Geoethical issues in prediction and prevention of potentially catastrophic natural events

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Acutely Ethical: New Resources for Using Location-Based Data in Crisis Situations
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President of the International Association for the Promotion of Geoethics (IAPG)

Involved in research on tsunamis and earthquakes since '70s

Author of more than 180 publications in peer review journals and books

Research topics:
Tsunamis. Numerical simulations. Tsunami and seismic risk assessments. Geo-observations and monitoring. Early Warning Systems, Geoethical issues


PLACET NATURA REGI TERRAM
INTERNATIONAL
ASSOCIATION for
PROMOTING
GEOETHICS
A multidisciplinary platform
for widening the discussion and creating awareness
about values and problems of ethics applied to the geosciences
Founded in 2012
Scientific, non-governmental, non-political organization
Legally registered as a NGO
More than 2100 members in 125 countries on 5 continents
http://www.geoethics.org/


Strategy 2016-2020
Projects
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Sessions in congresses
Orienting documents

Networking

IAPG promotes geoethics through the international cooperation with Associations, Organizations and Institutions

7 affiliations

17 agreements

5 partnerships

Books

1st Special Issue on geoethics in a JCR Journal

1st peer reviewed book on geoethics

2012 2014 2015 2015 2017 2017

All the IAPG publications are peer-reviewed

NEW! 2019

palgrave pivot "Exploring Geoethics"

Danger

A (natural) phenomenon that could lead to a damage, described in terms of physical and processual properties (its geometry, its dynamics…)
The danger can be an "actual" existing one, such as a creeping slope, or a "potential" one, such a future earthquake or a tsunami

Hazard

Probability that a given danger occurs within a given period of time and in a given region

For example: probability of a significant earthquake/tsunami affecting Japan in the next 50 years

Seismic hazard and tsunami hazard assessments have been undertaken in several countries of the world and globally for the whole Earth planet

The purpose is to provide a scientifically sound basis to the engineers, technicians, urban and industrial planners, politicians, civil protection operators and in general to the authorities for devising rational risk mitigation strategies and for implementing corresponding adequate policies

Two Elements

"Natural Hazards" involve always two elements

Nature and **Society**

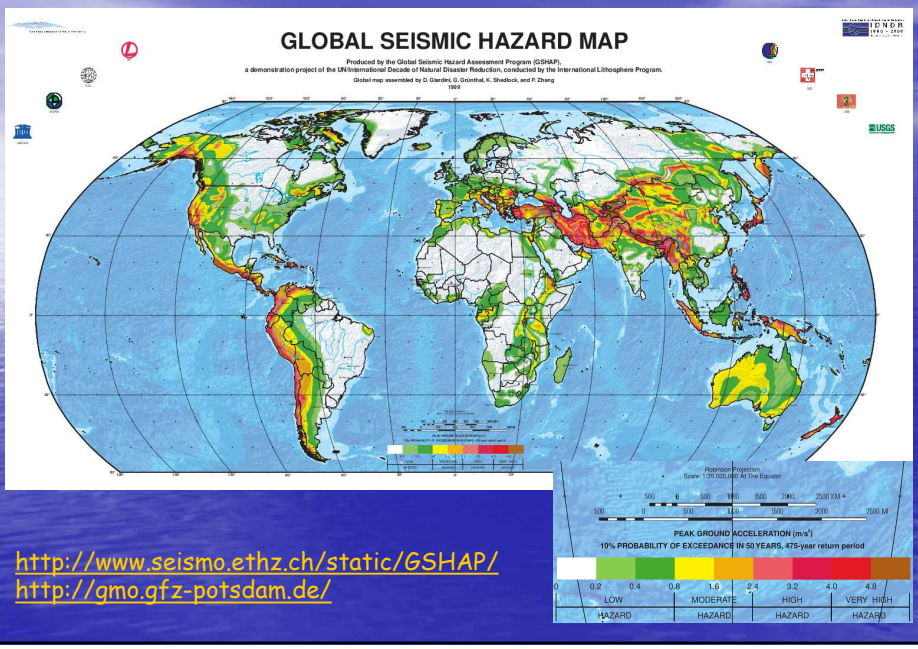
A natural phenomenon that occurs in a populated area is a **hazardous event**. And if it causes a large numbers of fatalities and/or great property damage is a **Natural Disaster**

Short- and Long-Term Predictions

1) A short-term prediction covers a time span in the future comparable with human activities time scales (from hours to years)

