Asian Journal of Water, Environment and Pollution, Vol. 21, No. 6 (2024), pp. 203-211.
DOI 10.3233/AJW240088

Comparative Review of Solid Waste Management Scenarios in India and Swaziland

Nkululeko Sabelo Dlamini and Pawan Kumar Jha*
Centre of Environmental Studies, University of Allahabad, Prayagraj, India
✉ pkjha@allduniv.ac.in

Received March 8, 2024; revised and accepted August 2, 2024

Abstract: This review assesses the solid waste management (SWM) scenarios of two developing countries, India and Swaziland. Further, it explores the existing relationship between SWM and the economy, public health, and the environment. An overview of the fundamental concept of a circular economy within SWM is presented. Embracing a circular economy emerges as a viable and more plausible strategy to address SWM challenges in developing countries. The prevailing SWM scenario in India and Swaziland confronts various issues, ranging from basic concerns like inadequate waste segregation to more intricate problems, such as the absence of effective funding mechanisms. Urbanisation, population growth, and economic development are highlighted as significant contributors to the prevailing SWM conditions in developing nations. The review culminates in sustainable solutions to the solid waste issue in developing nations, with a special emphasis on India and Swaziland, by incorporating ideas from the literature.

Key words: Solid waste management, circular economy, urbanisation, sustainable.

Introduction

Throughout history, human activities have inevitably generated waste, regardless of habitation size (Agarwal et al., 2015). The advent of industrialisation and civilisation increased raw material consumption, leading to a surge in waste production. Solid waste management (SWM) emerged as a pivotal municipal service crucial for urban functionality (Hoornweg and Bhada-Tata, 2012). Initially focussed on public health, SWM later incorporated environmental concerns (Memon, 2010). The United Nations Environment Programme (2024) defines waste as the unintended by-product of consumption and production. Memon (2010) emphasises the evolving importance of resource conservation and recovery in SWM, aligning with the 3Rs (Reduce, Reuse, Recycle) approach. Urban areas face a critical challenge in SWM and eliminating solid waste is impractical. Practicality lies in effective, scientifically approved waste management for sustainable urbanisation and development.

The global population explosion transformed SWM from a localised concern to an internationally pervasive social problem, impacting both developed and developing nations (Joseph, 2002). Developed countries, leveraging technological advancements and financial resources, lead in SWM, evident in their efficient strategies despite higher per capita waste production (Chang et al., 2012). Globally, 3 billion people lack access to controlled waste disposal facilities, and a doubling of MSW in lower-income cities in Africa and Asia within 15-20 years is predicted (Wilson et al., 2015). SWM emerges as a critical global issue, especially challenging for developing countries, posing significant health and

*Corresponding Author

environmental problems. Addressing the complexity of the solid waste issue requires an integrated approach, considering interconnected problems with conflicting objectives.

India and Swaziland

India and Swaziland both face developmental challenges, notably in solid waste management (SWM). India's growing economy has led to increased resource consumption and waste generation, particularly in urban areas lacking proper MSW disposal methods (Agarwal et al., 2012). Similarly, Swaziland encounters comparable issues (RUSER, 2020). Despite these parallels, the countries differ significantly in climate. India boasts diverse climates, ranging from tropical in the south to temperate and alpine in the Himalayan north (Attri and Tyagi, 2010), while Swaziland generally experiences subtropical conditions with distinct seasons and summer rains (Brown, 2011). Table 1 illustrates that India typically has hotter temperatures and higher rainfall than Swaziland. India hosts a population of 1.2 billion people, representing 17.5% of the world population (Chandramouli and General, 2011), across a land area of 3.287 million km^2. In contrast, Swaziland is characterised by homogeneity, with a small population of 1.2 million people and a total land area of 17,364 km^2 (Jappinen, 2016), significantly smaller than India (see Figure 1). Their population differences influence the scale of the waste problem in each country.

Solid Waste Scenario in India and Swaziland

Solid Waste Composition

Waste composition varies based on factors like food habits, cultural traditions, lifestyles, climate and income (Gupta et al., 2013). Understanding the changes and causes of waste composition is essential for improving waste management, and these changes in waste composition are strongly linked to economic growth in an area (Nguyen et al., 2020). Table 2 shows the types of solid waste according to their sources. In India, MSW composition at generation sources and collection points, on a wet weight basis, primarily includes a significant organic fraction (40–60%), ash and fine earth (30–40%),

Table 1: Population, geographic size, GDP per capita, annual rainfall, and temperature differences between India and Swaziland

	Population	*Area in km^2*	*GDP per Capita*	*Temperatures*		*Annual Rainfall Range*	
				Summer	*Winter*	*Highest*	*Lowest*
India	1.2 billion	3, 287, 263	$2, 411	32°C	10°C	12550 mm (Mawsynram, Meghalaya)	313 mm (West Rajasthan)
Swaziland	1.2 million	17, 364	$3, 987	20ºC	13ºC	1450 mm (Highveld Region)	550 mm (Lowveld Region)

*Sources:*Attriand Tyagi (2010), Brown (2011), Chandramouli and General (2011), Jappinen (2016), The World Bank (2024).

