Geophysical Research Abstracts
Vol. 20, EGU2018-17269, 2018
EGU General Assembly 2018

Probabilistic evaluation of the fault source of seismically induced mass-transport deposits: the example of Aysén fjord, Chile

Kris Vanneste (1), Katleen Wils (2), and Maarten Van Daele (2)

(1) Royal Observatory of Belgium, Brussels, Belgium (kris.vanneste@oma.be), (2) Renard Centre of Marine Geology (RCMG), Department of Geology, Ghent University, Ghent, Belgium

Many lakes and fjords throughout the world contain mass-transport deposits (MTDs) that have been triggered by earthquakes. These sediment archives are more and more studied to construct a record of past earthquakes. They often provide a more accurate chronology than is possible in paleoseismic trenches on land. However, because MTDs cannot usually be linked directly to the fault that caused them, assessment of the earthquake source (location and magnitude) proves more difficult. Based on comparison with observations of coseismically triggered mass wasting, previous studies have assigned minimum levels of ground shaking (or macroseismic intensity) required to generate different types of MTDs. Based on these intensity thresholds and the spatial distribution of MTDs, attempts have been made to infer the most likely earthquake source. These mostly rely on methods originally developed to estimate the location and magnitude of historical earthquakes based on intensity prediction equations (IPEs), but considering minimum intensities as actual intensity values.

Here, we develop an alternative method inspired by probabilistic seismic hazard assessment, and based on the probability of exceedance given by these IPEs. This approach simultaneously allows the possibility that the triggering intensity was larger than the assumed threshold and takes into account IPE uncertainties, two shortcomings of the existing methods. We implemented it in code built on top of the open-source hazard engine OpenQuake. This has the advantage that different distance metrics in IPEs are handled natively, more than one IPE can be applied simultaneously, 3-D rupture geometries are supported, and finite ruptures can be modelled in different ways (centered on a hypocenter or as part of a fault). The latter allowed further improvement of our method by considering a network of linked faults rather than uniformly gridded hypocentral positions.

We apply this new method to Aysén fjord, located in southern Chile alongside the Valdivia segment of the Peru-Chile subduction zone. Even though the 1960 Great Chilean earthquake (Mw=9.5) occurred on this segment, crustal earthquakes on the Liquiñe-Ofqui Fault Zone (LOFZ) have reached higher intensities in the fjord area. The LOFZ is a dextral strike-slip fault zone accommodating the parallel component of oblique subduction. It is a complex fault system containing several horsetail splays that intersect Aysén fjord. In 2007, an Mw=6.2 earthquake hit the fjord with intensities of VIII+, causing major landslides entering the fjord. A seismic-reflection survey showed that the sedimentary fill of Aysén fjord contains a record of at least five Holocene and possibly four older MTDs related to activity of the LOFZ. In a first step, we conduct a sensitivity analysis to evaluate the potential of the fjord to distinguish between different possible fault ruptures, and which IPE performs best. This analysis shows that the method works relatively well to resolve moderate earthquakes like the 2007 event on different fault sections intersecting the fjord. On more remote faults outside the fjord, only large earthquakes can be resolved, but similar probabilities are often obtained for lower magnitudes on faults closer to the fjord. Application to the MTD record is in progress.