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Earthquake shaking scenarios for the metropolitan area of Lisbon

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Abstract

In this study, we simulate and compare ground motion shaking in the city of Lisbon and surrounding counties (metropolitan area of Lisbon (MAL)), using two possible earthquake models: the onshore source area of Lower Tagus Valley, M5.7 and M4.7 and the offshore source area, Marques de Pombal Fault, M7.6, one of the possible source of the 1755 Lisbon earthquake. The stochastic and a new hybrid stochastic-deterministic approach (DSM) are used in order to evaluate the ground shaking and to characterize its spatial variability. Results are presented in terms of response acceleration spectra (PSA) and peak ground acceleration (PGA) with respect to bedrock and surface. Site effects are evaluated by means of equivalent stochastic non-linear one-dimensional ground responses analysis, performed for a set of stratified soil profile units properly designed to cope with the soil site conditions of MAL region. A sensitive study is carried out using different input parameters and different approaches in order to give the basic information to evaluate the range of uncertainty in seismic scenarios.

Keywords: Stochastic finite-fault modelling; Ground motion simulation; Response spectra; Deterministic-stochastic method; Non-stationary random process; Power spectral density function; Local effects; Metropolitan area of Lisbon

1. Introduction

In the framework of the ongoing European project ''LESSLOSS—Risk Mitigation for Earthquakes and Landslides'', finite-fault seismological models are proposed to compute the earthquake scenarios for three urban areas—Istanbul (Turkey), Lisbon (Portugal) and Thessaloniki (Greece). The subproject 10, SP10, examines earthquake disaster scenario predictions and loss modelling for those mentioned cities. In this paper only the earthquake scenario prediction for Lisbon will be presented.

The overall aim of SP10 is to create a tool, based on state-of-the art modelling software, to provide strong quantified statements about the benefits and costs of a range of possible mitigation actions, to support decision-making by city and regional authorities for seismic risk mitigation strategies [1]. For each case study, ground motion scenarios are developed for the most probable events for 50 and 500 years return period, locations and magnitudes derived from historical and geological data and regional studies.

The strong ground motion prediction requires the identification of the position, geometry and rupture mechanism of active faults, the knowledge of local elastic and anelastic structure of the crust and the determination of amplification effects due to the local site geology. Moreover even in case of an 'a priori' fixed fault source parameter model, the comparison of synthetic seismograms computed with different procedures requires a careful check of the numerical description of the source and propagation models.

The problem of the computation of site transfer functions to be used to evaluate ground motion at surface is also a topic investigated in the project. Some activities are devoted to issues mostly related to site characterization and site response assessments through a comparison of different methods selected for three countries.

The seismic risk of Lisbon derives partly from offshore sources (Fig. 1, top) that cause large events, such as that

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