Table 2: Types of solid waste classified according to their sources

Source	*Types of solid wastes*
Industrial	Hazardous wastes, housekeeping wastes, packaging food wastes, construction and demolition materials, ashes, special wastes
Municipal services	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge
Residential	Biodegradable organic waste, food wastes, paper, cardboard, plastics, dwellings textiles, wood, glass, metals, consumer electronics, batteries, tires, and household hazardous waste
Commercial and institutional	Special wastes, paper, cardboard, plastics, wood, food wastes, glass, metals, hazardous wastes, biomedical wastes
Construction and demolition	Wood, steel, concrete, and dirt
Agriculture	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides)

Sources: Sharma (2019), Wilson et al. (2015)

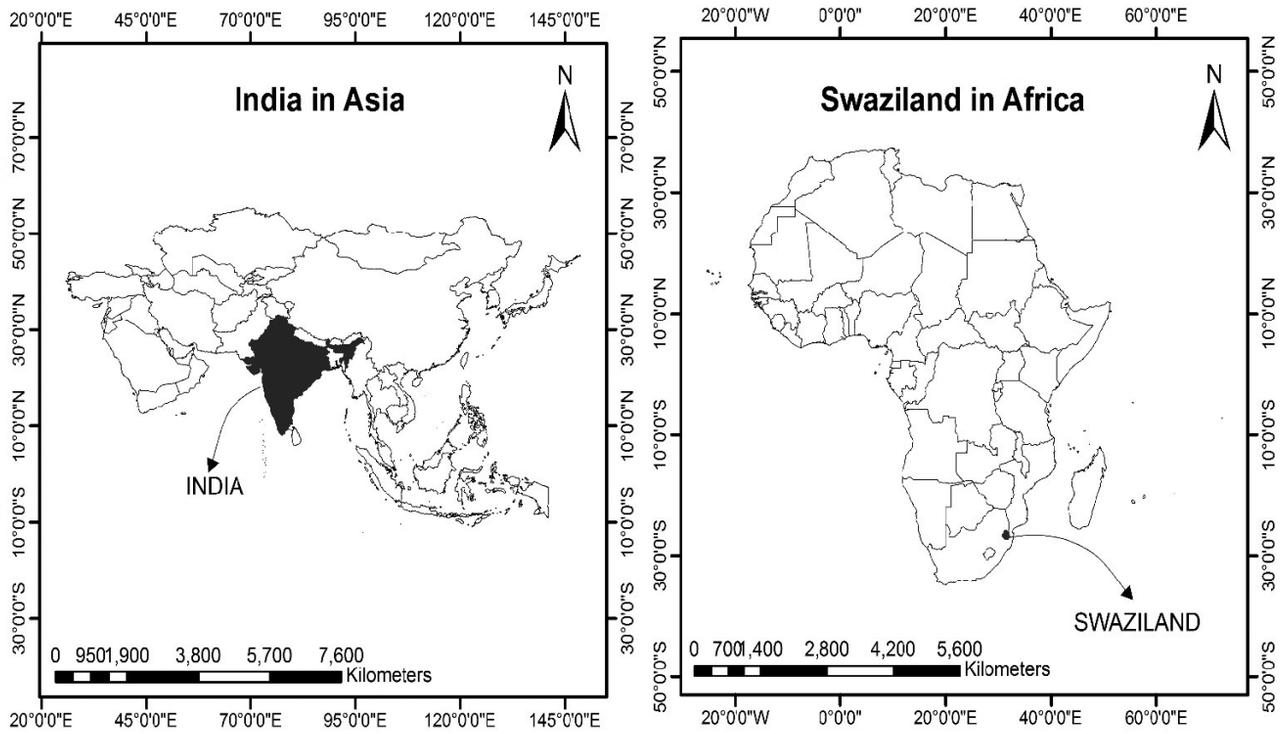

Figure 1: Map showing India's geographical position in Asia and Swaziland's position in Africa.

paper (3–6%) and minimal proportions of plastic, glass and metals (each less than 1%) (Kaushal et al., 2012). Swaziland's solid waste composition consists of 50-55% organic matter, and the remaining 45-50% is recyclable waste (paper, plastic, metal, and glass) and inert (SEA, 2014).

Solid Waste Management Process

Solid waste management constitutes a series of activities that can work seamlessly and efficiently to eradicate the waste problem when properly organised. Figure 2 shows a summary of SWM processes and activities in the SWM scenarios of India and Swaziland.

