

LANDFILL PRACTICES AND THEIR EFFECTS ON GROUNDWATER QUALITY IN KUWAIT

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Abstract: Solid waste is generated continuously everywhere in our modern world and in Kuwait it is no exception. This paper presents Kuwait in terms of municipal solid waste (MSW) and municipal solid waste landfills (MSWL) and its impact on the environment, especially groundwater. Due to the recent rapid economic growth in Kuwait, municipal solid waste (MSW) production is growing rapidly as well. To minimize municipal solid waste and its negative impacts, it is important to assess its causes to be able to manage it properly. Kuwait follows a conventional municipal solid waste handling method by dumping the waste into allocated landfills, without properly compacting, covering, containing, or treating it. Therefore, the groundwater flowing under those municipal solid waste landfills is mostly contaminated, which is a health and safety issue that needs to be addressed. Now since the Environmental Protection Law No. 42 of 2014 and its Executive Regulation of 2017 are officially legally effective, more environmental efforts needed to spread pollution prevention awareness. For example, society members and politicians need to understand the pollution prevention hierarchy of avoiding, reducing, reusing, recycling and disposing. By minimizing the negative environmental practices, the related economical costs will minimize as well.

Couple of environmental studies here analysed the recent environmental situation in Kuwait and its impact on the environment, to provide scientifically engineered action plans to help manage environmental issues better and control its negative impacts, to protect the public health.

Keywords: municipal solid waste (MSW), municipal solid waste landfills (MSWL), Environmental Protection Agency (EPA), Driving Forces-Pressure-State-Impacts-Responses (DPSIR), and groundwater.

INTRODUCTION

The State of Kuwait is a country in the Middle East. Located in the northeastern tip of the Persian Gulf, and it is one of the Gulf Cooperation Council (GCC) countries. Kuwait covers a small area of approximately 17,820 km², but it is one of the major oil producer countries in the world, “Kuwait relies heavily on oil export revenues, which is more than 75% of the government’s total profits and oil exports accounted for nearly 90% of total export profits.” [1]. Currently “The budget of Kuwait has been increasing yearly by almost 3%.” [2]. Therefore, with such a strong growing economy, the solid waste generation is equally increasing exponentially. “Kuwait has actually large per capita waste production of 1.8 kg per day, much larger than the international per capita average of 0.90 kg per day.” [3]. Kuwait recently came in second place in municipal solid waste (MSW) among the (GCC) countries

after the United Arab of Emirates (UAE) (Figure 1) [2]; even though, it is much smaller in size than the Kingdom of Saudia Arabia, Oman and UAE.

Kuwait needs proper management of its generated municipal solid waste to protect its environment (e.g., groundwater) and to ensure the health and safety of its population. The current common way to manage MSW in Kuwait is by collecting, hauling, and dumping it conventionally into several allocated municipal solid waste landfills (MSWL). “The landfill

locations are identified as an environmental issue for the city’s zones. The effects of these landfills are rising particularly after the city’s zones development.” [4]. Moreover, a couple of environmental studies have shown that the groundwater that flows below those conventional municipal solid waste landfills, have been contaminated due to the increased concentration levels of pollutant leaching from the buried municipal waste compositions and their byproducts.

