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Mineral processing techniques dedicated to the recycling of river sediments to produced raw materials for construction sector

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Introduction: The accumulation of sediments in waterways constitutes a serious problem for navigation. In EU, dredged sludge is considered as a waste and is usually landfilled. However, river sediments could be a source of raw materials for construction if the right pretreatment is applied. In Belgium, the deposit represents 2.400.000 m³/year for 1.540 km of waterways. In France, this represents 2.800.000 m³/year river sediments for 8.501 km of waterways.

Several challenges have to be overcome to use river sediment as raw materials for building sector, including social, legislative, economic and still technical or scientific. The most important challenge remains the presence of organic matter, which influences mechanical properties [1] of building material made with sediments, or influence properties of bricks [2], and the risk of leaching-out of pollutants.

Methods: Mineral processing techniques can be used to help for the recycling of river sediments. Dry or wet techniques has to be used to remove easily extractable pollutants like anthropogenic materials (plastic bottles, metal cans...), as well as to isolate several valuable fractions (sand, silt or clay).

Results: Dry techniques were demonstrated in the INTERREG project VALSE. This project regroups Walloon, Flemish and French partners who target to build a cycle track using sediments-bearing concrete. The pretreatment of the dredged sludge will consist in several steps: sieving, partial dehydration and finally deagglomeration of the sediments before adding into the concrete formula. The treated river sediments can further be used as a substitute for sand in a concrete formula.

In many cases, wet techniques are more suitable to treat river sediments, even if a more advanced separation is required. This has been demonstrated in a previous ERDF project named SOLINDUS, in the form of the building of a pilot station of approximately 1 ton/h. This pilot station was also used in the VALSE project. Anthropogenic materials were removed from the coarser fraction of river sediments by using trommels and vibrating screens. Coarse sand (size from 2 mm to 250 µm) can be extracted using a curved grid and fine sand (from 250 to 63 µm) can be separated using either a screw classifier or a bench of hydrocyclones. Then silt (between 63 and 15 µm) can be separated from the mixture of clay and fine silt (under 15 µm) using finer hydrocyclones. At the end of the process, the solids are flocculated and filtered.

These separations allow to concentrate the heavy metal pollution in the finest fraction and therefore reduce the volume of polluted materials.

Sand fractions can be washed using attrition and spiral techniques. The rubbing induced by attrition liberates the pollutants linked to the sand particles and spirals allow to separate light from dense particles, thanks to centrifugal forces.

After separations, clay and silt are recovered in water suspensions, which contain most of the pollutants, especially the heavy metals. Flotation techniques can be applied to remove heavy metals present as pollutants.

Discussion: The sand, silt and clay fractions of the sediments are therefore separated using wet mineral processing techniques, and are suitable to be used as raw materials for construction. The sand fraction can effectively be recycled into concrete, the silt fraction can be used in embankment or landscape butte, the clay fraction either in bricks or expanded-clay production.

This approach would contribute to circular economy objectives by reducing as far as possible the volume of sediments to be landfilled, and by reducing the demand of primary minerals.

References:

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[2] Mingwei Liu et al. (2018) Ceramics International