Do we need landfills?

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Global solid waste generation is postulated to increase from 2.01 billion metric tonnes (Mt) in 2016 to 2.59 billion Mt tin 2030 and to a high 3.4 billion Mt in 2050 (Kaza et al., 2018). Almost 50% of this waste is food waste, especially in developing countries. However, if one looks at the waste management options, only 8% of the total waste is disposed of into sanitary landfills (without gas collection), while 33% is still disposed of into dumpsites. Controlled landfill (LF) is only 4% and this is mostly in developed nations. Incineration (11%), recycling (14%) and biological treatment (5%) account for 30% of the total waste generated, which indicates that 70% of waste is still being landfilled in one way or other.

It is determined that 93% of the waste ends up in dumpsites in low income nations, whereas only 2% of the dumpsites are located in high income nations, which favours recycling (29%), incineration (22%) and composting (6%). It is evident that high income countries emphasize material recycling and incineration while low income nations can afford only dumping of waste for economic reasons. In fact, landfilling in the European Union (EU) countries is decreasing for several reasons, two of which are the ban on landfilling of organic waste and a high LF tax.

In Asian countries dumping of waste is extremely common and it ranges from 50% in the People’s Republic of China to almost 90% in Bangladesh. Developed nations such as Singapore and Japan employ incineration for 70–85% of their waste. According to a joint United Nations Environment Programme, Asian Institute of Technology and International Solid Waste Association (ISWA) report, 17 of the 50 largest dumpsites are in Asia (Asia Waste Management Outlook, 2017).

Landfills are associated with several social, economic and environmental issues. One of the most alarming examples was the collapse of a dumpsite in Payatas, Quezon City, Philippines in 2010 when almost 300 people (mostly informal waste recyclers) were buried, while hundreds of families became homeless. Subsequently, similar calamities have been reported from, for example, Indonesia and Sri Lanka.

Environmental degradation is a serious consequence of landfilling. This includes surface and groundwater contamination due to improper management of LF leachate. On an average 150 L of leachate is generated per Mt of solid waste (of course there are many variables that affect this quantity such as rainfall, moisture content in soil and cover, etc.).

In most developing countries, the leachate will flow to the nearest river or wetland and cause serious heavy metal contamination. Leachate from dumpsites cannot be effectively collected and treated since there is usually no geomembrane liner or leachate collection system at the bottom of a dumpsite.

Passive release of landfill gas (LFG) is a common practice in developing nations. It is almost impossible to quantify the LFG released passively although it can be estimated based on the quantum of organic waste disposed.

The LF methane accounted for more than 100 million Mt of carbon (C) equivalent released into the atmosphere per year. Municipal solid waste (MSW) landfills are the third largest source of human related methane emissions in the United States, accounting for 15% of these emissions in 2018.

Other negative impacts of landfills include land degradation, health risks to informal recyclers and escapement of waste to aquatic ecosystems. It is established that 12 million Mt of plastic from the MSW ends up in the ocean every year and 60–80% of the marine litter is plastic. Eventually some of these would become microplastics.

Another aspect that is peculiar to developing nations is the scavenging of recyclables from landfills. A good waste picker can earn about USD 10 per day. However, there are many issues pertaining to this such as occupational health, disease and so on.

A fully sanitary LF will be able to avoid most of the global issues, but there are many wastes to energy experts who prefer thermal treatment to landfilling for various reasons.

Landfill mining (LFM)/dumpsite rehabilitation on closure is vital to give value to the site. LFM is one of the best methods of LF or dumpsite rehabilitation and helps in perceiving the landfills or dumpsites as a resource to extract valuable recyclables or consider waste to energy on combustion. LFM is not new since it has been reported way back in 1950s, in Israel. Currently some 60–80 projects are reported, mainly in the EU countries. LFM is defined as the safe exploration, conditioning, excavation and integrated valorization of landfilled waste streams as both materials and energy using innovative technologies (Jones, 2013).

The process of LFM involves a series of steps ranging from the excavation of wastes, stabilizing, screening, sorting and safe disposal of recovered materials. The objective of LFM will determine the need to do the process since LFM is expensive. If the reclaimed land is to be used for property development, then it could be viable to carry out LFM.

For example, the capital cost of LFM per site is about USD 47,000 to 96,000, the operational cost is about USD 6000–9000 per Mt and the treatment cost would range from USD 0 to 900 per Mt, depending on the type of treatment, hazardous nature and land use options. Of course, there will be some income from recyclables or reversal of the LF tax which can be as much as USD 65 per Mt.

Cost avoidance savings on leachate treatment would run to approximately USD 55 per m^3. Other cost savings from the LF owner's standpoint are cost avoidance of constructing a new cell or acquiring land for a new LF site, and the ability to reuse the LF mining area for new waste placement. The cost savings can be very significant depending on the LF site location. There will also be real estate value of the reclaimed land should the LF operation be terminated and after activities to clean up the environment are completed. Finally, there will also be cost avoidance associated with management and monitoring of gas, groundwater, surface water, and LFG during the aftercare period, that is, the period from the completion of landfilling until the achievement of final storage quality. This total cost of LF monitoring should depend on the duration of the aftercare period, which is usually for a period of at least 30 years according to the LF regulatory or directive.

