# Tsunami runup by Lagrangian description

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**Abstract:**

Tsunamis can be generated by underwater earthquakes or by landslides. Mathematical models are useful for advanced warning and for estimating possible damages in order to design coastal protection. Rational predictions must include both transocean propagation and coastal runup. For the former task the linearized theory of dispersive waves is an adequate basis for computations. For coastal runup, nonlinearity must be accounted for. Based on Eulerian description coastal runup on an infinitely long beach has been solved by Carrier and Greenspan (1957) whose theory has been the cornerstone of tsunami prediction for half a century. Numerical computation for more complex coastal bathymetry is challenging because the moving shoreline is an unknown boundary and must be found as a part of the solution. For certain free boundary problems the use of Lagrangian description can be more advantageous. In the Eulerian description, all physical quantities are functions of fixed field points and time. In the Lagrangian description they are defined at the instantaneous position of each fluid particle. As a result the position of the free surface is known at all time, as required by the kinematic condition. The use of Lagrangian coordinates in nonlinear long waves was started by Airy (see Lamb, 1932, pp 259-260). Applications to tsunami has been made by Shuto (1967,1968,1978) who showed that runup predicted by linearized Lagrangian equations give good runup predictions. Further application to tsunami along an open coast have been reported by Goto (1979, 1980) and Fujima 2007).