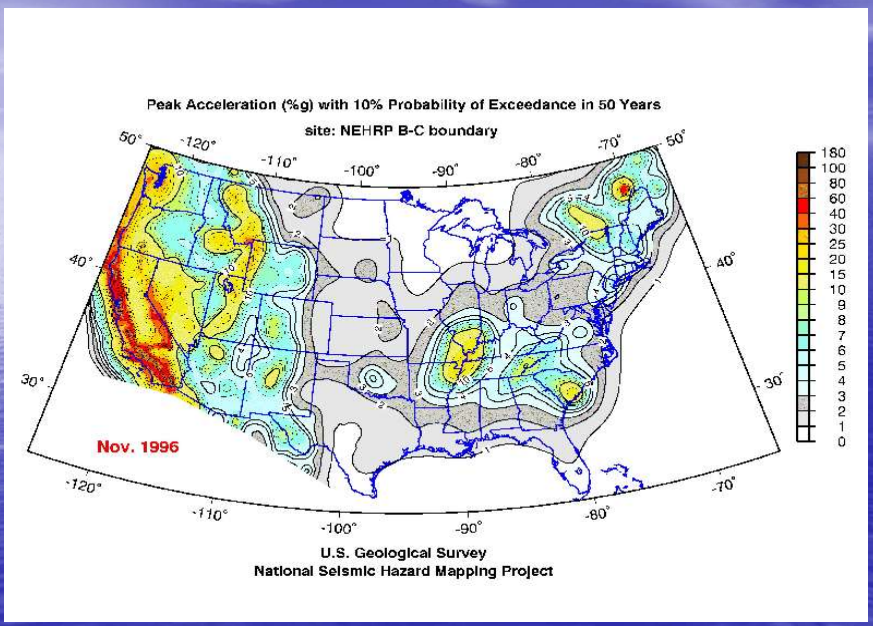
2) A long-term prediction covers a time span in the future much longer than human activities time scales (from decades to thousands of years)

Global Seismic Hazard Assessment Program (GSHAP)

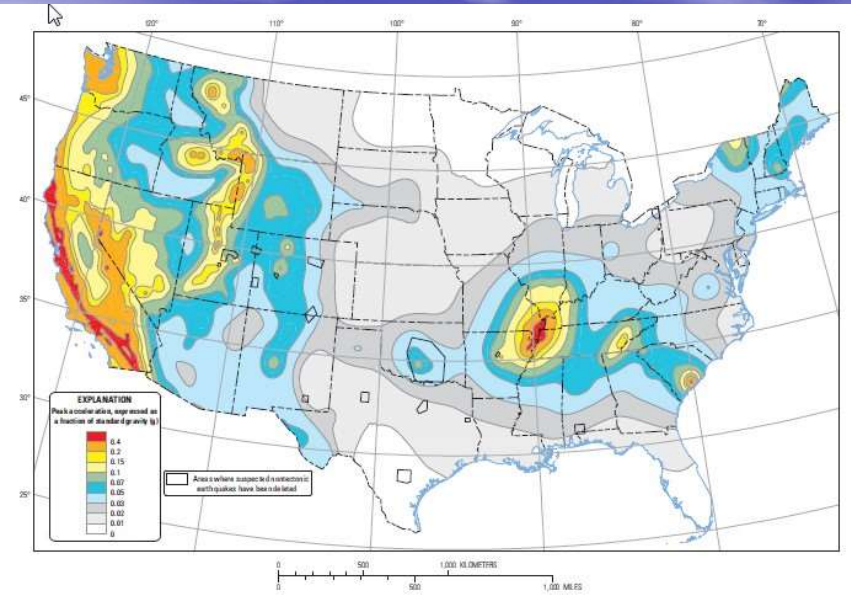


http://www.seismo.ethz.ch/static/GSHAP/
http://gmo.gfz-potsdam.de/

USA Seismic Hazard Map (USGS 1996)

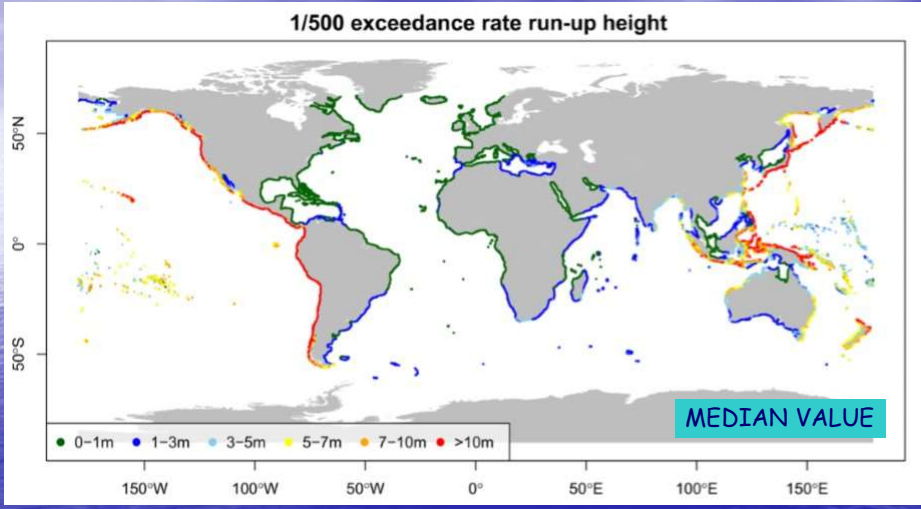


USA Seismic Hazard Map (USGS 2014)