Solid Waste Generation

Joshi and Ahmed (2016) highlight the impact of urban population growth in developing countries. In India, 31.2% reside in urban areas, totaling over 377 million across 7,935 towns. Swaziland's urban population increased by 1.7% compared to 2014, reaching 23.8% in 2019 (RUSER, 2020). Urbanisation, population and economic growth significantly increase waste generation as observed with Indian cities exceeding 100,000 people contributing 72.5% of India's waste, while 3,955 other urban centres generate only 17.5% (Asnani, 2006). Official data on waste generation in Swaziland indicates a per capita rate of 0.2 kg/day, but a lack of systematic measurement hampers accuracy (RUSER, 2020). However, recent observations suggest an average rate of 0.64 kg/day. Similar data challenges exist in India, where conflicting information on urban waste generation prevails due to inconsistent data collection (Mani and Singh, 2016). Joseph (2002) estimates daily per capita waste generation in India's small, medium, and large cities at 0.1 kg, 0.3–0.4 kg and 0.5 kg, respectively, with National Environmental Engineering Research Institute studies indicating variation from 0.3 to 0.6 kg/day.

The annual solid waste quantity in Indian cities has surged from 6 million tonnes in 1947 to 90 million tonnes in 2009, with projections estimating an increase to 300 million tonnes by 2047 (Gupta et al., 2015). In contrast, Swaziland generates comparatively less waste yet struggles with effective management. The national waste generation annually is 238,341 tonnes, with 42% generated in urban areas and 58% in rural areas (RUSER, 2020). Table 3 illustrates that cities in Swaziland exhibit significantly higher per capita solid waste generation than more populous Indian cities. Notably, industrial, and commercial hubs like Manzini and Matsapha have exceptionally higher per capita daily waste generation. The high waste generation

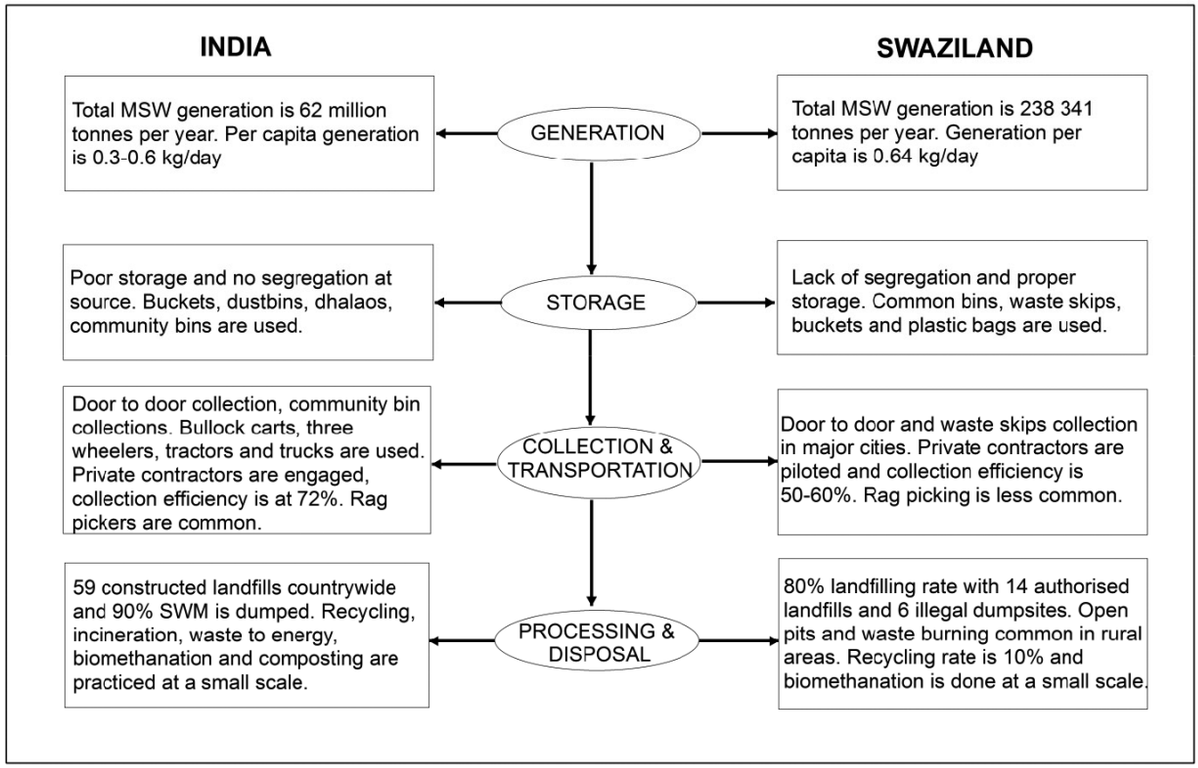

Figure 2: Solid waste management activities and practices in India and Swaziland.
Sources: **Singh (2021), Gupta (2015), Kaushal et al. (2012), Dutta (2014) SEA (2014), Jappinen, (2016).**

Table 3: Solid waste generation for some of the major cities in India and Swaziland

	City	*SW Generated (Tonnes/Day)*	*Population*	*Generation/Capita/Day (kg)*
India	Delhi	7 000	11 034 555	0.63
	Mumbai	9 000	12 442 732	0.72
	Chennai	4 248	4 646 732	0.91
	Kolkata	4 837	4 496 694	1.08
	Total	25 085	32 620 713	0.77
Swaziland	Mbabane	91	60 691	1.5
	Manzini	82	30 248	2.71
	Matsapha	46	7 571	6.07
	Piggs Peak	10	5 389	1.86
	Total	229	103 899	2.2

*Sources:*Census of India 2011 (2022), Eswatini Government (2022), Sharma and Chandel (2021), Singh (2021).

is attributed to non-residents contributing to waste generation during the day. Matsapha, for instance, has a daytime population of 35,000 which is reduced to 7,600 at night (Matsapha Municipality, 2022).

