Master's thesis proposal

**Probabilistic seismic-tsunami hazard analysis of the urban water supply in Valparaíso and Viña del Mar, Chile**

# Background

Environmental hazards can have a severe impact on human infrastructure, and it is therefore of great interest to know more about the potential risk and how to prevent damages. In case of Valparaíso and Viña del Mar (Chile) the main hazards are earthquake, tsunami, fire and landslide. [1] Regarding the seismic and tsunami hazards, multiple events have been recorded in Chile that have caused major disruptions to the infrastructure. [1] Within the project ‘Multi-risk analysis and information system components for the Andes region’ (RIESGOS) Valparaíso is the pilot region for the multi-risk scenario of an earthquake with following tsunami. [2]

Having this in mind, the idea is to do a probabilistic seismic hazard analysis (PSHA) for the urban water supply of the two communes in Chile with taking the tsunami hazard into account.

For this an exposure model is needed to represent the characteristics of the network. Dependent on which level the risk assessment is conducted (component level, connectivity, serviceability or functionality) different analyses of the network are required. [3] In case of water networks pipelines and water tanks are the main elements of which the behavior in case of an hazard scenario needs to be known. [4] To account for the hazard scenarios a stochastic event set of potential earthquakes is simulated, also called seismic catalogue. This catalogue contains the characteristics of earthquake events (location, magnitude, orientation) [5]. These characteristics can be inserted into a ground motion prediction equation to get a “statistical estimate of the expected ground motion and its standard deviation due to a given earthquake scenario” [6]. With fragility functions the obtained intensity measures such as peak ground velocity (PGV) can be related to the repair rates (RR) for different types of pipes. [7] In case of the water tanks peak ground acceleration (PGA) is used. [7] To know the probability of exceeding a certain amount of loss, a loss exceedance curve can be constructed. [4] A detailed performance-assessment framework is given by Yang et al. [8] A simplified risk evaluation of the water distribution network in Valparaíso considering seismic hazard was already done by Castro et al. [9]

For this thesis also the tsunami hazard is taken into account. Here, a method combining PSHA with a probabilistic tsunami hazard analysis (PTHA), as it was done in a paper of Risi et al., could be used to compute seismic and tsunami hazard curves. [10] In case of a tsunami hazard the intensity measures are inundation height or flow velocity. [10] Inundation maps of tsunamis triggered by earthquakes with magnitude higher than 8 are already available.

# Objectives

The main goal is to do a PSHA where also the impact of a tsunami hazard is included. Regarding the exposure database the purpose is to do an element-wise network analysis as it was done in a paper of Salgado-Gálvez et al. [4] At the end GIS is used to visualize the network and the related risk.

# Methodology

Data that is ready to use consists of:

- Seismic catalogue for Valparaíso and Viña del Mar

- Raw data of inundation maps for the scenarios in the catalogue with magnitude lager than 8

- Topology of the water supply network in shape file.

The procedure would be as follows:

1. Literature review: possible impact of a tsunami on an urban water supply network and combined impact (hazard+tsunami)
2. Gather information about seismic and tsunami hazard situation in Valparaíso
3. Exposure database in accordance with Salgado-Galvéz et al.: how is the water supply network constructed (location, age, construction material, characteristics of pipelines and water tanks), divide into 3 systems (water system, sewage system, administrative buildings). [4]
4. Choose a suitable GMPE to calculate the intensity measure. [11] Check for local side effects
5. Include related intensity measures of the tsunami hazard
6. Simulate pipe damages and estimate losses (use vulnerability and EPANET hydraulic model of CIGIDEN)
7. Use the shape file of the water network to build a map with GIS for better visualisation.
8. analyse uncertainty in the losses (e.g. loss exceedance curve)
9. If there is enough time, check for representative scenarios. [12]

**Supervised by**:

Hugo Rosero ([hugo.rosero@tum.de](mailto:hugo.rosero@tum.de))

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