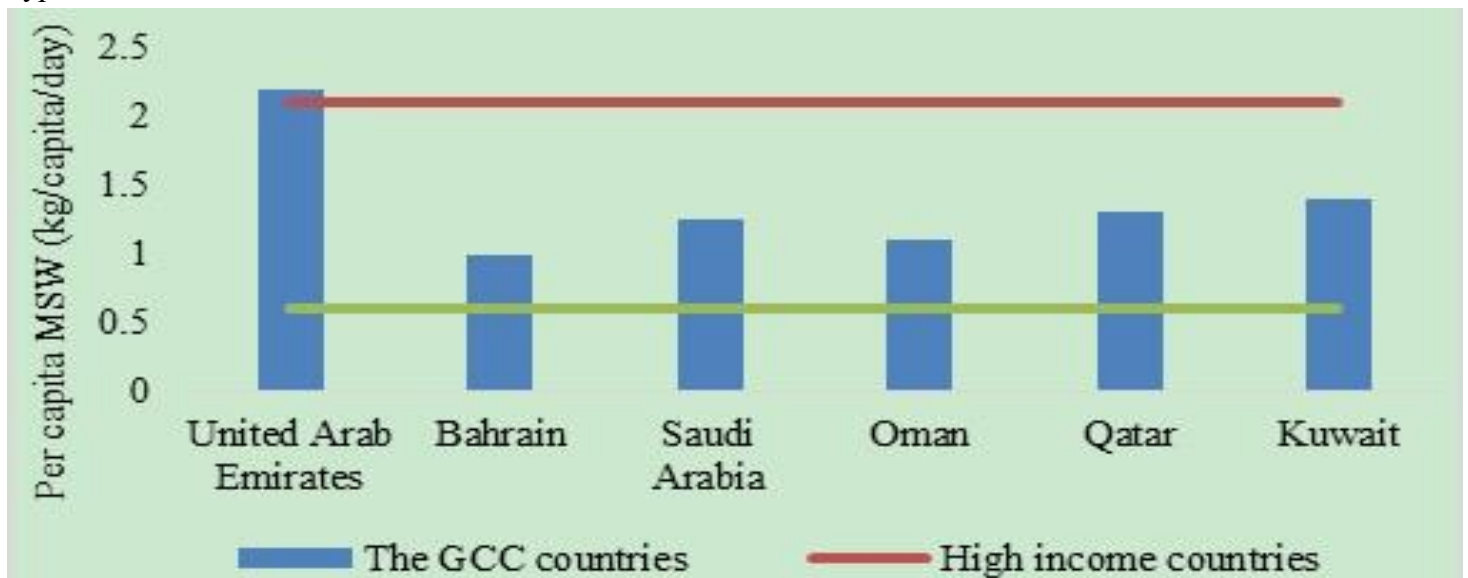


Figure 1: The GCC (MSW)

Several environmental researchers have addressed the topic of municipal solid waste (MSW) and municipal solid waste landfills (MSWL) in Kuwait with different focuses. AlLahou and Alsabbagh together have assessed the municipal solid waste management (MSWM) in Kuwait by using the driving forces-pressure-state-impacts-responses (DPSIR) framework. The DPSIR is a useful tool to allocate the source of MSW, and to provide a good action plan to minimize it, and its disposal at the allocated MSWL. In addition, “The pointers used in the DPSIR agenda are congregated from the three principles of sustainability: budget, environment, and society” [2]. These principles of sustainability correlate strongly to the Triple Bottom Concept, which is an essential fundamental concept in viewing and tackling environmental issues properly. The DPSIR outcomes in their study showed that as the number of residences in Kuwait increased, the MSW increased accordingly as well. Precisely, “The residential figure of Kuwait has enlarged by 7% yearly in average throughout 1993-

2021. The number of homes (both citizens and residents) has increased by 8% yearly.”. Therefore, the “MSW generated enlarged by over two tons in 2021 with an average yearly percentage of 6%” [2]. Furthermore, Al Lahou and Alsabbagh confirmed, that there are environmental impacts associated with MSWL, such as leachate effecting the groundwater in Kuwait.

As a response to the result of their assessment of MSWM in Kuwait, the authors stated that their study is still limited and incomplete in regards to MSW. However, they have recommended the following three useful key environmental points to reduce MSW in Kuwait [2]:

- “Turning recycling into a required regulation.”
- “Creating incentives to reduce waste generation at domestic and commercial buildings.”
- “Assigning ISO 14001 for waste-relevant accommodations and buildings.”

Other environmental researchers focused in more depth on municipal solid waste landfills (MSWL) negative impact on groundwater. As mentioned previously Kuwait covers an area around 18,000 km² of which “50 km² is inhibited by landfill dumpsites and is expected to increase to 60 km² by 2025.” [3]. Kuwait has eighteen municipal solid waste landfills (MSWL), but currently only four are still in operation (Figure 2) [4]. Details of these operational municipal solid waste landfills (MSWL) in Kuwait provided in (Table 1) [2] [4].

Table 1: Details of operational municipal solid waste landfills (MSWL) in Kuwait. [2] [4]

Landfill	Opening year	Area (km ²)
AlJahra	1986	1.73
Mena Abdullah	1991	1.15
Jenoub 7th Ring Road	1992	4.25
Kabd*	1999	1.0

* Kabd landfill was opened in 1999 and closed in 2001 for more than 10 years, then was reopened again [4].

The focus of AlRashed study is to evaluate Kabd community solid waste landfill impact on the groundwater in that zone.

He stated that Kabd solid waste landfill might be “a lasting long-term cause of pollution to the soil and groundwater”. He conducted this study to “establish suitable scientific resolutions to decrease the landfill effects.” [4]. For his sampling and analysis, AlRashed constructed five groundwater drilled water wells, where samples were composed from boreholes close to and down of the landfill. See Figure 3. Then he “geochemically analyzed the groundwater samples to measure the total dissolved solids (TDS), Chloride, Sulfate, Nitrate, Calcium, Magnesium, Sodium, Potassium, Iron, Copper, Nickel, Zinc,