Solid Waste Storage, Collection, and Transportation
Effective waste collection is a crucial aspect of SWM. Globally, two billion people lack access to solid waste collection services, leading to significant challenges in urban areas (Wilson et al., 2015). According to Apaydin et al. (2023), the sustainability of waste management heavily relies on the separation of waste at its source and the separate collection of these waste components. In Swaziland, local urban government authorities are responsible for collecting, treating, and disposing off solid waste. However, in unserviced rural areas, waste management is ad hoc and poses an increasing environmental threat (RUSER, 2020). In India, the Municipal Solid Waste (Management and Handling)

Rules, 2000 mandates urban local bodies to organise door-to-door waste collection, aiming to improve waste source segregation (Chikarmane, 2012). Despite improvements in door-to-door collection in some Indian cities, the segregation of waste at the source remains largely absent (Mani and Singh, 2016; Srivastava and Jha, 2023).

In India, labour-intensive collection methods prevail due to the availability of cheap labour, with 68% of waste collected daily, although this percentage varies between the different sizes of cities (Joseph, 2002; Planning Commission, 2014). Swaziland faces challenges, achieving only 50-60% collection efficiency in urban areas (SEA, 2014). In India, MSW storage at the source is lacking in many urban areas, with waste often collected without segregation and disposed off at community disposal centres (Kaushal et al., 2012). A similar lack of waste segregation occurs in Swaziland, where all types of waste are collected together. Indian cities employ various methods for waste storage, such as plastic buckets, dustbins, dhalaos, and open dumpsites, leading to poor collection efficiency (Gupta et al., 2013, 2015). In Swaziland, waste skips and compactor trucks are used for transportation, while in India, a range of vehicles, including bullock carts and trucks, transport waste, often complicating collection (Asnani, 2006; Kaushal et al., 2012).

Solid Waste Disposal

Open dumping and illegal landfilling remain the predominant methods in many developing countries due to their cost-effectiveness and simplicity (Asnani, 2006). MSW disposal practices in India and Swaziland reveal significant challenges. In India, over 90% of MSW is disposed off in unsuitable areas, lacking scientific and socio-environmental criteria (Dutta, 2014). Swaziland faces a similar issue, with 80% of waste ending up in landfills while burning and burying are common in peri-urban areas (SEA, 2014; Jappinen, 2016). Swaziland contends with illegal dumpsites and limited waste disposal facilities, with six dumpsites without operating licenses and only ten approved waste disposal facilities (RUSER, 2020). In India, although there are 59 constructed landfill sites, 376 are in the planning stage, and 1305 sites have been identified for future use (Joshi and Ahmed, 2016). In Indian cities, incineration is mainly confined to biomedical and biological wastes (Gupta et al., 2015). Swaziland lacks hazardous waste facilities, relying on South Africa for management, and exports some hazardous waste to the United Kingdom and pesticide waste to Germany (Jappinen, 2016).

Economic, Health and Environmental Implications of SWM

Economic

Economic factors do not only drive waste generation and limit SWM initiatives in developing countries but can also offer solutions to the waste problem. Waste poses a financial burden, representing wasted money considering material costs, disposal expenses, and the potential value of recyclable resources (SEA, 2014). Municipalities and Urban Local Bodies (ULBs) in India are facing financial difficulties, and the existing funds are not managed efficiently, reducing the potential for sustainable waste management (Soni et al., 2023). Proper waste management is economically sensible, enhancing city aesthetics for tourism, improving residents' well-being, and safeguarding property values (Gupta et al., 2013; Wilson et al., 2015). Viewing waste as a resource can transform SWM into an income-generating exercise. However, in many developing countries like India and Swaziland, waste management often follows a linear economy, which cannot be sustained in the long run (Mandpe et al., 2023), and it hinders the realisation of SWM's full income-generating potential through a circular economy (Gupta et al., 2013) as shown in Figure 3. Initiatives like recycling, composting, bio-methanation, and refuse-derived fuel showcase the positive economic impacts of waste on society.

