Extreme Geohazards: Assessing and Addressing the Risk of Global Disasters

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Introduction

With support from the European Science Foundation, the Geohazards Community of Practice of the Group on Earth Observations has prepared a white paper on extreme geohazards and their potential to generate global disasters. The recent large earthquakes illustrated the destruction they can inflict (Figure 1). Those relatively frequent hazards with major impacts are on our radar screen. The more we can handle events that occur frequently, the less we are worried about the less frequent events, and threats from low-frequency, high impact events are crossly underestimated in disaster risk reduction (DRR). This is particularly true for volcanic eruptions. So far, modern civilization has not been exposed to the most extreme events that occurred during the past few thousand years. Under today's circumstances, these events are associated with extreme disaster risks, comparable to other possible mega-disasters from extreme droughts, floods, pandemics, and asteroid impacts (Figure 2).

The Extreme Hazards

Besides local and regional direct impacts, large volcano eruptions have the potential to impact climate, infrastructure and resource supplies on global scale. Today, the largest eruptions that occurred during the last 2,000 years (Table 1 and Figures 3 to 5) are associated with extreme disaster risk. The extreme earthquakes that occurred during the last 100 years have illustrated the destruction they can inflict, both directly and indirectly through tsunamis (Figure 1). The resulting disasters are amplified in areas with poor building infrastructure. The comparison of earthquakes and volcano eruptions shows that volcanos are the geohazards that can cause the most extreme disasters with global impacts.

The Need for a Volcano Monitoring System

The disaster caused today by a large eruption comparable to the most extreme ones experienced during the last 2,000 years could reach global scale and trigger many environmental, economic, and social consequences. A global volcano monitoring system is required as a basis for an early warning system. However, efficient DRR will require to reduce vulnerability of infrastructure, increase economic and social resilience, and develop adaptive capabilities to potentially large long-term changes in environmental conditions.

