas were thought to be impacted. Iraq's most neglected area, Basra, has a high incidence of infectious illnesses, including diarrhea. Extreme weather and power failures in water delivery units resulted in a major outbreak of typhoid illness between 2005 and 2007, peaking in that year. 60% of the nation was affected by the cholera outbreak that same year, which expanded quickly [32,33].

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Nanotechnology and water purification

Sustainably providing safe, clean, and adequate water supplies is a global challenge; the insufficiency of pure water is one of the serious problems that many developing countries suffer from [34]. Therefore, resorting to applying nanotechnology in developing traditional water treatment techniques that include chemical treatments, water desalination, purification, ultraviolet treatment, and other means of water technology will lead to higher efficiency. These technologies therefore fill the shortage of pure water [35,36]. Nanotechnology is considered a scientific revolution and is applied in many fields, including industry, biomedicine, and environmental improvement [37-40]. It has the potential to improve the environment through the direct application of nanomaterial to detect, prevent, and remove pollutants [41]. Several recent efforts have sought to take advantage of the reactive and tunable properties of nanomaterials for water treatment [42]. Nanoparticles show higher reactivity due to their unique physicochemical properties, such as their small size (1–100 nm) and high surface area [43]. These particles have been used to improve the quality of naturally available water to a level suitable for human use [44]. The use of advanced nanotechnology has proven the actual role of technological progress in removing water pollution, and this has been supported by several recent scientific studies [45-48]. The application of nanotechnology may help ensure a continuous supply of safe drinking water to a growing population in a sustainable manner [49]. Compared with conventional small-sized adsorbents, nanomaterials have a much higher area-to-volume ratio, resulting in enhanced photo-catalytic activity, high adsorption capacity, high removal efficiency, and fast removal dynamics [50-52]. Sensing, detection, treatment, and pollution prevention are the three main aspects of water treatment related to nanoparticles (figure 1). A wide range of nanoparticles are used in water treatment, broadly classified into organic, inorganic, and polymeric nanoparticles [53,54].

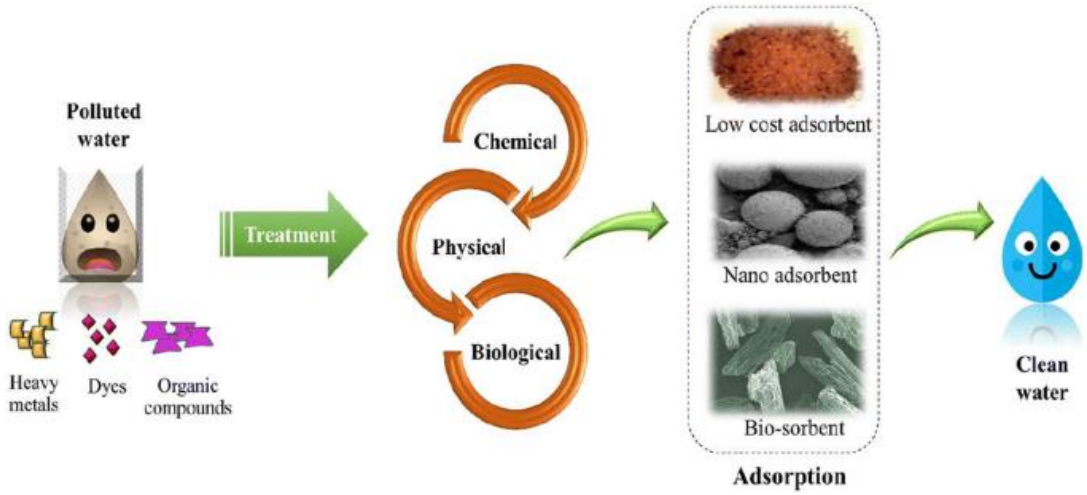

Figure 1: Application of nanotechnology in water purification.

Proposed Solutions to Improve Water Quality

1. War-torn societies face many wide-ranging economic and political challenges. Failure to operate health care and public health and awareness infrastructure contributes to the deterioration of the health of the Iraqi people.
2. Infectious diseases are increasing with poor sanitation and limited access to clean water, and long-term damage to water treatment plants has not been repaired.
3. The lack of electricity also continues to cause operational inefficiency, while services to the population are disrupted by a lack of equipment and machinery.
4. Technical staff and managers are needed to improve the overall organization and standards of water services, and public health awareness efforts must reach a larger audience.
5. In order to establish a solid basis for positive change, key issues of water quality, sanitation and waste disposal must be addressed.
6. Standard water treatment requires: clarification, filtration, purification, desalinization, routine maintenance, and nutritional value testing, with supplements added when needed.
7. Achieving a healthy environment in Iraq requires public health rehabilitation; infrastructure reconstruction and sustainable water quality techniques (figure 2).
8. Development with implementation of water quality and sustainable development programmers in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the Ministry of Water Resources through the reconstruction of infrastructure throughout Iraq
9. Conducting groundwater surveys that provide data on deficiencies and management of aquifers.
10. Work to improve the quantity and quality of water for disadvantaged residential areas.
11. Provide accurate and functional information for water and sanitation, along with models for reforming water and sanitation systems in the public sector.
12. Strategies must be flexible, effective and innovative to address issues as they arise.
13. Private sector enterprises are often more efficient and innovative than governments and can provide financial assistance and promote environmental sustainability.
1. Public-private partnerships are essential for sustaining financial assistance to poor areas (e.g. employment through public institutions), rebuilding government capacity and medical infrastructure, and supporting the Ministry of Health.

2. The need to control water quality, ensure daily access to clean water, and provide education on waterborne diseases, environmental pollutants and exposure.
14. The media can raise awareness about water health to address major problems.
15. Another important aspect of water-borne disease prevention is home-based water treatment. Reliance on the water treatment principle at Point-of-use water treatment, and safe storage of treated water.
16. Water treatment at the point of use focused on simple household water cleaning methods, such as boiling, bleaching, sediment filtration and UV clearance.
17. Boiling water can be environmentally unsustainable in developing countries, and boiling water can easily be re-contaminated as it is transported to a container and stored.

Figure 2: Water quality reconstruction approach in Iraq [55].

Conclusions

Every country in the world has different water quality, and availability depending on a number of factors, such as the country's location, climate, and economic standing. Iraq is a country in the Middle East with an arid climate. There is a persistent shortage of water in Iraq, and there are numerous causes of water pollution. The population of Iraq endured innumerable battles throughout the past century, which both directly and indirectly made the country's long-standing issues with water-borne illnesses worse. Alarmingly high rates of waterborne disease outbreaks are still being reported in Iraq. It is imperative that public health initiatives be combined with government reform in order to bring about and maintain long-term change. Reducing water-borne illnesses significantly and over time will require reforming public health and healthcare, increasing availability of drinking water through initiatives like re-melting

sweet water, establishing monitoring and assessment systems, and implementing sustainable development initiatives. Individuals in Iraq can have access to clean water, and the nation's health can be improved with a sustained commitment to change.

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