Landfilling and soil conditioning of dredged sediments: evaluation throughout a life cycle assessment

Laura Ferrans[1,2], William Hogland[1]

[1]Department of Biology and Environmental Science, Linnaeus University, Norra Kajplan, Kalmar, Sweden
[2]Energy and Industry, Sweco, Gjörwellsgatan 22, Stockholm, Sweden

Phone: +46-723-999019
E-mail: laura.ferrans@sweco.se

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Introduction: Dredging of sediments is carried out worldwide to increase water levels or restore aquatic ecosystems. Sediments in land require proper management and traditionally were taken to landfills of discharge in open oceans. However, these methods are restricted by environmental and legal reasons. Open ocean discharge can pollute other ecosystems and is forbidden in several countries. Moreover, landfills produce leachate and methane, which can negatively impact the environment. Alternatives to handle dredged materials are required and the use for beneficial purposes is an option that also contributes to stopping the depletion of natural resources sources [1]. Nutrients are essential for life and some like phosphorous are limited on the planet. Therefore, more sustainable sources are required. Dredged sediments commonly contain nutrients that can be recovered for beneficial uses. The use of dredged material as a soil conditioner can provide nutrients to soils and additionally enhance physical properties like water retention [2].

The evaluation of management scenarios for dredged sediments is fundamental to determining the best alternative in environmental, economic, social and technical terms. This study focused on the assessment of soil conditioning and landfilling using a life cycle assessment to evaluate the environmental impacts caused by the scenarios.

Methods: A life cycle assessment (LCA) was conducted to analyse the environmental impacts of (S1) landfilling and (S2) soil conditioning of dredged sediments from Malmfjärden bay, Sweden. The LCA software EASETECH [3] from Denmark Technical University was employed for the modelling. The scenarios contemplated the impacts caused from transportation from the treatment site until final use/disposal. The functional unit was 22 tons of sediments, and the selected evaluation method was ReCiPe V1.11 Hierarchies Europe.

Results: The impacts caused in both scenarios are shown in Table 1 that includes the main categories of global warming, toxicity and eutrophication. The results are provided in personal equivalent (PE).

Tab. 1: Impacts caused in landfilling and soil conditioning of dredged sediments in PE (positive and negative values show negative and positive impacts, respectively)

Scenario	Total*	Global warming	Eutro-phication	Toxicity
Landfilling	0.6	0.03	0.01	0.4
Soil cond.	-6	0.1	0.64	-5

*Includes other categories

Discussion: The scenario with higher negative impacts was landfilling and the most impacted categories were global warming, toxicity and eutrophication. The activity that caused most of the impacts was the operation of the landfill. The facility was modelled containing environmental protection measurements to collect leachate and methane. However, the emission of the collected methane and the treated leachate were responsible for causing the previously mentioned environmental impacts. The scenario had no-extremely high negative impacts, showing the importance of including protection measurements in landfills.

The second scenario had an overall positive score, and the positive impacts were related to the avoidance of producing and using fertilisers. However, the scenario presented negative impacts in the categories of toxicity, global warming and eutrophication. The impacts were caused during the spread of sediments due to the possible metal and nutrient emissions. Moreover, the decomposition of organic matter produced methane, affecting global warming. The overall score of the scenario showed the positive impacts to avoid using fertilisers; however, proper uses shall be considered to avoid polluting soil and aquatic ecosystems.

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References: [1] Akcil et al. (2015) *J. Clean. Prod.* **86**:24-36; [2] Renella et al. (2021) *Sustainability* **13**; [3] Clavreul et al. (2014) *Environ. Model. Softw.* **60**:18-30.