The Impact of Solid Waste on the Quality of Groundwater in Eastern Kabul

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DOI: https://doi.org/10.51584/IJRIAS.2025.100800064

Received: 15 August 2025; Accepted: 20 August 2025; Published: 11 September 2025

ABSTRACT

First of all, it is necessary to understand what waste is? Generally, waste refers to materials for which the cost of disposal is less than the cost of maintaining them. The management of solid waste is one of the fundamental problems in most developing and third-world countries. In most cities, the collection and disposal of waste is not done properly. Improper collection and disposal of solid waste is considered one of the main factors and sources of water, soil, and air pollution, posing a serious threat to human health and the environment. The research hypothesis is precisely the detrimental effects of solid waste on the quality of groundwater and the adoption of measures aimed at reducing risks. This research hypothesis entails understanding the factors and how solid waste affects the quality of ground-water in eastern Kabul. Research Objective The objective of the present research is to identify the factors and the way solid waste affects groundwater quality, environmental protection, and awareness. This research is based on library studies, review of books, scientific articles, browsing internet sites, and also frequent site visits. In conclusion, after a thorough examination of geomorphological and hydrogeological reports and documents of the studied area, specific recommendations will be made to reduce the risks posed by pollution. As result founded- out, that Landfilling is one of the most common methods worldwide due to its low cost compared to other methods and its applicability to a wide range of waste types.

Keywords: Solid waste, Source of pollution, Ground-water quality, impact.

INTRODUCTION

The city of Kabul, with a population density of over 6 million, as the capital of Afghanistan, faces serious challenges with the production of approximately 1.5 million tons of waste annually and a lack of sufficient facilities, equipment, and proper management for waste disposal and recycling. Developing countries like Afghanistan encounter enormous amounts of diverse waste every day during the industrialization process. This occurs while the increasing population growth and rising economic activities are accompanied by a lack of education in modern waste management. There are several methods to eliminate waste, including reducing waste production, recycling, incineration, underground storage, and sanitary landfilling. Sanitary landfilling of waste is one of the commonly employed methods in most countries for special waste. Landfilling is one of the most common methods worldwide due to its low cost compared to other methods and its applicability to a wide range of waste types.

To properly implement this method, it is necessary to find a suitable location that poses the least harm to our environment and natural resources around the landfill, has the lowest economic cost, and possesses the most suitable engineering characteristics. In addition to the many advantages that sanitary landfill has compared to other waste disposal methods, this method also has flaws, which include the release of greenhouse gases into the atmosphere due to methane production in landfills, and soil and water pollution resulting from leachate production. To control and reduce the adverse effects of waste disposal in land, all research and operational processes involved in sanitary waste burial must be carried out carefully and correctly. Generally, the proper and engineering burial of waste involves three stages: site selection, design and preparation, and execution operations. The goal of the site selection process is to identify and choose areas with the least risk to public health and the environment, while also being economically viable and minimizing preparation, equipment, and implementation costs. Various parameters must be considered when selecting a suitable location for waste burial.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

To dispose of waste in the city of Kabul, the Gizg area (located in Pul-e-Charkhi) has been designated approximately 20 kilometers southeast of the city, where the area of waste accumulation is shown in (Figure 1).

Fig.1 The location of landfill were collecting wastes in Gazak,Pul-i-Charkhi.Kabul [Source:Author].

Geology of Region

According to site selection criteria for landfills, the stone materials should ideally have lower permeability. Sedimentary rocks and limestone have a high potential for water absorption and are not considered suitable for landfill sites. Igneous rocks have limited absorption potential, making them the most suitable stones for landfill locations. In Kabul city, the surface is often covered by sedimentary rocks. Although the ground surface in the desired area is covered by sedimentary rocks, the deposits have relatively low and negligible permeability. Distance of the landfill from the sea: According to landfill site standards, it should be at least 100 meters away from surface water sources, stagnant waters, and the sea. Currently, this distance is much greater. Distance from the groundwater level: Attention to the groundwater level in site selection studies is of significant importance. If the groundwater level (w.t) is high, it can pose a pollution risk. In the studied area, the depth of the groundwater level fluctuates between 60-80 meters, which is related to the average category[2].

