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Recent tsunamis events and preparedness: Development of tsunami awareness in Indonesia, Chile and Japan

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ABSTRACT

Since the 2004 Indian Ocean Tsunami, there is a growing awareness of the risks that tsunamis pose to coastal communities. Despite the fact that the population of some countries such as Chile and Japan were aware of such events, many other places had virtually not heard about such phenomenon before 2004. Nevertheless, the frequent reoccurrence of major tsunamis in recent years has led to a heightened state of tsunami awareness in many areas of the world, which can be described by an increased knowledge, disaster preparedness and willingness of local populations to evacuate when the threat of these events arises. However, the response of different elements of society to tsunami warnings nowadays still appears to be inadequate a times, pointing to lack of awareness by at least some individuals, an over-reliance in defence mechanisms or lacking in the transmission of knowledge from previous events. This paper will explore these cultural issues using as a basis observations made by the authors during field visits to areas afflicted by the last three major events (Chile, Indonesia, and Japan). The level of tsunami awareness prior to these events will be explored through an analysis on the existence of multiple layers of safety against tsunami developed by previous generations, and whether these had been preserved over time. The potential impact of these major tsunamis in the development of tsunami awareness will be analysed based on questionnaires that indicate the willingness of local coastal communities to invest in disaster preparedness.

1. Introduction

There is an increasing worldwide awareness of the risk associated with tsunamis due to the high number of severe coastal disasters documented by the world media within a reasonably short period (from 2004 in Indonesia to 2011 in Japan). This has led many countries to develop early warning systems and evacuation plans (such as the development of the Indian Ocean Tsunami alarm system following the 2004 tsunami). Although these might make little sense in the short-run (due to the low frequencies of these events in many parts of the world), in the long-run, if they are maintained, they could reduce the mortality rates due to these events. However, for this to happen, it is imperative that a heightened state of tsunami awareness is created and kept, requiring investments in education, infrastructure and drilling exercises.

Prior to the 2004 Indian Ocean Tsunami the general public of most countries in the world were unaware of what a tsunami was or the danger they posed to coastal

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communities (though some countries, such as Japan or Chile, had long experience and awareness of these events). The present paper will discuss the development of a common tsunami awareness on a citizen and on institutional level that followed this event. The existence or not of this tsunami awareness and preparedness can be reflected by a number of factors. From the point of view of the authorities/institutions in a country it would be showcased by:

(1) the degree of risk awareness,
(2) the willingness to take measures for the reduction of risk, and
(3) the type of measures where the authorities have invested in the past (e.g. multi-layer safety indicates a tsunami awareness).

On a citizen level, the attitude of the local residents when faced with a tsunami will be investigated, regarding when and why the residents chose to evacuate during the past 3 major tsunamis (Chile in 2010, Indonesia in 2010 and Japan in 2011). Essentially, from the point of view of the citizen this can be manifested in:

(1) the willingness to evacuate,
(2) the willingness to support authorities' efforts to reduce tsunami risk, and
(3) taking protection measures individually.

Following each tsunami event typically there is a major drive to increase disaster preparedness through the construction of defence structures, relocation of communities away from danger zones and the improvement of evacuation systems, signifying the emergence of tsunami awareness on an institutional level. By interpreting all these elements from a multi-layer safety perspective, it is possible to gage the extent of tsunami awareness in each of these countries prior to each tsunami, and how this might influence future disaster preparedness. It should be noted that this concept of multi-layer safety actually did not originate from tsunami disaster mitigation, but was developed by the Dutch after Hurricane Katrina. In this sense a tsunami awareness would be part of a much wider “disaster preparedness”, though many elements of tsunami hazard mitigation are somewhat different to that of storm surge mitigation (as tsunamis can provide very little evacuation time and produce much higher inundation heights than storm surges).

Multi-layer safety is a concept in flood risk management that introduces the integration of flood risk probability-reducing measures and loss-mitigating measures in a flood protection system [1]. Essentially the role of the former is to prevent inundation while the latter is meant to function only in case when an extreme event exceeds the expectations of the prevention lines and inundation occurs. Within a multi-layer safety system 3 safety layers can be distinguished:

- Layer 1—Prevention: this is defined as preventing seawater from inundating areas that are usually dry, by building flood defences such as dykes or breakwaters.
- Layer 2—Spatial Solutions: this means using spatial planning and adaptation of buildings to decrease the loss if a flood does occur.
- Layer 3—Emergency Management: this layer focuses on the organisational preparation for floods, such as disaster plans, risk maps, early-warning systems, evacuation and medical help. For the case of tsunamis the most important component of the layer 3 would be a rapid evacuation plan, especially against what are now referred to as level 2 events (Shibayama et al. [2]).

Whether multiple layers of safety are present in a system, and which ones are prioritised, can vary significantly in different countries and regions, depending on a number of parameters that can be highly time-dependent. Some of them are the degree of public awareness of tsunami risk, the occurrence and severity of tsunamis in the past, the value of the area that needs to be protected in terms of human life, economic assets and natural environment, and the degree of flexibility in policy-making that allows economic resources to be available for financing disaster management projects (Tsimopoulou et al. [3,4]) Developing countries, whose resources for constructing infrastructure are limited, often compromise by using only loss-mitigating measures, which can be much cheaper and smaller in scale than prevention structures. On the other hand, richer countries such as Japan have more financial resources for flood protection hard measures, such as tsunami breakwaters and dykes. It is important to note how multi-layer adaptation is not unique to sea flooding, but can be found in human responses to other natural hazards (such as volcanic eruptions, see [5] for example).

In the present paper, the authors will analyse each of the 3 target countries (Indonesia, Chile, Japan) in terms of whether any tsunami counter-measures representative of the 3 layers of multi-layer safety existed before their respective tsunamis, and how they performed during the tsunamis. This analysis is an attempt to understand the level of tsunami awareness in the 3 target countries, if they had a deliberate risk management strategy or not, and how this awareness can be preserved and stimulated through further investments in multi-layer safety.

2. Chile

Chile has suffered from tsunami events regularly throughout its history. The last major one was in 1960, and therefore the threat that they pose was still present in the minds of the older generation. On February 27, 2010, a large earthquake of M 8.8 generated a tsunami that caused heavy damage to the coastal area (Mikami et al. [6]). The measured tsunami inundation height was 4–10 m throughout a wide area of Chilean coast, with a maximum recorded run-up height of over 20 m, as shown in Fig. 1. Structured interviews were carried out to collect information regarding the tsunami heights, evacuation and life after the disaster.

Generally speaking, it could be said that tsunami counter-measures were not adequately developed in Chile. Prevention measures were virtually non-existent, showing how little effort was made to develop layer 1 measures.