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A Seismic Hazard Module for Earthquake Loss Modelling in Tunisia

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Very few attempts have been made to characterise seismic hazard in Tunisia; primarily as a result of the fact that major events have not occurred within the country in the recent past. This situation, which is prevalent in many other countries, has resulted in relatively low societal awareness of the potential impact of future earthquake events and limited expenditure for monitoring seismic activity and quantifying the seismic hazard. This contribution outlines an attempt to develop a robust seismic hazard module that can be used in association with exposure and vulnerability information to estimate the likelihood of various levels of losses due to an earthquake.

Seismic activity in Tunisia is governed by the present-day kinematics and tectonics of the Africa-Eurasia plate margin. Activity diffuses as one moves southward away from this boundary leading to significant regional variations in the frequency and nature of earthquake occurrence. The change in geometry, as the margin moves out of north Africa, across the Mediterranean and into southern Italy, complicates the seismotectonics; particularly in the northeast of the country in the vicinity of the capital, Tunis.

The available database of instrumental recordings of earthquakes in Tunisia is sparse, despite the existence of a national seismic network, and quantification of activity rates for identified sources is heavily constrained by this limited dataset. While the literature suggests the presence of some significant active faults close to the capital of Tunis, it is not possible, on the basis of the available seismicity or literature, to develop magnitude-frequency distributions for these sources, nor is it possible to attribute reliable characteristic-earthquake rates. The same can be said for the numerous other individual fault sources that have been identified throughout the country. The definition of seismic source zones therefore represents a balance between encompassing large enough spatial regions to ensure reliable magnitude-frequency distributions can be obtained, while still representing the spatially varying nature of the governing seismotectonics.

Nine seismic sources are identified and activity rates are characterised using a doubly-bounded exponential distribution for each source. Prior to establishing the parameters of these distributions a significant amount of work is necessary to create a homogenous and complete seismicity catalogue. Numerous conversions among different magnitude scales are required as well as conversions between macroseismic intensity and magnitude. Ultimately, a homogenous catalogue is obtained in terms of the moment magnitude scale; ensuring consistency with the ground-motion models that are subsequently used.

The hazard module developed and presented herein is a part of a full earthquake loss model for Tunisia developed within the Willis Research Network. Within this “hybrid” model, multiple methodologies are employed to estimate physical damage and these approaches require different characterisations of ground-motion intensity as inputs. For this reason, ground-motions are predicted for both spectral ordinates and macroseismic intensity. The loss modelling framework is developed in order to enable both period-to-period and spatial correlations to be accounted for when simulating ground-motion fields. While incorporation of features such as spatial correlation is not currently possible for macroseismic intensity, the use of empirical conversion functions between spectral ordinates and intensity values allows this correlation to be embedded within the fields of intensity that are

generated. Local site conditions are incorporated into the specification of ground-motion fields through the use of empirical relationships between the topography and shear-wave velocity values.

The module that is presented constitutes a significant development over previous efforts to characterise seismic hazard in Tunisia. While the components of the module are developed with a view to estimating earthquake-induced loss, they could also be applied to generate seismic hazard maps for seismic design and long-term hazard mitigation purposes.