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Tsunami Wave Height and Flow Velocity Calculations Based on Density Measurements of Boulders: Case Studies from Anegada and Pakarang Cape

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Abstract : Inundation events, such as storms and tsunamis can leave onshore sedimentary evidence like sand deposits or large boulders. These deposits store indirect information on the related inundation parameters (e.g., flow velocity, flow depth, wave height). One tool to reveal these parameters are inverse models that use the physical characteristics of the deposits to refer to the magnitude of inundation. This study used boulders of the 2004 Indian Ocean Tsunami from Thailand (Pakarang Cape) and form a historical tsunami event that inundated the outer British Virgin Islands (Anegada). For the largest boulder found in Pakarang Cape with a volume of 26.48 m^3 the required tsunami wave height is 0.44 m and storm wave height are 1.75 m (for a bulk density of 1.74 g/cm^3. In Pakarang Cape the highest tsunami wave height is 0.45 m and storm wave height are 1.8 m for transporting a 20.07 m^3 boulder. On Anegada, the largest boulder with a diameter of 2.7 m is the asingle coral head (species Diploria sp.) with a bulk density of 1.61 g/cm^3, and requires a minimum tsunami wave height of 0.31 m and storm wave height of 1.25 m. The highest required tsunami wave height on Anegada is 2.12 m for a boulder with a bulk density of 2.46 g/cm^3 (volume 0.0819 m^3) and the highest storm wave height is 5.48 m (volume 0.216 m^3) from the same bulk density and the coral type is limestone. Generally, the higher the bulk density, volume, and weight of the boulders, the higher the minimum tsunami and storm wave heights required to initiate transport. It requires 4.05 m/s flow velocity by Nott's equation (2003) and 3.57 m/s by Nandasena et al. (2011) to transport the largest boulder in Pakarang Cape, whereas on Anegada, it requires 3.41 m/s to transport a boulder with diameter 2.7 m for both equations. Thus, boulder equations need to be handled with caution because they make many assumptions and simplifications. Second, the physical boulder parameters, such as density and volume need to be determined carefully to minimize any errors.

Keywords : tsunami wave height, storm wave height, flow velocity, boulders, Anegada, Pakarang Cape
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