A Review on Groundwater Pollution

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Abstract
Groundwater is one of the important components in development of any area. It is the major potable, agricultural and industrial source of water. In the past, it was thought that groundwater is protected from pollution by layers of rocks and soil that act as filters. The first signs of contamination of groundwater extracted from wells may be detected. The objective of this review is reviews researches of groundwater pollution and contamination as well as pollution types and the effects of groundwater contamination and pollution on public heath. Generally, groundwater pollution studies include the scientific understanding of biological, chemical and physical processes which control contaminants fate and movement in the underground environment. High chemical concentration in drinking water can pose a health hazard. Epidemiological studies have shown that the poor quality of drinking water as the main transport route has been responsible for many water-borne diseases. Several of microorganisms and synthetic chemicals have a potential to pollute groundwater. Drinking water containing bacteria and viruses can lead to diseases such as hepatitis or cholera. The serious health effects of lead are known learning difficulties in children; problems in the nerves, kidneys, liver and pregnancy risks. Protection measures are actually simpler and less costly than corrective measures for groundwater contamination. The choice of appropriate therapeutic technique depends on site-specific factors and often takes into account clean-up goals based on human health and environmental protection.

Keywords: *Groundwater, Contamination and Pollution, Review*

I. INTRODUCTION

Water is essential for life and for all economic activities. It is used for domestic, industrial and agricultural purposes. Having sufficient water in sufficient quantity and quality contributes to maintaining health. The availability of water of good quality is essential to prevent diseases and to improve the quality of life. The use of water increased due to increasing in human population and activities [1]. Groundwater is one of the important components in development of any area. It is the major potable, agricultural and industrial source of water. In 2003, it was estimated that groundwater holds nearly 50% of the drinking water supply, 40% of the demand for industrial water, and 20% of the water used for irrigation [2]. Globally, more than a third of water used by humans comes from groundwater. In rural areas, the ratio is higher: more than half of all drinking water worldwide is supplied from groundwater [3]. Groundwater pollution can also result from innumerable common practices, such as the use of fertilizers and pesticides as well as disposal of human, animal and agricultural waste [4]. Globally, many researchers have conducted a study on the quality of groundwater and pollution sources affected by the industrial and natural process [5]. This concept has been developed from the vulnerability of groundwater, which is therefore the most important part of the assessment of the risks of groundwater contamination [6, 7]. Quality changes of surface water, such as rivers or lakes, may be due to contamination of groundwater. In the past two decades, awareness of groundwater pollution and contamination has been grown up [8]. Groundwater contamination effects becomes widely. Seven million people of United States drink contaminated water yearly. The contaminated water which caused by vomiting, rash, hepatitis, diarrhea closed all around the US beaches. Ground water pollution can lead to poor drinking water quality, loss of water supply, degraded surface water systems, high cleaning costs, rising costs of alternative water supply and / or potential health problems [9]. The objective of this study is review researches of groundwater pollution and contamination as well as pollution types and the effects of groundwater contamination and pollution on public heath. Some of groundwater detection and remediation methods will be discuses in this review.

II. THEORY

Groundwater is the important potable, agricultural and industrial source of water. Therefore the ability to predict the conduct of chemical pollutants in the flowing groundwater is vital to a reliable assessment of hazardous or risks arising from groundwater pollution problems and the design of effective and effective mitigation techniques. Reliable prediction and quantification of pollutant movement can only be done if we understand the processes that control contaminant transport. These include: [10]

1- Physical, chemical and biological reactions that affect their soluble concentrations in groundwater,
2- Hydrodynamic dispersion
3- Advection.

