Assesment of Groundwater Contamination Near Lanfills

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Abstract- *Groundwater is a critical source of drinking water worldwide, but it is increasingly threatened by contamination from landfill sites. Landfills generate leachate—a toxic liquid formed by the percolation of water through waste—which can infiltrate aquifers and degrade groundwater quality. This paper reviews the sources, mechanisms, assessment methods, and impacts of groundwater contamination near landfills. It also discusses monitoring techniques and mitigation strategies. Studies show that contamination is most severe within 200–1000 m of landfill sites and includes heavy metals, organic pollutants, and microbial contaminants. Effective landfill management and monitoring systems are essential to protect groundwater resources.*

Keywords: Ground Water, Landfills, Contimination, SDG

I. INTRODUCTION

Groundwater accounts for a significant portion of global freshwater resources and is widely used for drinking, agriculture, and industrial purposes. However, improper waste disposal practices, especially unlined or poorly managed landfills, pose serious environmental risks.

Landfills remain one of the most common methods of municipal solid waste disposal. However, they produce leachate containing hazardous substances that can migrate into surrounding soil and groundwater systems, leading to contamination.

II. SOURCES AND CAUSES OF CONTAMINATION

The primary source of groundwater contamination near landfills is **leachate formation**. Leachate contains dissolved organic and inorganic compounds formed when rainwater infiltrates waste materials.

Key Causes:

- Absence of liners and leachate collection systems
- Improper waste segregation
- Aging landfill sites
- High rainfall and infiltration rates

In many developing regions, open dumping without engineered protection significantly increases contamination risk .

III. TYPES OF CONTAMINANTS

3Groundwater near landfills may contain a wide range of pollutants:

3.1 Heavy Metals

- Lead (Pb), Cadmium (Cd), Chromium (Cr), Nickel (Ni)
  These are toxic and can accumulate in living organisms.

3.2 Organic Pollutants

- Phenols, pesticides, hydrocarbons
- Persistent compounds such as PFAS (“forever chemicals”)

3.3 Inorganic Compounds

- Nitrates, chlorides, sulfates

3.4 Microbiological Contaminants

- Total coliforms and fecal bacteria

Studies have identified **up to 96 different pollutants** in groundwater near landfill sites

IV. MECHANISM OF GROUNDWATER CONTAMINATION

Contamination occurs through several processes:

1. **Leachate Generation** – Water percolates through waste forming toxic liquid
2. **Migration through Soil** – Leachate moves downward via infiltration

3. **Aquifer Contamination** – Pollutants reach groundwater table
4. **Plume Formation** – Contaminants spread horizontally with groundwater flow

The extent of contamination depends on:

- Soil permeability
- Depth of groundwater table
- Distance from landfill
- Age of landfill

Contamination generally decreases with increasing distance due to dilution and natural attenuation

V. METHODOLOGY FOR ASSESSMENT

Groundwater contamination near landfills is assessed using the following methods:

5.1 Sampling and Analysis

- Collection of groundwater samples from wells/boreholes
- Testing for physicochemical parameters (pH, TDS, COD, BOD)
- Heavy metal and microbial analysis

5.2 Monitoring Wells

Installed around landfill sites to track contamination spread.

5.3 Geophysical Methods

- Electrical resistivity surveys
- Subsurface mapping

5.4 Statistical and Modeling Approaches

- Water Quality Index (WQI)
- Contaminant transport models
- GIS-based spatial analysis

5.5 Laboratory Testing

Advanced techniques to identify microplastics and emerging contaminants .

VI. RESULTS AND DISCUSSION

Research indicates:

- Groundwater quality near landfills is often classified as **poor or very poor**
- Maximum contamination occurs within **200 m** of landfill sites
- Pollution levels may increase with landfill age and stabilize over time
- Contaminant concentration decreases with distance due to natural attenuation

In some cases, pollutant levels exceed permissible drinking water standards, making groundwater unsafe.

VII. ENVIRONMENTAL AND HEALTH IMPACTS

7.1 Environmental Impacts

- Soil degradation
- Ecosystem imbalance
- Surface water contamination

7.2 Human Health Impacts

- Waterborne diseases
- Heavy metal toxicity
- Long-term health risks (e.g., cancer from persistent chemicals)

Recent findings highlight emerging threats like PFAS, which persist in groundwater and pose serious health risks.

VIII. MITIGATION AND REMEDIATION MEASURES

8.1 Preventive Measures

- Proper landfill design with liners
- Leachate collection and treatment systems
- Waste segregation and recycling

8.2 Remediation Techniques

- Pump-and-treat systems
- Bioremediation
- Phytoremediation
- Monitored natural attenuation

8.3 Monitoring Strategies

- Regular groundwater quality assessment
- Installation of monitoring networks
- Use of predictive modeling tools

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