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Lack of infrastructure in a municipal sanitary landfill causes contamination of the water table

La falta de infraestructura en un relleno sanitario municipal ocasiona la contaminación del manto freático

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Abstract

Resumen

Leachate, Water table, Landfill, Landfill, Risk, Garbage

Lixiviados, Manto freático, Relleno sanitario, Riesgo, Basura

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Introduction

Nowadays, solid waste problems have become a significant challenge that represents a challenge for society; although there are other ways to address it, research and education are the most important and have a determining role (Murray et al., 2013).

The problems of solid waste (SW) management, specifically its disposal, can be traced back to prehistoric times when humans began to gather in villages. The accumulation of SW became a consequence of everyday life, in ancient times this did not project to be a significant problem as populations were small and the amount of land usable for SW assimilation was large (Careaga 2000; Murray 2005; Murray et al., 2019).

Today, the complication of MSW generation and its associated management and disposal does not escape any population globally and is most acute in large urban areas and growing cities. The majority of the population is concentrated in urban areas, presenting great challenges to solve urban-environmental problems, especially in large metropolises, as a result of a great increase in urbanisation since the industrial revolution, which created cities that were not prepared for the demographic explosion and whose growth reached a disorderly character (SEDESOL 2011).

The issue of MSW is one of the concerns of contemporary society and a global challenge for public management (ADIS 2006).

This problem of MSW generation, where the highest levels correspond to countries with high economic incomes, as is the case of the North American region, made up of Mexico, the United States and Canada UPED (2012).

Mexico is a country with a 72% urban population, concentrated in 383 cities with more than 15,000 inhabitants. The current anomalous projection in the urban area in the country, and the estimate will reach 121 million inhabitants in the next 18 years, which will reside in urban areas of more than one million people in 2030 SEDESOL (2011).

Such concentration and growth will demand diverse inputs for their sustainability, such as energy, water and materials, as well as adequate waste disposal, where inadequate disposal of municipal solid waste (MSW) in water and soil alters the quality of these resources, as well as their impact on human health and ecosystems. Population growth and the concentration in metropolitan-urban areas have not complied with the urban areas, have not complied with environmental regulations, which has a negative impact on the consumption and habits of the population (De Valle, 2005; Zaman, 2001; Zaman, 2014; Vij, 2012).

In Mexico, the transition from rural to urban changed consumption patterns from a society that produced mainly organic waste (OW) to one that produces inorganic waste (IW) derived from the consumption patterns of industrial societies (SEDESOL 2011).

The country generated 109,750 tonnes per day of MSW, of which 64% was deposited in sanitary landfills, 9% in landfills controlled with soil, and the remaining 27% in open dumps. One third of MSW ends up in clandestine, uncontrolled sites; this practice has caused environmental problems that affect the health of populations near open dumps (INEGI, 2010). In Mexico the average daily per capita RS generation is 0.9 kg in urban areas, 0.4 kg in rural areas and 1.5 kg in cities (INE, 2010).

In developing countries, MSW management is the responsibility of local authorities (Chen and Geng, 2010; Kanat, 2010; Okot., et al 2011). Mexico does not escape this condition, the "Constitución Política de los Estados Unidos Mexicanos" (Political Constitution of the United Mexican States) points out the commitment of municipal authorities regarding its collection, management and disposal [5].

However, in the country, management is insufficient due to the lack of progress in municipal landfill projects and their improvement in terms of legislation; a product of the perspective that was held on SW and the lack of capacity of municipalities to provide adequate infrastructure, coupled with scarce financial resources by municipalities to address this problem (Gutierrez, 2013; GTZ, 2003; Gutierrez, 2013).

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Currently, Xalisco's rubbish dump is the place where waste is concentrated in the municipality, which, like the rest of the towns, does not have a good organisation and, therefore, its domestic waste management is unconventional and inappropriate, since the municipal government limits itself to transferring it to the open dump, without considering the impact that the waste can have on the environment.