The most groundwater contamination problems are: [4]

1- Prevent introduction of contaminants to an aquifer

2- Predict movement of the contaminants if they are introduced as well as remove it to protect the biosphere effectively. Because of the importance of groundwater, difficulty and expense in addressing groundwater supplies, steps are often taken to prevent initial contamination. These steps may include protection of the entire aquifer, as well as the area around the head of the surface well, from unintentional contamination [12, 13]. Studies of groundwater contamination generally include: [14, 15]

- The scientific understanding of biological, chemical and physical processes which control contaminants movement and fate in the subsurface environment;
- The mathematical representation in transport models to predict the movement of contaminats;
- The determination of different model parameters in the field and the laboratory using different methods;
- The development of transport models to predict contaminants movement in case they are introduced;
- The development of management models which controlling and/or preventing the contaminants introduction into aquifer and determining methodology of safe disposal of hazardous wastes, and
- The development of methodology regarding contaminants removal to the extent necessary to effectively protect the biosphere.

Pollution of water sources occurs through point-to-point pollution and is not a source [16]. Pollution from an unspecified source is more ambiguous and can not be linked to a specific point such as the application of pesticides and fertilizers in agricultural fields [17]. It has been shown that agricultural land, sewage, runoff and runoff from urban areas and animal waste are responsible for increasing the number of micro-organisms found in water [16, 18, and 19]. The characters of water pollution point source are: a- Pollution can be accurately determined [20], and b- Limited real extent. A water pollution problem occurs when substances added to water to affect their chemical composition and caused threaten to human health and the ecosystem [21]. In addition to chemical contamination, groundwater quality can be further compromised by increasing levels of parameters that affect water quality, such as the concentration of hydrogen ions (pH), electrolysis (EC), turbidity, and microbiological content [22].

There are many routes by which groundwater are contaminated:

- Inter- aquifer leakage and irrigation returns [23].

- Leached from soluble solids at the surface and leaking from broken sewer pipes or lines [22].

- Percolation of liquid sprayed over land [24].

- Landfill leachate [25].

- Septic and sewerage effluent discharge [19].

Historically, ground water has been a source of high quality and relatively clean, drinking water, needing little if any or no treatment [27].

III. TYPES OF GROUNDWATER POLLUTION

Groundwater is exposed to various sources of pollution due to industrial revolution together with the lack of appreciation of chemicals and their potential impact on land and water bodies.

The presence of pollution within groundwater is a major challenge for delineation and identification. Leakage from chemical distribution infrastructure and petrochemicals, for example, pipelines and sewage collection systems such as sewage tanks, urban sewage channels and pipelines are few examples of the real life of unknown underground pollution. Products of mining activities and industrial complexes, which were stored in or underground without any rule to control the contamination of land, was one of the most difficult and difficult problems associated with pollution and management over the last hundred years [8].

The source pollutants characteristics which need to be identified include:

- The spatial locations of sources.

- The activity duration of sources which clarify the time of sources became active.

- The rate of injection of pollutant sources which determines the flow of contaminants from each source [8].

1.1 Groundwater Nitrate Contamination**:** Inorganic contamination of the greatest concern in groundwater is nitrate ions, which usually occur in aquifers near rural and suburban populations. Although uncontaminated groundwater generally has nitrate nitrogen levels of less than 2 ppm, nitrate in groundwater originates mainly from four sources:

- Use of nitrogen fertilizers, inorganic and animal manure.

- Atmospheric deposition.

- Human sewage deposited in septic systems.

- Cultivation of the soil [33].

Approximately 12 million tones of nitrogen per year are used as fertilizer in agriculture within United States, and the production of manure has contributed about 7 million tones or more. In most cases, nitrogen forms reduction in the soil are oxidized to nitrate, which then migrates to groundwater, where it dissolves in water and it is diluted because nitrate removal from well water is very expensive. Water contaminated with high levels of nitrate normally is not used for human consumption, at least in public-health [34].

1.2 Acidification: Acidified precipitation is a recognized and widespread phenomenon. The phenomenon of 'acid rain' has been known for over a century and is caused largely by the release of oxides of sulphur and nitrogen into the atmosphere. Acid precipitation effects on groundwater considered to be small. Other sources of acid in groundwater include: interaction of natural water-rock; contamination with industrial acids; and degradation of other contaminants [35].