Closure of dumpsites and ISWA initiative

In the editorial article of *Waste Management & Research* June 2019 edition, the status of progress on the ISWA's Closing Dumpsites Initiative (Law and Ross, 2019) was reported. At the World Congress 2019 in Bilbao, Spain, there were two important publications released in support of the closing dumpsites initiative – one was the 'Climate Benefits Due to Dumpsite Closure: Three Case Studies' (International Solid Waste Association, 2019a) and the other was the 'Landfill Operational Guidelines, 3rd edition' (International Solid Waste Association, 2019b). Under the leadership of the ISWA Task Force on Closing Dumpsites (TFCD), the first publication presents three case studies of successful dumpsite closure projects, in particular emphasizing the climate benefits realized from closing a dumpsite and that other dumpsite owners can learn from it and implement similar closure or remediation activities at their own sites. The second useful publication presents LF operational guidelines and technical details on how to operate and maintain the stability of a LF from the health and safety and environmental compliance points of view.

The TFCD's primary goal is to present cost savings and environmental benefits related to transitioning from dumps to engineered sanitary landfills, and in particular to encourage more municipalities in the developing countries, that currently heavily rely on open dumps for disposal of their waste, to participate in this initiative. And, of course, the secondary goal is to promote closing of the world's 50 largest dumpsites, that were identified by ISWA in 2014, by bringing public and private stakeholders and financial institutions together so that dumpsite closure can become a reality.

As previously mentioned, quantifying greenhouse gases (GHGs), including those short-lived climate pollutants (SLCPs), is not an easy task since it depends on so many parameters that may not be known at the time. Since the potential for total

C emissions reduction needs to be accurately predicted and quantified in order to attract any financial institution in providing funding to dumpsite closure and/or opening alongside a new engineered sanitary LF, it is important to use an appropriate estimation tool that can give accurate results in a dumpsite environment.

In May 2019, TFCD began a new case study to do just that. The case study has been funded by the Climate and Clean Air Coalition (CCAC) to conduct a feasibility study for quantification of GHGs of a dumpsite located in Tyre Caza in southern Lebanon. The model selected for this case study is the United Nations CCAC Solid Waste Emissions Estimation Tool (SWEET) for estimation of the total C emission reductions stemming from site closure. The SWEET is used to investigate waste sector emissions of SLCPs and other GHGs under multiple waste management scenarios. Data that were used in this study along with updated information were provided by Lebanon's Office of the Minister of State for Administrative Reform.

The selected dumpsite is called the Ras El-Ain Dumpsite (Ras El-Ain), which is located about 5 km south of Tyre City. Ras El-Ain operated from 1990 through to 2015, and received an estimated 54,000 Mg of waste in its last full year of operation. The dumpsite had an estimated volume of 300,000 m^3 in 2016, which is less than half of the volume of waste delivered after reductions from extensive waste burning, decay of organic materials, and ground surface settlement.

The SWEET model runs were prepared using available data on waste composition and current and projected annual rates of waste generation, collection, disposal, and diversion in Tyre Caza. The baseline scenario reflects current and future conditions under the continuation of “business-as-usual” waste management practices. Four alternative future waste management scenarios evaluate potential emissions reduction achieved by the following activities: remediation of all dumpsites in Tyre Caza; closure of all dumpsites in the caza; development of a regional sanitary LF to receive all wastes disposed in the caza; and increased recycling, composting and the production of refuse-derived fuel (RDF).

The SWEET’s estimates of waste sector SLCP emissions from Tyre Caza under different scenarios show that the management of methane emissions from disposal sites achieves the greatest amount of emissions reduction, followed by the reduction in black C emissions by ending waste burning. Future waste sector GHG emissions will increase at roughly the waste generation growth rate (projected to be 2%) if current diversion and disposal practices continue. Large emissions reductions are achievable by Tyre Caza if dumpsites are closed and remediated, and a new sanitary LF is developed. Once a LF is receiving all disposed wastes, emissions under alternative scenarios vary based on the year that the methane collection system begins to operate, the amount of waste diversion and accumulation of methane emissions reduction over time, and the addition of emissions from combustion if RDF is produced and used.

For most years in SWEET’s emissions forecasts for Tyre Caza, Alternative Scenario 3, which includes the development of the Integrated Waste Management Plan’s Phase 1 diversion programme without RDF, produces the lowest SLCPs. Under this scenario (ISWA, 2020), SLCP emissions are reduced from baseline levels by 37,130 Mg to 79,560 Mg emissions in 2030, reduced by 72,830 Mg to 57,040 Mg emissions in 2035, and reduced by 84,730 Mg to 59,550 Mg emissions in 2040.

In conclusion, the TFCD team will assist the owner or local authority to apply for funds from international sources to implement the study’s recommendations. Through this TFCD effort, the team aims to create a replicable approach that can be applied to the closure of dumpsites in countries throughout the developing world.

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