Health

SWM is crucial for public health and improper waste disposal leads to severe public health issues. The US Public Health Service identified 22 human diseases linked to improper MSW management (Alam and Ahmade, 2013). Uncollected solid waste locally contributes to flooding, air pollution, and health issues, including respiratory ailments, diarrhoea, and dengue fever (Hoornweg and Bhada-Tata, 2012). Indiscriminate disposal sites provide an ideal environment for microbial growth and the proliferation of insects and rats (Dehghani et al., 2021). They foster disease vectors like flies and mosquitoes, spreading diseases such as cholera, dengue, and malaria (Alam and Ahmade, 2013). In Swaziland, proximity to dumpsites correlates with diseases like malaria, chest pains, cholera, and diarrhoea (Abul, 2010). The 1994 plague in Surat, India, was linked to uncollected MSW, causing blockages, flooding, and waterborne diseases (Agarwal et al., 2012).

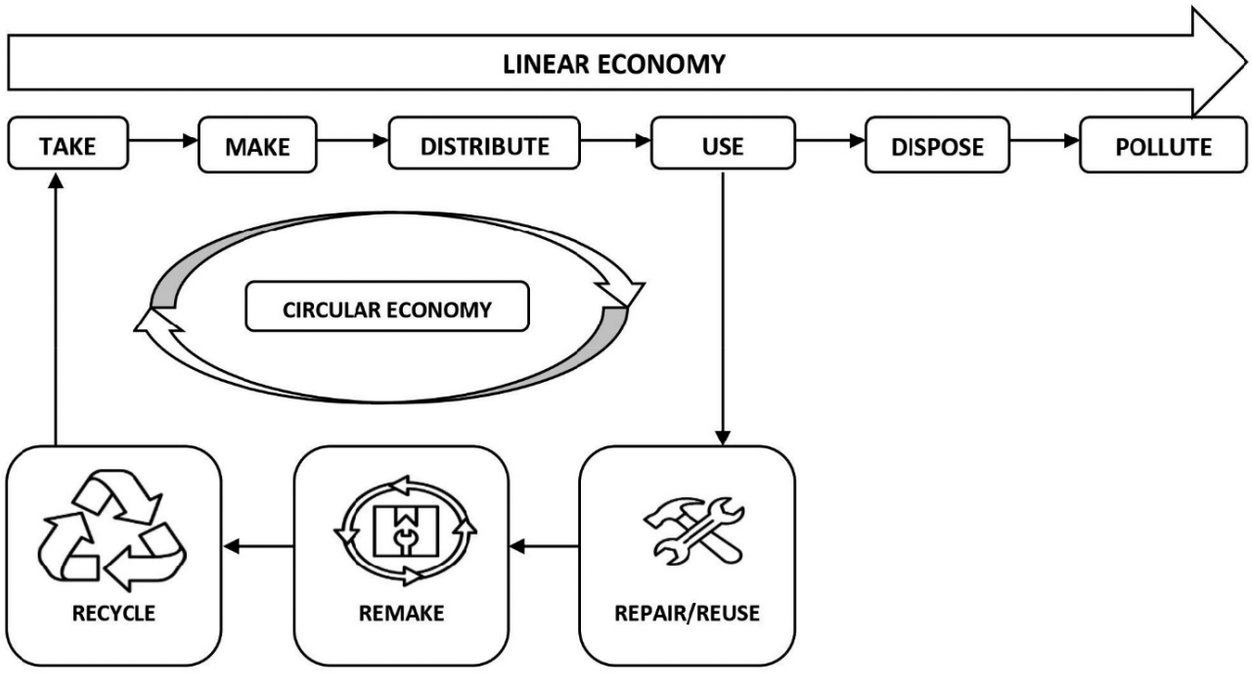

Figure 3: The difference between a linear economy and a circular economy in SWM.
***Sources*: Pont et al. (2019), Weetman (2016).**