Methodology

The purpose of this research is to diagnose the infrastructure of the municipal open dump in the municipality of Xalisco, Nayarit, Mexico. It is located at the coordinates 210 25'26.93"N and 1040 54' 39.75" (see figure 1), according to the Instituto de Geografía Estadística e Informática (INEGI), the predominant climate in the study area is warm with two variants, warm humid and warm sub-humid.

The warm humid has a rainfall of 1200 mm, a maximum of 780 mm in August and a minimum of 5 mm in April, with a temperature of 24 °C to 26 °C, the second climate is semi-warm sub-humid with an annual rainfall of 1000 mm to 1500 mm, a maximum in August and a minimum of 5 mm in May, with a temperature of 22 °C.

The study area presents a Neovolcanic Sierra Topoform system and Volcanoplastic soil, with a vegetation of forest 39.13%, and the second topoform is a plain with an Alluvial soil, Andesite and acid Toba, with a vegetation of jungle 23%, pasture 2.66% and agriculture 34.83%.

This is a descriptive longitudinal study, the study area has a follow-up of three visits per year and was studied from 1999 to the present (year 2021),

A tour of the entire perimeter of the municipal disposal site was carried out to check in detail the type of infrastructure it has and it was found that it lacks infrastructure for separating MS, the only thing that was found were some scavengers; people who separate recyclable material in the dumps.

This activity, although less appreciated by many, is important for society, as it prevents tons of MS from increasing in landfills and supplies almost all of the raw materials to be recycled in the paper, plastic, aluminium, iron and glass industries (SEDESOL 2001). The number of trucks arriving per day to the landfill was determined and the amount of MSW, which is stored in the landfill, was calculated, categorised according to the amount of MSW and MSW (special handling waste) received daily, both from households, businesses and industries (non-hazardous); Considering these parameters and reviewing the guidelines of the official standard, it was concluded that the municipal landfill of Xalisco Nayarit is a type B landfill (due to the number of inhabitants 65229 and the generation of 98 ton RS), according to NOM-083-SEMARNAT.

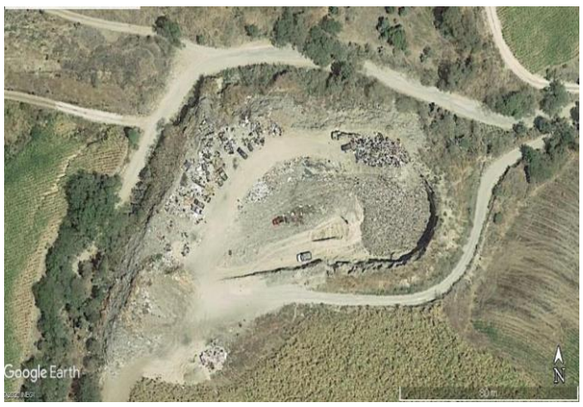

Figure 1 Area where the municipal landfill of Xalisco Nayarit is located, 2021

The aspects considered most relevant in the identification of alternatives for the selection of a site based on NOM-083-SEMARNAT-2003 were the following:

Estimation of waste generation

Area required to receive the volume of waste generated during the period of the construction work

Depth of the water table and nearby water bodies.

Location with respect to site infrastructure and roadways

Topographical conditions

Volume of usable material for cover

Prevailing winds

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Soil characteristics

Results and discussion

The lack of infrastructure at the open dump (landfill) causes an increase in leachate leaching into the groundwater table, causing contamination of the aquifers in the area; the abundant rainfall of 1500 mm per year increases the volume of leachate from the open dump to the lower soil layers and this in turn to the groundwater table. Therefore, the installation of a geomembrane is required to prevent leaching and contamination of the subsoil (see Figure 2).