1.3 Contaminated Land: Contaminated land presents the risk of groundwater contamination if the contaminants are able to migrate to the aquatic environment and continue to have potentially harmful concentrations. The consequences of pollution from human activities in the past and present have led and will continue to lead to serious contamination of groundwater [36, 37, 38]

1.4 Heavy Metals: In the past there has been a great interest in the fate of heavy metals due to the application of sewage sludge on agricultural land and from landfills. Additional sources of heavy metals include mining and smelting, burning of fossil fuels, metalworking, electronic and chemical industries, war and military training, and the launch of sports. In recent years, the recognition of potential toxic effects and long-term contaminants of heavy metal pollutants has focused on the protection of soil and groundwater [29].

1.5 Landfill: The landfills potential impact on groundwater quality hinges on the continuing debate between 'dilute and disperse' and 'containment' landfill design strategies. Understanding of landfill impact on groundwater requires knowledge of the composition of the landfill leachate. In general, leachate composition depends on the waste type, landfill design and practices, analytical procedures and timing. Most of the foregoing references relate to land filling of mixed household which typically contains a significant organic fraction, is biodegradable and is subject to significant long term consolidation settlement due to low initial density and biodegradation effects. However, certain industrial solid wastes are typically land filled in 'mono-disposal' facilities where only one or possibly two types of waste material are disposed. Examples of these sites are deposits of minerals and mining industry wastes (e.g. colliery shale, coal tailings, quarry fines) and pulverized fuel ash (PFA) from coal-fired power stations. Relatively few references were found on mono-disposal land filling [39]. Pollution of dumpsite (an engineering landfill) identified as a significant threats of groundwater resources [40].

1.6 Microbiological Contaminants: Microbiological contamination of groundwater is derived from wastewater from humans or animals. The large variety of pathogens that may be present in sewage includes pathogenic bacteria, viruses and protozoa. These contaminants can represent a potentially serious threat to public health if they are present in a water supply. Microbiological contaminants may enter the subterranean environment by leaking sewage, digging sinks, septic tanks, soaking liquids, mines used as a road to disposal, landfills or land-based drainage as fertilizer. The groundwater flow and degree of pollution will be largely subject to the loading of liquid waste and groundwater exposure to surface-derived pollution. Previous studies on the movement of microbiological pollutants in the aquifer environment were more commonly associated with groundwater contamination incidents and to a lesser degree with investigative surveys, both of which concentrated on bacteriological and to a lesser degree on viral contamination [29]. Refuse (domestic and industrial solid waste) is defined as non-useful and undesirable material originating from human activities and not free floating [29]. Poor management of solid materials has led to many catastrophic effects such as aesthetics, environmental hazards and pollution. Groundwater pollution may also occur due to the potential contamination of leachate from waste [41].

IV. REMEDIATION

Many organic and inorganic contaminants have been detected, mainly as a result of contamination from active and closed industrial facilities. It is anticipated that the legacy of past anthropogenic activities will be increasingly seen in groundwater, as today's contaminated land becomes tomorrow's groundwater pollution problem. Remediation is therefore rapidly becoming a necessary option, to restore or conserve groundwater quality and remove or contain contamination sources. The range of treatment required by the target concentration group is determined. There are two main categories of therapeutic objectives, the corrective target levels of the site and the non-specific target levels of non-site risks [29]. The presence of pollution in groundwater is a major challenge for delimitation and identification. Treatment of the contaminated site requires an ideal decision-making system to accurately and efficiently identify the source of the pollutants [8].

1.1 Acidification: The possible environmental impacts of acid precipitation have been recognized in the last 25-30 years. A large amount of researches have been published on the effects of acidification on streams and lakes, their environment, and on soil and more continuous. A recent review was made by Tickle, 1990. In contrast, relatively little work has been done on acidifications of groundwater, with the exception of one major British Geological Survey review [42].

