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A Discussion on Pollution of Groundwater

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Abstract: *Groundwater is crucial to any region's development. It supplies most industrial, agricultural, and drinkable water. It was thought dirt and rock filtered groundwater. Wells may reveal groundwater contamination. This paper reviews groundwater contamination and pollution studies, pollutant types, and public health effects. The biological, chemical, and physical factors that control subsurface pollutant fate and mobility are widely studied in groundwater contamination studies. Water with excessive chemical concentrations may be harmful. Epidemiological study links bad drinking water used as a key transit route to many waterborne infections. Many man-made compounds and bacteria may pollute groundwater. Drinking germy water raises your chances of cholera or hepatitis. Lead causes learning impairments in children, nerve, kidney, and liver problems, and increased pregnancy risk. Protection methods are cheaper and easier than groundwater contamination remediation. The best treatment strategy depends on site-specific characteristics and cleaning goals like human health and environmental protection.*

Keywords: Contamination, Groundwater, Pollution, Toxins, Monitoring

I. INTRODUCTION

Every economic activity and life needs water. In agriculture, industry, and the household. Quality and amount of water help maintain health. Water must be clean and accessible to prevent sickness and improve quality of life. Population and activity growth increased water use [1]. Groundwater is crucial to any region's development. It supplies most industrial, agricultural, and drinkable water. Groundwater provides roughly 50% of drinking water, 40% of industrial water, and 20% of agricultural water, according to 2003 estimates [2]. Over one-third of global water comes from groundwater. The proportion is higher in rural areas: groundwater provides almost half of the world's drinking water [3].

Common activities including pesticide and fertilizer usage and agricultural, human, and animal waste disposal may pollute groundwater [4]. Worldwide, researchers have examined how industrial and natural processes affect pollution sources and groundwater quality [5]. Because groundwater is susceptible, this notion was born. Thus, groundwater contamination hazard assessment is very crucial [6, 7]. Water quality in lakes and rivers may change due to groundwater contamination. Over the last 20 years, public awareness of groundwater contamination and pollution has grown [8]. The effects of groundwater contamination are widespread. Seven million Americans drink contaminated water annually. Toxic water caused diarrhea, dermatitis, hepatitis, and vomiting, closing all American beaches. Groundwater pollution may cause low drinking water quality, a shortage of water availability, deteriorating surface water systems, high cleaning costs, rising alternative water supply prices, and health risks [9]. This research reviews the literature on groundwater contamination, pollutant types, and public health effects. Groundwater detection and remediation methods are covered in this publication.

II. THEORY

The primary supply of drinkable, industrial, and agricultural water is groundwater. Thus, the capacity to forecast the behavior of chemical pollutants in groundwater is essential for the development of workable and efficient mitigation strategies as well as a trustworthy evaluation of the risks or hazards associated with groundwater contamination issues. Only by understanding the mechanisms governing contaminant mobility will it be possible to make accurate predictions and measurements of pollutant movement. Among them are [10]

1. Reactions involving matter, chemicals, and biology that modify their solubility in groundwater,
2. Dispersion of hydrodynamics
3. Provocation

The most groundwater contamination problems are: [4]
1. Prevent toxins from entering an aquifer.
2. To properly safeguard the biosphere, anticipate the migration of pollutants and remove them if they are introduced.

Owing to the significance of groundwater, as well as the cost, complexity, and inconvenience of treating groundwater sources, early contamination is often prevented. These precautions might include guarding against inadvertent pollution of the surface well head and the whole aquifer [12, 13]. Studies on contaminated groundwater often consist of: [p. 14–15]

• The development of management models that control and/or prevent the introduction of contaminants into an aquifer and determine the methodology for the safe disposal of hazardous wastes; • The scientific understanding of biological, chemical, and physical processes that control contaminants movement and fate in the subsurface environment; • The mathematical representation in transport models to predict the movement of contaminants; • The determination of different model parameters in the field and the laboratory using different methods; and
• The creation of a mechanism for the removal of toxins to the degree required to adequately safeguard the biosphere.

Water sources are not the source of pollution; rather, point-to-point contamination is the cause [16]. An anonymous source of pollution, like the use of fertilizers and pesticides in agricultural areas, is more confusing and difficult to pinpoint [17]. The quantity of microorganisms present in water has been shown to be increased by sewage, animal waste, runoff from urban areas, and agricultural land [16, 18, and 19]. Water pollution point sources have the following characteristics: a) precise measurement of contamination [20]; and b) limited actual area. When chemicals are introduced to water to change its chemical makeup and endanger human health and the ecology, there is an issue with water pollution [21]. Increasing levels of variables that impact water quality, such as the concentration of hydrogen ions (pH), electrolysis (E.C.), turbidity, and microbial content, may further deteriorate groundwater quality in addition to chemical pollution [22].