Solid wastes

Waste is referred to as solid, liquid, and gas materials (excluding wastewater) that are produced directly and indirectly from human activities and are considered surplus by the producer. It also refers to the collection of materials resulting from human and animal activities that are usually solid and are discarded unwantedly or rendered unusable. This definition generally encompasses all sources, types of classifications, composition, and characteristics of waste materials, which are divided into five main categories. Generally, waste refers to additional materials primarily generated by human activities in agricultural, industrial, and urban sectors. [UNICEF,1388].

Types of Waste

1-Urban Waste: This refers to waste generated by the activities of citizens. Urban waste consists of both solid and liquid waste and is often produced in densely populated areas of the city, making it a significant issue. The overall aim of managing urban solid waste is collection, sorting, recycling, and disposal. Urban waste is of two types:

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

1-1-Wet waste: Wet waste refers to waste that is capable of decomposing and is biodegradable. Most of this waste returns to the nature cycle very quickly due to its high rate of decomposition and is used as fertilizer. Waste resulting from leftovers of various food items, such as leftover bread, rice, fruits, and vegetables, tea leaves, hospital medical waste, kitchen and restaurant grease, tree leaves, and small branches of plants and shrubs are considered wet waste. Quick and proper disposal of this type of waste is very important, as the majority of waste is of this type and can lead to pollution and disease.

1-2- Dry waste: Dry waste consists of waste materials that are stable in nature and do not decompose for many years. This type of waste is divided into several categories: a) Paper: including various books, magazines, newspapers, cartons, bags, sacks, etc. b) Plastic: including various plastic containers, plastic bottles, children's toys, various disposable containers, etc. According to collected statistics, it takes an average of about (500 to 1000) years. h) Wood: includes various types of gates, windows, handles, bases, wooden boxes, chairs, tables, stools, wooden items, mats, etc. i) Textiles: includes various types of old clothes, cotton fabrics, linen, woolen, silk, curtains, and leather items[2]

2-*Industrial waste*: Includes waste resulting from industrial and mining activities, waste from treatment plants, gas, and oil industries, etc., such as iron shavings, waste materials from factories, and so on.

3-Hazardous waste: Refers to all waste that has at least one dangerous property, such as toxicity, pathogenicity, explosiveness (flammability), or corrosiveness, and requires special handling.

4-Agricultural waste: Refers to waste materials resulting from production activities in the agricultural sector, such as spoiled agricultural products and straw, etc.

5-Hospital waste: Refers to all infectious and harmful waste resulting from the daily activities of hospitals, health centers, clinics, medical specialty centers, and similar establishments. Inappropriate locations considering the permeability of rocks and the high level of groundwater for burying solid waste are clearly visible in figure (2).

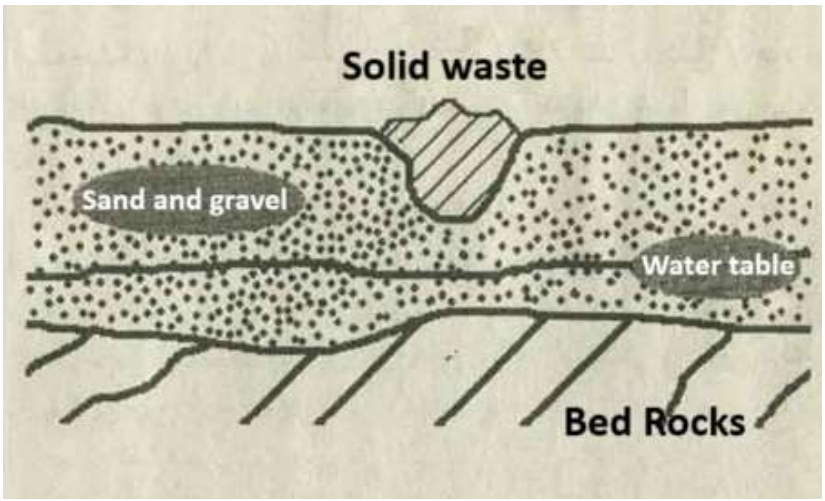

Fig.2 Unsuitable place for landfill, due to higher permeability of surface**.**

MATERIAL AND METHODS

Solid Waste in Kabul City: According to figures provided by the Kabul Municipality's Cleaning Department in 2024, the amount of solid waste in Kabul city is as follows: In Kabul city, the total amount of waste generated daily is 4,800 tons per day (365 days a year and 6 days a week).

