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New loss estimation module implemented in QUAKELOSS2: Case study M6.6 Bam earthquake

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One of the main goals of the IMPROVE Project is to develop a new generation of QUAKELOSS software. The new QUAKELOSS2 (QL2) is intended to be a flexible tool to store data and to implement procedures for loss estimation. It is open source and will allow community-based maintenance and further development of the database and estimating procedures. The tool focuses on the developing world, where only approximate information exists on building stock properties and population numbers. The following loss estimation upgrades are proposed for QL2: 1) damage estimation using fragility models based on vulnerability classes (level 1 estimation) and building types (level 2 estimation); 2) use of instrumental parameters such as PGA as earthquake demand for fragility analysis; and, 3) incorporation of a new tool for casualty (number of fatalities plus injured) estimation using the concept of initial casualty matrix. A new building stock database is to be developed considering data with different resolution (vulnerability class and building type including different structural characteristics such as: structural subclasses, period of construction, height of the building, level of seismic protection). The European Macroseismic Method for vulnerability analysis is proposed for the stated needs. The method itself was successfully applied to several case studies in Europe during the elaboration of the RISK-UE project. It is based on the implicit vulnerability model incorporated in the European Macroseismic Scale (EMS-98), the concept of “vulnerability index” and its calibration that makes it flexible and gives the possibility to define site-specific building types and vulnerability models not included in EMS-98. In order to test its resilience the new QL2 loss estimation module is applied to the city of Bam, Iran affected by an earthquake in 2003

(Mw=6.6). This event is an extreme case considering the damage that occurred and the collapse rates, as well as the epidemiological consequences. The damage and casualty potential in the city of Bam is calculated considering the building stock modeled with approximate distribution of the number of buildings by vulnerability classes A, B, C and D (50%, 40%, 9%, 1% of the total number of buildings, respectively), and an observed earthquake demand of I=10. For the population, an estimate of 78,000 was used. The following damage rates are calculated: 1) slight damage: 0.01; 2) moderate damage: 0.05; 3) heavy damage: 0.14; 4) very heavy damage: 0.29; and, 5) collapse: 0.51. The observed damage rates in Bam were 0.1, 0.11, 0.09, 0.12 and 0.58, respectively. The expected casualty potential is estimated using the initial casualty matrices derived from ATC-13 as the best approximation to the Bam data (observed number of fatalities was 22,000, or 28% of the population). The fatalities calculated by QL2 are within the range 11,600 - 13,250, or 15% - 17% of the population. Thus, they are underestimated by factor 1.7 - 1.9 when compared to the Bam data. The accuracy of the QL2 fatality estimates in near real-time can be considered suitable for rescue and medical response purposes, considering the uncertainty level in the determination of the earthquake epicenter, depth and magnitude.