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Tsunamis in the Caribbean Sea – Implications from coarse-clast deposits and the importance of their shape

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This presentation gives an overview of the results of a five-year research project on tsunami-induced boulder transport. It stresses the importance of the exact determination of boulder shapes in contrast to simplified bodies (such as cuboids), especially with regard to the transport distance. It also provides insights about a newly developed numerical boulder-transport model based on Pudasaini (2012). Additionally, some ideas how experimental research on tsunami-induced boulder transport may be improved and coordinated in the future will be presented.

The investigations by physical experiments are based on three boulder shapes of which one depicts the replica of an original boulder from the island of Bonaire (Caribbean Sea, Lesser Antilles). The experiments clearly reveal that the available impact area of the boulder has a great significance; however, this is so far insufficiently considered in analytical equations. In the given case, the comparison between the more streamline-shaped replica of the Bonaire boulder and an idealised cuboid boulder resulted in reduced transport distances of 30 %, in average. Additionally, statistical evaluations revealed that the entire process is highly sensitive with partly stochastic behaviour. Thus, we support the statement of Bressan et al. (2018) in this regard. We show, how important it is to calculate and communicate wave thresholds for mobilisation in terms of probability ranges instead of fixed values.

Based on the results of our own physical experiments and the evaluation of published physical experiments, we developed a tool, which supports researchers in assessing the accuracy of analytical equations for specific in-situ settings (Oetjen et al., 2021). This tool encompasses the crucial parameters (e.g., bottom roughness, boulder shape), combines their influence on the transport process and finally gives an indication of whether the present conditions tend to amplify or hamper the boulder transport. The benefit and the usage of the above-mentioned tool will be demonstrated exemplarily.

Furthermore, within the framework of the project a numerical Boulder-Transport-Model was developed which is based on the Immersed Boundary Method and the Two-Phase Flow Model of Pudasaini (2012). Insights into the functionality of the model and the importance of the increased flow density will be highlighted, while the further development steps will be indicated.

As part of the project, we also dealt with the future development of research on tsunami-induced boulder transport (cf. Oetjen et al., 2021). One important suggestion is to establish a standardised reference setup for experimental investigations within the research community. It would enable researchers to compare the results of their own experiments and the effect of the investigated parameters with well-documented reference values and assist them to evaluate and classify their experimental results accordingly.

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