Review on Municipal Solid Waste, Challenges and Management Policy in Pakistan

M. Asif[1], M. Laghari[1], A. M. Abubakar[2], S. K. Suri[4], A. Wakeel[3] and M. Siddique[4*]

[1]*Department of Energy and Environment Engineering, Faculty of Agriculture Engineering Tandojam, Sindh, Pakistan*
[2]*Department of Chemical Engineering, Faculty of Engineering, Modibbo Adama University, Yola, Adamawa State, Nigeria*
[3]*Department of Petroleum and Gas Engineering, Balochistan University of Information Technology, Engineering and Management Sciences (BUITEMS), Quetta, Pakistan*
[4]*Department of Chemical Engineering, BUITEMS, Quetta, Pakistan*
*Corresponding author: siddiqnasar786@gmail.com

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Abstract
MSW or manufacturing WM must be sustainable, to achieve SDG and address health, environmental and economic disposal concerns caused by large amounts of artificial garbage. Locals are put at risk, due to improper MSW management. In Pakistan, MSW output is increasing daily. Urban settlements and other organisations generate a large amount of garbage in various forms, which typically degrades and makes the surroundings unappealing. The soil state in the metropolitan area has decreased, due to irresponsible debris dumping. The dumping of contaminated litter and mixed fluids outside of waste disposal borders raises serious environmental issues on soil and water pollution. This review focused primarily on the impacts of MSW collection on soil and water quality at open waste disposal facilities, as assessed by a mixed soil-WQI. Improper waste disposal techniques, which include open dumping, uncontrolled landfilling and illegal disposal, can lead to contamination that negatively effects soil and water quality. One must also look for sustainable WM options. The consequences related to these gaseous emissions have been widely investigated.

***Keywords*:** landfills; MSW; pollution; soil quality.

Introduction•

The continual rise in waste production and other issues like energy scarcity and mineral exhaustion are all results of global industrial revolution, urbanization and growing human population. These pollutants can only be partially processed by soils through filtering or transformation. Problems, including water contamination, human interaction with contaminated soil, plants absorbing toxins and risks from landfill gases, become more severe after this ability is exceeded [1].

• The abbreviations list is on page 255.

More garbage is generated in places with higher population growth than in areas with less inhabitants. Socioeconomic conditions and activities that people engage in largely determine waste generation. Trash affects the ecosystem in several ways, such as air pollution, Gw contamination, creation of unpleasant odors and land pollution, which change how people view the environment. By 2050, there will be more than nine billion people on the planet. In emerging nations, significant expansion will occur, particularly in urban areas where the infrastructure for WW treatment is already deficient. If WW monitoring does not get prompt attention, the costs to the economy, environment and society are predicted to rise sharply [2, 3].

One of the biggest health problems limiting development and escalating poverty is contaminated water from poor WW management, which raises the cost of health care and reduces labor productivity. Roughly 900 million people worldwide lack access to proper sanitation, and 2.6 billion people, or roughly half of the population of the developing world, still lack access to clean water [4].

Every year, water-related illnesses kill at least 1.8 million children under the age of five, which amounts to about 17% of all deaths in this age range. 2.2 million people annually die from diarrheal illnesses worldwide. Approximately 88% of diarrheal occurrences are caused by poor hygiene and contaminated water [5].

After water supply and sanitation, MSW management services often rank third on the priority list for municipal commitments. The possible damage posed to the soil is the primary environmental issue connected to disposal locations [6].

As HM and other toxins are directly disposed on the soil and top, they can easily permeate the garbage over time, poisoning the soil and killing plants [7]. Depending on the pollutant's proclivity, it either deposits on soil-stored water or seeps into underground water. Hazardous waste containing Cd, Cu, Ni, Pb and Zn can alter the soil chemistry and endanger animals and flora that depend on it for nourishment [8].

Human activity, such as mining, smelting, manufacturing, agriculture and fossil fuel burning, adds HM (Cd, As and Hg) to the soils. The disposal of HM-containing products, such as paint, technical garbage and sewage, among many others, contributes to this pollution problem. Millions of individuals may suffer health consequences due to soil contamination [9].

Asbestos, dioxins and As all contribute to the development of cancer, but also harm the brain and reduce IQ. Pb, Hg and Cd induce kidney disease and affect the skeleton and bones, as also fluoride does it [10].

Gw around Olusosun's dumpsite was found to have higher levels of physicochemical characteristics than the one in Solus area. Certain factors that may have contributed to this include Olusosun's age, the type and amount of MSW that was dumped there and the proportion of clay in the soil [11].

The region's Gw samples are all acidic by nature, which may be due to the area's high population density and industrialization. Because of CO_2 high levels in the atmosphere, the water that percolates into the aquifer may be acidic [12].

