



# Tsunami Disaster Risk 2016

Past impacts and projections



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# Tsunami disasters: introduction

Tsunamis are rare, powerful and unpredictable natural hazards, with devastating consequences for coastal populations caught in their path. The vast majority are caused by earthquakes in active seismic areas and occur along a limited range of inhabited shores around the world (Figure 1). In total, 16 major tsunamis killed 250,900 people in 21 countries between 1996 and 2015, according to EM-DAT records.

Tsunamis are the deadliest type of major natural disaster on the planet in terms of the proportion of victims killed. This high level of mortality explains why World Tsunami Awareness Day is being inaugurated on November 5, 2016.

Mathematical projections undertaken for this report underline that the threat to human life from tsunamis is increasing at a time when substantial reductions in global disaster mortality (and the numbers of people affected) are key targets of the Sendai Framework for Disaster Risk Reduction adopted by UN Member States in March, 2015.

Tsunamis also pose a significant threat to critical infrastructure, including nuclear power plants and airports. These increasing risks demonstrate the need for a commensurate effort to reduce potential tsunami impacts.

## Key recommendations are:

- Regional and international disaster preparedness policies should prioritise areas where the largest numbers of people are vulnerable to tsunami events, and take into account how rapid demographic changes and rising sea levels can increase relative levels of exposure;
- The substantial risks related to nuclear installations on high-risk coastlines should also be of great concern when planning for future tsunami disasters;
- Tsunami early warning systems, risk information, education and preparedness are all needed to guide local populations and visitors on how to react after an earthquake, with evacuation routes clearly sign-posted.



**Figure 1:**

**Worldwide coastline at risk of large tsunamis produced by marine earthquakes in active subduction zones.<sup>1</sup>**

<sup>1</sup> Map from "Civil nuclear power at risk of tsunamis" Joaquin Rodriguez-Vidal  
Jose M. Rodriguez-Llanes · Debarati Guha-Sapir (2012) Springer Science+Business Media.

# Tsunami disaster risks worldwide

The scale of a tsunami disaster is a combined result of the intensity of the high-energy wave triggered by the quake, local coastal topography and the density of human settlements in harm's way.

The longest coastlines at risk are in South America, South and South East Asia and parts of Oceania, including the Pacific Islands, Australia and New Zealand (Figure 1). Ocean wave parameters, river mouth deltas and other topographical factors can also cause tsunami impacts beyond these identified risk zones, notably in East Africa.

Two particular hazards stand out in the recent history of tsunamis: the 2004 Indian Ocean event and the 2011 Tohoku tsunami in Japan.

The 2004 disaster claimed approximately 226,000 lives in 12 countries, the vast majority in Indonesia, Sri Lanka, India and Thailand. It was the worst of the five tsunamis to strike Indonesia, and accounted for most of the country's tsunami deaths (Table 1).

Sri Lanka's death toll in the 2004 disaster was disproportionately high relative to its population size. As with many disaster events, the social and economic impacts of such high mortality can be substantial and sustained when the dead and permanently injured represent a large share of the affected area's working population.

Approximately 9,000 foreign tourists were among the dead from the 2004 disaster. This represents around 4% of total mortality for that one event. The toll was particularly heavy in Thailand, where about 3,000 holidaymakers died. The bodies of 900 of them were not recovered.

**Table 1: Tsunami deaths including disaster occurrences, 1996-2015**

| Country          | Income group | Occurrence | Year                        | Total n° deaths |
|------------------|--------------|------------|-----------------------------|-----------------|
| Indonesia        | Lower middle | 5          | 2004, 2006 (x2), 2010, 2011 | 167,044         |
| Sri Lanka        | Lower middle | 1          | 2001                        | 35,399          |
| Japan            | High         | 2          | 2009, 2011                  | 19,847          |
| India            | Lower middle | 1          | 2004                        | 16,389          |
| Thailand         | Upper middle | 1          | 2004                        | 8,345           |
| Papua New Guinea | Lower middle | 1          | 1998                        | 2,182           |
| Chile            | High         | 3          | 2007, 2010, 2015            | 591             |
| Somalia          | Low          | 1          | 2004                        | 298             |
| Peru             | Upper middle | 2          | 1996, 2001                  | 152             |
| Samoa            | Lower middle | 1          | 2009                        | 148             |
| Maldives         | Upper middle | 1          | 2004                        | 102             |
| Vanuatu          | Lower middle | 1          | 1997                        | 100             |
| Malaysia         | Upper middle | 1          | 2004                        | 80              |
| Myanmar          | Lower middle | 1          | 2004                        | 71              |
| Solomon Islands  | Lower middle | 2          | 2007, 2013                  | 62              |
| American Samoa   | Upper middle | 1          | 2009                        | 34              |
| Tanzania         | Low          | 1          | 2004                        | 10              |
| Tonga            | Lower middle | 1          | 2009                        | 9               |
| Seychelles       | High         | 1          | 2004                        | 3               |
| Bangladesh       | Lower middle | 1          | 2004                        | 2               |
| Kenya            | Lower middle | 1          | 2004                        | 1               |
| <b>Total</b>     |              | <b>30</b>  |                             | <b>250,869</b>  |