- Total amount of fecal waste is 100 tons per day.
- Total solid waste amount is 300 tons per day.
- Food waste amount is 153 tons per day.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

• Gardening waste amount is 15 tons per day.

• Paper waste is 22.5 tons per day.

• Wood and plant waste is 3 tons per day.

• The amount of inorganic waste is 106 tons per day [Kabul Manucipality]. It is worth mentioning that various types of solid waste are transferred daily by a few limited vehicles of the municipality to the Gozak area and stored without any recycling, as clearly shown in (Figure 1,2.3).

Materials produced in places include: food waste, cardboard, plastic, textiles, leather, waste from garden cleanup, wood, glass, tin cans, aluminum, other metals, ashes, street debris, special waste (including bulky items, white household goods, yard waste that is collected separately, batteries, oil, and tires) and hazardous household waste that is produced daily in various forms throughout the city (Fig. 3).

Fig. 3 Household waste that is produced daily in various forms throughout the city[Source: Author].

Waste generation

The first stage of the waste management process involves all activities through which materials that are considered unusable or worthless are produced, and their owners no longer wish to keep them, so they attempt to dispose of them from their environment. Waste generation or refuse occurs in various forms: a child throwing away the paper wrapper after eating chocolate; a housewife deciding not to use or repair a broken wooden table and placing it outside the house; a doctor removing his disposable gloves after surgery and discarding them in a special container; all three generate waste. Furthermore, when leaves fall from trees in autumn or an animal dies in a corner of the city, waste is also produced. The dangers of waste generation: Waste not only causes the spread of diseases, foul odors, and unsightly views, but it can also cause significant damage by polluting soil, water, and air. As diverse as the components of waste are, the dangers posed by their constituents can also vary.

Finding a suitable location for waste burial. The landfill site is an extremely urgent issue that must be chosen with regard to geotechnical characteristics, land slopes, distance from the sea, groundwater levels, and aquifers because insufficient accuracy in choosing the landfill site can lead to long-term health problems and sanitation issues. Suitable locations for landfills are shown by distinguishing the hydraulic properties of the rocks in figure (4).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