1.2 Contaminated Land: Following the identification of contaminated land sites, determination of the potential risks posed by the site is vital before proceeding with extensive site investigation or remedial activity. Risk assessment methodologies have received a great deal of attention in recent years and a variety of approaches has been developed [38,43,44]. In general, future research on contaminated land is required to improve the understanding of the impact on groundwater quality, in order to classify risk and identify mitigation strategies. This involves collection of data on the extent of groundwater pollution from contaminated land, monitoring of the effectiveness of remediation procedures, as well as better understanding of the processes controlling and influence the nature and extent of pollution [45].

1.3 Heavy Metals: The behavior and mobility of trace metals in groundwater has been the subject of a growing number of research projects in the last decade. A detailed knowledge has been developed of the effects of pH and Eh conditions on the solubility, particularly to organic matter, clay minerals, hydrous iron and manganese oxides [46, 47].

1.4 Nitrate (NO^{-3}): Nitrate (NO^{-3}) groundwater contamination is a major concern in all intensive agricultural areas (pollution from non-point sources). Reddy and Lin, (1999) [48] conducted an investigation into the removal of nitrates from groundwater using a catalytic reduction process to selectively remove nitrate ions from groundwater, associated with the agricultural community. Palladium, platinum, and rhodium were used as three catalysts in this investigation. The catalytic reduction process described in this study is useful in removing NO-3 from groundwater associated with non-source pollution. Puckett and Timothy, (2001) [49] investigated the transfer of nitrates in the aquifer in relation to age, land-use practices and oxidation processes in central western Minnesota. The researchers found that nitrate concentrations are high and behave like oxygen, decreasing with both increasing age and depth.

V. METHODS USED IN DETECTION OF GROUNDWATER POLLUTION

The increasing demand for groundwater needs to be monitored and regulated on the basis of an overall assessment that includes the quality of groundwater, and not only the quantity, in order to ensure sustainable development and continuing use of the country's water resources [50,51]. Protection measures are in fact simpler and less costly than corrective measures for groundwater pollution [52]. The precise and effective characterization of unknown sources of pollution in the groundwater system is the first critical step in the process of controlling and treating sub-surface pollution, it is more complex related to pollution of surface water bodies which is relatively easier to detect. Some of the available methodologies for determining the source of groundwater pollution are reviewed here. However, it needs to be emphasized that often the efficiency of source identification depends on the availability and reliability of concentration field measurements, and hydro-geologic information. So a control network designed to collect geochemical field measurements can help improve the efficiency of source identification.

The repetitive use of source identification models and the design monitoring network can be combined sequentially to identify the source in an effective characterization methodology.

The characteristics of pollutant source that need to be determined include:

- The sources spatial locations.

- The activity duration of sources which clarify the time of sources became active.

- The rate of injection of pollutant sources that determines the flow of pollutants released from each source as a function of time [8].

Surface electrical resistivity was used as a tool to detect groundwater contamination. Water carries the pollutants through visible and invisible landscapes. at a local level, water-soluble components used in agriculture, industrial waste, dry waste sediments, etc., may be discovered by water and produce groundwater pollution, which will remain undetected until polluted water passes through a local well. The impact of pollution may appear in a downstream direction where river water is used for some vulnerable purposes such as irrigation [53].

There are four main assessment methods used to assess the risks of groundwater pollution with pesticides [28].

1. Methods of indexing: The methods of indexing are the most frequently used to assess groundwater pollution. Indexing methods use key parameters that are closely related to the entry of pollutants into groundwater, despite the vadose and saturated areas, for a comprehensive indicator of the characterization of pollution risks [28].

2. Process-based methods: Pollutants such as pesticides must pass through a series of physical, chemical and biological processes in the vadoss region and the saturated zone. Simulation models use numeric models to describe related migrations and conversions. Under simulation models and to a certain extent, a numerical indicator can be calculated to characterize the risk of pollution [7].

3. Statistical methods: Based on observed pollution information, statistical methods can be used to detect the relationships between investigation data and

pollution-related factors. Then, the evaluation indicators can be verified, each indicator with a value of relevance as analyzed by statistical method is assigned [54,55].

