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Groundwater contamination from municipal solid waste dumping - sociological study -implications for the economic system

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Abstract:

In this research, many cities in the developing world dump their municipal solid waste in unlined open dumps. Rapid population growth and urbanization have led to an increase in the production of solid waste, which in turn has contributed to a variety of environmental problems. Water percolating through waste picks up a wide range of things, including metals, minerals, organic compounds, bacteria, viruses, and other toxins, which then pose a hazard to both groundwater and surface water supplies in the form of leachate from these dumpsites. Since contaminated groundwater inside a peri-urban environment has such far-reaching consequences, it will be the main focus in this research.

Keywords:

Community Participation, Groundwater, Hydrogeology, Solid Waste, Socio-Economic Issues.

1. Introduction:

Groundwater, which accounts for less than one percent of the world's total volume of water but more than thirty percent of freshwater resource, is used for a wide range of applications. To continue and improve its positive effects on society, the economy, and the environment, groundwater must be sustainably managed. However, pollution (anthropogenic or geo-genic) can degrade this resource, sometimes irreparably. Many cities' groundwater supplies are unusable because of pollution from both point as well as non-point sources. Accidental leaks, landfills, septic systems, and radioactive waste sites are all examples of point sources that pollute groundwater (McGuire et al., 2016). Groundwater supplies must be protected at all costs, making aquifer protection essential. However, throughout the course of the last century, groundwater contamination has emerged as a major environmental issue. Thus, groundwater contamination causes ecological, social, and economic issues (Alam, Ahmed and Howladar, 2020). The protection and restoration of groundwater supplies is a pressing issue in the field of water resources study.

1.1. Aim:

The main aim of the research to discover more about the societal and economic effects of ground-water contamination caused by the illegal dumping of municipal solid waste. Many different types of pollutants, both organic and inorganic, have been found in groundwater.

1.2. Objective:

- To determine the extent to which leachate pollutes the environment when it seeps into the aquifer below.
- To investigate the monetary and social effects of declining water quality.
- To reduce the negative effects of leachate of groundwater by recommending improved management strategies.

1.3. Research question:

1) What is the leading cause of contaminated groundwater?
2) Who is responsible for the poisoning of the groundwater?
3) What measures can be taken to stop the pollution of underground water supplies?

2. Literature Review:

2.1. Groundwater contamination:

Many different types of pollutants, both organic and inorganic, have been found in groundwater. Variables like pH, temperature, minerals phase, chemical reactions with other substances, and the presence of microbes all affect the likelihood of chemical contamination in the groundwater system. A study of groundwater quality demonstrates that in many areas, the water quality was already in a critical state due to liquid and solid waste dumping and over abstraction. It was especially bad around rivers and other bodies of water (Arthika and Maheshwari, 2019). Insufficient progress has been made towards ensuring the long-term security of the world's water supply. Eventually, leachate seeps through landfills' cracks and into the aquifer below them, no matter how well they're designed (Lee and Jones-Lee, 2004). The main reasons for this are a lack of containment for the leachate and/or liner failure. Measurements like groundwater flow, quality of water, three lithological differences, hydraulic properties, etc. are needed in order to assess the level of contamination in the groundwater. Delineating the extent of groundwater contamination requires studying both the distribution of the contaminants and the underlying geology. Below figure 1 shows the contamination in ground water

