



EXTREME GEOHAZARDS

Why Extreme Geohazards?

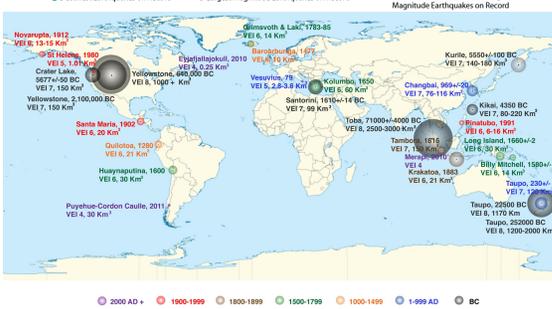
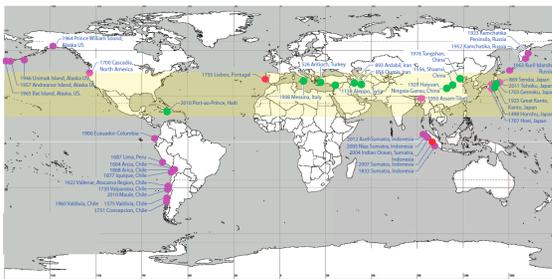
The growing, interconnected and increasingly exposed global population faces a mounting risk of a global catastrophe caused by extreme natural hazards.

- extreme hazards occurred in the past, but little exposure often limited the disaster
- increased exposure leads to more frequent disasters
- complexity of modern societies leads to more indirect effects
- sustainability crisis reduces resilience

Reducing the Disaster Risk and Increasing Resilience

Are We Prepared for the next big event?

With support from the European Science Foundation (ESF), the Geohazards Community of Practice (GHCP) of the Group on Earth Observations (GEO) is preparing a White Paper on the risk associated with low-probability, high-impact geohazards. These extreme events are in general not sufficiently accounted for in risk management, although the potential impacts of these events are comparable to those of a large asteroid, a global pandemic, or an extreme drought. The White Paper aims to increase the awareness of the risk associated with extreme geohazards as a basis for a comprehensive risk management.



1) Krakatau was similar to Santorini eruption, 1600 BC, although 4 times smaller

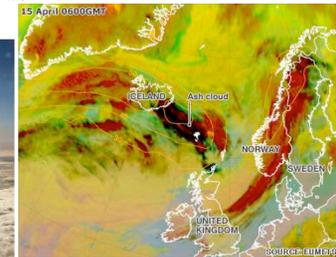
Deaths	Volcano	Year	Cause
92,000	Tambora, Indonesia ²⁾	1815	Starvation
36,417	Krakatau, Indonesia ¹⁾	1883	Tsunami
29,025	Mt. Pelee, Martinique	1902	Ash flows
25,000	Ruiz, Colombia	1985	Mudflows
14,300	Unzen, Japan	1792	Tsunami
9,350	Laki, Iceland ²⁾	1783	Starvation
5,110	Kelut, Indonesia	1919	Mudflows
4,011	Galunggung, Indonesia	1882	Mudflows
3,500	Vesuvius, Italy	1631	Mud and lava flows
3,360	Vesuvius, Italy	79	Ash flows

Extreme Hazards:

- knowledge of rare events is limited
 - we know better the "why" and "how" but not the "when"
 - probability is difficult to assess
 - risk assessment is challenged
- For a Poisson distribution, the chance that a 1 in N years event occurs in any given century is given in the table:

N	C in %
10	99.99
100	63.21
500	18.13
1,000	9.516
10,000	0.995
100,000	0.100

We have been very lucky that no major volcanic eruption has occurred during the last century. It would be silly to assume we will continue to be that lucky.



The 2010 Eyjafjallajökull eruption had a VEI 4, and ejected 0.25 km³. This was enough to cause serious problems around the North Atlantic. The 1783-85 Laki eruption with a VEI of 6 ejected 14 km³. Today, such an eruption could cause a global disaster.

Cost-Benefit Analysis

We use the example of the Toba eruption, 75,000 years ago, which had a VEI of 8, ejected 2,800 km³, and killed most likely about 60% of human population. Today, impacts would include an ash layer of several million square kilometers; destroying one or two seasons of crops for two billion people; reducing global temperature by 5-15 C, and substantial physical damage to infrastructure. The fatalities would be comparable to other global disasters, such as the 1918 Spanish flu, which killed 3% - 5% of global population. For the CBA, we assume that 10% of the global population is killed if the volcano eruption comes as a surprise. The Value of statistical life (VSL) is for the U.S. \$9.1 million (U.S. Department of Transportation). This implies that a U.S. citizen should be willing to spend \$910 to eliminate a 1 in 10,000 risk of fatality. The global VSL is \$2.22 million. A Toba-type eruption with a probability of 1 in 100,000 years and fatalities of 10% of the global population is equivalent to a probability of a random person dying in any particular year of 1 in 1,000,000. Consequently, an average person should be willing to pay \$2.22 per year to eliminate the risk. With a global population of over 7 billion, collectively we should be willing to spend \$15 billion per year to eliminate the risk. Assuming that we can eliminate half of the risk through early warning, the early warning would be worth \$7.5 billion per year. The 2014 USGS Budget includes only \$24.7 million for volcano monitoring. If we would aim for the same level globally, we would spend \$370 million annually for volcano monitoring.



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