There are several ways that contaminants might enter groundwater:
• Leakage between aquifers and irrigation returns.
• Seeped from fractured sewage pipes or lines and soluble solids at the surface.
· Liquid splashed over land percolating.
• Leachate from landfills.
• The release of sewage and septic effluent.
• Historically, groundwater has provided reasonably clean, high-quality drinking water with little to no requirement for treatment.

III. TYPES OF GROUNDWATER POLLUTION

The industrial revolution has exposed groundwater to a variety of contamination sources, and people have not given chemicals enough credit for their possible effects on land and water bodies.

Delineation and identification of groundwater are significantly hampered by the existence of contamination. Some real-world instances of unidentified subterranean contamination include leaks from petrochemical and chemical distribution infrastructure, pipelines, and sewage collecting systems such sewage tanks, urban sewage channels, and pipes. One of the hardest and most complicated issues with pollution and management over the last 100 years has been the products of mining operations and industrial complexes, which were held underground or under no regulations to prevent the contamination of land [8].

The following are the characteristics of the source pollutants that must be determined:

The sources' geographical positions; the length of time that each source was active, indicating when the source became active; and the rate at which pollutant sources are injected, indicating when each source releases toxins into the environment [8].

Groundwater Pollution with Nitrates: The most dangerous kind of inorganic pollution in groundwater is caused by nitrate ions, which are often found in aquifers close to suburban and rural areas. While nitrate-nitrogen levels in uncontaminated groundwater are typically less than 2 parts per million, there are four primary sources of nitrate in groundwater:

- Soil cultivation;
- Atmospheric deposition;
- Human sewage deposited in septic systems;
- Use of nitrogen fertilizers, inorganic and animal manure [33].

Manure contributes at least 7 million tons of nitrogen fertilizer to US agriculture's 12 million tons. Soil nitrogen is oxidized to nitrate, which migrates to groundwater and dissolves. Nitrate is diluted because removing it from well water is costly. Humans seldom drink high-nitrate water in public health circumstances [34].

Acidification: Acid precipitation is common. Nitrogen and sulfur oxides are the main cause of "acid rain," which has been seen for over a century. Acid rain harms small-scale groundwater. The natural water-rock interaction, industrial acid pollution, and degradation of other contaminants also acidify groundwater [35].

If contaminants migrate to aquatic ecosystems and remain toxic, polluted land might affect groundwater. Human-caused pollution has caused and will continue to pollute groundwater [36, 37, 38].

Heavy Metals: Because landfill and agricultural sewage sludge is applied to land, heavy metals' fate has been of great concern. Mining, smelting, burning fossil fuels, metallurgy, the chemical and electronic industries, fighting, military training, and sports may also produce heavy metals. The increased understanding of heavy metal contaminants' detrimental impacts and long-term pollution has raised concerns about soil and groundwater conservation [29].

Landfill: How "dilute and disperse" and "containment" landfill building methods effect groundwater quality will be debated. Understanding landfill leachate composition is crucial to understand landfill effects on groundwater. Leachate composition depends on landfill design, time, waste type, and analytical methodologies. Most of the publications above discuss land filling mixed households, which have a high organic content, are biodegradable, and are susceptible to long-term consolidation settling because to their low initial density. However, "mono-disposal" facilities, which dispose of one or two waste types, frequently dump specialized industrial solid wastes. Mine wastes including colliery shale, coal tailings, and quarry fines, and coal-fired power plant pulverized fuel ash (P.F.A.), are examples. Few resources exist on landfilling single-disposal garbage [39]. Groundwater contamination from engineered landfills is a serious concern [40].

Groundwater microbiological pollution comes from human or animal waste. Sewage contains several pathogens, including bacteria, viruses, and protozoa. If discovered in water, these contaminants may harm the public. Leaking sewage, digging sinks, septic tanks, soaking liquids, employing mines for disposal, landfills, or land-based drainage as fertilizer may introduce microbiological contaminants into the subsurface environment. The flow and degree of groundwater contamination are mostly affected by liquid waste loading and surface pollution. Prior research on aquifer microbiological contaminant transport was more often tied to groundwater pollution occurrences and investigative surveys. Most of these investigations focused on bacterial contamination and some virus contamination [29]. Non-useful and unpleasant human-made "refuse" is not floating [29]. This covers residential and industrial waste. Poor solid material management may cause pollution, environmental dangers, and disaster. Garbage leachate may pollute groundwater [41].

