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Editorial

Municipal Solid Waste—Addressing Environmental Concerns

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The current global situation demands a comprehensive and efficient approach to waste management to mitigate environmental impacts. This Editorial highlights several research papers from the Special Issue on Municipal Solid Waste Management in the journal *Sustainability*, contributing to the field of waste management by offering innovative solutions and tools for decision making. These studies explore various aspects of waste collection, landfill site selection, partnership formation, biochar utilization, incentive mechanisms, assessment methodologies, and addressing electronic waste concerns. The findings and insights presented within these papers stimulate discussion and provide valuable guidelines for policymakers, waste management professionals, and stakeholders.

During our working period, we received many submissions, which had significant contributions to the main topics of interest of our Special Issue. However, only eight high-quality papers were accepted after several rounds of strict review. These eight contributions are summarized in this Editorial, being integrated into a coherent narrative.

The papers highlighted in this e-book contribute to the advancement of waste management practices by exploring novel methodologies, technologies, and strategies. Through their findings, policymakers, waste management professionals, and stakeholders can make informed decisions toward sustainable waste management practices. By ensuring efficient waste collection, proper site selection, fostering partnerships, utilizing biochar, implementing incentive mechanisms, assessing alternative treatment strategies, analyzing waste patterns, and utilizing under-utilized assessment tools, we can collectively work towards a cleaner and greener future.

These studies play a crucial role in enhancing our comprehension of waste management strategies and their environmental implications, highlighting the significance of sustainable practices and well-informed decision making in this field. They primarily revolve around two key themes: "Municipal Solid Waste Management and Treatment" and "Improving waste management systems in developing countries: Challenges and solutions".

The "Municipal Solid Waste Management and Treatment" theme focuses on papers that explore various aspects of municipal solid waste management, including assessing environmental performance, landfill site selection, partnership for enhanced services, and incentive mechanisms. It highlights different approaches and strategies for managing municipal solid waste. The Municipal Solid Waste Management and Treatment theme revolves around papers that delve into waste treatment strategies, analysis methodologies, and waste development and management. It emphasizes the importance of utilizing tools such as life cycle assessment and material flow analysis for informing effective waste management practices.

When we group the eight papers into two key themes, it helps us to thoroughly analyze and understand the contribution of each study to the main lines of waste management issues. By categorizing them into distinct themes, we can identify the specific areas of waste management that each paper addresses and the unique insights and perspectives they offer. This, in turn, enables us to gain a more comprehensive understanding of the current state of waste management and the challenges that need to be addressed moving forward.

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Four papers discuss different aspects of managing municipal solid waste, such as collection, landfill site selection, partnership for waste management services, incentive mechanisms for disposal projects, and waste treatment strategies (Contributions 1–4). These papers share a common focus on improving the environmental performance and efficiency of municipal waste management processes.

Municipal solid waste (MSW) is currently a global concern, considering the exponential growth of the population, industrialization, and urban expansion (Contributions 2 and 5). This is due to the generation of large volumes of solid waste, as well as the inadequate disposal of these solid wastes, which is now a significant environmental problem faced by society (Contribution 6). The definition of MSW includes waste from various sources such as domestic wastes, commercial establishments, institutions, industries, and construction. This broad spectrum of sources contributes to its volume, influenced not only by external factors, but also by individual decisions along with improvements in lifestyle, such as the increasing demand for plastic products and packaging, as evidenced by the growing body of literature published in the field [1,2]. People need to be more aware and adopt behaviors that contribute to environmental sustainability.

Urbanization, characterized by the growth of urban and coastal areas due to significant migration, directly conditions coastal zones. Regardless of the waste category, improper waste management can lead to the degradation of air and water quality, risks to public health, harmful emissions contributing to climate change, and ocean contamination by microplastics, underscoring the urgency of sustainable waste management practices. The relationship between terrestrial, coastal, and marine environments is vital for successful waste management, recognizing that coastal issues can directly impact marine ecosystems (Contribution 2).

The choice of waste treatment strategy for a specific city remains one of the most complex challenges in waste management. Environmental, social, and economic considerations must be thoroughly assessed to ensure an integrated and truly sustainable approach, aiming for a cleaner and more resilient future (Contribution 3).

The other group of papers explores different aspects of waste management, including electronic waste (e-waste), landfill site selection, alternative energy sources, and municipal waste (Contributions 5–8). Together, these papers contribute to holistic understandings of waste management and provide valuable insights for policymakers and practitioners in the field.

This theme sheds light on the challenges faced by developing countries in implementing effective waste management systems. Lack of infrastructure, limited resources, and population growth contribute to the urgency of addressing these issues. The study proposes solutions such as public–private partnerships, community engagement, and technology transfer to overcome these challenges and achieve sustainable waste management practices.

Some studies highlight the importance of implementing sustainable waste management practices in self-governing regions. By analyzing data trends and evaluating waste management strategies, the research points out valuable insights for policymakers and waste management practitioners, ultimately contributing to more effective waste management practices. Additionally, exploring potential sustainable alternatives in coal-fired power plants by utilizing sewage-sludge- and food-waste-based biochar is emphasized. By studying the characteristics and combustion behavior of biochar, the research proposes a feasible solution that not only reduces waste disposal, but also decreases greenhouse gas emissions.