Aluminum, Lithium, Boron and Fluoride concentrations.” [4]. AlRashed groundwater analysis results were summarized in (Table 2) [4], which included as well the normal levels of World Health Organization (WHO) as a base to compare with his results. Clearly, his analyzed data when compared with standard levels of WHO, they showed higher concentration levels for total dissolved solids (TDS), chloride (Cl), sulfate (SO₄), sodium (Na), magnesium (Mg) and calcium (Ca), potassium

(K). Nevertheless, AlRashed found that those “high concentration levels incline to decline away from the landfill location.” [4]. It is stated that “The main process of solid waste disposal dominant in Kuwait is exposed discarding in uninhibited sand digs with a depth between 6 – 20 m, then covering the waste with sand but without compaction or any shield arrangement. Consequently, infection of the groundwater is likely due to its nearby level at the bottom of the waste disposal location.” [4]. This confirms the fact that groundwater underneath the conventional municipal solid waste landfills in Kuwait is mostly contaminated due to increased concentration levels of pollutant leaching from those buried municipal waste compositions and their byproducts.

Table 2: Elemental breakdown of groundwater trials (mg/L) from and around the study zone. [4]

Test Parameter	Test Method	1	2	3	4	5	WHO values for groundwater
TDS		98 20	10 410	9 930	12, 530	12, 740	500 mg/L or less

(Cl)	BS1377 Part3 1990	31 91	34 68	4 139	40 12	42 46	250 mg/L or less
(SO ₄)	BS1377 Part3 1990	23 32	24 78	2 520	26 45	26 70	400 mg/L or less
(Na)	Flame Photometric	41 00	42 80.5	4 290.2	43 20.5	43 27.2	35 mg/L or less
(Mg)	ASTM D 511	30 3.42	30 9.22	3 11.02	32 4.22	33 0.02	100 mg/L or less
(Ca)	ASTM D 511	82 8.4	83 1.2	8 33.3	84 5.2	84 9.3	75 mg/L or less
(K)	Flame Photometric	32	33	3 3.7	34. 4	36. 5	2 mg/L or less

Researchers in this third study addressed AlQurain closed MSWL impact on groundwater. AlQurain MSWL due to urban expansion is now actually inside the residential area. AlQurain MSWL is also contaminating the groundwater underneath it, especially as the groundwater level rises, during the winter months when there is more rain and less water evaporation rate.