IV. REMEDIATION

Most organic and inorganic contaminants were discovered at closed and functioning industrial sites. Today's contaminated soil will become tomorrow's groundwater pollution, revealing human activity's legacy. Remediation is becoming an essential option for improving groundwater quality and reducing pollution sources. The target concentration group's treatment range is determined. Therapeutic goals include site correction and non-site hazard targets [29]. Groundwater pollution hinders identification and delimitation. An appropriate decision-making system is needed to remediate the contaminated location and pinpoint the cause [8].

Acidification: For 25–30 years, acid precipitation has been shown to harm the ecosystem. Numerous research have examined how acidity affects lakes, streams, soil, and other continuous materials. Recent review by Tickle (1990). Groundwater acidification research is scarce, save for a thorough British Geological Survey review [94].

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After identifying hazardous land areas, evaluate the risks before investigating or remediating them. Risk assessment has garnered attention in recent years, with numerous techniques [38,43,44]. Further research on contaminated land is required to assess risk, identify mitigation methods, and understand groundwater quality effects. This involves collecting data on groundwater contamination from contaminated land, monitoring remediation methods, and understanding the processes that cause and affect pollution [45].

Heavy metals: Over the last decade, groundwater trace metal behavior and mobility study has grown. Solubility of organic matter, clay minerals, hydrous iron, and manganese oxides has been extensively examined under pH and Eh conditions [46, 47].

Nitrate ($NO^{-}3$) contamination of groundwater is a significant risk in areas with extensive agriculture (originating from non-point sources). Reddy and Lin (1999) [48] investigated removing nitrate ions from agricultural groundwater using catalytic reduction. This study employed rhodium, platinum, and palladium catalysts. Catalytic reduction removes NO-3 from non-source-contaminated groundwater in the research. Puckett and Timothy (2001) [49] examined aquifer nitrate transport in central-western Minnesota by age, land-use, and oxidation. The researchers found that nitrate concentrations are high and decline with depth and age like oxygen.

V. METHODS USED IN DETECTION OF GROUNDWATER POLLUTION

The increased demand for groundwater must be monitored and regulated based on an overall assessment of groundwater quantity and quality to ensure sustainable development and water resource usage [50,51]. Protection methods are cheaper and easier than groundwater remediation [52]. Subsurface pollution management begins with precisely and totally defining the sources of contamination unknown to the groundwater system, which is more difficult than surface water body pollution. This study reviews certain groundwater pollution detection methods. Source identification generally depends on hydro-geologic data and concentration field measurements' precision and reliability. A control network that collects geochemical field measurements may improve source identification.

The design monitoring network and recurring source identification models may be connected sequentially to efficiently characterize the source.

The pollutant source's attributes must be identified:

- The sources' position in space.
- The length of each source's activity, which indicates when it started to operate.
- The pollutant source injection rate, which establishes the flow of pollutants discharged from each source as a function of time [8].

Surface electrical resistivity is a groundwater contamination indicator. Water transports pollutants in visible and invisible settings. Agriculture, industrial, and dry waste sediments may pollute groundwater locally, which is not observed until contaminated water passes through a neighboring well. Contamination from river water irrigation may harm downstream applications [53].

Four main methods assess pesticide-induced groundwater contamination risks [28].

Techniques for indexing: Indexing methods are most popular for groundwater pollution evaluation. Indexing methods use important criteria related to groundwater contamination, excluding vadose and saturated zones, to categorize pollution threats [28].

A process-based approach: Pesticides undergo physical, chemical, and biological reactions in the saturated zone and vass. Simulation models use numerical models to explain migrations and conversions. Simulation models can provide a numerical indication of contamination risk [7].

Methods of statistics These methods may detect connections between inquiry data and pollution variables based on observed pollution. According to statistical analysis, evaluation indicators may be verified and given relevance values [54, 55].

4- Fuzzy thorough evaluation: Confirm pollutant categorisation before utilizing fuzzy comprehensive assessment. Additionally, assessment indicators must be selected. Next, collect standard values for each contamination level and indicator. Second, a relative membership score algorithm may determine how much each sample belongs to each contamination level. This step requires the indices' weight vector. Multiplying the relative optimal relative grade matrix by the order matrix yields a unique value vector. Pollution risk may be calculated using this vector [56,57].