Ten-percent probability of exceedance in 50 years map of peak ground acceleration

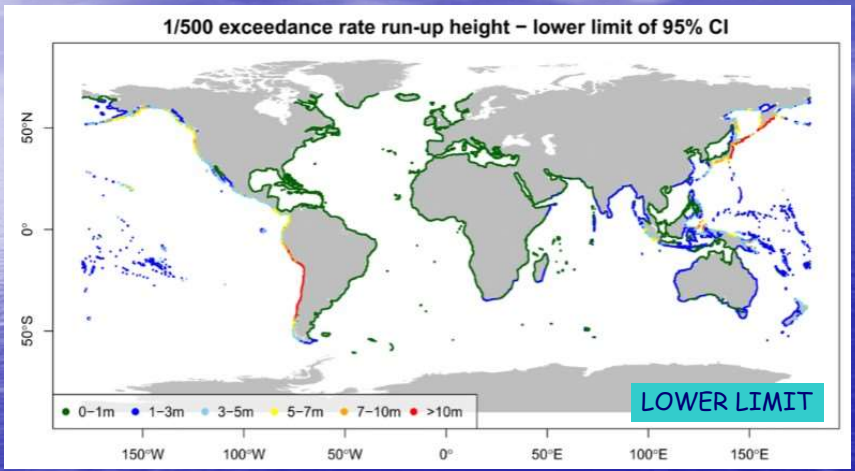
Global Tsunami Hazard Map



Run-up height in 500-year time interval

Davis et al. (2018) Geological Society London, Special Publications

Global Tsunami Hazard Map



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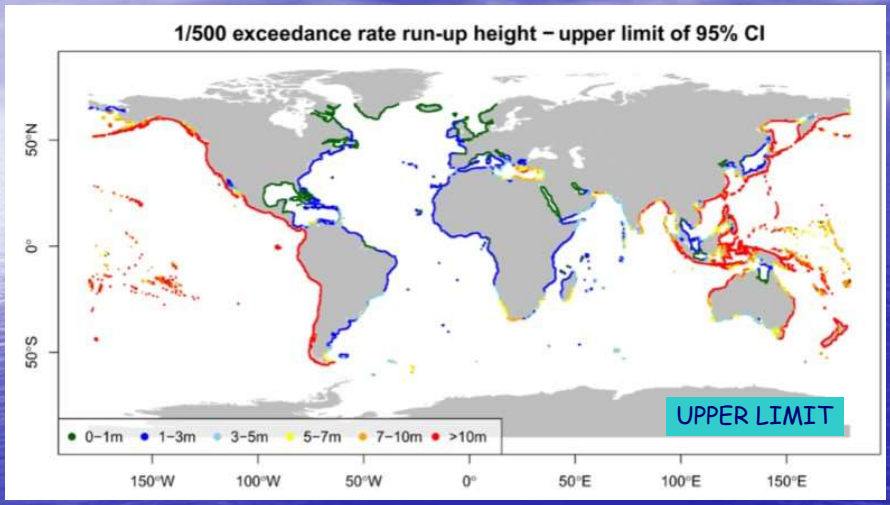
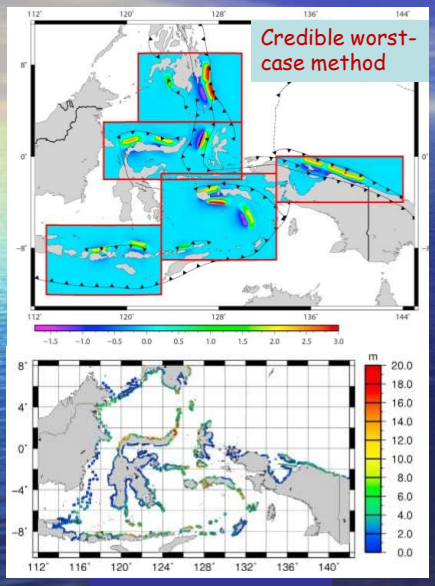