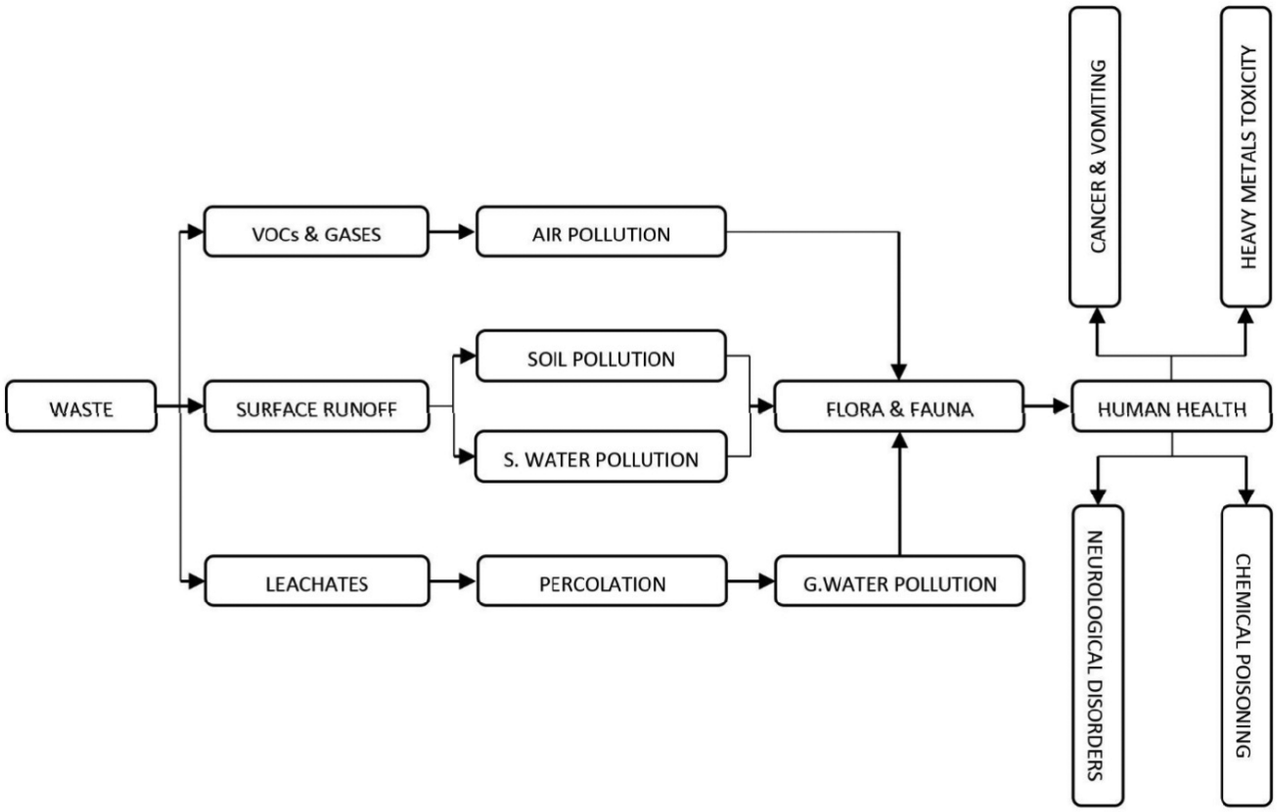

Figure 4: An illustration of how open dumping causes air, soil, and water pollution, affecting human health.
***Sources:* Alam and Ahmade (2013), Mavropoulos (2015), Wijekoon et al. (2022).**

Environment

Poorly managed solid waste is a substantial environmental challenge, leading to air, soil, and water pollution (Alam and Ahmade, 2013). Densely populated countries, including China, India, Pakistan, and Bangladesh, grapple with environmental issues due to mishandled solid waste (Khan et al., 2019). Solid waste is a source of microplastics in sediments, waterbodies, and aquatic life (Golwala et al., 2021). Despite Swaziland's smaller population and solid waste generation, it experiences notable environmental degradation and health impacts due to inadequately managed solid waste, as depicted in Figure 4 (Abul, 2010). SWM plays a substantial role in air pollution, contributing to about 3% of global anthropogenic greenhouse gas (GHG) emissions, with methane and carbon dioxide as major pollutants (Scheutz et al., 2009). In India, common landfill disposal contributes to groundwater pollution, especially in rapidly growing cities (Dutta, 2014).

Conclusions

SWM poses a significant challenge in developing nations like India and Swaziland. The literature review highlights the complexity of SWM issues in these countries, with India facing a more formidable task due to its larger population and higher urbanisation rates. India's heavy industrialisation further exacerbates the challenge. Swaziland lacks comprehensive information on SWM, hindering informed planning. Financial constraints impede both countries from achieving optimal SWM levels. Despite these challenges, practical measures such as waste segregation and the 3Rs concept, requiring minimal funding and generating income, can enhance SWM conditions and advance the circular economy model. The SWM sector lacks prioritisation in developing countries, leading to insufficient funding, inadequate policies, and weak legislation enforcement.

Overall, it is concluded that despite differences in size and population, developing countries encounter comparable SWM challenges with variations in scale. Solid waste administrators in India and Swaziland should improve SWM strategies using available technologies, enforcement of available laws and improvement of sanitation behavioural change programs like the Swachh Bharath Mission in India. Administrators should strengthen both public awareness and participation for effective SWM. Public engagement is notably lacking, emphasising the need for extensive research to understand community attitudes. Recognising SWM as an investment rather than a liability is crucial, aligning it with economic development to prevent resource wastage and environmental degradation, safeguarding public health.

Acknowledgements

The authors thank the University of Allahabad for facilitating this study. The authors express their gratitude to the Indian Council for Cultural Relations for awarding Nkululeko Sabelo Dlamini a fellowship.

References

Abul, S. (2010). Environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini: Swaziland. *Journal of Sustainable Development in Africa*, **12(7):** 64-78.

Agarwal, D., Gupta, A.K. and M.K. Agarwal (2012). Analysis of solid waste management strategies in major cities of Uttar Pradesh in India. *Journal of Pure and Applied Science and Technology*, **2(1):** 66-74.