**Figure 2:**  
**Location of civilian nuclear facilities (active, in expansion & under construction in 2012) located in tsunami risk areas.<sup>2</sup>**

The 2011 Tohoku disaster was the most serious of two tsunamis which struck Japan between 1996 and 2015. An 8.9 magnitude earthquake sent waves up to 10 metres high surging across more than 400 km of Japan's coastline, killing nearly 20,000 people and damaging the nearby Fukushima nuclear power plant. This incident highlighted the alarmingly large number of civilian nuclear facilities built or planned along the known tsunami-risk coastlines in Asia (Figure 2).

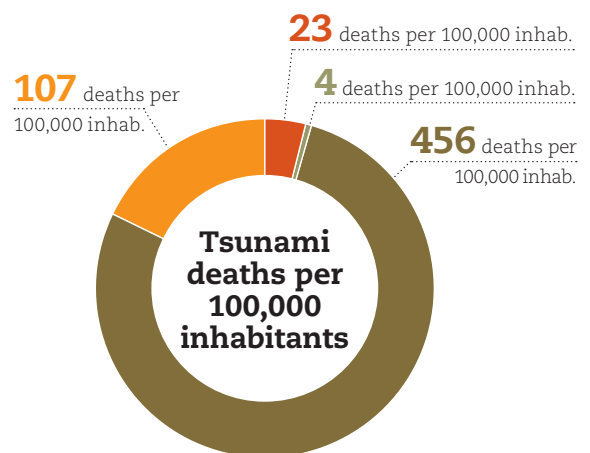
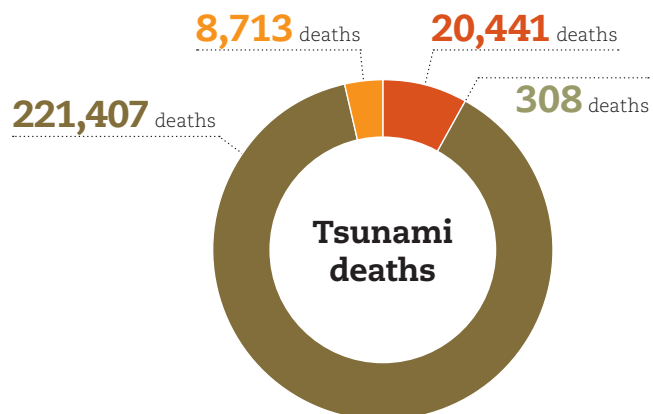
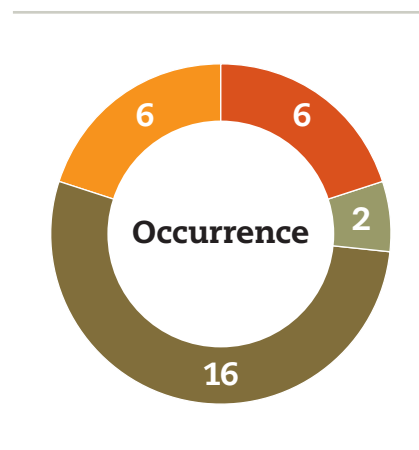
<sup>2</sup> Map from "Civil nuclear power at risk of tsunamis" Joaquin Rodriguez-Vidal · Jose M. Rodriguez-Llanes · Debarati Guha-Sapir (2012) Springer Science+Business Media.

# Tsunami risk & national income

In 1998, lower-middle-income Papua New Guinea lost 2,200 people in a tsunami triggered by a 7.1 magnitude earthquake. By contrast, just 19 people died in high-income Chile after it experienced an 8.3 magnitude earthquake in 2015. The lower death toll in South America reflected mass evacuations for which the country's national emergency office had run repeated practices.

Chile's success in saving lives was one of a number of recent achievements of local, national and international disaster risk reduction efforts. The creation of the Indian Ocean Tsunami Warning and Mitigation System post-2004 was another milestone, as was the UN's Sendai Framework for Disaster Risk Reduction which sets targets for reducing mortality and numbers of people affected by such events. But the 2015 Chilean tsunami also highlighted the disparities in the impacts of such disasters on the rich and the poor.

