Assessing circularity of inland dredging activities: a new tool for the Dutch Water Authorities to pave the way towards a circular economy of dredge sediments

Eldert Besseling[1], Fred de Haan[2], Ewoud Volbeda[1], Jip Koster[1], Vincent van Zelst[3], Luca Sittoni[3,4,5]

[1]NETICS BV, Edisonweg 10 (-300), Alblasserdam,The Netherlands
[2]Waternet, Waterschap Amstel Gooi en Vecht, Korte Ouderkerkerdijk 7, 1096 AC Amsterdam, The Netherlands
[3]Deltares, Boussinesqweg 1, Delft, The Netherlands
[4]EcoShape – Building with Nature, Spuiboulevard 210, Dordrecht, The Netherlands
[5]chair PIANC Working Group 214, Boulevard Roi Albert II 20, Brussels,Belgium

Phone: +31-6-2296-0671
E-mail: Eldert@Netics.nl

Introduction: Exposure to the climate change effects is increasing due to growing population and economy. These developments go hand-in-hand with increased pressure on natural habitats and resources. Contributing to a more sustainable environment, economy and society, as agreed by the United Nations in the sustainable development goals, circular economy has gained more and more interest among policy makers, scientist and industry all over the world. Circular economy (CE) aims to shift away from the classical linear – take – make - use – and – waste approach and establish a balance resulting in an economy that fits in Earth's boundaries including the environment and society (EU, 2017). While a clear political and societal momentum towards a CE is emerging, many different circular economy concepts exist (Kirchherr et al., 2017).
Translated to sediment management practices, the beneficial reuse of dredged material matches perfectly the philosophy of circular economy (Brils et al., 2014). Sediments to be dredged and often seen as waste offer a natural resource that can be applied over and over again in many sustainable applications. To date uptake in practice is limited mainly caused by a lack of knowledge (Besseling et al. 2019). However, ambitious circularity goals of national governments and water authorities provide opportunities to put theory into practice.

Methods: The Dutch Water Authorities have set an ambitious target to become 50% circular by 2030 and 100% circular by 2050. The main resource flow within the work package of the Water Authorities consists of locally dredged sediments. The key question addressed is how the Water Authorities can manage this resource flow in a circular manner. Deltares and NETICS are working closely together with 19 of the 21 Dutch Water Regional Authorities to answer this question and setup a quantitative tool to measure and guide the circularity of dredge sediments projects.
Most of the circularity concepts are focused on technical materials and technical products. Dredged sediments differ from these products as sediment as a natural resource is a biological material (Ellen MacArthur Foundation, 2015a). This factor gave rise to a circularity definition that, while based on circularity ingredients typical of technical materials, specifically focuses on biological resources (i.e. dredged sediments). This definition follows three main principles: 1) maximise benefits and added value for economy, environment and society. 2) strive to close cycles and re-use in high quality products, 3) minimize waste. In addition, key factors are following natural processes (what mother nature would do) and stakeholder engagement (Besseling et al. 2019).
A circularity tool for dredged sediments is set-up that assesses the level of circularity of dredging projects. These projects include the use of various dredging methods, transport distances, transport mediums and applications.
Assessment of the level of circularity is based on four criteria groups: costs and added value, volumes, emissions and system impact. The tool includes e.g. emissions by dredging machines and transport, but also greenhouse gas (GHG) emissions from ripening of sediments. The latter involves complex biochemical processesthat are subject of ongoing scientific research. We acknowledge that these processes are hard to predict accurately, however emissions from ripening cannot be neglected. For this reason, we included an adapted formulation of Middelburg (1989) and guidance to estimate GHG emissions from ripening using the current knowledge base.
Three most common pathways (i.e. dredging project chains) are selected based on case studies in discussion with the Water Authorities and a group of external experts. These particular cases include the re-use of sediment directly at the dredging location, beneficial use in a revetment and disposal of contaminated sediments. These case studies are used to assess the performance of the new circularity tool for dredged sediments. The tool will be expandable with other chains and can be tailor made by implementing client-specific data in the catalogue which forms the database of the tool.

Results and discussion: The circularity tool is available as a user-friendly desktop application that is designed specifically for (freshwater) dredging activities for Water Authorities. The tool assigns a score (similar to an energy label) to possible pathways based on user input. It will stimulate sustainable dredging and contribute to the ambitious targets for a 100% circular economy in 2050.
The assessment method and the tool are developed by NETICS and Deltares in close collaboration with the Dutch Water Authorities and are reviewed by an external expert panel. Nevertheless, we acknowledge that the tool, just like all models, is a representation of reality based on underlying the formulations. Further improvement and validation should be carried out prior to wide-use for practical applications.
This presentation will give insight in the definition of circular economy for dredged sediments and introduces the science-behind and the features and results of the new circularity tool.

References:

[1] European Commission (2017). Booklet Circular Economy Research and Innovation – Connecting economic & environmental gains. B-1049. Brussels.
[2] Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, conservation and recycling*, *127*, 221-232.
[3] Besseling, E., Sittoni, L., Janssen, S. (2019). Onderzoek circulair gebruik van bagger bij de waterschappen.
[4] Brils, J., de Boer, P., Mulder, J., & de Boer, E. (2014). Reuse of dredged material as a way to tackle societal challenges. *Journal of soils and sediments*, *14*(9), 1638-1641.
[5] Ellen MacArthur Foundation (2015a), "Towards a Circular Economy: Business Rationale for an Accelerated Transition''
[6] Middelburg, J. J. (1989). A simple rate model for organic matter decomposition in marine sediments. *Geochimica et Cosmochimica acta*, *53*(7), 1577-1581.