VI. WATER QUALITY AND PUBLIC HEALTH

Public health and water quality have several links [58]. Human survival requires potable water [59]. Many ideas suggest that water contamination with bacteria, the biggest risk factor for the spread of diseases that may kill, has caused many waterborne illnesses [60].

International efforts and modern technologies for safe drinking water production have not stopped the development of waterborne sickness [61]. There is evidence of drinking water pollution during storage, minimal regulations, and little public awareness [62, 63].

Even with the best treatment system and disinfection, mechanical failure, human error, or source water quality decline may lower water quality [62,63,64]. High chemical concentrations in drinking water may provide health risks, whereas bacterial infection poses few pathogens [65]. Epidemiological research has connected many waterborne diseases to poor drinking water quality (excrement, environmental pollution, or chlorinated water) as the major method of transmission [66].

Here are several aquatic sickness transportation methods:

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

Many man-made compounds and bacteria may pollute groundwater. Drinking germy water raises your chances of cholera or hepatitis. High-nitrate water may cause methemoglobinemia, or Blue Baby Syndrome, in newborns. Lead exposure may cause learning difficulties in children, neurological, renal, and liver problems, and an increased risk of pregnancy [93].

VII. APPLICATIONS

Groundwater pollution and contamination have been examined worldwide using various methods. Some of these investigations and their findings:

Jennings et al. [68] studied groundwater nitrate toxicity in 1998. They found that toddlers under a year old, pregnant women, individuals of all ages with lower stomach acidity, and those born without methemoglobin are most vulnerable to shallow well water.

Hueb (2001) [69] examines groundwater contamination from cobalt compounds. After 25000 well tests in Bangladesh, 20% had cobalt levels over 0.05 mg/l-1, which is against the WHO (1993) [22].

Guidelines for water quality Calcareous rock aquifers exhibited high calcium and magnesium contents, according to Merit and Press (1997) [32].

Al-Sudani (2003) [70] detected groundwater anions, salinity, and nitrate contamination in the Debagah basin in northern Iraq. Both the south and north of the basin have nitrate and salinity contamination.

Rosen et al. (2004) evaluated groundwater nitrate contamination after ending the Carson, US, unlined sheep line [71].

Kong et al. (2004) identified aldicarb, phorate, and terbufos in pesticide-contaminated groundwater in Hebei and Shandong potato-producing areas [72].

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

Huang et al. (2008) [74] found minor groundwater contamination from organochlorine pesticides in the Pearl River delta.

Akankpo and Igboekwe (2011) [75] used surface electrical resistivity and geochemistry to detect groundwater contamination. The rubbish dump in Uyo, southwest Nigeria, hosted two of the five geo-electric soundings. The results show that groundwater contamination may be quantified using water sample total (T.D.S.) and chloride levels.

Al-Shamaa and Ali (2011) [76] examined Badra-Jasan in Eastern Iraq's Wasit province. Based on essential components and salinity concentrations in 19 water samples, this basin's surface and groundwater hydrochemical studies found nitrate and salt pollution. Salinity contamination is only observed in the Quaternary deposits and Muqdadiyah formation confined aquifer, while surface water and the unconfined aquifer are polluted.

Lo Russo and Taddia (2012) studied a Piemonte, northwest Italy, technology for protecting drinking water wells [77]. This technique relied on integrating large-scale aquifer risk assessment with local WHPA delineation. This method has been tried on a community well to supply economical, adequate drinking water. There are still several issues to resolve before this method is widely used.

The semi-urban Croton Watershed in New York State supplies 10% of New York City's drinking water. Management's main concern is watershed pollution as the water supply is unfiltered. The sodium and dissolved chloride concentrations were proportional to road length, although they included more chloride than expected for pure road salt dissolution. Wetlands in the Croton watershed presumably exchange cations and absorb salt, causing this displacement. The results showed that Croton Hydrologic System management and decision-making must include pollution [78].

Lagos University's hydrogeochemical processes and groundwater quality were discovered by Odukoya et al. (2013) [79]. Lead contributed the most (37.8%) to the pollution index, with 50% of water samples having ratings over 1. Mn contributed 29.3%, following this. In order, Al, Ni, and Fe concentrations were 19.13%, 8.66%, 4.25%, and 0.82%.

Ehteshami et al. (2013) evaluated livestock facilities and groundwater nitrate leaching in Ray, Iran [80]. LEACHN mimicked soil and groundwater nitrate transport. Many scenarios and performance sensitivity tests were run to examine groundwater contamination factors.