The increase in e-waste is a direct consequence of population growth, which has gained significant attention from governments, industries, the academic community, and civil society organizations, as it is one of the fastest-growing waste streams globally. This concept includes all discarded electrical and electronic devices without the intention of reuse. E-waste represents a considerable challenge to current management practices. Proper management of these wastes is crucial, as they contain hazardous substances such as heavy metals, flame retardants, and chlorofluorocarbons, which impact both human health and

the environment. Despite challenges in management, electronic waste also represents an attractive resource base for urban mining, containing precious metals valued in billions of euros. The complexity of managing these wastes has driven the development of tools such as material flow analysis (MFA) and life cycle assessments (LCA) (Contribution 7).

The energy recovery of urban solid waste is one way to achieve sustainable development. Among various options, some strategies stand out. The controlled burning of waste, known as incineration, takes place in specific furnaces designed for this purpose. It is an effective method for reducing waste volume by up to 95%, but its main disadvantage is the high cost. Incinerators necessitate an initial investment, maintenance, and operation. Although incineration generates electricity, it raises concerns due to the emission of micropollutants during the combustion process (Contributions 3 and 4). This technology has been identified as the most environmentally friendly when compared with others, such as landfill and mechanical-biological treatment [1]. Anaerobic digestion, targeted at high-moisture content waste, offers an interesting alternative as it generates a combustible gas composed of methane, carbon monoxide, and hydrogen. This method proves suitable for waste production on a smaller scale and can be a viable solution when combined with other fuels (Contribution 4). Biomass co-firing in coal-fired power plants has been widely recognized as an effective strategy to reduce CO_2 emissions into the atmosphere. Coal-fired power plants play a significant role in global primary energy consumption. Nevertheless, coal combustion is also a notable source of air pollution. Therefore, to mitigate this pollution, the co-combustion of biomass and coal is proposed, using various types of biomass such as agricultural residues, algae, wood processing residues, sewage sludge (SS), and food waste (FW). Sewage sludge, while a potential option, faces challenges due to its high concentration of heavy metals, which can contribute to atmospheric pollution (Contribution 8). The composting process is becoming increasingly popular in waste disposal, as it also simplifies the separation of recyclable materials. This method is the best option for soil remediation and restoring soil nutritional content. Furthermore, MSW composting is an economically viable option and can be implemented at any community level. The use of landfills represents the simplest, cheapest, and most common way to manage the disposal of MSW. However, it is the least environmentally friendly approach to waste disposal. The use of landfills compromises the efficiency of waste disposal and can lead to serious issues such as groundwater contamination and air pollution due to the release of harmful gases from landfills, as well as soil contamination (Contribution 4).

The selection of the landfill site is a relevant and necessary issue for waste management. However, it is an extremely complex task as it must take into account various environmental, economic, and sociopolitical criteria that need to comply with stringent regulations and respond to different opinions [3]. The arbitrary and non-scientifically based selection of sites for solid waste disposal implies potential threats to the health of the local population, especially those residing in the vicinity.

The increase in municipal solid waste generated in recent years has compelled waste managers to seek more effective, technically viable, environmentally efficient, and economically sustainable collection systems. The assessment of MSW services using performance indicators plays a crucial role in improving service quality. The collection, transfer, and transportation of MSW are affected by inadequate container collection systems, poor route planning, lack of schedule information, insufficient infrastructure, poor road conditions, and an insufficient number of collection vehicles. This becomes a growing problem for waste management organizations that must ensure efficient and economically/environmentally sustainable collection, transportation, separation, and final disposal (Contribution 1) [4,5].

LCAs are a very useful tool to analyze how each of the processes described above contributes to the overall efficiency landscape of waste disposal options. Additionally, they enable the assessment, in terms of energy demand and emissions of CO_2, SO_2, and NO_x, of collection and transportation systems.

Another concept under consideration is synergy, which emphasizes the need for collaborative and integrated approaches to address the complex challenges associated with waste management. This synergy promotes solutions that transcend boundaries, aiming for a more effective and comprehensive approach to urban solid waste management (Contribution 2).

The Municipal Solid Waste Management e-book contains papers that present innovative methodologies, technologies, and strategies that significantly improve waste management practices. These insights can help policymakers, waste management professionals, and stakeholders make informed decisions for sustainable waste management. By ensuring efficient waste collection, appropriate site selection, fostering partnerships, utilizing biochar, implementing incentive mechanisms, evaluating alternative treatment strategies, analyzing waste patterns, and employing under-utilized assessment tools, we can collectively work towards a cleaner and more environmentally friendly future.

However, there are still obstacles that must be addressed to achieve true sustainability in waste management. These challenges include a lack of awareness and education, inadequate infrastructure and limited funding and resources, gaps in policy and regulations, technological limitations, and changing waste compositions influenced by social and behavioral factors. Addressing these challenges requires a comprehensive approach involving education and awareness campaigns, investment in infrastructure and technology, policy reform, and community involvement. By tackling these challenges, we can progress towards sustainable and environmentally friendly waste management.

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