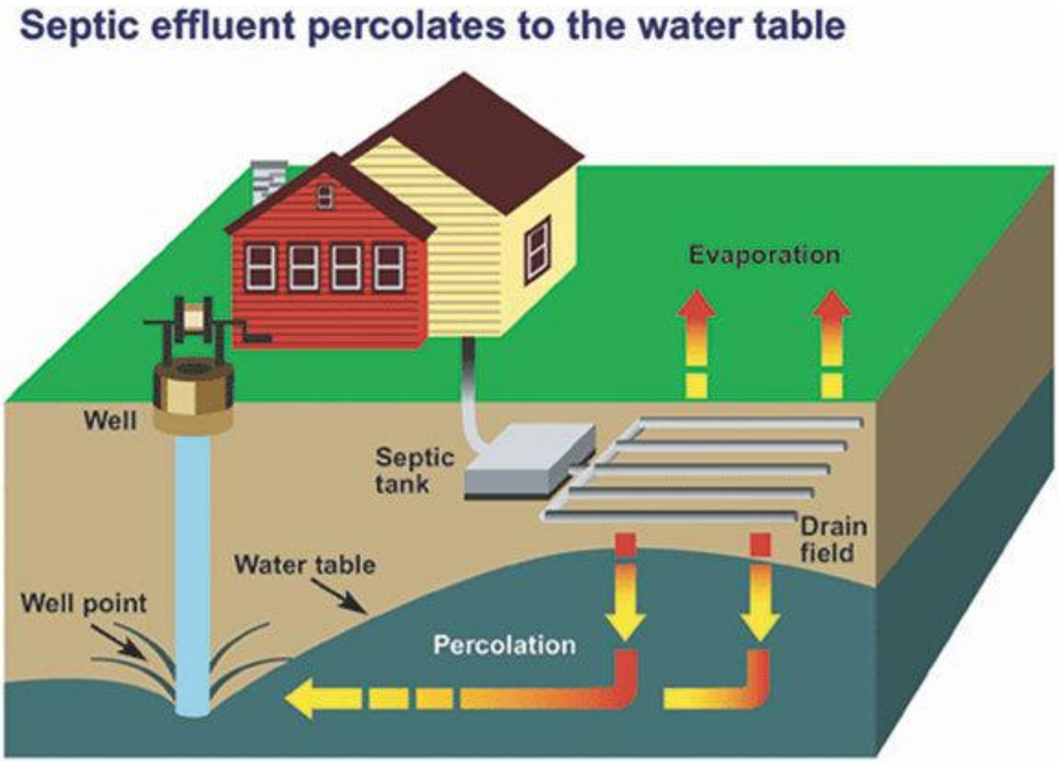

Figure.1: Ground water contamination (source: Zeidan, 2017)

2.2. Leachate:

Water seeps into landfills, seeps through garbage, and presses the waste down under its own weight, all of which contribute to the production of leachate. Water that seeps into a landfill acts as a vehicle, transporting potentially harmful stuff from landfill to water bodies. This is because it picks up various soluble elements from the trash, which can then enter the groundwater and the surface water. Waste composition, time, temperature, moisture, and accessible oxygen are crucial elements that affect the quality of the leachate. In general, landfills in different climates may produce leachate of varying quality from the same waste type (Chanthikul et al., 2004). How a dump is run can also have an effect on the quality of its leachate. During the monsoon season, a landfill's active phases release a large amount of leachate. These days, most sanitary landfills are built with impervious liners with leachate collection, removal, as well as treatment systems to prevent contaminated groundwater (Chanthikul et al., 2004). But even landfills with cutting-edge technologies like liners or leachate collection systems aren't bulletproof; if they aren't leaking today, they likely will begin leaking a few decades after they're closed (Chanthikul et al., 2004). If a contaminant is introduced into the groundwater system, the system may respond by shifting the concentration of contaminants in different areas of the system at different times.

2.3. Flow and contaminant transport modelling:

Measurements of hydraulic properties of the primary formations and in-depth field investigations of the local geology are required to determine the groundwater flow characteristics. More data is needed, and the models get more complicated, to examine the pollutant, migration rates, or the concentration distribution over time. The volume of water into the aquifer or the concentration of pollutant at the source have the greatest impact on the contaminant migration with in groundwater, followed by the direction of groundwater flow and the hydraulic conductivity as in aquifer underneath the landfills.

The transmissivity of an aquifer is quantified as rate at which water may permeate a permeable medium of a certain thickness, and this is referred to as the hydraulic conductivity (K) of the aquifer. Even at generally consistent locations, K can vary from a magnitude of one or more. Groundwater flow velocities can be estimated with much less error if hydraulic conductivity is known. Not only that, but it plays a significant role in determining the ultimate destination and movement of contaminants (Szymański et al., 2018). Slug tests, multi-well pumping tests, and single-well pumping tests are the most frequent ways to measure K. The most accurate data on K can be obtained from pumping tests, however these may be challenging to carry out in polluted areas.

Since chloride ions mass transmission is the most reliable parameter for locating leachate contamination near a landfill (Szymański et al., 2018, Jhamnani and Singh, 2009), only this factor was taken into account during the contaminant mass evaluation. The chloride, DOC, and COD levels in the leachate are quite high. Those who rely on the aquifer for their drinking water are in danger because the concentration is probably around 1000 mg/L. The water balance, both locally and globally, looked to be accurate in MODFLOW. Cell sizes smaller than characteristic length are required for reliable estimates of ground water rates, particles traces, and the transit times associated with these quantities.

$$\lambda = \sqrt{Tc}$$

Where T = Aquifer Transmissivity

c = resistance of the aquitard

The modelling flow and transport in highly discretized regions is often important when dealing with large-scale ground water contamination problems.

