Dredged sediments as a plant-growing substrate: Potential source of nutrients

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Introduction: Dredging of sediments is a common worldwide activity to increase the water depth of bays or restore aquatic ecosystems. On land, dredged sediments require a proper disposal management option. Traditionally, landfilling and open-ocean disposal were the most frequent solutions to handle dredged sediments. However, the methods are restricted by environmental and legal reasons such as the potential pollution to other ecosystems. Finding alternatives to traditional dumping methods has converted into a priority to enhance the sustainable management of dredged sediments [1].

Beneficial use of sediments represents an option to manage the material safely, and it could contribute to cease the depletion of natural resources [2]. Nutrients are essential for life, and therefore new sources are required, especially for limited elements on Earth such as phosphorous [3]. Unpolluted sediments could be employed as a plant-growing substrate in gardening, plant-nursery or agriculture, where the plants will directly up-take the nutrients found on the sediments.

Kalmar is a municipality located in south Sweden and has a semi-enclosed bay named Malmfjärden. The water body is connected to the Baltic Sea and currently is shallow and presents eutrophication problems. The LIFE-SURE project aims to test in the bay a new environmental-friendly dredging technique. The dredged material is intended to be used in beneficial uses to improve the implementation of a circular economy in the region. The aim of this study is to use dredged sediments as a plant-growing substrate to cultivate *Centaurea cyanus*, which is a flower that enhances bee pollination.

Methods: Dredged sediments were extracted from the dewatering treatment system belonging to the LIFE-SURE project. The material was collected manually from an equalization tank, where the fresh dredged material is firstly retained. The sediments were settled in the bottom of the tank and were collected using a pre-cleaned shovel. The collected material was stored on pre-cleaned and acid-washed plastic boxes that were later stored at 4 ºC, before analysis.

Pure sediments (100% sed) and a mix with sand (50% sed - 50% sand) were used as the plant-growing substrate. Sand was selected since it does not provide nutrients, but it could improve the water holding capacity of the sediments. Before and after the experiment, each substrate was characterized to determine the particle size and the concentration of metals and macro and micro-nutrients. The samples were analyzed in certified external laboratories.

The experiment was run for three months under controlled conditions in a semi-automatic greenhouse. The light:dark period was fixed to 16:8 hours. The temperature was always between 25 +/- 2 ºC, and the humidity was in the range between 65 +/- 3 %. The substrates were watered manually to always maintaining a soil moisture of 50%. At the end of the experiment, the cultivated plants were characterized to analyze metals.

Fig. 1: Plants in the greenhouse experiment

Results: The sediments were mainly constituted by silt and clay and had a medium-high concentration of nitrogen and phosphorous. The metals (As, Pb, Cd, Cr, Ni, Cu, and Zn) had a medium-low concentration. The flowers grew in both 100% sed and 50% sed - 50% sand substrates; however, the plants never reach a length higher than 15 cm (see Fig. 1). Fertilizers were never added, suggesting that the plants directly up-took nutrients from the sediments. The obtained flowers presented a medium concentration of metals.

Discussion: The sediments from Malmfjärden are a promising material to be used as a plant-growing substrate. In the future, other mixing materials (such as compost) are recommended to improve the harvest of plants. The method could also be employed to remove metals from contaminated sediments.

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References: [1] Akcil et al. (2015) *J. Cleaner Production* **86**:24-36; [2] Ferrans et al. (2019) *Adv. Geosci* **49**:137-147; [3] Li et al. (2019) *Sci* **648**:1244-1256.