

Global Earthquake Model (GEM) Global Seismic Hazard Map

The Global Earthquake Model (GEM) Global Seismic Hazard Map (version 2018.1) depicts the geographic distribution of the Peak Ground Acceleration (PGA) with a 10% probability of being exceeded in 50 years, computed for reference rock conditions (shear wave velocity, V_{50} , of 760-800 m/s). The map was created by collating maps computed using national and regional probabilistic seismic hazard models developed by various institutions and projects, and by GEM Foundation scientists. The OpenQuake engine, an open-source seismic hazard and risk calculation software developed principally by the GEM Foundation, was used to calculate the hazard values. A smoothing methodology was applied to homogenise hazard values along the model borders. The map is based on a database of hazard models described using the OpenQuake engine data format (NRML); those models originally implemented in other software formats were converted into NRML. While translating these models, various checks were performed to test the compatibility between the original results and the new results computed using the OpenQuake engine. Overall the differences between the original and translated model results are small, notwithstanding some diversity in modelling methodologies implemented in different hazard modelling software. The hashed areas in the map (e.g. Greenland) are currently not covered by a hazard model. The map and the underlying database of models are a dynamic framework, capable to incorporate newly released open models. Due to possible model limitations, regions portrayed with low hazard may still experience potentially damaging earthquakes. The GEM Foundation plans to release future updates of this map on a regular basis as new information becomes available. Technical details on the compilation of the hazard and risk maps and the underlying models are available at <http://www.globalquakemodel.org/gem>

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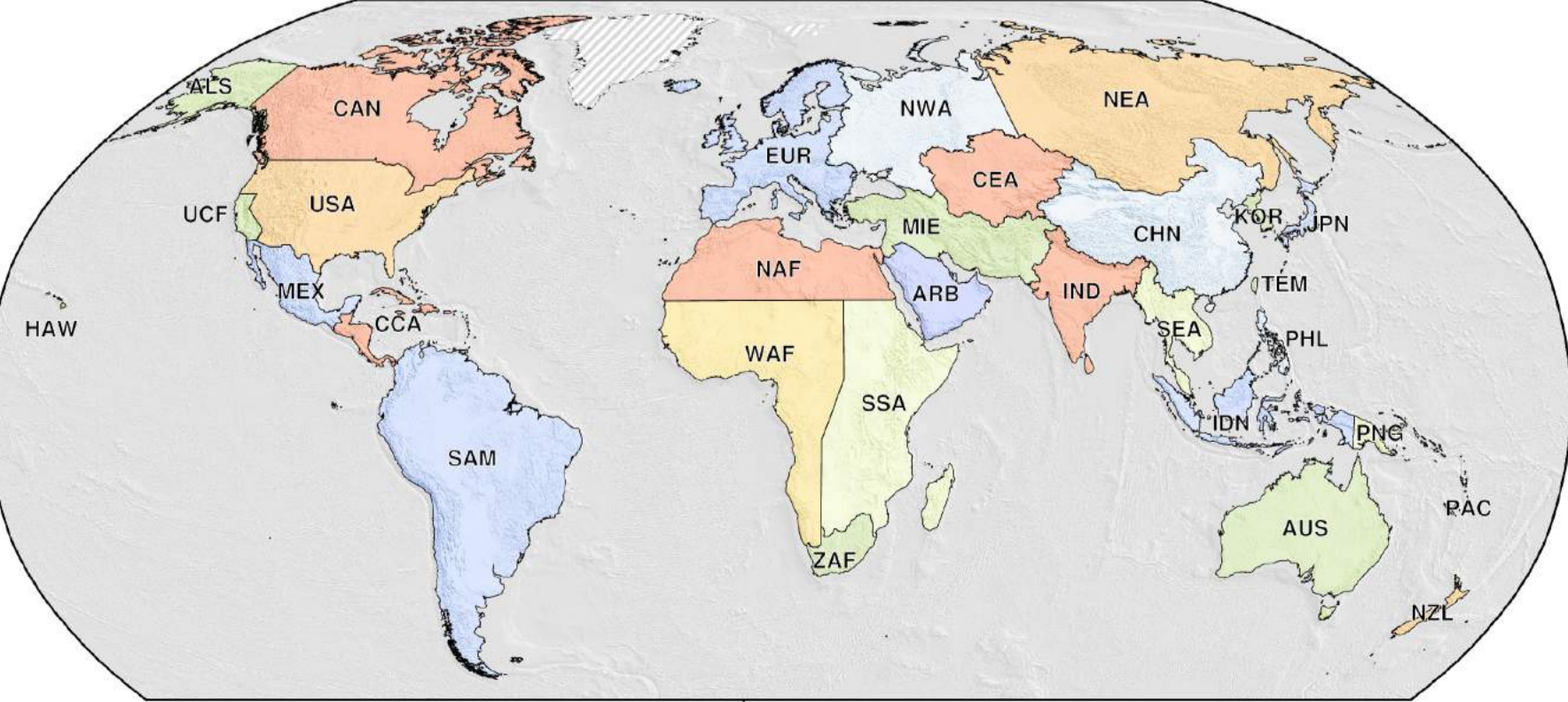
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Contacts:
GEM (Global Earthquake Model) Foundation
Via Ferrata, 1 - 27100, Pavia, Italy
info@globalquakemodel.org

More information available at:
