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Shakemaps from the urban Strong Ground Motion of Chania

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Introduction

The project HELPOS – Hellenic System for Lithosphere Monitoring, Greece aims to create/upgrade a unified network to record the ground motion with the use of a variety of sensors. Among the HELPOS goals is to build urban accelerometer networks such as the dense Strong Ground Motion (SGM) network that have been installed in the Chania basin. The dense SGM networks aiming to continuously monitor the ground motion in urban environments and present the results in enhanced detail shakemaps, especially in areas where high variations in the Peak Ground Acceleration (PGA) values due to the local site effects are observed.

The geology of the investigation area

The Crete island has a complex geology of Crete which is characterised by continuous nappe units, a product of the different stress fields that acted since upper Oligocene-Miocene, due to the tectonic plates collision, which have placed the extensive tectonic nappes on Plattenkalk limestone of the Talea Ori unit (Mountrakis, 1986; Kilias et al. 1999). In the Chania area, at the southern part there are thick recrystallized limestones and marbles which are considered as the lowest units of Crete and above them there are Neogene sediments mainly consisted of marles, sandstones and limestones. Most of the Chania southern basin is covered with Quaternary alluvial deposits and in the northern part where the urban area is located, there are Neogene sediments such as marles with sandstones and limestones (Mountrakis, 2012).

The utilized sensors

Aiming to monitor the Peak Ground Acceleration distribution in the different geological formations, a dense strong ground motion network started operating in the Chania broader basin area as well as the crucial parts of the urban area and the old Venetian town. The first two types of sensors that have been installed have similar recording capabilities, the REF TEK 130 ANSS/02 and the 130 SM. To provide a detailed information regarding the ground motion during earthquakes six accelerometers were utilized in the area of interest with sampling rate at 250Hz. The initial results of the SGM network suggested that the sensor grid should be denser to provide better spatial resolution. Aiming to enhance the resolution of the results more REF TEK accelerometers were installed and afterwards we start using the cost-effective choice, the Satways' GSense. Examples of the monitoring installation of each sensor type are provided in figure 1.

Figure 1. The three types of accelerometer installed for the SGM network, the Ref Tek 130 ANSS/02(left) the 130 SM (middle) and the GSense (right).

Interpolation Method for shakemaps

The ArcGIS environment has been adopted to present the PGA values recorded from the SGM network in shakemaps. Among the available interpolators in the software, the geostatistical Kriging which uses a linear combination of weighted measured values to estimate the value at a point was preferred. Microtremors H/V spectral ratio studies that were performed in the location of each SGM station. The obtained predominant frequency f0 and amplitude A0 values (the largest peak) are used as variables to give a trend to the Ordinary Co-Kriging interpolation method. The PGA along with f0 and A0 variables which reflect the thickness and material properties of the geological formations are fitted in empirical semivariograms aiming to find the optimal fitting between observed and empirical values. An example of the interpolation results is illustrated in figure 2.

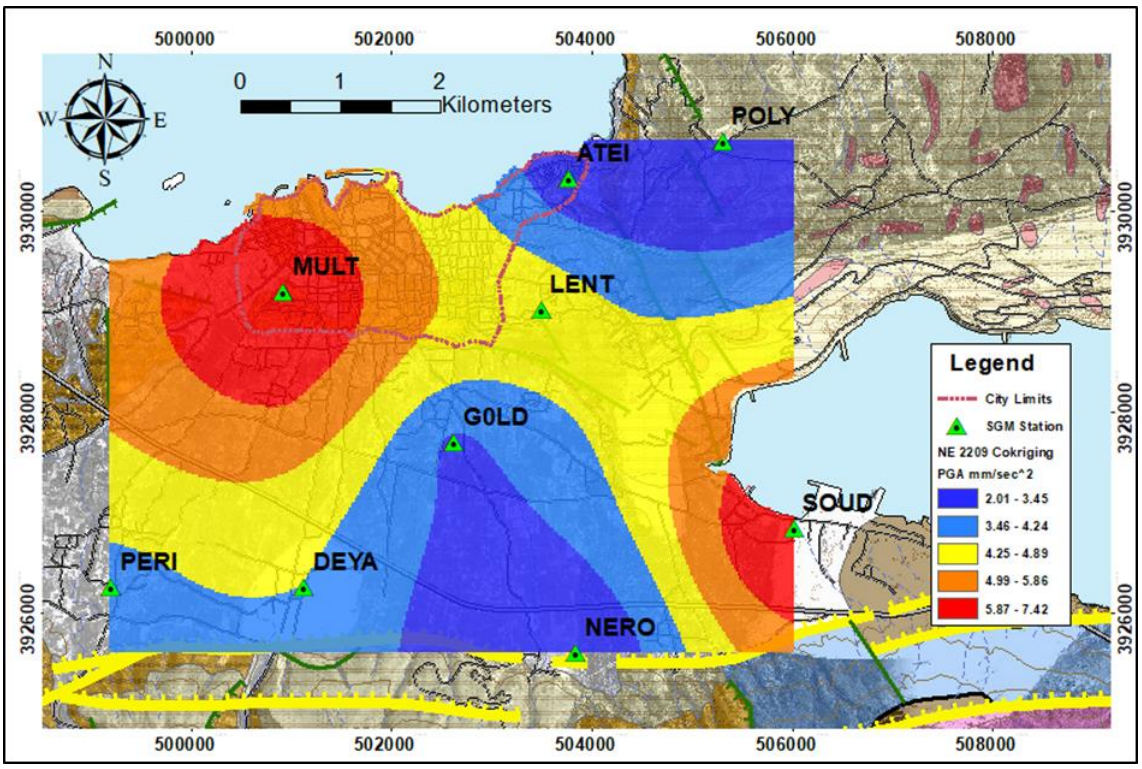

Figure 2. The PGA distribution obtained with the Ordinary Cokriging interpolation method for a local magnitude 4.1 earthquake (26/01/2018 22:09 UTC), located 64 km away northeast of Chania.

Results

The dense network of fourteen SGM station in the broader area Chania permits to monitor the PGA distribution the different parts of the urban. The SGM instruments are constantly recording the ground motions which enables the construction of detailed shakemaps. The use of ground parameters related with the geology and local site effects, f0 and A0 obtained by microtremors studies can improve the interpolation results.

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