A type of health treatment for people is water with a very low pH. When compared to Olusosun's dumpsite, WQI further demonstrated that the impact of other waste sites is still very small in the surrounding Gw. WQI for samples near Solus' dumpsite classified them as excellent, good and poor. WQI near Olusosun's dumpsite yield results that were good, poor and extremely poor [13].

Nearly all of the surrounding Gw has nitrate levels above the permitted limit, by WHO, of 10 mg/L. Nitrate pollution has been associated with suffering and mortality, posing a serious threat to health [14].
Soil features have a direct impact on plants diversity. Many studies have shown that open waste collection poses a worldwide threat to plant life on the globe, leading to permanent damage [15].
Hard residual contaminants impact the soil's physicochemical qualities, being eventually responsible for lower flora productivity [16].
In their initially occurring place, pollutants disrupt plants' normal metabolism, generating an unseen harm that later develops as a visible one. Town life has been under tremendous pressure due to residents activites. The population [17] produces a variety of litter, both biodegradable and non-biodegradable.
If adequate disposal does not exist, waste can have a severe environmental impact. However, garbage may be transformed into a resource that benefits everyone, with proper collection and disposal methods. Much litter can be reused, while there are exciting uses for energy-producing materials that are now widely available [18].
Clean landfills, biogas-generating methods, worm composting, incineration and other MSW combustion technology encourages WtE [19].
Rapid use of home (untreated) WW may not be beneficial for agricultural uses, unless it undergoes a particular purification process. Water of poor quality can affect irrigated crops, by allowing salt to collect in the root zone and preventing fluid permeability/uptake through the earth to the plants [20].
The amount available for arable cultivation and other agricultural operations diminishes when pollutants in irrigation water render soils used for farming useless, as salts and different metals such as Pb accumulate in them over time [21].
Our ecosystem is being stripped of its original equilibrium, and implications are disastrous. When contaminants come from several sources and their yields vary, it is difficult to assess soil contamination [22].
MSW is an excellent source of organic compounds, which may enhance soil structure and have other desirable farming qualities. The time-consuming process of dealing with MSW can be transformed into an important asset that may help producing various required fertilizers [23].
Home solid trash, which includes biodegradable and non-biodegradable materials, such as bottles, metal rags and leaves, accounts for 90% of all produced waste. Commercial garbage has created the least amount of waste (10%) [24].
Towns in India have been turning into overflowing landfills, due to the sites' MSW indiscriminate evacuation. Socioeconomic environment has a significant impact on the hard leftover carriers' huge physicochemical and biological properties [25].
The goal of this overview was to provide current information on the effects of open MSW areas' management on water and soil quality [26].

Implications of unplanned MSW dumping

Environmental hazards, such as stratospheric ozone destruction, photo-oxidants formation, epidemics caused by stray animals, global warming brought on by GhG (CH_4 and CO_2) release, fires, threats to birds and dumping sites odors, are some of

MSW dumping negative effects. If MSW management is employed in an effective way, some of these hazards can be removed [27].
Therefore, technological interventions are required to reduce waste and make use of it. Waste should be viewed as a misplaced resource. MSW must be collected, stored, transported, separated and made ready for disposal, due to its immense potential for resources recovery [28].
Only wastes that cannot be recycled or repurposed should be sent for disposal. Compost can be made out of organic waste. WM plans should be designed, so that most of the produced garbage can be used in some way [29].
For proper MSW management, coordinated efforts and the adoption of a scientific approach by the relevant authorities are required, as well as educating the population about the importance of environmentally sound WM practices. Ensuring that different wastes are kept separated from the moment people or households start to dispose of them is the biggest challenge [30].

Garbage towards treasure potential

WM structure should prioritize trash reduction, then recovery opportunities. Decrease, reuse and recycle ought to be used to decrease waste creation. The last and fifht R now represents repurchase and maintenance, respectively [31].
Thus, persuading customers to rebuy items created from recovered MSW can benefit recycling firms. The steps that follow may be performed so that garbage from MSW creates “wealth” [32].

Composting from MSW

MSW composting provides a soil conditioner, which boosts its productivity. It is often regarded as a low-cost waste disposal approach. In Pakistan, waste contains 40-60% (or maybe more) of recyclable materials with high moisture content. It is not suitable for burning, due to its poor calorific value. The process of composting along with biomethanation has the potential to be more effective in reducing waste treatment [33].

Anaerobic digestion

The anaerobic breakdown of solid waste in landfills results in CH_4 production, which contributes to global warming. This GhG gas is 21 times more powerful than CO_2. Landfill gases have an approximate calorific value of 4500 Kcal/m^3. The methanation process, which converts CH_4 into fuel for energy production or combustion, can also produce compost for improving soil [34].
In a developing nation like India, this method is beneficial. CH_4 emissions from garbage are projected to be between 2 million and many times more tonnes per year in six major Indian metropolises. By 2047, it is anticipated to annually reach 39 million tonnes [35].