4 - Fuzzy comprehensive assessment method: The fuzzy comprehensive assessment method requires first requires make sure of the classification of pollution. In addition, the evaluation indicators should be selected, and then a standard value of each indicator under each contamination level must be collected. Second, the degree to which each sample belongs to each contamination level can be determined by merging the data into a relative membership score formula. In this step, the weight vector of the indices is also needed. Finally, by multiplying the matrix of the relative optimal relative grade by the order matrix, a distinct value vector can be achieved, and the risk of pollution can be assessed according to this vector [56,57].

VI. WATER QUALITY AND PUBLIC HEALTH

Water quality and public health are linked in many ways [58]. Human life essentially depends on potable water [59]. Many theories have suggested that water has been responsible for the transmission of many water-borne diseases through bacterial contamination of drinking water, which is the most serious risk factor for the spread of diseases causing disease and death [60].

Despite global efforts and the availability of modern techniques for the production of safe drinking water, it has been reported that the transmission of waterborne disease is a matter of major concern [61]. Pollution of drinking water during storage, lack of regulations and limited understanding and awareness among the population is documented [62,63].

The negative effects of mechanical failure, human error or degradation of source water quality, even with the best treatment system and the disinfection process, can sometimes lead to water quality degradation [62,63,64]. Health risks can be caused by high chemical concentration in drinking water; however, in the case of bacteria contamination there are only a small number of many that cause a danger to consumer health [65]. Epidemiological studies have shown that poor quality of drinking water (referred to as feces, environmental pollution or chlorinated water) as the major transmission route was responsible for many water-borne diseases [66].

Examples of such transport methods for waterborne diseases are:

1. Consumption of untreated, inadequately treated, or contaminated water directly or indirectly through food preparation.

2. Contaminated water contact with body such as fresh water, seawater, swimming pool.

Several of microorganisms and synthetic chemicals have a potential to pollute groundwater. Drinking water containing bacteria and viruses can lead to diseases such as hepatitis or cholera. Methemoglobinemia or Blue Baby Syndrome, a disease affecting infants, can be caused by drinking high nitrates water. Serious health effects of lead are known learning difficulties in children; neurological, kidney and liver problems and the risk of pregnancy [67].

VII. APPLICATIONS

Historically, groundwater contamination and pollution has been investigated all over the world using different methods and techniques. Some of these investigations and their results are shown bellow:

1. Jennings et al., (1998) [68] conducted a study on the toxicity of nitrates in groundwater and showed that among infants less than one year old, pregnant women, people of all ages with reduced gastric acidity or hereditary lack of met hemoglobin reeducates, those most vulnerable to exposure are those who use shallow wells to drink water.

2. Hueb, (2001) [69] conduct a research on groundwater contamination with chemicals such as cobalt. The study showed that (20%) have high levels of cobalt higher than $0.05 mg.l^{-1}$, after 25000 tests on wells implemented in Bangladesh, , which is contrary to the (WHO, 1993) [22].

3. Water quality guidelines Merit and Press, (1997) [32] assessed water quality; high levels of calcium and magnesium were reported in aquifers in calcareous rocks.

4. Al-Sudani, (2003) [70] studied the Debagah basin in north of Iraq where groundwater contamination was indicated with major anions, salinity and nitrate. Salinity and nitrate contamination were indicated in southern and northern part of the basin.

5. Rosen et al., (2004) [71] investigated the prediction of groundwater nitrate contamination after the closure of the unlined sheep line in Carson, United States.

6. Kong et al., (2004) [72] surveyed the contamination of groundwater by pesticides in the potato growing area of Hebei and Shandong, and revealed the presence of aldicarb, phorate, and terbufos.

7. Lee et al. (2007) [73] discovered 13 types of organic chlorine pesticides in 56 shallow groundwater samples collected from an agricultural area in the Taihu Basin.