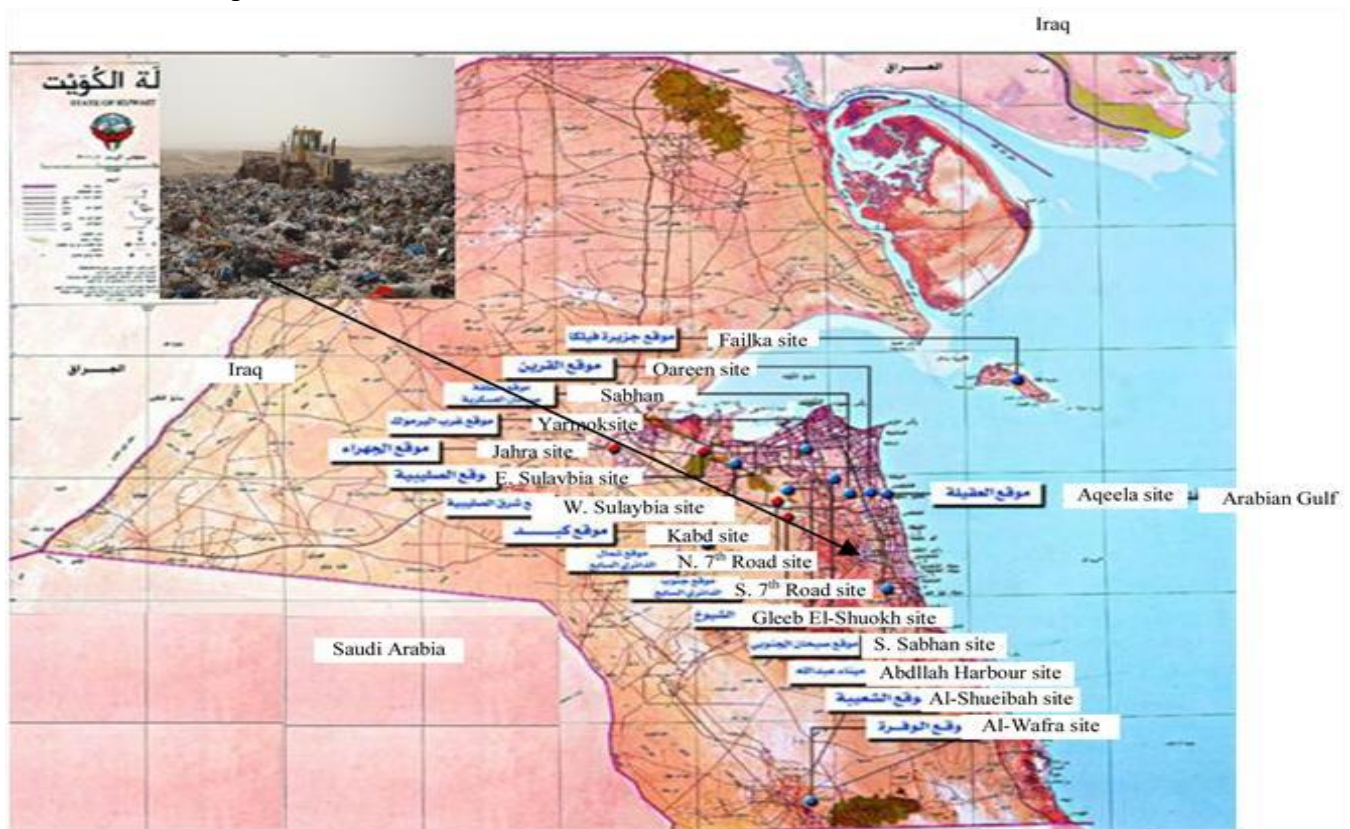


Figure 2: Closed and operational municipal solid waste landfills (MSWL) locations [3].

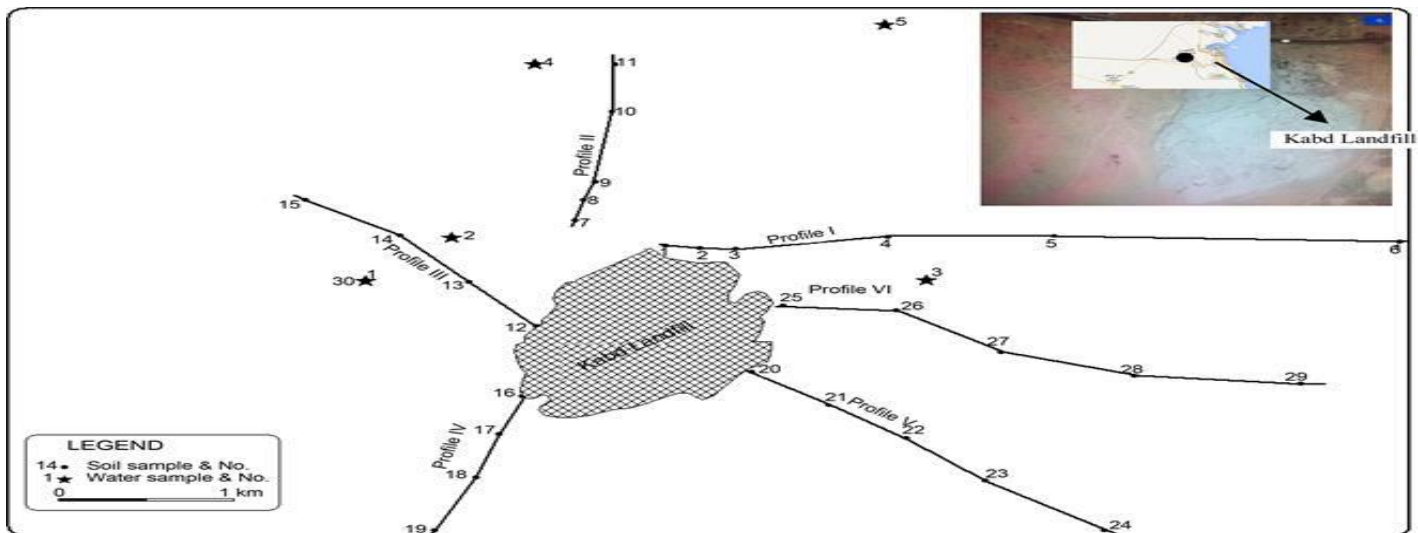


Figure 3: Trials places of groundwater locations and soil trials about Kabd Landfill [3].

2. CONCLUSION

Overall, municipal solid waste (MSW) is an ongoing process that needs proper management and control to minimize its environmental negative impacts. The State of Kuwait is a rich country. Therefore, the Environmental Protection Agency (EPA), environmental engineers, and politicians need to work together to improve the current conventional municipal solid waste landfills, to protect the health and safety of the population as well as preserving Kuwait's environment (e.g., groundwater). The Environmental Protection Agency (EPA) in Kuwait also needs to spread environmental awareness among the people in the society to gain their collaboration in preventing pollution. The population have to be aware of pollution prevention measures of avoiding, reducing, reusing and recycling to protect and preserve their own environment. Obviously, there is no other way around actually disposing municipal solid waste. Nevertheless, many advanced environmental technologies are currently available to minimize the negative environmental impacts of MSW, and to ensure the health and safety of the people such as a waste-to-energy facility.

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