ESM and RRSM - two world class strong motion databases for seismologists and engineers

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Seismic strong-motion data play a fundamental role in Seismology and Engineering Seismology. They provide non-saturated strong ground motion waveform recordings of an earthquake which are essential for a) studying the seismic source in the near field, b) quantifying promptly the strong ground shaking in real-time, c) deriving attenuation ground motion prediction equations, d) providing input to civil engineers for building/infrastructure design and retrofit and for e) emergency planning and risk assessment. For these reasons rapidly available, quality checked strong motion data and their products are relevant for stakeholders (e.g., seismologists, engineers, urban planners).

Within EPOS, the two main sources of strong motion data in Europe are the RRSM (Rapid Raw Strong Motion DB) and the ESM (Engineering Strong Motion DB). Both systems provide prompt access to data and derived products of importance to seismologists and engineers. The RRSM is fully automated and provides access in near real-time, whereas the ESM is carefully reviewed and is available with a short delay.

The Engineering Strong-Motion database (ESM) contains more than 45,000 accelerometric waveforms of earthquakes recorded in and outside Europe by 46 European agencies from 1969 to 2017, with a magnitude threshold of M4. The database contains the records of
the largest earthquakes in Europe (Mw 6.5 2017 Central Italy; Mw 7.6 1999 Izmit; Mw 7.5 1977 Romania; Mw 7.3 2011 Van), whereas the largest PGA, close to or exceeding 1g, have been recorded at Gazli (Mw 6.7, 1976 Armenia) and Bam (Mw 6.6, 2003 Iran, Fig. 3). The database is up to date and data are made available after manual processing. Station and event metadata are periodically revised and made available with relevant strong-motion parameters for engineering seismology applications. The average delay time for the ESM depends on the data and metadata availability and on the importance of the earthquake, usually spanning from a few hours to several weeks. In cases of offline data the upload strongly depends on waveform restrictions.

The Rapid Response Strong-Motion Database (RRSM) is a completely automated system that is triggered by earthquake notifications by EMSC to collect relevant raw waveform data from the European Integrated Data Archive (EIDA) within minutes following an earthquake. Strong motion parameters are calculated automatically in a cyclic process to incorporate delayed waveform data. It is targeted to have an immediate response to the occurrence of an earthquake with magnitude larger than 3.5 in Europe.

The selection of which database to use typically depends on the time delay after the earthquake occurrence. A clear example is provided by the plan for the generation of the European maps of ground shaking (shakemaps). These maps should be available as fast as possible but be regularly updated in order to use the best available data and the largest amount of data (Fig. 1). Initial shakemaps available after a few minutes following earthquake occurrence should rely on RRSM to provide first estimates of the ground shaking suffered in the epicentral area. In the hours that follow the event, shakemaps are continuously updated as additional and manually reviewed information becomes available, relying on the ESM database (Fig. 2). In any event, the maps are an important tool both for the first rescue teams to provide first aid in the affected area and, at the opposite extreme, for the urban planners when they wish to choose the boundaries of the affected areas based upon the peak ground observations.

In conclusion, less than ten years ago, strong-motion data were made available through static databases, rarely accessible online, with often significant time. The insufficient density of strong-motion networks resulted in the collection of relatively few strong motion records for only a small number of earthquakes and most ground motion studies were performed using only a small subset of data that is available nowadays. The amount of strong-motion data now grows dramatically, due to better quality instrumentation, denser networks and the real time transmission of often continuous data streams. Database are, as consequence, dynamic and are constantly being updated thanks to webservises that allow access to waveforms and seismic catalogues. The challenge for the future is to handle large amounts of data and create high level products and
services for different stakeholders. Providing strong motion information within minutes of an earthquake is a reality thanks to a near real-time data accessibility and processing together with proper acknowledgment of the data sources.

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