SEICHE – Seismicity of the plate Interiors – Challenges to Hazard Evaluation

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Probabilistic seismic hazard assessment (PSHA) is arguably the most valuable product that the seismologists offer to the society. PSHA quantifies the potential for destructive earthquake-related phenomena at a site, thus providing the basis for public safety policies. PSHA implies the analysis of the long-term behaviour of sources, from seismicity data (instrumental and historic) and geological data from active faults. The latter is a multidisciplinary field that includes geodesy and remote sensing, geomorphology and paleoseismology (last 50000 years). Geomorphological studies based on aerial photos, remotely-sensed data or high resolution DEM's help constrain the recent tectonic activity of a region [26]. Palaeoseismology, on the other hand, reconstructs the seismic history of an area from geological evidence through trenching and off-fault evidence (seismites, liquefaction, etc). Integrated with historical and instrumental seismicity and space geodesy, these geological techniques allow the quantification of tectonic activity in the full timespan relevant for PSHA. PSHA in plate interiors – less active than margins but often highly populated - raises specific challenges [27]. Standard PSHA assumes independence of earthquakes both in time and space. Yet the last decade showed that faults interact at distance through physical processes such as stress changes or fluid migration, and spatial/temporal clustering of paleoearthquakes has been noted to be more of a rule than an exception on some fault zones, particularly in plate interiors [20]. There is increasing awareness that a deeper understanding of the processes of stress build-up is required in order to avoid misleading PSHA results in plate interiors [21]. Space geodesy plays a key role: GPS and InSAR allow the detection of inter- and intra-seismic ground deformation, with complementary space and time resolution, opening paths to an increased understanding of the earthquake preparation processes. Tracking down the stress build-up with geodetic techniques implies the detection and quantification of fault creep. This is also critical for the correct interpretation of fault slip data from paleoseismology. GPS data constrain regional deformation, whereas InSAR will show how a fault responds to the stress in the interseismic period. Demonstrated for faults with large to intermediate slip rates [28, 29], this is becoming realistic also with slower tectonics, as advances in SAR interferometry allow the detection of sub-millimeter deformation [30 16]. With the launch of the two ESA Sentinel-1 satellites in 2013 and 2014, SAR data will be acquired for almost every point on the globe at least every six days. Previous and current work of the SEICHE team makes it unique in terms of installed capacity for PSHA studies in Portugal. A seismicity catalogue suitable for PSHA was prepared through a critical review of instrumental and historical sources [17], and historical accounts were reinterpreted at the light of emerging science [6]. The team introduced palaeoseismology in Portugal [9, 10], and pioneered the use of geomorphology to identify the surface traces of active faults [11]. It led the instrumental study of ground motion prediction equations in SW Iberia [8], and made important contributions to the instrumental study of the sources [12, 13]. In the scope of projects

GMES TERRAFIRMA and FCT SUBSIn (PI S. Heleno), the team also pioneered the use of large SAR datasets to detect sub-milimeter ground deformation in Portugal [16]. Current projects led by SEISHE team members will produce higher-resolution maps of LTVFZ using LIDAR data (FCT project FINDER, PI G. Besana-Ostman), in conjunction with other high-resolution DEM's (FCT project RIVERSAR, PI S. Heleno) and characterize site response (FCT project SCENE, PI S. Vilanova). Currently the PI coordinates fault source research in Iberia for FP7 project SHARE (Seismic Hazard Harmonization for Europe), which uses the previous PSHA results of the team as reference for SW Iberia [12, 18]. One of the main outcomes of recent research, by the project's team and others, is that seismic hazard in Portugal is dominated by intraplate seismicity [18], even if the traditional subjective perception, marked by the impact of the 1755 earthquake, may differ. In fact, earthquakes at the plate boundary will only have destructive effects onshore if they have very high (~8.5) magnitudes, in which case they are extremely rare in view of the slow rate of convergence, and have little impact on the hazard except at the very long return periods. At the widely used return period of 475 years, for example, PSHA in Portugal can only have satisfactory results if the intraplate seismicity is well understood. The SEISHE team is in a very good standing to tackle the challenges of seismic hazard assessment in Portugal and adjacent regions within the scope of emerging plate interior earthquake science. More than 40 years since its introduction, PSHA is undergoing a dynamic phase worldwide, pushed by advances in space technology and new ideas in various fields. Due to its multiple and transversal competences, the SEISHE team can have a pivotal role in the progress of PSHA. Besides the ongoing projects listed above, a number of proposals also led by SEICHE members are being submitted in the present call (SPLASH, PI G. Besana-Ostman; FARSIGHT, PI S. Vilanova; QUAKELOC, PI S. Custodio) to address outstanding issues of PSHA. With one exception, all SEISHE team members hold CIENCIA contracts that will end between 2012 and 2014. The purpose of the SEISHE project is to provide an umbrella for the articulation of the ongoing and future research, and give continuity to a team that was built up over the last decade.

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