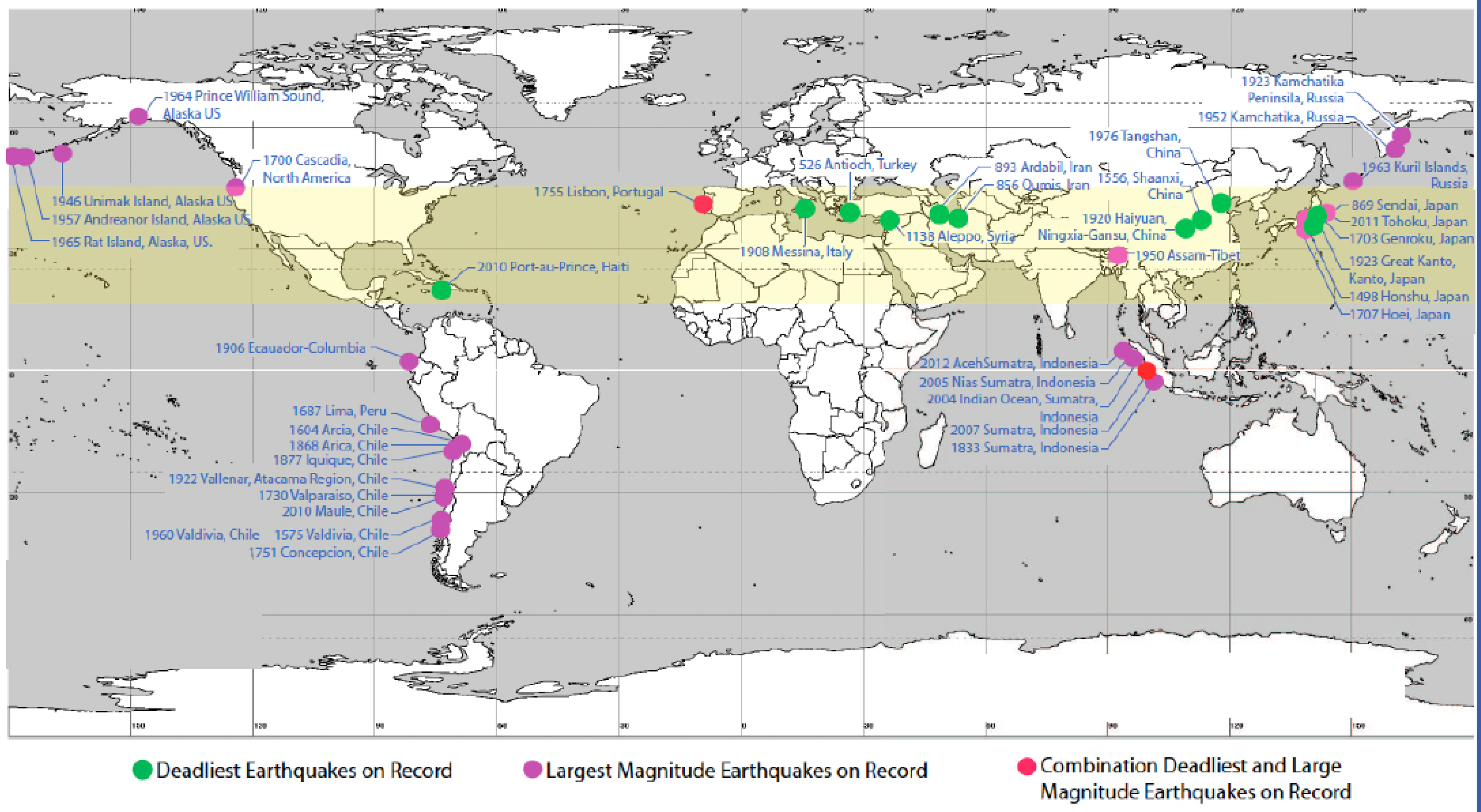

Figure 1: Largest and most destructive earthquakes on record

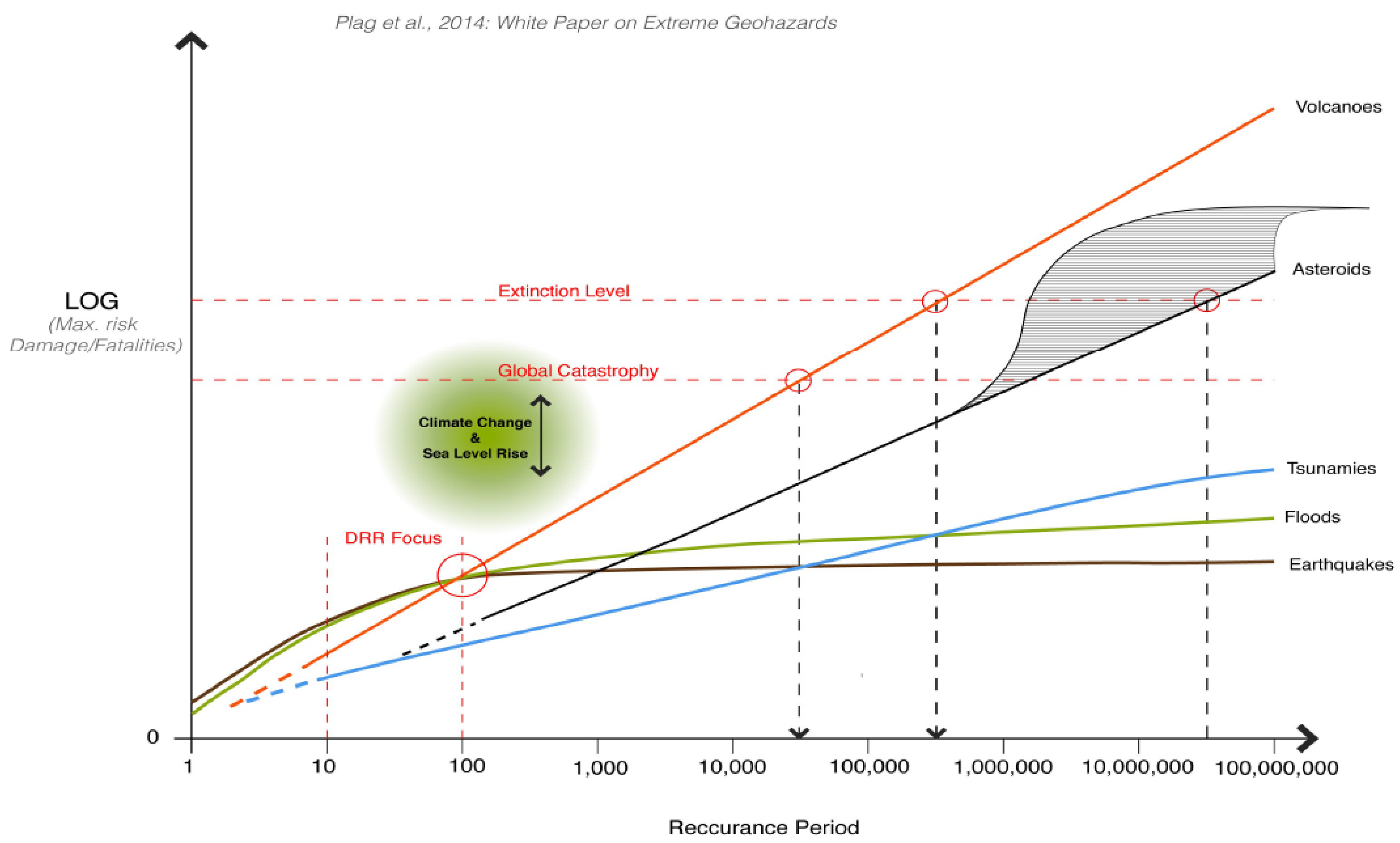

Figure 2: Schematic comparison of risk associated with natural hazards

The Way Forward

We suggest a paradigm shift toward integrated DRR and Resilience (D3R) programs that more aggressively facilitate the public trust, cooperation, and communication needed to adequately prepare for and recover from expected disasters as well as Black Swan disasters. In D3R, science does not have the primary goal to reduce uncertainties and prediction errors for hazards, but rather to develop antifragile processes and strengthen resilience through increased social