GeoForschungsZentrum Potsdam

International Decade for Natural Disaster Reduction
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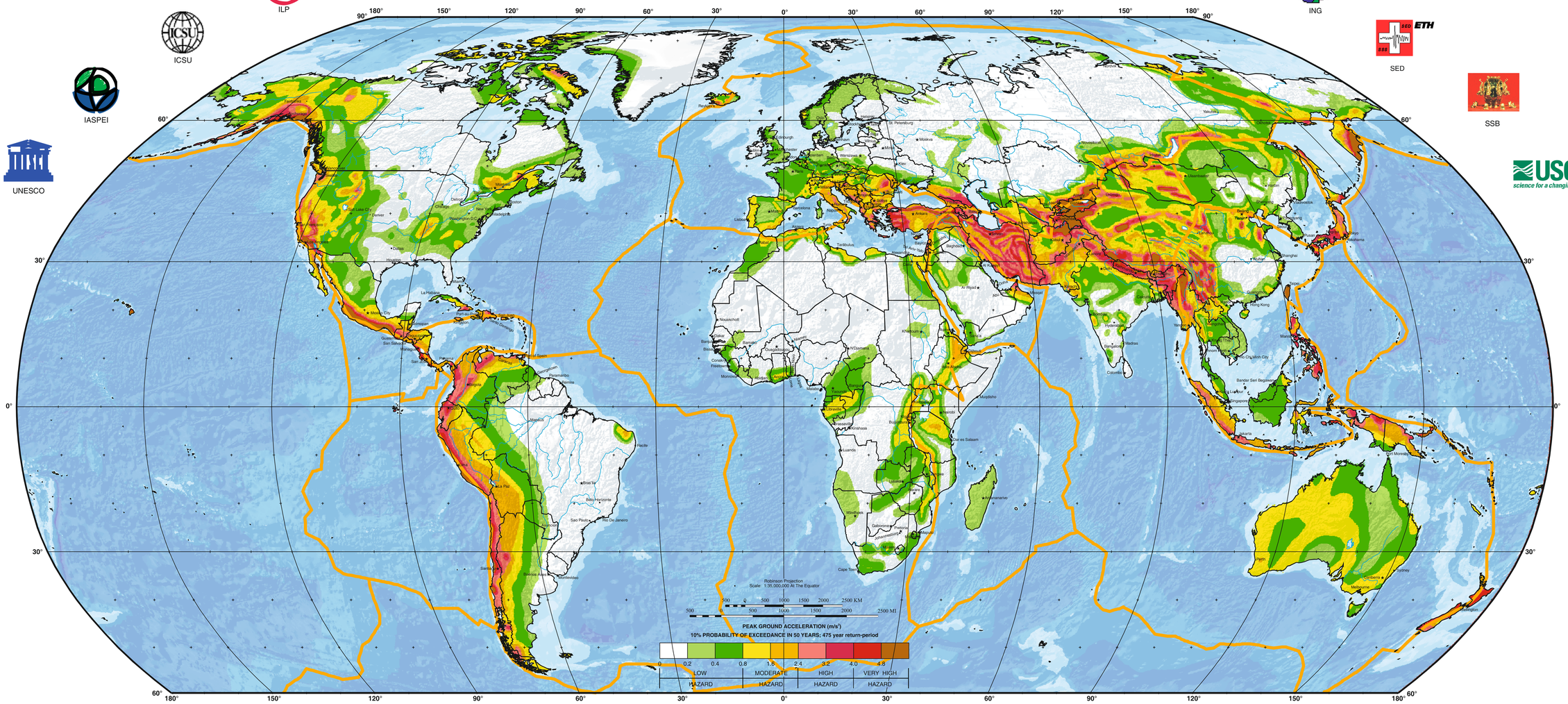
Building a Culture of Prevention

GLOBAL SEISMIC HAZARD MAP

Produced by the Global Seismic Hazard Assessment Program (GSHAP),
a demonstration project of the UN/International Decade of Natural Disaster Reduction

Global map assembled by
D. Giardini, G. Grünthal, K. Shedlock and P. Zhang, 1999

ILP · ICSU · IASPEI · UNESCO · ING · SED · SSB · USGS



Seismic hazard

Seismic hazard is defined as the probable level of ground shaking associated with the recurrence of earthquakes. The assessment of seismic hazard is the first step in the evaluation of seismic risk, obtained by combining the seismic hazard with vulnerability factors (type, value and age of buildings and infrastructures, population density, land use, date and time of the day). Frequent, large earthquakes in remote areas result in high seismic hazard but pose no risk; an the contrary, moderate earthquakes in densely populated areas entail small hazard but high risk.

