

Tsunamis and the urban environment

Implications for national and regional planning

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Tsunamis are described as long water waves with periods greater than five minutes. They are generated impulsively by mechanisms such as exploding islands, submerged landslides, rock falls into bays and tectonic displacements associated with earthquakes. To reduce the risk of tsunamis it is necessary to obtain an understanding of the geological processes that control them and of the distribution of the areas that are susceptible to them. It is then possible to assess the level of hazard so that structures can be located in areas where it is lower.

The coastal topography of Costa Rica is varied, ranging from low-lying coastlines and enclosed playas (beaches), through rocky headlands fringed with coral reefs to coastal cliffs in hard rocks. The low-lying coastlines and playas are most vulnerable to inundation from the run-up of a tsunami and the rocky headlands with coral reefs are most vulnerable to flooding by a tsunami overtopping a high protective structure. Assessing the susceptibility of these areas to the tsunami hazard begins by considering the likelihood of a particular section of coastline being in the proximity of an offshore seismic source. Such maps can readily be drafted by a seismologist. As an example, the Tsunami Hazard Susceptibility Map for Costa Rica offers a first look-see at the risk to the coastline from the tsunami hazard. This is

very useful for National Scale Planning as it quickly characterises the coastline tsunami susceptibility into the three broad categories of low, medium and high. While planning at the national scale, it can readily be seen that coastal areas near to potential seismic sources, shown as light blue areas with an estimate of magnitude, represent a high risk where more detailed planning cannot be



avoided. Such high risk areas are the low-lying playas on the Caribbean coast to the south east of Limon where a magnitude 7.5 earthquake caused a tsunami in 1991.

The tsunami struck the coast between Limon and the Panamanian border. Tsunami arrival times along this section of the coast were generated about the axis of maximum uplift which runs parallel to the coast between three and eight kilometres offshore in seawater of approximately 50 metres depth. The axis of uplift intersects the shoreline just to the north of Limon where it caused the sea to retreat by 75 metres. It also completely destroyed buildings on the shoreline like the Hotel Las Olas featured in the photograph.

Information gained by undertaking the tsunami hazard assessment can be used to organise the land-related factors taking into account the roughness and friction created by buildings, trees and engineered structures to minimise the potential for destruction. So, a 'Tsunami Aware Plan' for the organisation of these elements would be to locate the residential, lifeline and access routes beyond the estimated inundation zone, but to build in some contingency for protection should this estimation be conservative, for instance by planting trees between the urbanised area and the coastline.

The tsunami risk to the coastline of Costa Rica is indicated, along with the location of the axis of the source for the 1991 tsunami. The light blue areas are potential seismic sources with estimates of magnitude.



The exposed coral reef in front of the Hotel Las Olas indicates the pre-earthquake shoreline.