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Can the risk of coastal hazards be better communicated?

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ABSTRACT

Destructive coastal hazards, including tsunami inundation and storm surges, periodically affect many of the world's coasts. To quantify the risk of such events and to identify premium levels for such hazards, the insurance industry commonly uses the available scientific literature, coupled with probabilistic modelling. Often, communicating the results of the modelling to clients is difficult, as it involves world or regional scale risk maps and complex statistics of recurrence intervals and exposure. Risk maps are particularly problematic because they necessarily generalise the information conveyed to the mapping scale, thereby reducing detail. As a result, entire coastlines can be labelled as "high risk", discouraging clients from investing, and/or leading to inappropriately high premium levels. This raises the question: What is the best way to communicate risk at a regional scale without broad generalisations? In our study, we have used historical events as case studies via the pedagogical premise of "Concept, Example, Consequence", and created a novel multifaceted poster map. Our approach will encourage reinsurance industry practitioners and clients to reconsider their communication of risk, re-evaluate localised risk, and provide a detailed alternative to the broad generalisations found in many products in the marketplace.

1. Introduction

The coast is a very popular place to live, work and visit [1]. The Low Elevation Coastal Zone (LECZ),i.e. the area below 10 m elevation with a direct connection to the sea [2], makes up 2% of the global land surface, but contains approximately 10% (estimates range from 400 to 634 million people) of the global population [2–4]. Coasts are among the most highly productive ecosystems in the world, and provide significant support for human livelihoods and wellbeing via fisheries, primary production, tourism, recreation, biodiversity habitat, resource extraction and transport [5]. Coastal locations provide access to port facilities and their associated advantages of high-volume cargo shipping, and as such are often favourable locations for large-scale manufacturing. The legacy of maritime trade [2,6] means that many of the world's major economic hub cities (e.g. New York, London, Shanghai, Tokyo, Singapore) are located on, or near, the coast, with 13 of the world's 20 most populous cities in 2005 having a port [6]. An increase in volume of maritime cargo and increasingly larger vessels has led to major new investments along the coast, including the construction of new, larger port facilities. This is especially true of the Indo-Pacific region, where 52 of the 136 largest and most populous port cities are based [6]. Many major infrastructure developments are also located on the coast, for example nuclear power stations to allow easy access to cooling water [7], and tourist and recreational facilities, to take advantage of beaches and the aesthetic beauty of the coastline [1].

However, coastal developments and infrastructure are vulnerable to damage or destruction from coastal hazards [6,8]. Tsunamis can inundate land and lead to major infrastructure damage; storms can cause storm surges; heavy rainfall can cause flooding; and strong winds can damage buildings [3,9]. For example, Typhoon Haiyan (Philippines, 2013) caused a total economic loss close to US$13B [10], with damage to infrastructure and agriculture estimated at US$900M [11] and the Indian Ocean Tsunami (2004) damaged or destroyed almost two thirds of the built infrastructure of urban Banda Aceh, Sumatra, Indonesia [12].

In the aftermath of coastal hazard events, losses are assessed and

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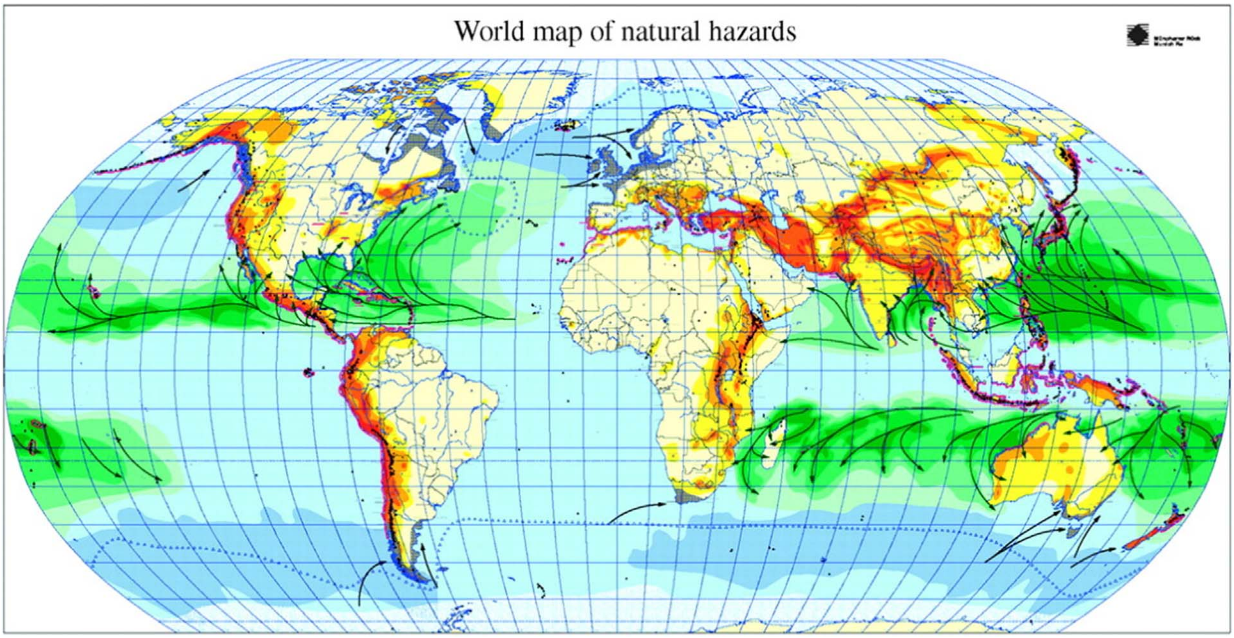

