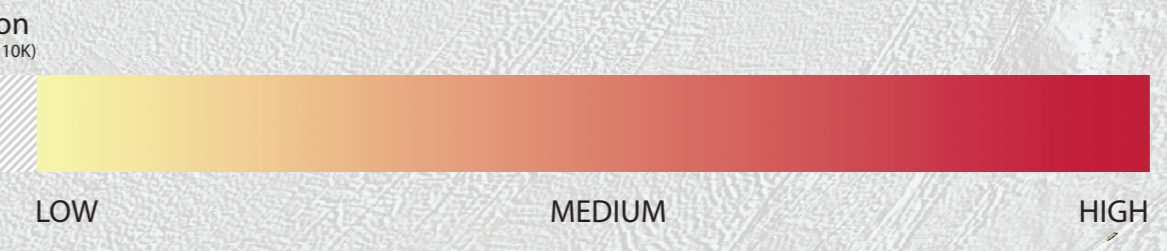




**GEM**  
GLOBAL EARTHQUAKE MODEL  
working together to assess risk



Earthquakes can have adverse impacts that extend beyond physical damage or casualties and can severely damage economies and negatively influence societies and social well-being. The addition of the Social Vulnerability component into GEM's scientific framework provides the means to analyze and better understand the various socio-economic factors that may exacerbate the impact of an earthquake, or that may affect the ability of communities to fully recover from damaging earthquake events. The global modelling of socio-economic vulnerability consists of three maps that depict spatially varying characteristics that affect the impact and recovery potential of populations from damaging earthquakes.

The first map is the *Global Social Vulnerability Map*, which presents a composite index that was developed to measure characteristics or qualities of social systems that create the potential for loss or harm. Here, the social vulnerability index helps to explain why some countries will experience adverse impacts from earthquakes differentially where the linking of social capacities with disaster impacts suggests that communities with higher percentages of age dependent populations, homeless, disabled, under-educated, and foreign migrants are likely to exhibit higher social vulnerability than communities lacking these characteristics. Other relevant factors that affect the social vulnerability of populations include population density, slum populations, and international tourists.

vulnerability and resilience of its population. The latter includes measurements of single-sector economic dependence, income inequality, and employment status.

To choose indicators contextually exclusive for use in each map, the starting point was an exhaustive review of the literature on earthquake social vulnerability and resilience. For a variable to be considered appropriate and selected, three equally important criteria were met:

- This procedure resulted in a 'wish list' of approximately 300 variables of which 78 were available and fit for use based on the three criteria.

For variables to be allocated to an index, a two-tiered validation procedure was utilized. For the first tier, variables were assigned to each of the respective indices based on how each variable was cited within the literature, i.e., as being part of an index of social vulnerability, economic vulnerability, or recovery/resilience. For the second tier, machine learning and a multivariate ordinal logistic regression modelling procedure was used for external validation. Here, focus was placed on the statistical association between the socio-economic vulnerability indicators and the adverse impacts from historical earthquakes on a country-by country-basis.

Countries not demonstrating at least a minimal earthquake risk, i.e., seismicity  $<0.05$  PGA (Pagani et al. 2018) and  $< \$10,000$  USD in predicted average annual losses (Silva et al. 2018) were eliminated from the analyses so as not to include countries with minimal to no earthquake risk. A total study area consists of 136 countries.

The Global Socio-Economic Vulnerability Maps 2020 is a product of the GEM Foundation's collaborative work with the Department of Geography at the University of Connecticut, USA. GEM is a non-profit foundation in Pavia, Italy funded through a public-private partnership with a vision to create a world that is resilient to earthquakes. Formed in 2009 through the initiative of the Organization for Economic Co-operation and Development (OECD) Global Science Forum in 2006, GEM participants represent national research and disaster management institutions; private sector companies mainly in insurance, risk financing and engineering; and academic and international organizations.

GEM supports the Sendai Framework for Disaster Risk Reduction (SFDRR) goals by contributing openly accessible products for hazard and risk assessment and capacity development through risk reduction projects. GEM also serves as a baseline or exemplar for the development of a broader multi-hazard framework for risk assessment in support of a holistic and comprehensive approach to disaster risk reduction.

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This map is the result of a collaborative effort and extensively relies on the enthusiasm and commitment of various organisations to openly share and collaborate. The creation of this map would not have been possible without the support provided by several public and private organisations during GEMs second and third working programmes, 2014-2018 and 2019-2021 respectively. None of this would have been possible without the extensive support of all GEM Secretariat staff. These key contributions are profoundly acknowledged. A complete list of the contributors can be found at: [www.globalquakemod.org/global-social-vulnerability](http://www.globalquakemod.org/global-social-vulnerability).

This map is an informational product created by the GEM Foundation for public dissemination purposes. The information included in this map must not be used for the design of seismic socio-economic policies or to support any important decisions involving human life, capital and movable and immovable properties. The values of social vulnerability and risk values used in this map do not constitute an alternative nor do they replace any national government policy or actions. For more information on the methodology used to generate the estimates derived nationally, Readers seeking information should contact the national authorities tasked with social economic and risk assessment. The socio-economic vulnerability maps are based on the results of an integration process that is solely the responsibility of the GEM Foundation.

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