Run-up height for a 500-year time interval

Davis et al. (2018) Geological Society London, Special Publications

Indonesia Tsunami Hazard



Løvholt et al., 2012

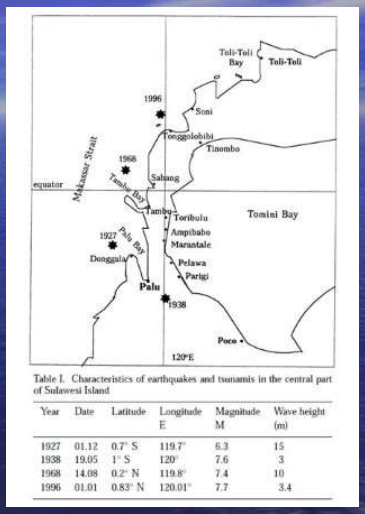
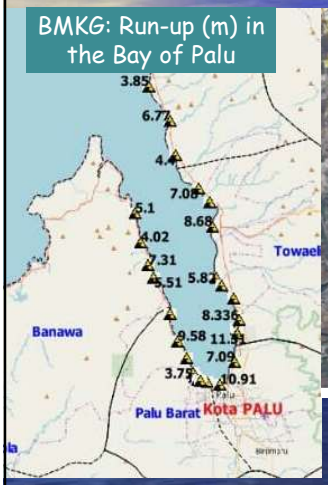


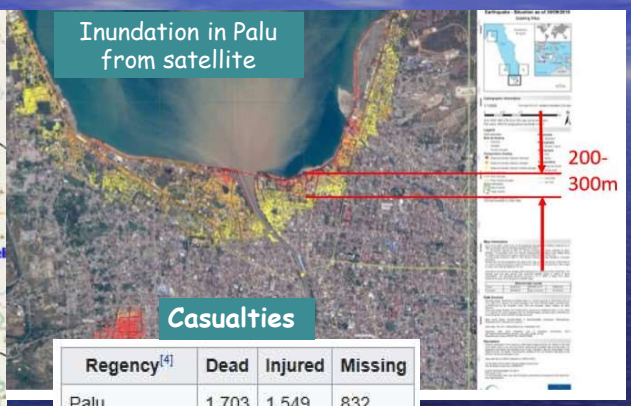
Table I. Characteristics of earthquakes and tsunamis in the central part of Sulawesi Island

Year	Date	Latitude	Longitude E	Magnitude M	Wave height (m)
1927	01.12	0.7° S	119.7°	6.3	15
1938	19.05	1° S	120°	7.6	3
1968	14.08	0.2° N	119.8°	7.4	10
1996	01.01	0.83° N	120.01°	7.7	3.4

Pelinovski et al., 1997

28 September Sulawesi Tsunami





Casualties

Regency[4]	Dead	Injured	Missing
Palu	1,703	1,549	832
Sigi	366	1,112	227
Donggala	171	1,750	14
Parigi Moutong	15	27	2
Total	2,245	4,488	1,075

How to evaluate a prediction?

1) A short-term prediction can be evaluated at the end of the interval of forecast on the basis of the real occurrences

Every day one can judge if the one-day weather forecast issued the day before was accurate, successful, useful or wrong. After a tsunami, one can evaluate the correctness of the launched tsunami warning, etc

2) A long-term prediction cannot be evaluated at the end of the period

Seismic-tsunami hazard maps with the maximum event expected in the next 500 years is hard to validate or to falsify in the next 10 years

How to evaluate and compare methods of prediction?

1) In the STP one can introduce a goodness index: statistics on the number of useful predictions over the total number of predictions made with the same method

2) In the LTP there is no goodness index based on the performance

A method can be judged not on results but on internal consistency

A Prediction Method

1) is a sequence or a tree of logical steps

2) makes a number of assumptions

3) uses algorithms, models, computational tools

- ❑ Repeatability
- ❑ Sensitivity Analysis

What to do if two sound Prediction Methods give different (inconsistent) predictions?

Make a prediction by combining the two methods together ?

Temptation: build up a Universal Method (method of methods) by combining all the possible methods together

The main point of this presentation is that the chief-value of all seismic and tsunami hazard studies (including theory, concept, quantification and mapping) resides in the social and political values of the provided products, which is a standpoint entailing a number of relevant geoethical implications.

Viewed from the classical perspective, the main ethical obligations of geoscientists are restricted to performing hazard estimations in the best possible way from a scientific point of view, which means selecting the "best" available data, adopting sound theoretical models, making use of rigorous methods…

What is outlined here, is that this is an insufficient minimalistic position, since it overlooks the basic socio-political and therefore practical value of the hazard-analysis final products.

The new geoethical perspective is that the line is replaced by **a loop**, where geoscientists and users interact cyclically:

1) where theory and methods themselves are not determined a-priori, but they result also in response of geoscientists-users interactions, and
2) where user needs can be modified ex-post in response to geoscientists elaborations.

These two-way feedback actions, opening also the path to close interdisciplinary approaches involving geosocial and decision-making sciences, are the main challenge for the present generation of geoscientists.

Unfortunately they are not properly and adequately reflected in the today university educational systems, and in professional societies

Thanks for your attention

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