The basic elements of modern probabilistic seismic hazard assessment can be grouped into four main categories:

1. Earthquake catalogues and databases: the compilation of a uniform database and catalogue of seismicity for the historical (pre-1900), early-instrumental (1900-1964), and instrumental periods (1964-today).
2. Earthquake source characterization: the creation of a master seismic source model to describe the spatial-temporal distribution of earthquakes, using evidence from earthquake catalogues, seismotectonics, paleoseismology, geomorphology, mapping of active faults, geodetic estimates of crustal deformation, remote sensing, and geodynamic models.
3. Strong seismic ground motion: the evaluation of ground shaking as a function of earthquake size and distance, taking into account propagation effects in different tectonic and structural environments and using direct measures of the damage caused by the earthquake (the seismic intensity) and instrumental values of ground motion.
4. Computation of seismic hazard: the computation of the probability of occurrence of ground shaking in a given time period, to produce maps of seismic hazard and related uncertainties at appropriate scales.

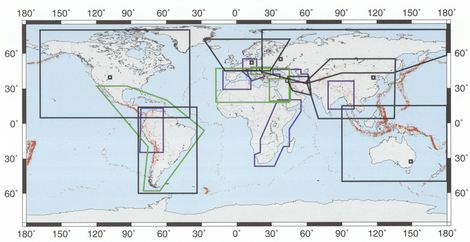
Seismic hazard maps depict the levels of chosen ground motions that likely will, or will not, be exceeded in specified exposure times. Hazard assessment programs commonly specify a 10% chance of exceedance (90% chance of non-exceedance) of some ground motion parameter for an exposure time of 50 years, corresponding to a return period of 475 years. This Global Seismic Hazard Map depicts Peak Ground Acceleration (PGA) with a 10% chance of exceedance in 50 years. The site classification is rock everywhere except Canada and the United States, which assume rock and (or) firm soil as the reference ground conditions. PGA, a short-period ground motion parameter that is proportional to force, is the most commonly mapped ground motion parameter because current building codes that include seismic provisions specify the horizontal force a building should be able to withstand during an earthquake. Short-period ground motions affect short-period structures (e.g. , one- to two-story buildings, the largest class of structures in the world). This GSHAP map depicts the likely level of short-period ground motion from earthquakes in a fifty-year window. The map colors chosen to delineate the hazard roughly correspond to the actual level of the hazard. The cooler colors represent lower hazard while the warmer colors represent higher hazard. Specifically, white and green correspond to low hazard (equivalent to 0% - 8% g where g equals the acceleration of gravity); yellow and orange correspond to moderate hazard (8% - 25% g); pink and dark pink correspond to high hazard (25% - 40% g); and red and brown correspond to very high hazard (>40% g). In general, the largest seismic hazard values in the world occur in areas that have been, or are likely to be, the sites of the largest plate boundary earthquakes.

Compilation of the Global Seismic Hazard Map

In order to mitigate the risk associated with the recurrence of earthquakes, the GSHAP fostered a regionally coordinated, homogeneous approach to seismic hazard evaluation. The GSHAP strategy was to establish a mosaic of regions led by selected regional centers and of multinational test areas under the coordination of large working groups. Some areas, specifically the Mediterranean and the Middle East, were included in several overlapping projects. In addition, the GSHAP allied with existing hazard projects to avoid duplications and strengthen cooperation across borders (e.g., in the Balkans and Near East). Working groups of national experts representing the different disciplines required for seismic hazard assessment were assembled for each region or test area. These working groups produced common regional earthquake catalogues and source characterizations, and compiled or computed regional hazard values. In some cases (parts of Africa, The Western Pacific, and North America) the GSHAP hazard map was derived from published materials. Finally, an editorial committee supervised the integration of the results of all the regional projects into the Global Seismic Hazard Map.

The PGA data were combined with a shaded relief base map using ArcInfo 7.2.1 geographic Information System (GIS), Software. The cell size of the PGA and relief base grids is 0.0833 degrees.

GSHAP Regions and Regional Centers



GSHAP regions and regional centers are outlined in black, multinational test areas are outlined in blue, and cooperating projects are outlined in green.

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The Global Seismic Hazard Assessment Program - GSHAP

The Global Seismic Hazard Assessment Program (GSHAP) was launched in 1992 by the International Lithosphere Program (ILP) with the support of the International Council of Scientific Unions (ICSU), and endorsed as a demonstration Program within the framework of the United Nations International Decade for Natural Disaster Reduction (UN/IDNDR).

Minimization of the loss of life, property damage, and social and economic disruption due to earthquakes depends an reliable estimates of seismic hazard. National, state, and local governments, decision makers, engineers, planners, emergency response organizations, builders, and the general public require seismic hazard estimates for land use planning, improved building design and construction (including adoption of building construction codes), emergency response preparedness plans, economic forecasts, housing and employment decisions, and many more types of risk mitigation. The GSHAP was designed to provide a useful global seismic hazard framework and serve as a resource for any national or regional agency for further detailed studies applicable to their needs.

The GSHAP cooperated with a number of international organizations, including the International Association of Seismology and Physics of the Earth Interior (IASPEI), UNESCO, the International Association of Earthquake Engineering, and the World Meteorological Organization.

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For more information
The GSHAP map and all associated documentation, including regional reports, maps of seismicity, source characterization and site classification information, and GSHAP yearly reports are available via the Internet through the GSHAP homepage,
http://www.seismo.ethz.ch/GSHAP/ and from

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Copies of the Annali di Geofisica volume containing all of the published GSHAP reports may be obtained from

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