<http://www.globalquakemodel.org/gem>

Contributing models

- Alaska, USA [ALS] - 2007**
Developed by the United States Geological Survey and converted into the OpenQuake engine by GEM.
• Authors: R.L. Wesson, O.S. Boyd, C.S. Mueller, C.G. Bufe, A.D. Frankel, M.D. Petersen
• Website: <https://earthquake.usgs.gov/hazards/hazmap/>
- Andean Peninsula [APB] - 2018**
Developed by the South Geological Survey and converted into the OpenQuake engine by GEM.
• Authors: H. Zahran, V. Sokolov, S. El-Hadidy, Yousef, W. W. Alabdadi, M. J. Rebolol, L. C. F. Stewart, M. El-Hadidy
• Website: <https://www.sgs.gov.sa/en/information/information/pages/information.aspx>
- Australia [AUS] - 2018**
Developed by Geoscience Australia.
• Authors: T. Allen, J. Griffin, M. Leonard, D. Clark, H. Ghazemi
• Website: <http://www.ga.gov.au/about/projects/safety/australia>
- Canada [CAN] - 2015**
Developed by Natural Resources Canada, partly adjusted to the OpenQuake engine by GEM.
• Authors: J. Adams, S. Hachuk, T. Allen, G. Rogers
• Website: <http://www.earthquakecanada.nrc.ca/>
- Caribbean and Central America [CCA] - 2018**
Developed within the project CCAIRA. Cuba and Puerto Rico were included a posteriori by GEM. Organisations involved in CCAIRA: GEM - University of Costa Rica, Costa Rica - Costa Rican Institute of Electricity, Costa Rica - Nicaraguan Institute of Terrestrial Studies, Nicaragua - Catholic University of El Salvador, El Salvador - Ministry of Environment and Natural Resources, El Salvador - Panama University, Panama.
• Authors: J. Garcia-Pelaez, R. Gee, R. Styrón, V. Poggi
- Central Asia [CEA] - 2018**
Developed within the EMCA project, coordinated by the Helmholtz German Research Centre for Geosciences, Germany. Organisations involved: Institute of Geology, Earthquake Engineering and Seismology of the Academy of Sciences of the Republic of Tajikistan - Institute of Geophysical Research, Kazakhstan - International University of Innovation Technologies, Kyrgyzstan - Kyrgyzstan Institute of Geology, Kyrgyzstan - Central Asian Institute of Applied Geosciences, Kyrgyzstan - Institute of Mechanics and Seismic Stability of Structures of the Academy of Sciences of Uzbekistan, Uzbekistan - Mavnavviro Institute of Seismology, Uzbekistan.