While just over half of tsunamis hit lower-middle-income countries, these countries accounted for the vast majority of people killed and the highest level of deaths per 100,000 population (Figure 3). This reflects the numbers of people living in harm's way and also the impact of poverty and poor building standards.



**Figure 3**

**Total number of country-level tsunami disasters, related deaths and deaths per 100,000 inhabitants by national income bracket, 1996-2015**

- High Income
- Upper middle income
- Lower middle income
- Low income

# What could the future hold?

In addition to major tsunamis typically caused by submarine earthquakes, people living on exposed shores and river deltas are also vulnerable to lower-impact tsunamis associated with earthquakes. Such events should also be taken into account during tsunami disaster preparedness planning.

By extrapolating from EM-DAT data and UN population projections<sup>3</sup> to the end of the Sustainable Development Goals process in 2030, it is possible to illustrate the potential scale of increased death tolls and numbers affected from this combined threat of major and lower-impact tsunamis (Table 2).

Of the 10 sub-regions struck by such disasters in the last 15 years, eight would see higher numbers of victims if these events were repeated in 2016-2030. The biggest rise in deaths and affected would occur in East Africa (up 44%) in line with UN expectations that this region will experience one of the highest population growth rates in the world.

Melanesia (e.g. Fiji and the Solomon Islands) would also experience a sharp increase in victims (up by 35%) under this scenario. South and South East Asia, together with parts of South America, would suffer the greatest numbers of dead and affected in absolute terms, with only East Asia and Europe seeing small declines due to expected falls in their respective populations.

**Table 2.**

**All tsunami-related losses: deaths & people affected 2001-2015 & regional projections 2016-2030**

| World regions at risk from tsunamis & tsunami-like events |                      | No of disasters 2001-2015 | No of countries affected | Total deaths & numbers affected |                   | Projected % increase deaths & affected |
|---|----------------------|---------------------------|--------------------------|---------------------------------|-------------------|--|
|   |                      |                           |                          | 2001-2015                       | 2016-2030         |  |
| African regions   | East Africa          | 1                         | 4                        | 110,225                         | 159,208           | 44%                                    |
|   | North Africa         | 1                         | 1                        | 212,527                         | 272,417           | 28%                                    |
|   | <b>Total Africa</b>  | <b>2</b>                  | <b>5</b>                 | <b>322,752</b>                  | <b>431,625</b>    | <b>34%</b>                             |
| American regions  | North America        | 1                         | 1                        | 3,529                           | 3,964             | 12%                                    |
|   | South America        | 6                         | 2                        | 4,876,086                       | 5,646,830         | 16%                                    |
|   | <b>Total America</b> | <b>7</b>                  | <b>3</b>                 | <b>4,879,615</b>                | <b>5,650,794</b>  | <b>16%</b>                             |
| Asian regions   | East Asia            | 6                         | 2                        | 470,302                         | 453,294           | -4%                                    |
|   | South East Asia      | 9                         | 5                        | 3,987,191                       | 4,728,619         | 19%                                    |
|   | South Asia           | 2                         | 4                        | 1,753,126                       | 1,999,290         | 14%                                    |
|   | <b>Total Asia</b>    | <b>17</b>                 | <b>11</b>                | <b>6,210,619</b>                | <b>7,181,203</b>  | <b>16%</b>                             |
| European regions  | Eastern Europe       | 1                         | 1                        | 7,514                           | 7,450             | -1%                                    |
|   | <b>Total Europe</b>  | <b>1</b>                  | <b>1</b>                 | <b>7,514</b>                    | <b>7,450</b>      | <b>-1%</b>                             |
| Oceanian regions  | Melanesia            | 4                         | 2                        | 11,375                          | 15,377            | 35%                                    |
|   | Polynesia            | 1                         | 3                        | 8,782                           | 9,422             | 7%                                     |
|   | <b>Total Oceania</b> | <b>5</b>                  | <b>5</b>                 | <b>20,157</b>                   | <b>24,799</b>     | <b>23%</b>                             |
| <b>Global Total</b>                                       |                      | <b>32</b>                 | <b>25</b>                | <b>11,440,657</b>               | <b>13,295,871</b> | <b>16%</b>                             |

N.B.: The projections are based on 15 years of past EM-DAT data projected forward 15 years to 2030. The past data include people killed and affected by earthquakes with associated lower-impact tsunamis in addition to populations affected or killed by major tsunamis. The projected figures represent the dead and affected over the 2016-2030 period and are not year-by-year projections.

<sup>3</sup> Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision, DVD Edition.