8. Huang et al., (2008) [74] found that groundwater in area of the Pearl River delta is lightly polluted by organochlorine pesticides.

9. Akankpo and Igboekwe, (2011) [75] had monitored contamination of groundwater using surface electrical

resistivity and geochemical methods. Five geo-electric soundings were implemented with two at the waste dump in Uyo, southwestern Nigeria. The results indicate that total (TDS) and chloride values of water collected samples showing an evidence of a quantitative contamination assessment in groundwater.

10. Al-Shamaa, and Ali, (2011) [76] studied Badra-Jasan in Wasit province in Eastern Iraq. According to the surface and groundwater hydrochemical study in this basin according to salinity concentrations and major elements analyzed for 19 water samples, pollution of salinity and nitrate was identified. Pollution of both parameters has accrued in surface water and unconfined aquifer, while salinity pollution has been identified only in the confined aquifer of of the Quaternary deposits and Muqdadiyah formation.

11. Lo Russo, and Taddia, (2012) [77] studied s technical approach developed in Piemonte, northwest Italy, designed to protect drinking water wells. An important aspect of this approach was to integrate the assessment of the vulnerability of the aquifer on a large scale while identifying the local WHPA delineation. This method has been successfully tested on a well for drinking water in the community at reasonable and effective prices. However, in order for this method to be widely accepted, additional improvement is needed in some areas.

12. A semi-urban area of Croton Watershed (New York State, USA) provides 10% of New York City's drinking water. Unstable pollution in watersheds is a major concern for managers because water supply is currently unfiltered. The concentrations of sodium and dissolved chloride, while associated with the length of the road, stochiometrically had more chloride than expected for pure road-salt dissolution. This displacement is likely to be due to the exchange of cations and the absorption of sodium by wetlands in the watershed at Croton. The results showed that contamination in Hydrologic system of Croton must be addressed in current management policies and decision-making [78].

13. Identification of hydrogeochemical processes and Groundwater quality in Lagos University, Nigeria have been conducted by Odukoya, et al., (2013) [79]. The results of the study indicated that 50% of the water samples showed a pollution index higher than 1, and the lead contributed the largest percentage (37.8%) in the pollution index. This was followed closely by Mn, which contributed 29.3%. Concentrations of Al, Ni, Fe were 19.13%, 8.66%, 4.25% and 0.82% respectively.

14. Ehteshami,et al., (2013) [80] analyzed the environmental impact of livestock facilities and nitrate leaching in groundwater in Ray- Iran. The Nitrate movement within soil and groundwater was simulated by LEACHN. By identifying different scenarios and analyzing performance sensitivity, they carefully studied the factors affecting groundwater pollution.

15. Al-Alwany, (2013) [81] studied the suitability of groundwater in Dabaa region – western desert of Iraqi. Study results showed that toxic components of groundwater were effect on plants with mild to moderate effect of sodium concentration.

16. Coimbatore is one of the largest industrial and textile areas in southern India, where pollution of groundwater in an urban environment is a major issue. Coimbatore groundwater system has deteriorated because of industrialization along with agricultural activities and rapid urbanization in surrounding areas [82].

17. Aliewi, and Al-Khatib, (2015) [83] studied the Salfit District area which is located in the northern part of the West Bank of Palestine. This area is located on recharge areas of karstified limestone aquifers. There are many pollutants in Salfit's aquifer recharge zone which percolating and polluting into groundwater aquifers. The health of the Salfit population is directly threatened as results showed that water sources polluted using the Durov diagram. Microbiological analysis of potable water showed higher levels of total Coliforms.

18. Landfills are the most widely used method for municipal solid waste (MSW) disposal method in China. However, these facilities have caused serious groundwater contamination due to the leakage of leachate. Han, et al., (2016) [84] Studied and analyzed 32 scientific papers, a field survey and an environmental assessment report related to groundwater contamination caused by landfills in China. The groundwater quality in the vicinity of landfills was assessed as “very bad” by a comprehensive score (FI) of 7.85 by the grading method in China. Variety of pollutants consisting of 96 groundwater pollutants, 3 organic matter indicators, 2 visual pollutants and 6 aggregative pollutants had been detected in the various studies.