• Authors: S. Ulak, D. Brink, M. Pila, L. Dancu, G.A. Weatherill, E. Zuccolo, A. Ischuk, N.N. Mikhalkova, K. Abdalrhmanov, S. Parslov, K. Fleming
• Website: <http://www.earthquake.org/>
- China [CHN] - 2015**
Developed by the Institute of Geophysics of the China Earthquake Administration and converted into the OpenQuake engine by Changlong Li with a collaboration between the Institute of Geophysics of the China Earthquake Administration, the Swiss Seismological Service, Swiss Federal Institute of Technology, Switzerland and GEM.
• Authors: M. Gao, G. Chen, X. Xia, X. Xu, L. Li, Y. Yu
• Website: <http://www.earthquake.org/>
- Europe [EUR] - 2013**
Developed within the EU-funded SHARE project, coordinated by the Swiss Federal Institute of Technology, Zurich, Switzerland. Organisations involved: Helmholtz Centre Potsdam, German Research Centre for Geosciences, Germany - The National Institute of Geophysics and Volcanology, Italy - Joseph Fourier University, France - University of Favia, Italy - Aristotle University of Thessaloniki, Greece - The French Geological Survey, France - Center of Research in Astronomy, Astrophysics and Geophysics, Algeria - Instituto Superior Tecnico, Portugal - Bogazici University, Turkey - National Laboratory for Civil Engineering, Portugal - Middle East Technical University, Turkey - Montenegro Seismological Observatory, Montenegro - Natural Environment Research Council, United Kingdom - National Institute for Earth Physics, Romania - National and Kapodistrian University of Athens, Greece - Norwegian Scientific Army, Norway - Royal Observatory of Belgium, Belgium. Updated version of the model to be released in 2020.
• Authors: J. Woessner, L. Dancu, D. Giardini, H. Crowley, F. Cotton, G. Crowley, G. Valentini, R. Anderson, R. Baati, M. Bezi, Demircioglu, S. Hermer, C. Meati, R. W. Musson, A.N. Rovida, K. Sesayon, M. Stucchi
• Website: <http://www.earthquake.org/>
- Hawaii, USA [HAW] - 1998**
Developed by the United States Geological Survey and converted into the OpenQuake engine by GEM.
• Authors: F. W. Klein, A.D. Frankel, C.S. Mueller, R.L. Wesson, P.G. Okubo
• Website: <https://earthquake.usgs.gov/hazards/hazmap/>
- Indonesia [IND] - 2017**
Developed by the Team for Updating Seismic Hazard Maps of Indonesia. The team belongs to the National Center for Earthquake Studies under the Center for Research and Development of Housing and Settlements of the Ministry of Public Works and People Housing. Ministries involved: Ministry of Public Works and People Housing, Ministry of Energy and Mineral Resources, Ministry of Transportation, Ministry of Research, Technology and Higher Education, and National Disaster Management Authority of Indonesia. Organisations involved: Bureau of Meteorology, Climatology and Geophysics, Indonesian Research Institute, Geospatial Information Agency, Center for Research and Development of Housing and Settlements, Centre of Volcanology and Geological Hazard Mitigation, Indonesian Academy of Sciences, Bandung Institute of Technology, University of Indonesia, University of Gajah Mada, University of Diponegoro, Indonesian Society for Geotechnical Engineering, and Indonesian Disaster Expert Association. The team collaborated internationally with Geoscience Australia, Australia.
• Authors: M. Jayam, L. Fazal, D. Nasiruddin, G. Melano, S. Widayanto, W. Triyoso, A. Rudyanto, S. Hidayati, M. Asurafik, M. Rifan, F. Curmies
- India and surroundings [IND] - 2012**
Developed by Nath and Thingbaijam (2012), revised and implemented into the OpenQuake engine by N. Ackerley (Natural Resources Canada).
• Authors: N. Ackerley, K.K.S. Thingbaijam, S.K. Nath
- Japan [JPN] - 2014**
Developed by the Headquarters for Earthquake Research Promotion, Japan and converted into the OpenQuake engine format with a collaboration between the National Research Institute for Earth Science and Disaster Resilience, Japan, and GEM.
• Authors: H. Fujiwara, N. Morikawa, S. Kawas, S. Aoi, S. Sena, T. Maeda, H. Azuma, K. X. Hao, A. Isaki, K. Wakamatsu, M. Imoto, N. Hasegawa, T. Ochiyama, T. Hayakawa, M. Takahashi
• Website: <http://www.jpnps.bps.go.jp/>
- Korean Peninsula [KOR] - 2018**
Assembled by GEM.
