Guest editorial to the special issue—Seismic risk assessment in Italy

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The most recent National Risk Assessment in Italy was issued by the Italian Civil Protection Department in 2018 (ICPD 2018), coherently with EU decision 1313/2013 and responding to the specific requirement of the “Sendai Framework for Disaster Risk Reduction 2015–2030” to periodically adjourn the assessment of disaster risk.

As required by the Civil Protection Code in Italy (Decree Law n.1 of 2/1/2018), risk assessment should not only be based on a robust scientific base, but it should also achieve consensus by a wide scientific audience. Starting from these premises, the National Risk Assessment 2018, from now on indicated as NRA 2018, was prepared with significant support of the scientific community, involving the competence centers of the Italian Civil Protection Department. The document, presenting an overview of potential major disasters in Italy, analyzed the natural risks that are of interest for the civil protection, namely: seismic, volcanic, tsunami, hydraulic, hydro-geological, adverse meteorological events, droughts and forest fires.

Concerning the analysis of seismic risk in Italy, it can build upon the experience acquired and the knowledge systematization achieved in previous studies dealing with nation-wide seismic risk assessment. Those studies include, among other, the risk maps produced by the Italian Seismic Service (Lucantoni et al. 2001) and their updated version presented in Bramerini and Di Pasquale (2008) that are a reference for a coherent nation-wide probabilistic assessment, suitably combining hazard and vulnerability models, as well as exposure data for the whole territory.

The update proposed for seismic risk assessment in the framework of NRA 2018 takes into account the advancements achieved by the scientific community, that has made several enhancements in the fields of hazard, vulnerability and exposure assessment.

Concerning seismic hazard, the MPS04 model (Stucchi et al. 2004, 2011), providing probabilistic seismic hazard assessment for Italy, was officially adopted as reference model in the Prime Minister Ordinance (OPCM 2006) and also specifically addressed for the use in engineering applications by national technical codes (NNT 2008, 2018). This is the hazard model that was employed for the NRA 2018.

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Concerning exposure, the first nation-wide risk studies for Italy relied on an exposure model developed at the national scale and based on the data on population and dwellings collected by the national census (National Institute of Statistics, ISTAT 1991). Several subsequent studies relied on similar exposure models, where updated census dataset (ISTAT 2001, 2011), giving information on construction age, building material and number of stories, were used as the primary source for building vulnerability/exposure classification. Being based on data sources collected by non-experts and primarily for other scopes, ISTAT databases on buildings and dwellings may be affected by significant uncertainties regarding the structural characteristics of the building stock. Census data have the advantage of being homogeneous and complete for the whole national territory. Several efforts were pursued in the last years to provide alternative approaches for building inventory and with the aim to ameliorate and/or integrate available data. A promising tool recently implemented to enhance data-sources for building inventory and exposure assessment is the interview-based CARTIS form (Zuccaro et al. 2015), which is aimed at the typological and structural characterization of urban settlements. However, in 2018 the CARTIS approach had not yet been implemented exhaustively at national level and could not be employed for the national risk assessment. Therefore, the reference database adopted for the exposure assessment in the NRA 2018 is the one based on census returns (ISTAT 2001).

Concerning vulnerability, several models were developed in the last decades to estimate damage likelihood for ordinary building types. Such models, referring to masonry (M) or reinforced concrete (RC) structures, adopt a variety of approaches, ranging from (1) analytical, that is based on analytical estimation of building response and assessment of fragility curves, to (2) empirical, relying on the calibration of fragility curves based on damage data from past earthquakes, to (3) hybrid approaches, combining different evaluation systems (e.g. analytical assessment of response and subsequent calibration based on damage data). Although theoretically a single vulnerability model could be adopted in the convolution process with hazard and exposure models towards calculation of seismic risk, the extreme variability of existing vulnerability models do not allow them to be combined in a single vulnerability model for the risk assessment at the national scale.

Therefore, the Italian Civil Protection Department decided to perform the National Risk Assessment 2018 (ICPD 2018) using, for the first time, a consensus-based multi-model methodology. Expert representatives of the two Centers of Competence of the DPC operating in the seismic risk field, namely ReLUIS—Network of university laboratories for seismic engineering—and EUCENTRE—European Centre for Training and Research in Earthquake Engineering—were involved and invited to develop Vulnerability/Exposure Models (VEM) suitable to be employed in the evaluation of risk at the national scale. In order to achieve the goal, it was essential to develop a specific platform for risk assessment that allowed different VEM to be compatibly used and the relevant risk results to be suitably combined and represented through web-gis.

A useful resource that was available to the research community is the unified database DaDO (Dolce et al. 2017, 2019), including detailed damage data from the 8 most important Italian earthquakes in the period 1976–2012. The availability of these datasets allowed for the implementation of new empirical vulnerability models, but also for the calibration of different models, including the analytical ones, through scenario analyses.

This special issue collects papers describing the general approach adopted for seismic risk assessment in the framework of NRA 2018, the risk calculation platform, the single specifically developed Vulnerability/Exposure Models (VEM), as well as a paper comparing the fragility curves adopted by the different VEMs. Future perspectives towards the next national

risk assessment are also discussed in a paper dealing with the ongoing advancements in vulnerability and exposure modeling in Italy.

More in detail, the multi-model methodology adopted to develop the consensus-based national seismic risk assessment, as well as the main results in terms of expected damage and impact measures (unusable buildings, homeless, casualties, direct economic losses), are described in (Dolce et al. 2020).

The National Risk Assessment 2018 is performed with the support of the purposely set up risk calculation web-gis platform IRMA (Italian Risk Maps), specifically developed by EUCENTRE (Borzi et al. 2020a), and employed to share and compare data and models to evaluate the seismic risk of Italian residential buildings.

Concerning vulnerability/exposure models, 4 VEMs were developed for ordinary residential masonry buildings and 2 for reinforced concrete buildings by different research groups.

For the development of Vulnerability/Exposure Models for ordinary masonry buildings: Rosti et al. (2020a) and Zuccaro et al. (2020) adopt empirical approaches, Donà et al. (2020) employ an analytical approach, while Lagomarsino et al. (2021) use a hybrid (heuristic) methodology.

Concerning ordinary reinforced concrete buildings, Rosti et al. (2020b) use an empirical approach to develop the relevant Vulnerability/Exposure model, while Borzi et al. (2020b) adopt an analytical one.

In da Porto et al. (2021), a thorough comparison of the different vulnerability/exposure models is presented, by comparing results of scenario analyses performed using the different VEMs with reference to the two recent seismic events of L'Aquila 2009 and Amatrice 2016.

Finally, in Masi et al. (2021), the new developments that are being performed by the scientific community towards the next national seismic risk assessment in Italy to be released at the end of 2021 are described. Information is provided relevant to the upgrade of the vulnerability model implemented in the new version of the platform used for risk calculation (IRMA), the analytical-mechanical approach set up to derive the fragility curves of reinforced concrete buildings. The risk assessment of special construction types, such as schools, churches and bridges, to provide a more comprehensive understanding of the national seismic risk is finally discussed.

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Declaration

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