Figure 2 Natural soil where solid waste is deposited, showing the lack of the geomembrane (Murray 1999)

On the way to the landfill, we were able to identify several open dumps. Land where municipal solid waste is deposited and accumulated without any technical, sanitary and operational control, as well as the absence of infrastructure works to minimise negative impacts on the environment. The main problem is the concentration of solid waste, which represents a high point of infection and contamination, allowing the proliferation of pests, gases and pathogens (SEDESOL, 2001).
At the entrance of the landfill, we observed piles of rubbish, as well as the disposal of these on a soil that was previously used to saturate a pit of an attempted sanitary landfill, since this place really lacks geomembrane or any other means to reduce the environmental impact and, over the years, the generation of leachates according to NOM 083.

The main problems in this area are the misuse of the soil of the RS dump, which is contaminated by both chemicals and solid waste. The conflict lies in the fact that the workers use this soil to cover pits and potholes on roads in the municipality of Xalisco, increasing the range of contamination of the landfill, as well as allowing the spread of the various problems that this site represents to regions outside of it.

At this dump, we observed a pile of rubber tyres, which were arranged as barriers to prevent landslides or collapse of the structure of the dump and the road that allows us to access it.

Eventually, after crossing the current section of the landfill, we arrived at a plain that at first glance looks like farmland, but was actually an anthropogenic plain created by the compaction of the rubbish over time, which is why it emanated bad odours. One of the problems that could arise from this area in the future could be that it could be used for a real plantation, which would be affected by the contaminated soil and the emission of gases from the site (see figure 3).

Figure 3 Solid waste deposits, anthropogenic plain
Source: (Murray, 202l)

An investigation of the landfill (open dump) was carried out on the conditions of the site, the transport of waste and its disposal at the landfill. By counting the number of trips that arrive per day, we were able to determine the amount of waste that enters daily, which ranges between 160 and 162 cubic metres of waste, deposited by municipal trucks; "between 52 and 56 tons" per day according to (Leao, 2010).

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It was concluded that the municipal landfill of Xalisco Nayarit is a type B landfill (by the number of inhabitants and the generation of RS) according to NOM-083-SEMARNAT as stated in the standard (SEMARNAT, 2019).

It was also observed that society is focused on satisfying the production needs of capital, falling into the tendency to discard everything that is not useful without any type of waste separation or recycling (since the average waste generation per person is 920 g to 1.2 kg per day "If we took advantage of all organic waste and all inorganic waste that is recyclable, we would only produce 17% of the waste that we currently generate", which is in agreement with (Aguilar, 2008).

Our behaviour not only has repercussions in the environmental field, but also in the field of public health, since an open-air landfill like the one in Xalisco allows for easy reproduction of harmful fauna or sanitary vectors, which are responsible for transferring infections to nearby communities; CO2 and methane, which are the two main gases responsible for the greenhouse effect and fires in landfills based on (Tchobanoglous. et al., 1994).

Dioxins and carcinogenic compounds; leachates, which pollute surface and ground water bodies; and, among other things, landscape deterioration (SEDESOL, 2001).

We must react and do something to solve this problem, attack the root of the problem, reduce the generation of solid waste and separate it from storage at source, follow up after collection and integrate systems of separation, transformation and recovery of waste as an intermediate point before transferring it for final transportation to a landfill or sanitary landfill.

Conclusions

The location of an adequate site for the final disposal of solid waste must comply with the guidelines set out in NOM-083-SEMARNAT-2003 for the correct disposal of solid waste with an infrastructure that avoids leachate runoff into the water table.

The municipal government must apply the regulations that correspond to the management of urban solid waste as specified in the Official Mexican Norm 083 of SEMARNAT.

The City Council should use the different means of dissemination to raise public awareness of the culture of reduction, recycling, reuse and recovery of solid waste in order to reduce the volume that enters the final disposal sites on a daily basis.

Having an adequate infrastructure in the municipal sanitary landfill will prevent contamination of the water table and public health problems due to the consumption of water contaminated with leachates.

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