2.4. Disposal of municipal solid waste:

A number of environmental and social issues have arisen as a direct result of the strain that increasing urbanization has placed on metropolitan land and water supplies. The number of people living in cities has expanded by a factor of 100 in the previous 200 years, while the global population has increased by a factor of six. Huge amounts of solid garbage are produced in urban areas due to rising populations and increased manufacturing. The term "municipal solid waste" (MSW) refers to both commercial and residential trash produced in urban areas, whether solid or semi-solid, excluding hazardous wastes from industry but including biomedical wastes that have been treated. Dumping MSW without source segregation further complicates the situation. Open dumps are the most often used system for managing solid waste disposal in underdeveloped nations, despite the fact that this practice poses major environmental and health risks (Nyathi and Olowoyo, 2022). A possible pollution source, leachate from the dumpsites has the potential to contaminate land, surface water, and groundwater in the surrounding areas. Both local resource users and also the environment both face serious danger from this kind of contamination.

3. Methodology:

3.1. Data collection:

The secondary data is collected from Newspaper, journal, Articles and website. Groundwater contamination from municipal solid waste (MSW) disposal leachate is being addressed using a multidisciplinary and integrative strategy. Socio-economic and environmental factors, as well as the migration of leachate and the modelling of pollutant movement, are all included in the research. Using the slug test under Aquifer Parameters and the Water Sampling Procedure, were used to analyze the data.

3.2. Water sampling procedure:

Before taking a sample, we purged and emptied at least two borehole volume from a screened borehole. For multilayer systems, minimizing diffusion biases across the porous polyethylene walls necessitated a complete cleansing of each multilevel channel. Once the system was purged, samples were taken once at low gas pressure to maintain a laminar flow. 14 samples were taken from different depths within BH5 and examined for pH, EC, and TDS to learn about the groundwater chemistry and identify the different litho units. After the boreholes were dug, water samples were taken test for different physicochemical characteristics. pH, total dissolved solids, electrical conductivity, chlorine, sulphate anion, magnesium, sodium, potassium, and heavy metals such as cadmium, chromium, lead, thallium, and zinc were all taken into account.

3.3. Aquifer parameters slug test:

The hydraulic parameters of the aquifer system, like hydraulic conductivity, can be estimated with the use of the Slug test, which is performed in the drilled boreholes. Initiating a slug test entails rapidly increasing or decreasing the well's water level. The slug test requires the manual measurement of borehole water levels using a marked steel tape. Initial displacements (y_0) is the difference between the static starting location and the dynamic starting position of the water level during the slug test. As the water in the wells returns to its static level, subsequent y readings of displacement are recorded. Analyzing the slug test includes fitting a straight solution to the water level displacement data. The method's main benefit is that it takes into consideration the aquifer's geometrical features. If the depth to bedrock is unknown or cannot be determined, then applying this method becomes problematic.

To find out the hydraulic conductivity by

$$k.\frac{r_c^2\ 1n.R^e/r_w}{2Le}\frac{1}{t}\ 1n\frac{y_o}{y_t}$$

One of two equations, one for partial penetrating well and the other for fully penetrating wells, is used to fit the analog data (R e/r w).

4. Discussion:

Residents of the area around the landfill view groundwater contamination as an urgent problem. This study investigates the issue of leachate seeping out of a solid waste landfill and contaminating the aquifer underneath. Water Sampling Method, Aquifer Parameters, and Slug Test Analysis were conducted to learn more about the nuances of groundwater quality inside the research area. Leachate through solid waste disposal is now a major source of groundwater contamination, which has detrimental effects on the ecosystem, human health, and societal stability.

5. Conclusion:

Due to the presence of heavy metals including Pb, Fe, Zn, and Cr, it is recommended that residents stay away from using groundwater for household purposes inside the east and south-east for just a distance of one km. post-monsoon infiltration water dilutes contaminants more than pre-monsoon water does, while pre-monsoon water concentrates them. It is possible that a combination of low socioeconomic level and widespread use of contaminated groundwater contributes to the higher rates of sickness in the poor and middle-class. Groundwater flow direction with water quality variation is consistent with people's observations of changes in the water. Though they are aware of the water's low quality, locals nonetheless rely on it for household use due to financial constraints.

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New and emerging Biotech developments

Major happenings in the biotech industry can have a significant impact on humanity, the Earth and the animal kingdom, so it's not surprising that headlines from the field are of immense interest to tech experts and the general public alike. Forbes Technology Council discusses some of the amazing new and emerging biotech tools and developments everyone should know about and why they're so exciting.

1. Brain Mapping
2. Autonomous Therapeutic Systems
3. AlphaFold
4. Cellular Anti-Aging Research
5. CRISPR-Based Gene Editing
6. Microbiome Manipulation
7. Living Medicines
8. Lab-Grown Organs
9. Epigenetics And Digital Therapeutics
10. Sophisticated Wearables
11. Bioluminescent Imaging
12. Brain-Computer Interfaces
13. Lab-Grown Meats
14. Organoid Intelligence
15. 3D Bioprinting
16. Plastic-Eating Bacteria
17. Generative AI
18. Quantum Technology

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