Agarwal, R., Chaudhary, M. and J. Singh (2015). Waste management initiatives in India for human wellbeing. *European Scientific Journal*, *ESJ*, **11(10):** 105-127.

Alam, P. and K. Ahmade (2013). Impact of solid waste on health and the environment. *International Journal of Sustainable Development and Green Economics (IJSDGE)*, **2(1):** 165-168.

Apaydin, O. and G.S. Akçay Han (2023). Analysis of municipal solid waste collection methods focusing on zero-waste management using an analytical hierarchy process. *Sustainability*, **15(17):** 13184.

Asnani, P.U. (2006). Solid Waste Management. *In:* India Infrastructure Report 2006: Urban Infrastructure. Oxford University Press, New Delhi, India. Retrieved November 20, 2021,:https://www.novalindia.com/download/800657578220370149123789 1.pdf

Attri, S.D. and A. Tyagi (2010). Climate profile of India. Contribution to the Indian Network of Climate Change Assessment (National Communication-II)*, India Meteorology Department, New Delhi, India*.

Brown, R. (2011). Parliamentary role and relationship in effectively addressing climate change issues – Swaziland. A study commissioned and supported by the International Institute for Environment and Development (IIED) in partnership with European Parliamentarians for Africa (AWEPA).Retrieved November 16, 2021, https://www.iied.org/g03058

Census of India (2011). Office of Registrar General and Census Commissioner, India Ministry of Home Affairs, Government of India. Retrieved August 06, 2022, https://

censusindia.gov.in/census.website/data/census-tables

Chandramouli, C. and Registrar General (2011). Census of India. Rural urban distribution of population, provisional population total. New Delhi: Office of the Registrar General and Census Commissioner, India.Retrieved December 13, 2021: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/unpd_201510_egm-s2-chandramouli_presentation.pdf

Chang, N.B., Qi, C., Islam, K. and F. Hossain (2012). Comparisons between global warming potential and cost–benefit criteria for optimal planning of a municipal solid waste management system. *Journal of Cleaner Production*, **20(1):** 1-13.

Chikarmane, P. (2012). Integrating waste pickers into municipal solid waste management in Pune, India. WIEGO Policy Brief (Urban Policies). Retrieved November 27, 2021: http://www.wiego.org/sites/default/files/publications/files/Chikarmane_WIEGO_PB8.pdf

Dehghani, M.H., Omrani, G.A. and R.R. Karri (2021). Solid waste—sources, toxicity, and their consequences to human health. *In:* Soft computing techniques in solid waste and wastewater management (pp. 205-213). Elsevier.

Dutta, V. (2014). Seasonal variation on physico-chemical characteristics of leachate in active and closed municipal solid waste landfill site in Lucknow, India. *G-Journal of Environmental Science and Technology*, **1(4):** 90-95.

Eswatini Government (2022). The 2017 Population and Housing Census, Ministry of Labour and Social Security. Retrieved August 06, 2022, https://www.gov.sz/index.php/scholarship/124-economic-planning-a-development/2455-eswatini-census-documents.

Golwala, H., Zhang, X., Iskander, S.M. and A.L. Smith (2021). Solid waste: An overlooked source of microplastics to the environment. *Science of the Total Environment*, **769:** 144581.

Gupta, N., Yadav, K.K. and V. Kumar (2015). A review on current status of municipal solid waste management in India. *Journal of Environmental Sciences*, **37:** 206-217.

Gupta, S.K., Pandey, S.K., Singh, N.B., Singh, A., Singh, V.K. and T. Verma (2013). Municipal solid waste characterizations and management strategies for the Lucknow city, India. *Int. J. Eng. Res*, **8(17)**: 2031-2036.

Hoornweg, D. and P. Bhada-Tata (2012). What a waste: A global review of solid waste management. *World Bank. Int. J. Environ. Sci. Technol*, **8(4):** 677-686.

Jappinen, M.A.D. (2016). Understanding the Participatory Development approach to Solid Waste Management-A case study of Mnyamatsini, Swaziland. *Lund University Publications – Student Papers.*

Joseph, K. (2002). Perspectives of solid waste management in India. International symposium on the technology and management of the treatment and reuse of the municipal solid waste, Shanghai, China (15-20).Retrieved August 16, 2022,:https://citeseerx.ist.psu.edu/pdf/e267aa9ea308471bca80a6679b4a66c17feb2cbf

Joshi, R. and S. Ahmed (2016). Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science*, **2(1):** 1139434.

Kaushal, R.K., Varghese, G.K. and M. Chabukdhara (2012). Municipal solid waste management in India-current state and future challenges: A review. *International Journal of Engineering Science and Technology*, **4(4):** 1473-1489.

Khan, B.A., Cheng, L., Khan, A.A. and H. Ahmed (2019). Healthcare waste management in Asian developing countries: A mini review. *Waste Management and Research*, **37(9)**: 863-875.