Fig. 1. The Munich Re NATHAN World Map of Natural Hazards (WMNH) [13 by permission of the Royal Society], presents natural hazard data corresponding to its geographical location. Geopolitical boundaries are marked on the basemap, but the emphasis is placed on natural features (e.g. major rivers) and natural hazards. The WMNH uses a red-green-blue colour scheme, with seismic/earthquake hazards presented in a red-yellow colour scale, with the deeper reds indicating greater risk. Tropical cyclones are presented in a green shade scale, with greater intensity values indicated by increasingly darker shades; extra-tropical storm areas are represented by a shade of blue slightly darker than that used to represent the oceans. Typical storm track directions are shown as black arrows. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

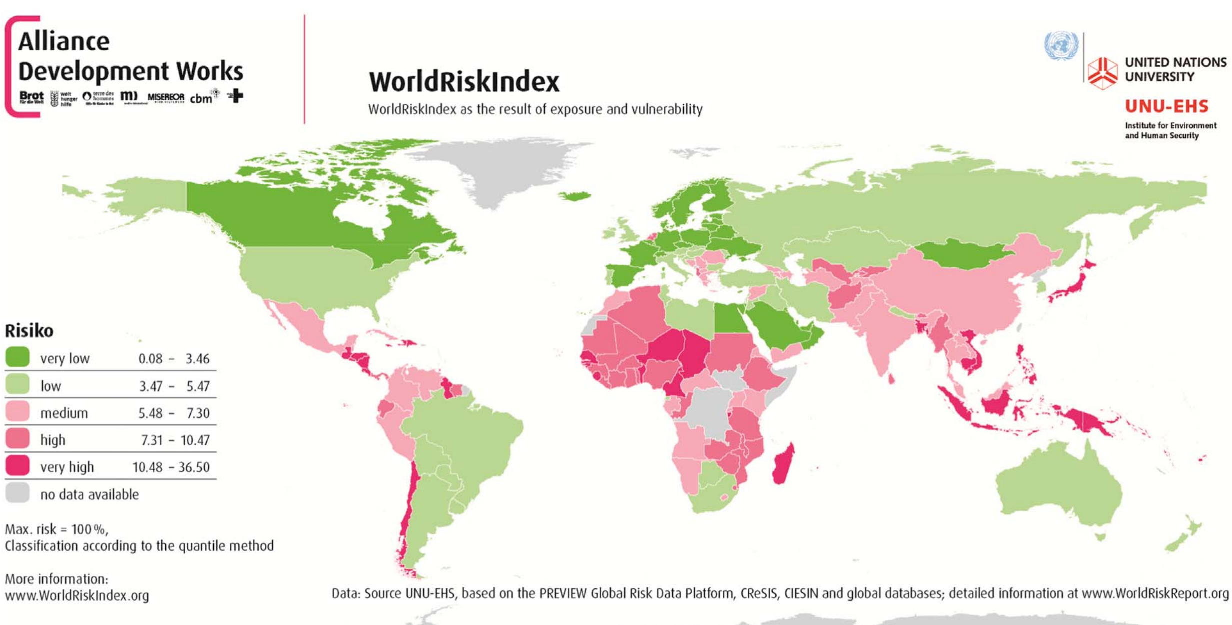

Fig. 2. World Risk Report WorldRiskIndex map [15] presents the total (aggregated) risk based on vulnerability and exposure of the population and infrastructure of each country to all natural and man-made hazards (Entwicklung Hilft [Alliance Development Works]/United Nations University (2014): WorldRiskReport 2014. Berlin: Bündnis Entwicklung Hilft by permission). The risk level for each country is displayed using a red-green colour scheme, with dark red (magenta) corresponding to the greatest risk and dark green corresponding to little risk. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

damage repaired, with costs borne by individuals, insurance companies, re-insurance companies and/or governments [12]. In order to set appropriate premiums, generate profits and minimise exposure to irrecoverable financial loss and loss of reputation, the insurance industry commonly uses the available scientific literature and probabilistic modelling to quantify the recurrence intervals, potential damage and risk of such natural events [13]. This level of risk and possible exposure to natural hazards is commonly communicated to clients through the use of hazard maps [13,14], which can be of varying scales, from global coverage maps (e.g. Figs. 1 and 2) to local maps.

Our initial inspection of current regional risk and hazard maps indicates that the assessments of risk and hazards based on modelled data, the short instrumental record and the fragmentary documented history of events in the Indo-Pacific region, deem almost every coast at high risk of being affected by coastal hazards at the regional to global scale (Fig. 1). This outcome may result in the unintended consequence of decreased investment and higher insurance premiums. However, it would be unjust and unscientific to label entire coastlines "high risk", as