

## BOOKS REVIEW



### WASTE MANAGEMENT IN DEVELOPING COUNTRIES

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The book is aimed at a broad readership, from sector experts to readers without consolidated experience in this field. Indeed, through its 12 chapters, the book provides a detailed analysis of the state-of-the-art of solid waste management (SWM) in developing countries (DCs), appropriate technologies to be adopted, and the impact of inadequate SWM on the environment and human health, also considering the greenhouse gas (GHG) emissions. Social aspects are also discussed. World-renowned experts were involved in writing the book.

The first Chapter summarises crucial waste characterisation, collection, and transportation elements. It is stressed that the world population will continue to grow significantly over the next few decades, with a prevailing push coming from DCs. Consequently, solid waste gener-

ation will increase in those regions, and appropriate strategies will be crucial to avoid making the situation more troublesome. Furthermore, it is highlighted that waste management planning, design, and implementation depend on using reliable data. The authors emphasize that waste generation per capita, waste composition and density are essential elements to consider for developing adequate strategies, and they are strongly influenced by factors such as the regional income level and seasonal variation. All these aspects are essential, although sometimes underestimated.

Chapter 2 focuses on landfill disposal in DCs. The authors highlight that, in these areas, dumpsites often represent the prevalent SWM method. An innovative approach is presented based on the 3S idea (Sanitisation, Subsistence economic, Sustainable landfilling). Then, discussing the sustainable landfill, the authors introduce the concept of the bioreactor landfill, and among the possibilities, they identify the semi-aerobic landfill as probably the most appropriate in DCs. It is based on natural air ventilation, without high-technological tools, to favour oxygen in the waste mass by natural advection, speeding up waste stabilization and leachate nitrogen removal. Thus, considering that, at least in the short-medium term, in several DCs, a considerable amount of waste will continue to be disposed of instead of recycled or composted, the sustainable landfill appears strategic.

In Chapter 3, an innovative model (i.e., the WROSE) is presented and applied in a case study in South Africa. It aims to assess GHG emissions associated with SWM practices, considering alternative waste diversion pathways. Although similar models have been used internationally, the WROSE represents a reliable alternative with potential use in countries from the Global South. Additional interesting aspects concern the estimate of the landfill space savings associated with waste diversion.

In Chapter 4, an intriguing approach is discussed. It aims to identify the best leachate treatments for cost efficiency based on site-specific conditions. Thus, although it focuses on Latin American areas, it could also be implemented in other DCs (and probably even in industrialised countries). It could appear provocative to claim that leachate qualitative standards are often inefficient when only based on tabular limits; however, the author indirectly refers to the concept of health risk analysis that has spread over the last decades in Europe and the USA. Consequently, considering site-specific conditions, it is highlighted that the so-called fate and transport models should be applied to avoid resource squandering.

Chapter 5 implements the WROSE model in another South African case study, i.e., the Garden Route District

Municipality; thus, it has elements in common with Chapter 3. The authors compared three Scenarios:

- (1) the disposal of unsorted, untreated MSW to landfill;
- (2) unsorted and untreated MSW are mechanically separated, and then the organic fraction undergoes anaerobic digestion;
- (3) similar to the second scenario but with the organic fraction that undergoes composting.

Within a 50-year projection, the landfilling of all MSW represented the worst scenario in terms of GHG emissions, highlighting additional reasons for minimising the waste to be disposed of in such sites.

In Chapter 6, the legislative aspects of solid waste management are discussed. The gaps often affecting DCs are highlighted, particularly the lack of reliable data, financial availability, awareness, and regulations. Concerning regulations, the issues interest their adoption and enforcement; the latter is sometimes even more challenging as it requires well-established governance that allows efficient monitoring and control. Thus, solutions are discussed for E-waste, plastic waste, and legislation in general. Finally, the Waste Management Law 28-00 issued in 2006 in Morocco is presented as a case study offering engaging insights.