Mandpe, A., Paliya, S., Gedam, V.V., Patel, S., Tyagi, L. and S. Kumar (2023). Circular economy approach for sustainable solid waste management: A developing economy perspective.*Waste Management & Research*, **41(3):** 499-511.

Mani, S. and S. Singh (2016). Sustainable municipal solid waste management in India: A policy agenda. *Procedia Environmental Sciences*, **35:** 150-157.

Matsapha Municipality (2022). Population. Retrieved August 07, 2022,:https://matsapha.co.sz/about-us/.

Mavropoulos, A. and D. Newman (2015). Wasted Health – The Tragic Case of Dumpsites. *International Solid Waste Association (ISWA) Report, Vienna*. Retrieved August 07, 2022: https://www.iswa.org/blog/wasted-health-the-tragic-case-of-dumpsites/?v=c86ee0d9d7ed

Memon, M.A. (2010). Integrated solid waste management based on the 3R approach. *Journal of Material Cycles and Waste Management*, **12(1)**: 30-40.

Ndlovu, N. (2016). Influence of governance institutions on households' willingness to pay for improved solid waste management in the peri-urban settlements of Matsapa Swaziland, Doctoral dissertation, University of Pretoria. Retrieved August 23, 2022,:https://repository.up.ac.za/handle/2263/57271

Nguyen, K.L.P., Chuang, Y.H., Chen, H.W. and C.C. Chang (2020). Impacts of socioeconomic changes on municipal solid waste characteristics in Taiwan. *Resources, Conservation and Recycling*, **161:** 104931.

Planning Commission. (2014). Report of the Task Force on Waste to Energy. Vol. I, Planning Commission, New Delhi, May. Retrieved May 06, 2022: http://swachhbharaturban.gov.in/writereaddata/Task_force_report_on_WTE.pdf.

Pont, A., Robles, A. and J.A. Gil (2019). e-WASTE: Everything an ICT scientist and developer should know. *IEEE Access*, **7:** 169614-169635.

Review and update of the State of the Environment Report – Restoring the Environment for Climate Resilient Economic Recovery (RUSER)(2020).Retrieved May 03, 2022, https://www.undp.org/sites/g/files/zskgke326/files/migration/sz/UNDP-SZ-SOER-Report-2021.pdf.

Scheutz, C., Kjeldsen, P. and E. Gentil (2009). Greenhouse gases, radiative forcing, global warming potential and waste management—an introduction. *Waste Management and Research*, **27(8):** 716-723.

Sharma, B.K. and M.K. Chandel (2021). Life cycle cost analysis of municipal solid waste management scenarios for Mumbai, India. *Waste Management*, **124:** 293-302.

Sharma U.C. (2019). Energy from Municipal Solid Waste. *In book:* Environmental Science and Engineering, Solid Waste Management, *Studium Press LLC USA*, **5:** 193-213.

Singh, R. (2021). Solid Waste Management in Eswatini: Challenges and Opportunities. Centre for Science and Environment, New Delhi.Retrieved July 17, 2022, : https://www.cseindia.org/solid-waste-management-in-eswatini-challenges-and-opportunities-11248.

Soni, A., Das, P.K. and P. Kumar (2023). A review on the municipal solid waste management status, challenges and potential for the future Indian cities. *Environment, Development and Sustainability*, **25(12):** 13755-13803.

Srivastava, A. and P.A. Jha (2023) Multi-model forecasting approach for solid waste generation by integrating demographic and socioeconomic factors: A case study of Prayagraj, India. *Environ Monit Assess*, **195:** 768.

Swaziland Environment Authority (SEA) (2014). Swaziland State of Environment Report 2012/13: Consequences of Inaction. University of Swaziland: Kwaluseni. Retrieved May 02, 2022, :http://eea.org.sz/wp-content/uploads/2020/09/SOER-2014.pdf

The World Bank (2024). GDP per capita (Current US$) 2022. Retrieved May 29, 2024,: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locationsandname_desc=trueandview%3Dmap&view=map

United Nations Environment Programme. (2024). Global Waste Management Outlook 2024: Beyond an age of waste – Turning rubbish into a resource. Nairobi. Retrieved May 30, 2024: https://wedocs.unep.org/20.500.11822/44939

Weetman, C. (2016). A circular economy handbook for business and supply chains: Repair, remake, redesign, rethink. Kogan Page Publishers, New York.

Wijekoon, P., Koliyabandara, P.A., Cooray, A.T., Lam, S.S., Athapattu, B.C. and M. Vithanage (2022). Progress and prospects in mitigation of landfill leachate pollution: Risk, pollution potential, treatment and challenges. *Journal of Hazardous Materials*, **421:** 126627.

Wilson, D.C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, K. and O. Simonett (2015). Global waste management outlook. UNEP, Division of Technology, Industry and Economics (DTIE), Report publication, 1-346; ISBN: 978-92-807-3479-9. Retrieved August 10, 2022. https://eprints.whiterose.ac.uk/99773/1/GWMO_report.pdf