Automated surveying and evaluation of underwater slopes

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About 70% of the produced sand and gravel in Germany is extracted by so-called dredging – underwater mining. The management of these deposits is subject to the challenge of increasing automation, while increasing the yield and reducing the specific extraction costs (personnel, energy, wear). For each of these three core objectives, there are already numerous solutions and practical approaches. Achieving these three goals at the same time, does not seem possible at the present. Rather, they seem to be at odds: Maximum use of deposits goes hand in hand with lower production capacities, and therefore with increased costs. Automated dredging is borne by the output (mining losses today range from 15% to over 30%, depending on the used mining equipment and/or device-specific boundary parameters).

The extraction of gravel and sand in dredging operation usually does not take place from the the natural grain formation in the in-situ deposit. The material is extracted from slopes formed by a mixing process. An initially still relatively steep slope collapses at time X under its own load and forms a new “broken slope”. The slope angle of such broken slopes results from a complex of different deposit parameters; the shear strength of the soil is of particular impact, which in turn is significantly dependent on the angle of internal friction. The deposits considered here are usually sedimentary and therefore characterized in a horizontal and vertical direction by a heterogeneous composition. As a result, the slope angle of the broken slope is not a constant and can vary in small-scale. Furthermore, the time of “breaking”, the reallocation process from the working slope to the broken slope, within a deposit is not constant as well. During this reallocation process, which can also be described as a settlement flow, the gravel-sand material goes through a mixing process. Coarse material settles earlier, fine material continues to flow.

For the future planning of sand and gravel mining, current and widely collected information on the broken slopes must be available. For this purpose, the survey of the slopes must be decoupled from the dredger. Such approaches exist in practice already, with so-called drone boats, equipped with GPS and corresponding echosounders that can independently measure predefined lake areas. In a further development process, in addition to the spatial measurement of the broken slopes, information on the mixing of the excavated material during the reallocation process during a slope break is recorded. The collection of empirical data on the grain distribution of the dredged material, their allocation to the extraction position, makes it possible to obtain the spatial allocation of the material composition. If the information on the spatial and qualitative status of the broken slopes is available, a proactive mining plan can be carried out taking into account the maximization of the yield and quality control. In addition, the mining equipment management has to be optimized in the future, to move automatically, quickly, and accurately from one mining spot to the next adjacent spot. This ensures to win even the thin areas of broken slopes with a high extraction capacity.