Testing of heavy metals recovery from dredged sediments

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Introduction: Dredging activities are necessary to maintain the navigation depth of harbors and channels. Additionally, dredging can prevent the loss of water bodies [1]. A large amount of extracted sediments is produced around the world [2]. The removed material is widely disposed of at open seas or landfills [1]. Much of the dredged material is polluted and is classified as unsuitable for open-sea disposal [3]. Traditional sediment disposal methods are constrained by regulations and are unsuitable due to their possible contamination, lack of stability, and limited space capacity [1]. Finding new disposal routes for sediments become a challenge for environmental managers [2].
The municipality of Kalmar, located at the southeast coast of Sweden, has a semi-enclosed bay named Malmfjärden (See Figure 1). The water body currently presents problems of shallowness and slight pollution. The municipality of Kalmar along with Linnaeus University planned a project to recover the Malmfjärden bay. The LIFE-SURE project links up the public, industrial and academic sectors to demonstrate a sustainable dredging method. Conservation of the bay is essential to protect the natural ecosystem and enhance the landscape and tourism of the area.

Fig. 1: Location of Kalmar, southeast Sweden

The LIFE-SURE project plans to reuse the majority of the dredged sediments. Possible uses include as soil conditioner, raw material for construction and filling, and as a source for heavy metals and nutrients.
This study aims to retrieve sediments from the bay, and to characterize and test recovery of heavy metals.

Methods: The sediments were sampled from 30 different locations. A core manual sampler (Plexiglas tube- 1m long) was employed for sampling. Triplicates were collected in each station. Each core was divided into the top layer (0-20 cm) and the bottom layer (21-60 cm). Before analysis, the samples were refrigerated at 4ºC.
Physical parameters such as particle size and loss of ignition were analyzed at LNU laboratories. The concentration of heavy metals, nutrients and organic pollutants were analyzed at external laboratories.
The extraction test of heavy metals was performed in a magnetic stirrer. The chelating agents selected were ethylenediaminetetraacetic acid (EDTA) and Ethylenediamine-N,N'-disuccinic acid (EDDS). The concentration of the agents was tested for 0.01M and 0.05M. The pH was evaluated in a range from 4 to 8. The contact time and liquid to solid ratio were constant with values of 24 hours and 25:1 respectively.

Results: The sediments from Malmfjärden are mainly constituted by silt and clay. There is none or little presence of organic pollutants (PAH, PCB and aliphatic components) and low-medium concentration of heavy metals.
The removal of iron was low with rates lower than 10%. Higher removal was obtained for vanadium and copper with values between 20-30% and 50-60% respectively.

Discussion: Chemical leaching is a potential technique to recover heavy metals from marine sediments. The efficiency of the process depends on several variables such as pH, contact time, chelating agent and its concentration, and availability of heavy metal. Future experiments should focus on optimizing the process to bridge the gap between laboratory and real full-scale implementation.

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