VIII. CONCLUSION

The spilling or injection of industrial, municipal, and agricultural toxins into aquifers is threatening groundwater quality. Chemical mishaps, leaky underground storage tanks, poorly managed hazardous waste sites, and landfills and lakes may contaminate groundwater. Groundwater pollution may also result from chemical, fertilizer, and pesticide usage and agricultural, human, and animal waste disposal. The effects of groundwater pollution are broad. Human infectious illnesses are the worst effects of water pollution in rural regions without sanitary services. Protection methods are cheaper and easier than groundwater remediation. The right treatment technique depends on site-specific factors and cleaning goals that reduce health and environmental risks. Numerous theories suggest that water contamination with bacteria, the biggest risk factor for disease transmission, has caused many waterborne ailments. Microbial pollution in drinking water causes more illnesses than chemical contamination. Drinking chemical-laden water may hurt you.

REFERENCES

[1]. H.I.Z. “Al-Sudani, Hydrochemical Evaluation and Utilization of Groundwater”. Khanaqin Area, Diyala Governorate - East of Iraq. Iraqi Journal of Science, 59 (4C), 2018, 2279-2288.

[2]. S. S. D. “Foster and P. J. Chilton, Groundwater: The Processes and Global Significance of Aquifer Degradation,” Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358 (1440), 2003, 1957-1972. doi:10.1098/rstb.2003.1380

[3]. T. Harter, “Basic Concepts of Groundwater Hydrology. A.N.R. Publication 8083”, FWQP Reference Sheet 11.1, University of California. U.S.A. 2015.

[4]. U.S. Environmental Protection Agency. Wellhead Protection:” A Guide for Small Communities, Chapter3”: Ground Water Contamination, Office of Research and Development, Washington, DC 20460.144p. 1993.

[5]. S. Selvakumar, N. Chandrasekar and G. Kumar, “Hydrogeochemical characteristics and groundwater contamination in the rapid urban development areas of Coimbatore, India”. Water Resources and Industry, 17, 2017, 26–33.

[6]. C.Z. Sun and S.S. Lin, “Review of ground water vulnerability concept and assessment”, Jilin Geology,19, 2000, 30-6

[7]. S. Foster, J. Chilton, M. Moench, F. Cardy and “M. Schiffler, Groundwater in Rural Development: Facing the Challenges of Supply and Resource Sustainability”, World Bank Technical Paper 463, Washington DC. U.S.A. 2000.

[8]. M. Amirabdollahian and B. Datta, “Identification of Contaminant Source Characteristics and Monitoring Network Design in Groundwater Aquifers”: An Overview. Journal of Environmental Protection, 4, 2013, 26-41.

[9]. “U.S. Environmental Protection Agency. Wellhead Protection: A Guide for Small Communities”, Chapter 3: Ground Water Contamination, Office of Research and Development, Washington, DC 20460.144p. 1993.

[10]. “S. Foster, J. Chilton, M. Moench, F. Cardy and M. Schiffler, Groundwater in Rural Development”: Facing the Challenges of Supply and Resource Sustainability, World Bank Technical Paper 463, Washington DC. U.S.A. 2000.

[11]. "S. Foster, R. Hirata", D. Gomes, M. D'Elia and M. Paris, Groundwater Quality Protection. World Bank, Washington DC, U.S.A., 2002, 103 p. doi:10.1596/0-8213-4951-1

[12]. A. Fadlelmawla and M. A Dawoud, "An Approach for Delineating Drinking Water Wellhead Protection Areas at the Nile Delta", Egypt, Journal of Environmental Management, 79 (2), 2006, 140-149.

[13]. S. Y. Feng, S. Y. Huo, S. Z. Kang, Z. J. Tang and F. X. Wang, "Groundwater Simulation Using a Numerical Model under Different Water Resources Management Scenarios in an Arid Region of China", Environmental Earth Sciences, 62 (5), 2011,961-971.

[14]. X. H. Wang, "Conceptual Design of a System for Selecting Appropriate Groundwater Models in Groundwater Protection Programs", Environmental Management, 21 (4), 1997, 607-615. doi:10.1007/s002679900053

[15]. W. Zhou, B. F. Beck, A. J. Pettit and B. J. Stephenson, "A Groundwater Tracing Investigation as an Aid of Locating Groundwater Monitoring Stations on the Mitchell Plain of Southern Indiana", Environmental Geology, 41 (7), 2002, 842-851.