Managing hazardous wastes within Pakistan

SWM in Pakistan has become a major issue, due to rising urbanization, population expansion and inadequate infrastructure. Environmental issues are growing, because

of widespread challenges with garbage disposal, reuse and recycling, including collection [36]. Table 1 contains some important information on Pakistan's MSW production.

Table 1: Solid waste generation [36].

City	Population	Produced MSW (tons)
Quetta	500,000	295
Hyderabad	4,900,000	3478
Lahore	9.000.000	6411
Peshawar	2,800,000	1799
Karachi	21,100,000	9338
Faisalabad	6,400,000	3996

Content of garbage production
Pakistan's urbanization and population growth have resulted in increased waste material production. Organic waste, plastics, newspapers and glass are among the materials found in garbage.

Waste collection
Solid garbage disposal is often inconsistent and inadequate, particularly in remote and informal settlements. Many municipal governments fail to offer regular garbage collection services [37].

Waste disposal
Poor disposal of trash has become a major issue. Common waste disposal and burning methods, such as open dumping and junk burning, damage both the environment and the soil, endangering the health of local communities [38].

Waste recycling
There are few formal recycling centers in Pakistan, which has hindered the recycling process. These facilities gather recyclable materials from garbage dumps in certain locations, as part of unauthorized efforts to recycle [39].

Legislation and policies
Pakistan has only enacted a few laws and guidelines for SWM, including Pakistanis' Environment Protection Act of 1947, and National Environmental Quality Guidelines for MSW. However, these regulations have not always been effectively implemented or enforced [40].

Social knowledge and instruction
There is currently little public education or knowledge of garbage control procedures. To improve the deployment of waste techniques, it is required to promote behavioral modifications and raise public awareness [41].

Obstacles

Inadequate finance, poor infrastructure, a shortage of waste treatment plants and a general lack of education regarding the need for appropriate garbage elimination and reuse are just a few of the issues faced by Pakistan's waste treatment industry [42].

Initiatives and strategies

With the challenges, there have been some municipal efforts to improve garbage management. NGO, along with nonprofit organizations in the community, have worked to raise awareness, promote reuse and recycling, and enhance trash disposal and collecting processes [43].

What exactly is waste-free?

Zero-waste projects aim to address global warming, while reducing the environmental effects of our throwaway lifestyle. This "zero waste" mindset argues that chemicals must be managed to retain value, prevent damage to the environment and safeguard renewable resources. It seeks to ensure that things may be repaired, reused or repurposed, to benefit either consumers or the surrounding ecosystem [44]. To reach zero waste, one must shift from WM through landfills and incinerator facilities to value-added resources recycling. The Solid Waste Association of North America defines zero waste as any effort to eliminate garbage by reducing unnecessary usage and increasing solid waste recovery through sanitation and recycling [45].

Some zero-waste definitions emphasize recycling and composting as waste-reduction strategies. While an item approaches the end of its utility, zero-waste principles surpass decomposition and recycling. They encompass every stage of the process, particularly from design to raw material procurement, manufacture and disposal [46].

Conclusion

This study about beneficial and long-term treatment of MSW, has highlighted the need for a proper assessment of landfill management, along with a critical review of potential approaches to ensure that its requirements are maintained and kept in Pakistan. Additionally, improved WM globally expands air pore space and aids soils in fighting compaction, which reduces their productivity and yields, by obstructing root growth, air drive and water penetration. Developing nations use MSW materials more inefficiently than advanced nations. China may strengthen garbage management through several financial ways. Some of the employed techniques are manure formation, recycling, bio methanation, WtE and bio-fuels. Composting and biomethanation are considered as the most suitable. Possible damage posed to the soil is the primary ecological issue related to disposal sites. Whenever trash is immediately placed on the soil, various pollutants, including HM, such as Pb, Cd, Cr, Co and Ni, swiftly move to the surface before infiltrating the ground below. As a result, it is advised that these open dump sites are shut down, and that municipalites provide training to the community on pretreatment and use of sustainable WM methods.

Recommendation of the study

Different work should be organized for solving MW issues, such as vehicles, drivers and collectors.

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No competing interests.

Authors' contributions
M. Asif: wrote the manuscript. **M. Laghari**: helped with the manuscript. **A. M. Abubakar**: removed grammar mistakes. **S. K. Suri**: gave a sequence to the manuscript. **A. Wakeel**: helped with DOI references. **M. Siddique**: made the abstract and conclusion.

Abbreviations
CH_4: methane
CO_2: carbon dioxide
GhG: greenhouse gas
Gw: groundwater
HM: heavy metal
MSW: municipal solid waste
MT: million tonnes
NGO: non-governmental organization
SDG: sustainable development goals
T: temperature
WHO: world health organization
WM: waste management
WQI: water quality index
WtE: waste- to-energy
WW: wastewater

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