Tsunami hazards of the Maltese Islands

by **Denis Camilleri**

TSUNAMI is composed of two Japanese words, meaning harbour wave, although it is now known that tsunamis do not originate in harbours. Tsunamis threaten coastlines around all the oceans of the world. However, 80 per cent of all tsunamis occur in the Pacific Ocean, in an area known as the Ring of Fire.

Tsunamis in the Pacific are more frequent and devastating *(see table)* than in the Mediterranean. However, due to the vast development that has occurred around the Mediterranean shoreline over the past century, it now requires economic measures to reduce in a reasonable manner the risks from a tsunami event.

Due to the growing economic importance of the Mediterranean shorelines, tsunami catalogues were compiled, covering the whole European coast, financed by the EU called GITEC (acronym for Genesis and Impact of Tsunamis on the European Coasts).

The Mediterranean region is active with earthquakes and volcanoes, some of these generating tsunamis, 20 per cent of which have been damaging. Around 1500 BC, the eruption of the volcano Santorin, on the island of Thera, is said to have caused a tsunami, which led to the sudden decline of the Minoan civilisation around the island of Crete, with many attributing the legend of Atlantis to this event, which as described by Plato, was a highly developed island culture which sank beneath the sea.

In 365 AD, following a 7.7 magnitude earthquake in Crete, a tsunami caused extensive damage in Libya, Egypt, Calabria and as far as Spain. This tsunami is unique in history, in that it is the only event of its kind known to have propagated across the entire Mediterranean.

Physics of tsunami

A tsunami begins when an underwater disturbance suddenly displaces a column of ocean water. Sometimes, landslides trigger tsunamis, or a chunk of land may break off the coast and slide into the ocean. Or a volcano may erupt depositing ash and molten rock onto the sea bed.

In seas over 6,000 m deep, the tsunami waves propagate with a speed exceeding 800 km/h, equivalent to that of a commercial jet plane and a wave height of only a few tens of centimeters. They can move from one side of the Pacific Ocean to the other in less than a day.

Tsunami waves are distinguished from ordinary ocean waves by their great length between wave crests often exceeding 100 km, and with the time between these crests ranging from 10 minutes to an hour. Wind driven waves have a wavelength of 100 to 200 m, while their period between crests varies from five to 20 seconds.

However, as the tsunami approaches land, the wave slows down, the height of the wave increases and their wavelength decreases. An enormous wall of water builds up and then inundates the land in a tide-like flood.

Offshore and coastal features can alter the size and impact of tsunami waves. Deep water close to the shore hampers the build-up of a very high wave. A coral reef can act as a breakwater, diminishing some of a tsunami's energy. However, a V-shaped bay can act as a funnel, concentrating the energy of the tsunami into a smaller area.

The force of some tsunamis is enormous. Large rocks weighing several tons, along with boats and other debris can be moved inland hundreds of metres. Boulders with masses around 200 tons (about 5 m across) can be displaced by tsunami surges only 10 m deep, whereas short period storm waves with heights of 100 to 150 m are required to produce the same movement.

Table – run-ups in metres, with their rate of occurrence in years for various seas.

Run-up-m	Mediterranean	Black Sea	Indian Ocean	North America	Caribbean	South America	Hawaii	New Zealand	South West Pacific
10	250	1,000	1,000	1,000	1,000	200	200	250	200
15	1,000	-	-	-	-	750	-	1,000	-
20	-		-	-	-	1,000	1,000		,000

Mediterranean Tsunami Characteristics.

Return tsunami periods for global regions

These are derived from measurements of run-up, which is the height that the wave extends up to on steep shorelines, measured above the normal height of the sea. The occurrence of various runup heights in the different global regions is outlined in the accompanying table.

Mediterranean tsunami characteristics

The table indicates that the Mediterranean Sea has a higher rate of occurrence than the Boxing Day tsunami that occurred in the Indian Ocean, together with the probability also of a run-up height of 15 m. On the other hand run-up heights of 20 m are possible in the Pacific. Further, in the more exposed parts of the Mediterranean a 1.5 m-high runup has a return period of 100 years, with 500-year return period for a 4 m high run-up. Most Mediterranean tsunami sources lie along mainland and island coastal regions, with tsunamis reaching local coasts soon after they have been generated, giving little time for warning.

For a 2 m runup, slight damage may be caused to light structures, while for a 4 m run-up damage is generally caused to light structures close to the coast and littered with floating debris. For runups greater than 10 m, solid structures are damaged, severe scouring of cultivated land and littering of the coast with floating items and sea animals occurs, together with loss of lives and wave is accompanied with a loud roar.

Historical records show that the Western Mediterranean is less prone to damaging tsunamis than the East. The strongest tsunamis are excited in the Aegean Sea and the Hellenic and Calabrian arcs. The Messina earthquake (M 7.5, 1908) caused waves of 8.5 m on the Sicilian and more than 10 m on the Calabrian Coast, with the maximum height of 11.7 m at S. Alessio. The Messina Straits and the eastern coastline of Sicily, especially around Catania, have an average of 10 tsunamis per 100 years.

The last tsunami recorded in this region was 1954, so a high probability exists for another tsunami disaster relatively soon.

Anticipated Maltese tsunami hazards.

G.P. Agius de Soldanis in his *Gozo Antico e Moderno,* recounts how the sea at Xlendi rolled out to about one mile and swept back a little later "con grande impeto e mormorio", in the earthquake (M 7) of 1693, when the Mdina Cathedral, among other buildings, collapsed. This description tallies with that of a destructive tsunami.

The repeat of a similar tsunami for a run-up approximating 10 m, with a return period taken at 1,000 years, would be disastrous for Malta's economy, considering tourism to contribute nearly a third of Malta's GDP. As tourist facilities and part of the Island's infrastructure are placed in low-lying coastal areas, evaluations of the most important risks should be undertaken. "Low-lying areas" might be defined as those less than three-five metres above sea-level, or seven-ten metres in the most hazardous regions.

Extensive building damage to the low-lying tourist and residential developments are to be expected. For infrastructural works, such as the two power stations and port works, even if turbines and compressors remain on their foundations, corrosion will produce a very large loss, with salvaging being very costly, due to the certainty of heavy rusting. Seacraft in bays or ports are at a higher risk than those out at sea.

As it is easy to go onto high land, being about 15 m above sea-level on foot, within 20 to 30 minutes, it is important that Malta form part of the European Tsunami Warning System (GITEC), for casualties to be kept to a minimum in such an event.

An alert 10-year-old girl was instrumental in saving lives via direct hotel management communication in the Indian Ocean tsunami. Now that global tsunami risk awareness is real, communication should be easier in the event of a similar tsunami disaster, although humans are well known for their short memories.

This article is based on findings of a report commissioned by the Malta Insurance Association.

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