capital. An international process is needed to assess repeatedly the risk associated with extreme geohazards and our preparedness to cope with these high-impact events. This process could be an amalgam of the process used by the IPCC and the QDR carried out by the Department of Defense of the USA.

Table 1: Largest volcanic eruptions during the last 2,000 years

Deaths	Volcano	Year	Cause
92,000	Tambora, Indonesia 2)	1815	Starvation
36,417	Krakatau, Indonesia 1) 2)	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

Figure 3: Laki, Iceland, 1783. Area impacted by volcanic ash

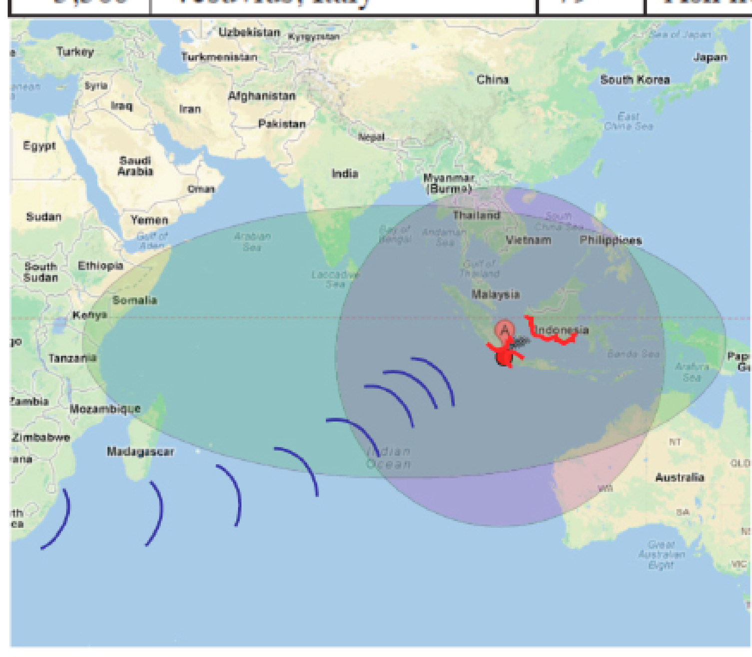

Figure 5: Krakatau, Indonesia, 1883.

Figure 4: Mount Tambora, Indonesia, 1815