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Comparison of environmental impacts related to municipal solid waste (MSW) and construction and demolition waste (CDW) management and recycling

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1. Introduction

Municipal solid waste (MSW) and construction and demolition waste (CDW) count about 70% of the total amount of solid waste generated at a global level (UNEP, 2015). Solving the management issues related to both waste fractions might support the transition toward a sustainable development, although it is a big challenge in low to middle income countries. In developing countries, MSW and CDW are used to be disposed of in open dumping areas, though the vast majority of the these wasted materials can be recovered or recycled (Ferronato and Torretta, 2019). Management and planning of these two waste fractions requires different approaches, too many times unknown by the policy makers and experts of low-middle income countries. Therefore, research related to the parameters and environmental impacts indicators of MSW and CDW are required in order to consider both management applications and issues. The research presented in this paper would answer to the following questions: "what is the environmental indicator that is most affected by MSW and CDW management system, respectively?" and, "which actions should be prioritized in order to reduce such environmental impacts?" It represents a novel contribution to the scientific literature, since scientific articles are mainly focused on the introduction of specific waste streams, without considering that SWM is a complex and heterogeneous system.

The LCA of the MSW and CDW management of La Paz (Bolivia) is implemented in order to evaluate which parameters and environmental impact indicators should be considered in order to prioritize technical interventions. La Paz is facing many environmental issues due to MSW and CDW uncontrolled disposal, collection, and landfilling. The lack of technological availability, the low financial support, and technical knowledge do not allow the improvement of the SWM system in short terms. However, the local municipal government is trying to support selective collection systems, the implementation of awareness campaigns and the introduction of new treatment plants (Ferronato et al., 2019). The results obtained by the LCA and the comparison among different waste stream provide a novel point of view to the international discussion related to the steps that should be made toward a circular economy in developing countries.

2. Methods

The LCA has been conducted with the software WRATE v.4, which allows modeling the environmental impacts of a SWM system. The functional unit is the amount of MSW and CDW generated in 2019 while the system boundary is the SWM system of La Paz, from the waste generation and collection to the final disposal. The objective of the LCA is to evaluate the environmental impacts generated by the system, comparing the MSW and CDW systems in order to evaluate management priorities for supporting sustainability. Recycling of MSW and CDW was also evaluated, in order to quantify the environmental benefits related to resource recovery. Six environmental impact indicators were assessed: Depletion of abiotic resources (kg Sb-eq), human toxicity potential (kg 1,4-DCB -eq), Freshwater aquatic ecotoxicity potential (kg 1,4-DCB -eq), Acidification potential (kg SO_2-eq), Eutrophication potential (kg PO_4^{3-} -eq), and global warming potential (kg CO_2-eq).

The information related to the SWM system of La Paz were collected through field analysis, interviews, and the assessment of local documentation, as well as the cooperation with local and international partners. LCA modeling has been supported by the introduction of local data about the MSW and CDW generation, collection system, and waste flows. The database of the software WRATE v.4 has been used when local data were not available. The environmental impacts were presented in terms of European person equivalent (PE) in order to make comparable the waste fractions assessed. Sensitivity analysis related to the recycling rate of MSW and CDW were also implemented for assessing the main environmental impact indicators which are benefit by waste recycling.

3. Results and Discussion

Results are reported in Figure 1. The main environmental impact indicator affected by the MSW management system is the global warming potential, while the CDW affects the most the freshwater ecotoxicity potential. In both cases, the final disposal in sanitary landfill and open dumping areas is the main source of environmental impact.

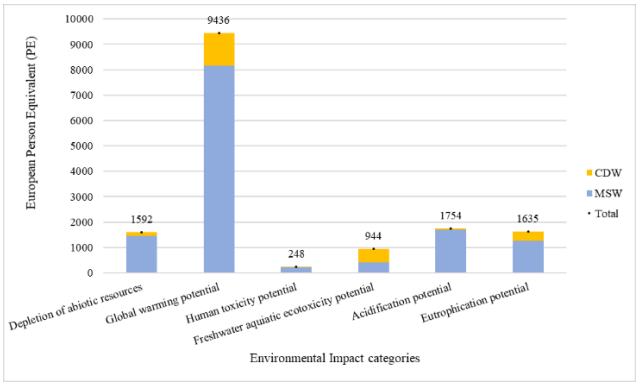

Figure 1: Environmental impact indicators normalized related to CDW and MSW.

Therefore, final disposal should be minimized for both cases. For MSW, efforts should be spent for the recovery of the organic fractions, while for the CDW the reduction of the inert aggregates should be prioritized in terms of quantities disposed of. Open dumping of these waste fractions affects the water bodies, therefore uncontrolled disposal should be avoided. At the same time, priorities in MSW final disposal areas should be also guaranteed, achieving high efficiencies of landfill gas collection.

Recycling can be an opportunity of waste recovery for both waste fractions. However, recycling of inorganic waste related to MSW does not reduce considerably the global warming potential, while CDW recycling can be affected by transportation distances and recycling efficiencies. In addition, not all environmental impacts indicators are benefit by recycling.

4. Conclusions

Knowing the most important environmental impacts generate by the SWM, it is easier to prioritizing efforts related to SWM. The research provides evidence about the most important indicators that should be considered for MSW and CDW, waste fractions involved within the SWM of a megacity like La Paz. Recycling can be an option to waste treatment, although it does not allow to obtain always positive effects. Transportation distances should be evaluated since they might affect the benefits related to the reduction of virgin material use. At the same time, the most important environmental impacts are not always benefit by recycling. These results can be of interest for decision makers and experts in the field of solid waste management for implementing SWM projects for reducing environmental impacts and improving sustainability. Future research should be focused on integrated assessment of SWM, involving all waste fractions generated at municipal level.

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