Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08348, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08348
EGU General Assembly 2008

Merging historical and geophysical datasets to model catastrophic mass wasting and tsunami events in the Nordfjord region of western Norway

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Valleys, lakes and fjords are spectacular features of the Norwegian landscape. Yet, their beauty often contrasts with the natural hazard that they represent. Three lacustrine systems in the Nordfjord region have been surveyed combining simultaneously 3.5 kHz (pinger) single-channel and 1 in3 airgun multi-channel systems. A seismostratigraphic analysis of the 1 in3 airgun multi-channel datasets allowed the identification of five major units defined by differences in the seismic facies. The lowermost seismic unit stands for glacial deposits in contact with the basement while the overlying seismic facies correspond to the subsequent sedimentary infilling reaching a total thickness of more than 60 m. Overall this succession is interpreted to reflect glaciomarine sedimentation during ice retreat and transition to marine and lacustrine sedimentation as glacio-isostatic rebound turned the fjord into a land-locked lake. In both the marine and lacustrine records there is evidence of variability of mass-wasting activity like large rock avalanches and debris-flows.

January 15th 1905 and September 13th 1936 are recorded in Norwegian history as dates of occurrence of the most devastating natural hazards in modern times. During these two catastrophes, large rock-falls collapsed into the valley provoking tsunami waves as high as 74 m and killing all together more than 135 people. Evidence for

these disasters appears in the seismic record as well as older unknown events preceding historical times. During the 1936 event over one million m3 of rock material collapsed into the lake from Mount Ramnefjellet, resulting in the formation of a megaturbidite, seiche and slide deposits that covered almost all the basin floor reaching up to 3 m thickness.

Using a physically-based mathematical model we have numerically simulated the 1936 landslide and related tsunami in order to better understand the effects of such events on a small lacustrine basin. This kind of dataset is the first in Norwegian lakes providing valuable information that can be further amalgamated with other historical, marine and terrestrial records. The geophysical data permit extending the identification of mass wasting events beyond the historical record providing a model that can be applied to comparable basins at various temporal and geographical scales.