Performing seismic scenario in the Luchon - Val d'Aran area, Central Pyrenees

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INTRODUCTION

For both Spain and France, the Pyrenees are one of the most active seismic zones. Seismic risk mitigation is then a priority in this area. In this context, European project SIPYR aimed at developing rapid response systems to help planning emergency interventions in case of major seismic crisis. One of the developed tools for seismic risk mitigation is seismic risk scenario to help evaluating consequences of a seism on a limited area.

In this study, we will focus on the Luchon - Val d'Aran area, which constitutes one of the pilot zones of the project, chosen by its specific seismicity and its issue as a main touristic area. We present here the seismic risk scenario performed in this area through the three main steps of the study: local hazard calculation and mapping, vulnerability assessment, seismic risk scenario calculation.

LOCAL HAZARD MAPPING AND CALCULATION

Local geology can be responsible for important modifications of seismic ground motion both in amplitude and frequency content. It is then essential to take it into account in seismic scenario generation.

In this study, site effects are taken into account through maps of homogeneous seismic response zones and corresponding specific acceleration spectra for each mapped zones. Specific acceleration spectra have been calculated through 1D linear equivalent simulations.

In the French part of the area, we realized a campaign of 75 H/V measurements, 21 MASW profiles and 3 seismic noise arrays measurements to fulfill the poor existing geological and geotechnical data (figure 1). These measurements show unexpected low frequency resonances in the alluvial formations, with frequencies reaching 0.5 Hz in the central part of the Luchon valley.

In the Spanish side, 98 H/V measurements were carried out. Soil fundamental frequency ranges between 1.7 and 9.0 Hz, typical values of thin soils. Ambient noise array measurements were carried out in 8 sites. Mean shear-wave velocity obtained from array techniques ranges from 300 to 500 m/s, and thickness of the soil layer varies between 20 and 50 meters.

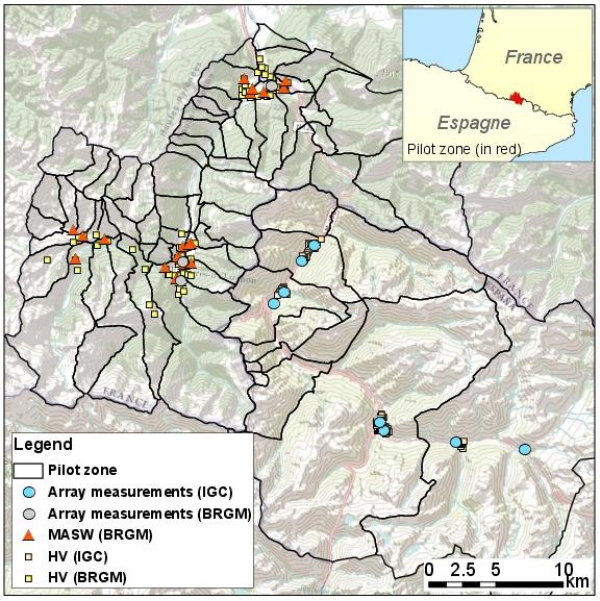

Figure 1 – Geophysical measurements location.

We then performed a combined interpretation of geological, geotechnical and geophysical data to map zones with homogeneous geology and frequency resonance and define representative 1D soil columns for each zone. With those soil columns, and for each defined zone, we calculate specific acceleration spectra using results of the probabilistic seismic study performed in ISARD project (Secanell et al., 2008) as acceleration input data.

VULNERABILITY ASSESMENT

The current building vulnerability has been assessed using the RISK-UE method of vulnerability indices. This method was developed based on the vulnerability classes defined by the EMS-98 intensity scale. Semi-empirical functions transform vulnerabilities indices into physical damage distributions as a function of seismic intensity.

The main typologies of current buildings and their respective distributions have been identified during field surveys. For the whole pilot zone, we also mapped the different types of soil occupancy as follows: downtown areas, residential areas, sky resorts. Old maps and aerial images have been used to date the built areas. This information has been integrated into a GIS.

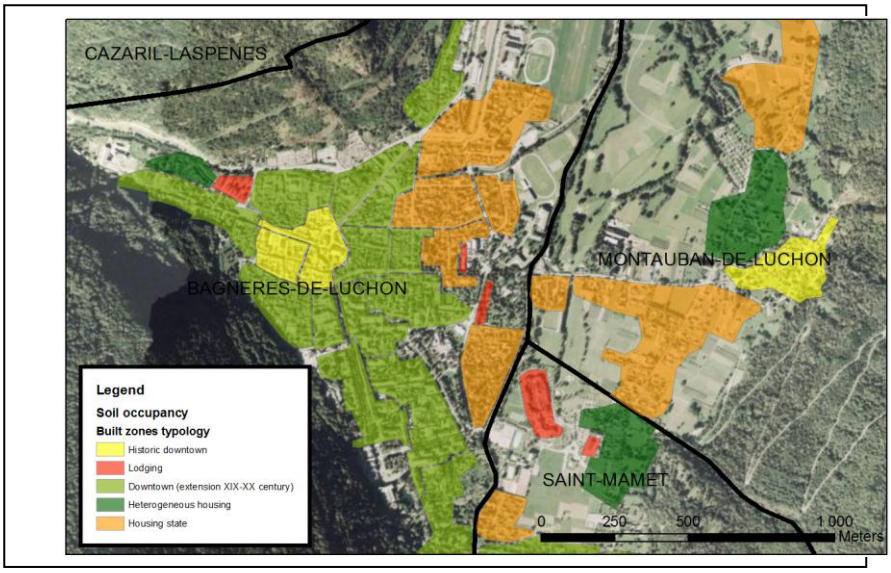

Figure 2 – Example of cartography of soil occupancy and built areas in Bagnères-de-Luchon town.

SEISMIC RISK SCENARIO

The seismic risk scenario consists in evaluating potential damages of an earthquake, crossing regional hazard, local hazard and current building vulnerability. In the pilot zone of Val d'Aran-Luchonnais, we performed two kinds of scenario. The first one is a deterministic one, considering the observed intensities of the 1923 earthquake in Vielha (Val d'Aran, intensity VIII-VII). The second one is a risk map based on the probabilistic expected accelerations from the hazard map of Pyrenees (ISARD project). This risk map considers the soil amplification measured and mapped in the first step of this work showing the effect of different soil conditions in terms of damages to current building.

Results show that heavy damages (partial or complete collapse) are few and mainly concentrated at historic downtowns. These zones, characterized by a high concentration of old stone masonry buildings, are highly vulnerable and mainly located on soft soils with potential amplification effects. Results also show that moderated damages can't be neglect as they could be important in number, generating important number of people without shelters and important economic losses.

ACKNOWLEDGEMENTS

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