19. landfills method were used widely in China to dispose municipal solid waste (MSW). However, these facilities cause contamination of groundwater due to leakage of leachate. Han, et al., (2016) [84] Studied and analyzed 32 scientific papers, field survey and environmental assessment report on groundwater pollution due to landfills in China. Groundwater quality in areas close to landfills was assessed as "very poor" according to (FI) of 7.85 through China grading method. A variety of contaminants consisting of 96 contaminated groundwater, 3 indicators of organic matter, 2 optical pollutants and 6 pollutants collected in different studies.

20. Majolagbe, et al. (2017) [85] studied the potential vulnerability of groundwater in the surroundings to the pollution from Solous dumpsite (an engineering

landfill) in Lagos, Nigeria was investigated. Physico chemical analyses revealed the groundwater with acidic pH which portend health risk, while microbiological examination showed the groundwater samples to exceed the permissible limits of World Health Organization guidelines total heterotrophic bacteria (<10 cfu /ml at 37◦C) for drinking water. Various water quality indices were also used to show variation of quality trends in the water samples collected.

21. Al-Sudani, (2017**)** [86] studied groundwater in Iraqi marshland area, where total dissolved salts of groundwater was very high concentration. The groundwater can't be used for human, agriculture and animal purposes due to the long distance of groundwater movements from recharge to discharge area beneath marshlands.

22. Al-Sudani, (2017**)** [87] studied Khan al-Baghdadi area which located in Anbar governorate in west of Iraq. The results of groundwater salinity distribution as essential hydrochemical properties showed high concentration within carbonate aquifers extended in the area. The groundwater utilization can be used for agriculture purposes although high concentrations of salinity.

23. Al-Sudani, (2018) [88] studied hydrogeological properties of groundwater in Karbala'a governorate in the middle west of Iraq, where several well was polluted and contaminated with nitrate and major as well as minor ions in the area of study.

24. Al-Sudani, (2019) [89] studied salinity pollution of groundwater in south of Iraq. Depending on eighty six wells, the aquifer formed by Dibdibba formation and alluvial fan deposits in south of Iraq characterized by groundwater pollution with salinity while a small area located to the west of studied area was unpolluted zone.

25. Al-Sudani, (2019) [90] studied the groundwater system of Dibdibba sandstone aquifer in south of Iraq, where multi wells were highly contaminated with several anions and cations as well as nitrate ion.

26. Al-Sudani, (2019) studied the hydrochemistry of groundwater in northeast part of Anbar governorate in the west of Iraq.

VIII. CONCLUSIONS

The quality of groundwater is increasing threatened due to agricultural, urban and industrial wastes that leak or are injected underlying aquifers. Groundwater is vulnerable to pollution as pollutants can enter from landfills and lakes used to store waste, chemical spills and underground storage tanks leakage, and hazardous waste sites improperly managed. Groundwater pollution can also result from innumerable common practices, such as the use of fertilizers and pesticides; the disposal of human, animal and agricultural waste; and the use of chemicals. Groundwater pollution effects are extensive. Most serious effects of water pollution is human infectious disease in rural countries where sanitation facilities are seldom found. Protection measures are in fact simpler and less costly than corrective measures for groundwater pollution. The choice of appropriate therapeutic technology depends on site-specific factors and often takes into account cleaning targets based on potential risks that protect human health and environment. Many theories have suggested that water has been responsible for the transmission of many water-borne diseases through bacterial contamination of drinking water, which is the most serious risk factor for the spread of diseases. Diseases derived from chemical contamination of potable water are negligible compared to the number caused by microbial contamination. High chemical concentration in drinking water can lead to health risks.

IX. CONFLICTS OF INTEREST

The author declares that they have no conflicts of interest.

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