[16]. G. Allenby and M. Margaret, "World, Environment and People. Science Press", N.S.W., Australia. 1993.

[17]. A.D. Viste and A.J. Rice, Major sources of groundwater contamination; "Assessing the extend of point and Non-point Contamination in Shallow. Aquifer System". Groundwater Contamination and Control. Edited by Uri Zoller. 1994.

[18]. C. Berka, D. McCallum and B. Wernick, "Resource Management and Environmental Studies". Department of Civil Engineering, University of Columbia, Vancouver, Bc, Canada. Paper presented at: Lower Fraser Basin in transition: Symposium and Workshop, Kwantlen College, Surrey, BC, Canada. 1995.

[19]. C.E. Boyd, Water Quality. "An Introduction. Kluwer Acad. Publisher", U.S.A. 330 p. 2000.

[20]. M.J. Hammer, "Water and Wastewater Technology", 3rd Edition, Published by Prentice-Hall Inc, Englewood Cliff, New Jersey. 1996.

[21]. J. Nathanson, "Basic Environmental Technology, Water Supply, Waste Management and Pollution Control". 2nd (eds) Published by Prentice-Hall Inc. 1997.

[22]. WHO: "World Health Organization. Guidelines for Drinking Water Quality", 2nd (eds), Vol.1. Recommendations. World Health; Geneva. 445p. 1993.

[23]. V.N. Reinhold, "Ground water Treatment Technology, 2nd Ed. Evan K Nyer". 1992.

[24]. M. J. Beckett, "Land Contamination", Contaminated Land, Problems and Solution. Edited by Tom Cairney. Published by Chapman and Hall. 1993.

[25]. E. G. Blight, "On Isolating a Landfill from the Surrounding Water regime". Microbiology of Landfill Sites, Eric Senor, 2nd ed, Published by C.R.C. Press. 1995.

[26]. U.S. Environmental Protection Agency. "Wellhead Protection: A Guide for Small Communities", Chapter 3: Ground Water Contamination, Office of Research and Development, Washington, DC 20460.144p. 1993.

[27]. "V.N. Reinhold, Ground water Treatment Technology", 2nd Ed. Evan K Nyer. 1992.

[28]. Y.Y. Zhao and Y.S. Pei, "Risk evaluation of groundwater pollution by pesticides in China: a short review". The 18th Biennial Conference of International Society for Ecological Modelling, Procedia Environmental Sciences, 13, 2012, 1739 -1747.

[29]. Briffett, L. Houlden, S. Kirk, A. McMahon, P. Miles, R. Stephenson and E. Walker, "Groundwater Pollution Research Reviews. Geraghty and Miller International", Inc Conqueror House,Vision Park, Histon. Cambridge.85 p. 1996.

[30]. C.A.J. Appelo and D. Postma, "Geochemistry, Ground water and Pollution", A.A. Balkama, Rotterdam. 536 p. 1999.

[31]. A.D. Eaton, L.S. Clesceri and A.E. Greenbury, "Standard methods for the examination of water and waste water", American Public Health Association, American Water Works Association and Water Environment Association, Washington D.C., U.S.A. 1995.

[32]. W. Merit and D. Press, "Water Quality and Pig Performance". Facts sheet; Ministry of Agriculture, Food and Rural Affairs, Ontario. 1997.

[33]. D.A.M. Barzinji and D.G.A. Ganjo, "Water Pollution", Limnological Investigations in Kurdistan region and Other part of Iraq. International Journal of Science, Environment and Technology, 3 (3), 2014, 776–799

[34]. C. Barid and M. Cann, "Environmental chemistry". 3rd Edition, W.H Freeman and Company press, pp 425. U.S.A. 2005.

[35]. M. Ford, J.H. Tellam and M. Hughes, "Pollution-Related Acidification in the Urban Aquifer, Birmingham", UK. Journal of Hydrolongy, 140, 1992, 297-312.

[36]. J.H. Tellam, "The Groundwater Chemistry of the Lower Mersey Basin Permo-Triassic Sandstone Aquifer System", U.K. - 1980 and Pre-Industrialisation Urbanisation. Journal of Hydrology, 161 (1-4), 1994, 287-325.

[37]. D.N. Lemer and J.H. Tellam, "The Protection of Urban Groundwater from Pollution. Journal of the Institute of Water and Environmental Management", 6 (1), 1992, 28-37.