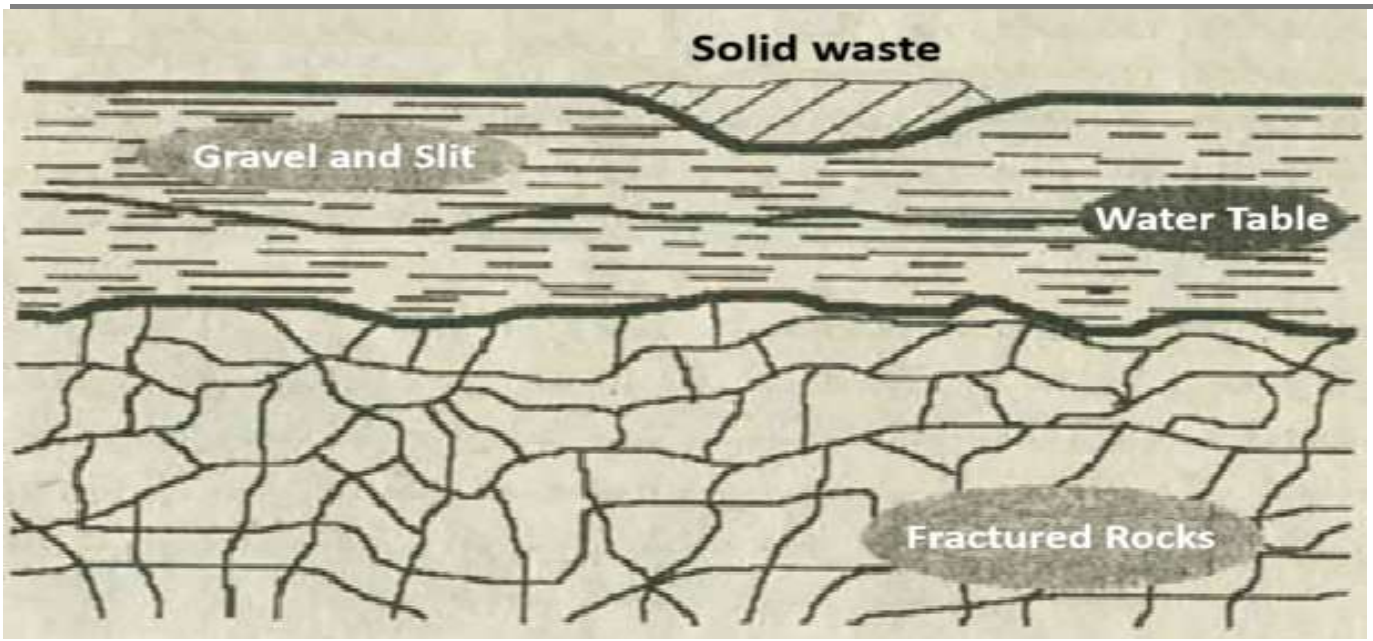

Fig.4 Suitable locations for landfills are shown by distinguishing the hydraulic properties of the rocks [Source: Author].

Effective indicators in landfill site selection: Distance from surface water: The potential effects of the landfill site on the quality and quantity of water and aquatic ecology are due to pollution caused by leachate release and surface runoff. Proper management of surface water through the design and construction of a special waste landfill is very important. Appropriate preventive measures should be taken to prevent surface water from reaching active landfill areas. The adoption of appropriate methods for collecting surface runoff depends on the topography of the area and the climatic conditions of the landfill site, so maintaining a standard distance from surface water is essential. The distance categories have- been shown in table1.

Tab.1 The relation between landfill distance and surface water [13].

No	Very suitable	suitable	unsuitable	Very unsuitable
1	250-300	-	-	-
2	>8km	8-6	6-2	2-1
3	250-5000	-	-	-
4	150-600	-	-	-
5	500-800	600-300	400-100	100-0

Slope: Waste disposal sites should not be hilly (sloping). A better and more suitable location is areas with high elevation that are flat and without slope. Areas with steep slopes receive lower scores for site selection because rainfall and water infiltration pose risks of landslides and collapses. Additionally, sites with a high slope require more excavation and backfilling, making them economically unfeasible as well. The values assigned to slope are presented in Table 2.

Tab.2 slope Category [13].

No	**Very suitable**	**suitable**	**unsuitable**	**Very unsuitable**
1	0.5	15-5	40-15	>40
2	0.5	10-5	20-10	>20
3	0.5	5-0	20-10	>20

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Ground water depth: The most important factor of solid waste hazards concern to ground water depth. In the region with deep ground water surface any danger for ground water quality, but in region with low ground water surface usually it became a great danger for Environment and health.

The rate of hazards from solid wastes due to ground water depth shown in tab.3

Table.3 Relation between ground water depth and hazards [13].

Category	Ground water depth(m)	Hazards
1	3-20	Very unsuitable
2	20-40	Unsuitable
3	40-60	Middle
4	60-80	Suitable
5	>80	Very suitable

Discursion

Solid waste by itself (directly) does not have a significant impact on groundwater quality; rather, it becomes a dangerous and serious threat when it is introduced into groundwater reserves and sources through rain droplets, surface water flows, winds, etc. In simpler terms, solid waste turns into a serious hazard when it leaches. Groundwater pollution caused by leachate from landfills and air pollutant transfer is one of the major environmental problems. Accurately understanding the geological conditions of the areas surrounding the landfill is essential for assessing the capability and capacity of the site to contain pollutants. These aspects include topography, structural details and characteristics of soil layers, grain size composition of the soils, and hydrogeological features. Among the topographic information that renders a site unsuitable and leads to the failure of a water location, the likelihood of slope failure and the failure of unstable lands can be mentioned. Factors considered in the characteristics of soil layers include rock type, weather conditions, extent and distribution of structural features such as fractures, layering, karst effects, and permeability of layers.

RESULTS AND RECOMMENDATIONS

1. The upper seasonal waters are more susceptible to pollution due to their proximity to the ground's surface.
2. The risk of groundwater contamination due to solid waste is greater in spring compared to other seasons of the year.
3. The quality of groundwater in areas where medical solid waste accumulates (hospitals, polyclinics, and vaccination centers) is more at risk, as toxic substances are washed away and dissolved by rainwater and may reach groundwater sources and reserves.
4. Considering the geographical location of Kabul city, the eastern area of Kabul (But-Khak) is considered a suitable location for waste disposal because of its distant location from residential areas and water sources.

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