• Authors: J. Garcia-Pelaez, R. Gee, R. Styrón
- Mexico [MEX] - 2018**
Developed by GEM.
• Authors: J. Garcia-Pelaez, R. Gee, R. Styrón
- India and surroundings [IND] - 2012**
Developed by the EMCA project, coordinated by the Helmholtz German Research Centre for Geosciences, Germany. Organisations involved: Institute of Geology, Earthquake Engineering and Seismology of the Academy of Sciences of the Republic of Tajikistan - Institute of Geophysical Research, Kazakhstan - International University of Innovation Technologies, Kyrgyzstan - Kyrgyzstan Institute of Geology, Kyrgyzstan - Central Asian Institute of Applied Geosciences, Kyrgyzstan - Institute of Mechanics and Seismic Stability of Structures of the Academy of Sciences of Uzbekistan, Uzbekistan - Mavnavviro Institute of Seismology, Uzbekistan.
• Authors: S. Ulak, D. Brink, M. Pila, L. Dancu, G.A. Weatherill, E. Zuccolo, A. Ischuk, N.N. Mikhalkova, K. Abdalrhmanov, S. Parslov, K. Fleming
• Website: <http://www.earthquake.org/>
- Middle East [ME] - 2016**
Developed within the EMCA project, jointly coordinated by the Swiss Federal Institute of Technology, Switzerland, and the Kandilli Observatory and Earthquake Research Institute, Turkey. Institutions involved: International Institute for Earthquake Engineering and Seismology, Iran - Middle East Technical University, Turkey - Sakarya University, Turkey - University of Pinarbaşı, Pakistan - Yarmouk University, Jordan - American University of Beirut, Lebanon - Imam Javahiriyyeh Tishri State University, Georgia - National Academy of Sciences, Armenia - National Academy of Sciences, Azerbaijan
• Authors: D. Giardini, L. Dancu, M. Erdik, K. Sesayon, M.D. Demircioglu, S. Aksoy, L. Guen, M. Zare, S. Adami, A. Anvari, A. Arakelyan, A. Askan, M. Arvanitoyan, H. Babayan, T. Chelidze, R. Durgaparan, A. Elas, H. Hamzehloo, K. Hassami, D. Kalfali, D. Koko, A. Kazakchanyan, M.A. Khan, T. Mamudi, M. Al-Gharabi, M. Saib, B. Terzelli, M. Ullrich, D. Varzantashvili, M. Wessner, H. Yagci, M.T. Yilmaz
• Website: <http://www.earthquake.org/>
- Northern Africa [NAF] - 2016**
Developed by GEM.
• Authors: V. Poggi, J. Garcia-Pelaez, R. Styrón
- Northeastern Asia [NEA] - 2018**
Developed by GEM.
• Authors: V. Poggi, J. Garcia-Pelaez, R. Styrón
- Northwestern Asia [NWA] - 2018**
Developed by GEM and the Swiss Federal Institute of Technology, Switzerland.
• Authors: V. Poggi, J. Garcia-Pelaez, R. Styrón
- New Zealand [NZL] - 2016 corrected**
GIS Science led the development of the model and converted it into the OpenQuake engine.
• Authors: E.R. Abbott, N. Horspool, M. Garsellenberger, R. Huso, C. Van Houzelle, G. McWerry, S. Cassens
• Authors 2016 model: M. Spirling, G. McWerry, M. Garsellenberger, N. Litchfield, R. Van Duzen, K. Berryman, P. Barnes, L. Wallace, P. Villamor, R. Langridge, G. Lamarche, S. Nodder, M. Reynolds, B. Bradley, D. Rhoades, W. Smith, A. Nicol, J. Pettinga, K. Clark, K. Jacups
• Website: <https://www.gns.cri.nz/>
- Pacific Islands [PAC] - 2018**
Developed by GEM.
• Authors: K. Johnson
- Philippines [PHI] - 2018**
Developed jointly by the Philippine Institute of Volcanology and Seismology and GEM.