[38]. M.P. Henton and P.J. Young, "Contaminated Land and Aquifer Protection. Journal of the Institute of Water and Environmental Management", 7(5), 1993, 539-547.

[39]. H. Robinson, J. Gronow, P.S. Durrant, M. Taylor, C.E. Reeve, P.G. Mackey, R. Mull and J.P.L. "Dearlove, Groundwater Protection in the U.K. - Assessment of the Landfill Leachate Source Term. Journal of the Institute of Water and Environmental Management", 6 (2), 1992, 229-236.

[40]. U.K. Singh, M. Kumar, R. Chauhan, P.K. Jha, A. Ramanathan and V. Subramanian, "Assessment of the impact of dumpsite on groundwater quality: a case study of the Pirana site in western". India. Environmental Monitoring Assessment 141, 2008, 309-21.

[41]. K. S. Makey, "Natural Buffers for Sludge Leachate Stabilization, Groundwater", 20 (4), 1982, 420- 429.

[42]. R.Muralidaran, G.Muthaiyan, M.Nicky wifred joseph, M.Sugumar, S.Suresh babu, "Analysis of Surface and Ground Water in Ranipet Industrial Area" SSRG International Journal of Civil Engineering 4.3 (2017): 54-57.

[43]. P.L. Walker, S. Munro, C.L. Hawkings, and F.E. Shepherd, "The Application of Risk Assessment to Contaminated Land - The British Gas Experience". Journal of the Institute of Water and Environmental Management, 8 (6), 1994, 607-614.

[44]. J.A. Cole, R.L. Norton and H.A.C. Montgomery, "Countering Acute Pollution Events – Procedures Currently being adopted in the United Kingdom" Water Science and Technology, 29 (3), 1994, 203-205

[45]. P. Bardos and H.J. "van Veen, Review of Longer Term or Extensive Treatment Technologies". Land Contamination and Reclamation, 4 (1), 1996, 19-36.

[46]. B.J. Alloway and A.P. Jackson**,"** The Behavior of Heavy Metals in Sewage Sludge Amended Soils**"**. Science of the Total Environment, 1000, 1991, 223-257.

[47]. B.J. Alloway and D.C. Ayres, "Chemical Principles of Environmental Pollution, Blackie, Glasgow". 1994.

[48]. K.J. Readdy and J.M. Lin, "Nitrate removal from groundwater using catalytic reduction. Science direct research" .34 (3), 1999, 14.

[49]. L.J. Puckett and K.C. Timothy, "Transport and Fate of Nitrate in a Glacial Outwash Aquifer in Relation to Ground Water Age, Land Use Practices, and Redox Processes". United States Geological Survey USGS. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. Journal of Environmental Quality 31, 2001,782-796.

[50]. R.C. Leyland, "Vulnerability Mapping in Karst Terrains, Exemplified in the Wider Cradle of Humankind World Heritage Site". MS.c thesis University of Pretoria, South Africa. 2008.

[51]. N. Goldscheider, "Karst groundwater vulnerability mapping: application of a new method in the Swabian Alb", Germany. Hydrogeology Journal, 13, 2005, 555–564.

[52]. Margane, "Management, Protection and Sustainable Use of Groundwater and Soil Resources in the Arab Region". Guideline for the Delineation of Groundwater Protection Zones. Vol. 5, ACSAD-BGR Technical Cooperation Project. 2003.

[53]. A.O. Akankpo and M.U. Igboekwe, "Monitoring Groundwater Contamination Using Surface Electrical Resistivity and Geochemical Methods". Journal of Water Resource and Protection, 3, 2011, 318-324

[54]. S.Y. Chen, G.T. Fu, H.C. Zhou and G.L. Wang, "Fuzzy analysis model and methodology for aquifer vulnerability evaluation". Journal of Hydraulic Engineering. 7, 2002, 23-30.

[55]. S.Y. Chen and G.L. "Wang Fuzzy optimization interaction model for assessing groundwater pollution potential and case study". Journal of Dalian University of Technology. 39, 1999, 811-5.

[56]. Z. Fang, C.L. Xiao, X.J. Liang and B. Feng "Fuzzy comprehensive evaluation of the groundwater vulnerability in songnen plain". Journal of Jilin University (Earth Science Edition), 3, 2007, 546-50.

[57]. L.J. Zhang, Z.Y. Gong and X.T. "Sun Fuzzy comprehensive judgment of groundwater environmental vulnerability". Natural Sciences Journal of Harbin Normal University, 17, 2001, 109-12.

