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Revisiting boulder fields on Bonaire (Leeward Antilles)

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Blocks and boulders are typical sedimentary features of rocky shorelines worldwide. In many cases, their deposition is related to tsunamis or severe storms, though inferences of certain extreme wave events from the boulder record, and in particular the differentiation between storms and tsunamis, remain difficult. At the eastern coast of Bonaire (Leeward Antilles), numerous limestone boulders and blocks (up to approx. 130 t) are distributed on top of a 3 to 6 m a.s.l. (above mean sea level) palaeo-reef terrace. Disagreement exists among a number of scholars concerning the transport processes involved in the formation of these boulder fields. In this paper, numerical approaches of coastal boulder entrainment and transport were applied in order to provide new and more reliable data on their origin. To improve the reliability of the boulder transport model, more realistic input parameters were provided by DGPS measurements of the boulder dimensions (3D models by triangulation of point clouds using a GIS) and the calculation of bulk densities by taking into account the different coralline lithofacies of the reef-rock clasts. Boulder transport equations from literature were modified and now consider the irregular shape and real dimensions of the boulders and blocks. The results indicate that boulder weight and dimension, and thus calculated wave energy and wave heights were overestimated in most of the previous studies, where calculations of boulder volume were based on multiplication of the main axes. The results of this study and wave heights observed during recent high-magnitude hurricanes seem to rule out storm-generated waves for the dislocation of the largest boulders and blocks, and point to the occurrence of palaeo-tsunamis on Bonaire. However, the majority of coarse-clast deposits may have been generated by hurricane swells. The results underline the significance of more realistic field data in modelling boulder transport by waves.