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Seismic and tsunami hazard investigation in Valparaiso in the framework of the project "MAR VASTO"

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In the framework of the MAR VASTO Project (“Risk Management in Valparaíso/Manejo de Riesgos en Valparaíso”), completed in 2008 and funded by BID/IDB (Banco InterAmericano de Desarrollo/ InterAmerican Development Bank), managed by ENEA (Italian Agency for New Technologies, Energy and Environment), with the participation of Italian and Chilean partners and the support of local stakeholders, the most important hazards have been investigated carried out.

Valparaíso represents a distinctive case of growth, inside a remarkable landscape, of an important Pacific Ocean seaport (over the 19th and 20th centuries), up to reaching a strategic importance in shipping trade, declined after the Panama Canal opening (1914). Thus, Valparaíso tells the never-ending story of a tight interaction between society and environment, stratifying different urban and architectonic layers, sometimes struck by disasters and always in danger. Certainly, the city has been subjected to various natural hazards (seismic events, but also tsunamis, landslides, etc.) and anthropic calamities (mainly wild and human-induced fires). These features make Valparaíso a paradigmatic study case about hazard mitigation, and risk factors must be very well evaluated during the restoration phases to be planned in the future.

Seismic Hazrad. The major goal is to provide a dataset of synthetic time series representative of the potential ground motion at the bedrock of Valparaiso, especially at selected sites (e.g. the three important churches located in the Valparaiso urban area: La Matriz, San Francisco, Las Hermanitas de la Providencia), for different scenarios; the characteristics of the calculated signals (e.g. amplitude, frequency content and duration of shaking) are determined by the earthquake source process and the wave propagation effects of the path between the source and the site. The synthetic signals, to be used as seismic input in a subsequent engineering analysis, have been produced at a very low cost/benefit ratio taking into account a broad range of source characteristics, path and local (geological and geotechnical) conditions. The realistic modeling of ground motion requires the simultaneous knowledge of the geotechnical, lithological, geophysical parameters and topography of the medium, on one side, and tectonic, historical, paleoseismological, seismotectonic models, on the other, for the best possible definition of the probable seismic source. Many parametric studies of the ground motion have been performed, taking into account the variations due to the choice of the focal mechanism parameters, the geometry of the seismic source and the rupture process.

Tsunami Hazard. The Chilean coast is currently exposed to the effects of near and far field tsunamis generated in the Pacific Ocean. For instance, the catastrophic events of the last century, 1868 and 1877, overwhelmed the coast of the northern region of the country. This historic situation has contributed to an awareness of the risk involved and therefore to the development of research on the subject in Chile. The organisation in charge of detecting and issuing the warning is the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA). The SHOA report has been used as the reference document for the tsunami hazard assessement for the Valparaiso site and it has been complemented with a) set of parametric studies about the tsunamigenic potential of the 1985 and 1906 scenario earthquakes; b) analytical modelling of tsunami waveforms for different scenarios, in order to provide a complementary dataset to be used for the tsunami hazard assessment at Valparaiso. Using as a base of knowledge the inundation map provided by SHOA associated to the 1906 event, an upper bound of the multiplication factor for the tsunami hazard associated to be used for the different scenarios has been obtained.