[58]. H.G. Brutland, "World Water Day Thursday 22 March. Help Make the difference". 2001.

[59]. W.C. Michiels and D.L.E. "Moyson, Bacteriological Analysis. Handbook of Water Analysis"; edited by Leo M.L.Nollet. Published by Marcel Dekker Inc. 2000.

[60]. UNEPA/WHO: United Nation Environmental Program Agency/ "World Health Organization. A practical Guide to the Design and Implementation of fresh water quality studies and monitoring". Edited by Jamie Bartram and Richard Balance. Publish on behalf of UNEPA/WHO. 1996

[61]. M. Stevens, S. McCounell, P. Nadehaum, M. Chapman, S. Ananthakumar and J. McNeil, "Drinking Water Quality and Treatment Requirements": A risk based Approach. Water, 12-16. 1995,

[62]. W.R. Mackenzie, N.J. Hoxie, M.E. Proctor, M.S. Gradus, K.A. Blair, "A massive outbreak in Milwaukee of cryptosporidium infection transmitted through public water supply". New Engineering Journal Med. 331 (3), 1994, 161-167.

[63]. P.A. Roefer, J.T. Monscvitz and D.J. Rexing, "The Las Vegas cryptosporidiosis out break. JAWWA", 88, 1996, 95-106.

[64]. E. E. Geldreich, "Microbial Quality of Water Supply in Distrbution System". Publisher C.R.C. Press Inc, Co-operate N.W. Boca, Roton, Florida 33-41. 1996.

[65]. WHO:World Health Organization, "Guideline for drinking water quality. Recommendations". 4th Ed. Geneva, World Health Organization. 520 p. 2011.

[66]. F.G. Lee and J.L. Anne, "Public Health Significance of Waterborne Pathogens in Domestic Water Supplies and Reclaimed Water". 1993.

[67]. R.Pakuththarivaalan, D.Ramraj, S.Shyam sunder, M.Shylaja, N.S.Ashik "Quality Analysis of Ground Water in Cuddalore District Neyveli Block using Conventional Method", International Journal of Engineering Trends and Technology (IJETT), V46(3),162-168 April 2017.

[68]. D. Jennings, S. Paul and D.W. Diane, Nitrates in Drinking water. "Washington State Department of Health (WSDOH)". An electronic media retrieved from the website: http:// www.doh.wa.gov/ehp/dw. 1997.

[69]. J.A. Hueb, "Improving Water, Planning and Management Worldwide". New World Water. Publication of World Water Council, France. 2001.

[70]. H.I.Z. Al-Sudani, "Hyrogeological System of Debagah Basin In North of Iraq", Ph.D. Thesis , University of Baghdad, College of Science. 153 p. 2003.

[71]. M.R. Rosen, R.R. Reeves, S. Green, B. Clothier and N. Ironside, "Prediction of Ground water nitrate contamination after closure of an unlined sheep feedlot. Vadose Zone Journal". 3 (6), 2004, 990-1006.

[72]. D.Y. Kong. Z.L. Zhu, L.L. Shi, Z.J. "Shan and D.J. Cai, Effect of pesticides on groundwater under sweet-potato-based cropping systems in northern China". Journal Agro-Environ Sci, 23, 2004,1017-20.

[73]. B.H. Li, Z.Y. Ren, H.H. Chen, X.J. Cao and F. Liu, "Residues of organochlorine pesticides in shallow groundwater of agricultural region in Taihu basin", Journal of Agro-Environ Sci.26, 2007, 1714-8.

[74]. G.X. Huang, J.C. Sun, S. Wang, H.Y. Du, Y.D. Lu, B.F. Zhi,

[75]. "Elementary research of organochlorine pesticide in groundwater of Pearl River delta". Journal Agro-Environ Sci, 27, 2008, 1471-5.

[76]. A.O. Akankpo and M.U. Igboekwe, "Monitoring Groundwater Contamination Using Surface Electrical Resistivity and Geochemical Methods". Journal of Water Resource and Protection, 3, 2011, 318-324

[77]. I.M. Al-Shamaa and B. M. Ali, "Hydrochemical Pollution of Groundwater in Badra-Jassan basin / Eastern of Iraq. Diyala Agricultural Sciences Journal". 3 (2), 2011, 669-679.

[78]. S. Lo Russo and G. Taddia, "Aquifer Vulnerability Assessment and Wellhead Protection Areas to Prevent Groundwater Contamination in Agricultural Areas": An Integrated Approach. Journal of Water Resource and Protection, 4, 2012, 674-685