• Authors: PHVDCS, Johnson, R. Styrón
• Website: <https://www.phivolcs.dost.gov.ph/>
- Papua New Guinea [PNG] - 2015**
Developed within a collaboration between the Port Moresby Geophysical Observatory and Geoscience Australia.
• Authors: H. Oshamini, C. Mokoé, M. Leonard, P. Curmies, M. Mokoé, S. Spiropoulos, F. Taranu, E. Bari
- South America [SAM] - 2018**
Initially developed within the SARA project and updated by GEM. Organisations involved: GEM, Colombian Geological Survey, Colombia - National University of Colombia, Colombia - University of Valle, Colombia - Venezuelan Foundation for Seismological Research, Venezuela - University of Mexico, Venezuela - National Observatory, Brazil, Institute of Astronomy, Geophysics and Atmospheric Sciences, Brazil - Federal University of Rio Grande do Norte, Brazil - National Polytechnic University, Ecuador - San Carlos Observatory - Bolivia - University of Chile, Chile - University of Concepcion, Chile - Pontifical Catholic University of Chile, Chile - Research Center for Disaster Risk Management, Chile - Peruvian Geological Service, Peru - University of San Luis, Argentina - University of Antofagasta, Argentina - National Institute of Seismic Prevention, Argentina - National Institute of Geophysics and Volcanology, Italy
• Authors: J. Garcia-Pelaez, M. Pagani, K. Johnson, R. Styrón, V. Poggi
- Continental Southeastern Asia [SEA] - 2018**
Developed by the Earth Observatory of Singapore, Singapore and Mahidul University, Thailand.
• Authors: V. Poggi, R. Durrheim, Q.M. Tuhua, G.A. Weatherill, R. Gee, M. Pagani, A. Nyshita, D. Debraux
- Sub-Saharan Africa [SSA] - 2018**
Developed by GEM in collaboration with AfricaArray within the project SSAHARA.
• Authors: V. Poggi, R. Durrheim, Q.M. Tuhua, G.A. Weatherill, R. Gee, M. Pagani, A. Nyshita, D. Debraux
- Taiwan [TAI] - 2015**
Developed within the Taiwan Earthquake Model initiative, a collaboration between various Taiwanese research institutions.
• Authors: Y.-J. Wang, C.-H. Chan, Y.-T. Lee, K.-F. Ma, J.-H. Shyu, R.-J. Rau, C.-T. Cheng
• Website: <http://www.earthquake.usgs.gov/hazards/hazmap/>
- California, USA [CAL] - 2014**
Developed within a project supported by the United States Geological Survey, the Southern California Earthquake Center, the California Geological Survey and the California Earthquake Authority. The model was converted into the OpenQuake engine by GEM.
• Authors: E.H. Field, Q.P. Biagi, P. Bird, T.E. Dawson, K.R. Felzer, D.D. Jackson, K.M. Johnson, T.H. Jordan, C. Madden, A.J. Michael, R.R. Miller, M.T. Page, T. Parsons, P.M. Powers, B.E. Shaw, W.R. Thatcher, R.J. Waldron, Y. Zeng
• Website: <http://www.gppg.org/ucsf/>
- United States of America [USA] - 2014**
Developed by the United States Geological Survey and converted into the OpenQuake engine by GEM.
• Authors: M.D. Petersen, M.P. Moschetti, P.M. Powers, C.S. Mueller, K. M. Haller, A.D. Frankel, Y. Zeng, S. Rezacan, G.C. Harman, O.S. Boyd, E.H. Field, R. Chen, K.S. Rukstales, N. Lucc, R.L. Wheeler, R.A. Williams, A.H. Olsen
• Website: <https://earthquake.usgs.gov/hazards/hazmap/>
- Western Africa [WAF] - 2018**
Developed by GEM.
• Authors: V. Poggi
- South Africa [ZAF] - 2018**
Developed by the Council of Geoscience, South Africa.
• Authors: V. Midsi, B. Marcutanu, T. Mulabisa, B.S. Zulu, T. Pule, S. Myerdel, G. W. Rathod
• Website: <http://www.geoscience.org.za/>



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