Geophysical Research Abstracts
Vol. 12, EGU2010-2588, 2010
EGU General Assembly 2010

Modelling of Charles Darwin's tsunami reports

Shamil Galiev

Department of Mechanical Engineering, The University of Auckland, Auckland, New Zealand (s.galiyev@auckland.ac.nz)

Darwin landed at Valdivia and Concepcion, Chile, just before, during, and after a great 1835 earthquake. He described his impressions and results of the earthquake-induced natural catastrophe in The Voyage of the Beagle. His description of the tsunami could easily be read as a report from Indonesia or Sri Lanka, after the catastrophic tsunami of 26 December 2004. In particular, Darwin emphasised the dependence of earthquake-induced waves on a form of the coast and the coastal depth: '… Talcuhano and Callao are situated at the head of great shoaling bays, and they have always suffered from this phenomenon; whereas, the town of Valparaiso, which is seated close on the border of a profound ocean... has never been overwhelmed by one of these terrific deluges…' . He reports also, that '… the whole body of the sea retires from the coast, and then returns in great waves of overwhelming force ...' (we cite the Darwin's sentences following researchspace. auckland. ac. nz/handle/2292/4474).

The coastal evolution of a tsunami was analytically studied in many publications (see, for example, Synolakis, C.E., Bernard, E.N., 2006. Philos. Trans. R. Soc., Ser. A, 364, 2231-2265; Tinti, S., Tonini, R. 205. J.Fluid Mech., 535, 11-21). However, the Darwin's reports and the influence of the coastal depth on the formation and the evolution of the steep front and the profile of tsunami did not practically discuss. Recently, a mathematical theory of these phenomena was presented in researchspace. auckland. ac. nz/handle/2292/4474. The theory describes the waves which are excited due to nonlinear effects within a shallow coastal zone. The tsunami elevation is described by two components: . Here is the linear (prime) component. It describes the wave coming from the deep ocean. is the nonlinear component. This component may become very important near the coastal line. After that the theory of the shallow waves is used. This theory yields the linear equation for and the weakly-nonlinear equation for . The last equation contains the forcing term which is generated by nonlinearity and depends on . The nonlinear shock-like solution for is constructed which is valid within the narrow coastal zone.

Then the tsunami evolution near a coast is studied. It is found that the coastal evolution strongly depends on the profile of the bottom and the distance from the coastline. Far from this the wave surface is smooth and the wave is long enough. The wave profile begins to change quickly, if the coastal water is shallow. The steep (discontinuous) front of the tsunami can be generated. The water level reduces ahead of the front, or the ebb can appear there. Then this front begins to move away from the coast – into the ocean. This direction is opposite to the motion of the whole wave. The amplitude of the front is increased. The water wall is formed. This process explains the catastrophic effect of a tsunami, when a water-wall appears instantly. The wave, having two steep peaks, may be generated in the case of very shallow water. In contrast with this, the tsunami, practically, does not change, if the coastal water is deep.

On the whole, the conclusions agree with the Darwin's reports.