

USAR Project: New optimization software for the formulation and the treatment of dredged sediments for valorization in civil engineering

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Introduction: In order to ensure the quality of service of harbor infrastructures, harbor managers organize dredging and cleaning campaigns. In France, more than 50 Mm³ of sediments are dredged each year [1]. Traditional management methods, such as immersion, are becoming more and more restrictive. Indeed, regulations become more and more constrained because of the presence of contaminants such as Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals in the dredged materials which could constitute a major issue for the environment if the sediments are not managed properly. To overcome this problem, finding alternatives as part of a sustainable development approach becomes a necessity. Several methods of management are developed to promote the use of sediments in civil engineering. Sediments are considered as a potential alternative of substitution of natural materials [2]. In this context, the USAR project (Using Sediment As a Resource) was initiated to promote and generalize the use of sediments as a secondary raw material for large-scale construction. In this contribution, we will present an optimization software for the formulation and the treatment of dredged sediments in civil engineering applications. The four areas concerned in this study are: road application, concrete, dike and spreading. The management of sediments requires significant resources which are often costly. In this context the purpose of the software is to propose an optimal solution that meets the different technical and environmental requirements at a lower cost.

Methods: In the optimization process, the software relies on several parameters that we have to define previously. Indeed, the software is equipped with a geographical map that lists all the sediments of partner countries of the USAR project as well as the storage centers. This geolocation allows the assessment of the distances between dredging zones, storage centers and the location of projects. According to this information, the software will be able to compute the transport cost and integrate it into the optimization process. For each application, we have defined the environmental thresholds that sediments must meet. For this we have referred to the current legislation of each country/region. To verify that the sediments meet all the technical requirements

of use and dimensions for each application, the software is based in its calculation on formulation laws that we have implemented for each type of application. Indeed, to establish these laws, we first identified the decision criteria that rule the dimension of each type of work. Then formulation laws were developed, predicting the value of the desired use or sizing parameters on the basis of the sediment standard physical and chemical input data.

Results: The interactive software developed in the frame of this work is a powerful tool that facilitates sediment management by optimizing treatment and formulation processes. It has a database of dredged sediments, storage centers and acceptance thresholds. Four applications have been developed in this project. For each application (roads, dike, concrete, spreading), we have defined formulation laws to allow the assessment of the technical potential of a sediment valorization according to their features. These laws are subsequently implemented in the software, as well as economic and environmental components, and finally suggest the most suitable solution for the project.

Discussions: Given the complexity of the issue of dredged sediment management, it is necessary to have a decision support tool in order to guide the valorization domain efficiently. To address this issue the software developed in the frame of this work allows the optimization of the formulation and the treatment of dredged sediments by performing a technical, environmental and economic analysis to meet the expectations of the project.

Acknowledgements: As a partner, IMT Lille Douai thanks the USAR project partners for their contributions.

References: [1] Dubois V (2006) *Étude du comportement physico-mécanique et caractérisation environnementale des sédiments marins. Valorisation en technique routière*, Doctoral thesis, Ecole des Mines Douai [2] *Final Report Promoting Integrate Sediment Management* (2014).