Towards a unified and worldwide database of surface ruptures (SURE) for Fault Displacement Hazard Analyses

*Stéphane Baize[1], Johann Champenois[1,2], Francesca Cinti[4], Timothy Dawson[3], Yann Klinger[2], James McCalpin[6], Koji Okumura[7], David Schwartz[5], Oona Scotti[1], Pilar Villamor[8]

1. IRSN, France, 2. IPGP, France, 3. CGS, USA, 4. INGV, Italy, 5. USGS, USA, 6. Geo-Haz Consulting, USA, 7. Hiroshima University, Japan, 8. GNS Science, New Zealand

Assessing Fault Displacement Hazard is based on empirical relationships predicting on-fault and off-fault surface rupture, these equations being derived from earthquake data. The regressions that are used so far are based on sparsely populated datasets, including a limited number of mainly pre-2000 events. A common effort has started in 2015 to constitute a worldwide and unified database to improve further estimations (SURE). This database would update existing databases that relate earthquake magnitude to surface faulting. Since 2015, two workshops have been organized to start discussions on how to build such a database: it was decided that, together with existing datasets, the future database will include 1) recent cases which deformation have been captured and measured with modern techniques, 2) new parameters which are relevant to properly describe the rupture.

Correlation of pre- and post-seismic optical images is one of the interesting techniques to complete the deformation fields. This technique has been successfully applied to “historical” cases in California (1992 Landers and 1999 Hector Mine events), demonstrating that a considerable part of coseismic deformation was distributed off the major fault. Applied with high resolution images, we could map in detail the surface deformation associated with the 2016 M7.8 Kaikoura earthquake (NZ), using the sub-pixel correlator MicMac which provides reliable results especially in near-fault area. We use pairs of ortho-images to measure the horizontal coseismic displacement field. Optical satellite images from different satellites are processed (Sentinel-2A, Landsat8, etc.) to present a dense map of the surface ruptures and to analyze high density slip distribution along all major ruptures. Displacement field from optical correlation will be combined to other co-seismic measurements to figure out the 3D displacement. Dealing with the new parameters in the database, two of them will be included first: fault geometry and segmentation, and geological nature of surficial layers. Recently, the 2010 M7.2 El Mayor-Cucapah (Mexico) studies have shown that the number of slip planes, their dip and the rupture zone thickness have been strongly influenced by them. For the Kaikoura earthquake, those aspects could be treated later, once this huge rupture will have been investigated in the field.

To date, the database, which includes the “earthquake table”, “fault portion table” and obviously “observation point table”, merges the existing databases. However, the objective is to incorporate well-known earthquake cases described in literature and to explore the post-2000 M6+ inland earthquakes that could potentially provide relevant data. A first search in the USGS earthquake database provided a catalog of 130 shallow M6+ onshore epicenters since 2000, most having occurred in Asia (China, Iran, Japan, Russia, Pakistan, Turkey, Kyrgyzstan, Nepal, Myanmar) and very few having reported surface rupture information. There is consequently a need for regional geologists’ participation: this will be one major task of the SURE working group in the next years and, in this perspective, the JpGU-AGU joint meeting in Japan is a unique opportunity to go ahead in gathering Asian geologists.

Keywords: earthquake-related hazard, surface faulting, worldwide & unified database

