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Runup of tsunami waves on a plane beach: statistical approach

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Tsunami waves approaching the coast frequently cause extensive coastal flooding, destruction of coastal constructions and loss of lives. Its destructivity can be intensified by the seische oscillations in bays and harbours, induced by tsunami waves. Meanwhile, the process of tsunami wave runup on the coast is usually studied for incident solitary-like disturbances: this is a typical input in laboratory and numerical experiments. Theoretically, this process is studied in the framework of nonlinear shallow-water theory with the use of the hodograph (Legendre) transformation. Analytical solutions are obtained for initial disturbances as a solitary wave: soliton, Gaussian and Lorentz pulses, N – waves and some other pulses of specific shapes. All solutions (theoretical and experimental) do not take into account the real long tsunami record, which usually contains seische oscillations. Such oscillations can be considered as a quasi-stationary random process with known statistics. In this paper the runup of irregular waves on the plane beach is studied in the framework of nonlinear shallow-water theory with an assumption of the non-breaking runup. Typical period of seische oscillations in harbours is 15 -45 min that provides validity of this assumption. Statistical analysis of the runup characteristics (water displacement and shoreline velocity) is carried out for an incident wave field with the Gaussian distribution. The probability density function of the runup characteristics is not Gaussian, and its deviation from the Gaussian distribution can be expressed through the breaking parameter or a self-similarity parameter.