Chapter 7 deals with the waste informal sector, focusing on the MENA region. It is not easy to find such a detailed document on this topic; indeed, the organizational structure of the informal waste sector is described with great accuracy. Thus, the chapter is of undoubted value. However, the disorder that sometimes emerges in the text can make some parts of the Chapter challenging to follow. Experiences from three North African countries are presented, i.e., Algeria, Morocco, and Tunisia. It is emphasised that the informal sector may play a crucial role in DCs to improve waste separation and recycling, reducing waste disposed of in landfills and dumpsites, aiming at the circular economy. Issues affecting waste pickers are discussed, and several reasonable improvements are proposed, taking previous research and successful experiences as a reference.

Chapter 8 discusses the Max-Neef's Fundamental Human Needs (FHNs). They are used as social indicators of sustainability in the context of waste management, taking eight South African townships as case studies. The nine FHNs through which the authors assess waste management are the following: subsistence; affection; participation; creation; understanding; idleness; protection; freedom; identity. It is unique to find such analysis in technical manuals about solid waste, making the chapter a characterising element of the book. Additionally, the methodology used in the quantitative and qualitative data collection appears strong and can be taken as a reference for other studies. The only discordant note: the results could have been presented more clearly.

Chapter 9 introduces the concept of urban mining, i.e., actions and technologies aiming to recover materials and energy from products of the urban environment. Thus, focusing on South Africa, some of the high-priority waste streams identified by the South African Research, Develop-

ment and Innovation waste roadmap are considered: glass from MSW, waste tyres, paper mill sludge, and bone from organic waste. They are discussed, aiming at their reuse as building materials. Indeed, the massive amount of natural resources exploited worldwide in the construction and demolition sector and the waste produced must be kept in mind. Therefore, using waste as a resource to generate new hybrid materials represents a great opportunity.

In Chapter 10, composting is discussed. It must be kept in mind that the organic fraction represents the higher percentage of MSW generated worldwide. Thus, its sustainable management is paramount, and composting presents multiple advantages. Indeed, it extends landfill lifetime, reduces GHG emissions, and produces an organic fertiliser and soil improver. The authors stress that DCs need to improve composting regulations and show examples from industrialised countries. Some technical aspects are presented. Furthermore, the need for adequate compost quality standards is discussed, highlighting that they are rarely considered in DCs.

Chapter 11 introduces the biochemical conversion of waste with the primary purpose of producing biogas. Thus, anaerobic digestion (AD) is discussed. The authors point out that many kinds of organic waste can be used. However, such feedstocks can have different characteristics to be considered, including the pathogenicity and presence of chemical pollutants, mainly in the cases of manure and sludges, less for food and green waste; thus, pre- and post-treatments can be required. AD products are the biogas and the digestate, obtaining energy and material from waste, respectively. In DCs, the digestate can be used as a fertiliser, while the biogas is mainly for cooking or lighting. It must be considered that AD has already been used at the industrial level in industrialised countries; however, appropriate forms of such technology can also be implemented in DCs and are described in the Chapter. It is crucial to keep in mind that the biogas from AD represents a form of renewable energy strategic in fighting climate change; indeed, on the one hand, no fossil fuels are used; on the other hand, during biogas (mainly methane) combustion, CO<sub>2</sub> is generated. It is important to note that when landfills and dumpsites receive organic waste, methane is generated in anaerobic conditions, and it is a GHG several times more potent than CO<sub>2</sub>. The Chapter gives essential elements regarding challenges, benefits, and strategies to consider for making AD in DCs successful.

The last Chapter is dedicated to the thermochemical conversion of organic waste. Although it could appear a high-tech topic, it deserves to be discussed also for DCs. With this in mind, the authors investigate many technologies whose potential implementation depends on site-specific conditions. Thus, it is highlighted that the waste characterisation plays a crucial role. Among the technologies discussed, the one that could probably find more straightforward implementation in DCs is hydrothermal carbonisation. Indeed, temperatures between 180°C and 260°C are required, and the main product is hydrochar that can be used as solid fuel, activated carbon for gas and water purification, or soil amendment.

Overall, the book discusses a broad topic that would ap-

pear challenging to present exhaustively in a monograph. Notwithstanding, it succeeds and adequately examines technical, governance, social, legislative, and environmental aspects of SWM in DCs. It has all the potential to represent an excellent scientific reference for anyone wanting to deal with the topic or merely understand more about it.

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